Remedial Investigation

Tiger Oil
1808 North 1st Street
Yakima, Washington

for
Washington State Department of Ecology

May 22, 2017

GeoEngineers
Earth Science + Technology

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File No. 0504-101-03

May 22, 2017

Prepared for:

Washington State Department of Ecology
Toxics Cleanup Program - Central Region Office
1250 West Alder Street
Union Gap, Washington 98903

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ABBREVIATIONS AND ACRONYMS

BETX	benzene, ethylbenzene, toluene and xylenes
bgs	below ground surface
COC	contaminants of concern
cPAHs	carcinogenic polycyclic aromatic hydrocarbons
CSM	Conceptual Site Model
CUL	Cleanup Level
DRPH	diesel-range petroleum hydrocarbons
Ecology	Washington State Department of Ecology
EPA	Environmental Protection Agency
FS	Feasibility Study
GeoEngineers	GeoEngineers, Inc.
GRPH	gasoline-range petroleum hydrocarbons
HCID	hydrocarbon identification
LCS	laboratory control sample
MTCA	Model Toxics Control Act
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MS	matrix spike
MSD	matrix spike duplicate
ORP	oxidation-reduction potential
ORPH	oil-range petroleum hydrocarbons
PAHs	polycyclic aromatic hydrocarbons
PVC	polyvinyl chloride
RPD	relative percent difference

ABBREVIATIONS AND ACRONYMS (CONTINUED)

SAP	Sampling and Analysis Plan
TEE	Terrestrial Ecological Evaluation
TPH	total petroleum hydrocarbons
RI	Remedial Investigation
USGS	United States Geological Survey
UST	underground storage tank
VCP	Voluntary Cleanup Program
VI	vapor intrusion
VOCs	volatile organic compounds
WAC	Washington Administrative Code

EXECUTIVE SUMMARY

GeoEngineers, Inc. has conducted a Remedial Investigation (RI) of the Tiger Oil, North 1st Street site located at 1808 North 1st Street, Yakima, Washington (site or subject property). This RI summarizes previous and recent site characterization activities conducted to assess subsurface contamination at the site. This RI has been prepared in accordance with the Model Toxics Control Act (MTCA) and complies with the recent Washington State Department of Ecology (Ecology) guidance documents for preparing an RI.

The 0.65-acre site is bordered by arterial roadway North 1st Street to the east and the Sun Country Inn to the south and west of the site. A paved entrance to the All Star Motel and Ron Nehls Auto Sales is located to the north. The site operated as a retail gasoline station and convenience store until closure in 2001. The site contains two buildings and three historical fuel dispenser islands formerly under a central canopy. Buildings at the site include the larger former convenience store in the southwest corner of the site and a smaller kiosk near the center of the site. The site is generally paved, except where four former underground storage tanks (USTs) were removed in 2005.

Two recent phases of soil assessment have been performed (in 2014 and 2016); also, five quarters of groundwater monitoring have occurred at wells N1MW-1 through N1MW-5, and one quarter in wells N1MW-6 through N1MW-8. The results of soil sampling indicate the presence of petroleum contamination in soil, generally limited to the zone of groundwater fluctuation, in the northern portion of the subject property. Petroleum contamination in soil appears limited to the vicinity of the former USTs and former dispenser islands, and extends to the north partially beneath the Ron Nehls Auto Sales facility, and to the east partially beneath North 1st Street. The downgradient (east) extent of petroleum contamination has not been defined and likely terminates beneath North 1st Street. Data from borings located on the east side of North 1st Street indicate soil contamination does not extend across the street. The contamination is primarily in the gasoline-range although low concentrations of diesel-range hydrocarbons (below MTCA Method A cleanup levels) have been detected.

Groundwater impacts from the gasoline release are limited to the immediate vicinity of the former UST nest and downgradient (east) of the dispenser islands. The groundwater plume likely extends beneath North 1st Street based on the presence of gasoline-range petroleum hydrocarbons above MTCA Method A cleanup level in N1MW-6 and N1MW-7 located on the eastern property edge. However, similar to the soil plume, the plume likely terminates beneath the street since groundwater samples collected on the east side of the street do not exceed MTCA Method A.

The groundwater gradient is relatively flat with an average of 0.0025 feet/foot. Natural attenuation parameters including dissolved oxygen concentrations, oxidation-reduction potential (ORP), temperature and nitrate concentrations suggest that biodegradation may be occurring near N1MW-5 through N1MW-8 under aerobic conditions with limited denitrification and anaerobic respiration occurring at times. Based on the results of groundwater monitoring performed for five quarters, the groundwater plume appears stable.

The Preliminary Vapor Intrusion (VI) Assessment conducted for the site indicates immediate action is not necessary, because the site is vacant. However, the need for further VI assessment should be revisited when future site use is determined based on the presence of xylene concentrations in groundwater in the immediate plume vicinity. Further assessment may include the collection of soil gas data or the evaluation of building construction methods that mitigate potential vapor impacts.

The Site does not present a substantial potential for posing a threat of significant adverse effects to terrestrial ecological receptors. Soil contamination leaching to groundwater and potential vapor intrusion into buildings (depending on future site use) are the only applicable potential human health exposure pathways for soil and groundwater contamination at the site.

Continued groundwater monitoring of site monitoring wells for three more quarters will allow for assessment of seasonal variations in groundwater contaminant concentrations and plume stability. Although biodegradation of the gasoline groundwater plume appears to be occurring, site closure will likely require remediation to meet MTCA cleanup levels.

The summary is provided for general informational purposes and should not be solely relied upon. Please refer to the entire report to obtain a more comprehensive understanding of the RI/FS activities.

1.0 INTRODUCTION

This document presents a comprehensive Remedial Investigation (RI) including results of a data gap assessment conducted in 2016 for the Tiger Oil North 1st Street site located at 1808 North 1st in Yakima, Washington (Vicinity Map, Figure 1). Site assessment activities conducted since 2014 have identified the presence of hazardous substances including petroleum hydrocarbons, naphthalene and volatile organic compounds (VOCs) in soil and groundwater at the site.

This RI was conducted to satisfy the requirements of the Model Toxics Control Act (MTCA). The RI provides details and results of the 2016 data gap assessment, summarizes site assessment data collected from April 2014 through March 2015 and historical site data, and presents a conceptual site model. Results of previous assessment activities have been submitted to the Washington State Department of Ecology (Ecology). The outline of this RI report follows Ecology RI checklist and RI template, which became effective June 1, 2016 for sites in the Voluntary Cleanup Program (VCP).

1.1. General Site Information

GENERAL SITE INFORMATION

Site Information	Description
Site Name	Tiger Oil North 1st Street, Fmr 6013
Site Address	1808 North 1st Street, Yakima, Washington 98902
Ecology Regional Office	Central Region, 1250 W Alder Street Union Gap, Washington 98903
Ecology Site Manager	Jeff Newschwander, 509.454.7842, jene461@ecy.wa.gov
Consultant	GeoEngineers, Spokane Washington
Potentially Liable Person	City of Yakima, 129 N 2nd St, Yakima, WA 98901, 509.575.3764
Current Owner	City of Yakima, 129 N 2nd St, Yakima, WA 98901, 509.575.3764
Ecology Facility/Site ID	477
Cleanup Site ID	4922
Assessor's Parcel No.	18131244412

The 0.65-acre site is located at 1808 North 1st Street in Yakima, Washington, as shown in Site Plan and Soil Analytical Results, Figure 2. The site is bordered by arterial roadway North 1st Street to the east and the Sun Country Inn to the south and west of the site. A paved entrance to the All Star Motel and Ron Nehls Auto Sales is located to the north.

The site operated as a retail gasoline station and convenience store until closure in 2001. The site contains two buildings and three historical fuel dispenser islands formerly under a central canopy. Buildings at the site include the larger former convenience store in the southwest corner of the site and a smaller kiosk near the center of the site. The site is generally paved, except where four former underground storage tanks (USTs) were removed (Figure 2) in 2005.

1.2. Site History

The Tiger Oil North 1st Station was constructed in May and June 1979 (Soil Exploration Company 1985) and operated as a retail gasoline station and convenience store until closure in 2001. Gasoline and diesel products were stored on site in USTs for distribution.

In 1982, a hydrostatic test of the dispenser lines indicated leakage. All lines were subsequently replaced; however, it was determined that a release of approximately 12,000 to 22,000 gallons of leaded and unleaded gasoline had occurred from the delivery lines between the tanks and dispensers (Wagner et al. 1991). The release reportedly contaminated drinking water wells to the east and residential units in the area were eventually connected to a public water supply source.

Assessment and remediation activities for the 1982 release included installation of 34 groundwater monitoring wells and two recovery wells. Removal efforts indicate that approximately 40 gallons of free (gasoline) product were recovered between 1982 and 1983. Recovery efforts were ceased in 1983 because of the cost of spill response efforts and low product recovery volume. Groundwater monitoring conducted in 1984, 1985 and 1989 indicated concentrations of gasoline-range petroleum hydrocarbons (GRPH), benzene, toluene and xylenes were greater than MTCA Method A cleanup levels (CULs) in groundwater samples collected from wells directly east of the site (Wagner et al. 1991). A 1991 United States Geological Survey report on the changes in the concentration and areal extent of groundwater contamination (Wagner et al. 1991) at the site indicated that concentrations of petroleum contaminants had been reduced from when monitoring had begun in 1984.

In 2005, four USTs were decommissioned at the site and the subsurface fuel lines were drained and capped with quick setting cement. The tanks removed from the site included:

- 20,000-gallon steel unleaded gasoline tank
- 10,000-gallon steel unleaded gasoline tank
- 8,000-gallon steel unleaded gasoline tank
- 6,000-gallon diesel tank

Upon removal, the tanks were examined by Tetra Tech FW, Inc., Tri-Valley Construction and Ecology. The tanks had minor surface rust and were reported to be in good condition with no visual evidence of leaks or holes. However, some visual evidence of staining near the fill pipe and turbine unit, and in the surrounding soil was observed near the 20,000-gallon UST (Tetra Tech 2005). Evidence of fill piping or turbine unit spillage was not observed on the other three tanks.

Soil samples collected from the tank removal excavation in 2005 indicated the presence of GRPH at depths of 8 and 13 feet in 2 of the 10 samples collected (McCreedy 2005). The soil samples did not contain detectable concentrations of benzene. The UST excavation was backfilled with 220 cubic yards of clean imported backfill (McCreedy 2005). Fuel dispensers and product delivery lines were not assessed as part of the 2005 work and the location of the underground product delivery lines is unknown.

In 2014, GeoEngineers advanced eight direct push borings (N1DP-1 through N1DP-8) and installed five groundwater monitoring wells (N1MW-1 through N1MW-5) at the site (GeoEngineers 2015a). Results of the 2014 assessment indicated GRPH, diesel-range petroleum hydrocarbons (DRPH), and benzene, ethylbenzene, toluene and xylenes (BETX) compounds exceeded MTCA Method A CULs in soil samples collected near the former tank pit and fuel dispenser islands. GRPH exceeding MTCA Method A criteria was also found near the former convenience store and vent pipes.

Groundwater monitoring was conducted in September 2014, December 2014, March 2015 and August 2016 (GeoEngineers 2015a, 2015b, 2015c, 2016b) in five groundwater monitoring wells at the site. Groundwater monitoring indicated groundwater flows generally to the east. GRPH and BETX compounds in groundwater samples from wells N1MW-1 through N1MW-5 were less than MTCA Method A CULs during the 2014, 2015 and 2016 sampling events.

1.3. Site Use

The anticipated future use of the 1808 North 1st Street site is as commercial/retail. We understand there are currently no plans to develop the site.

2.0 FIELD INVESTIGATIONS

Field investigations at the site began in the early 1980's and continue to present day. Field investigations were initiated in 1982 or 1983 after hydrostatic testing of dispenser lines indicated leakage at the retail gas station. Field investigation included soil borings and groundwater monitoring well installations; however, limited documentation for field investigations was available. Field investigations in response to leakage generally continued through the 1980's and the most recent report documenting older investigations was produced in draft format in 1991 by the United States Geological Survey (USGS) and Ecology.

During removal of four USTs in 2005, additional soil sampling was conducted. The site generally was dormant without additional investigations until 2014, when site assessment activities were conducted under direction from Ecology. The 2014 site assessment, which included groundwater monitoring, was followed by two groundwater monitoring events through the first quarter in 2015. Previous investigations are described in Section 2.1.

In 2016, GeoEngineers conducted a data gap site assessment and resumed groundwater monitoring in the third quarter of 2016. Data gap site assessment results (which included soil sampling and installation of groundwater monitoring wells) are presented in this RI report. Groundwater monitoring conducted in the third and fourth quarters of 2016 are provided in separate reports.

2.1. Previous Environmental Investigations

Previous environmental investigations completed for the 1808 North 1st Street site and summarized in Section 1.2 include the following:

- "Hydrogeologic Evaluation, Gasoline Spill Investigation, Tiger Oil, Yakima, Washington," May 9, 1985 (Appendix A).
- "Gasoline Loss Investigation, Quarterly Monitoring, Tiger Oil #3, North First Street, Yakima, Washington," August 15, 1986 (Appendix B).

- "Changes Between 1984 and 1989 in the Concentration and Aerial Extent of Ground-Water Contamination from a Gasoline and Diesel Fuel Leak at a Site in Yakima, Washington, Preliminary Report," April 10, 1991 (Appendix C).
- "UST Decommissioning and Site Assessment at Tiger Oil Corporation Facility, 1808 First Avenue, Yakima, Washington," March 17, 2005 (Appendix D).
- Letter to Alex Smith, Assistant Attorney General, Ecology, and Thomas L Mackie, Hydrogeologist, Site Manager Toxics Cleanup Program Re: Tiger Oil Corporation (Tiger) – 1808 North First Street (North First) and 1606 East Nob Hill Blvd. (East Nob), Yakima, Washington. August 9, 2005. (Appendix E).
- "Phase II Site Assessment Report, Tiger Oil North 1st Street, 1808 North 1st Street, Yakima, Washington," February 11, 2015.
- "Quarterly Groundwater Monitoring, Fourth Quarter 2014, Tiger Oil North 1st, Yakima, Washington," March 26, 2015.
- "Quarterly Groundwater Monitoring, First Quarter 2015, Tiger Oil North 1st, Yakima, Washington," May 18, 2015.
- "Quarterly Groundwater Monitoring, Third Quarter 2016, Tiger Oil North 1st, Yakima, Washington," December 13, 2016.
- "Quarterly Groundwater Monitoring, Fourth Quarter 2016, Tiger Oil North 1st, Yakima, Washington," December 15, 2016.

The five recent reports prepared in 2015 and 2016 are on file at Ecology's Central Region Office and are not appended to this report. However, soil and groundwater data collected during these assessments and monitoring events are included in Tables 1 through 8 provided in this report.

2.2. Remedial Investigation Site Characterization

The 2016 data gap site assessment activities included 11 soil probe explorations to define the extent of petroleum impacted soil and the installation of three groundwater monitoring wells N1MW-6 through N1MW-8. Groundwater samples were collected from the soil probes. Data gap activities generally consisted of the following:

- Drilling 11 direct-push borings (N1DP-9 through N1DP-19) in August 2016 to observe subsurface conditions and collect soil samples in and near the area of contamination to better delineate the extent of soil contamination. Borings were drilled to depths of 19 and 20 feet below ground surface (bgs).
- Analyzing selected direct-push soil samples for GRPH, DRPH, BETX, polycyclic aromatic hydrocarbons (PAHs) and total lead.
- Collecting groundwater samples from 11 temporary wells installed in direct push borings N1DP-9 through N1DP-19 where groundwater was encountered.
- Analyzing the groundwater samples for GRPH, DRPH and oil-range petroleum hydrocarbons (ORPH) using the hydrocarbon identification (HCID) method.
- Installing three groundwater monitoring wells (N1MW-6 through N1MW-8) and collecting soil samples in October 2016.
- Developing the new groundwater monitoring wells using surge and purge techniques.

- Surveying the new groundwater monitoring wells for horizontal and vertical references.
- Completing quarterly groundwater monitoring in the five existing wells (N1MW-1 through N1MW-5) in August 2016 and in all eight wells (N1MW-1 through N1MW-8) in November 2016. The groundwater monitoring included measurements of groundwater levels, evaluation of groundwater flow directions and collection of groundwater samples for chemical analysis. Analyses included GRPH, DRPH, VOCs, lead and conventional analyses (nitrate, sulfate and total organic carbon). Additionally, field parameters, including pH, temperature, conductivity, dissolved oxygen, and turbidity were measured to evaluate geochemical conditions in the Site aquifer.

2.2.1. Sampling and Monitoring

The sampling and analysis plan (SAP) for the RI was developed based on data obtained during the site assessment and previous groundwater monitoring results.

2.2.1.1. Soil sampling

Eleven soil borings (N1DP-9 through N1DP-19) were completed using truck-mounted direct-push drilling equipment in August 2016 and three soil borings N1MW-6 through N1MW-8) were completed using hollow stem auger drilling equipment in October 2016. Borings were advanced to depths of 19 to 21 feet bgs. Soil samples obtained from the borings were field screened for evidence of contamination using visual observations, water sheen tests, and measuring volatile organic vapors. Fifteen soil samples obtained from the borings were submitted to TestAmerica Laboratories, Inc. (TestAmerica) for chemical analysis in general accordance with the SAP. Soil borings and monitoring well locations are shown on Figures 2 and 3. Soil sampling analytical results are presented in Tables 1 and 2. The boring logs and soil sampling procedures are presented in Appendix F.

2.2.1.2. Groundwater Sampling

Groundwater samples were collected from temporary wells placed in direct-push borings N1DP-9 through N1DP-19 and submitted to TestAmerica for analysis. Groundwater was sampled by installing a temporary well screen which ranged in length from 3 to 10 feet at the bottom of the boring and lowering polyethylene tubing into the temporary well. Depth to groundwater was measured and then the well was purged using a peristaltic pump for approximately 3 to 6 minutes. Water was routed through a water quality meter and flow through cell during well purging, then the flow-through cell was disconnected, and a sample of the water was collected for chemical analysis when there was a visual reduction in water turbidity or the water quality meter indicated reductions in turbidity. Grab groundwater sample analytical results are presented in Table 3.

Hollow stem auger borings N1MW-6 through N1MW-8 were completed as 2-inch-diameter, schedule 40 polyvinyl chloride (PVC) monitoring wells and screened from 9 to 19 or 10 to 20 feet bgs. Wells were advanced to depths of 19 or 21 feet bgs and packed with silica-sand up to 2 feet above the screen, sealed with bentonite chips to 1 foot bgs and then capped with a cement well monument. Wells were developed by Cascade Drilling Co. and then surveyed by a licensed professional surveyor, PLS, Inc. (PLS), on October 25, 2016. GeoEngineers conducted subsequent groundwater sampling of the existing and new groundwater monitoring wells on November 17, 2016.

Depth to groundwater, as measured from the top of the PVC well casing, ranged from approximately 10.26 feet (N1MW-4) to 13.24 feet (N1MW-7) in November 2016. Groundwater elevations recorded during the various monitoring events are provided in Table 1. Based on groundwater elevations measured on

November 17, 2016, groundwater flow in the shallow unconfined aquifer beneath the property generally was toward the east, as shown in Site Plan and Groundwater Data, November 17, 2016, Figure 3.

Groundwater monitoring wells were purged and sampled using dedicated tubing, a peristaltic pump and standard low-flow sampling methodology (Environmental Protection Agency [EPA] 1996). Groundwater quality parameters were usually measured at 3-minute intervals during well purging and samples were generally collected when water quality parameter stabilized in conformance with the criteria presented in Appendix H or 30 minutes of purging had elapsed. Groundwater field parameters recorded at the conclusion of well purging are provided in Table 5.

Groundwater samples were obtained from monitoring wells N1MW-1 through N1MW-5 in August 2016 and N1MW-1 through N1MW-8 in November 2016. Groundwater sample results are presented in Table 6 and are summarized in Section 2.3.3.

2.2.1.3. Investigation Derived Waste

Investigation-derived waste consisting of soil cuttings and well development and purge water was contained in 55-gallon drums, labeled and stored on the subject property pending profiling and disposal. Drums are scheduled to be removed by June 2017.

2.2.2. Regional Geology

The site is located on the alluvial floodplain of the Yakima River in the Ahtanum-Moxee subbasin (Wagner et al. 1991). The alluvial valley is oriented east-west between the basalt ridges of Cowiche Mountain and Yakima Ridge to the north, and Ahtanum Ridge and Rattlesnake Hills to the south. Columbia River Basalts underlie the valley at depths ranging from 300 to 1,000 feet below the surface.

The approximately 40-mile-long, 7-mile-wide valley is relatively flat with elevations in the valley floor ranging between 1,000 and 1,500 feet. The south flowing Yakima River is fed by perennial streams throughout the valley.

2.2.3. Site Geology

In general, surficial material consists of asphalt concrete pavement with localized areas of gravel base layers. Subsurface conditions observed below surficial materials generally consisted of brown silt and fine sand to depths of about 5 to 8 feet. Rounded gravel with varying amounts of silt and sand was observed below the silts and fine sands to depths of about 15 to 20 feet, which was the extent of the borings.

2.2.4. Site Hydrogeology

Based on groundwater level measurements obtained during the RI and previous groundwater monitoring events, measured depth to groundwater at the site ranges from approximately 10 to 15 feet bgs. Depth to groundwater and groundwater elevations are presented in Table 4. Groundwater flow in the shallow unconfined aquifer beneath the property generally is toward the east, as shown in Figure 3. The estimated hydraulic groundwater gradient of the shallow aquifer was about 0.0023 feet per foot (about 12 feet per mile). Groundwater elevation contours were interpreted from depth to water measurements, surveyed elevations of well casings and Surfer Version 1.2.

2.3. Sampling/Analytical Results – August and October 2016 Assessment

The following sections summarize the analytical results from the soil and groundwater samples collected in August 2016 and soil analytical results from groundwater monitoring well installation in October 2016.

2.3.1. Quality Analyses

Data validation was completed on each set of soil and groundwater monitoring data. The laboratory followed the specified analytical methods based on the data validation. Accuracy was acceptable, as demonstrated by the surrogate, laboratory control sample (LCS), and matrix spike/matrix spike duplicate (MS/MSD) percent recovery values. Precision was acceptable, as demonstrated by the MS/MSD and laboratory/field duplicate relative percent deviation (RPD) values. A summary of data validation along with the laboratory analytical reports are presented in Appendix G.

2.3.2. Soil

Soil samples were collected at subsurface depths ranging from 12 feet to 15½ feet. Selected samples were analyzed for GRPH, DRPH, VOCs, PAHs, carcinogenic PAHs (cPAHs), and lead. Results are compared to MTCA Method A cleanup levels for unrestricted land use and are shown in Tables 1 and 2. Soil sampling locations and the inferred limits of soil exceeding MTCA CULs are shown on Figure 2 and cross-sections showing the inferred subsurface limits of soil contamination area shown on Cross Sections A-A' and B-B', Figures 4 and 5, respectively. Results of the RI soil sampling were generally consistent with results of the 2014 assessment.

GRPH exceeded the MTCA CUL of 30 milligrams per kilogram (mg/kg) in direct-push samples N1DP-10 through N1DP13 at depths of 14½ to 15 feet bgs and in monitoring well boring samples N1MW-6 through N1DP-8 at depths of 12 to 15½ feet bgs. GRPH were detected in the sample from N1DP-14 at a depth of 14½ to 15 feet bgs at a concentration just below the MTCA CUL (23 mg/kg). GRPH were not detected in the remaining analyzed samples.

DRPH were detected in direct-push samples N1DP-9 (ORPH also detected), N1DP-11, N1DP-12, N1DP-13, N1DP-14 at depths of 14½ to 15 feet bgs, and in monitoring well boring samples N1MW-6 and N1MW-8 at depths ranging between 12 and 15½ feet bgs. According to the laboratory, the detected DRPH in sample N1DP-9(14.5-15) may be influenced by the concentration of ORPH in the sample. Also, according to the laboratory, the detected DRPH in samples NIDP-11(14.5-15), NIDP-12(14.5-15), and NIDP-13(14.5-15) may be influenced by the relative concentration of GRPH in the samples. All detected concentrations were less than the diesel MTCA CUL of 2,000 mg/kg.

ORPH were detected in direct-push sample N1DP-9 at a depth of 14½ to 15 feet bgs at a concentration less than the MTCA CUL of 2,000 mg/kg. ORPH were not detected at concentrations greater than laboratory reporting limits in any other soil samples analyzed during the RI.

Benzene was detected in one soil sample from monitoring well boring N1MW-8 at a concentration less than the MTCA CUL of 0.03 mg/kg. Benzene was not detected at concentrations greater than laboratory reporting limits in any other soil samples obtained during the RI.

Ethylbenzene was detected in direct-push soil samples N1DP-13 (14½ to 15 feet bgs) and monitoring well samples N1MW-7 and N1MW-8 (15 to 15½ feet bgs) at concentrations exceeding the MTCA CUL of

6 mg/kg. Ethylbenzene was either not detected or detected at concentrations below the MTCA CUL in the remaining soil samples analyzed.

Toluene was either not detected or was detected at concentrations less than the MTCA CUL of 7 mg/kg in all soil samples from the 2016 RI.

Total xylenes were detected in direct-push sample N1DP-13 (14½ to 15 feet bgs) and monitoring well samples N1MW-6 through N1MW-8 at concentrations exceeding the MTCA CUL of 9 mg/kg. Ethylbenzene was either not detected or detected at concentrations less than the MTCA CUL in the remaining soil samples analyzed.

Lead was detected in direct-push sample N1DP-13 (14½ to 15 feet bgs) at a concentration below the MTCA CUL of 250 mg/kg. Lead was not detected at concentrations greater than the laboratory reporting limit in the remaining analyzed samples.

Carcinogenic PAHs were not detected in the soil samples submitted for analysis during the RI. Naphthalenes were detected in direct-push soil samples N1DP-12 and N1DP-13 (14½ to 15 feet bgs), and in monitoring well sample N1MW-8 (15 to 15½ feet bgs) at concentrations exceeding the MTCA CUL of 5 mg/kg. Other PAH analytes either were not detected or were detected at concentrations less than MTCA CULs in the remaining RI soil samples.

2.3.3. Groundwater

Groundwater was encountered and sampled from temporary wells placed in N1DP-9 through N1DP-19 on August 3 and 4, 2016. Groundwater samples were analyzed for GRPH, DRPH and ORPH using the qualitative NWTPH-HCID method. The NWTPH-HCID analytical results indicated that GRPH, DRPH or ORPH might be present at the following locations:

- N1DP-10, N1DP-13, N1DP-14 (GRPH, DRPH)
- N1DP-11 (GRPH)
- N1DP-12 (GRPH, DRPH, ORPH)
- N1DP-16 (ORPH)
- According to the laboratory, detected DRPH in samples NIDP-10, NIDP-12, NIDP-13, and NIDP-14 may be influenced by the relative concentration of GRPH in the samples.

The types of petroleum hydrocarbons detected for each sample location are provided in parenthesis above. Analytical methods using NWTPH-HCID analysis are generally considered qualitative and therefore the results should not be used to consider cleanup actions. The NWTPH-HCID analyses were used as screening tools to guide monitoring well placement as a result of the direct-push borings.

Groundwater samples were collected from N1MW-1 through N1MW-5 on August 22, 2016 and N1MW-1 through N1MW-8 on November 17, 2016 for analysis by TestAmerica. The results of sampling are presented in GeoEngineers' quarterly monitoring reports (GeoEngineers 2016a, 2016b). Chemical analytical results are summarized and compared to MTCA Method A CULs in Table 6. A summary is presented below:

- Contaminants of concern (COCs) have been detected in monitoring wells N1MW-1, N1MW-2 and N1MW-5 during previous events; however, the detected concentrations have been less than MTCA CULs and COCs were not detected in these wells in August and November 2016.
- COCs have not been detected in wells N1MW-3 and N1MW-4 at concentrations greater than laboratory reporting limits since sampling began in September 2014 (five sampling events).
- COCs were detected in wells N1MW-6, N1MW-7 and N1MW-8 at concentrations greater than MTCA CULs in November 2016.
- Natural attenuation parameters indicate that biodegradation might be occurring near N1MW-2 and near N1MW-5 through N1MW-8 and conditions near these locations are most likely aerobic with limited denitrification and anaerobic respiration occurring at times.

2.4. Preliminary VI Assessment

GeoEngineers conducted a vapor intrusion (VI) evaluation following the Preliminary VI Assessment approach presented in Ecology's draft VI guidance (Ecology 2016a) and Implementation Memorandum No. 14 (Ecology 2016b). The purpose of the VI evaluation was to evaluate whether subsurface petroleum contamination at the site may pose a risk to people at the former convenience store on site or the northern adjacent Ron Nehls auto sales building via inhalation of indoor air. The former convenience store is not occupied; therefore, the VI evaluation is presented for informational purposes to assess the probability that indoor air may be impacted if a building is constructed on the Tiger Oil property in the future.

As noted in Section 2.3, the subsurface contamination is primarily gasoline-range petroleum hydrocarbons. The purpose of Preliminary VI Assessment is to "determine whether any potential exists for toxic vapors to be present in the subsurface that could migrate and enter nearby buildings" (Ecology 2016a and 2016b). This initial evaluation is presented below.

- **Are chemicals of sufficient volatility and toxicity known or reasonably suspected to be present in the subsurface at or in the vicinity of the Subject Property? Yes.** As noted above, petroleum contaminants remain in soil and groundwater beneath the northern half of the site near the former tank pit and fuel dispenser islands. The inferred limits of soil impacts exceeding MTCA CULs are shown on Figure 2.
- **Are occupied buildings present (no) or could they be constructed in the future (yes) above or near site contamination? (Note that Ecology considers "near" to mean within 30 feet from the edge of subsurface petroleum contamination)? Yes.** As shown on Figure 2, the inferred limits of petroleum soil contamination are within 30 feet vertically of the former convenience store building. Future uses of the site are unknown and vapor intrusion impacts will need to be taken into consideration with future site developments.
- **Are there sufficient data about the location(s) and dimensions of the subsurface contamination? Yes**
- **Do the volatile, toxic substances present at the site in groundwater indicate a potentially unacceptable vapor intrusion source? Yes.** Concentrations of xylenes in groundwater samples from N1MW-6 through N1MW-8 exceed the Method B Noncancer groundwater screening levels established in Ecology's Draft Guidance (Table B-1, updated April 2015). Screening results are presented in Table 8.

Based on this Preliminary VI Assessment, immediate action is not necessary; however, the need for further VI Assessment should be re-visited when the future site use is determined. Further assessment may include the collection of soil gas data, and building construction methods that mitigate potential impacts.

3.0 CONCEPTUAL SITE MODEL

The Conceptual Site Model (CSM) is a model of the potential contaminant sources, release mechanisms, and transport mechanisms currently present at the site. The CSM also identifies potential receptors and associated exposure pathways for site contaminants. The CSM does not quantify potential risks to human health or the environment posed by site-related contamination. It is intended to focus remedial actions (site investigations, monitoring, cleanup actions, etc.) on those areas of the Site that may warrant further consideration. A schematic of the Conceptual Site Model is presented as Figure 6.

Petroleum hydrocarbon (gasoline and diesel), VOC and naphthalene contamination present at the site likely resulted from the distribution of fuels and the release of leaded and unleaded gasoline at the site in 1982. The current condition of site media of concern is described below.

The media of concern for the site are soil and groundwater due to the presence of contaminants at concentrations in soil and groundwater exceeding the MTCA CULs. Most contamination in soil and groundwater is GRPH which is readily mobile in soil. Investigations have identified most impacts at the soil-groundwater interface. The depth of soil contamination is generally from 12 to 15 feet bgs. Soil sampling indicates that petroleum impacts may extend to depths up to 19 feet bgs.

Depth to groundwater at the site is approximately 10 to 15 feet bgs and generally occurs in the shallow unconfined aquifer beneath the property. The inferred groundwater flow direction is toward the east. The groundwater hydraulic gradient is relatively flat.

Grab groundwater samples obtained from direct-push borings N1DP-1, N1DP-2, N1DP-3, N1DP-4, N1DP-5 and N1DP-8 in April 2014 and N1DP-10, N1DP-12, N1DP-14 and N1DP-16 in August 2016 identified petroleum hydrocarbons at concentrations slightly exceeding their respective MTCA CULs; however, these samples were collected from the open borehole and might have been affected by suspended solids or soil mobilized from a higher depth interval.

Groundwater samples collected to date from the eight monitoring wells during the RI show that concentrations of one or more COCs in wells N1MW-6, N1MW-7 and N1MW-8 located in the immediate vicinity of the former USTs and fuel dispensers exceed their respective groundwater CULs.

Analytical and field screening results generally indicate that petroleum contamination has not migrated to the north or south of the property. The highest concentrations were generally identified near and downgradient of the former tank pit. Soil contamination depths appear to begin at approximately 12 to 15 feet bgs. Field screening indicated that contamination may extend to 6 to 8 feet below the water surface of the unconfined aquifer.

The 2014 and 2016 soil explorations also indicated that contamination may have migrated beneath and across North 1st Street; however, chemical analysis of soil from N1MW-2, N1DP-17, N1DP-18 and N1DP-19, and field screening of soil from N1DP-6 and N1DP-7 advanced on the property east of North 1st Street indicated that contaminants of concern in soil are less than MTCA Method A CULs on the east side of North 1st Street (Figure 2). The downgradient extent of soil contamination is not defined, but likely is located beneath North 1st Street.

Based on the geology, hydrogeology and the distribution of remaining contaminants at the site, the potential exposure pathways to contamination at the site include:

- Leaching/migration of contamination from soil to groundwater.
- Vapor intrusion of xylenes into potential future site buildings.

Because groundwater at the Site is isolated from human contact and groundwater contamination at the site is generally delineated and is not used for human consumption, human ingestion of hazardous substances in groundwater, is not a potential exposure pathway. Note the downgradient extent of groundwater contamination is not precisely defined but likely is located beneath North 1st Street.

At present the site is vacant although the Former Convenience Store remains on site. Future land use is assumed to be commercial based on local zoning and surrounding site uses.

Potential receptors and exposure pathways include:

- Commercial workers (vapor intrusion).

Soil biota, plants and animals are unlikely to be impacted based on the depth of the contaminant plume.

3.1. Contaminant Fate and Transport

Data indicate that there has been migration of contamination from soil to groundwater. Petroleum-hydrocarbon concentrations in groundwater samples from monitoring wells near the former USTs (N1MW-6 through N1MW-8) are greater than MTCA CULs (Table 6). Vertical and horizontal transport might have been facilitated by seasonal groundwater fluctuations and flow; however, the groundwater gradient is relatively flat. Petroleum-related contaminants in groundwater do not appear to extend much beyond the release location and likely extend east of the site beneath North 1st Street. Data indicate the plume does not extend across North 1st Street. Physical mechanism for transport of contaminants from soil to groundwater are limited by the low average annual rainfall and asphalt covering a large portion of the site.

4.0 PROPOSED CLEANUP STANDARDS

Cleanup standards consist of: (1) cleanup levels that are protective of human health and the environment, and (2) the point of compliance at which the cleanup levels must be met. Cleanup levels were developed as part of the RI planning activities. This process identified potential exposure pathways for human and environmental impacts based on the planned land use. Cleanup standards for remedial alternative evaluation are presented below.

4.1. Contaminant-Specific Standards

Indicator hazardous substances are not proposed for the site.

4.2. Soil Cleanup Standards

Soil cleanup levels for the site are based on MTCA Method A values for unrestricted land use for the protection of human health. The standard point of compliance for the soil cleanup levels presented in Tables 1 and 2 is throughout the soil column from the ground surface to 15 feet bgs, in accordance with Washington Administrative Code (WAC) 173-340-740(6)(d).

4.3. Groundwater Cleanup Standards

Groundwater cleanup levels for the Site are based on MTCA Method A values for potable water. In accordance with WAC 173-340-720(2)(d), groundwater at the Site is classified as a potential future source of drinking water because it is present in sufficient quantity, contains less than 10,000 milligrams per liter (mg/L) total dissolved solids and is not too deep to recover. The standard point of compliance for the groundwater cleanup levels presented in Table 6 and 7 is throughout the site from the uppermost level of the saturated zone extending vertically to the lowest depth that could potentially be affected at the site.

4.4. Cleanup Standards for Other Media

Indoor air cleanup levels are based on MTCA Method B indoor air quality CULs, however indoor air quality was not evaluated as part of the RI. A Preliminary VI Assessment was conducted to evaluate the potential for vapor intrusion from the subsurface petroleum contamination. As discussed in Section 2.4, the vapor intrusion pathway does appear to be potentially complete for the site and soil vapor is considered a potential risk to human health.

4.5. Terrestrial Ecological Evaluation

Terrestrial ecological evaluation (TEE) requirements were reviewed for the site. The site qualified for an exclusion under WAC 173-340-7491(1)(c) since there is less than 1½ acres of contiguous land within 500 feet of the site. In addition, a review of MTCA Table 749-1 indicated that the site does not have a substantial potential for posing a threat of significant adverse effects to terrestrial ecological receptors; therefore, the site is removed from further ecological consideration. The TEE forms documenting this determination for the site are presented in Appendix H.

Based on this evaluation, soil contamination leaching to groundwater and potential vapor intrusion (depending on future site use) remain the only applicable, potential exposure pathways for soil contamination at the site.

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The following sections summarize the results of the RI and provide recommendations for the site for future assessment, remediation and development activities.

5.1. Summary and Conclusions

The results of additional soil sampling performed as part of this RI indicate the presence of petroleum contaminated soil appears to be limited to the zone of groundwater fluctuation. The lateral extent of contamination is limited to the northern portion of the subject property near the former USTs and former dispenser islands, and extending to the north partially beneath the Ron Nehls Auto Sales facility, and to the east partially beneath North 1st Street. The contamination is primarily in the gasoline-range although low concentrations of diesel-range hydrocarbons (less than MTCA Method A cleanup levels) have been detected.

Groundwater impacts from the gasoline release are limited to the immediate vicinity of the former UST nest and downgradient (east) of the dispenser islands. The groundwater plume likely extends east beneath North 1st Street based on the presence of GRPH greater than MTCA Method A cleanup level in groundwater samples collected from wells MW-6 and MW-7, which are located on the eastern property edges.

The groundwater gradient is relatively flat with an average of 0.0025 feet/foot. Natural attenuation parameters including dissolved oxygen concentrations, ORP, temperature and nitrate concentrations suggest that biodegradation may be occurring near the plume (vicinity of N1MW-5 through N1MW-8) under aerobic conditions with limited denitrification and anaerobic respiration occurring at times. Based on the results of groundwater monitoring performed in wells N1MW-1 through N1MW-5 for four quarters, the groundwater plume appears stable.

Based on the Preliminary VI Assessment conducted for the site, immediate action is not necessary, because the site is vacant. However, the need for further VI assessment should be re-visited when future site use is determined based on the presence of xylene concentrations in groundwater samples from N1MW-6 through N1MW-8 that exceed the Method B Noncancer groundwater screening levels established in Ecology's Draft Guidance (Table B-1, updated April 2015).

The site does not have a substantial potential for posing a threat of significant adverse effects to terrestrial ecological receptors. Therefore, soil contamination leaching to groundwater and potential vapor intrusion (depending on future site use) remain the only applicable, potential exposure pathways for soil and groundwater contamination at the site.

5.2. Recommendations

We recommend continued groundwater monitoring of site monitoring wells for three more quarters to assess seasonal variations in groundwater contaminant concentrations. Although biodegradation of the gasoline plume appears to be occurring, site closure may require remediation of soil and groundwater impacts to meet MTCA cleanup levels.

Vapor intrusion may be a concern depending on future site use. Further assessment may be required including the collection of soil gas data. Alternatively, building construction methods may be utilized that mitigate potential vapor impacts.

6.0 LIMITATIONS

This report has been prepared for the exclusive use of Washington Department of Ecology in their evaluation of the Tiger Oil North 1st Street Property located in Yakima, Washington. No other party may rely on the product of our services unless we agree in advance and in writing to such reliance.

Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted environmental science practices in this area at the time this report was prepared. No warranty or other conditions express or implied should be understood.

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TABLES

Table 1

Soil Chemical Analytical Results - TPH, VOCs, EDB and Metals[1]

Tiger Oil North 1st Street
Yakima, Washington

Sample Location	Sample Name	Sample Date	Approximate Sample Depth Interval (feet)	TPH[2]			Volatile Organic Compounds - BETX, MTBE, EDC[3]								EDB[4]	Metals[5]
				GRPH mg/kg	DRPH mg/kg	ORPH mg/kg	Benzene mg/kg	Ethylbenzene mg/kg	Toluene mg/kg	Xylene, m-,p- mg/kg	Xylene, o- mg/kg	Total Xylenes mg/kg	MTBE mg/kg	EDC mg/kg	EDB µg/kg	Lead mg/kg
N1DP-1	N1DP-1:12	4/16/2014	12	**6,200**	**728**	58.3 U	**0.220**	**67.6**	1.05 U	**299**	**84.8**	**384**	0.0630 U	1.05 U	1.04 U	**4.25**
N1DP-2	N1DP-2:14.5	4/16/2014	14.5	**613**	19.7 U	49.3 U	**0.0140**	**0.693**	0.0936 U	**1.02**	0.187 U	**1.02**	0.00561 U	0.936 U	0.936 U	**4.14**
N1DP-3	N1DP-3:14.5	4/16/2014	14.5	**4,170**	**544**	52.0 U	**0.166**	**59.1**	**3.94**	**256**	**99.5**	**356**	0.0475 U	0.791 U	0.992 U	**5.15**
N1DP-3	N1DP-3:15	4/16/2014	15	**904**	**365**	**255**	**0.0392**	**14.4**	**2.28**	**59.0**	**21.8**	**80.8**	0.00673 U	0.112 U	0.998 U	**4.12**
N1DP-4	N1DP-4:16	4/16/2014	16	**415**	**107**	**277**	**0.0111**	**0.592**	0.0886 U	**0.728**	0.177 U	**0.742**	0.00532 U	0.0886 U	0.931 U	**3.51**
N1DP-8	N1DP-8:16.5	4/16/2014	16.5	**29,400**	**748**	47.9 U	**3.19**	**386**	**378**	**1,990**	**678**	**2,660**	0.555 U	9.25 U	0.976 U	**4.92**
N1MW-1	N1MW-1(14-15')	4/16/2014	14-15	5.56 U	10.5 U	26.2 U	0.0167 U	0.111 U	0.111 U	0.445 U	0.222 U	0.667 U	0.0334 U	0.111 U	1.03 U	**5.31**
N1MW-1	DUPLICATE 3 (N1MW-1)	4/16/2014	14-15	6.51 U	9.33 U	23.3 U	0.0195 U	0.130 U	0.130 U	0.520 U	0.260 U	0.781 U	0.0390 U	0.130 U	1.06 U	**3.55**
N1MW-2	N1MW-2(14-15')	4/16/2014	14-15	4.94 U	10.1 U	25.3 U	0.0148 U	0.0988 U	0.0988 U	0.395 U	0.198 U	0.593 U	0.0296 U	0.0988 U	1.05 U	**5.86**
N1MW-3	N1MW-3(12-13')	4/16/2014	12-13	5.9 U	**17.0** U	**81.1**	0.0177 U	0.118 U	0.118 U	0.472 U	0.236 U	0.708 U	0.0354 U	0.118 U	1.05 U	**4.80**
N1MW-4	N1MW-4(10-11')	4/16/2014	10-11	**5.35**	9.85	24.6 U	0.0153 U	0.102 U	0.102 U	0.409 U	0.205 U	0.614 U	0.0307 U	0.102 U	1.09 U	**4.55**
N1MW-5	N1MW-5(11-12')	4/16/2014	11-12	6.19 U	**18.6** U	**126**	0.0186 U	0.124 U	0.124 U	0.495 U	0.248 U	0.743 U	0.0371 U	0.124 U	1.13 U	**3.22**
N1DP-9	NIDP-9(14.5-15)	8/3/2016	14.5 - 15 ft	5.4 U	**16** J	**180**	0.022 U	0.11 U	0.11 U	0.43 U	0.22 U	0.65 U	--	--	--	5 U
N1DP-10	NIDP-10(14.5-15)	8/3/2016	14.5 - 15 ft	**90**	10 U	26 U	0.02 U	0.1 U	0.1 U	0.4 U	0.2 U	0.6 U	--	--	--	4.6 U
N1DP-11	NIDP-11(14.5-15)	8/3/2016	14.5 - 15 ft	**150**	**16** J	27 U	0.022 U	**1**	0.11 U	**4.9**	**1.1**	**6**	--	--	--	4.4 U
N1DP-12	NIDP-12(14.5-15)	8/4/2016	14.5 - 15 ft	**2,900**	**160** J	26 U	0.026 U	0.13 U	0.13 U	**0.55**	0.26 U	0.78 U	--	--	--	4.3 U
N1DP-13	NIDP-13(14.5-15)	8/4/2016	14.5 - 15 ft	**3,800**	**700** J	29 U	0.23 U	**48**	1.1 U	**170**	**44**	**210**	--	--	--	**7.8**
N1DP-14	NIDP-14(14.5-15)	8/4/2016	14.5 - 15 ft	**23**	**12**	26 U	0.026 U	0.13 U	0.13 U	0.52 U	0.26 U	0.78 U	--	--	--	7.6 U
N1DP-15	NIDP-15(14.5-15)	8/4/2016	14.5 - 15 ft	6 U	10 U	26 U	0.024 U	0.12 U	0.12 U	0.48 U	0.24 U	0.72 U	--	--	--	4.9 U
N1DP-16	NIDP-16(14.5-15)	8/4/2016	14.5 - 15 ft	6.7 U	11 U	26 U	0.027 U	0.13 U	0.13 U	0.54 U	0.27 U	0.81 U	--	--	--	5.2 U
N1DP-17	NIDP-17(14.5-15)	8/3/2016	14.5 - 15 ft	6.2 U	11 U	26 U	0.025 U	0.12 U	0.12 U	0.49 U	0.25 U	0.74 U	--	--	--	4.3 U
N1DP-18	NIDP-18(14.5-15)	8/3/2016	14.5 - 15 ft	5.8 U	11 U	26 U	0.023 U	0.12 U	0.12 U	0.46 U	0.23 U	0.69 U	--	--	--	4.9 U
N1DP-19	NIDP-19(14.5-15)	8/3/2016	14.5 - 15 ft	4.6 U	11 U	27 U	0.018 U	0.091 U	0.091 U	0.36 U	0.18 U	0.55 U	--	--	--	5.4 U
N1MW-6	NIMW-6(12.5-13)	10/17/2016	12.5 - 13 ft	**940**	**25**	27 U	0.019 U	**4.7**	0.096 U	**25**	1.9 U	**25**	--	--	--	6.6 U
N1MW-7	NIMW-7(15-15.5)	10/18/2016	15 - 15.5 ft	**1,900**	11 U	27 U	0.019 U	**25**	**3.5**	**100**	**31**	**130**	--	--	--	6.6 U
N1MW-8	NIMW-8(12-12.5)	10/17/2016	12 - 12.5 ft	**170**	**150**	26 U	0.017 U	**0.24**	0.084 U	**1.4**	**0.53**	**1.9**	--	--	--	6.2 U
N1MW-8	NIMW-8(15-15.5)	10/17/2016	15 - 15.5 ft	**1,200**	**210**	28 U	**0.025**	**11**	**1.3**	**58**	**21**	**80**	--	--	--	6.8 U
MTCA Method A CULs[6]				30[7]	2,000	2,000	0.03	6	7	9[8]			0.1	NE	5	250

Notes

[1] Chemical analyses conducted by TestAmerica of Spokane, Washington.

[2] Diesel-, gasoline and lube oil-range petroleum hydrocarbons were analyzed using Northwest Methods NWTPH-Dx and NWTPH-Gx.

[3] Benzene, Ethylbenzene, Toluene, and Xylenes (BETX), methyl tert-butyl ether (MTBE), 1,2-dichloroethane (EDC) analyzed using Environmental Protection Agency (EPA) Method 8260C.

[4] 1,2-dibromoethane (EDB) analyzed using EPA Method 8011.

[5] Metals analyzed using EPA Method 6010C.

[6] Model Toxics Control Act (MTCA) Method A unrestricted land use cleanup levels (CULs) for soil.

[7] If benzene is present, the Gasoline-range petroleum hydrocarbon (GRPH) cleanup level is 30 mg/kg. If benzene is not present and the total of ethylbenzene, toluene and xylenes is less than 1% of the gasoline mixture the GRPH cleanup level is 100 mg/kg.

[8] Cleanup level based on protection of groundwater for drinking water use, using the procedures described in WAC 173-340-747(4). This is a total value for all xylenes.

GRPH = Gasoline-range Petroleum Hydrocarbons; DRPH = Diesel-range Petroleum Hydrocarbons; ORPH = Oil-range Petroleum Hydrocarbons; µg/kg = milligrams per kilogram; mg/kg = milligrams per kilogram; U = analyte was not detected greater than the laboratory reporting limit;

NE = Not Established; -- = not analyzed.

Bold indicates analyte concentration exceeds laboratory reporting limit.

Bold and shading indicate that the analyte was detected greater than the MTCA Method A CUL.

Table 2

Soil Chemical Analytical Results - PAHs and cPAHs[1]

Tiger Oil North 1st Street
Yakima, Washington

				Carcinogenic PAHs[2]								PAHs[2]										
Sample Location	Sample Name	Sample Date	Sample Depth Interval (feet)	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Chrysene	Dibenzo(a,h)anthracene	Indeno(1,2,3-c,d)pyrene	cPAH TEQ[3]	Naphthalene	1-Methylnaphthalene	2-Methylnaphthalene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(g,h,i)perylene	Fluoranthene	Fluorene	Phenanthrene	Pyrene
				µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
N1DP-1	N1DP-1:12	4/16/2014	12	--	--	--	--	--	--	--	--	**9,180**	**8,970**	**18,600**	--	--	--	--	--	--	--	--
N1DP-2	N1DP-2:14.5	4/16/2014	14.5	--	--	--	--	--	--	--	--	19.3 U	**242**	**466**	--	--	--	--	--	--	--	--
N1DP-3	N1DP-3:14.5	4/16/2014	14.5	--	--	--	--	--	--	--	--	**17,600**	**11,700**	**24,600**	--	--	--	--	--	--	--	--
N1DP-3	N1DP-3:15	4/16/2014	15	--	--	--	--	--	--	--	--	**10,100**	**6,890**	**14,600**	--	--	--	--	--	--	--	--
N1DP-4	N1DP-4:16	4/16/2014	16	--	--	--	--	--	--	--	--	409 U	**710**	**1,610**	--	--	--	--	--	--	--	--
N1DP-8	N1DP-8:16.5	4/16/2014	16.5	--	--	--	--	--	--	--	--	**30,300**	**20,900**	**46,100**	--	--	--	--	--	--	--	--
N1MW-1	N1MW-1(14-15')	4/16/2014	14-15	--	--	--	--	--	--	--	--	20.8 U	20.8 U	20.8 U	--	--	--	--	--	--	--	--
N1MW-1	(N1MW-1)	4/16/2014	14-15	--	--	--	--	--	--	--	--	21.6 U	21.6 U	21.6 U	--	--	--	--	--	--	--	--
N1MW-2	N1MW-2(14-15')	4/16/2014	14-15	--	--	--	--	--	--	--	--	20.3 U	20.3 U	20.3 U	--	--	--	--	--	--	--	--
N1MW-3	N1MW-3(12-13')	4/16/2014	12-13	--	--	--	--	--	--	--	--	22.0 U	22.0 U	22.0 U	--	--	--	--	--	--	--	--
N1MW-4	N1MW-4(10-11')	4/16/2014	10-11	--	--	--	--	--	--	--	--	21.4 U	21.4 U	21.4 U	--	--	--	--	--	--	--	--
N1MW-5	N1MW-5(11-12')	4/16/2014	11-12	--	--	--	--	--	--	--	--	22.2 U	22.2 U	22.2 U	--	--	--	--	--	--	--	--
N1DP-9	NIDP-9(14.5-15)	8/3/2016	14.5 - 15 ft	10 U	10 U	10 U	10 U	10 U	10 U	10 U	7.6	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
N1DP-10	NIDP-10(14.5-15)	8/3/2016	14.5 - 15 ft	10 U	10 U	10 U	10 U	10 U	10 U	10 U	7.6	10 U	**25**	**44**	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
N1DP-11	NIDP-11(14.5-15)	8/3/2016	14.5 - 15 ft	11 U	11 U	11 U	11 U	11 U	11 U	11 U	8.3	**80**	**200**	**370**	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U
N1DP-12	NIDP-12(14.5-15)	8/4/2016	14.5 - 15 ft	10 U	10 U	10 U	10 U	10 U	10 U	10 U	7.6	**510**	**2,400**	**5,700**	**12**	10 U	10 U	10 U	10 U	**15**	**38**	10 U
N1DP-13	NIDP-13(14.5-15)	8/4/2016	14.5 - 15 ft	11 U	11 U	11 U	11 U	11 U	11 U	11 U	8.3	**19,000**	**22,000**	**42,000**	**110**	**57**	**20**	11 U	**18**	**200**	**350**	**17**
N1DP-14	NIDP-14(14.5-15)	8/4/2016	14.5 - 15 ft	10 U	10 U	10 U	10 U	10 U	10 U	10 U	7.6	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
N1DP-15	NIDP-15(14.5-15)	8/4/2016	14.5 - 15 ft	10 U	10 U	10 U	10 U	10 U	10 U	10 U	7.6	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
N1DP-16	NIDP-16(14.5-15)	8/4/2016	14.5 - 15 ft	11 U	11 U	11 U	11 U	11 U	11 U	11 U	8.3	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U
N1DP-17	NIDP-17(14.5-15)	8/3/2016	14.5 - 15 ft	11 U	11 U	11 U	11 U	11 U	11 U	11 U	8.3	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U
N1DP-18	NIDP-18(14.5-15)	8/3/2016	14.5 - 15 ft	10 U	10 U	10 U	10 U	10 U	10 U	10 U	7.6	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
N1DP-19	NIDP-19(14.5-15)	8/3/2016	14.5 - 15 ft	11 U	11 U	11 U	11 U	11 U	11 U	11 U	8.3	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U
N1MW-6	NIMW-8(12.5-13)	10/17/2016	12.5 - 13 ft	11 U	11 U	11 U	11 U	11 U	11 U	11 U	8.3	**350**	**1,100**	**2,100**	11 U	11 U	11 U	11 U	11 U	**11**	**18**	11 U
N1MW-7	NIMW-7(15-15.5)	10/18/2016	15 - 15.5 ft	11 U	11 U	11 U	11 U	11 U	11 U	11 U	8.3	**12**	**28**	**52**	11 U	11 U	11 U	11 U	11 U	11 U	11 U	11 U
N1MW-8	NIMW-8(12-12.5)	10/17/2016	12 - 12.5 ft	11 U	11 U	11 U	11 U	11 U	11 U	11 U	8.3	**54**	**390**	**670**	**12**	11 U	11 U	11 U	11 U	**17**	**23**	11 U
N1MW-8	NIMW-8(15-15.5)	10/17/2016	15 - 15.5 ft	11 U	11 U	11 U	11 U	11 U	11 U	11 U	8.3	**880**	**2,800**	**5,600**	**72**	**17**	**36**	11 U	**11**	**83**	**150**	**13**
MTCA Method A CULs[4]				NE	100	NE	NE	NE	NE	NE	100	5,000			NE	NE	NE	NE	NE	NE	NE	NE

Notes

[1] Chemical analyses conducted by TestAmerica of Spokane, Washington.

[2] Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs) and PAHs (Polycyclic Aromatic Hydrocarbons) were analyzed using Environmental Protection Agency (EPA) Method 8270D.

[3] Carcinogenic PAHs toxic equivalency factor (TEQ) calculated using toxicity equivalency factors (TEF) from MTCA Table 708-2. One half the reporting limit was used to calculate the TEQ for results less than reporting limits.

[4] Model Toxics Control Act (MTCA) Method A unrestricted land use cleanup levels (CULs) for soil.

µg/kg = micrograms per kilogram; -- = not analyzed; U = analyte was not detected greater than the laboratory reporting limit, NE = Not Established.

Bold indicates analyte concentration exceeds laboratory reporting limit.

Bold and shading indicate that the analyte was detected greater than the MTCA Method A CUL.

Table 3

Groundwater Chemical Analytical Results - Direct-Push Temporary Well Samples

Northwest HCID[1]

Tiger Oil North 1st Street

Yakima, Washington

Sample Location	Sample Name	Sample Date	TPH - HCID[2]		
			Gasoline-range Petroleum Hydrocarbons mg/L	Diesel-range Petroleum Hydrocarbons mg/L	Oil-range Petroleum Hydrocarbons mg/L
N1DP-1	041614:N1DP-1:GW	4/16/2014	**1.0**	**1.0**	0.62 U
N1DP-2	041614:N1DP-2:GW	4/16/2014	0.62 U	0.62 U	**0.67**
N1DP-3	041614:N1DP-3:GW	4/16/2014	**11.0**	**5.4**	**7.2**
N1DP-4	041614:N1DP-4:GW	4/16/2014	0.61 U	**0.79**	0.61 U
N1DP-5	041614:N1DP-5:GW	4/16/2014	0.62 U	0.62 U	**1.7**
N1DP-6	041614:N1DP-6:GW	4/16/2014	0.61 U	0.61 U	0.61 U
N1DP-7	041614:N1DP-7:GW	4/16/2014	0.61 U	0.61 U	0.61 U
N1DP-8	041614:N1DP-8:GW	4/16/2014	**5.1**	**2.1**	**1.0**
N1DP-9	NIDP-9:080316	8/3/2016	0.13 U	0.34 U	0.34 U
N1DP-10	NIDP-10:080316	8/3/2016	**0.80**	**0.88** J	0.32 U
N1DP-11	NIDP-11:080316	8/3/2016	**0.19**	0.33 U	0.33 U
N1DP-12	NIDP-12:080416	8/4/2016	**1.5**	**1.2** J	**0.37**
N1DP-13	NIDP-13:080416	8/4/2016	**0.66**	**0.40** J	0.34 U
N1DP-14	NIDP-14:080416	8/4/2016	**0.65**	**0.95** J	0.32 U
N1DP-15	NIDP-15:080416	8/4/2016	0.14 U	0.35 U	0.35 U
N1DP-16	NIDP-16:080416	8/4/2016	0.13 U	0.32 U	**1.8**
N1DP-17	NIDP-17:080316	8/3/2016	0.13 U	0.33 U	0.33 U
N1DP-18	NIDP-18:080316	8/3/2016	0.13 U	0.33 U	0.33 U
N1DP-19	NIDP-19:080316	8/3/2016	0.13 U	0.34 U	0.34 U
MTCA Method A CULs[3]			0.8/1[4]	0.5	0.5

Notes

[1] Chemical analyses conducted by TestAmerica of Spokane, Washington.

[2] Diesel-, gasoline and oil-range petroleum hydrocarbons were analyzed using Northwest Method Hydrocarbon Identification (NWTPH - HCID).

[3] Model Toxics Control Act (MTCA) Method A cleanup levels (CUL) for groundwater. However, the HCID analysis method is considered qualitative and should not be used to determine compliance with cleanup levels.

[4] Cleanup level for gasoline is 0.8 mg/L when benzene is present and 1 mg/L when there is no detectable benzene in groundwater.

mg/L = milligrams per liter; -- = not analyzed; U = analyte was not detected above the laboratory reporting limit

Bold indicates analyte concentration exceeds laboratory reporting limit.

Bold and shading indicate that the analyte was detected greater than the MTCA Method A CUL.

and should not be used to consider cleanup actions.

Table 4

Summary of Groundwater Level Measurements

Tiger Oil North 1st Street
Yakima, Washington

Well Number	Grid Northing[1] (feet)	Grid Easting[1] (feet)	Top of Casing Elevation[2] (feet)	Screen Elevation[2] (feet)	Date Measured	Depth to Groundwater[3] (feet)	Groundwater Elevation[2] (feet)	Change in Groundwater Elevation[4] (feet)
N1MW-1	470569.0	1637341.4	1,084.85	1075.4 to 1065.4	09/18/14	13.78	1,071.07	NA
					12/11/14	13.65	1,071.20	0.13
					03/10/15	14.05	1,070.80	-0.40
					08/22/16	13.59	1,071.26	0.06
					11/17/16	13.20	1,071.65	0.39
N1MW-2	470616.9	1637480.0	1,083.81	1073.8 to 1063.8	09/18/14	13.31	1,070.50	NA
					12/11/14	13.01	1,070.80	0.30
					03/10/15	13.30	1,070.51	-0.29
					08/22/16	13.01	1,070.80	0.00
					11/17/16	12.57	1,071.24	0.44
N1MW-3	470475.5	1637358.7	1,084.61	1074.6 to 1064.6	09/18/14	13.75	1,070.86	NA
					12/11/14	13.56	1,071.05	0.19
					03/10/15	13.86	1,070.75	-0.30
					08/22/16	13.41	1,071.20	0.15
					11/17/16	13.00	1,071.61	0.41
N1MW-4	470595.3	1637199.9	1,082.13	1075.1 to 1065.1	09/18/14	11.10	1,071.03	NA
					12/11/14	10.91	1,071.22	0.19
					03/10/15	11.26	1,070.87	-0.35
					08/22/16	10.59	1,071.54	0.32
					11/17/16	10.26	1,071.87	0.33
N1MW-5	470681.7	1637363.0	1,083.43	1074.4 to 1064.4	09/18/14	12.48	1,070.95	NA
					12/11/14	12.27	1,071.16	0.21
					03/10/15	12.56	1,070.87	-0.29
					08/22/16	12.09	1,071.34	0.18
					11/17/16	11.78	1,071.65	0.31
N1MW-6	470639.0	1637363.5	1,083.54	1073.1 to 1063.1	11/17/16	11.90	1,071.64	NA
N1MW-7	470586.4	1637370.7	1,084.84	1076.0 to 1066.0	11/17/16	13.24	1,071.60	NA
M1MW-8	470623.5	1637328.3	1,084.51	1074.5 to 1064.5	11/17/16	12.83	1,071.68	NA

Notes:

[1] Grid northing and easting are referenced to NAD83, Washington State Plane Coordinate System, South Zone.

[2] Elevations are referenced to the North American Vertical Datum of 1988 (NAVD88).

[3] Depth to water measurements obtained from the north side of the top of PVC well casing.

[4] Represents change in groundwater elevation from previous monitoring event, as measured in monitoring wells.

NA = Not Applicable

Table 5

Summary of Groundwater Field Parameters[1]

Tiger Oil North 1st Street
Yakima, Washington

Well Number	Date Collected	pH	Temperature (°C)	Specific Conductivity (mS/cm)	Dissolved Oxygen (mg/L)	ORP - Field[2] (mV)	Turbidity (NTU)	Soluble Ferrous Iron (mg/L)	Monitoring Well Headspace[3] (ppm)
N1MW-1	09/18/14	6.57	17.03	0.25	2.46	54	16.31	1.3	1.5
	12/11/14	6.59	16.99	0.23	1.04	13	1.15	1.0	1.5
	03/10/15	6.76	15.29	0.24	4.33	519	2.42	--	0.3
	08/22/16	6.52	17.56	0.44	4.23	244	16.23	--	1.8
	11/17/16	6.56	17.46	0.38	1.83	59.9	1.01	0	--
N1MW-2	09/18/14	6.69	17.46	0.27	0.05	-143	1.03	0	0.0
	12/11/14	6.49	16.50	0.25	0.14	-90	4.13	0	0.0
	03/10/15	6.72	13.17	0.23	0.06	44	4.54	--	13.2
	08/22/16	6.62	18.47	0.36	0.88	-230	13.61	--	0.0
	11/17/16	6.58	17.46	0.44	0.46	58	0.75	2	--
N1MW-3	09/18/14	6.75	16.25	0.26	5.69	-148	0.07	0	0.3
	12/11/14	6.65	16.32	0.24	6.32	142	0.86	0	0.3
	03/10/15	6.82	14.08	0.22	8.07	230	0.34	--	0.0
	08/22/16	6.70	17.72	0.37	4.64	-133	0.00	--	1.9
	11/17/16	6.72	16.33	0.33	2.77	121	0.18	<0.5	--
N1MW-4	09/18/14	6.68	16.77	0.24	5.82	90	4.48	0	0.1
	12/11/14	6.65	15.83	0.21	6.77	135	0.59	0	0.1
	03/10/15	6.82	13.83	0.21	8.63	267	4.90	--	0.0
	08/22/16	6.53	16.9	0.32	5.91	-99	43.22	--	0.0
	11/17/16	6.73	16.6	0.27	4.87	68.3	0.17	0	--
N1MW-5	09/18/14	6.49	18.25	0.25	0.98	-25	0.12	1.5	0.1
	12/11/14	6.53	17.01	0.23	0.90	-24	2.35	2.0	0.1
	03/10/15	6.61	13.95	0.23	0.42	132	2.17	--	0.4
	08/22/16	6.40	19.60	0.36	0.11	-326	11.61	--	0.0
	11/17/16	6.57	17.58	0.30	0.17	75	0.30	0.5	--
N1MW-6	11/17/16	6.58	16.71	0.33	0.15	9	4.23	2.8	--
N1MW-7	11/17/16	6.87	17.72	0.51	0.38	-13	16.1	2.3	--
M1MW-8	11/17/16	6.61	16.90	0.60	0.74	-7	3.65	4.0	--

Notes:

[1] Reported water quality parameters reflect stabilized conditions at the conclusion of well purging during low-flow sampling.

[2] Field ORP values are relative to the reference electrode associated with the multi-parameter meter.

[3] Well headspace measurements were obtained using a photoionization detector immediately upon removal of the well's compression cap.

- = not recorded

ORP = Oxidation reduction potential; °C = degrees Celsius; mS/cm = millisiemens per centimeter; mg/L = milligrams per liter; mV = millivolts;
NTU = nephelometric turbidity units; ppm = parts per million

Table 6

Summary of Groundwater Chemical Analytical Results[1]

Monitoring Well Samples - TPH, VOCs, Lead, Conventionals

Tiger Oil North 1st Street
Yakima, Washington

Method and Analytes	Units	Location and Sample Date																
		Regulatory Levels[2]	N1MW-1					Duplicate (N1MW-1)	N1MW-2					N1MW-3				
			09/18/14	12/11/14	03/10/15	08/22/16	11/17/16	11/17/16	09/18/14	12/11/14	03/10/15	08/22/16	11/17/16	09/18/14	12/11/14	03/10/15	08/22/16	11/17/16
TPH by Northwest Method NWTPH-Gx																		
Gasoline-range hydrocarbons	µg/L	800[3]	**256**	<100	**120**	<100	< 100	< 100	**506**	**372**	**340**	<100	< 100	<100	<100	<100	<100	< 100
TPH by Northwest Method NWTPH-Dx																		
Diesel-range hydrocarbons	mg/L	0.500	<0.234	<0.233	<0.230	<0.13	< 0.13	< 0.14	**0.459**	**0.269 J**	**0.280**	<0.13	< 0.13	<0.231	<0.234	<0.240	<0.13	< 0.13
Heavy oil-range hydrocarbons	mg/L	0.500	<0.389	<0.388	<0.380	<0.21	< 0.22	< 0.24	<0.382	<0.383	<0.390	<0.21	< 0.22	<0.386	<0.389	<0.390	<0.21	< 0.21
VOCs by Method EPA 8260C																		
Benzene	µg/L	5	<0.200	<0.200	<0.20	<0.20	< 0.20	< 0.20	<0.200	<0.200	<0.20	<0.20	< 0.20	<0.200	<0.200	<0.20	<0.20	< 0.20
Ethylbenzene	µg/L	700	<1.00	<1.00	<1.0	<1.0	a	< 1.0	**5.17**	<1.00	<1.0	<1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0
Methyl t-butyl ether (MTBE)	µg/L	20	<1.00	<1.00	<1.0	--	--	--	<1.00	<1.00	<1.0	--	--	<1.00	<1.00	<1.0	--	--
Toluene	µg/L	1,000	<1.00	<1.00	<1.0	<1.0	< 1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0
Xylene, m-,p-	µg/L	1,000[4]	<2.00	<2.00	<2.0	<2.0	< 2.0	< 2.0	<2.00	<2.00	<2.0	<2.0	< 2.0	<2.00	<2.00	<2.0	<2.0	< 2.0
Xylene, o-	µg/L		<1.00	<1.00	<1.0	<1.0	< 1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0
Xylene, total	µg/L		<3.00	<3.00	<3.0	<3.0	< 3.0	< 3.0	<3.00	<3.00	<3.0	<3.0	< 3.0	<3.00	<3.00	<3.0	<3.0	< 3.0
Metals by EPA Method 200.7																		
Lead	mg/L	0.015	--	<0.0140	<0.014	<0.014	< 0.014	< 0.014	--	<0.0140	<0.014	<0.014	< 0.014	--	<0.0140	<0.014	<0.014	< 0.014
Anions by EPA Method 300.0																		
Nitrate-nitrogen	mg/L	10[5]	**0.84**	**0.610**	**0.78**	**5.7**	**5.3**	**5.2**	<0.200	<0.200	<0.20	**0.43**	**0.85**	**1.24**	**0.740**	**0.86**	**3.5**	**1.9**
Sulfate	mg/L	250[6]	**9.69**	**7.90**	**8.8**	**17**	**16**	**16**	**5.25**	**5.50**	**5.7**	**17**	**16**	**10.1**	**8.25**	**8.5**	**15**	**10**
General Chemistry by EPA Method 5310C																		
Total organic carbon	mg/L	NE	**1.55**	**1.05**	**1.0**	**1.1**	**1.2**	**1.0**	**1.66**	**1.41**	**1.1**	**1.0**	**1.0**	**1.22**	<1.00	<1.0	<1.0	**1.0**

Method and Analytes	Units	Regulatory Levels[2]	Location and Sample Date												
			N1MW-4					N1MW-5					N1MW-6	N1MW-7	N1MW-8
			09/18/14	12/11/14	03/10/15	08/22/16	11/17/16	09/18/14	12/11/14	03/10/15	08/22/16	11/17/16	11/17/16	11/17/16	11/17/16
TPH by Northwest Method NWTPH-Gx															
Gasoline-range hydrocarbons	µg/L	800[3]	<100	<100	<100	<100	< 100	<100	<100	<100	<100	< 100	**9,400**	**27,000**	**18,000**
TPH by Northwest Method NWTPH-Dx															
Diesel-range hydrocarbons	mg/L	0.500	<0.232	<0.232	<0.240	<0.13	< 0.14	**0.238**	<0.234	<0.230	<0.13	< 0.13	**1.5 J**	**3.7 J**	**6.1 J**
Heavy oil-range hydrocarbons	mg/L	0.500	<0.386	<0.387	<0.390	<0.22	< 0.23	<0.384	<0.391	<0.380	<0.22	< 0.22	< 0.23	< 0.22	< 0.21
VOCs by Method EPA 8260C															
Benzene	µg/L	5	<0.200	<0.200	<0.20	<0.20	< 0.20	<0.200	<0.200	<0.20	<0.20	< 0.20	< 4.0	**5.6**	**43**
Ethylbenzene	µg/L	700	<1.00	<1.00	<1.0	<1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0	**300**	**1,400**	**480**
Methyl t-butyl ether (MTBE)	µg/L	20	<1.00	<1.00	<1.0	--	--	<1.00	<1.00	<1.0	--	--	--	--	--
Toluene	µg/L	1,000	<1.00	<1.00	<1.0	<1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0	< 20	**180**	**26**
Xylene, m-,p-	µg/L	1,000[4]	<2.00	<2.00	<2.0	<2.0	< 2.0	<2.00	<2.00	<2.0	<2.0	< 2.0	**950**	**5,300**	**1,600**
Xylene, o-	µg/L		<1.00	<1.00	<1.0	<1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0	**270**	**2,000**	**1,100**
Xylene, total	µg/L		<3.00	<3.00	<3.0	<3.0	< 3.0	<3.00	<3.00	<3.0	<3.0	< 3.0	**1,200**	**7,300**	**2,700**
Metals by EPA Method 200.7															
Lead	mg/L	0.015	--	<0.0140	<0.014	<0.014	< 0.014	--	<0.0140	<0.014	<0.014	< 0.014	< 0.014	< 0.014	< 0.014
Anions by EPA Method 300.0															
Nitrate-nitrogen	mg/L	10[5]	**0.95**	**0.620**	**1.1**	**3.0**	**1.5**	**0.49**	**0.350**	**0.51**	**5.4**	**0.38**	**0.48**	**0.75**	**0.96**
Sulfate	mg/L	250[6]	**8.49**	**6.92**	**8.2**	**13**	**8.1**	**9.68**	**9.25**	**13**	**16**	**19**	**17**	**14**	**31**
General Chemistry by EPA Method 5310C															
Total organic carbon	mg/L	NE	**1.19**	<1.00	**1.0**	<1.0	< 1.0	**1.36**	**1.09**	**1.1**	**1.2**	**1.2**	**4.1**	**7.3**	**10**

Notes:

[1] Chemical analyses conducted by TestAmerica of Spokane, Washington.

[2] Regulatory level refers to Washington State Model Toxics Control Act (MTCA) Method A cleanup level unless otherwise footnoted.

[3] Cleanup level for Gasoline-range petroleum hydrocarbons (GRPH) is 800 µg/L as a result of benzene detections in N1MW-7 and N1MW-8.

[4] Cleanup level for total xylenes.

[5] Regulatory level based on maximum contaminant level established by Title 40 Code of Federal Regulations, Part 141.

[6] Regulatory level based on secondary maximum contaminant level recommended by the Environmental Protection Agency.

-- = not analyzed; EPA = Environmental Protection Agency; J = result was estimated; NE = not established; mg/L = milligrams per liter; µg/L = micrograms per liter; TPH = total petroleum hydrocarbons; VOC = volatile organic compounds;

Bold indicates analyte concentration exceeds laboratory reporting limit.

Bold and shading indicates analyte was detected greater than the applicable regulatory level.

Table 7

Summary of Chemical Analytical Results - Groundwater PAHs[1]

Tiger Oil North 1st Street
Yakima, Washington

		Carcinogenic PAHs							**cPAH TEQ**^{2}	**Naphthalene**	**2-Methylnaphthalene**	**1-Methylnaphthalene**	**Naphthalene (Total)**	**Acenaphthylene**	**Acenaphthene**	**Fluorene**	**Phenanthrene**	**Anthracene**	**Fluoranthene**	**Pyrene**	**Benzo(ghi)perylene**
		Benzo(a)anthracene	**Benzo(a)pyrene**	**Benzo(b)fluoranthene**	**Benzo(k)fluoranthene**	**Chrysene**	**Dibenzo(a,h)anthracene**	**Indeno(1,2,3-cd)pyrene**													
TEF^{2}		**0.1**	**1.0**	**0.1**	**0.1**	**0.01**	**0.1**	**0.1**													
Sample ID	**Date Collected**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**	**μg/L**
N1MW-1	09/18/14	<0.0858	<0.0858	<0.0858	<0.0858	<0.0858	<0.0858	<0.0858	0.06	**0.242**	**0.487**	**0.400**	**1.129**	<0.0858	<0.0858	<0.0858	<0.0858	<0.0858	<0.0858	<0.0858	<0.0858
Duplicate (N1MW-1)	09/18/14	<0.0893	<0.0893	<0.0893	<0.0893	<0.0893	<0.0893	<0.0893	0.07	**0.331**	**0.629**	**0.503**	**1.463**	<0.0893	<0.0893	<0.0893	<0.0893	<0.0893	<0.0893	<0.0893	<0.0893
N1MW-2	09/18/14	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847	0.06	**3.24**	<0.0847	**10.1**	**<13.4**	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847
N1MW-3	09/18/14	<0.0850	<0.0850	<0.0850	<0.0850	<0.0850	<0.0850	<0.0850	0.06	<0.0850	<0.0850	<0.0850	<0.2550	<0.0850	<0.0850	<0.0850	<0.0850	<0.0850	<0.0850	<0.0850	<0.0850
N1MW-4	09/18/14	<0.0854	<0.0854	<0.0854	<0.0854	<0.0854	<0.0854	<0.0854	0.06	<0.0854	<0.0854	<0.0854	<0.2562	<0.0854	<0.0854	<0.0854	<0.0854	<0.0854	<0.0854	<0.0854	<0.0854
N1MW-5	09/18/14	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847	0.06	**0.550**	<0.0847	**0.410**	**<1.045**	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847	<0.0847
MTCA Method A Unrestricted Land Use CUL[3]		NE	0.1	NE	NE	NE	NE	NE	0.1[4]	NE	NE	NE	160[5]	NE	NE	NE	NE	NE	NE	NE	NE

Notes:

[1] Polycyclic aromatic hydrocarbons (PAHs) analyzed using EPA Method 8270D by TestAmerica Laboratories, Inc., in Spokane, Washington.

[2] Carcinogenic PAH (cPAH) toxic equivalency (TEQ) calculated using toxicity equivalency factors (TEF) from MTCA Table 708-2, based on methodology described in MTCA Cleanup Regulation WAC 173-340-708. One half the reporting limit was used to calculate the TEQ.

[3] Model Toxics Control Act (MTCA) Method A unrestricted land use cleanup levels.

[4] MTCA Method A cleanup level for benzo(a)pyrene

[5] Cleanup level for total naphthalenes

μg/L = micrograms per liter; NE = Not Established.

Bold indicates analyte concentration exceeds laboratory reporting limit.

Table 8

Summary of Groundwater Chemical Analytical Results^1 - Vapor Intrusion Screening Evaluation

Tiger Oil North 1st
Yakima, Washington

		Location and Sample Date															
		Vapor Intrusion Screening Levels^2	N1MW-1					Duplicate (N1MW-1)	N1MW-2					N1MW-3			
Method and Analytes	**Units**		09/18/14	12/11/14	03/10/15	08/22/16	11/17/16	11/17/16	09/18/14	12/11/14	03/10/15	08/22/16	11/17/16	09/18/14	12/11/14	03/10/15	08/22/16	11/17/16
TPH by Northwest Method NWTPH-Gx																		
Gasoline-range hydrocarbons	µg/L	NE	**256**	<100	**120**	<100	< 100	< 100	**506**	**372**	**340**	<100	< 100	<100	<100	<100	<100	< 100
TPH by Northwest Method NWTPH-Dx																		
Diesel-range hydrocarbons	mg/L	NE	<0.234	<0.233	<0.230	<0.13	< 0.13	< 0.14	**0.459**	**0.269 J**	**0.280**	<0.13	< 0.13	<0.231	<0.234	<0.240	<0.13	< 0.13
Heavy oil-range hydrocarbons	mg/L	NE	<0.389	<0.388	<0.380	<0.21	< 0.22	< 0.24	<0.382	<0.383	<0.390	<0.21	< 0.22	<0.386	<0.389	<0.390	<0.21	< 0.21
VOCs by Method EPA 8260C																		
Benzene	µg/L	103	<0.200	<0.200	<0.20	<0.20	< 0.20	< 0.20	<0.200	<0.200	<0.20	<0.20	< 0.20	<0.200	<0.200	<0.20	<0.20	< 0.20
Ethylbenzene	µg/L	2,780	<1.00	<1.00	<1.0	<1.0	< 1.0	< 1.0	**5.17**	<1.00	<1.0	<1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0
Methyl t-butyl ether (MTBE)	µg/L	87,000	<1.00	<1.00	<1.0	--	--	--	<1.00	<1.00	<1.0	--	--	<1.00	<1.00	<1.0	--	--
Toluene	µg/L	15,600	<1.00	<1.00	<1.0	<1.0	< 1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0
Xylene, m-,p-	µg/L	310	<2.00	<2.00	<2.0	<2.0	< 2.0	< 2.0	<2.00	<2.00	<2.0	<2.0	< 2.0	<2.00	<2.00	<2.0	<2.0	< 2.0
Xylene, o-	µg/L	440	<1.00	<1.00	<1.0	<1.0	< 1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0
Xylene, total	µg/L	NE	<3.00	<3.00	<3.0	<3.0	< 3.0	< 3.0	<3.00	<3.00	<3.0	<3.0	< 3.0	<3.00	<3.00	<3.0	<3.0	< 3.0

Method and Analytes	Units	Location and Sample Date													
		Vapor Intrusion Screening Levels[2]	N1MW-4					N1MW-5					N1MW-6	N1MW-7	N1MW-8
			09/18/14	12/11/14	03/10/15	08/22/16	11/17/16	09/18/14	12/11/14	03/10/15	08/22/16	11/17/16	11/17/16	11/17/16	11/17/16
TPH by Northwest Method NWTPH-Gx															
Gasoline-range hydrocarbons	µg/L	NE	<100	<100	<100	<100	< 100	<100	<100	<100	<100	< 100	**9,400**	**27,000**	**18,000**
TPH by Northwest Method NWTPH-Dx															
Diesel-range hydrocarbons	mg/L	NE	<0.232	<0.232	<0.240	<0.13	< 0.14	**0.238**	<0.234	<0.230	<0.13	< 0.13	**1.5 J**	**3.7 J**	**6.1 J**
Heavy oil-range hydrocarbons	mg/L	NE	<0.386	<0.387	<0.390	<0.22	< 0.23	<0.384	<0.391	<0.380	<0.22	< 0.22	< 0.23	< 0.22	< 0.21
VOCs by Method EPA 8260C															
Benzene	µg/L	103	<0.200	<0.200	<0.20	<0.20	< 0.20	<0.200	<0.200	<0.20	<0.20	< 0.20	< 4.0	**5.6**	**43**
Ethylbenzene	µg/L	2,780	<1.00	<1.00	<1.0	<1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0	**300**	**1,400**	**480**
Methyl t-butyl ether (MTBE)	µg/L	87,000	<1.00	<1.00	<1.0	--	--	<1.00	<1.00	<1.0	--	--	--	--	--
Toluene	µg/L	15,600	<1.00	<1.00	<1.0	<1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0	< 20	**180**	**26**
Xylene, m-,p-	µg/L	310	<2.00	<2.00	<2.0	<2.0	< 2.0	<2.00	<2.00	<2.0	<2.0	< 2.0	**950**	**5,300**	**1,600**
Xylene, o-	µg/L	440	<1.00	<1.00	<1.0	<1.0	< 1.0	<1.00	<1.00	<1.0	<1.0	< 1.0	**270**	**2,000**	**1,100**
Xylene, total	µg/L	NE	<3.00	<3.00	<3.0	<3.0	< 3.0	<3.00	<3.00	<3.0	<3.0	< 3.0	**1,200**	**7,300**	**2,700**

Notes:

[1] Chemical analyses conducted by TestAmerica of Spokane, Washington.

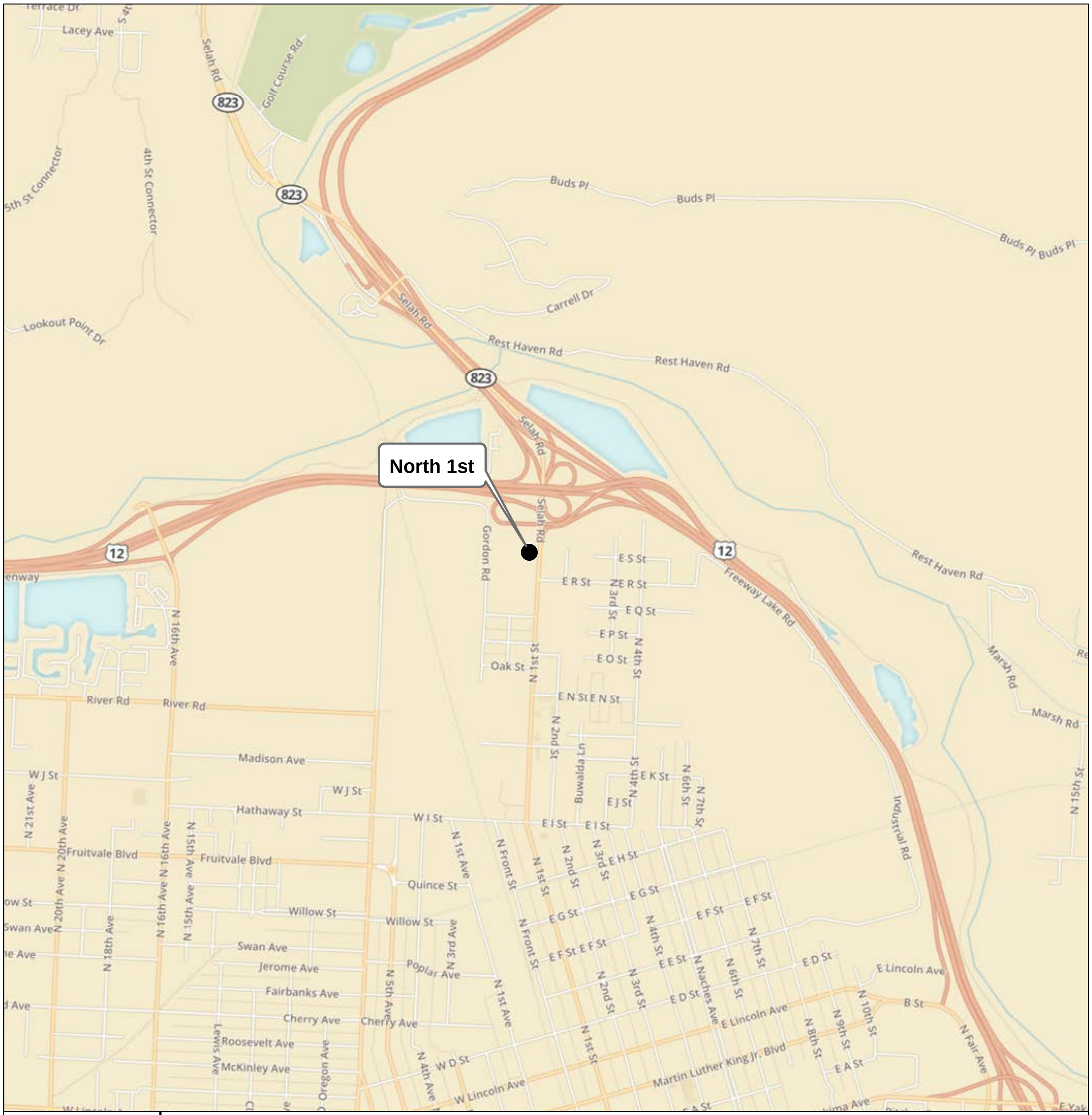
[2] Vapor intrusion screening level Method B Noncancer from Table B-1 of Ecology Draft Guidance (updated April 2016).

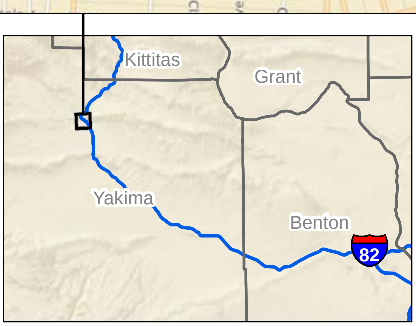
-- = not analyzed; EPA = Environmental Protection Agency; J = result was estimated; NE = not established; mg/L = milligrams per liter; µg/L = micrograms per liter; TPH = total petroleum hydrocarbons; VOC = volatile organic compounds

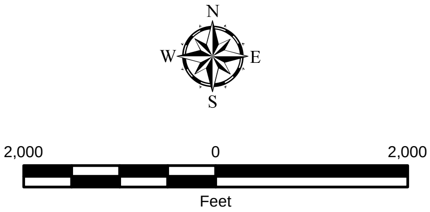
Bold indicates analyte concentration exceeds laboratory reporting limit.

Bold and shading indicates analyte was detected greater than the applicable regulatory level.

FIGURES







Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
Data Sources: ESRI Data & Maps, Street Maps 2008.
Base map from ESRI Data Online.
Projection: NAD 1983, UTM Zone 10 North.

Vicinity Map

Tiger Oil North 1st
Yakima, Washington

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Figure 1

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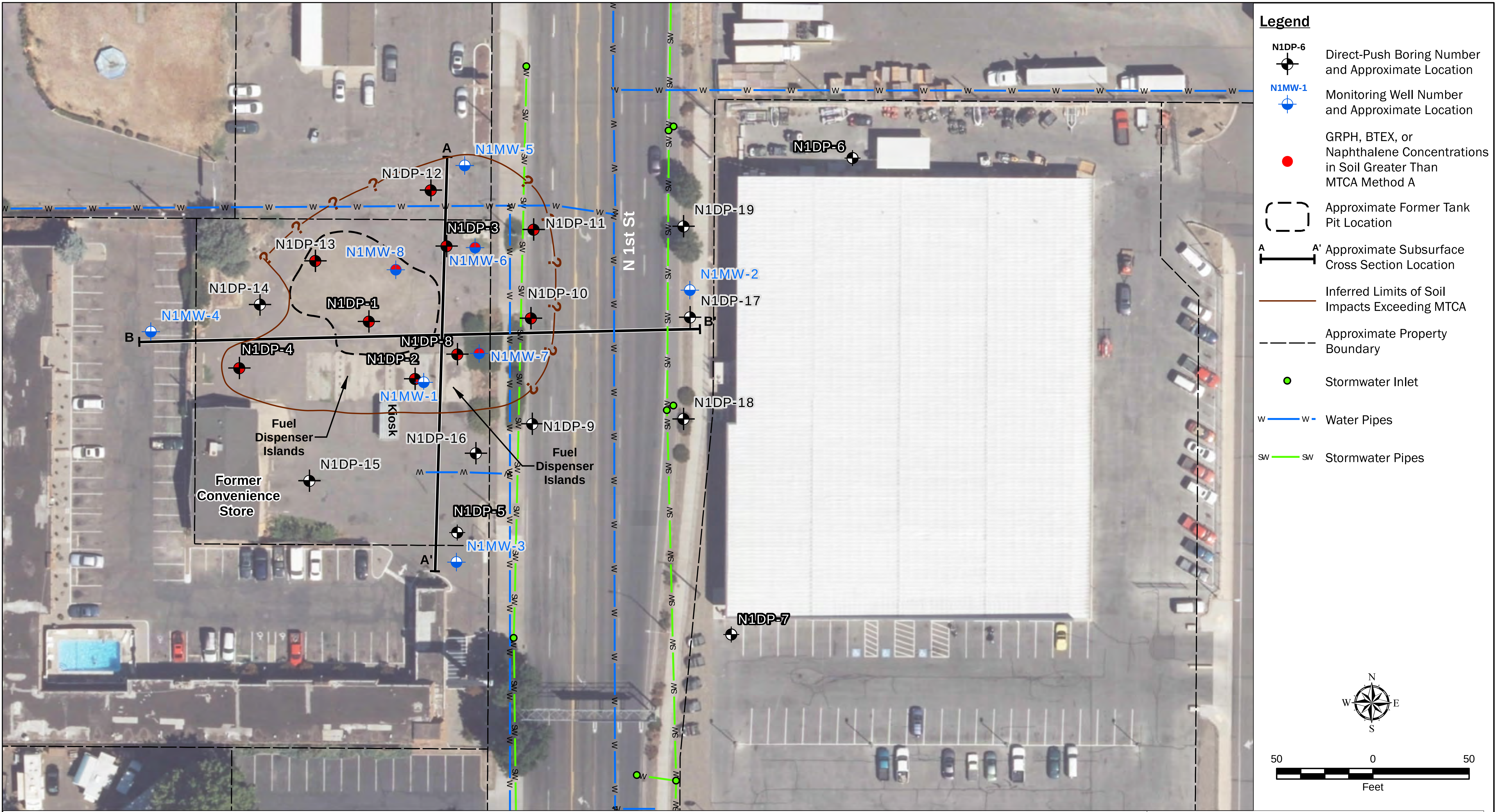

Data Source: Aerial base from ArcGIS Online.
Property Boundary from City of Yakima Engineering Department.
Water and Stormwater data from City of Yakima GIS Open Source, http://gis.yakimawa.gov/.

Projection: NAD 1983 StatePlane Washington South FIPS 4602 Feet

Notes:
1. The locations of all features shown are approximate.
2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.

Path: P:\0\0504101\MXD\TigerOil\NorthFirst\050410103_YakimaGIS_SoilAnalytical.mxd Map Revised: 29 March 2017 ccabrera

Site Plan and Soil Analytical Results

Tiger Oil North 1st
Yakima, Washington

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Figure 2

Legend

- N1MW-1 <100 ⌖ Monitoring Well Number, GRPH Concentration and Approximate Location
- ● GRPH and DRPH Concentrations in Groundwater Greater Than MTCA Method A
- Approximate Former Tank Pit Location
- Approximate Property Boundary
- Estimated Groundwater Flow Direction
- 1,071.3 Approximate Groundwater Elevation Contours (0.1-foot Interval)

Well ID	Groundwater Elevation (Feet)
N1MW-1	1,071.65
N1MW-2	1,071.24
N1MW-3	1,071.61
N1MW-4	1,071.87
N1MW-5	1,071.65
N1MW-6	1,071.64
N1MW-7	1,071.60
N1MW-8	1,071.68

N W E S

50 0 50

Feet

Data Source: Aerial base from ArcGIS Online.
Property Boundary from City of Yakima Engineering Department.
Water and Stormwater data from City of Yakima GIS Open Source,
http://gis.yakimawa.gov/.

Projection: NAD 1983 StatePlane Washington South FIPS 4602 Feet

Notes:
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2. This drawing is for information purposes. It is intended to assist in showing features discussed in an attached document. GeoEngineers, Inc. cannot guarantee the accuracy and content of electronic files. The master file is stored by GeoEngineers, Inc. and will serve as the official record of this communication.
3. Groundwater elevations are referred to the North American Vertical Datum of 1988 (NAVD 88).
4. Groundwater elevations contours interpreted by Surfer Version 12.

Site Plan and Groundwater Elevations, November 17, 2016

Tiger Oil North 1st
Yakima, Washington

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Figure 3

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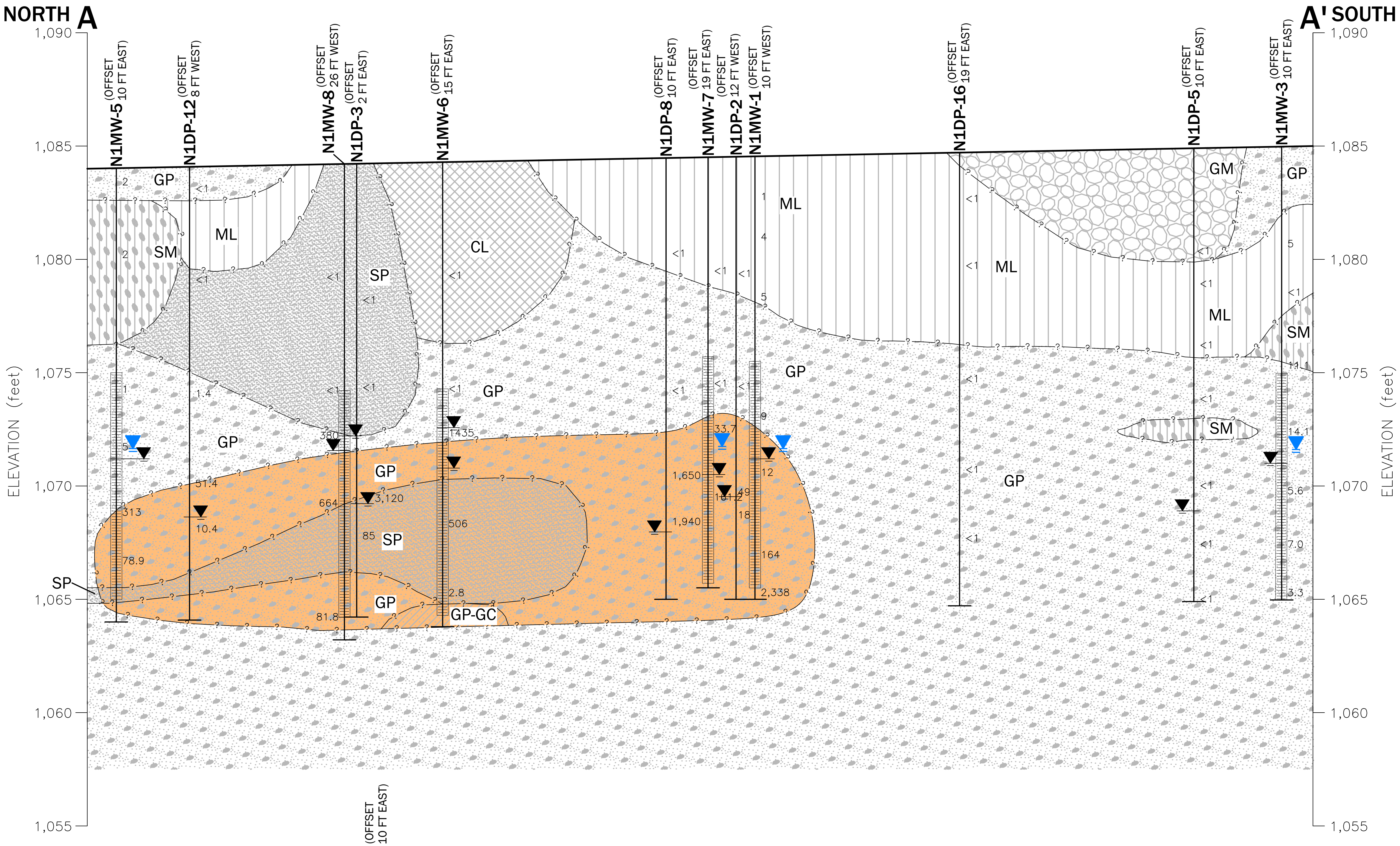


20 0 20
Horizontal Scale in Feet
5 0 5
Vertical Scale in Feet
Vertical Exaggeration: 4X

LEGEND:

N1MW-5 (OFFSET 10 FT EAST) — BORING / MONITORING WELL NUMBER AND APPROXIMATE LOCATION

78.9 — PID READINGS

SP — SOIL TYPE AT SAMPLE LOCATION

—?—?—?— — SOIL CONTACT

▼ — MEASURED GROUNDWATER LEVEL IN EXPLORATION AT TIME OF DRILLING

SCREEN LOCATION

● INTERPRETED ZONE OF SOIL CONTAMINATION BASED ON REVIEW OF ANALYTICAL DATA, FIELD DATA AND ENGINEERING JUDGEMENT

▼ GROUNDWATER ELEVATION CALCULATED FROM DEPTH TO WATER MEASUREMENTS COLLECTED ON NOVEMBER 2016

UNIFIED SOIL CLASSIFICATION GROUP SYMBOL

- ▨ GP
- ▨ CL
- ▨ GP-GC
- ▨ GM
- ▨ SM
- ▨ ML
- ▨ SP

Notes:
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 2 for location of Cross Section.
3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

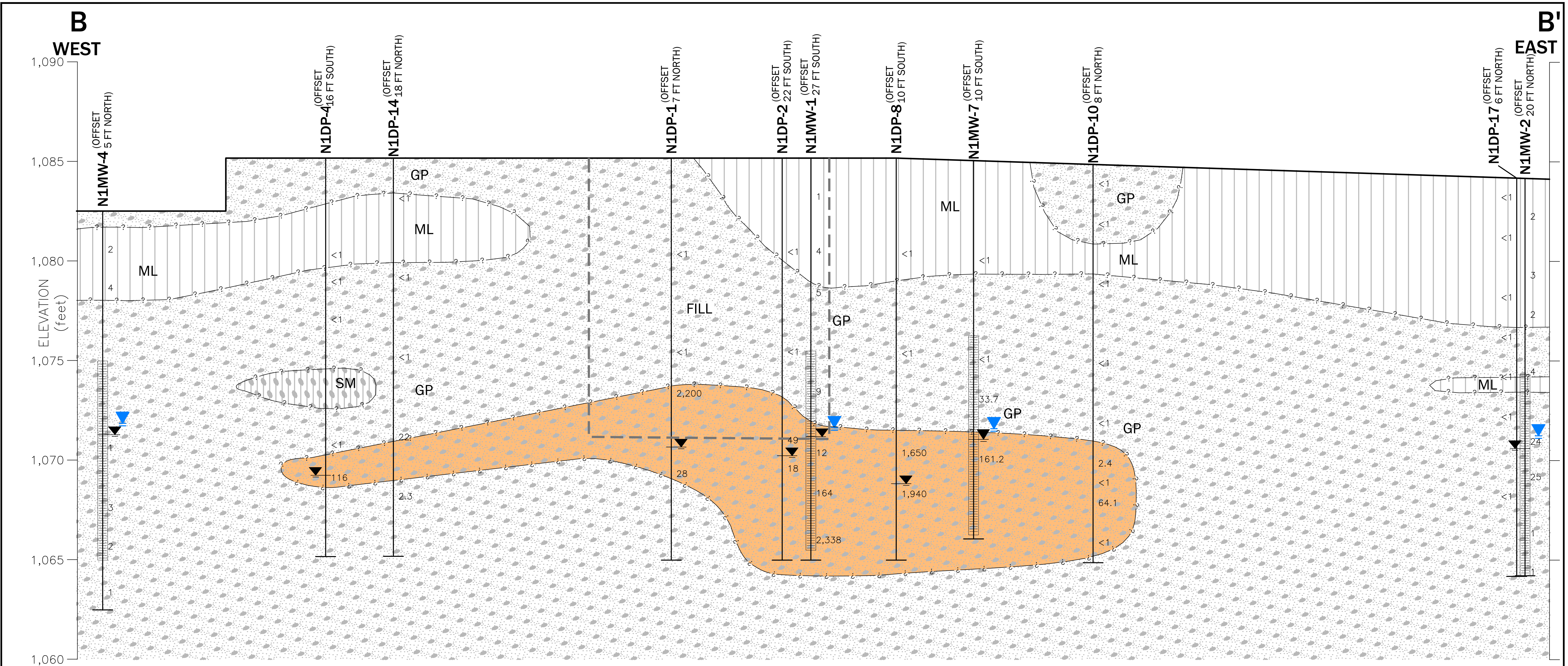
Subsurface Cross Section A-A' and PID Readings

Tiger Oil North 1st
Yakima, Washington

GEOENGINEERS

Figure 4

P:\0\0504101\CAD\03\Environmental Report\0504101103_T400_F04_F05_Tiger Oil North 1st_Cross Sections.dwg TAB:F4 Date Exported: 03/30/17 - 12:07 by hmara



LEGEND:

N1MW-4 (OFFSET 5 FT NORTH) — BORING / MONITORING WELL NUMBER AND APPROXIMATE LOCATION

2 — PID READINGS

SP — SOIL TYPE AT SAMPLE LOCATION

—?—?—?— SOIL CONTACT

▼ MEASURED GROUNDWATER LEVEL IN EXPLORATION AT TIME OF DRILLING

▥ SCREEN LOCATION

🟧 INTERPRETED ZONE OF SOIL CONTAMINATION BASED ON REVIEW OF ANALYTICAL DATA, FIELD DATA AND ENGINEERING JUDGEMENT

▼ GROUNDWATER ELEVATION CALCULATED FROM DEPTH TO WATER MEASUREMENTS COLLECTED ON NOVEMBER 2016

– – – APPROXIMATE FORMER TANK PIT LOCATION

UNIFIED SOIL CLASSIFICATION GROUP SYMBOL

▨	GP
▨	SM
▥	ML

20 0 20
Horizontal Scale in Feet
5 0 5
Vertical Scale in Feet
Vertical Exaggeration: 4X

Notes:
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 2 for location of Cross Section.
3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

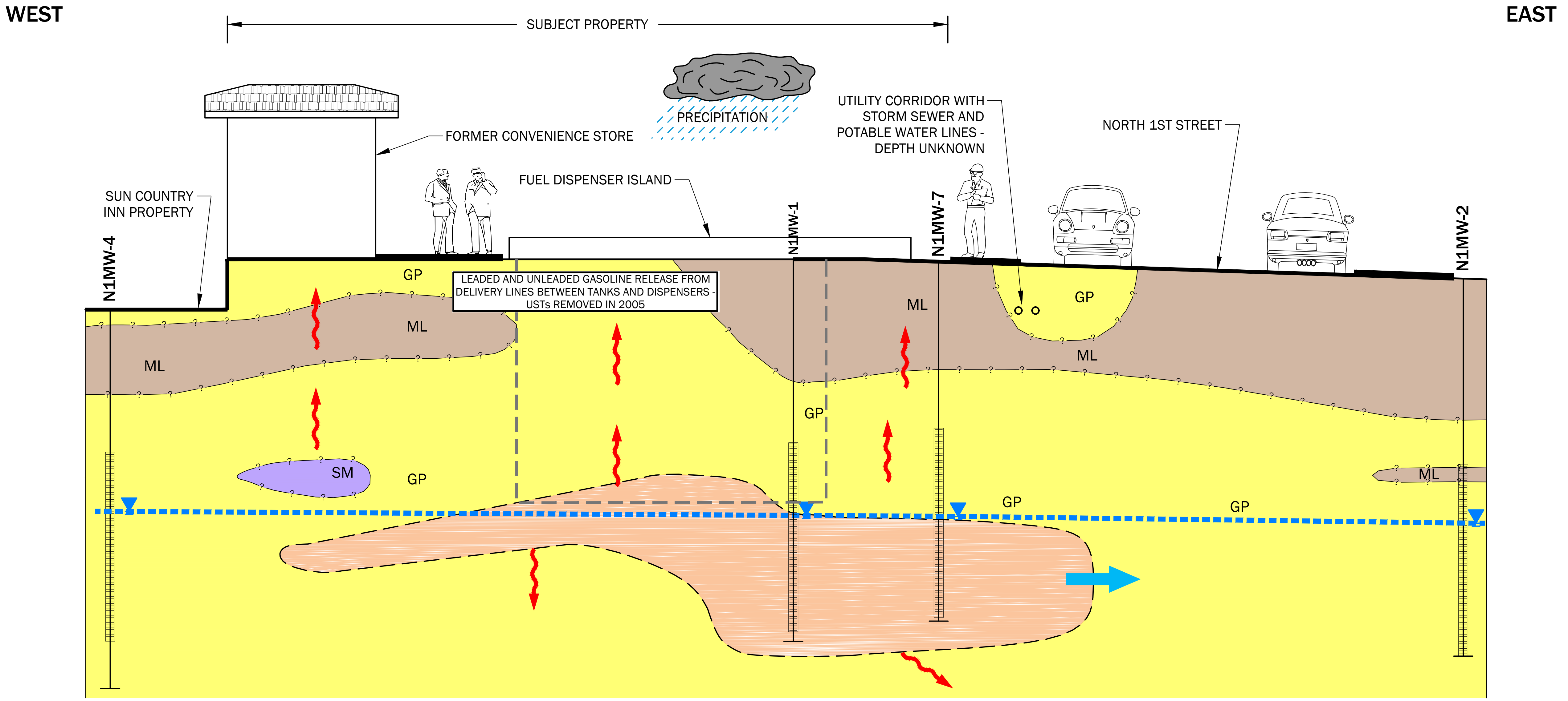
Subsurface Cross Section B-B' and PID Readings

Tiger Oil North 1st
Yakima, Washington

GEOENGINEERS

Figure 5

P:\0\0504101\CAD\03\Environmental Report\050410103_T400_F04_F05_Tiger Oil North 1st_Cross Sections.dwg TAB:F5 Date Exported: 03/30/17 - 12:09 by hmara



LEGEND:

N1MW-1 MONITORING WELL IDENTIFICATION AND APPROXIMATE LOCATION

SP SOIL TYPE AT SAMPLE LOCATION

—?—?—?— SOIL CONTACT

SCREEN LOCATION

PRECIPITATION/INFILTRATION (AVERAGE 8-INCHES/YEAR)

➡ GROUNDWATER FLOW DIRECTION

INTERPRETED ZONE OF CONTAMINANT PLUME (PETROLEUM HYDROCARBONS, PAHs, VOCs)

UNIFIED SOIL CLASSIFICATION GROUP SYMBOL

🟨	GP	POORLY-GRADED GRAVEL
🟪	SM	SILT WITH SAND/SANDY SILT
🟫	ML	SILT

GROUNDWATER TABLE - AVERAGE GRADIENT 0.0025 FEET/FOOT

ASPHALT OR CONCRETE IMPERVIOUS SURFACE

APPROXIMATE FORMER TANK PIT

POTENTIAL CONTAMINANT MIGRATION PATHWAY (VAPOR INTRUSION, LEACHING TO GROUNDWATER)

Notes:
1. The subsurface conditions shown are based on interpolation between widely spaced explorations and should be considered approximate; actual subsurface conditions may vary from those shown.
2. Refer to Figure 5 for location of Cross Section.
3. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

NOT TO SCALE

Conceptual Site Model

Tiger Oil North 1st
Yakima, Washington

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Figure 6

APPENDIX A

Hydrogeologic Evaluation, Gasoline Spill Investigation, May 8, 1985

RECEIVED
MAY - 9 1985
DEPARTMENT OF
CENTRAL REGION

HYDROGEOLOGIC EVALUATION
GASOLINE SPILL INVESTIGATION
TIGER OIL
YAKIMA, WASHINGTON

N. 1st

May 8, 1985

#120-12955

soil exploration company

SOIL EXPLORATION COMPANY
662 CROMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/645-6446

a sister corporation to TWIN CITY TESTING AND ENGINEERING LABORATORY INC.

May 8, 1985

Federated Insurance Company
129 East Broadway
Owatonna, Minnesota 55060

Attn: Mr. Brad Nesseth

Subj: Hydrogeologic Evaluation
Gasoline Spill Investigation
Tiger Oil
Yakima, Washington
#120-12955

OFFICERS:
CHARLES W. BRITZIUS
chairman of the board
NORMAN E. HENNING
president
ROBERT F. WITTMAN
executive vice president
CLINTON R. EUE
secretary/treasurer

HOME OFFICE:
ST. PAUL, MN

OFFICES IN:
MANKATO, MN
ROCHESTER, MN
WAITE PARK, MN

Gentlemen:

We have completed our subsurface investigation for the above referenced site as verbally authorized by Mr. Brad Nesseth on November 16, 1984. We are transmitting five copies of our report to you. Additional copies will be forwarded as noted below.

All the samples received from our test borings will be held at this office for a period of three months following the date of this report. The samples will then be discarded unless we are notified to hold them for a longer period of time.

We appreciate the opportunity to have served you in regard to this project. If you have any questions regarding the information in this report, or if we can be of additional service, please contact us.

Very truly yours,

Soil Exploration Company

Mark S. Mason
Project Manager/Environmental Geologist

MSM/pp

Encs.

cc: 1 - Washington Department of Ecology
Attn: Mr. Al Newman
1 - IT Corporation
Attn: Mr. John Clark
1 - Zaremba Claims Services
Attn: Mr. Ronald Zaremba
1 - Weeks, Dietzen & Skala
Attn: Mr. Roland Skala

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Figures

TABLE OF CONTENTS (continued)

HYDROGEOLOGIC EVALUATION
GASOLINE SPILL INVESTIGATION
TIGER OIL
YAKIMA, WASHINGTON
120-12955

1.0 INTRODUCTION

The purpose of our work performed at this site was to define hydrogeologic conditions influencing the movement and migration of petroleum products and to provide information relative to evaluating the horizontal and vertical distribution of petroleum product contamination.

The scope of our services provided on this project consisted of the following.

1. Mobilizing to the site on November 30, 1984, to evaluate site conditions, and meet with local representatives and the Washington Department of Ecology.
2. Installing 12 monitoring wells for providing water level and water quality information.
3. Pumping all monitoring wells at a rate of 7 GPM for a minimum of 10 minutes or until clear discharge water was observed.
4. Collecting water samples from the previously mentioned monitoring wells and 9 private residences.
5. Analyzing all water samples for the presence of total hydrocarbons expressed as gasoline, benzene, toluene and xylene concentrations.
6. Preparing a final report which presents information regarding ground water remediation.

2.0 BACKGROUND INFORMATION

2.1 Project History

The Tiger Oil Exxon station is located on North First Street, Yakima, Washington (Figure 1). As we understand, the station was constructed in May and June, 1979. Regular, premium, unleaded and diesel petroleum products are stored below ground and distributed.

Hydrostatic testing of all dispenser lines was conducted during September, 1982. At that time, all lines produced a positive test (indicating leakage). All lines were subsequently replaced.

An environmental consultant from Seattle was retained by Tiger Oil to assess the environmental impact of the lost petroleum products. Fourteen monitoring wells were installed as part of their effort. At that time, petroleum product contamination appeared to be confined locally, and two recovery wells and one injection well were drilled to facilitate free product removal. Approximately 40 gallons of gasoline were recovered. Pumpage exceeded 100 GPM and minimal drawdown in the recovery well was achieved.

An additional three monitoring wells were later installed to further delineate the extent of hydrocarbon contamination (May 9, 1983). This extended study concluded that hydrocarbon migration was still limited to an area approximately 250' downgradient from the Tiger Oil station.

Due to unknown monitoring well construction details and previous monitoring well abandonment, only three of the seventeen monitoring wells were included in our study.

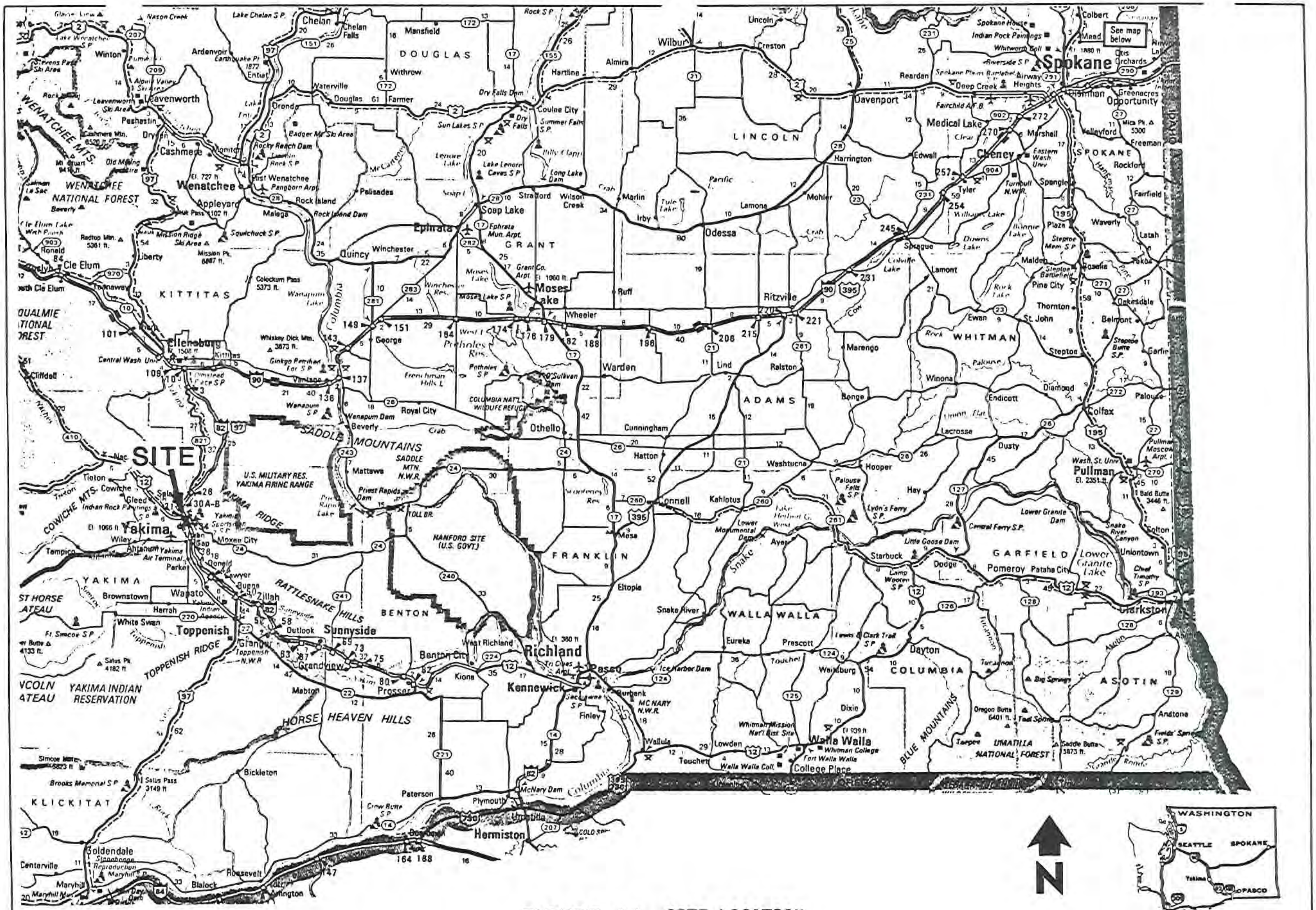


FIGURE #1 SITE LOCATION

YAKIMA, WASHINGTON

SOIL EXPLORATION
company

2.2 Site Information

The Tiger Oil Exxon station is located in a business/residential district on North First Street, Yakima, Washington (Figure 2). U.S. Highway 12 is located approximately 850' north of the station. The station is constructed on the alluvial floodplain of the Yakima River. Parent material for the alluvium is derived from the surrounding basaltic bluffs. Local relief on the floodplain is minimal, with a low gradient maintained toward the Yakima River. The Yakima River is approximately 1000' NE of the Tiger Oil station, and is the local ground water discharge point.

3.0 PROJECT RESULTS

3.1 Soil Conditions

Twelve additional soil borings were drilled at this site between November 17, 1984, and February 20, 1985 (Figure 2). All soil borings were finished as monitoring wells. A W-22 Bucyrus Erie cable tool drilling rig was used to advance all borings. Using this method, only composite samples were recovered.

The results of the soil borings are presented on the attached logs in Appendix 1. A review of these logs indicates that the upper 21' of soil are primarily alluvial deposits consisting of lean clay to silty clay, with a little gravel from 0'-6'. In all borings the clays were underlain by coarse alluvium consisting of silty sand with a little gravel. Cobbles and boulders were encountered at all depths.

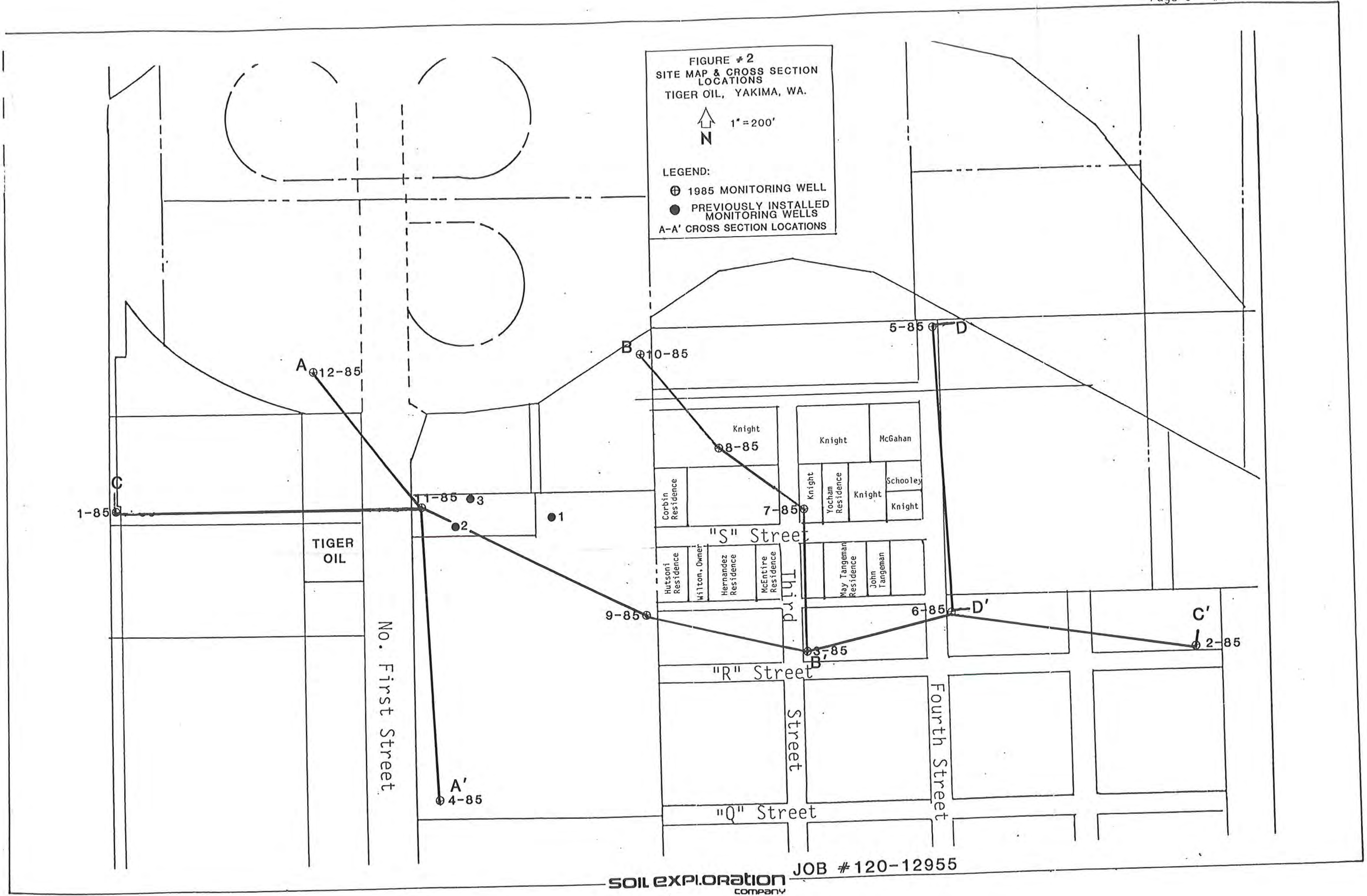
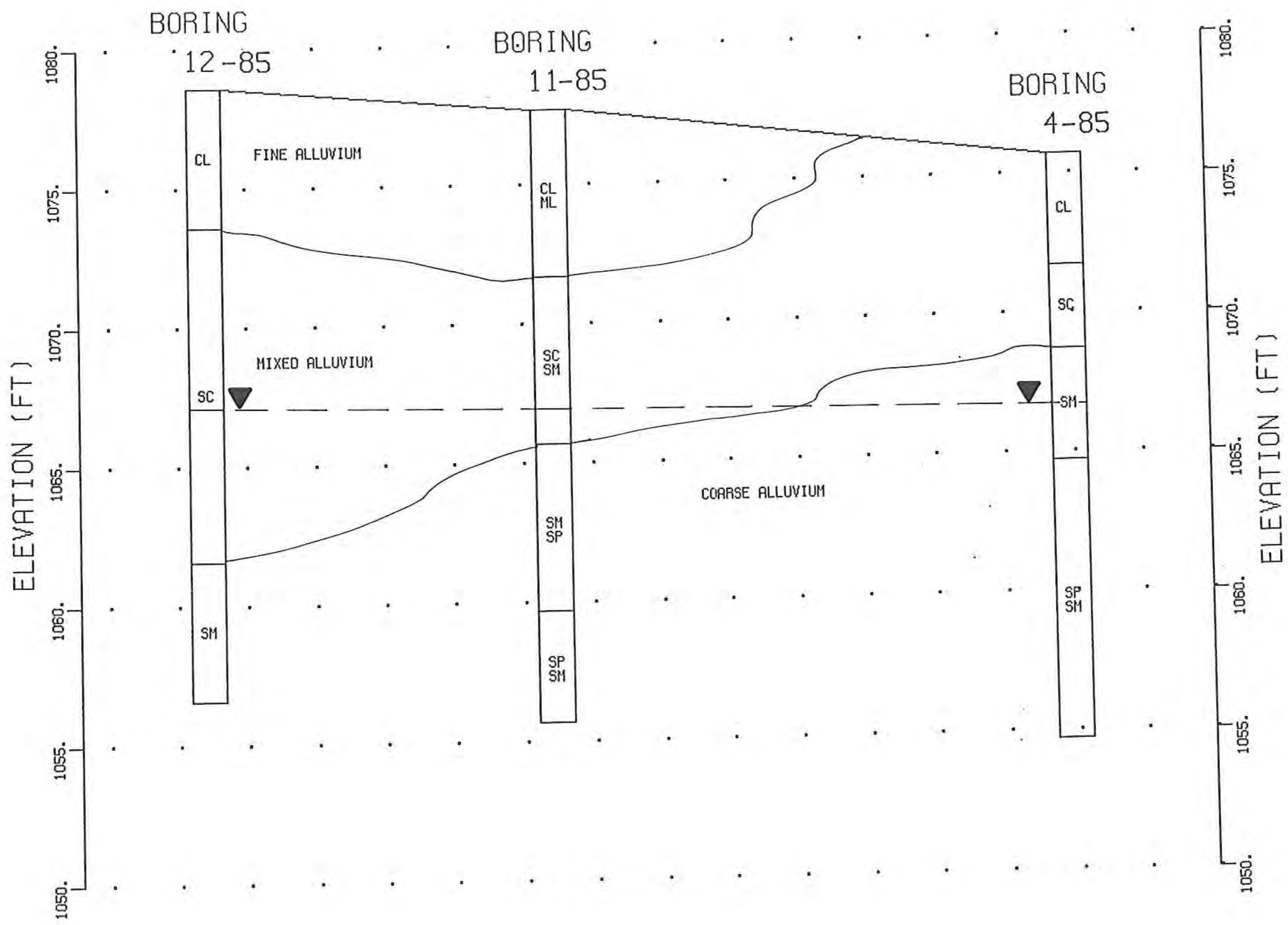


FIGURE #2
SITE MAP & CROSS SECTION LOCATIONS
TIGER OIL, YAKIMA, WA.

JOB #120-12955

A ⟷ A'

CROSS SECTION LOCATIONS SHOWN ON FIGURE #2



NOTE: EXCEPT AT BORING LOCATIONS THE GROUND SURFACE, WATER LEVEL, AND BOUNDARIES BETWEEN SOIL LAYERS ARE INFERRED.

FIGURE #3

SOIL PROFILE

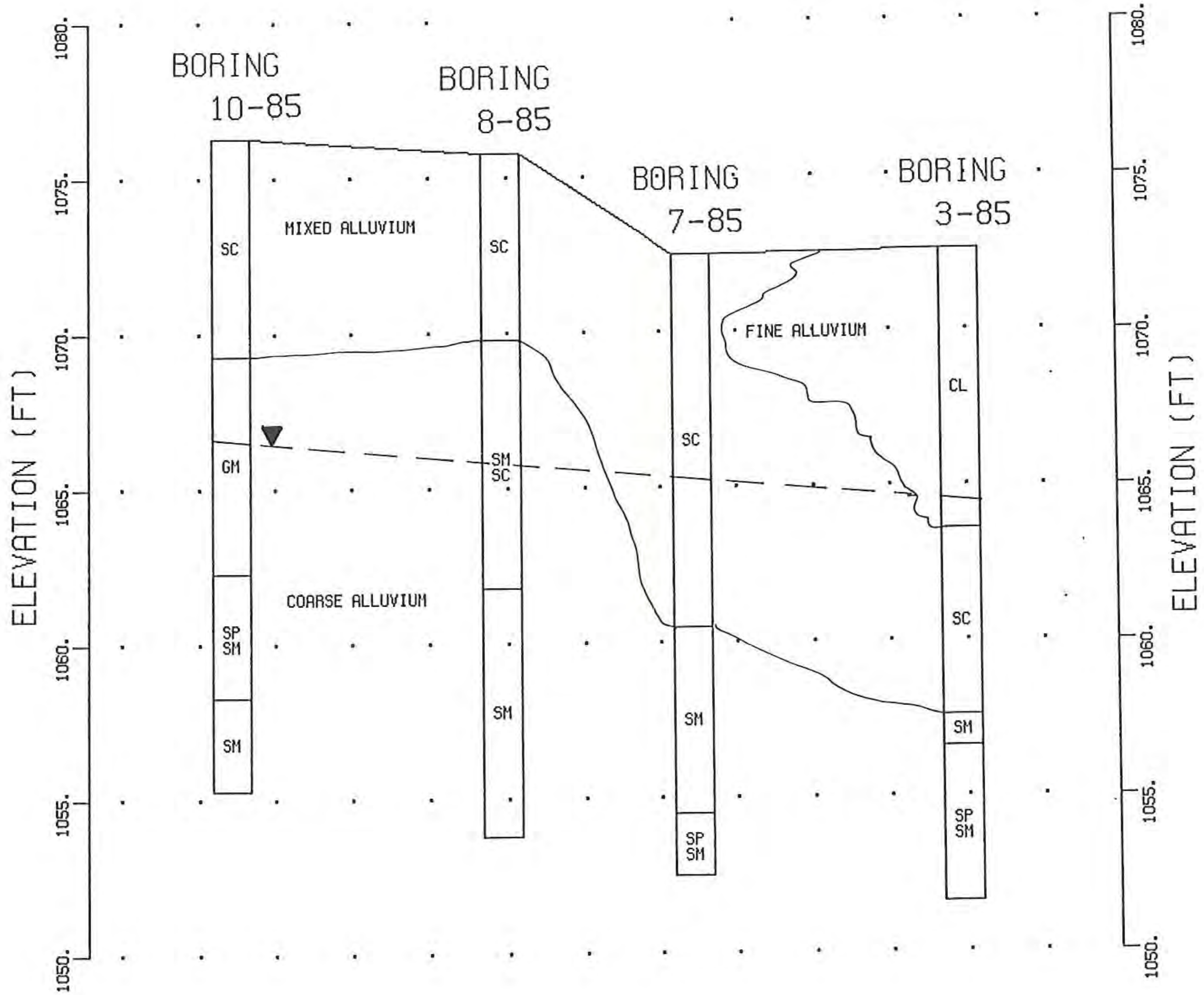
GASOLINE SPILL INVESTIGATION
YAKIMA, WASHINGTON
W.O. 120-12955

SOIL EXPLORATION COMPANY

SCALE: VERT: 1 IN = 5. FT
HORZ: 1 IN = 200. FT

B ↔ B'

CROSS SECTION LOCATIONS SHOWN ON FIGURE #2



NOTE: EXCEPT AT BORING LOCATIONS THE GROUND SURFACE, WATER LEVEL, AND BOUNDARIES BETWEEN SOIL LAYERS ARE INFERRED.

FIGURE #4

SOIL PROFILE

GASOLINE SPILL INVESTIGATION
YAKIMA, WASHINGTON
W.O. 120-12955

SOIL EXPLORATION COMPANY

SCALE: VERT: 1 IN = 5. FT
HORZ: 1 IN = 200. FT

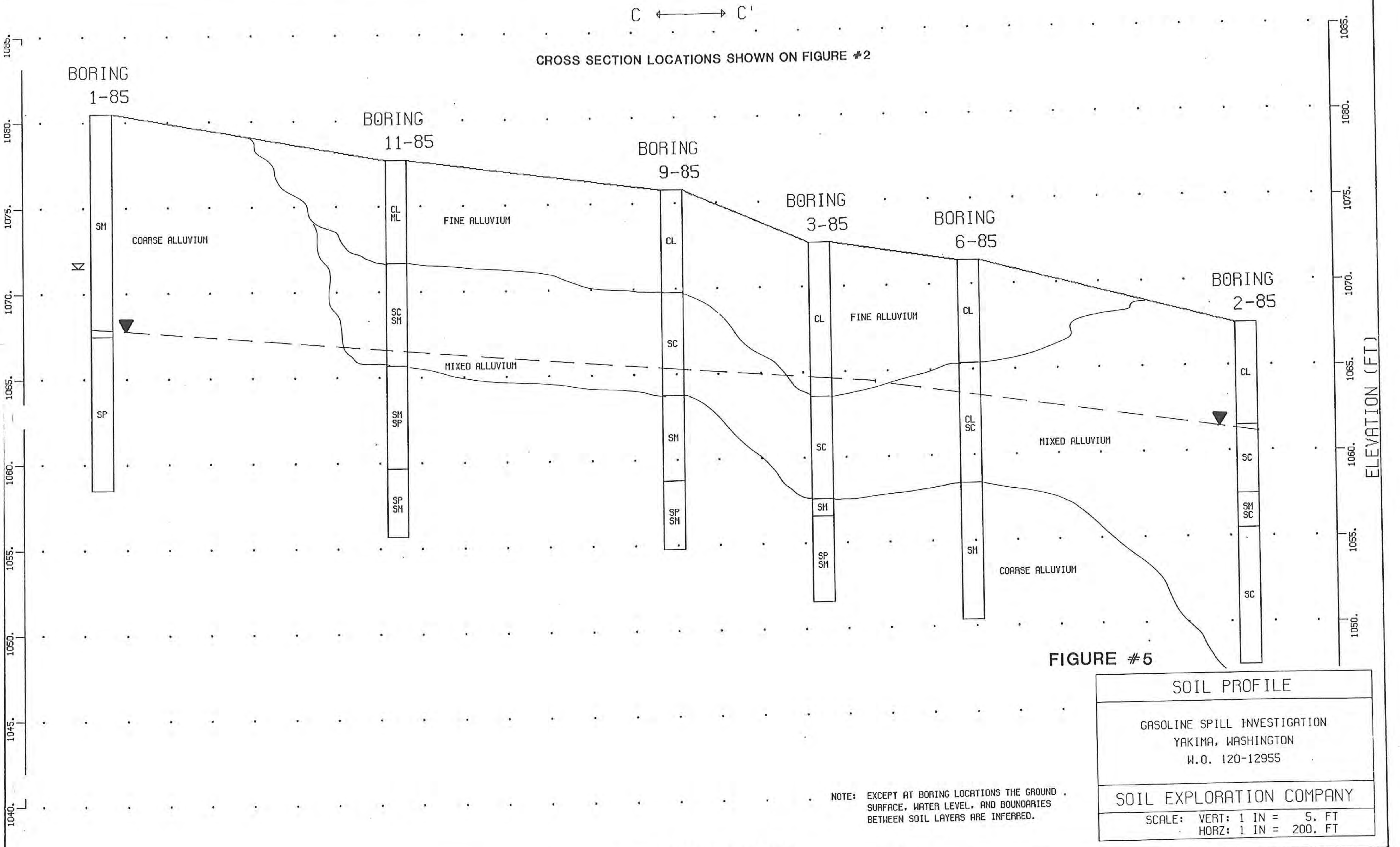


FIGURE #5

SOIL PROFILE

GASOLINE SPILL INVESTIGATION
YAKIMA, WASHINGTON
W.O. 120-12955

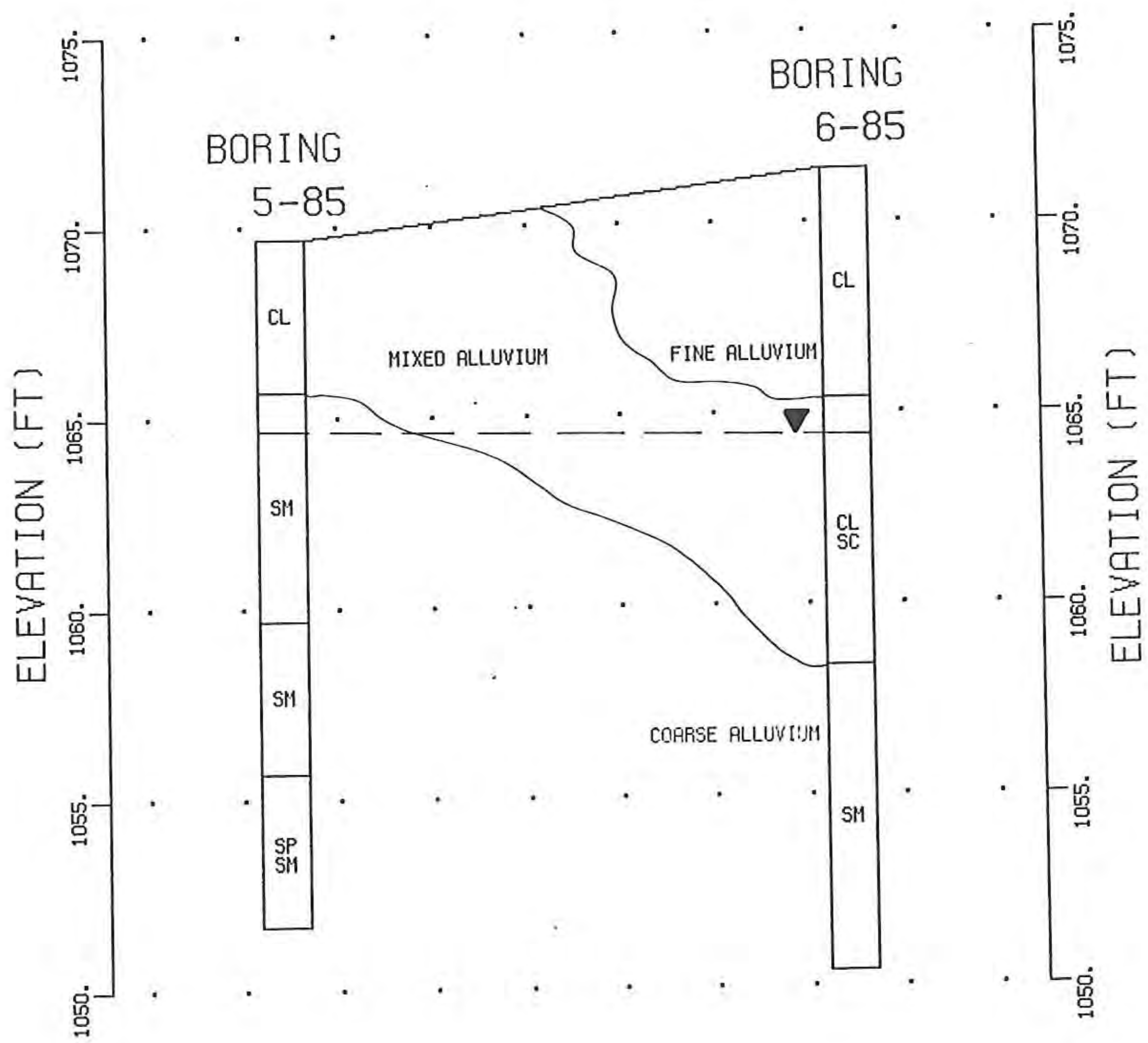
SOIL EXPLORATION COMPANY

SCALE: VERT: 1 IN = 5. FT
HORZ: 1 IN = 200. FT

NOTE: EXCEPT AT BORING LOCATIONS THE GROUND SURFACE, WATER LEVEL, AND BOUNDARIES BETWEEN SOIL LAYERS ARE INFERRED.

D ↔ D'

CROSS SECTION LOCATIONS SHOWN ON FIGURE #2



NOTE: EXCEPT AT BORING LOCATIONS THE GROUND SURFACE, WATER LEVEL, AND BOUNDARIES BETWEEN SOIL LAYERS ARE INFERRED.

FIGURE #6

SOIL PROFILE

GASOLINE SPILL INVESTIGATION
YAKIMA, WASHINGTON
W.O. 120-12955

SOIL EXPLORATION COMPANY

SCALE: VERT: 1 IN = 5. FT
HORZ: 1 IN = 200. FT

Figures 3, 4, 5 and 6 present cross-sectional illustrations of soil conditions inferred from our boring logs.

3.2 Monitoring Wells

Two inch diameter flush thread schedule 40 PVC monitoring wells were installed in all borings. All monitoring wells are equipped with 15' of screen. The final screening interval was decided in the field after depth to ground water data was available. All wells with the exception of 2-85 and 5-85 are installed such that 10' of screen extends below the water table and 5' extends above the static water table on the day that they were installed. Monitoring wells 2-85 and 5-85 are screened such that approximately 11' of screen extends into the water table. This decision was based on depth to ground water data of approximately 6' and a minimum criteria of one foot of filter sand above the screen before the grout seal. All monitoring wells were filter packed with coarse sand.

3.3 Ground Water

Stabilized ground water elevations and surface elevation data are presented on Tables 1 and 2. A review of these tables indicates that depth to ground water varies from 5.43' below the surface at monitoring well 5-85 to 12.96' below the surface at monitoring well 1. Figure 7 presents a ground water contour map generated from the water level data recorded on February 20, 1985.

Table 2

Ground Water and Surface Elevation Data (2-21-85)

Location	Date	Ground Elevation	Reference Elevation*	Depth to Water From Top of 2" PVC Riser	Ground Water Elevation
1-85	2-21-85	1080.5	1080.34	12.78	1067.56
2-85	2-21-85	1067.5	1066.98	5.79	1061.19
3-85	2-21-85	1072.6	1072.18	7.69	1064.49
4-85	2-21-85	1075.7	1075.74	9.00	1066.74
5-85	2-21-85	1069.7	1069.38	5.10	1064.28
6-85	2-21-85	1071.4	1071.13	7.17	1063.96
7-85	2-21-85	1072.5	1072.15	7.14	1065.01
8-85	2-21-85	1075.8	1075.66	9.53	1066.13
9-85	2-21-85	1075.8	1075.48	9.54	1065.94
10-85	2-21-85	1076.3	1076.03	9.38	1066.65
11-85	2-21-85	1077.7	1077.21	10.48	1066.73
12-85	2-21-85	1078.6	1078.24	11.25	1066.99
1	2-21-85	1078.1	1080.34	13.72	1066.62
2	2-21-85	1078.0	1080.45	13.88	1066.57
3	2-21-85	1076.9	1079.49	12.70	1066.79

* Reference Elevation = Top of 2" PVC riser.

All reference and ground surface elevations were surveyed by a local professional land surveyor and referenced to Yakima county datum (same as USC and GS sea level datum).

Table 1

Ground Water and Surface Elevation Data (2-20-85)

Location	Date	Ground Elevation	Reference Elevation*	Depth to Water From Top of 2" PVC Riser	Ground Water Elevation
1-85	2-20-85	1080.5	1080.34	--	--
2-85	2-20-85	1067.5	1066.98	5.74	1061.24
3-85	2-20-85	1072.6	1072.18	7.60	1064.58
4-85	2-20-85	1075.7	1075.74	9.00	1066.74
5-85	2-20-85	1069.7	1069.38	5.11	1064.27
6-85	2-20-85	1071.4	1071.13	7.17	1063.96
7-85	2-20-85	1072.5	1072.15	7.11	1065.04
8-85	2-20-85	1075.8	1075.66	9.51	1066.15
9-85	2-20-85	1075.8	1075.48	9.54	1065.94
10-85	2-20-85	1076.3	1076.03	9.38	1066.65
11-85	2-20-85	1077.7	1077.21	10.48	1066.73
12-85	2-20-85	1078.6	1078.24	11.25	1066.99
1	2-20-85	1078.1	1080.34	--	--
2	2-20-85	1078.0	1080.45	--	--
3	2-20-85	1076.9	1079.49	--	--

* Reference Elevation = Top of 2" riser.

All reference and ground surface elevations were surveyed by a local professional land surveyor and referenced to Yakima county datum (same as USC and GS sea level datum).

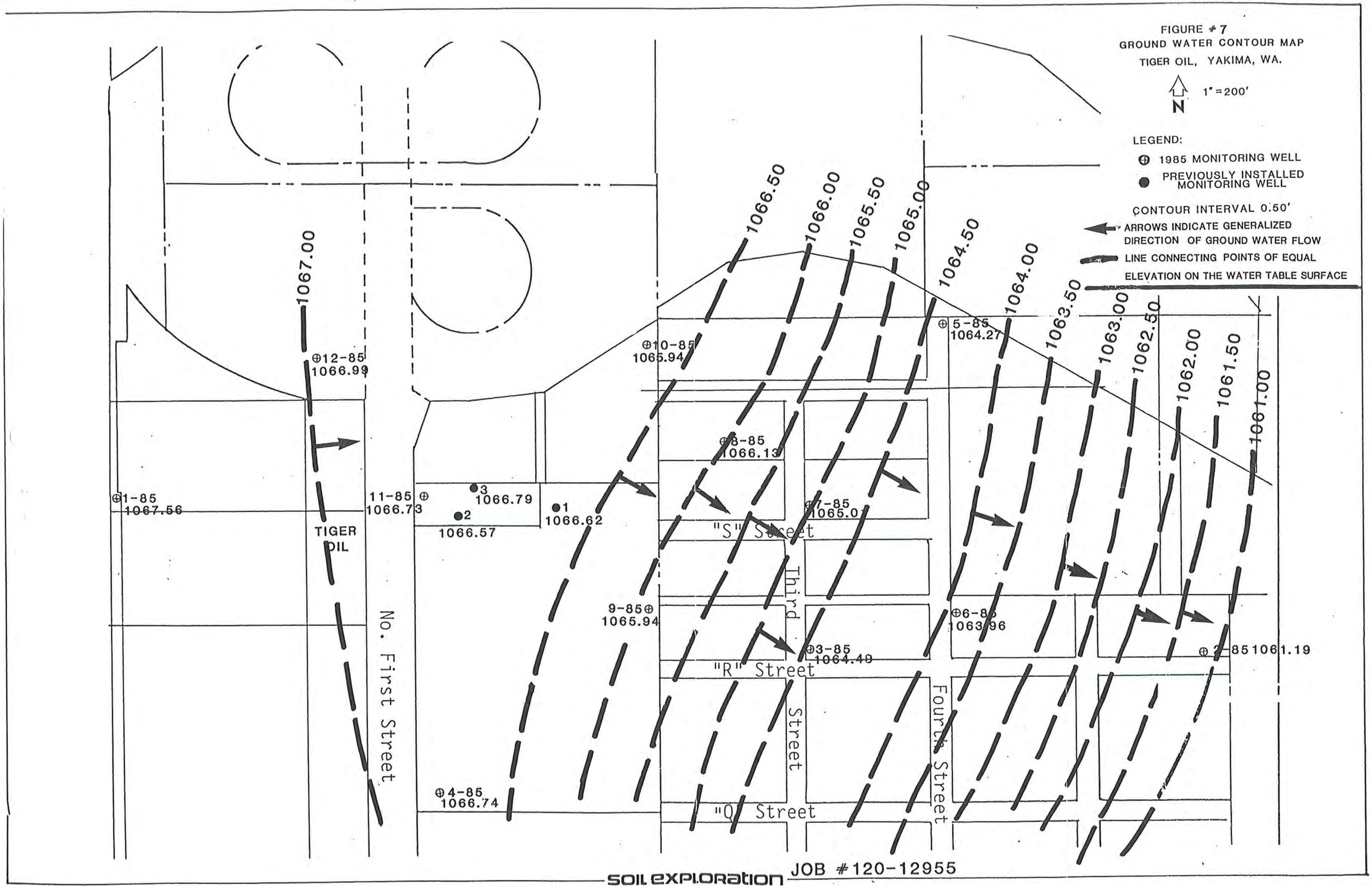


FIGURE # 7
GROUND WATER CONTOUR MAP
TIGER OIL, YAKIMA, WA.

SOIL EXPLORATION COMPANY JOB #120-12955

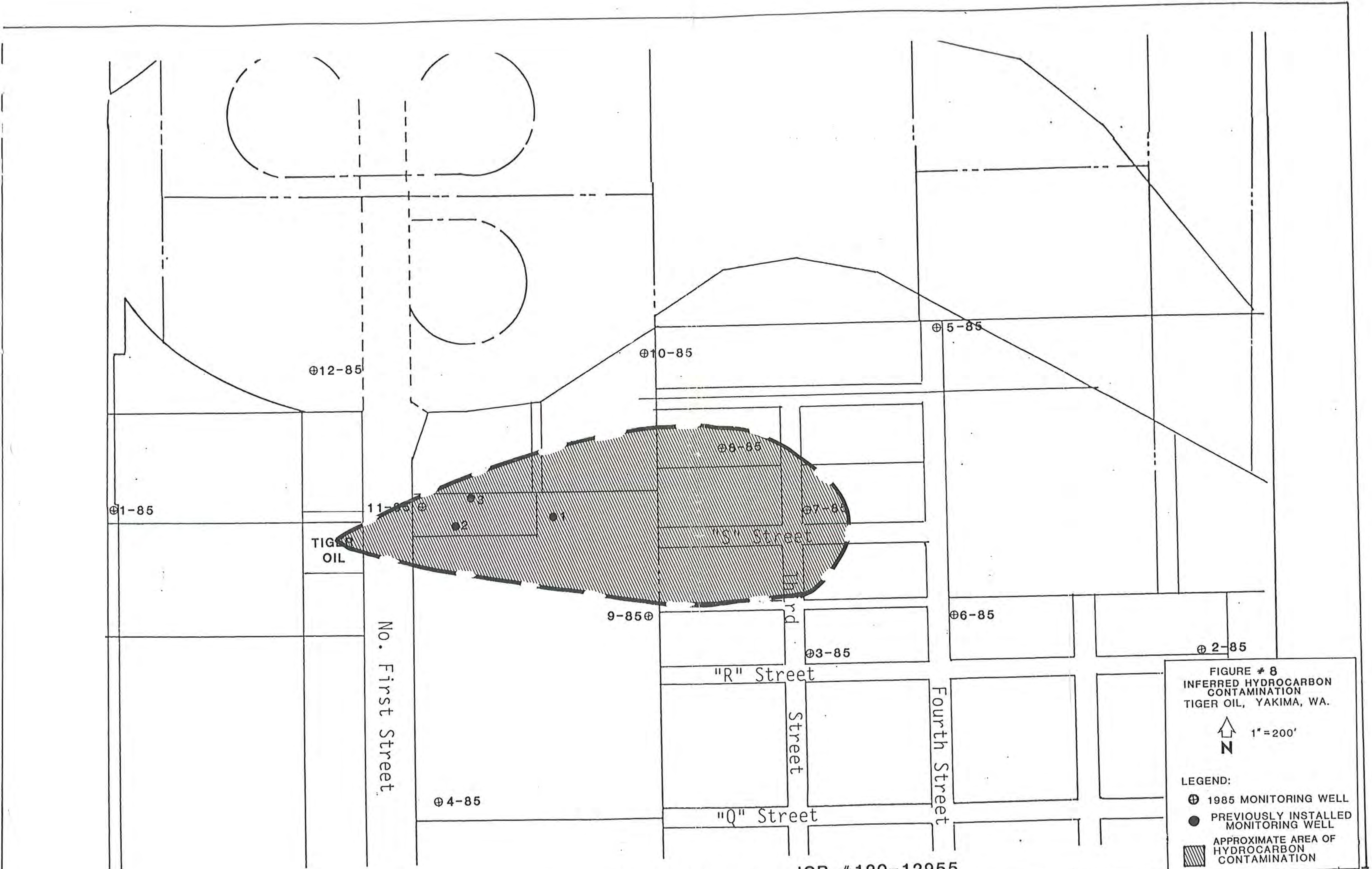


FIGURE # 8
INFERRED HYDROCARBON CONTAMINATION
TIGER OIL, YAKIMA, WA.

JOB #120-12955

soil exploration company

TABLE 4

Volatile Analysis

(Sampled February 21, 1985)

Parameter	MW-1 (ug/L)	MW-2 (ug/L)	MW-3 (ug/L)	MW-4 (ug/L)	MW-5 (ug/L)	MW-6 (ug/L)	MW-7 (ug/L)	MW-8 (ug/L)	MW-9 (ug/L)	MW-10 (ug/L)	MW-11 (ug/L)	MW-12 (ug/L)	Lower Detectable Limit (ug/L)
Total Hydrocarbons as Gasoline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	23390	ND	1
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1460	ND	1
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5300	ND	1
Xylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6260	ND	1

For purposes of these samples ug/L = ppb

ND = Not Detected

Examination of Table 3 indicates that residual hydrocarbon contamination of the soils appears to be confined to the areas near borings 11-85 and 8-85 (Figure 8).

3.5 Chemical Analysis Results

Water samples collected on February 19, February 21, and March 25, 1985 were forwarded to our sister company, Twin City Testing and Engineering Laboratory, Inc., for analysis to quantify concentrations of benzene, toluene, xylene and total hydrocarbons expressed as gasoline. Table 4 presents the results for the chemical analysis. Sampling information forms for all samples collected on February 19 and 21, 1985 are located in Appendix II. Chain of custody forms for all samples are attached in Appendix III.

Review of the data presented in Table 4 indicates that monitoring well 11 and the Yocham residence private water supply well contain hydrocarbon contamination. Hydrocarbon contamination of the Yocham well appears to have increased when sampled on March 25, 1985. This may be due to increased ground water infiltration caused by spring thawing. Chemical analysis methodology procedures are included in Appendix IV.

Water level measurements combined with vertical and horizontal controls indicate that potential for ground water flow is generally eastward through the study area (Figure 7). We have calculated the hydraulic gradient to be 0.0023. The local ground water discharge point is the Yakima River, which is approximately 2,500 feet downgradient from the site. We have been informed by Washington Department of Ecology personnel that the hydraulic gradient generally increases during the summer due to irrigation.

3.4 Petroleum Product Observations

As our borings were advanced, all recovered soil samples were examined for the presence of fuel oil using visual appearance and odor as criteria. Table 3 summarizes the vertical zone of petroleum product contamination as inferred from the boring data.

Table 3

Petroleum Product Observations

Boring #	Interval of Contamination	Comments
1-85	--	Not detected
2-85	--	Not detected
3-85	--	Not detected
4-85	--	Not detected
5-85	--	Not detected
6-85	--	Not detected
7-85	--	Not detected
8-85	Sample designated as 14-22'	Slight gasoline odor
9-85	--	Not detected
10-85	--	Not detected
11-85	6-12'	Strong gasoline odor
	12-18'	Slight gasoline odor
12-85	--	Not detected

TABLE 4 (cont)

Volatile Analysis
(Sampled February 19, 1985)

Parameter	Wilton (ug/L)	Hernand. (ug/L)	Corbin (ug/L)	Tangeman (ug/L)	Yocham (ug/L)	McGohan (ug/L)	Hutson (ug/L)	Suddeth (ug/L)	Knight (ug/L)	Lower Detectable Limit (ug/L)
Total Hydrocarbons as Gasoline	ND	ND	ND	ND	14	ND	ND	ND	ND	1
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Xylene	ND	ND	ND	ND	5	ND	ND	ND	ND	1

For purposes of this sample ug/L = ppb

ND = Not Detected

NOTE: Well locations are shown on Figure 2.

TABLE 4 (cont)

Volatile Analysis

(Sampled March 25, 1985)

Parameter	#3003 Knight (ug/L)	#3004 Yocham (ug/L)	Lower Detectable Limit (ug/L)
Total Hydrocarbons as Gasoline	ND	3120	1
Benzene	ND	28	1
Toluene	ND	680	1
Xylene	ND	980	1

For purposes of these samples ug/L = ppb

ND = Not Detected

4.0 DISCUSSION

Based on the data presented, we feel that low concentrations of dissolved hydrocarbons are present in the surficial aquifer. Water quality data, combined with soil contamination observations, indicate that a vertical zone of residual soil contamination may exist.

During periods of high infiltration (i.e., spring thaw, irrigation season), percolating ground water removes adsorbed hydrocarbons from the soils. Generally, this type of infiltration is usually associated with increased ground water elevations. Dissolved hydrocarbons will in turn be transported and diffused downgradient, which will eventually result in an enlarging plume.

As infiltration decreases, ground water elevations may drop. As the water table drops, some dissolved hydrocarbons will again adsorb to soil particles and be rendered immobile.

This cycling of the water table will produce maximum dissolved hydrocarbon contamination during the mobile phase, and minimal dissolved hydrocarbon contamination during the immobile phase, or low water phase, when water flows through the lower soils that have reduced or no residual hydrocarbon contamination.

This hypothesis is supported by contaminated soils being observed at monitoring well 8-85 (using odor as a criterion) and no dissolved hydrocarbon contamination being detected in the water sample collected at MW-8 on February 21, 1985.

We should point out that shallow private water supply wells may act as gradient control wells, which may concentrate hydrocarbons locally and produce potable water of unacceptable quality.

5.0 RECOMMENDATIONS

5.1 General

Based on our findings, we feel that a "pocket" of free gasoline does not exist. In view of this, ground water depression for product recovery is not recommended. Due to the high hydraulic conductivity, past efforts to significantly depress the water table failed. Considering this, gradient control should not be used as a feasible alternative to cleaning up hydrocarbon contamination.

As we understand, alternative water supplies (deep wells, city water supply) have been provided for area residents that have wells which have been affected by hydrocarbon contamination. Due to the remedial nature of this action, we recommend that a monitoring program be implemented to document ground water flow and quality over a period of one year before re-evaluating site conditions and possible implementation of other remedial measures.

5.2 Monitoring Program

Table 5 outlines the schedule for monitoring and sampling through April, 1986. Should unusually high hydrocarbon concentrations occur in any of our monitoring wells during this monitoring period, we will evaluate this anomaly accordingly.

We propose to submit factual reports to the Washington Department of Ecology on a quarterly basis. Summary reports will include water level and quality data generated during the quarterly sampling/monitoring interval. Field observations and our interpretation of the data will be included in these reports.

Table 5

Monitoring and Sampling Schedule

Date	Task					
	Water Levels all Monitoring Wells	Sample all 1985 MW	Sample Knights Residence	Sample* Select Private Wells	Qtrly Report	Annual Report
May 1985	X	X	X	X		
June 1985	X		X		X	
July 1985	X		X			
Aug 1985	X	X	X	X		
Sept 1985	X				X	
Oct 1985	X					
Nov 1985	X	X	X	X		
Dec 1985	X				X	
Jan 1986	X					
Feb 1986	X	X	X	X		
March 1986	X					
April 1986	X					X

* Private wells to be sampled will be decided on a quarterly basis.

6.0 METHODS

6.1 Soil Sampling and Classification

As our borings were advanced, composite soil samples were collected when a change in soil conditions or hydrocarbon contamination was noted. All soil samples were visually and manually classified by our geologist in accordance with ASTM: D 2487-83. Representative samples were returned to our laboratory for further examination and verification of field classification. Charts illustrating the soil classification procedures and descriptive terminology and symbols used on the soil boring logs are attached in Appendix V.

All borings were put down using a 6" cable tool. Only disturbed composite samples were recovered. Because of this method, our determination of the depth and extent of the various layers of soil and the consistency of cohesive soils are only approximate.

6.2 Monitoring Well Installation

Information regarding monitoring well construction and installation is provided on the attached monitoring well construction sheets (Appendix VI).

6.3 Water Sampling

Ground water samples were collected after a minimum of 3 well volumes of ground water were extracted from the monitoring well. Water samples were collected using dedicated "clean" bottom loading Teflon bailers with virgin rope. All samples were preserved with blue ice and transported to Twin City Testing and Engineering Laboratory, Inc. for analysis before a 14-day holding time elapsed.

Water samples collected from private wells were collected after a non-filtered, non-aereated cold water faucet had been running at a rate of approximately 1 GPM for a 30-minute period. All samples were preserved with blue ice.

7.0 REMARKS

The recommendations contained in this report represent our professional opinions. These opinions were arrived at in accordance with currently accepted engineering practices at this time and location. Other than this, no warranty is implied or intended.

This report was written by: Mark S. Mason

Mark S. Mason
Project Manager/Environmental Geologist

Date: May 8, 1985

This report was reviewed by: Jerry R

Jerry R. Rick, Manager
Environmental Department

Date: May 8, 1985

LOG OF TEST BORING

JOB NO. 120-12955 VERTICAL SCALE 1" = 3' BORING NO. 3-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

TH FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1072.6'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	COMMENTS
	LEAN CLAY, dark brown (CL)	FINE ALLUVIUM					
					1	CT	
				▼			
9	CLAYEY SAND W/GRAVEL, brown (SC)	MIXED ALLUVIUM			2	CT	
15	SILTY SAND W/A LITTLE GRAVEL, brownish gray, wet (SM)	COARSE ALLUVIUM			3	CT	
16	SAND W/SILT AND GRAVEL, medium to coarse grained, brownish gray, waterbearing (SP-SM)						
					4	CT	
21	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
1-9	12:30	16'	16'		to	8'
1-10	1:00		SEE NOTE		to	
					to	
					to	

START 1-9-85 COMPLETE 1-10-85

METHOD 6DC 0-19' @ 8:30

CT (Cable Tool) 0-21'

CREW CHIEF Mason

APPENDIX I

BORING LOGS

LOG OF TEST BORING

JOB NO. 120-12955 VERTICAL SCALE 1" = 3' BORING NO. 1-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

SURFACE ELEVATION 1080.5

TH . ÉET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	SILTY SAND W/A GRAVEL TO A LITTLE GRAVEL, cobbles above 4', brownish gray, moist to wet (SM)	COARSE ALLUVIUM					
					1	CT	
				▼	2	CT	
13	SAND W/A LITTLE GRAVEL, AND WITH GRAVEL BELOW 19', medium to coarse grained, brownish gray, waterbearing *Drilling slurry				3	CT	
21	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

START 11-17-84 COMPLETE 11-18-84

METHOD 6DC 0-17' @ 4:00

CT (Cable Tool) 0-21'

CREW CHIEF Mason

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
11-18	3:00	17'	17'		to	9' *
11-18	4:15	21'	17'		to	9½'*
11-20	9:00		See Note		to	
					to	

662 CROMWELL AVENUE **SOIL EXPLORATION COMPANY** ST PAUL, MN 55114

LOG OF TEST BORING

JOB NO. 120-12955
VERTICAL SCALE 1" = 3'
BORING NO. 2-85
PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

H FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1067.5'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	SANDY LEAN CLAY W/A LITTLE GRAVEL, dark brown (CL)	MIXED ALLUVIUM			1	CT	
6	CLAYEY SAND W/A LITTLE GRAVEL, dark brown (SC)			▼	2	CT	
10	SILTY SAND W/A LITTLE GRAVEL, brownish gray, wet (SM/SC)				3	CT	
2	CLAYEY SAND W/A LITTLE GRAVEL, brownish gray with a little reddish brown and green below about 17' (SC)				4	CT	
20	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
1-7	3:00	17'	19'		to	7'
1-8	8:00	20'	19'		to	NMR
1-8	2:00		SEE NOTE		to	
					to	

START 1-7-85 COMPLETE 1-8-85 @ 8:00

METHOD 6DC 0-19'
CT (Cable Tool) 0-21'

CREW CHIEF Mason

LOG OF TEST BORING

JOB NO. 120-12955 VERTICAL SCALE 1" = 3' BORING NO. 4-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

TH ET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE		COMMENTS
	SURFACE ELEVATION 1075.7'				NO	TYPE	
	SANDY LEAN CLAY W/A LITTLE GRAVEL, dark brown (CL)	MIXED ALLUVIUM			1	CT	
4	CLAYEY SAND W/GRAVEL, brown (SC)				2	CT	
7	SILTY SAND W/A LITTLE GRAVEL, grayish brown, wet (SM)	COARSE ALLUVIUM		▼	3	CT	
11	SAND W/SILT AND GRAVEL, grayish brown, waterbearing (SP-SM)				4	CT	
21	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-14	2:00		SEE NOTE		to	
					to	

START 1-10-85 COMPLETE 1-14-85

METHOD 6DC 0-20' @ 8:30

CT (Cable Tool) 0-21'

CREW CHIEF Mason

LOG OF TEST BORING

JOB NO. 120-12955

VERTICAL SCALE 1" = 3'

BORING NO. 5-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

TH ET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1069.7'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	CLAYEY SAND W/A LITTLE GRAVEL, brown (SC)	MIXED ALLUVIUM			1	CT	
4	SILTY SAND W/A LITTLE GRAVEL, grayish brown, moist to wet (SM)	COARSE ALLUVIUM		▼	2	CT	
10	SILTY SAND W/GRAVEL, brownish gray, wet (SM)				3	CT	
14	SANDW/SILT AND A LITTLE GRAVEL, medium to fine grained, grayish brown, waterbearing (SP-SM)				4	CT	
18	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-16	9:00		SEE NOTE		to	
					to	

START 1-14-85 COMPLETE 1-15-85 @ 2:00

METHOD 6DC 0-17'
CT (Cable Tool) 0-18'

CREW CHIEF Mason

LOG OF TEST BORING

JOB NO. 120-12955 VERTICAL SCALE 1" = 3' BORING NO. 7-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

'H FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1072.5'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	COMMENTS
	CLAYEY SAND W/A LITTLE GRAVEL, some cobbles, brownish gray (SC)	MIXED ALLUVIUM			1	CT	
				▼	2	CT	
12	SILTY SAND W/GRAVEL, brownish gray, wet (SM)	COARSE ALLUVIUM			3	CT	
18	SAND W/SILT AND A LITTLE GRAVEL, medium to fine grained, grayish brown, waterbearing (SP-SM)				4	CT	
20	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-22	3:30		SEE NOTE		to	
					to	

START 1-21-85 COMPLETE 1-22-85

METHOD 6DC 0-18' @ 1:00

CT (Cable Tool) 0-20'

CREW CHIEF Mason

LOG OF TEST BORING

JOB NO. 120-12955 VERTICAL SCALE 1" = 3' BORING NO. 6-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

TH N FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1071.4'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	LEAN CLAY W/A LITTLE GRAVEL, dark brown (CL)	FINE ALLUVIUM			1	CT	
6	SANDY LEAN CLAY W/A LITTLE GRAVEL, brown (CL/SC)	MIXED ALLUVIUM		▼	2	CT	
13	SILTY SAND W/A LITTLE GRAVEL, brownish gray, wet (SM)	COARSE ALLUVIUM			3 4	CT CT	
21	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-18	1:00		SEE NOTE		to	
					to	

START 1-17-85 COMPLETE 1-18-85

METHOD 6DC 0-19' @ 10:00

CT (Cable Tool) 0-21'

CREW CHIEF Mason

662 CROMWELL AVENUE SOIL EXPLORATION company ST PAUL, MN 55114

SE-V-18(84-B)-3

LOG OF TEST BORING

JOB NO. 120-12955

VERTICAL SCALE 1" = 3'

BORING NO. 8-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

SURFACE ELEVATION 1075.8'

H FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	CLAYEY SAND W/A LITTLE GRAVEL, dark brown (SC)	MIXED ALLUVIUM			1	CT	
6	SILTY SAND W/A LITTLE GRAVEL, some cobbles, moist to wet, brownish gray (SM/SC)	COARSE ALLUVIUM		▼	2	CT	
14	SILTY SAND W/GRAVEL, a few cobbles, brownish gray, wet (SM)				3	CT	
					4	CT	Slight gasoilne odor
22	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
2-14	3:00		SEE NOTE		to	
					to	

START 2-13-85 COMPLETE 2-14-85

METHOD 6DC 0-20' @ 1:00

CT (Cable Tool) 0-22'

CREW CHIEF Mason

SAMPLING INFORMATION

Sampling Point MW 11-85 Project Tiger #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02211300 Date Sampled 2/21/85 Time 1300 AM/PM

Describe Sampling Point 2" flush with grade PVC mo ni toring well

Well Depth 20 ft. below MP Casing Diameter 2 inches

Depth to Water (below MP) 10.48 ft. Date 2/20/85 Time 1510 AM/PM

Discharge Rate = 5 gpm x 0.00223 = 0.05115 cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☐ Submersible Pump ☐ Bailer ☑ Other

Pump intake or bailer set at ft. below MP.

Tubing (type: Teflon), (new or previously used) cleaned was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for

Approximate sample collection and field measurement discharge rate = N/A

Sample Appearance: Cloudy Odor: strong gasoline-like odor

Note any Sampling Problems:

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

2-20-85 TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)
1516				10.60		
1524				10.60		
Date Time						
2-21 1300				10.47		

Pumping start time 1512 WL 10.48

Pumping stop time 1524 WL 10.60

Comments: Developed with pump prior to extracting three well volumes with bailer

Form Completed by: MSM Witnessed by:

SOIL EXPLORATION company

LOG OF TEST BORING

JOB NO. 120-12955 VERTICAL SCALE 1" = 3' BORING NO. 9-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

'TH N FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1075.8'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	LEAN CLAY, dark brown (CL)	FINE ALLUVIUM			1	CT	
6	CLAYEY SAND W/GRAVEL, grayish brown (SC)	MIXED ALLUVIUM		▼	2	CT	
12	SILTY SAND W/GRAVEL, brownish gray, wet (SM)	COARSE ALLUVIUM			3	CT	
17	SAND W/SILT AND GRAVEL, medium grained, brownish gray, water-bearing (SP-SM)				4	CT	
21	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-24	3:00		SEE NOTE		to	
					to	

START 1-23-85 COMPLETE 1-24-85

METHOD 6DC 0-20' @ 1:00

CT (Cable Tool) 0-21'

CREW CHIEF Mason

SAMPLING INFORMATION

Sampling Point Yocham Residence Project Tiger Oil #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02191400 Date Sampled 02/ 19/ 85 Time 1400 AM/PM

Describe Sampling Point Kitchen sink

Well Depth 28 ft. below MP Casing Diameter ____ inches

Depth to Water (below MP) ____ ft. Date __ / __ / __ Time ____ AM/PM

Discharge Rate = ____ gpm x 0.00223 = ____ cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☒ Submersible Pump ☐ Bailer ☐ Other ____

Pump intake or bailer set at ____ ft. below MP.

Tubing (type: ____), (new or previously used) was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for ____

Approximate sample collection and field measurement discharge rate = ____

Sample Appearance: clear Odor: none

Note any Sampling Problems: ____

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)

Pumping start time ____ WL ____

Pumping stop time ____ WL ____

Comments: Water running for 20 minutes before collecting water samples

Form Completed by: Mark Mason Witnessed by: ____

soil exploration company

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point Suddeth Residence Project Tiger Oil #3

Location 302 "S" Street, Yakima, WA W.O. # 120-12955

Sample ID # 02191540 Date Sampled 02/19/85 Time 1540 AM/PM

Describe Sampling Point Kitchen sink

Well Depth 18 ft. below MP Casing Diameter ____ inches

Depth to Water (below MP) ____ ft. Date __/__/__ Time ____ AM/PM

Discharge Rate = ____ gpm x 0.00223 = ____ cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☒ Submersible Pump ☐ Bailer ☐ Other ____

Pump intake or bailer set at ____ ft. below MP.

Tubing (type: ____), (new or previously used) was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for ____

Approximate sample collection and field measurement discharge rate = ____

Sample Appearance: Clear Odor: None

Note any Sampling Problems: ____

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)

Pumping start time ____ WL ____

Pumping stop time ____ WL ____

Comments: Water running for 20 minutes before collecting water samples

Form Completed by: Mark Mason Witnessed by: ____

soil exploration company

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point McGahan Residence Project Tiger Oil #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02191337 Date Sampled 02 / 19 / 85 Time 1337 AM/PM

Describe Sampling Point Kitchen sink

Well Depth 70 ft. below MP Casing Diameter 6" inches

Depth to Water (below MP) ______ ft. Date __/__/__ Time ______ AM/PM

Discharge Rate = ______ gpm x 0.00223 = ______ cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☒ Submersible Pump ☐ Bailer ☐ Other ______

Pump intake or bailer set at ______ ft. below MP.

Tubing (type: ______), (new or previously used) was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for ______

Approximate sample collection and field measurement discharge rate = ______

Sample Appearance: clear Odor: None

Note any Sampling Problems: ______

Samples Collected: ______

EVACUATION / STABALIZATION TEST DATA

TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (^oC)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)

Pumping start time ______ WL ______

Pumping stop time ______ WL ______

Comments: Water running for 20 minutes before collecting water samples

Form Completed by: Mark Mason Witnessed by: ______

soil exploration company

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point Tangemon Residence Project Tiger Oil #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02191415 Date Sampled 02 / 19 / 85 Time 1415 AM/PM

Describe Sampling Point Kitchen sink

Well Depth _____ ft. below MP Casing Diameter _____ inches

Depth to Water (below MP) _____ ft. Date / / Time _____ AM/PM

Discharge Rate = _____ gpm x 0.00223 = _____ cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☒ Submersible Pump ☐ Bailer ☐ Other _____

Pump intake or bailer set at _____ ft. below MP.

Tubing (type: _____), (new or previously used) was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for _____

Approximate sample collection and field measurement discharge rate = _____

Sample Appearance: Clear Odor: None

Note any Sampling Problems: _____

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)

Pumping start time _____ WL _____

Pumping stop time _____ WL _____

Comments: Water running for 20 minutes before collecting samples

Form Completed by: Mark Mason Witnessed by: _____

soil exploration company

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point Hutson Residence Project Tiger Oil #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02191515 Date Sampled 02 / 19 / 85 Time 1515 AM/PM

Describe Sampling Point Kitchen sink

Well Depth 28 ft. below MP Casing Diameter ______ inches

Depth to Water (below MP) ______ ft. Date __/__/__ Time ______ AM/PM

Discharge Rate = ______ gpm x 0.00223 = ______ cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☒x Submersible Pump ☐ Bailer ☐ Other ______

Pump intake or bailer set at ______ ft. below MP.

Tubing (type: ______), (new or previously used) was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for ______

Approximate sample collection and field measurement discharge rate = ______

Sample Appearance: Clear Odor: None

Note any Sampling Problems: ______

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)

Pumping start time ______ WL ______

Pumping stop time ______ WL ______

Comments: Water running for 20 minutes before collecting water samples

Form Completed by: Mark Mason Witnessed by: ______

soil exploration company

SAMPLING INFORMATION

Sampling Point MW-5-85 Project Tiger #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02210949 Date Sampled 2 /21 /85 Time ________ AM/PM

Describe Sampling Point 2" flush with grade PVC monitoring well

Well Depth 14.95 ft. below MP Casing Diameter 2 inches

Depth to Water (below MP) 5.90 ft. Date 2 / 20/85 Time 1016 AM/PM

Discharge Rate = 5 gpm x 0.00223 = 0.05115 cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☐ Submersible Pump ☐ Bailer ☒ Other ________

Pump intake or bailer set at 8 ft. below MP.

Tubing (type: Teflon), (new or previously used) cleaned was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for ________

Approximate sample collection and field measurement discharge rate = N/A

Sample Appearance: brown cloudy Odor: none

Note any Sampling Problems: none

Samples Collected: volatiles

EVACUATION / STABALIZATION TEST DATA

2-20-85 TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)
1020				11.78		5 gpm
1025				11.80		
Date Time						
2-21 0949				5.11		

Pumping start time 1018 WL 5.11

Pumping stop time 1029 WL 11.80

Comments: Developed with pump prior to extracting 3 well volumes with bailers.

Form Completed by: MSM Witnessed by: ________

soil exploration company

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point MW-6-85 Project Tiger #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02211007 Date Sampled 2 /21 /85 Time 1007 AM/PM

Describe Sampling Point 2" flush with grade PVC monitoring well

Well Depth 19 ft. below MP Casing Diameter 2 inches

Depth to Water (below MP) 7.17 ft. Date 2 / 20 / 85 Time 1037 AM/PM

Discharge Rate = 5 gpm x 0.00223 = 0.05115 cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☐ Submersible Pump ☐ Bailer ☒ Other

Pump intake or bailer set at 9 ft. below MP.

Tubing (type: Teflon), (new or previously used) cleaned was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for

Approximate sample collection and field measurement discharge rate = N/A

Sample Appearance: cloudy Odor: none

Note any Sampling Problems: none

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

2-20-85 TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)
1047				7.50		5
1051				7.50		
Date Time						
2-21 1007				7.17		

Pumping start time 1042 WL 7.17

Pumping stop time 1052 WL 7.50

Comments: Developed with pump prior to extracting 3 well volumes with bailers

Form Completed by: MSM Witnessed by:

SOIL EXPLORATION COMPANY

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point MW-8-85 Project Tiger #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02211040 Date Sampled 2/21/85 Time 1040 AM/PM

Describe Sampling Point 2" flush with grade PVC monitoring well

Well Depth 19.90 ft. below MP Casing Diameter 2 inches

Depth to Water (below MP) 9.53 ft. Date 2/20/85 Time 1150 AM/PM

Discharge Rate = 5 gpm x 0.00223 = 0.05115 cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☐ Submersible Pump ☐ Bailer ☒ Other

Pump intake or bailer set at 11 ft. below MP.

Tubing (type: Teflon), (new or previously used) cleaned was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for

Approximate sample collection and field measurement discharge rate =

Sample Appearance: cloudy Odor: none

Note any Sampling Problems: None

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

2-20-85 TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)
1157				9.60		
1701				9.60		
Date Time						
2-21 1040				9.51		

Pumping start time 1153 WL 9.51

Pumping stop time 1203 WL 9.60

Comments: Developed with pump prior to extracting 3 well volumes with bailer

Form Completed by: MSM Witnessed by:

soil exploration company

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point MW-7-85 Project Tiger #3
Location Yakima, WA W.O. # 120-12955

Sample ID # 02211022 Date Sampled 2/21/85 Time 1022 AM/PM
Describe Sampling Point 2" flush with grade PVC monitoring well

Well Depth 18.90 ft. below MP Casing Diameter 2 inches
Depth to Water (below MP) 7.14 ft. Date / / Time 1104 AM/PM
Discharge Rate = 5 gpm x 0.00223 = 0.05115 cfs.
At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☐ Submersible Pump ☐ Bailer ☒ Other
Pump intake or bailer set at 9 ft. below MP cleaned
Tubing (type: Teflon), (new or previously used) was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for

Approximate sample collection and field measurement discharge rate = N/A

Sample Appearance: cloudy Odor: none
Note any Sampling Problems: none

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

2-20-85 TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)
1121				7.48		5
1125				7.50		
Date Time						
2-21 1022				7.11		

Pumping start time 1117 WL 7.11
Pumping stop time 1127 WL 7.50

Comments: Developed with pump, prior to extracting 3 well volumes with bailer

Form Completed by: MSM Witnessed by:

soil exploration company

-2(84-B)

SAMPLING INFORMATION

Sampling Point MW-9-85 Project Tiger #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02211135 Date Sampled 2 / 21 / 85 Time 1135 AM/PM

Describe Sampling Point 2" Flush with grade PVC monitoring well

Well Depth 19.50 ft. below MP Casing Diameter 2 inches

Depth to Water (below MP) 9.54 ft. Date 2 /20 /85 Time 1336 AM/PM

Discharge Rate = 5 gpm x 0.00223 = 0.05115 cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☐ Submersible Pump ☐ Bailer ☒ Other

Pump intake or bailer set at 12 ft. below MP.

Tubing (type: Teflon), (new or previously used) cleaned was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for

Approximate sample collection and field measurement discharge rate =

Sample Appearance: cloudy Odor: none

Note any Sampling Problems: none

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

2-20-85 TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)
1343				9.78		
1348				9.78		
Date Time						
2-21 1135				9.55		

Pumping start time 1338 WL 9.54

Pumping stop time 1349 WL 9.78

Comments: Developed with bailer prior to extracting 3 well volumes with bailer

Form Completed by: MSM Witnessed by:

soil exploration company

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point MW-4-85 Project Tiger #3
Location Yakima, WA W.O. # 120-12955

Sample ID # 02211200 Date Sampled 2 /21 /85 Time 1200 AM/PM
Describe Sampling Point 2" flush with grade PVC monitoring well

Well Depth 19.90 ft. below MP Casing Diameter 2" inches
Depth to Water (below MP) 9.00 ft. Date 2 /20/ 85 Time 1245 AM/PM
Discharge Rate = 5 gpm x 0.00223 = 0.05115 cfs.
At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☐ Submersible Pump ☐ Bailer ☒ Other
Pump intake or bailer set at 11 ft. below MP. cleaned
Tubing (type: Teflon), (new or previously used) was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for

Approximate sample collection and field measurement discharge rate = N/A

Sample Appearance: cloudy Odor:
Note any Sampling Problems: none

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

2-20-85 TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)
1253				10.10		
1257				10.10		
Date Time						
2-21 1200				8.99		

Pumping start time 1248 WL 9.00
Pumping stop time 1258 WL 10.10

Comments: Developed with pump prior to extracting 3 well volumes with bailer

Form Completed by: MSM Witnessed by:

soil exploration company

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point Knight Residence Project Tiger Oil #3

Location 1815 Third St., Yakima, WA W.O. # 120-12955

Sample ID # 02191830 Date Sampled 02 / 19 / 85 Time 1830 AM/PM

Describe Sampling Point Kitchen sink

Well Depth ______ ft. below MP Casing Diameter ______ inches

Depth to Water (below MP) ______ ft. Date __/__/__ Time ______ AM/PM

Discharge Rate = ______ gpm x 0.00223 = ______ cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☒ Submersible Pump ☐ Bailer ☐ Other ______

Pump intake or bailer set at ______ ft. below MP.

Tubing (type: ______), (new or previously used) was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for ______

Approximate sample collection and field measurement discharge rate = ______

Sample Appearance: Clear Odor: None

Note any Sampling Problems: ______

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)

Pumping start time ______ WL ______

Pumping stop time ______ WL ______

Comments: Water running for 20 minutes before collecting samples

Form Completed by: Mark Mason Witnessed by: ______

soil exploration company

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point MW-1-85 Project Tiger #3
Location Yakima, WA W.O. # 120-12955

Sample ID # 02210846 Date Sampled 02 / 21 / 85 Time 0846 AM/PM
Describe Sampling Point 2" Flush with grade PVC monitoring well

Well Depth 21 ft. below MP Casing Diameter 2" inches
Depth to Water (below MP) 12.78 ft. Date 02 / 21 / 85 Time 0846 AM/PM
Discharge Rate = 5 gpm x 0.00223 = 0.05115 cfs.
At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☐ Submersible Pump ☐ Bailer ☒x Other
Pump intake or bailer set at ____ ft. below MP.
Tubing (type: Teflon), (~~new or~~ cleaned previously used) was used to collect all samples (yes, ~~no~~)
and all field measurements (yes, ~~no~~)x Tubing used only for

Approximate sample collection and field measurement discharge rate = N/A

Sample Appearance: Clear Odor: None
Note any Sampling Problems:

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)
	Pumped on December 17, 1984 by well driller					
Date Time						
022185 0846				12.78		

Pumping start time WL
Pumping stop time WL

Comments: Well developed with pump prior to extracting three well volumes with bailer

Form Completed by: Mark Mason Witnessed by:

SOIL EXPLORATION COMPANY

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point MW-2-85 Project Tiger Oil #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02210910 Date Sampled 02/ 21 / 85 Time 0910 AM/PM

Describe Sampling Point 2" Flush with grade PVC monitoring well

Well Depth 18 ft. below MP Casing Diameter 2 inches

Depth to Water (below MP) 5.79 ft. Date 02 /20 / 85 Time 0859 AM/PM

Discharge Rate = 5 gpm x 0.00223 = 0.5115 cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☐ Submersible Pump ☐ Bailer ☒ Other

Pump intake or bailer set at 20 ft. below MP.

cleaned

Tubing (type: Teflon), (~~new/~~or previously used) was used to collect all samples (yes, ~~no~~) and all field measurements (yes, ~~no~~). Tubing used only for

Approximate sample collection and field measurement discharge rate = N/A

Sample Appearance: Clear Odor: None

Note any Sampling Problems: None

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

02-20-85 TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)
0902				5.75		8
0913				5.76		
Date Time						
022185 0910				5.74		

Pumping start time 0900 WL 5.74

Pumping stop time 0915 WL 5.79

Comments: Developed with pump prior to extracting three well volumes with bailer

Form Completed by: Mark Mason Witnessed by:

SOIL EXPLORATION company

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point MW-3-85 Project Tiger Oil #3
Location Yakima, WA W.O. # 120-12955

Sample ID # 02210928 Date Sampled 02 /21 /85 Time 0928 AM/PM
Describe Sampling Point 2" Flush with grade PVC Monitoring Well

Well Depth 18.70 ft. below MP Casing Diameter 2 inches
Depth to Water (below MP) 7.69 ft. Date 02/ 20/ 85 Time 0950 AM/PM
Discharge Rate = 5 gpm x 0.00223 = 0.05115 cfs.
At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☐ Submersible Pump ☐ Bailer ☒X Other
Pump intake or bailer set at 9.5' ft. below MP.
Tubing (type: Teflon), (~~new or~~ XXXXX cleaned previously used) was used to collect all samples (yes, ~~no~~)
and all field measurements (yes, ~~no~~). Tubing used only for

Approximate sample collection and field measurement discharge rate = N/A

Sample Appearance: Cloudy Odor: None
Note any Sampling Problems: None

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

02-20-85 TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)
0954				8.30		5
0957				8.35		5
Date Time						
022185 0928				7.67		

Pumping start time 0951 WL 7.60
Pumping stop time 0900 WL 8.35

Comments: Developed with pump prior to extracting three well volumes with bailer

Form Completed by: Mark Mason Witnessed by:

SOIL EXPLORATION COMPANY

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point MW 10-85 Project Tiger #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02211245 Date Sampled 2 / 21/ 85 Time 1245 AM/PM

Describe Sampling Point 2" flush with grade PVC monitoring well

Well Depth 19 ft. below MP Casing Diameter 2" inches

Depth to Water (below MP) 9.38 ft. Date 2 / 20/ 85 Time 1410 AM/PM

Discharge Rate = 5 gpm x 0.00223 = 0.05115 cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☐ Submersible Pump ☐ Bailer ☒ Other

Pump intake or bailer set at 12 ft. below MP.

Tubing (type: Teflon), (new or previously used) cleaned was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for

Approximate sample collection and field measurement discharge rate = N/A

Sample Appearance: Cloudy Odor: None

Note any Sampling Problems: None

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

2-20-85 TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)
1416				9.68		
1421				9.72		
Date Time						
2-21 1245				9.38		

Pumping start time 1412 WL 9.38

Pumping stop time 1423 WL 9.72

Comments: Developed with pump prior to extracting three well volumes with bailer

Form Completed by: MSM Witnessed by:

SOIL EXPLORATION company

SE-V-2(84-B)

SAMPLING INFORMATION

Sampling Point MW 12-85 Project Tiger #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02211225 Date Sampled 2 / 21/ 85 Time 1225 AM/PM

Describe Sampling Point 2" flush with grade PVC monitoring well

Well Depth 21 ft. below MP Casing Diameter 2 inches

Depth to Water (below MP) 11.25 ft. Date 2/ 20/ 85 Time 1440 AM/PM

Discharge Rate = 5 gpm x 0.00223 = 0.05115 cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☐ Submersible Pump ☐ Bailer ☒ Other

Pump intake or bailer set at 13' ft. below MP.

Tubing (type: Teflon), (new or previously used) cleaned was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for

Approximate sample collection and field measurement discharge rate = N/A

Sample Appearance: cloudy Odor: none

Note any Sampling Problems: none

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

2-20-85 TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)
1448				11.30		
1452				11.20		
Date Time						
2-21 1225				11.23		

Pumping start time 1443 WL 11.25

Pumping stop time 1454 WL 11.20

Comments: Developed with pump prior to extracting three well volumes with bailer.

Form Completed by: MSM Witnessed by:

SOIL EXPLORATION COMPANY

APPENDIX III

CHAIN OF CUSTODY

Project: Tiger Oil #3, Yakima, WA

W.O. # 120-12955

Shipped by:

Shipped to:

Attention of:

Comments:

Hazardous materials suspected? (yes/no)

Sampling Point	Location	Field ID #	Date	Sample Type	No. of Containers	Analysis Required	(optional) Lab ID
MW-1-85	Yakima, WA	02210846	02-21-85	Water	2	Volatiles	
MW-2-85	"	02210910	"	"	2	"	
MW-3-85	"	02210928	"	"	2	"	
MW-4-85	"	02211200	"	"	2	"	
MW-5-85	"	02210949	"	"	2	"	
MW-6-85	"	02211007	"	"	2	"	
MW-7-85	"	02211022	"	"	2	"	
MW-8-85	"	02211040	"	"	2	"	
MW-9-85	"	02211135	"	"	2	"	
MW-10-85	"	02211245	"	"	2	"	
MW-11-85	"	02211300	"	"	2	"	
MW-12-85	"	02211225	"	"	2	"	

Sampler(s) (signature) Mark S. Mason

Field ID	Relinquished by: (signature)	Received by: (signature)	Date/Time		Comments
	Mark S. Mason		2-21-85	9:05 AM	

Sealed for shipment by: (signature) ______ Date/Time ______ Shipment method: ______

Received for Lab by: (signature) ______ Date/Time ______ Comments [illegible]

Receiving Laboratory: Please return original form after signing for receipt of samples.

SOIL EXPLORATION COMPANY

SE-V-1(83-A)

Sample Identification/Field Chain of Custody Record

Project: Tiger Oil #3, Yakima, WA.
Shipped by:
Shipped to:
Comments:

W.O. # 12042955
Attention of:
Hazardous materials suspected? ([✓ yes]/no)

Sampling Point	Location	Field ID #	Date	Sample Type	No. of Containers	Analysis Required	(optional), Lab ID
Wilton Residence	Yakima, WA.	02191500	02-19-85	Water	2	Volatiles	
Hernandez Residence	"	02191445	"	"	2	"	
Corbin Residence	"	02191430	"	"	2	"	
Tangeman Residence	"	02191415	"	"	2	"	
Yecham Residence	"	02191400	"	"	2	"	
McGahan Residence	"	02191337	"	"	2	"	
Hutson Residence	"	02191515	"	"	2	"	
Suddeth Residence	"	02191540	"	"	2	"	
Knight Residence	"	02191830	"	"	2	"	

Sampler(s) (signature) Mark L. Mason

Field ID	Relinquished by: (signature)	Received by: (signature)	Date/Time		Comments
All	Mark L. Mason		2-20-85	9:05AM	

Sealed for shipment by: (signature) Date/Time Shipment method:

Received for Lab by: (signature) Date/Time Comments Report To Mark Mason

Receiving Laboratory: Please return original form after signing for receipt of samples.

SOIL EXPLORATION COMPANY

SE-V-1 (83-A)

Sample Identification/Field Chain of Custody Record

Project: TIGER OIL #3
Shipped by: ZAREMBA Claims
Shipped to: Twin City TESTING
Comments:

W.O. # [illegible]

Attention of:
Hazardous materials suspected? (yes/no)

Sampling Point	Location	Field ID #	Date	Sample Type	No. of Containers	Analysis Required	(optional) Lab ID
KNIGHT	WELL #8		3/25		2		
Vo-GAM	TAP-Kitchen		3/25		2		
			Presence 'not of gasoline				

Sampler(s) (signature)

Field ID	Relinquished by: (signature)	Received by: (signature)	Date/Time		Comments

Sealed for shipment by: (signature) Date/Time 3/25/85 730P Shipment method: Federal Express

Received for Lab by: (signature) Date/Time Comments

Receiving Laboratory: Please return original form after signing for receipt of samples.

SE-V-1(83-A)

SOIL EXPLORATION COMPANY

LOG OF TEST BORING

JOB NO. 120-12955
VERTICAL SCALE 1" = 3'
BORING NO. 11-85
PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

SURFACE ELEVATION 1077.7'

[illegible]	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	SILTY CLAY W/SAND, dark brown (CL-ML)	FINE ALLUVIUM			1	CT	
6	CLAYEY SAND W/GRAVEL, brownish gray (SC/SM)	MIXED ALLUVIUM		▼	2	CT	Strong gasoline odor
2	SILTY SAND W/A LITTLE GRAVEL, brownish gray, wet (SM/SP)	COARSE ALLUVIUM			3	CT	Slight gasoline odor
18	SAND W/SILT AND A LITTLE GRAVEL, medium grained, brown, water-bearing (SP-SM)				4	CT	
22	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-31	11:00		SEE NOTE		to	
					to	

START 1-29-85
COMPLETE 1-30-85 @ 3:00
METHOD 6DC 0-20'
CT (Cable Tool) 0-22'
CREW CHIEF Mason

LOG OF TEST BORING

JOB NO. 120-12955 VERTICAL SCALE 1" = 3' BORING NO. 10-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

TH ET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1076.3'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO.	SAMPLE TYPE	COMMENTS
	CLAYEY SAND W/GRAVEL, COBBLES AND BOULDERS, brownish gray (may be fill) (SC)	FILL OR MIXED ALLUVIUM			1	CT	
7	SILTY GRAVEL, brownish gray, wet (GM)	COARSE ALLUVIUM		▼	2	CT	
14	SAND W/SILT AND GRAVEL, brownish gray, waterbearing (SP-SM)				3	CT	
18	SILTY SAND W/A LITTLE GRAVEL, brownish gray, wet (SM)				4	CT	
21	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-29	11:30		SEE NOTE		to	
					to	

START 1-25-85 COMPLETE 1-28-85

METHOD 6DC 0-20' @ 3:00

CT (Cable Tool) 0-21'

CREW CHIEF Mason

LOG OF TEST BORING

JOB NO. 120-12955 VERTICAL SCALE 1" = 3' BORING NO. 12-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1078.6'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	LEAN CLAY, dark brown (CL)	FINE ALLUVIUM					
					1	CT	
5	CLAYEY SAND W/GRAVEL, a few cobbles, brownish gray (SC)	MIXED ALLUVIUM			2	CT	Very slight gasoline odor
				▼			
					3	CT	Very slight gasoline odor
17	SILTY SAND W/GRAVEL, grayish brown, wet (SM)	COARSE ALLUVIUM					
					4	CT	
22	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
2-20	2:00		SEE NOTE		to	
					to	

START 2-19-85 COMPLETE 2-20-85

METHOD 6DC 0-20' @ 1:00

CT (Cable Tool) 0-22'

CREW CHIEF Mason

APPENDIX II

SAMPLING INFORMATION FORMS

SAMPLING INFORMATION

Sampling Point Wilton Residence Project Tiger Oil #3

Location Takima, WA W.O. # 120-12955

Sample ID # 02191500 Date Sampled 02/19/85 Time 1500 AM/PM

Describe Sampling Point

Well Depth 23 ft. below MP Casing Diameter ____ inches

Depth to Water (below MP) ____ ft. Date / / Time ____ AM/PM

Discharge Rate = ____ gpm x 0.00223 = ____ cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☒ Submersible Pump ☐ Bailer ☐ Other ____

Pump intake or bailer set at ____ ft. below MP.

Tubing (type: ____), (new or previously used) was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for ____

Approximate sample collection and field measurement discharge rate = ____

Sample Appearance: Clear Odor: None

Note any Sampling Problems:

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (^{o}C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)

Pumping start time ____ WL ____

Pumping stop time ____ WL ____

Comments: Water running for 20 minutes before sampling

Form Completed by: Mark Mason Witnessed by: ____

SOIL EXPLORATION COMPANY

SAMPLING INFORMATION

Sampling Point Corbin Residence Project Tiger Oil #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02191430 Date Sampled 02/ 19 / 85 Time 1430 AM/PM

Describe Sampling Point Kitchen sink

Well Depth 90' ft. below MP Casing Diameter ______ inches

Depth to Water (below MP) ______ ft. Date __/__/__ Time ______ AM/PM

Discharge Rate = ______ gpm x 0.00223 = ______ cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☒ Submersible Pump ☐ Bailer ☐ Other ______

Pump intake or bailer set at ______ ft. below MP.

Tubing (type: ______), (new or previously used) was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for ______

Approximate sample collection and field measurement discharge rate = ______

Sample Appearance: clear Odor: None

Note any Sampling Problems: ______

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)

Pumping start time ______ WL ______

Pumping stop time ______ WL ______

Comments: Water running for 20 minutes before collecting samples

Form Completed by: Mark Mason Witnessed by: ______

SOIL EXPLORATION company

SAMPLING INFORMATION

Sampling Point Hernandez Residence Project Tiger Oil #3

Location Yakima, WA W.O. # 120-12955

Sample ID # 02191445 Date Sampled 02 / 19 /85 Time 1445 AM/PM

Describe Sampling Point Bathroom sink

Well Depth ______ ft. below MP Casing Diameter ______ inches

Depth to Water (below MP) ______ ft. Date / / Time ______ AM/PM

Discharge Rate = ______ gpm x 0.00223 = ______ cfs.

At least 3 bore volumes have been evacuated before sampling.

Sampling Method: Tap ☒ Submersible Pump ☐ Bailer ☐ Other ______

Pump intake or bailer set at ______ ft. below MP.

Tubing (type: ______), (new or previously used) was used to collect all samples (yes, no) and all field measurements (yes, no). Tubing used only for ______

Approximate sample collection and field measurement discharge rate = ______

Sample Appearance: Clear Odor: None

Note any Sampling Problems: ______

Samples Collected: Volatiles

EVACUATION / STABALIZATION TEST DATA

TIME	pH (UNITS)	TEMPERATURE CORRECTED CONDUCTANCE (umhos/cm)	TEMPERATURE (°C)	WATER LEVEL (NEAREST 0.01 ft)	CUMULATIVE VOLUME OF WATER REMOVED FROM WELL (gallons)	PUMPING RATE (gpm)

Pumping start time ______ WL ______

Pumping stop time ______ WL ______

Comments: Water running for 20 minutes before sampling

Form Completed by: Mark Mason Witnessed by: ______

soil exploration company

TABLE 1

(continued)

Volatile Analysis

SAMPLE IDENTIFICATION:

Tiger Oil #3, Yakima, WA

TCT #1919	MW-1-85	TCT #1925	MW-7-85
1920	MW-2-85	1926	MW-8-85
1921	MW-3-85	1927	MW-9-85
1922	MW-4-85	1928	MW-10-85
1923	MW-5-85	1929	MW-11-85
1924	MW-6-85	1930	MW-12-85

Parameter	#1919 MW-1 (ug/L)	#1920 MW-2 (ug/L)	#1921 MW-3 (ug/L)	#1922 MW-4 (ug/L)	#1923 MW-5 (ug/L)	#1924 MW-6 (ug/L)	#1925 MW-7 (ug/L)	#1926 MW-8 (ug/L)	#1927 MW-9 (ug/L)	#1928 MW-10 (ug/L)	#1929 MW-11 (ug/L)	#1930 MW-12 (ug/L)	Lower Detectable Limit (ug/L)
Total Hydrocarbons as Gasoline	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	23390	ND	1
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1460	ND	1
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	5300	ND	1
Xylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6260	ND	1

For purposes of these samples ug/L = ppb

ND - Not Detected

TABLE 1

Volatile Analysis

SAMPLE IDENTIFICATION:

Tiger Oil #3, Yakima, WA

TCT #1910	Wilton	TCT #1915	McGohan
1911	Hernandez	1916	Hutson
1912	Corbin	1917	Suddeth
1913	Tangeman	1918	Knight
1914	Yochan		

Parameter	#1910 Wilton (ug/L)	#1911 Hernand. (ug/L)	#1912 Corbin (ug/L)	#1913 Tangeman (ug/L)	#1914 Yochan (ug/L)	#1915 McGohan (ug/L)	#1916 Hutson (ug/L)	#1917 Suddeth (ug/L)	#1918 Knight (ug/L)	Lower Detectable Limit (ug/L)
Total Hydrocarbons as Gasoline	ND	ND	ND	ND	14	ND	ND	ND	ND	1
Benzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Toluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	1
Xylene	ND	ND	ND	ND	5	ND	ND	ND	ND	1

For purposes of this sample ug/L = ppb

ND - Not Detected

MEMO TO: Mark Mason, SEC

FROM: Harry Fisher, TCT

DATE: March 9, 1985

SUBJ: Purge and Trap
SEC 120-12955
TCT 2A-3512

INTRODUCTION:

This memo presents the results of our analysis of water samples for volatiles. The samples were received on February 25, 1985. The scope of our work was limited to analyzing the samples for the presence of benzene, toluene, xylenes and total hydrocarbons as gasoline using gas chromatographic techniques.

SAMPLE IDENTIFICATION:

Tiger Oil #3, Yakima, WA
TCT #1910-1930

METHODOLOGY:

These samples were analyzed using a Tekmar LSC-2 Liquid Sample Concentrator linked to a Perkin-Elmer Sigma 300 Gas Chromatograph with FID on a six-foot stainless steel column packed with SP-1000 100/120 mesh packing. Xylene, benzene, and toluene were identified by retention time and quantified by comparison with known standards using a SP-4000 data system. We calculated gasoline concentration by ratioing total peak area to a gasoline standard total peak area.

RESULTS:

These are summarized in Table 1.

REMARKS:

The samples were consumed in the analysis.

Credt 4416 - $2310

Harry

HDF/ma

APPENDIX IV

CHEMICAL ANALYSIS METHODOLOGY

MEMO TO: Mark Mason, SEC

FROM: Harry Fisher, TCT

DATE: April 5, 1985

SUBJ: Purge and Trap
SEC 120-12955
TCT 2A-3632

INTRODUCTION:

This memo presents the results of our analysis of water samples for volatiles. The samples were received on March 27, 1985. The scope of our work was limited to analyzing the samples for the presence of benzene, toluene, xylenes and total hydrocarbons as gasoline using gas chromatographic techniques.

SAMPLE IDENTIFICATION:

Tiger Oil #3

TCT #3003	Knight
TCT #3004	Yocham

METHODOLOGY:

These samples were analyzed using a Tekmar LSC-2 Liquid Sample Concentrator linked to a Perkin-Elmer Sigma Gas Chromatograph with FID on a six-foot stainless steel column packed with SP-1000 100/120 mesh packing. Xylene, benzene, and toluene were identified by retention time and quantified by comparison with known standards using a SP-4000 data system. We calculated gasoline concentration by ratioing total peak area to a gasoline standard total peak area.

RESULTS:

These are summarized in Table 1.

REMARKS:

The samples were consumed in the analysis.

Credit 4416 - $220.00

HDF/ma

TABLE 1

Volatile Analysis

SAMPLE IDENTIFICATION:

Tiger Oil #3

TCT #3003 Knight
TCT #3004 Yocham

Parameter	#3003 Knight (ug/L)	#3004 Yocham (ug/L)	Lower Detectable Limit (ug/L)
Total Hydrocarbons as Gasoline	ND	3120	1
Benzene	ND	28	1
Toluene	ND	680	1
Xylene	ND	980	1

For purposes of these samples ug/L = ppb

ND - Not Detected

APPENDIX V

SOILS TERMINOLOGY

GENERAL NOTES

DRILLING AND SAMPLING SYMBOLS

SYMBOL	DEFINITION
HSA	3 1/4" I.D. Hollow Stem Auger
_FA	4", 6" or 10" Diameter Flight Auger
_HA	2", 4" or 6" Hand Auger
_DC	2 1/2", 4", 5" or 6" Steel Drive Casing
_RC	Size A, B, or N Rotary Casing
PD	Pipe Drill or Cleanout Tube
CS	Continuous Split Barrel Sampling
DM	Drilling Mud
JW	Jetting Water
SB	2" O.D. Split Barrel Sample
_L	2 1/2" or 3 1/2" O.D. SB Liner Sample
_T	2" or 3" Thin Walled Tube Sample
3TP	3" Thin Walled Tube (Pitcher Sampler)
_TO	2" or 3" Thin Walled Tube (Osterberg Sampler)
W	Wash Sample
B	Bag Sample
P	Test Pit Sample
_Q	BQ, NQ, or PQ Wireline System
_X	AX, BX, or NX Double Tube Barrel
CR	Core Recovery - Percent
NSR	No Sample Recovered, classification based on action of drilling equipment and/or material noted in drilling fluid or on sampling bit.
NMR	No Measurement Recorded, primarily due to presence of drilling or coring fluid.
▼	Water Level Symbol

TEST SYMBOLS

SYMBOL	DEFINITION
W	Water Content - % of Dry Wt. - ASTM D 2216
D	Dry Density - Pounds Per Cubic Foot
LL, PL	Liquid and Plastic Limit - ASTM D 4318

Additional Insertions in Last Column

SYMBOL	DEFINITION
Qu	Unconfined Comp. Strength-psf - ASTM D 2166
Pq	Penetrometer Reading - Tons/Square Foot
Ts	Torvane Reading - Tons/Square Foot
G	Specific Gravity - ASTM D 854
SL	Shrinkage Limits - ASTM D 427
OC	Organic Content - Combustion Method
SP	Swell Pressure - Tons/Square Foot
PS	Percent Swell
FS	Free Swell - Percent
pH	Hydrogen Ion Content, Meter Method
SC	Sulfate Content - Parts/Million, same as mg/L
CC	Chloride Content - Parts/Million, same as mg/L
C*	One Dimensional Consolidation - ASTM D 2435
Qc*	Triaxial Compression
D.S.*	Direct Shear - ASTM D 3080
K*	Coefficient of Permeability - cm/sec
D*	Dispersion Test
DH*	Double Hydrometer - ASTM D 4221
MA*	Particle Size Analysis - ASTM D 422
R	Laboratory Resistivity, in ohm - cm - ASTM G 57
E*	Pressuremeter Deformation Modulus - TSF
PM*	Pressuremeter Test
VS*	Field Vane Shear - ASTM D 2573
IR*	Infiltrometer Test - ASTM D 3385
RQD	Rock Quality Designation - Percent

* See attached data sheet or graph

WATER LEVEL

Water levels shown on the boring logs are the levels measured in the borings at the time and under the conditions indicated. In sand, the indicated levels may be considered reliable ground water levels. In clay soil, it may not be possible to determine the ground water level within the normal time required for test borings, except where lenses or layers of more pervious waterbearing soil are present. Even then, an extended period of time may be necessary to reach equilibrium. Therefore, the position of the water level symbol for cohesive or mixed texture soils may not indicate the true level of the ground water table. Perched water refers to water above an impervious layer, thus impeded in reaching the water table. The available water level information is given at the bottom of the log sheet.

DESCRIPTIVE TERMINOLOGY

DENSITY TERM	"N" VALUE	CONSISTENCY TERM
Very Loose	0-4	Soft
Loose	5-8	Medium
Medium Dense	9-15	Rather Stiff
Dense	16-30	Stiff
Very Dense	Over 30	Very Stiff

Standard "N" Penetration: Blows Per Foot of a 140 Pound Hammer Falling 30 inches on a 2 inch OD Split Barrel Sampler

Lamination	Up to 1/2" thick stratum
Layer	1/2" to 6" thick stratum
Lens	1/2" to 6" discontinous stratum, pocket
Varved	Alternating laminations of clay, silt and /or fine grained sand, or colors thereof
Dry	Powdery, no noticeable water
Moist	Below saturation
Wet	Saturated, above liquid limit
Waterbearing	Pervious soil below water

RELATIVE GRAVEL PROPORTIONS

CONDITION	TERM	RANGE
Coarse Grained Soils	A little gravel	2 - 14%
	With gravel	15 - 49%
Fine Grained Soils		
15-29% + No. 200	A little gravel	2 - 7%
15-29% + No. 200	With gravel	8 - 29%
30% + No. 200	A little gravel	2 - 14%
30% + No. 200	With gravel	15 - 24%
30% + No. 200	Gravelly	16 - 49%

RELATIVE SIZES

Boulder	Over 12"
Cobble	3" - 12"
Gravel	
Coarse	3/4" - 3"
Fine	#4 - 3/4"
Sand	
Coarse	#4 - #10
Medium	#10 - #40
Fine	#40 - #200
Silt & Clay	– #200, Based on Plasticity

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM Designation: D 2487 - 83
(Based on Unified Soil Classification System)

				Soil Classification	
Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Group Symbol	Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well graded gravel[F]
			$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
			$Cu < 6$ and/or $1 > Cc > 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	$PI > 7$ and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			$PI < 4$ or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OL	Organic clay[K,L,M,N] Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	$\frac{\text{Liquid limit - oven dried}}{\text{Liquid limit - not dried}} < 0.75$	OH	Organic clay[K,L,M,P]
					Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor			PT	Peat
Fibric Peat >67% Fibers	Hemic Peat 33%-67% Fibers			Sapric Peat <33% Fibers	

[A] Based on the material passing the 3-in. (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

[E] $Cu = D_{60} / D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains $\geq$15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains $\geq$15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains $\geq$30% plus no. 200, predominantly sand, add "sandy" to to group name.

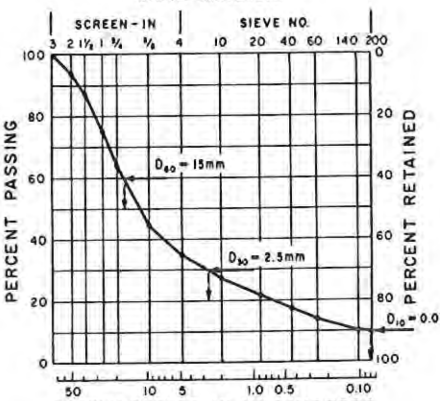
[M] If soil contains $\geq$30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] $PI \geq 4$ and plots on or above "A" line.

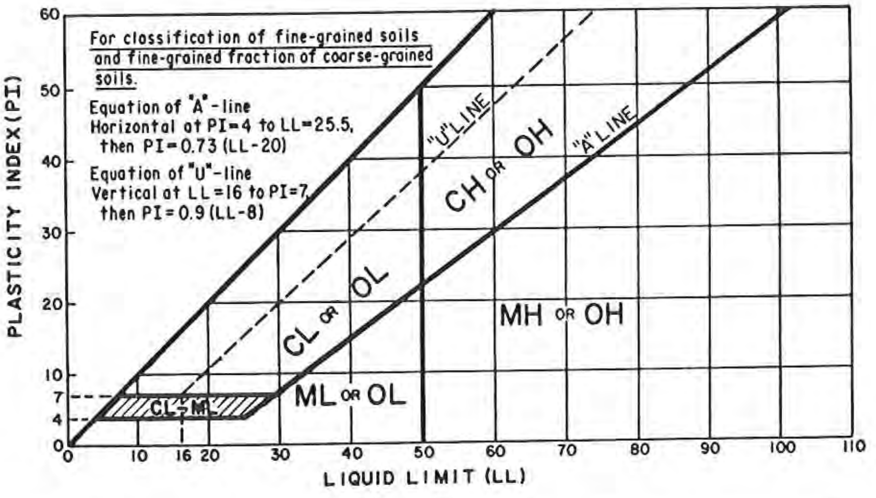
[O] $PI < 4$ or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



$$C_u = \frac{D_{60}}{D_{10}} = \frac{15}{0.075} = 200 \qquad C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = \frac{(2.5)^2}{0.075 \times 15} = 5.6$$



APPENDIX VI

MONITORING WELL CONSTRUCTION SHEETS

INSTALLATION OF MONITORING WELL

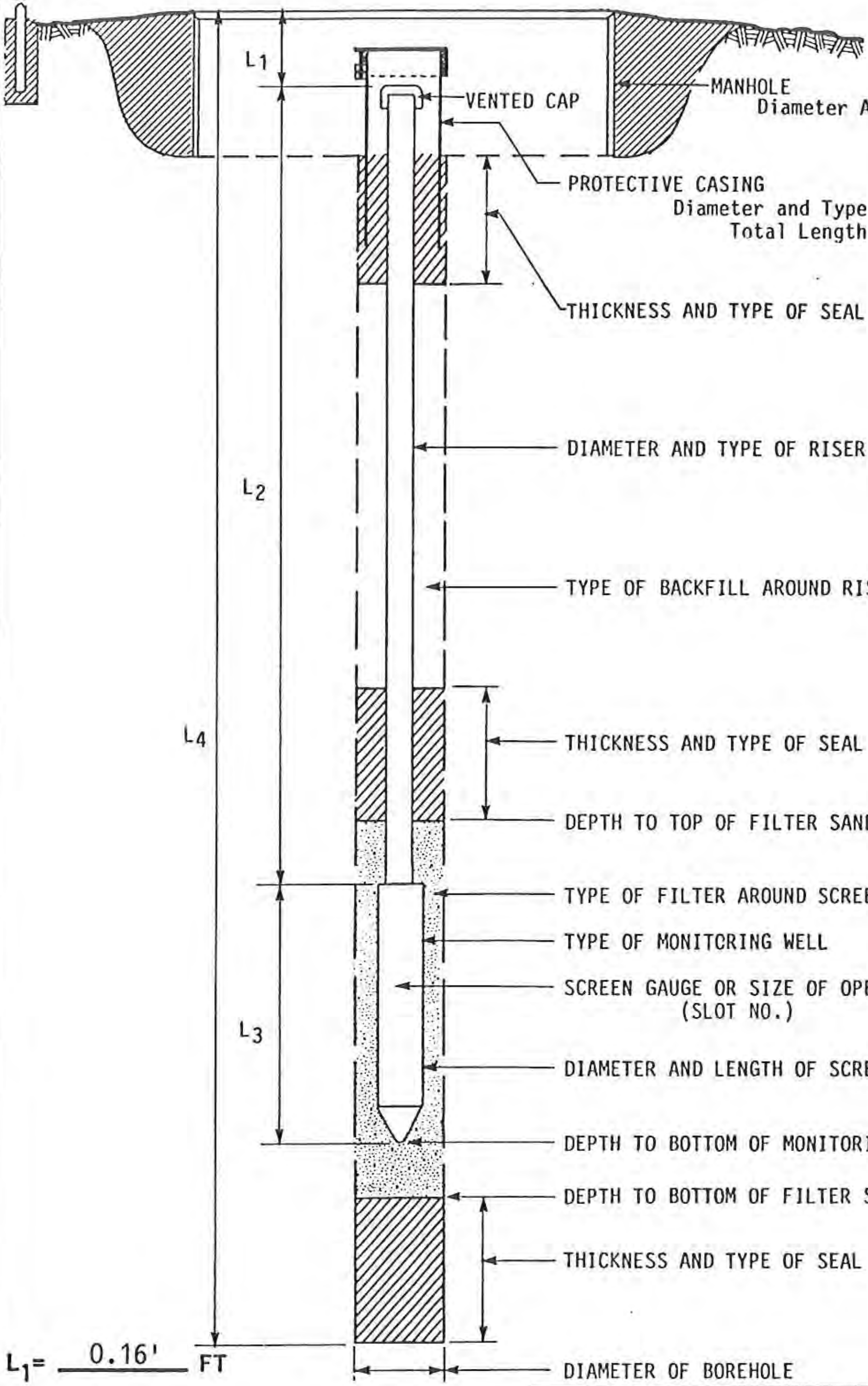
JOB NO. 120-12955

MONITORING WELL NO. 1-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1080.5'

TOP OF RISER ELEVATION 1080.34' (With Cap Removed)



VENTED CAP

MANHOLE
Diameter And Type 12" steel
Depth 5"

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 4' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 4'

TYPE OF FILTER AROUND SCREEN Filter Grout

TYPE OF MONITORING WELL 2' FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 21.0'

DEPTH TO BOTTOM OF FILTER SAND 21.0'

THICKNESS AND TYPE OF SEAL None

DIAMETER OF BOREHOLE 6"

L_1= 0.16' FT

L_2= 5.84' FT

L_3= 15' FT

L_4= 21' FT

MONITORING WELL WATER LEVEL MEASUREMENTS			
DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
11-20-84	9:00am	13.0'	
1-7-85	10:18	12.60'	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date ________ Time ________

SOIL EXPLORATION COMPANY

INSTALLATION OF MONITORING WELL

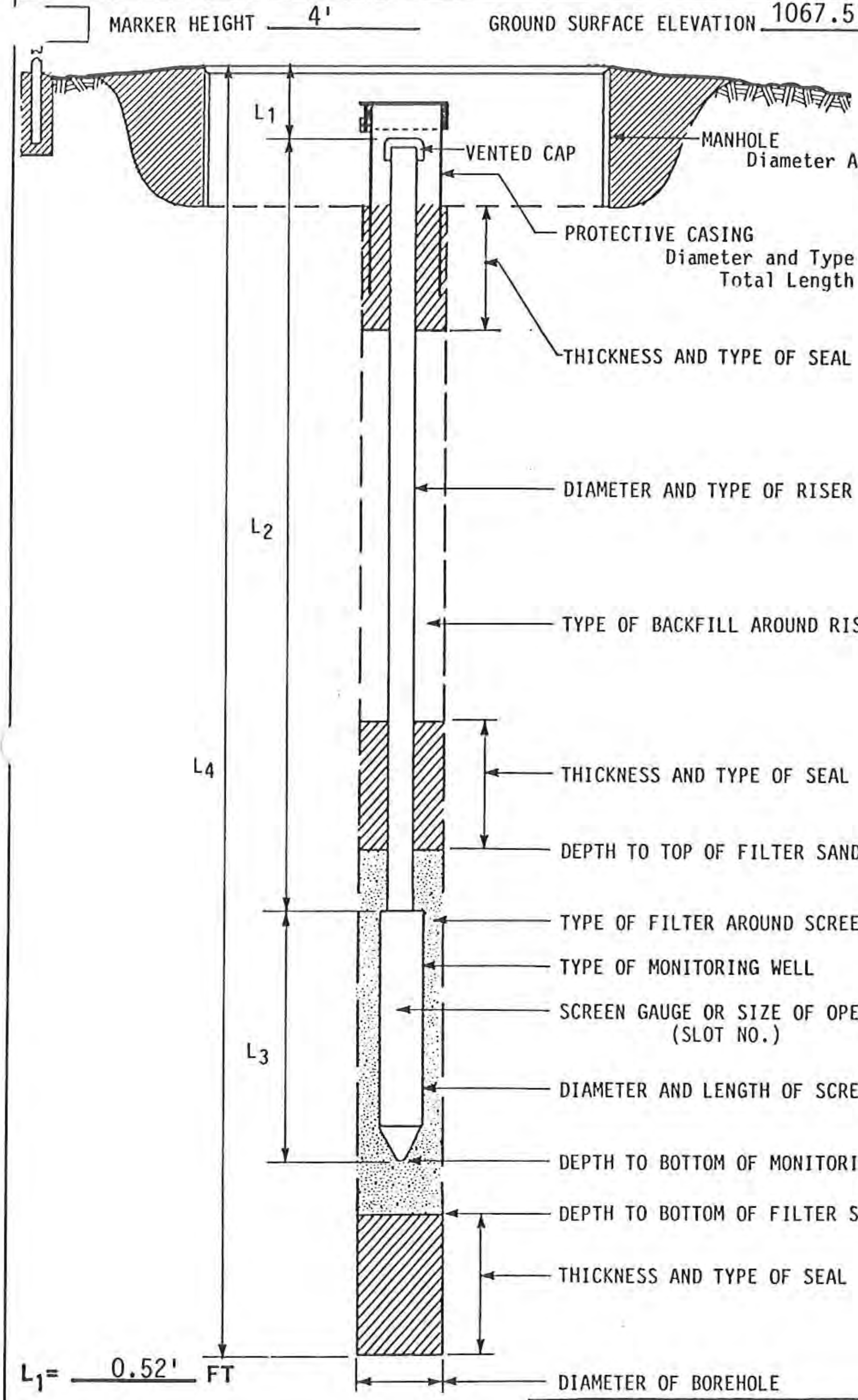
JOB NO. 120-12955

MONITORING WELL NO. 2-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1067.5'

TOP OF RISER ELEVATION 1066.98'
(With Cap Removed)



MANHOLE
Diameter And Type 12" steel
Depth 5"

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 2.5' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 2.5'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 18.52'

DEPTH TO BOTTOM OF FILTER SAND 20.0'

THICKNESS AND TYPE OF SEAL None

DIAMETER OF BOREHOLE 6"

L1= 0.52' FT

L2= 3' FT

L3= 15' FT

L4= 20.0' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-21-85	9:10 am	5.79'	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date 1-8-85 Time 2:00 pm

SOIL EXPLORATION COMPANY

INSTALLATION OF MONITORING WELL

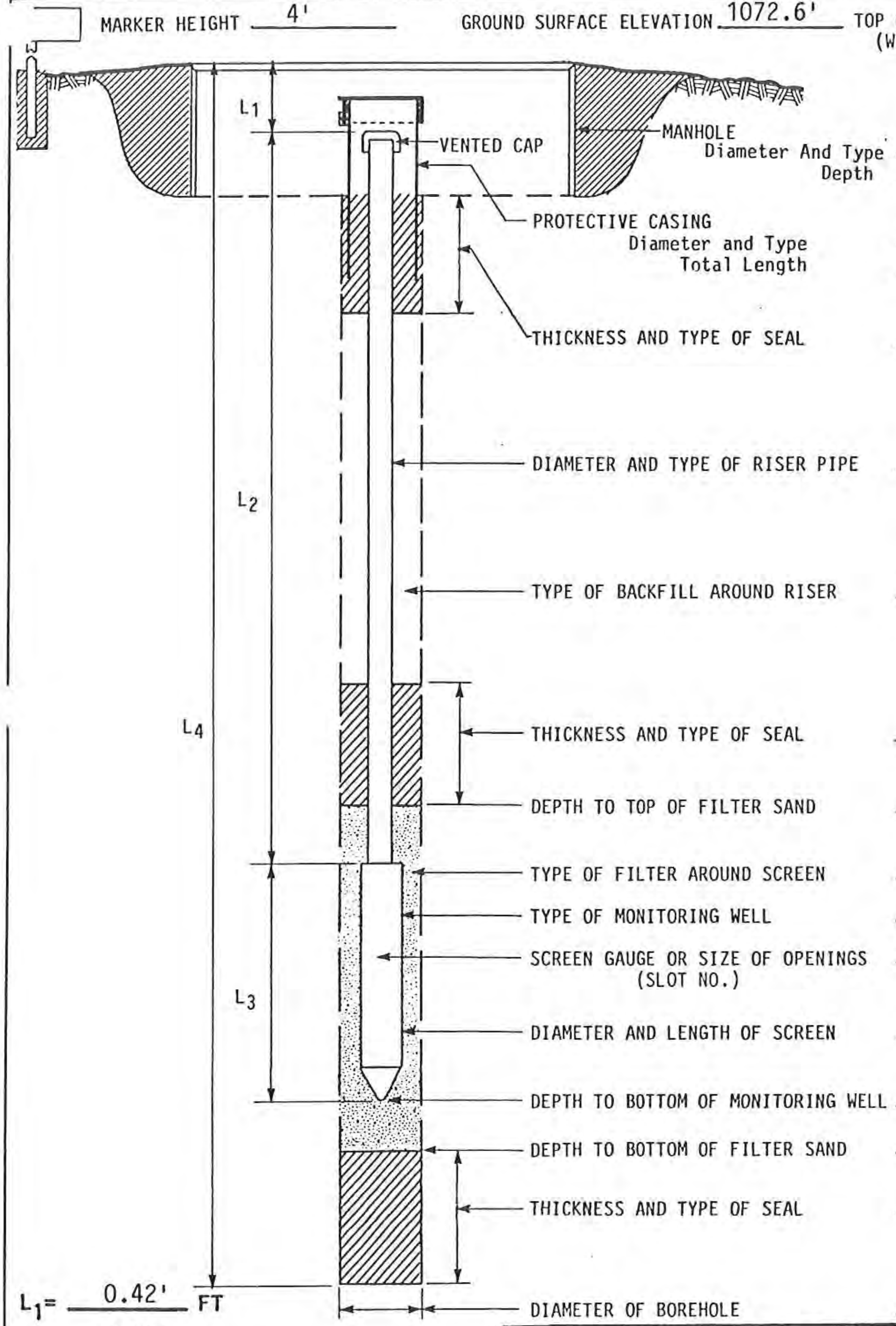
JOB NO. 120-12955

MONITORING WELL NO. 3-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1072.6'

TOP OF RISER ELEVATION 1072.18' (With Cap Removed)



MANHOLE Diameter And Type 12" steel

Depth 5"

PROTECTIVE CASING Diameter and Type 6" steel

Total Length 2'

THICKNESS AND TYPE OF SEAL 3' Grout

DIAMETER AND TYPE OF RISER PIPE s" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 19.12'

DEPTH TO BOTTOM OF FILTER SAND 21.0'

THICKNESS AND TYPE OF SEAL None

DIAMETER OF BOREHOLE 6"

L_1= 0.42' FT

L_2= 3.70' FT

$_3$= 15' FT

L_4= 21' FT

MONITORING WELL WATER LEVEL MEASUREMENTS			
DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-21-85	9:28 am	7.69'	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date 1-10-85 Time 1:00 pm

SOIL EXPLORATION COMPANY

INSTALLATION OF MONITORING WELL

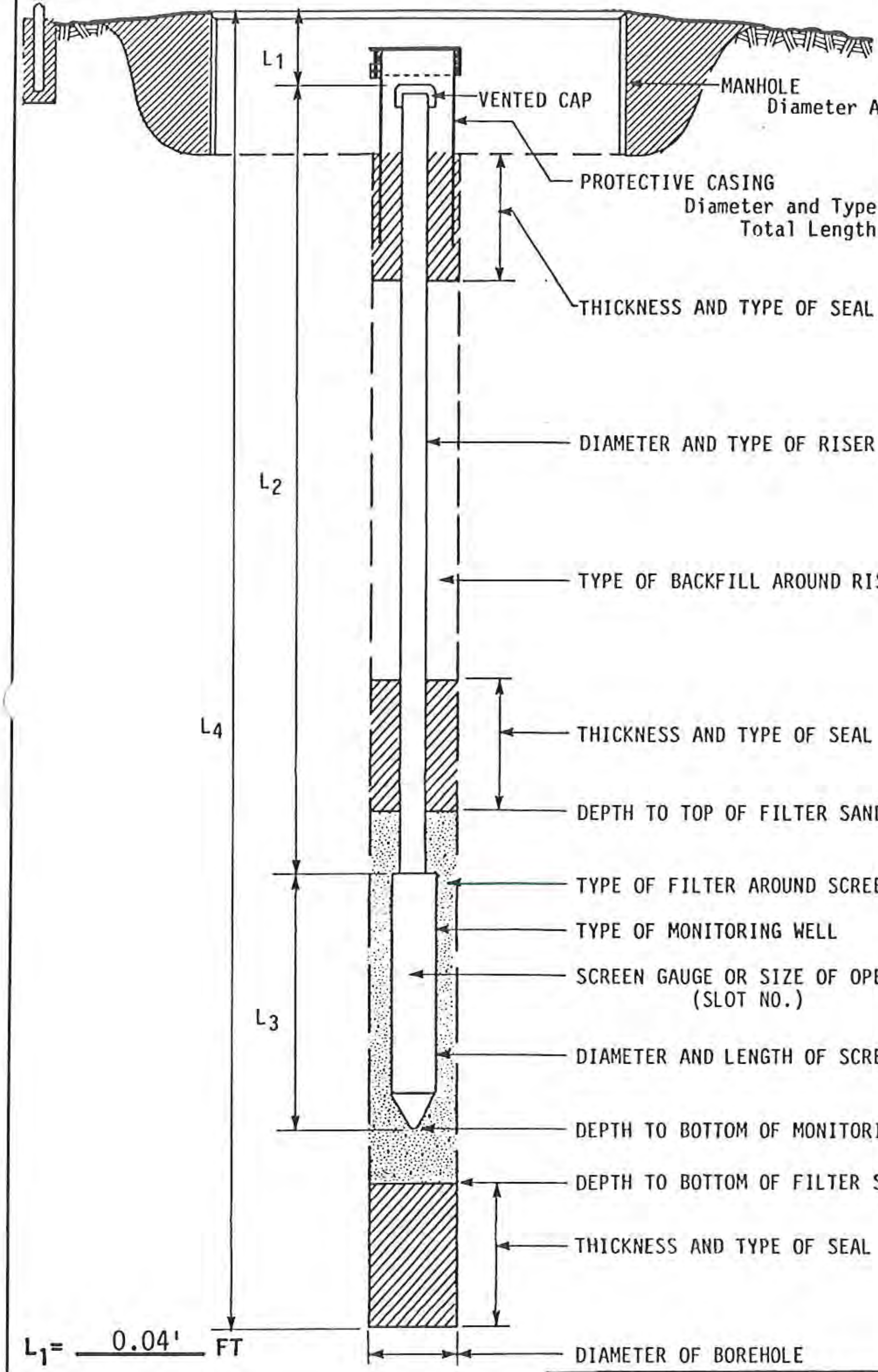
JOB NO. 120-12955

MONITORING WELL NO. 4-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1075.7'

TOP OF RISER ELEVATION 1075.74'
(With Cap Removed)



MANHOLE
Diameter And Type N/A
Depth N/A

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 3' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 19.94'

DEPTH TO BOTTOM OF FILTER SAND 21.0'

THICKNESS AND TYPE OF SEAL -

DIAMETER OF BOREHOLE 6"

L_1= 0.04' FT

L_2= 4.90' FT

L_3= 15' FT

L_4= 21' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	12:00	9.00'	
2-21-85	12:00	9.00'	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date 1-14-85 Time 2:00 pm

SOIL EXPLORATION COMPANY

INSTALLATION OF MONITORING WELL

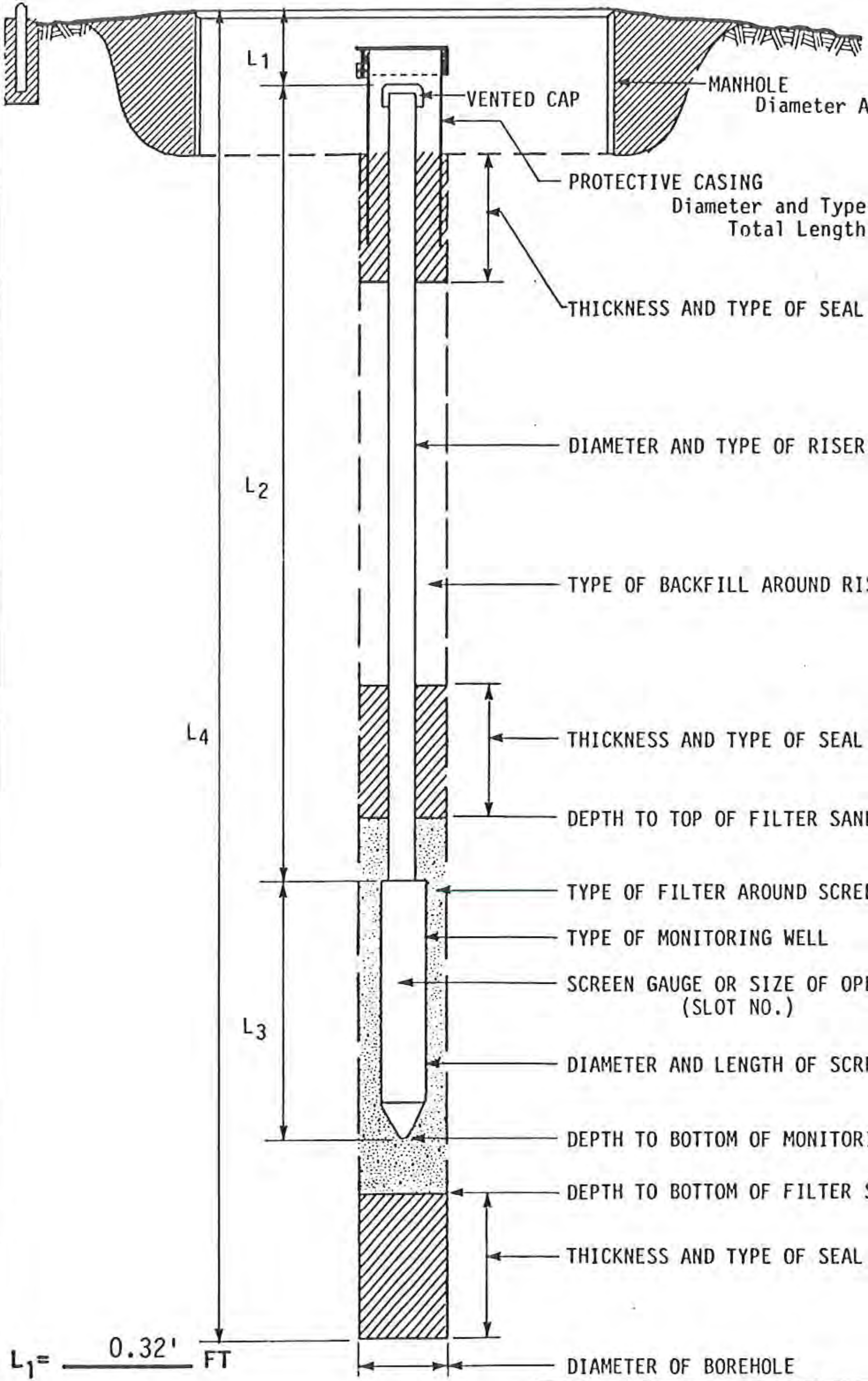
JOB NO. 120-12955

MONITORING WELL NO. 5-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1069.7'

TOP OF RISER ELEVATION 1069.38'
(With Cap Removed)



MANHOLE
Diameter And Type 12" steel
Depth 5"

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 1.0' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 1.0'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 16.82'

DEPTH TO BOTTOM OF FILTER SAND 18.0'

THICKNESS AND TYPE OF SEAL None

DIAMETER OF BOREHOLE 6"

L_1= 0.32' FT

L_2= 1.5' FT

L_3= 15' FT

L_4= 18' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	10:18 am	5.11'	
2-21-85	9:49	5.10	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date ____ Time ____

SOIL EXPLORATION COMPANY

INSTALLATION OF MONITORING WELL

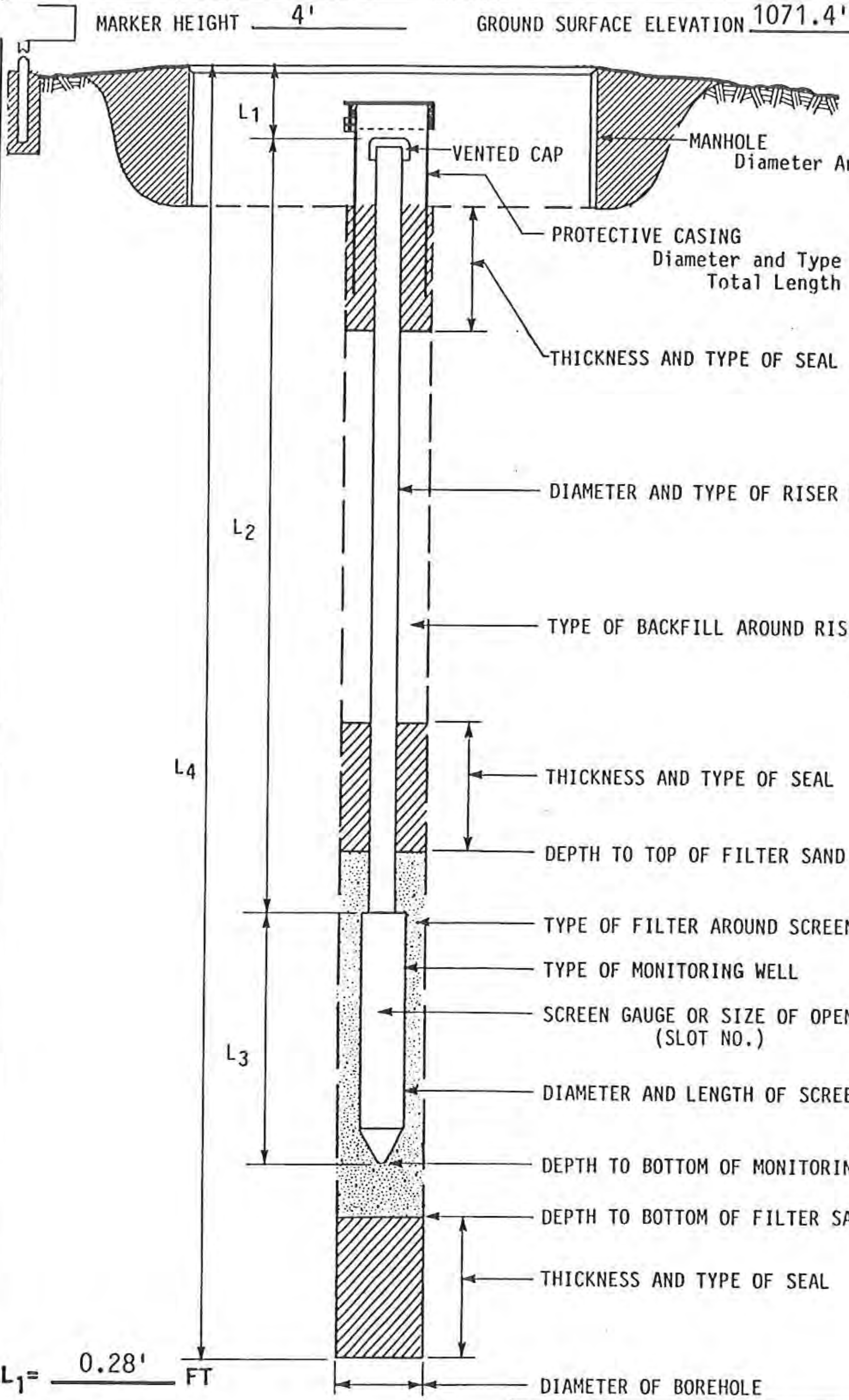
JOB NO. 120-12955

MONITORING WELL NO. 6-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1071.4'

TOP OF RISER ELEVATION 1071.12' (With Cap Removed)



MANHOLE Diameter And Type 12" steel

Depth 5"

PROTECTIVE CASING Diameter and Type 6" steel

Total Length 2'

THICKNESS AND TYPE OF SEAL 2' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 2'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 19.28'

DEPTH TO BOTTOM OF FILTER SAND 21.0'

THICKNESS AND TYPE OF SEAL -

DIAMETER OF BOREHOLE 6"

L_1= 0.28' FT

L_2= 4' FT

$_3$= 15' FT

L_4= 12' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	10:42am	7.17'	
2-21-85	10:07	7.17'	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:

Date 1-18-85 Time 1:00 pm

SOIL EXPLORATION company

INSTALLATION OF MONITORING WELL

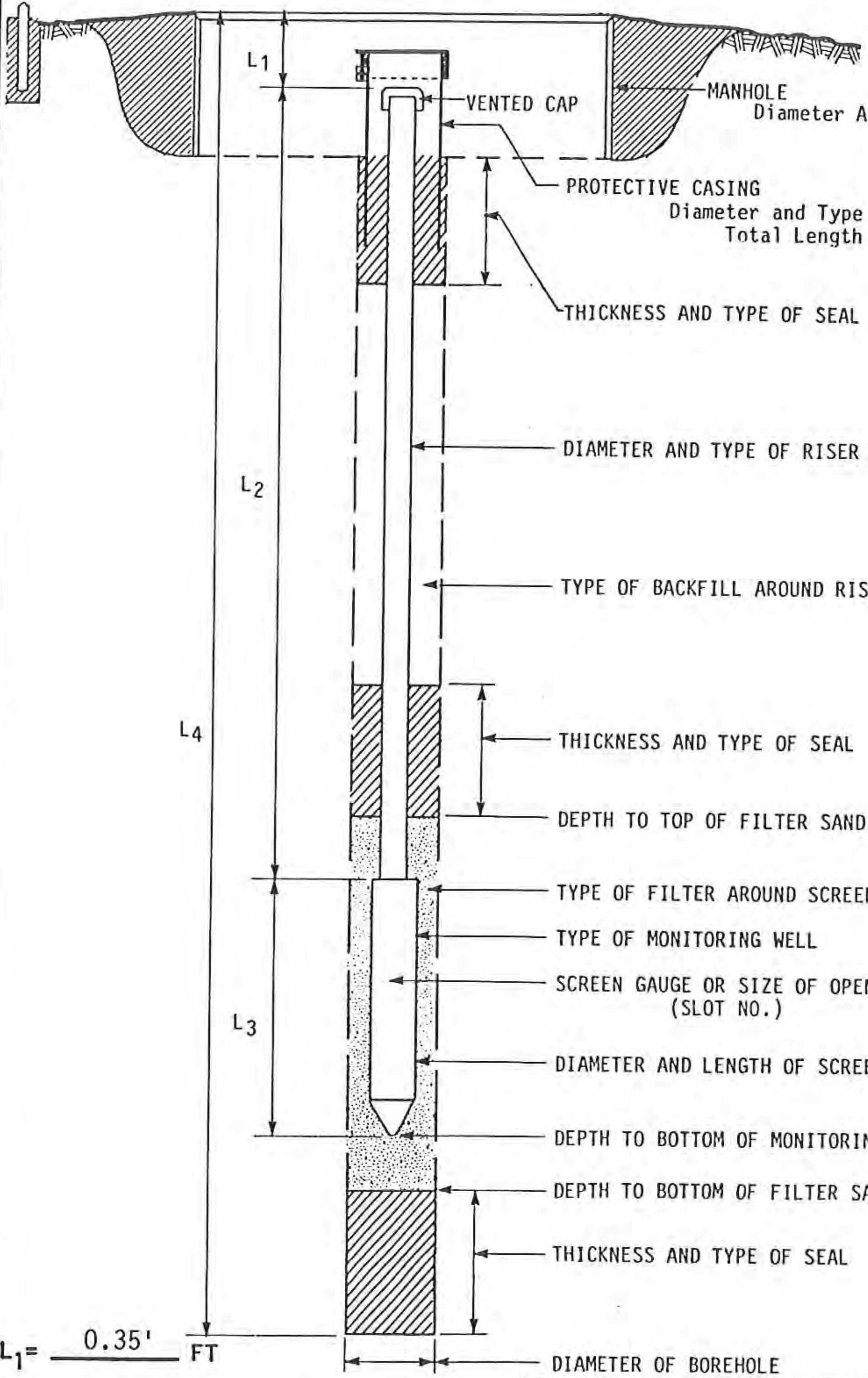
JOB NO. 120-12955

MONITORING WELL NO. 7-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1072.5'

TOP OF RISER ELEVATION 1072.15'
(With Cap Removed)



MANHOLE
Diameter And Type 12" steel
Depth 5"

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 2' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 2'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 19.25'

DEPTH TO BOTTOM OF FILTER SAND 20.0'

THICKNESS AND TYPE OF SEAL -

DIAMETER OF BOREHOLE 6"

L_1= 0.35' FT

L_2= 3.90' FT

$_3$= 15' FT

L_4= 20' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	11:17am	7.11'	
2-21-85	10:22	7.15'	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date 1-22-85 Time 3:30 pm

SOIL EXPLORATION COMPANY

INSTALLATION OF MONITORING WELL

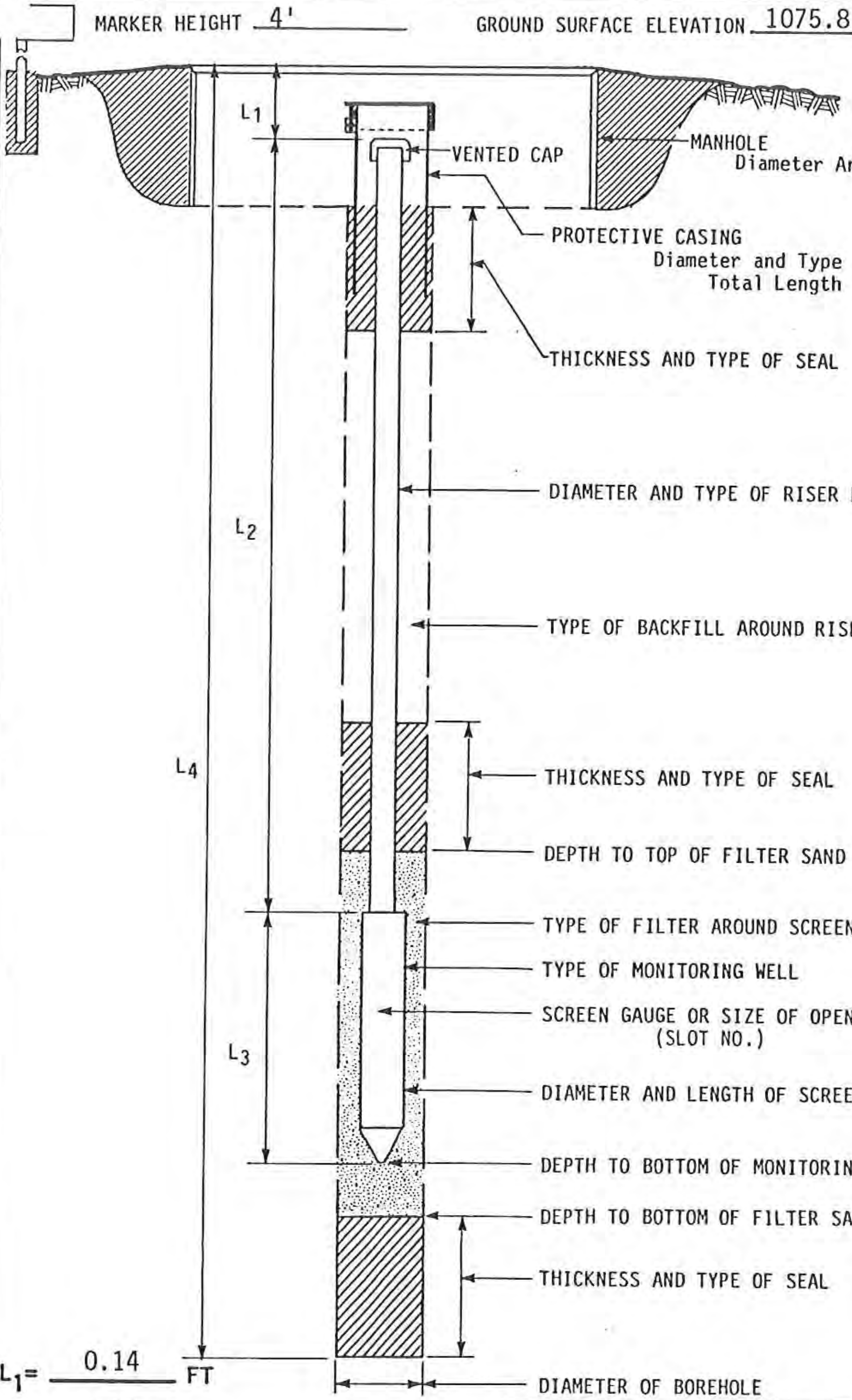
JOB NO. 120-12995

MONITORING WELL NO. 8-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1075.8'

TOP OF RISER ELEVATION 1075.66' (With Cap Removed)



MANHOLE
Diameter And Type N/A
Depth N/A

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 3' grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter gravel

THICKNESS AND TYPE OF SEAL None

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 slot

DIAMETER AND LENGTH OF SCREEN 2" x 15'

DEPTH TO BOTTOM OF MONITORING WELL 20.04'

DEPTH TO BOTTOM OF FILTER SAND 22.0'

THICKNESS AND TYPE OF SEAL None

DIAMETER OF BOREHOLE 6"

L_1= 0.14 FT

L_2= 4.90 FT

L_3= 15.0 FT

L_4= 22.0 FT

MONITORING WELL WATER LEVEL MEASUREMENTS			
DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	11:53	9.51	
2-21-85	10:40	9.51	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date 2/14/85 Time 3:00 PM

SOIL EXPLORATION company

INSTALLATION OF MONITORING WELL

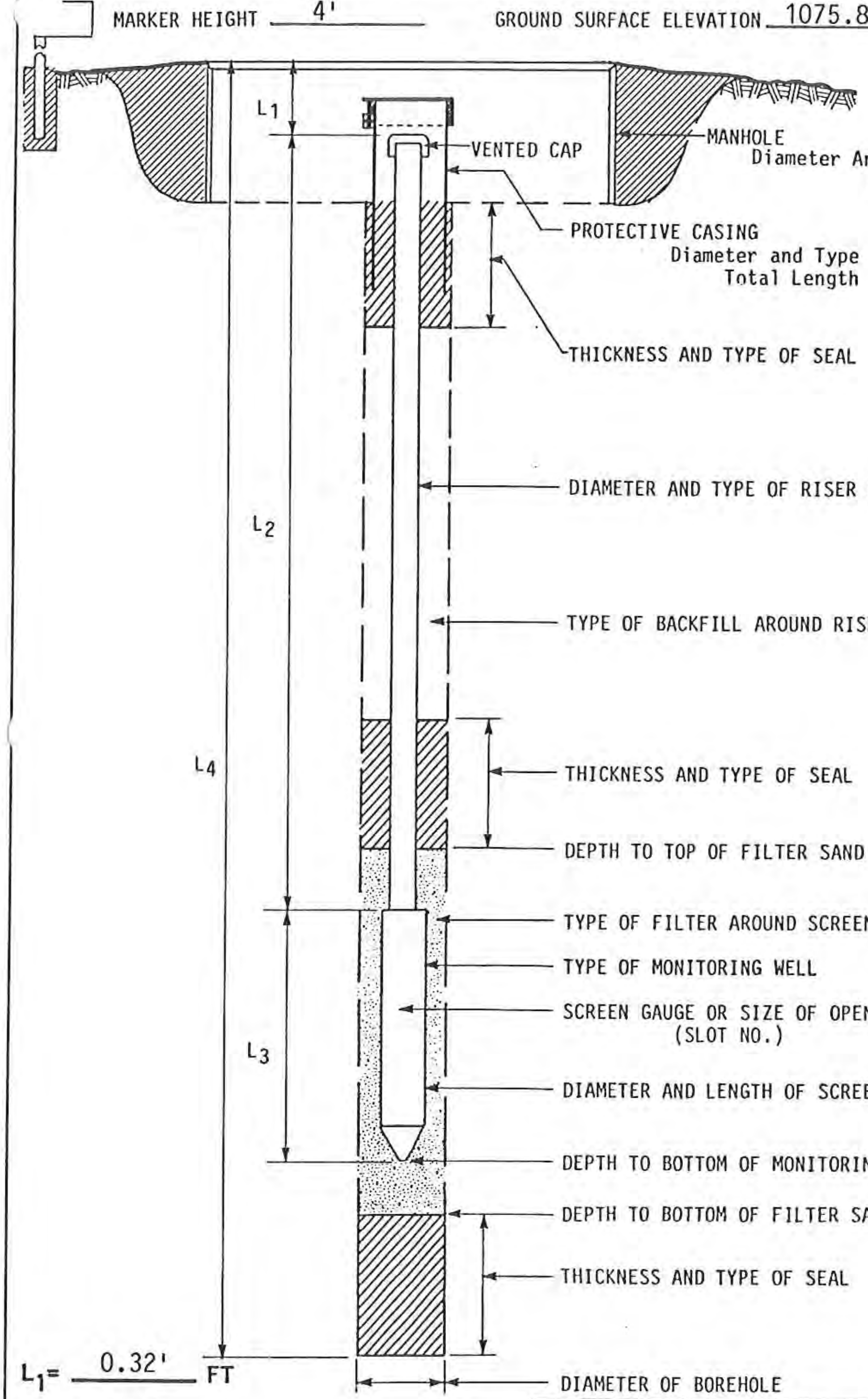
JOB NO. 120-12955

MONITORING WELL NO. 9-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1075.8'

TOP OF RISER ELEVATION 1075.48'
(With Cap Removed)



MANHOLE
Diameter And Type N/A
Depth N/A

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL N/A

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 19.82'

DEPTH TO BOTTOM OF FILTER SAND 21.0'

THICKNESS AND TYPE OF SEAL -

DIAMETER OF BOREHOLE 6"

L1= 0.32' FT

L2= 4.50' FT

L3= 15' FT

L4= 21' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	1:38pm	9.54'	
2-21-85	11:35am	9.54'	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date 1-24-85 Time 3:00 pm

soil exploration company

INSTALLATION OF MONITORING WELL

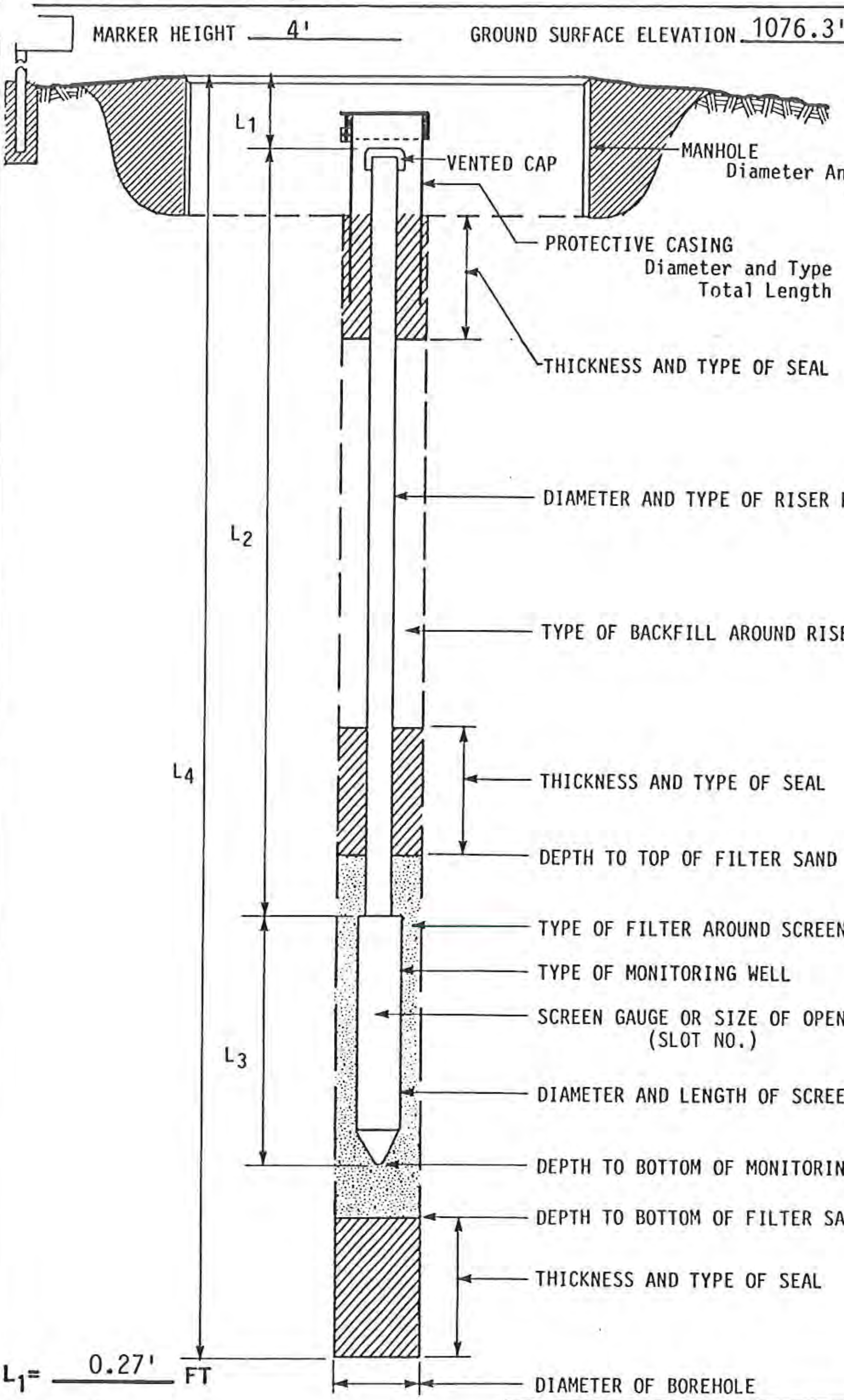
JOB NO. 120-12955

MONITORING WELL NO. 10-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1076.3'

TOP OF RISER ELEVATION 1076.03'
(With Cap Removed)



MANHOLE Diameter And Type 12" steel

Depth 5"

PROTECTIVE CASING Diameter and Type 6"steel

Total Length 2'

THICKNESS AND TYPE OF SEAL 3' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 19.27'

DEPTH TO BOTTOM OF FILTER SAND 21.0'

THICKNESS AND TYPE OF SEAL -

DIAMETER OF BOREHOLE 6"

L_1= 0.27' FT

L_2= 4' FT

L_3= 15' FT

L_4= 21' FT

MONITORING WELL WATER LEVEL MEASUREMENTS			
DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	2:12 pm	9.38'	
2-21-85	12:45	9.38	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date 1-29-85 Time 11:30

SOIL EXPLORATION COMPANY

INSTALLATION OF MONITORING WELL

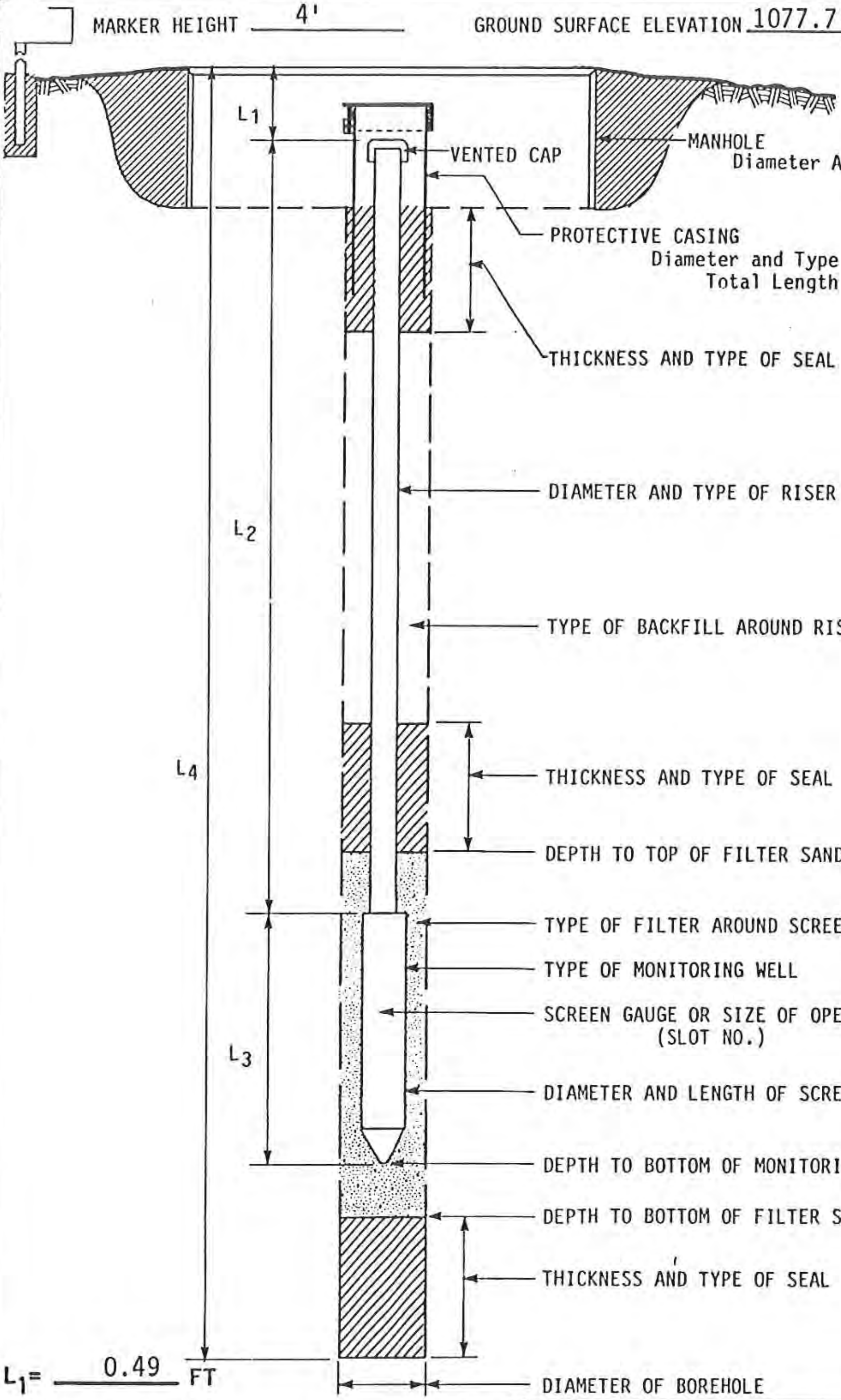
JOB NO. 120-12955

MONITORING WELL NO. 11-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1077.7'

TOP OF RISER ELEVATION 1077.21'
(With Cap Removed)



MANHOLE
Diameter And Type N/A
Depth N/A

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 3' grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter gravel

THICKNESS AND TYPE OF SEAL None

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 slot

DIAMETER AND LENGTH OF SCREEN 2" x 15'

DEPTH TO BOTTOM OF MONITORING WELL 20.49'

DEPTH TO BOTTOM OF FILTER SAND 22.0'

THICKNESS AND TYPE OF SEAL None

DIAMETER OF BOREHOLE 6"

L_1= 0.49 FT

L_2= 5.0 FT

L_3= 15.0 FT

L_4= 22.0 FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	3:12pm	10.48	
2-21-85	3:00pm	10.48	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date 1-31-85 Time 10:00 am

SOIL EXPLORATION COMPANY

INSTALLATION OF MONITORING WELL

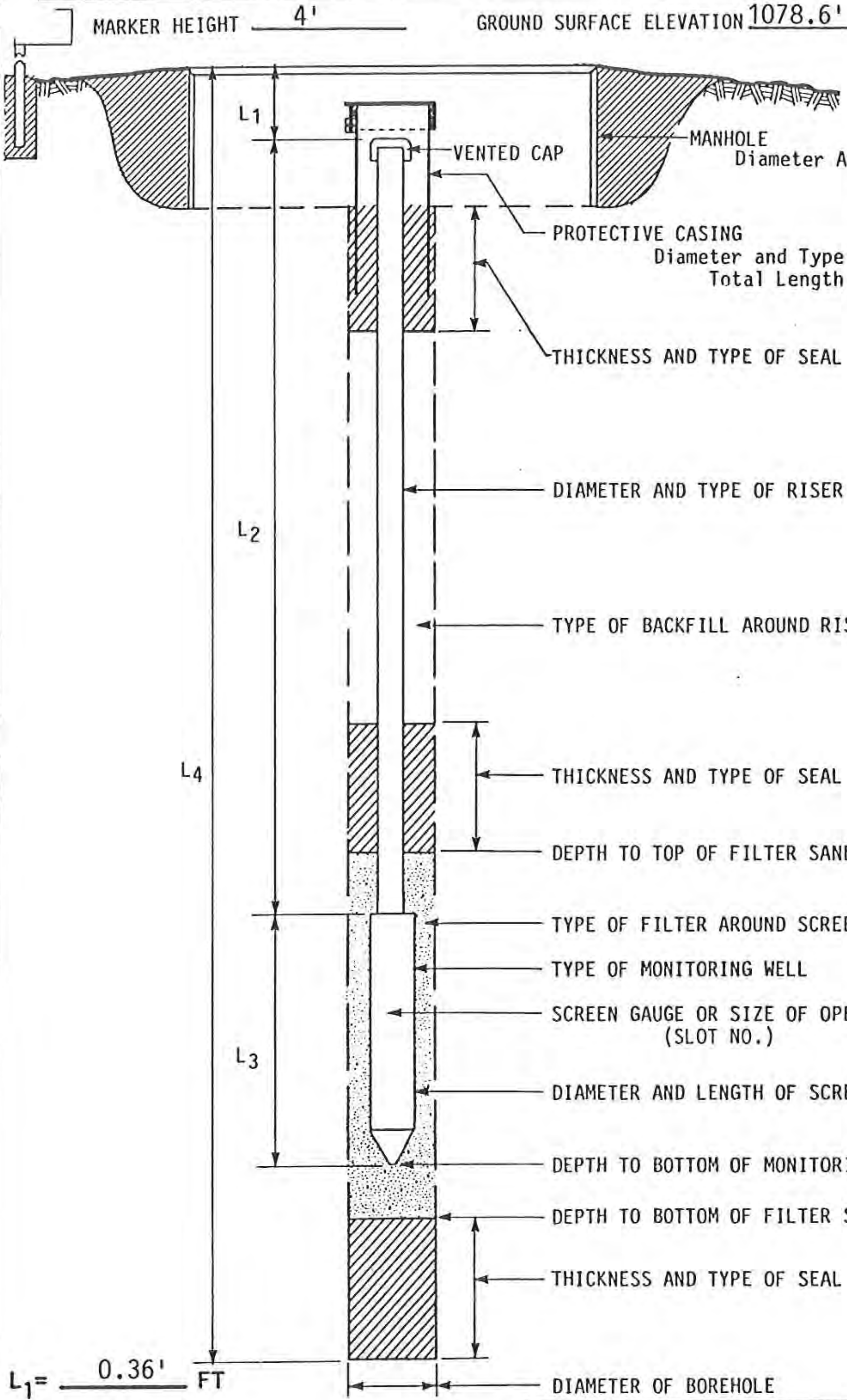
JOB NO. 120-12955

MONITORING WELL NO. 12-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1078.6'

TOP OF RISER ELEVATION 1078.24'
(With Cap Removed)



MANHOLE
Diameter And Type 12"steel
Depth 5"

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 3' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 21.36'

DEPTH TO BOTTOM OF FILTER SAND 22.0'

THICKNESS AND TYPE OF SEAL -

DIAMETER OF BOREHOLE 6"

L_1 = 0.36' FT

L_2 = 6' FT

L_3 = 15' FT

L_4 = 22' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	3:12	10.48'	
2-12-85	3:00	10.48	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date 2-20-85 Time 2:00 pm

SOIL EXPLORATION COMPANY

APPENDIX B

Gasoline Loss Investigation, Quarterly Monitoring, August 15, 1986

GASOLINE LOSS INVESTIGATION
QUARTERLY MONITORING
TIGER OIL #3
NORTH FIRST STREET
YAKIMA, WASHINGTON

#120 86-602
AUGUST 15, 1986

RECEIVED
AUG 21 1986
DEPARTMENT OF ECOLOGY
CENTRAL REGION OFFICE

twin city testing
corporation

twin city testing
corporation

662 CROMWELL AVENUE
ST. PAUL, MN 55114
PHONE 612/645-3601

August 15, 1986

State of Washington
Department of Ecology
3601 West Washington Avenue
Yakima, Washington 98903

Attn: Mr. Al Newman

Subj: Gasoline Loss Investigation
Quarterly Monitoring
Tiger Oil #3
North First Street
Yakima, Washington
#120 86-602
Claim #82U-021

Gentlemen:

Twin City Testing Corporation has summarized all data collected at the above site since our last report dated December 3, 1985.

If you have any questions regarding the attached data, please feel free to contact me at (612) 641-9372.

Very truly yours,

Twin City Testing Corporation

Mark S. Mason

Mark S. Mason
Environmental Geologist/Project Manager

MSM/jr

Encs

cc: 1 - Federated Insurance Company
Attn: Mr. Craig Kautz
1 - IT Corporation
Attn: Mr. John Clark
1 - Weeks, Dietzen & Skala
Attn: Mr. Roland Skala
1 - United States Geological Survey
Attn: Mr. Gary Turney

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QUARTERLY MONITORING

TIGER OIL #3

NORTH FIRST STREET

YAKIMA, WASHINGTON

#120 86-602

1.0 INTRODUCTION

This report presents the results of work performed at the above site since our last report dated December 3, 1985 report. All work completed is in accordance with the Twin City Testing Corporation (TCT) report dated May 8, 1985 (#120 86-12955). The monitoring program has consisted of the following.

1. Site inspection.
2. Recording ground water and product levels in all 1985 monitoring wells.
3. Collecting representative ground water samples from monitoring wells 7-85, 8-85, 9-85, 10-85, 11-85 and from the Knight residence.

2.0 BACKGROUND INFORMATION

Table 1 presents monitoring well water level data for October, November and December, 1985 while Table 2 presents monitoring well water level data for January, February and March, 1986. A review of the water level data

TABLE #1

GROUND WATER ELEVATION DATA

	Date Depth to Ground Water				
Location	10-85	11-85	12-85	Reference Elevation	Ground Water Elevation 12-85
1-85	10.78	11.73	12.56	1,083.34	1070.78
2-85	4.96	5.81	Snowed in	1,066.98	Not Available
3-85	6.13	6.82	7.62	1,072.18	1064.56
4-85	7.14	8.13	8.94	1,075.74	1066.80
5-85	4.39	4.95	5.11	1,069.38	1064.27
6-85	6.28	7.50	7.63	1,071.13	1063.50
7-85	6.11	7.13	7.37	1,072.15	1064.78
8-85	8.42	9.03	9.33	1,075.66	1066.33
9-85	8.16	8.92	9.23	1,075.48	1066.25
10-85	7.38	7.86	8.21	1,076.03	1067.82
11-85	9.01	9.81	10.46	1,077.21	1066.75
12-85	9.86	10.60	11.26	1,078.24	1066.98

*Reference Elevation = Top of 2" PVC riser.

Note: All measurements in feet.

TABLE #2

GROUND WATER ELEVATION DATA

	Date Depth to Ground Water				
Location	1-86	2-86	3-86	Reference Elevation	Ground Water Elevation 3-86
1-85	12.11	11.86	11.46	1,083.34	1071.88
2-85	5.58	5.39	5.19	1,066.98	1061.79
3-85	7.72	7.50	7.38	1,072.18	1064.80
4-85	8.73	8.62	8.19	1,075.74	1067.55
5-85	4.77	4.62	4.57	1,069.38	1064.81
6-85	7.26	6.98	6.87	1,071.13	1064.26
7-85	6.85	6.78	6.66	1,072.15	1065.49
8-85	9.21	9.11	8.77	1,075.66	1066.89
9-85	9.38	9.25	8.91	1,075.48	1066.57
10-85	8.89	8.83	8.49	1,076.03	1067.54
11-85	10.19	9.98	9.52	1,077.21	1067.69
12-85	10.89	10.72	10.27	1,078.24	1067.97

*Reference Elevation = Top of 2" PVC riser.

Note: All measurements are in feet.

indicates that ground water elevations have increased during the Spring, 1986. The rise in water level elevations may be due to increased seasonal recharge.

Figures 1 and 2 present the ground water elevations and flow directions as calculated from the December, 1985 and March, 1986 water level elevations Using these data, the December, 1985 hydraulic gradient is .0034 ft/ft, and the March, 1986 hydraulic gradient is .0035 ft/ft. The March, 1986 water level at monitoring well 10-85 reflects a higher water level than would be expected. We suspect that this anomaly may be due to infiltration and local recharge from an adjacent ditch.

3.0 CHEMISTRY RESULTS

All collected water samples were submitted to the TCT chemistry laboratory for analysis to determine benzene, toluene, xylene and total hydrocarbons expressed as gasoline concentrations. The results of these analyses are presented in Tables 3 and 4. A review of these tables indicates the presence of dissolved hydrocarbons at monitoring well 11-85. Since August, 1985, dissolved hydrocarbon concentrations at monitoring well 8-85 have decreased from 12 parts per million (ppm) total hydrocarbons to 0 ppm total hydrocarbons. Chemistry methodologies are attached in Appendix A.

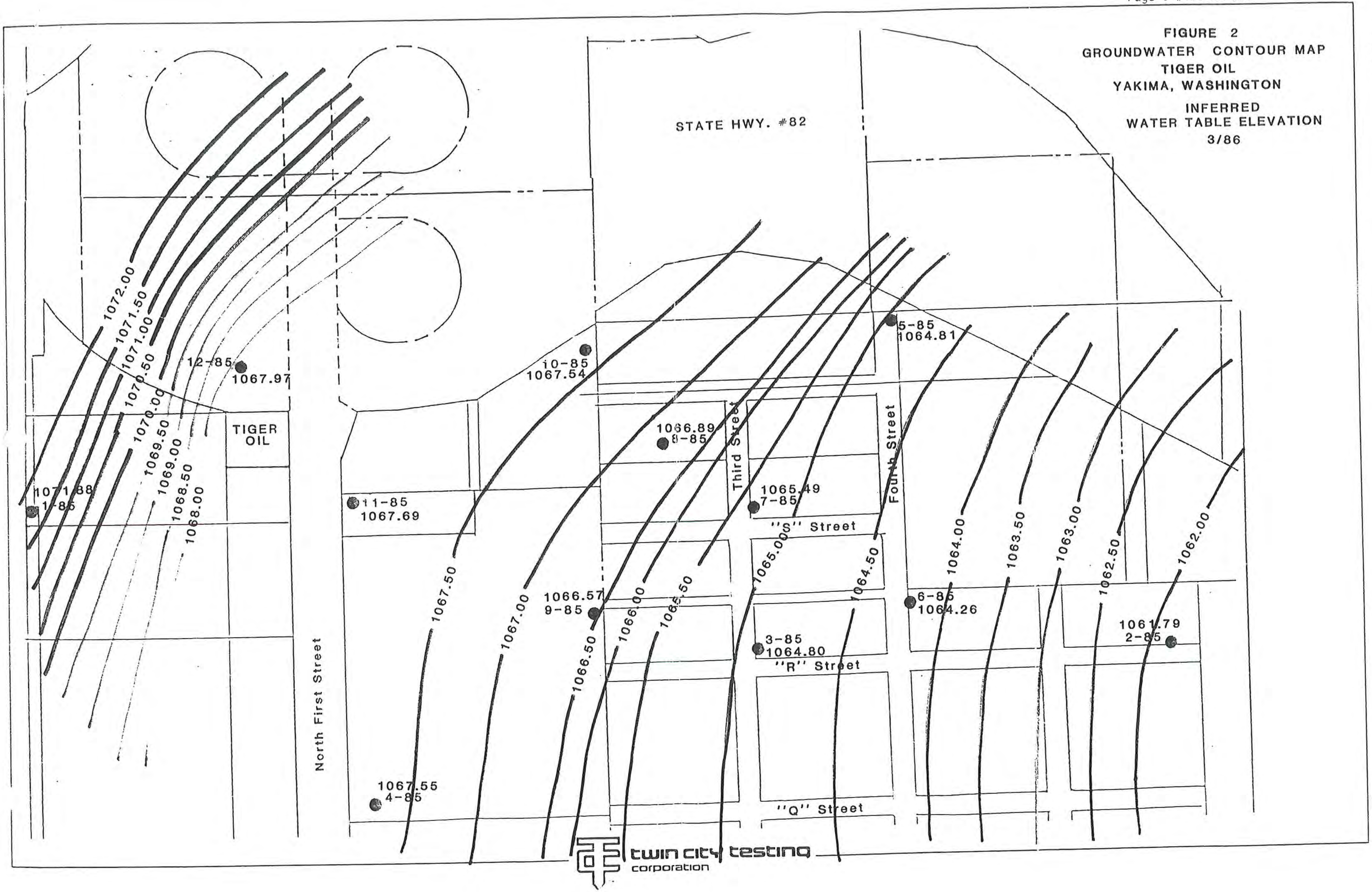
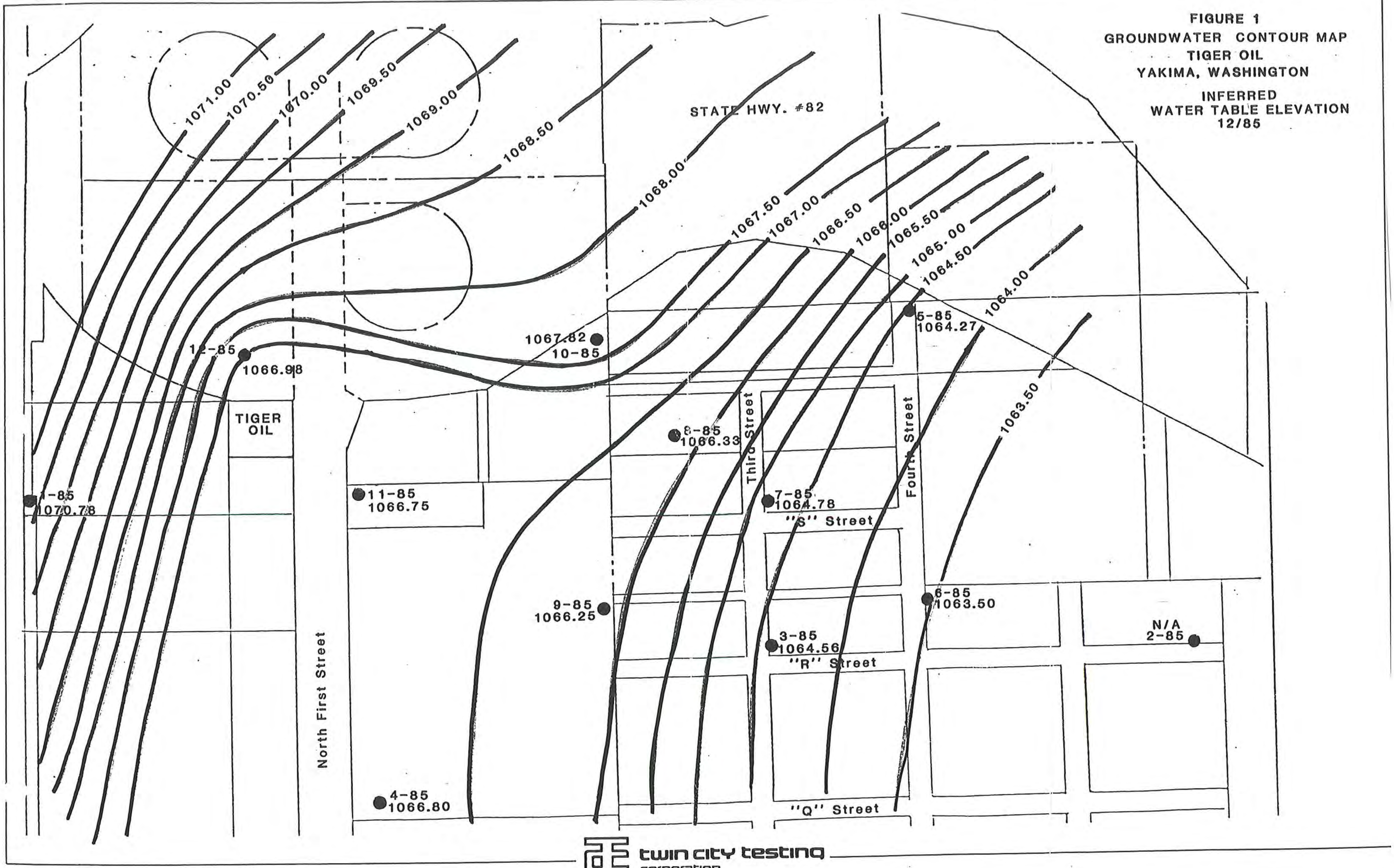


FIGURE 2
GROUNDWATER CONTOUR MAP
TIGER OIL
YAKIMA, WASHINGTON

INFERRED
WATER TABLE ELEVATION
3/86

FIGURE 1
GROUNDWATER CONTOUR MAP
TIGER OIL
YAKIMA, WASHINGTON

INFERRED
WATER TABLE ELEVATION
12/85



twin city testing
corporation

TABLE #4

VOLATILE ANALYSIS

JUNE 20, 1986

Parameter	Knight Residence ug/L	MW-7 ug/L	MW-8 ug/L	MW-9 ug/L	MW-10 ug/L	MW-11 ug/L
Total Hydrocarbons as Gasoline	ND	ND	ND	ND	ND	45,000
Benzene	ND	ND	ND	ND	ND	680
Toluene	ND	ND	ND	ND	ND	7,000
Xylene	ND	ND	ND	ND	ND	18,000

For purposes of this analysis, ug/L = ppb

ND = Not Detected

4.0 DISCUSSION

Based on the data presented, downgradient (MW-8-85) hydrocarbon contamination has decreased. However, the higher level of dissolved hydrocarbon concentrations at MW-11-85 may be explained by local irrigation solubilizing previously immobile hydrocarbons. Water level information for June, 1986 will be provided on our next report.

5.0 RECOMMENDATIONS

Mr. Gary Turney of the United States Geological Survey (U.S.G.S.) has recently notified TCT of the survey's plans to install additional site monitoring wells. In view of the thorough site study being completed by the U.S.G.S., TCT, on behalf of Tiger Oil, requests permission from the State of Washington, Department of Ecology to discontinue site monitoring.

6.0 REMARKS

The recommendations contained in this report represent our professional opinions. These opinions were arrived at in accordance with currently accepted engineering and hydrogeologic practices at this time and location. Other than this, no warranty is implied or intended.

This report was prepared by: Mark S. Mason

Mark S. Mason
Environmental Geologist/Project Manager

Dated: August 15, 1986

This report was reviewed by: Kevin D. Krueger

Kevin D. Krueger
Project Manager

Dated: August 15, 1986

Proofread by: P. Wright

TABLE #3

VOLATILE ANALYSIS

DECEMBER 16, 1985

Parameter	Knight Residence (ug/L	MW-7 (ug/L)	MW-9 (ug/L)	MW-10 (ug/L)	MW-11 (ug/L)
Total Hydrocarbons as Gasoline	ND	ND	ND	ND	28,000
Benzene	ND	ND	ND	ND	710
Toluene	ND	ND	ND	ND	1,100
Xylene	ND	ND	ND	ND	750

For purposes of this analysis, ug/L = ppb

ND = Not Detected

twin city testing
and engineering laboratory, inc.
662 CROMWELL AVENUE
ST PAUL MN 55114
PHONE 612/645-3601

REPORT OF: CHEMICAL ANALYSIS

PROJECT: TIGER OIL # 3

Date: June 30, 1986

REPORTED TO: Twin City Testing
Attn: Mark Mason
662 Cromwell Ave
St Paul, Minn 55114

LABORATORY No. 120 86-602

INTRODUCTION:

This report presents the results of our analysis of water samples for volatiles. The samples were received on June 20, 1986 from Mark Mason of Twin City Testing. The scope of our work was limited to analyzing the samples for the presence of benzene, toluene, xylenes and total hydrocarbons as gasoline using gas chromatographic techniques.

SAMPLE IDENTIFICATION:

TCT@ 12914 MW-7
TCT# 12915 MW-8
CT# 12916 MW-9
TCT# 12917 MW-10
TCT# 12918 MW-11
TCT# 12919 Knight residence
TCT# 12920 Lab blank

METHODOLOGY:

Gasoline contamination was determined using a Tekmar LSC-2 Liquid Sample Concentrator linked to a Perkin-Elmer Sigma 300 gas chromatograph with FID. Benzene, toluene and xylene were identified by retention time and quantified by comparison with known standards using a VG Analytical data system. Gasoline concentration was calculated by ratioing total peak area to a gasoline standard total peak area.

RESULTS:

These are summarized in Table #1.

REMARKS:

The samples were consumed in the analysis. The samples were analyzed on June 27, 1986.

TWIN CITY TESTING
CORPORATION

Chris Bremer Harold D Fisher (ms) W. Welbes

Chris Bremer	Harold D Fisher	William F Welbes
Asst. Laboratory Supervisor	Chromatography Group Leader	Vice-President Chemistry

REPORT OF: CHEMICAL ANALYSIS

PROJECT: TIGER OIL #3

REPORTED TO:

Date: June 30, 1986

LABORATORY No. 120 86-602

TABLE #1

Volatile Analysis

SAMPLE IDENTIFICATION:

PARAMETER:	TCT# 12914 (ug/L)	TCT# 12915 (ug/L)	TCT# 12916 (ug/L)	Lower Detectable Limit (ug/L)
Total Hydrocarbons as Gasoline	ND	ND	ND	1
Benzene	ND	ND	ND	1
Toluene	ND	ND	ND	1
Xylene	ND	ND	ND	1

For purposes of this analysis ug/L = ppb

N.D. = Not detected

REPORT OF: CHEMICAL ANALYSIS

PROJECT: TIGER OIL #3

Date: June 30, 1986

REPORTED TO:

LABORATORY No. 120 86-602

TABLE #1

Volatile Analysis

SAMPLE IDENTIFICATION:

PARAMETER:	TCT# 12917 (ug/L)	TCT# 12918 (ug/L)	TCT# 12919 (ug/L)	Lower Detectable Limit (ug/L)
Total Hydrocarbons as Gasoline	ND	45,000	ND	1
Benzene	ND	680	ND	1
Toluene	ND	7,000	ND	1
Xylene	ND	18,000	ND	1

For purposes of this analysis ug/L = ppb

N.D. = Not detected

APPENDIX A

CHEMISTRY METHODOLOGY

twin city testing
and engineering laboratory, inc.
662 CROMWELL AVENUE
ST. PAUL. MN 55114
PHONE 612/645-3601

REPORT OF: CHEMICAL ANALYSIS

PROJECT: TIGER OIL #3

DATE: December 30, 1985

REPORTED TO:
Twin City Testing
Attn: Mark Mason
662 Cromwell Avenue
St Paul, MN 55114

FURNISHED BY:

COPIES TO:

LABORATORY No. 120 86-602

INTRODUCTION

This report presents the results of our analysis of water samples for volatiles. The samples were received on December 16, 1985. The scope of our work was limited to analyzing the samples for the presence of benzene, toluene, xylenes and total hydrocarbons as gasoline using gas chromatographic techniques.

SAMPLE IDENTIFICATION

TCT Number 19344 - Knight Residence
TCT Number 19345 - MW-10-85
TCT Number 19346 - MW-11-85
TCT Number 19347 - MW-7-85
TCT Number 19348 - MW-9-85
TCT Number 19349 - Lab Blank

METHODOLOGY

These samples were analyzed using a Tekmar LSC-2 liquid sample concentrator linked to a Perkin-Elmer Sigma 300 Gas Chromatograph with FID on a six-foot stainless steel column packed with SP-1000 100/200 mesh packing. Benzene, toluene and xylene were identified by retention time and quantified by comparison with known standards using an SP-4100 data system. Gasoline concentration was calculated by ratioing total peak area to a gasoline standard total peak area.

RESULTS

The results are summarized in Table #1.

REMARKS

The samples were consumed in the analysis.

TWIN CITY TESTING CORPORATION

Chris Bremer
Chris Bremer
Asst. Laboratory Supervisor

Harold D Fisher
Chromatography Group Leader

W. Welbes
William F Welbes
Vice-President Chemistry

CB/HDF/WFW/ms

TABLE #1

Volatile Analysis

Parameter	Knight Residence (ug/L)	MW-10 (ug/L)	MW-11 (ug/L)	MW-7 (ug/L)	MW-9 (ug/L)	Lab Blank (ug/L)	Lower Detectable Limit (ug/L)
Total Hydrocarbons as Gasoline	ND	ND	28,000	ND	ND	ND	1
Benzene	ND	ND	710	ND	ND	ND	1
Toluene	ND	ND	1,100	ND	ND	ND	1
Xylene	ND	ND	750	ND	ND	ND	1

For purposes of this analysis ug/L = ppb

ND = Not Detected

APPENDIX C

Changes Between 1984 and 1989 in the Concentration and Areal Extent of Groundwater Contamination from a Gasoline and Diesel Fuel Leak, April 10, 1991

CHANGES BETWEEN 1984 AND 1989 IN THE CONCENTRATION AND AREAL EXTENT OF GROUND-WATER CONTAMINATION FROM A GASOLINE AND DIESEL FUEL LEAK AT A SITE IN YAKIMA, WASHINGTON

By Richard J. Wagner and J. C. Ebbert

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report __-____

Prepared in cooperation with
STATE OF WASHINGTON DEPARTMENT OF ECOLOGY

Tacoma, Washington
1990

DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information write to:	Copies of this report can be purchased from:
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ILLUSTRATIONS--Continued

PLATES

[Plate in pocket at end of report]

Plate 1. Map showing locations of ground-water and soil-gas sampling sites

TABLES

TABLES--Continued

CONVERSION FACTORS AND VERTICAL DATUM

Multiply inch-pound units	*By*	*To obtain metric units*
inch	25.4	millimeter (mm)
foot	0.3048	meter (m)
mile	1.609	kilometer (km)
square mile	2.590	square kilometer(km^2)
gallon (gal)	3.785	liter (L)
micromho per centimeter at 25 degrees Celsius (µmho/cm at 25 °Celsius)		microsiemen per centimeter at 25 degrees Celsius (µS/cm at 25 °C)

Sea Level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929(--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Temperature: To covert degrees Farhrenheit (°F) to degrees Celsius (°C), use the following equation: °C = 5/9 (°F - 32).

Trade-Name Disclaimer: Use of brands, firms, or trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

CHANGES BETWEEN 1984 AND 1989 IN THE CONCENTRATION AND AREAL EXTENT OF GROUND-WATER CONTAMINATION FROM A GASOLINE AND DIESEL FUEL LEAK AT A SITE IN YAKIMA, WASHINGTON

By Richard J. Wagner and J. C. Ebbert

ABSTRACT

Following discovery in the early 1980's of a gasoline and diesel-fuel leak at a service station in Yakima, Washington an unsuccessful attempt was made to recover the free-floating petroleum product. From 1984 through 1989, data were collected from observation wells drilled near the site of the leak and from nearby domestic wells. Between February 1985 and November 1986, benzene, toluene, xylenes, and other soluble compounds of petroleum origin were found at relatively large concentrations in all samples from observation wells within 300 feet of the service station. These same compounds were also found in some samples and at smaller concentrations in domestic wells as far as 1,500 feet downgradient of the service station. Ground-water samples collected in March 1989 indicate concentrations of these soluble compounds had decreased, and areal extent where they were present was smaller than when monitoring began in 1984.

INTRODUCTION

In 1980, 1981, and 1982, the residents of a neighborhood in the northeast part of Yakima, Washington, complained to the Washington State Department of Ecology (WDOE) about the odor and taste of gasoline in water from their domestic or irrigation wells, which are open to a shallow, unconfined ground-water system. The WDOE investigated the complaints and determined that the source of the gasoline and diesel fuel was leakage near the land surface from improperly installed pump delivery lines at a service station located on North First Street (fig. 1). New delivery lines and storage tanks had been installed at the station in May and June 1979. Leak tests, reported to have been performed at that time and again in December 1980, did not reveal any leaks. Additional tests, conducted in September 1982 as a result of the complaints from private well owners, revealed leaks in the delivery lines, which were repaired immediately.

An audit of gasoline and diesel fuel inventory records, conducted by representatives of the service station, indicated that about 5,970 gallons of leaded gasoline and 1,740 gallons of diesel fuel were lost during the period from September 1981 through October 1982. This represents an average leakage rate of 550 gallons of product per month. If the leak began shortly after the December 1980 test and was constant, then about 12,000 gallons could have been lost during the 22-month period from the time of the test to the repair of the leaks. If the December 1980 test was invalid, and the system leaked at constant rate during the entire 40-month period from the time of installation, then the product loss could have been as much as 22,000 gallons.

An insurance company, representing the service station, initiated an attempt to recover the lost gasoline and diesel fuel in 1982-83 because of the potential to further contaminate drinking water. At least 13 observation wells and two recovery wells were installed on, or adjacent to, the service station property. Three of the observation wells contained several inches of free product, pure gasoline or diesel fuel, floating on top of the water. The recovery operation was discontinued because only 40 gallons of free product were recovered. All but three of the wells were subsequently destroyed. In the summer of 1985, most homes having affected wells were connected to alternate water supplies.

Purpose and Scope

The purpose of this report is to present and compare current and past distributions and concentrations of petroleum-related compounds in ground water near the site of the gasoline and diesel-fuel leak on North First Street in Yakima, Washington. This report presents data collected from three separate investigations: a March 1989 single sampling, sample collection during a 1985 to 1987 study that was part of the Ground-Water Toxics Substances Hydrology Program, and sample collection from October 1984 through November 1986 that was part of the insurance company study. Data collected by the three sampling studies are presented in tables in this report. Comparisons between studies and changes in time are made by presenting distributions of selected compounds in maps. Sampling procedures and laboratory methods that were used by the three studies are also described.

Description of the Study Area

The City of Yakima is the commercial center for the Yakima River valley, a major agricultural area within south-central Washington. The service station on North First Street, where the gasoline and diesel-fuel leak occurred, is located approximately 2,000 feet southwest of the Yakima River (fig. 1). Land use in the vicinity of the service station consists of some orchards and vacant lots interspersed among commercial and residential properties.

The general direction of ground-water flow is eastward from the service station to the river. The subsurface geologic materials immediately underlying the area consist predominantly of coarse-grained alluvial deposits. The water table is approximately 10 feet below land surface. Additional information on the geohydrology is given in the section "Geohydrologic Setting".

Annual precipitation in the valley is about 8 inches (U.S. Department of Commerce, 1987), with more than half of this occurring during the winter months as snow. Potential evapotranspiration, using a modified Blaney-Criddle calculation (U.S. Department of Agriculture, 1970), is approximately 38 inches annually. Consequently, crops require extensive irrigation. Most irrigation water is diverted surface water, but some is pumped ground water. The main municipal water supply for the city of Yakima is surface water; however, some individual residences and small water purveyors rely on ground water.

Geohydrologic Setting

The study area in Yakima, Washington is located in the Ahtanum-Moxee subbasin (fig. 2), which lies along an east-west oriented alluvial valley between two similarly oriented basalt ridges: Cowiche Mountain and Yakima Ridge on the north, and Ahtanum Ridge and Rattlesnake Hills on the south. The valley lies along a broad structural syncline, is approximately 7 miles wide and 40 miles long, and has a relatively flat alluvial surface that ranges between 1,000 and 1,500 feet in elevation. The basalt ridges on either side of the valley were formed by anticlinal upwarp, are much narrower than the valley, and range between 2,000 and 3,000 feet in elevation. Perennial east-west oriented streams flow along the valley from both directions toward the valley center and empty into the perennial north-south, through-flowing Yakima River. A significant summer inflow of water into the higher parts of the valley comes by way of irrigation canals fed by dam-regulated flow along the Yakima River and its tributaries upstream of the study area.

Folded and faulted basalts are exposed along the anticlinal ridges and are found at depths of 300 to 1,000 feet beneath the synclinal valley (fig. 3). The basalt flows belong to the Columbia River Group (table 1), and they are interbedded with, and underlie, a thick section of clastic rocks of debris-flow, lacustrine, and fluvial origin located along the valley axis. The oldest of these clastic units, the Ellensburg Formation (table 1), is from 100 to perhaps 1,000 feet thick in the valley and is dominated by semi-consolidated laharic (volcanically generated debris flow) fine to coarse clastics. Above these beds lie about 100 to 500 feet of Pleistocene glaciofluvial fine-grained lake, and coarser-grained river-laid clastics.

Above these, and comprising much of the surficial material at and near the study site, are 50 to 75 feet of Holocene unconsolidated alluvial sands and gravels laid down beneath the present flood plain by the Yakima River and beneath adjacent terraces by streams older, and perhaps larger, than the present Yakima River. The clasts within these two recent alluvial deposits are dominantly of volcanic (andesitic and basaltic) composition.

The shallow stratigraphy of the study site was determined by descriptive geologic logs from recent drilling of observation wells (fig. 4). In general, the lithologic descriptions show an upper 15- to 20-foot-thick depositional unit beneath the present flood plain, with about 5 feet of clay, silt, and sand at the surface (overbank deposits), and 10 feet of sandy, coarse gravels and cobbles below the overbank deposits. The lower contact of this upper unit is indistinct, but it overlies 30 to 50 feet of lower, older gravels and sands, probably deposited in similar environments. At normal stages of flow, the Yakima River is flowing within the upper fluvial unit, and perhaps within the top of the gravel layer of these fluvial deposits. There is a good permeable connection between the Yakima River and the adjacent water-table aquifer within these recent fluvial deposits. The ground-water-quality data at the site indicate that the leaked gasoline and diesel fuel, and the dispersed dissolved compounds downgradient of the leak, are wholly contained within the upper and lower Holocene alluvial deposits.

There is upward ground-water flow from the basalts through the Ellensburg clastics into Holocene alluvium and into the perennial drainages (personal communication, Henry Bauer, USGS, 1990), including the Yakima River (fig. 4). Regionally, the ground-water flow is generally eastward (fig. 5) from the leak site toward the Yakima River. During the study, the general direction of local ground-water movement was from west to east-southeast, and the velocity of ground water was estimated from between 0.2 to 1.2 feet per day, based upon water-level measurements and interpretation of geologic well logs (written communication, J. Pankow, OCG, 1986). In general, the water table lies 7 to 12 feet beneath ground level. The upper sand, silt, and clay of the alluvium is unsaturated, and the lower parts of the coarser-grained alluvium is saturated.

Continuous hydrographs of two water-table wells document annual fluctuations of 2 to 3 feet, and there are two unequal annual peaks. One peak is in late spring, coincident with maximum vertical recharge from precipitation, and a second peak is in the late summer and early fall, coincident with upgradient recharge from irrigation returns and canal leakage (figs. 6 and 7, and table 2).

Data Collection

Three studies have been conducted since the gasoline and diesel fuel recovery program was discontinued. The first study, under the general direction of the insurance company, consisted of several phases with different contractors. Three wells still remained from the original recovery program at the end of 1984 (M1-82 through M3-82, pl. 1). In October 1984, selected domestic wells were sampled for the analysis of soluble aromatic compounds in ground water. In December 1984, 12 new observation wells (M1-85 through M12-85, pl. 1) were drilled. Beginning in February 1985, water levels were measured, and selected observation and domestic wells were sampled for the insurance-company study at 3-month intervals to determine the direction of ground-water flow and concentrations of petroleum-related compounds in ground water.

The second study, which started in 1985, was conducted by the U.S. Geological Survey (USGS) and the Oregon Graduate Center (OGC) as part of the U.S. Geological Survey Toxic Substances Hydrology Program, hereafter referred to as the ground-water toxics study. This study was initiated to determine the transport and fate of gasoline and diesel fuel in a subsurface environment. The study was discontinued in 1987, and no data or results were published. During this study, the USGS and OGC collected ground-water samples three times, soil-gas samples twice, and samples of aquifer material once. Soil-gas samples and volatile samples were analyzed by OGC and inorganic samples were analyzed by the USGS National Water Quality Laboratory (NWQL). In August 1985, water samples were analyzed for petroleum-related hydrocarbons. In November 1985, soil-gas samples were collected, using driven probes, and analyzed for petroleum-related hydrocarbons. From April through June of 1986, water samples were collected from selected domestic and observation wells and from temporary wells driven to the water table and pulled out after sampling. In late summer and early fall of 1986, 32 observation wells and 8 multilevel soil-gas sampling tubes were installed. In November 1986, water samples were collected from the new, larger network of observation wells. All ground-water samples were analyzed for volatile hydrocarbons and dissolved oxygen, and selected samples were analyzed for trace metals and common ions. In November 1986, samples of ground water and aquifer material were collected from selected observation wells and analyzed for lead. During the ground-water toxics study, water levels were measured monthly from February 1985 to April 1987. Water-level recorders, which were installed in M8 and M14, have operated continuously from January 1987 to the present (1991).

The third study was conducted in cooperation with WDOE to determine the current distributions and concentrations of petroleum-related compounds in ground water. In March 1989, ground-water samples were collected from 27 observation wells and analyzed for volatile hydrocarbons. Samples from six wells were analyzed for trace metals and common ions. Water levels were measured at the time the samples were taken.

The results and additional information on the conduct of this, and the other two sampling programs, are given in the sections "Sampling Studies, Field Techniques, and Laboratory Procedures," and "Chemistry of Ground Water, Soil Gas, and Aquifer Materials".

Processes Affecting the Fate and Distribution of Petroleum Hydrocarbons in a Subsurface Environment

Both gasoline and diesel fuel are refined petroleum products and are mixtures of numerous organic compounds with different physical and chemical properties. The fate and distribution of the individual compounds in a subsurface environment are governed to a large extent by these properties. For example, the aromatic hydrocarbons are the most water-soluble components of gasoline and diesel fuel and are relatively easily dissolved and transported in ground water. Selected properties of some of the major aromatic compounds in gasoline and diesel fuel are given in table 3.

After the spill or leak of a liquid petroleum product, some of it will flow through the unsaturated zone to the water table by gravity, and some of it will be held in the unsaturated zone by surface tension. The petroleum that reaches the water table will float and spread on top of the water table because it is less dense than water. The transport of hydrocarbon compounds by ground water initially will be limited to those which can be dissolved in ground water at the petroleum-water interface. Once dissolved in ground water, compounds may be transported by advection and dispersed horizontally and vertically in the ground water.

Seasonal variations in the water-table elevation can increase dispersion and dissolution of hydrocarbon compounds in the ground water. When the water table rises, some of the petroleum will remain trapped in the interstitial pores by surface tension below the rising interface (Schwille, 1981). When the water table falls, some water is trapped above the falling interface. This sequence of events substantially increases the vertical distance over which the petroleum is dispersed and provides additional surface area for the dissolution of hydrocarbon compounds into ground water. During periods of ground-water recharge, downward percolating ground water can dissolve hydrocarbons from the petroleum trapped in the unsaturated zone.

The relative proportions of various petroleum hydrocarbons dissolved in the ground water also are affected by volatilization, biodegradation, and sorption. The low-molecular-weight hydrocarbon compounds can volatilize from the petroleum product or from the ground water and diffuse into the unsaturated zone. The presence of hydrocarbon gases in the unsaturated zone is sometimes used to indicate the presence of petroleum hydrocarbons in ground water.

Some hydrocarbons preferentially sorb to soil particles. These compounds are not as readily transported as those in the gas phase or the ground water. Some sediment characteristics that affect sorption are grain size, moisture, and organic content.

A variety of naturally occurring soil microbes can, under favorable conditions, degrade hydrocarbon compounds found in gasoline and diesel fuel. Biodegradation is most efficient under aerobic conditions with sufficient supplies of nitrogen and phosphorus, a near-neutral pH, and warm soil temperatures. Under these conditions, some hydrocarbon compounds can be completely degraded into carbon dioxide and water (Atlas, 1981). Anaerobic biodegradation of petroleum hydrocarbons also has been observed, but generally at lower rates than aerobic biodegradation (Healy and Daughton, 1986).

Samples collected for the analysis of volatile hydrocarbons during all three studies were preserved by chilling to 4 °C. It has been observed, however, that significant biodegradation can occur if analyses are not performed within seven days (personal commun., Brooke Connor, USGS, 1989).

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Clar Pratt, Alan Newman, and William Meyers of the WDOE provided much background information about the Yakima site. Dr. James F. Pankow, professor at the Oregon Graduate Center (OGC) and director of the OGC Water Research Laboratory in Portland, Oregon, provided technical advice, as well as planning and executing much of the reconnaissance sampling. J.R. McPherson and Lorne M. Isabelle of OGC analyzed the volatile organic compounds in the

1985-86 ground-water toxics study, and William Fish coordinated the program for the analysis of lead in the aquifer material and in water. Mark S. Mason, of Soil Exploration Company, St. Paul, Minnesota, provided information about the drilling and monitoring program during the insurance study. Michael Schroeder and the staff at the U.S. Geological Survey National Water Quality Laboratory (NWQL) provided technical advice and assistance for the 1989 sampling. Brooke Connor and Donna Rose of NWQL analyzed the volatile organic compounds sampled in 1989. Valuable assistance for the quality assurance program used during the 1989 reconnaissance was provided by Mark Sandstrom of the NWQL Methods Research and Development Section.

Appreciation also is extended to the many property owners who granted access to land, private wells, and monitoring wells during the samplings.

Well-Identification System

Wells in this report are referenced by identification numbers that are listed in table 4. Their locations are shown on plate 1. The table cross-references these identification numbers with the station name stored in WATSTORE, the U.S. Geological Survey computer data base, and identifiers used in correspondence and progress reports during previous studies. The identification numbers in this report are prefixed by an M for observation wells, D for domestic wells, T for temporary wells installed for the collection of water samples, SG for multidepth soil-gas wells, and SGT for temporary wells installed for the collection of soil-gas samples. The temporary water wells and soil-gas wells were removed immediately after sample collection.

SAMPLING STUDIES, FIELD TECHNIQUES, AND LABORATORY PROCEDURES

Field and laboratory methods used during the three studies were, in general, quite similar, and the methods are detailed for comparative purposes. Field and laboratory methods are discussed separately, and quality assurance procedures and results are given in Appendix A.

Ground-Water Sampling

Insurance Company Study

Twelve observation wells were installed using a cable-tool drilling rig. Wells were constructed with 2-inch-diameter, flush-threaded, PVC (polyvinyl chloride) casing and 15 feet of PVC screen, 10 feet of which extended below the water table. Water samples were collected from the wells using bottom-filling Teflon bailers. A minimum of three casing volumes of water were pumped from a well before a ground-water sample was collected. Water samples from domestic wells were collected from cold-water faucets that were allowed to run at a rate of about 1 gallon per minute for a 30-minute period prior to sampling. The samples were from untreated sources that were non-filtered and non-aerated. All samples were preserved on ice and transported to a private laboratory for analysis.

Ground-Water Toxics Study

The ground-water toxics study included three water-sampling periods with different objectives. The first sampling was done (August 1985) to determine the farthest extent of dissolved hydrocarbon movement in the ground water.

The second sampling (April through June 1986) was done with additional temporary wells to better delineate the extent of dissolved hydrocarbons and to determine appropriate sites for 34 additional observation wells. In the third sampling period (November 1986), samples were collected from some of the new observation wells.

The additional 34 observation wells were drilled using the air-rotary method. The wells were constructed of 2-inch PVC casing, with 3- to 5-foot lengths of 0.10-inch slotted PVC screen at the bottom. Most screens were set so that the middle part of the screen was close to the surface of the water table at the time of drilling. Sections of PVC casing were welded together rather than cemented to prevent contamination by solvents used in the cement. The annulus around each screen was packed with sand to a depth of several feet above the screen and then sealed to the surface with bentonite or a bentonite and cement mix. Several deeper wells that were drilled below the water table were packed with sand several feet above the screen, backfilled with clean cuttings, and then surface sealed with a bentonite and cement mix. The wells were developed by pumping.

In the spring of 1985, staff of the Oregon Graduate Center collected ground-water samples from 28 temporary wells. The wells were installed by jackhammering a steel drive tube to a depth 2 feet below the water table and then removing the tube with a railroad jack. A 3-foot length of 3/8-inch flexible tubing was attached to the top of a 3/8-inch stainless steel pipe and lowered down the hole to collect a sample, a vacuum was applied when the pipe was a few inches below the water table, the flexible tubing was then bent and clamped, and the pipe was lifted out of the hole. Two 14-mL (milliliter) sample vials were filled. The sample vials were filled by slowly releasing the clamp, and the vials were stored on ice for later analysis. Some modifications to this sample collection procedure were made during the course of the study. To prevent borehole collapse upon removal of the steel drive tube, a perforated tip was attached to the end of the tube and the tube was left in the hole during sample collection. Also, samples were collected by securing the sample vial at the end of a thin stainless steel rod and lowering the vial to the water table directly through the driven hollow tube. All downhole tools that were used in this phase were cleaned with a methanol solution and dried with an electric hair dryer.

Bottom-filling glass bailers were used to collect water samples from observation wells for the analysis of volatile hydrocarbons. Before each sample was collected, five casing volumes were pumped from the well. Prior to sampling each well, the bailer was rinsed with a 10-percent methanol solution and an acetone-hexane mixture (60 to 40, by volume). Remaining solvent residues were then removed from the bailer by baking in an oven, by heating with an electric hair dryer, or by aspirating with a vacuum pump. The cleaned sampler was then rinsed by bailing three times from the well. A sample vial was filled from the fourth bailing and packed in ice until analysis. The technique used to collect samples from domestic wells was similar to that used during the insurance company study. All volatile hydrocarbon water samples collected were analyzed by the staff from the Oregon Graduate Center.

1989 Study

The procedure used to sample observation wells in the 1989 study was nearly identical to that used during the ground-water toxics study. One difference was that the bailer was rinsed with organic-free water after the acetone-hexane rinse. Also, the bailer was routinely baked in an oven at 105 °C for 1/2 hour after the organic-free water rinse. Results of tests to check the adequacy of the cleaning procedure are given in Appendix A.

Samples collected were analyzed by the U.S. Geological Survey National Water Quality Laboratory (NWQL) in Arvada, Colorado. Field quality-assurance procedures included duplicate samples, field blanks, and field-spiked samples with known amounts of target compounds. These procedures are described in Appendix A.

Ground-Water Analysis Methods

All three studies utilized similar gas-chromatographic techniques for determining concentrations of volatile hydrocarbons in ground-water samples. Differences in techniques are noted below and references are given for more details. Analyses performed by Oregon Graduate Center produced concentrations that were blank-corrected, as referenced in Appendix A. Analyses performed by the other studies were not blank-corrected.

Insurance Company Study

Samples were analyzed for benzene, toluene, and total xylenes (the sum of the meta, para, and ortho isomers), and a value was calculated for total hydrocarbons expressed as gasoline. Samples were analyzed using a Tekmar LSC-2 liquid sample concentrator linked to a Perkin-Elmer Sigma 300 gas chromatograph with flame ionization detection (FID), on a 6-foot stainless steel column with SP-1000 100/120 mesh packing. Total xylenes, benzene, and toluene were identified by retention time and quantified by comparison with known standards using an SP-4000 data system. Total gasoline concentrations were calculated by comparison of total peak area to a gasoline standard total peak area.

Ground-Water Toxics Study

The analytical method utilized by Oregon Graduate Center was purge and trap with whole-column cryotrapping. This method was employed with fused-silica, capillary-column gas chromatography (GC), as developed by Pankow and Rosen (1984) and optimized by Pankow (1986). Both FID and mass spectrometric (MS) detection were utilized. The purge and trap device used was a Chemical Data Systems Model 320 concentrator. The GC/MS used was a Hewlett-Packard 5790A GC interfaced to a Finnigan 4000 MS/DS (data system). The carrier flow from the capillary column exiting the GC was split, approximately half of the flow directed into the MS source, and the remainder to a FID housed in a Hewlett-Packard 5700A GC.

Normally, a 5.0-mL aliquot of sample was loaded into the sparging vessel and each aliquot was spiked with 10 µL (microliter) of an internal standard solution in methanol. In the case of highly contaminated samples, smaller sample aliquots were loaded into the sparging vessel and organic-free water was added to produce 5.0 mL of diluted sample for analysis. Samples were analyzed for a set of 18 target compounds (table 5) known to be components of gasoline and diesel fuel. During sample analysis, standards containing known concentrations of target and internal standards compounds were routinely run. Replicates of the samples were run back to back, a day apart, and in one case, 6 days apart.

Sample concentrations were computed based on the appropriate sample and standard peak areas and were blank-corrected using replicate values of blanks, duplicates, and standards. The internal-standard compounds served to compensate for any variations in the purging efficiencies and the system response. The response factors were assumed to be linear over the concentration range of interest.

1989 Study

The method utilized by the NWQL to analyze samples was purge and trap. This method was employed with gas chromatography and electron impact mass spectrometry (GC/MS) as per EPA Method 524.2 (U.S. Environmental Protection Agency, 1988a), and the list of volatile organic compounds targeted by this analytical method was modified by adding standards for the quantification of five compounds in addition to those targeted by EPA Method 524.2 (table 5). The purge and trap device used was a Tekmar LSC 2000 with an ALS 2016 and

ALS 2032. The 25-mL sample was purged for 11 minutes at ambient temperature with a gas flow of 40 mL per minute, desorbed at 180 °C for 4 minutes onto a 30 meter x 0.53 mm ID (inside diameter) DB-624 megabore column and baked at 225 °C for 15 minutes. Temperature of the Finnigan Incos 50 MS/DS was held at 10 °C for 1 minute, then increased to 160 °C at 5 degrees per minute, and held at 160 °C for 1 minute. The megabore column was coupled directly to the mass spectrometer, which was set to analyze from 45 to 300 atomic mass units with a scan time of 1 second. A Hewlett-Packard HP5996A MS/DS was used for those samples on which a library search was performed. Ten percent of the samples were run in duplicate, and 10 percent of the less-contaminated samples were spiked with a solution containing six matrix spike compounds. Additional quality assurance measures included daily blanks, daily standards, daily instrument tuning, and quality control check samples.

A library search was performed on selected analyses in an attempt to identify non-target compounds. Mass spectra from corresponding GC peak maxima were compared with National Bureau of Standards library reference spectra using a computer library search. The best library matches were selected according to a "reliability factor"--a parameter used by the library search algorithm to quantify the match between the sample and library spectra. The best computer matches were compared with the sample spectrum manually to attempt the best possible tentative identification.

Soil Gas

Samples of soil gas, the gas in the pore spaces in the soils and sediments above the water table, were collected from temporary-driven sampling tubes and from permanent wells in which multidepth sampling tubes were installed. Samples from the temporary-driven wells were taken from locations with the lowest expected concentrations and then from locations where larger concentrations were expected. A 6-foot-long, 3/4-inch OD (outside diameter), 1/4-inch ID stainless steel casing tube was driven to a depth of 5.5 feet below land surface and then backed out a few inches. Then, a 7-foot stainless steel sampling tube was inserted 1 inch beyond the bottom of the casing tube. Two hundred mL of soil gas, an amount which was greater than 5 times the volume of the sampling system, were drawn through the sampling tube with a vacuum pump. A Tenax-GC sample cartridge was then placed in line and the system was pumped for about 12 minutes at a rate of about 40 mL per minute. The sample cartridge was then removed, the ends were capped, and the sample was stored in an organic-free environment at ambient temperature prior to analysis.

Sampling techniques and analytical methods for multidepth wells were the same as for the temporary driven wells. The stainless steel sampling tubes each extended to a specified depth, were surrounded with sand, and were sealed from each other with concrete.

Soil-gas analysis was done by adsorption onto a Tenax cartridge followed by thermal desorption with whole-column cryotrapping on the GC and FID and MS detection. The Tenax cartridges needed no sample preparation prior to desorption. The cartridge was placed in the desorption apparatus and purged for 10 minutes with a backflow of helium to remove the oxygen and most of the methanol. The Tenax cartridge was desorbed at 250 °C for 10 minutes at 30 psi and the released compounds were readsorbed onto the GC column, which was held at a temperature of -80 °C. After desorption, the GC column temperature was raised rapidly to 0 °C, and then programmed to increase at 10 °C per minute to 250 °C. Additional details are given by Ligocki and Pankow (1985).

Aquifer Materials

In November 1986, samples of both solid aquifer material and water were collected from selected observation wells. Concentrations of lead dissolved in water and lead adsorbed onto the surface of the less-than-63-µm (micrometer) fraction of the aquifer material were determined. Because samples of aquifer material could not be obtained easily by coring, due to the cobblely nature of the deposits, samples of fine-grained aquifer materials that had passed through well screens after installation of the well were obtained by placing a pump intake near the bottom of the well. Approximately 5 gallons of sediment-laden water were pumped from each undeveloped well and collected in a clean plastic bucket. The sediment was separated by settling, dewatered by filtering into a firm cake, placed in a polyethylene bag, and stored on ice. The firm cake was then processed by mixing with water and wet-sieving through a 63-µm polypropylene sieve. The less-than-63-µm fraction was filtered to a moist cake, subsampled, and digested with a solution composed of 6% Ultrex nitric acid and 1 molar reagent-grade ammonium acetate. The samples were then analyzed in the same manner as the filtered ground water (Fish, 1987). After developing the well by pumping at 10 gallons per minute for 20 to 30 minutes, ground-water samples were collected by pumping through acid-washed Tygon tubing and filtering through acid-washed 0.1 µm (pore-size) membrane filters into acid-washed polypropylene bottles.

CHEMISTRY OF GROUND WATER, SOIL GAS, AND AQUIFER MATERIALS

Volatile Organic Compounds in Ground Water

Insurance Company Study

During the insurance company study, at least one of the three target compounds (benzene, toluene and total xylenes) was detected at least once in four of the 21 wells (figs. 8 to 12 and table 6). Target compounds were detected consistently, and at relatively large concentrations, in water from well M11-85, located about 150 feet from the leak site. Target compounds were consistently detected in only one domestic well, D10, located about 1,200 feet downgradient, but concentrations were smaller than in M11-85. Target compounds were detected in wells M8-85 and M10-85, located about 900 feet downgradient of the leak site, but the occurrences were sporadic and concentrations were relatively small. The wells used in this study were too widely separated to define in detail the distributions of hydrocarbon compounds in ground water.

Ground-Water Toxics Study

During the ground-water toxics study, ground-water samples were analyzed for up to 23 aromatic hydrocarbons, primarily alkylated-benzenes (table 5). All but six of the compounds were identified in ground water. Concentrations of compounds found during the different sampling periods of this study are given in table 7. Because of changes in analytical methods during the course of the study, not all of the target compounds were analyzed in each of the sampling periods. Furthermore, the method for reporting analytical results when concentrations were near background or detection levels differed among sampling periods.

Data for benzene, toluene, naphthalene, and total xylenes are shown in figures 8 through 11. These four compounds are some of the more water-soluble aromatic compounds in gasoline (table 3), and their presence and concentrations compare well with the presence of other target compounds. Concentration isopleths of 5 μg/L (micrograms per liter) are estimated and approximate locations shown for each of the four compounds, and the symbols identify locations where concentrations are greater or less than 500 μg/L. A value of 5 μg/L was chosen as the isopleth concentration because it is an order of magnitude greater than the level of detection for most compounds and, consequently, there is a high certainty of detection at this concentration, eliminating any doubt of trace detections at or near the detection level. The isopleth concentration is significant because it is also the drinking water MCL for benzene (U.S. Environmental Protection Agency, 1988c). An MCL does not exist for toluene, naphthalene, or total xylenes, but there is a proposed MCL for toluene of 2,000 μg/L and a secondary MCL for total xylenes of 10,000 μg/L.

During the first sampling period in August 1985, detectable concentrations of benzene, toluene, naphthalene, and total xylenes were identified in samples from 5 of 15 insurance company observation wells, 1 of 13 temporary wells, and 2 of 31 domestic wells (table 7). Although petroleum-related compounds were detected as far as 1,000 feet from the service station, concentrations of individual compounds exceeded 500 µg/L only in samples from the three wells closest to the service station (figs. 8 to 11). A petroleum sheen was noted on samples from two of these three wells (M3-82 and M11-85), indicating the presence of free product.

During the second sampling, from April through June 1986, detectable concentrations of benzene, toluene, naphthalene, or total xylenes were found in the samples from 5 of 6 insurance company observation wells and at all 29 of the temporary wells. Observed concentrations of benzene, toluene, naphthalene, and total xylenes (figs. 8 to 11) indicate that some of the dissolved compounds had migrated in an east-north easterly direction.

During the third sampling in November 1986, benzene, toluene, naphthalene, or total xylenes were detected in samples from 5 of 8 insurance company observation wells and in 18 of the 23 observation wells installed during this study (pl. 1 and table 4). Concentrations of some of these four compounds exceeded 500 µg/L at eight of the observation wells within 400 feet of the service station (figs. 8 to 11).

The vertical distribution of hydrocarbons dissolved in ground water was also investigated. Observation wells which penetrated deeper into the aquifer, M2, M6.1, M7.1, and M13 (pl. 1 and table 4) were sampled in November 1986. Observation wells M6.1 and M7.1 are paired with shallow wells, M6.2 and M7.2, respectively. Observation wells M6.1 and M6.2 were installed in the same hole about 1,300 feet downgradient of the service station, with M6.1 extending to 46 feet below land surface and the latter well screened at the water table. Observation wells M7.1 and M7.2 are a similar pair installed in a hole about 500 feet downgradient from the service station. Benzene, toluene, naphthalene, total xylenes, ethyl benzene, and other alkyl benzenes were detected in all the deeper observation wells that were sampled. Concentrations of dissolved hydrocarbons in the ground water from observation wells M2 and M6.1 were less than 1 μg/L; whereas, observation well M7.1 had a concentration of 3.2 μg/L total xylenes. Concentrations of dissolved hydrocarbons in ground water from observation well M13 ranged from 0.5 to 47 μg/L. The concentrations of dissolved hydrocarbons in ground water from deeper wells range from one to more than three orders of magnitude smaller in comparison to the concentrations of hydrocarbons dissolved in ground water from observation wells at the water-table surface. The major portion of the leaked gasoline and diesel fuel dissolved in the ground water appears to be near the surface of the water table. Further, the migration of dissolved hydrocarbons in the ground water is preferentially in a horizontal downgradient direction.

1989 Study

Concentrations of volatile organic compounds in ground-water samples collected in 1989 indicate that there are still dissolved components of gasoline and diesel fuel in the ground water (table 8, figs. 8 to 11). Concentrations of benzene, toluene, naphthalene, and total xylenes greater than the detection limit of 0.2 μg/L were found in ground-water samples from 11 of the 27 sampled wells. Concentrations exceeded 500 μg/L for only total xylenes at two wells, M3-82 and M16. Significant amounts of toluene or other alkyl benzenes were also found at these two wells and at M11-85, but concentrations for all compounds were less than 500 μg/L.

In March 1989, concentrations of petroleum-related compounds in ground water were less than in 1985 and 1986 (tables 6 and 7, figs. 8 to 11). Consequently, the concentrations of petroleum-related products dissolved in ground water appear to be decreasing, and the area within specific concentration isopleths also appears to be decreasing. However, one should note the above conclusion is based on a single sampling in 1989.

Common Constituents, Trace Metals, and Dissolved Organic Carbon in Ground Water

The shallow ground water within the leak area is predominantly of the calcium-magnesium bicarbonate type (see fig. 13 and table 9). Specific conductance values ranged from 208 to 390 µS/cm (microsiemens per centimeter) at 25 °C, and values of pH ranged from 6.3 to 6.9. Dissolved-oxygen concentrations were low, with a median value of 0.6 mg/L (milligrams per liter). Dissolved-oxygen concentrations upgradient of the leak area at observation well M1-85 ranged from 6.3 to 6.8 mg/L; whereas the ground water contained little or no oxygen at sites M2082, M3-82, M11-85, M12, M16 and M18 in the leak area. Concentrations of metals were generally less than 0.10 mg/L and did not exceed the MCL (Maximum Contaminant Level) for drinking water, except for dissolved manganese, which exceeded the secondary MCL at 15 sites, and dissolved iron, which exceeded the secondary MCL at 12 sites (U.S. Environmental Protection Agency, 1988b). The median concentration of dissolved organic carbon was 1.9 mg/L, with values ranging from 0.6 to 81 mg/L.

Small dissolved-oxygen concentrations in ground water caused by the oxidation of organic compounds in the gasoline and diesel fuel affected concentrations of iron and manganese as well as the concentrations and speciation of nitrogen compounds in ground water at the site. Small concentrations of dissolved oxygen are often indicative of the biological oxidation of carbon and consumption of oxygen. Under these reducing conditions, iron and manganese are more soluble and concentrations of iron and manganese in ground water are generally larger than under oxidizing conditions. Reduced forms of nitrogen, particularly ammonia, are also found in anoxic ground water. Samples analyzed during the ground-water toxics study and the 1989 study show a strong relationship between the detection of volatile hydrocarbons in the ground water and large concentrations of iron and manganese, detectable ammonium, and nitrate values at or near the level of detection. Reduced forms of sulfur were not specifically analyzed, but the smallest concentrations of sulfate were analyzed in ground water from wells within the leak area. Samples analyzed for dissolved organic carbon generally showed a relationship between elevated concentrations of dissolved organic carbon in the ground water and the detection of volatile hydrocarbons. Elevated concentrations of dissolved organic carbon from observation wells M7-85 and M6.2 could be due to contamination during processing and handling, but these values could also be representative of non-volatile forms of hydrocarbons.

A sufficient number of samples were analyzed for inorganic constituents to accurately define the area of reduced conditions during the November 1986 sampling (see fig. 14 and table 9). The differences between the areas of reducing conditions and oxidizing conditions are clearly defined. In 1989, however, the smaller number of samples shows a general picture of reduced conditions immediately downgradient of the leak area and oxidizing conditions upgradient and further downgradient of the leak area (fig. 14). There were exceptions to this relationship in both studies. Samples from observation well M29 also indicate reduced conditions, but the concentrations of volatiles were small. During the ground-water toxics study and the 1989 study, results from observation well M18 indicate reduced conditions, but concentrations of volatile samples during the 1989 study are much smaller than November 1986. As the spill products age, non-volatile forms of carbon will prevail and the oxidation of these species will also cause reduced conditions. During the ground-water toxics study, samples from observation well M1-82 contained large concentrations of volatile hydrocarbons and dissolved manganese, but the concentrations of ammonium, nitrate, and iron were small.

It is quite unlikely that reduced conditions in the leak area are due to a natural phenomenon. The permeable soils and the relatively large influx of freshly-oxygenated ground water that flows past the leak area toward the river are strongly supportive of biodegradation of the spilled diesel and gasoline as the cause of the reduced conditions of ground water immediately downgradient of the leak site.

Lead in Ground Water and Aquifer Materials

Concentrations of lead in the filtered ground-water samples ranged from 1.4 to 10.1 µg/L (table 10). These concentrations are less than the EPA drinking-water MCL of 50 µg/L (U.S. Environmental Protection Agency, 1988c). Samples of aquifer material contained lead with concentrations 30 to 10,000 times greater than in ground-water samples on a per weight basis (table 9). Because of the large affinity of the divalent lead ion for sediment, it is not unusual to find small concentrations of lead in ground water and large concentrations of lead in sediments. As a result of this affinity, inorganic lead is relatively immobile in ground water.

There is little or no correlation between concentrations of lead in soil and in ground water (correlation coefficient = -0.19). Fish (1987) concluded that a simple adsorption or ion-exchange model does not explain the distribution of lead between the solid and aqueous phases. Calculations indicated that the observed concentrations of lead in the ground water were near the limit of solubility for $PbCo_3$. Therefore, precipitation of $PbCO_3$ may control the concentration of lead in ground water. Because the area with elevated concentrations of lead in the aquifer materials is similar to the area with elevated levels of aromatic hydrocarbons dissolved in ground water (fig 15), the source of the lead is probably lead additives in gasoline, tetraethyl and tetramethyl lead.

The similarity between spatial distributions of lead in the aquifer materials and some of the aromatic compounds dissolved in ground water suggests that some of the lead has moved in approximately the same direction as some of the aromatic compounds dissolved in the ground water (Fish, 1987). Consequently, Fish concluded that the lead is, or has been, more mobile than the retardation factors imply, and that there are several possible modes of transport. Shortly after the gasoline leak, the lead could have been transported as part of the free product. It could have been transported by ground water when in the more soluble alkyl lead phase, which subsequently degraded to inorganic lead that precipitated out of solution. The lead in the aquifer materials also could have been transported by colloidal-size particles.

Soil Gas

In November 1985, soil-gas samples were collected from seven temporary wells, SGT1 through SGT3 and SGT6 through SGT9 (fig. 16). Although plans were made to collect samples from about 25 wells, problems with frozen ground and cobblely soil resulted in fewer samples collected than planned. Also, because of problems with internal standards, concentrations of compounds detected in the soil-gas samples were qualitative and not quantitative.

In November 1986, soil-gas samples were collected from six multidepth soil-gas tubes (fig. 16, table 11). Target compounds (table 12) and mixed alkanes were detected at some depths at three of the six wells, SG3, SG5, and SG8 (fig. 16). With the exception of toluene and several alkyl benzenes that were found at mid-depths of 3 to 6 feet below land surface in SG8, most compounds were detected only close to the water table at the deepest levels from which samples were withdrawn (table 11). This is consistent with the steep concentration gradients of concentrations in soil gas near the water table that have been found by others (see for example, Hult and Grabbe, 1985).

Target compounds (table 12) were detected in samples from wells SGT2 and SGT7. Also, chromatographs for samples from wells SGT1, SGT3, and SGT9 contained peaks that are indicative of likely degradation products of aromatic hydrocarbon compounds (J.R. McPherson, Oregon Graduate Center, Beaverton, Oregon, verbal commun., 1989). Soil gas from wells SGT6 and SGT8 did not contain detectable amounts of hydrocarbon compounds. Although gas samples were collected from wells SGT4 and SGT5, difficulties with collection and analyses of samples from these two wells preclude making any statements about the presence or absence of hydrocarbon compounds in soil gas at these two sites. These two wells are not shown in figure 16.

SUMMARY AND CONCLUSIONS

An estimated 12,000 to 22,000 gallons of gasoline and diesel fuel were leaked to unsaturated sediments and shallow ground water from an improperly installed delivery line at a service station in Yakima, Washington. Data indicate the fuel leak is contained within unconsolidated sediments and shallow ground water 7 to 12 feet below land surface.

Unsuccessful attempts in 1982-83 at recovery of fuel in the ground were followed by a study in 1984-85, under the direction of an insurance company, to monitor the presence of dissolved hydrocarbons in ground water. From August 1985 through November 1986, in a separate study by the U.S. Geological Survey, dissolved hydrocarbons and lead were determined in ground water and soil gas was determined in the unsaturated sediments. Fine-grained sediments in the aquifer were also analyzed for lead. The gasoline leak in Yakima was selected to be a part of a national study of ground-water sites contaminated by toxic compounds, but the study was discontinued before an interpretive phase was completed. In a follow-up study, data were collected in March 1989 to determine the concentrations and areal extent of dissolved hydrocarbons in ground water and to compare results with those of the two previous studies.

All three studies utilized similar gas-chromatographic techniques for determining concentrations of benzene, toluene, naphthalene, and total xylenes in shallow ground water for five sampling periods beginning in 1985. A large concentration of 600 µg/L toluene and 980 µg/L of total xylenes was found in one domestic well about 1,200 feet downgradient of the leak, but water in other domestic wells sampled beginning in 1984 had hydrocarbon concentrations that were all less than 500 µg/L. Samples collected from 1985 to 1986 indicate dissolved hydrocarbons in observation wells commonly exceeded 500 µg/L at distances of 150 to 500 feet downgradient from the gasoline leak. Soil-gas samples taken in November 1986 indicated dissolved hydrocarbons were detected only close to the water table.

By March 1989, concentrations of dissolved hydrocarbons had decreased and the areal extent over which they were present in shallow ground water was smaller. Concentrations of dissolved hydrocarbons were less than 500 µg/L near the source of the leak and were generally below 5 µg/L at distances more than 350 feet from the source of the leak. In contrast, during the sample periods of November 1986 and earlier, hydrocarbon concentrations exceeded 5 µg/L at distances of 600 to 1,000 feet from the source of the leak. The decrease in dissolved hydrocarbons in the shallow ground water between 1984-86 and 1989 could be due to natural dispersal, volatilization, or biodegradation.

Concentrations of dissolved lead in ground water were small for the sample periods from 1986-89. These concentrations were 1.4 to 10.1 µg/L and less than the MCL of 50 µg/L for drinking water. Lead has a high affinity for soils and is relatively immobile in ground water. However, concentrations of lead in aquifer sediments suggest lead has moved in the aquifer in the same direction as the dissolved hydrocarbons have moved.

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APPENDIX A: QUALITY ASSURANCE

The quality of the data from all three studies cited in this report appears to be good. Differences between concentrations in duplicate samples are within reasonable limits and concentrations of standards, spiked samples, and blank samples were satisfactory (see tables A1 to A6).

Insurance Company Study

The quality assurance portion of the insurance company study consisted of field blanks, lab blanks, and duplicate samples. Concentrations of benzene, toluene, and total xylenes in field and laboratory blanks were less than the detection limit of 1 microgram per liter (table A1). Sample results for the insurance company study were not blank corrected. Replicate analyses of a sample from observation well M11-85 indicate good reproducibility for all compounds except toluene. On August 27, 1985, personnel from the insurance company study and the ground-water toxics study independently collected samples from four wells and the samples were analyzed by their respective laboratories (see table A2). The agreement between the two sets of results is good except for the concentration of benzene in the samples from well M8-85, and perhaps the concentration of toluene in the samples from M11-85. Differences between other concentrations can easily be attributed to variabilities in sample collection and analysis.

Ground-Water Toxics Study

The quality assurance during the ground-water toxics study consisted of collecting duplicate samples, doing replicate analysis, and analyzing trip-blank samples. Organic-free blank water for trip blanks and sample dilutions was prepared in the OGC laboratory. The replicate analyses of trip blanks and duplicate samples were used for the calculation of statistical limits of detection. Mean and standard deviation of concentrations detected in the trip blanks for the August 1985 sampling are listed in table A3. Sample results were correspondingly blank-corrected. Concentrations determined for mixtures of standard solutions supplied by the U.S. Environmental Protection Agency are compared with concentrations in the standards (table A4).

1989 Study

Organic Constituents

The quality assurance during the 1989 study consisted of collecting duplicate samples and equipment-rinse samples, using blank-water samples and trip-blank samples, and spiking samples with identical concentrations of target compounds in the field and in the laboratory. The blank water used during the current program was commercially available, Burdick & Jackson HPLC water. Equipment-rinse samples consisted of 40 mL of this water that was passed through the sampler after cleaning. Tests were made to check the adequacy of the cleaning procedure prior to field sampling and also during the sampling period.

Samples of the blank water, blank water from an equipment rinse, and blank water from an equipment rinse after baking the sampler were analyzed for volatile hydrocarbon compounds (table A5). The blank water contained relatively small concentrations of methylene chloride and chloroform. Compounds tentatively identified using a NBS library search routinely were hexane and methylcyclopentane. Equipment-rinse blanks contained small concentrations of benzene, toluene, total xylenes, and larger concentrations of methylene chloride and chloroform. The equipment-rinse blanks also contained relatively large concentrations of compounds that were tentatively identified as hexane, methylcyclopentane, 3-methylpentane, and acetone. Equipment-rinse blanks that were passed through the sampler after it was baked at 105 °C contained only small concentrations of chloroform, bromodichloromethane, chlorodibromomethane, and 1,2-dichloropropane. This could complicate the identification of bromide or chloride-substituted methane compounds used as fuel additives, but this poses no problem with the interpretation of other petroleum-related hydrocarbons in the ground-water samples.

Trip blanks were collected with the intention of analyzing the samples only if a problem was suspected in collection or processing techniques. Because no anomalous results were found, the trip blanks were not analyzed. Sample results for the 1989 study are not blank-corrected.

One set of replicate samples from observation well M8-85 was spiked in the field with target compounds to check the effective recovery of compounds from a field-matrix sample. Supelco VOC Standard Mixture 2, containing target compounds at a concentration of 2,000 ng/μL (manograms per microliter), was diluted at NWQL to 4 ng/µL. One hundred µL of the 4 ng/µL solution were added to the sample in the field to give a spike concentration of 10 mg/L. An extra sample, un-spiked, also was sent to the laboratory for spiking in the laboratory (table A5). The difference in recovery between the field spikes and the lab spikes ranges from +25 to -7 percent, with an average difference for FS1 of 4 percent and an average of 12 percent for FS2. These differences are considered to be normal, but differences between some of the field and laboratory spike values suggest a partial loss of some compounds which may be due to biodegradation (personal commun., Brooke Connors).

Inorganic Constituents

Various sums, differences, and ratios, based on aquatic chemistry principles, were computed for each inorganic sample. These computations check the consistency between constituent concentrations in a sample and provide a gross check in the accuracy and completeness of the analysis. Two of the most useful computations are the cation-anion balance and calculated dissolved-solids concentration, which are defined in the following paragraphs.

The cation-anion balance is the difference, in percent, between the sums of the concentrations of cations and anions, expressed in milliequivalents. Ideally, this value is zero, but non-zero values occur when a cation or anion concentration is in error, or when the concentration of a significant ion (often a metal) is not determined. The acceptable difference varies with the total sum of cations and anions. The differences ranged from 0.0 to 5.97 percent.

Calculated solids is the dissolved-solids concentration determined by summing the concentrations of cations, anions, silica, and other major dissolved constituents. This value is theoretically equal to the dissolved-solids concentration determined in the laboratory by residue upon evaporation. Differences usually are due to errors in analyses of the various cations or anions (which may be verified by the cation-anion balance), or errors in the laboratory-determined dissolved-solids concentration. For analyses at the study site, differences between the calculated and analyzed dissolved solids ranged from 2 to 9 percent.

The primary controls on field values of pH, specific conductance, dissolved oxygen, and temperature are proper instrument calibration and field procedures. However, pH and specific conductance also are determined in the laboratory. Differences between laboratory and field specific conductances were less than 5 percent in all cases (table A6).

Field and laboratory pH differed by more than 0.2 units for only three out of 18 samples and none of these differences are more than 0.5 units. Because pH and specific conductance can change during the time between the field and laboratory determinations, these comparisons must be considered approximations at best, but the good agreement generally serves to confirm the field values.

Field determinations of bicarbonate concentrations were checked by calculating alkalinities from them and comparing the results to laboratory-determined alkalinities. Field and laboratory alkalinities differed by more than 5 percent for only one of six samples.

Duplicate samples were collected and analyzed for both inorganic and organic constituents during the 1989 study (table A7). Dissolved zinc is the only constituent where duplicate sample results do not agree. Results were verified by reruns of split samples. The differences could be explained by contamination during handling or natural variability in the water. The ground water sampled at the site contained particulate matter which could be variable from one sample to another (see turbidity values, table A6). Upon acidification, colloidal zinc would be transformed into the dissolved state.

Table 1.--*Major hydrogeologic units in the Ahtanum-Moxee subbasin, Washington*

System	Series	Group	Formation	Hydrogeologic description
Quaternary	Holocene			Alluvium and terrace deposits consisting principally of unconsolidated stream deposits of silt, sand, and gravel, with cobbles throughout. Locally lacustrine, paludal, and eolian deposits occur. Generally, deposit is a thin mantle less than 50 feet thick, but known to reach 165 feet thick at one point in subbasin. Estimates of porosity range from 15 to 25 percent and from 0.4 to 86 feet per day hydraulic conductivity.
	Pleistocene			Coarse sand and gravel deposits including large amounts of cemented mixture of basaltic gravel, sand, silt, and clay. Locally contains discontinous and unconsolidated bodies of glacial fluvial and lacustrine deposits. Up to 500 feet in thickness. In general unit has low permeability except in unconsolidated sections.
Tertiary	Micocene to Pliocene	–	Ellensburg	A thick sequence of stream- and lake-deposited silt, sand, and gravel which is composed chiefly of volcanic ash, pumice, and hornblende andesite. Thickness exceeds 1,000 feet in some parts of subbasin. It has moderate to high porosity and low to medium permeability, and provides a large amount of effective storage. Permeable strata form important aquifers. Unit includes all conformably underlying sediments of similar lithology that intertongue with flows of the Columbia River Basalt.
		Columbia River Basalt	Saddle Mountains Wanapum Grande Ronde	Sequence of dark lava flows which contains some interbedded lake- and stream-deposited materials. Individual lava flows range from less than 20 to over 200 feet in thickness. The maximum thickness of the Columbia River Basalt exceeds 4,000 feet in the Yakima River Basin. Water generally moves along the interflow zones, which are more permeable than the massive centers of the flood. The porosity of this formation probably ranges from 5 to 10 percent, and its permeability ranges from low to very high. Provides a large quantity of effective ground-water storage and includes some important aquifers.

PRELIMINARY SUBJECT TO REVISIONS

Table 2.--*Observed water levels in observation and domestic wells*

[Water levels are in feet below land surface (table 4)]

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifer	Date	Water level
M1-82	Feb 21, 1985	11.37	M2-82	Feb 21, 1985	11.48	M3-82	Feb 21, 1985	10.05
	May 11	10.57		May 11	10.55		May 11	9.23
	Aug 29	8.84		Aug 29	9.47		Aug 29	8.05
	Apr 23, 1986	10.00		Apr 23, 1986	9.88		Apr 23, 1986	8.61
	May 14	9.36		May 14	9.12		May 14	7.96
	Jun 23	9.00		Jun 23	8.54		Jun 23	7.51
	Jul 28	8.91		Jul 28	8.40		Jul 28	7.45
	Sep 22	8.69		Sep 22	8.25		Sep 22	7.23
	Nov 19	11.12		Nov 19	11.01		Nov 19	9.76
	Dec 17	11.46		Dec 17	11.40		Dec 17	10.03
	Jan 20, 1987	11.67		Jan 20, 1987	11.60		Jan 22, 1987	10.23
	Feb 17	11.58		Feb 17	11.46		Feb 17	10.15
	Mar 16	11.39		Mar 16	11.32		Mar 16	9.96
	Apr 22	11.05		Apr 22	10.86		Apr 22	9.67
				Mar 18, 1989	11.65		Mar 18, 1989	10.16
M1-85	Feb 21, 1985	12.9	M2-85	Feb 20, 1985	6.22	M3-85	Feb 20, 1985	7.98
	May 10	11.58		21	6.27		21	8.07
	Jun 09	9.37		May 10	6.11		May 11	7.60
	Aug 02	9.84		Jun 09	5.37		Jun 09	6.64
	29	9.95		Aug 02	5.66		Aug 02	7.14
	30	9.69		29	5.72		29	7.28
	Sep 21	9.68		30	5.58		30	7.04
	Oct 16	10.91		Sep 21	5.57		Sep 21	6.98
	Nov 15	11.86		Oct 16	5.44		Oct 16	6.51
	Dec 13	12.69		Nov 15	6.29		Nov 15	7.20
	Jan 24, 1986	12.24		Jan 24, 1986	6.06		Dec 13	8.00
	Feb 21	11.99		Feb 21	5.87		Jan 24, 1986	8.10
	Mar 20	11.59		Mar 20	5.67		Feb 21	7.88
	Apr 23	10.58		Apr 23	5.67		Mar 20	7.76
	May 14	9.72		May 14, 1986	5.67		Apr 23	7.40
	Jun 23	9.11		Jun 23	6.34		May 14	6.86
	Jul 28	9.00		Jul 28	6.60		Jun 23	7.13
	Sep 22	8.96		Sep 22	5.51		Jul 28	7.17
	Nov 20	12.48		Nov 20	6.62		Sep 22	6.44
	Dec 17	12.85		Dec 18	7.04		Nov 20	8.96
	Jan 21, 1987	13.17		Jan 22, 1987	7.18		Dec 17	8.68
	Feb 18	13.05		Feb 17	6.64		Jan 22, 1987	8.66
	Mar 16	12.75		Mar 16	6.24		Feb 18	8.59
	Apr 23	12.25		Apr 23	6.66		Mar 16	8.40
	Mar 13, 1989	13.33		Mar 14, 1989	9.14		Apr 23	8.38

PRELIMINARY SUBJECT TO REVISIONS

Table 2.--*Observed water levels in observation and domestic wells*

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifer	Date	Water level
M4-85	Feb 20, 1985	8.95	M5-85	Feb 20, 1985	5.39	M6-85	Feb 20, 1985	7.55
	21	8.95		21	5.38		21	7.55
	May 11	7.91		May 10	5.17		May 10	7.25
	Jun 09	5.83		Jun 09	4.69		Jun 09	6.61
	Aug 02	6.12		Aug 02	5.04		Aug 02	7.14
	29	6.31		29	5.13		29	7.48
	30	6.07		30	4.91		30	6.89
	Sep 21	6.04		Sep 21	4.89		Sep 21	6.88
	Oct 16	7.10		Oct 16	4.67		Oct 16	6.66
	Nov 15	8.09		Nov 15	5.23		Nov 15	7.88
	Dec 13	8.90		Dec 13	5.39		Dec 13	8.01
	Jan 24, 1986	8.69		Jan 21, 1986	5.05		Jan 24, 1986	7.64
	Feb 21	8.58		Feb 21	4.90		Feb 21	7.36
	Mar 20	8.15		Mar 20, 1986	4.85		Mar 20	7.25
	Apr 23	6.96		Apr 23	5.02		Apr 23	7.14
	May 14	6.07		May 14	4.79		May 14	6.70
	Jun 23	5.40		Jun 23	5.02		Jun 23	7.16
	Jul 28	5.07		Jul 28	5.10		Jul 28	7.34
	Sep 22	4.94		Sep 22	4.56		Sep 22	6.37
	Nov 20	8.55		Nov 20	5.30		Nov 20	7.72
	Dec 17	8.98		Dec 18	5.49		Dec 17	8.11
	Jan 21, 1987	9.26		Jan 22, 1987	5.56		Jan 22, 1987	8.31
	Feb 17	9.04		Feb 18	5.48		Feb 18	8.03
	Mar 16	8.92		Mar 16	5.32		Mar 16	7.87
	Apr 23	8.27		Apr 23	5.46		Apr 23	7.93
				Mar 13, 1989	5.64		Mar 13, 1989	8.52
M7-85	Feb 20, 1985	7.40	M8-85	Feb 20, 1985	9.47	M9-85	Feb 20, 1985	9.81
	21	7.43		21	9.49		21	9.81
	May 11	7.13		May 11	8.92		May 11	9.07
	Jun 09	6.09		Jun 09	7.92		Jun 09	7.88
	Aug 02	6.72		Aug 02	8.43		Aug 02	8.22
	29	6.79		29	8.50		29	8.32
	30	5.63		30	7.33		30	8.11
	Sep 21	6.09		Sep 21	7.93		Sep 21	8.02
	Oct 16	6.40		Oct 16	8.38		Oct 16	8.43
	Nov 15	7.42		Nov 15	8.99		Nov 15	9.19
	Dec 13	7.66		Dec 13	9.29		Dec 13	9.50
	Jan 24, 1986	7.14		Jan 24, 1986	9.17		Jan 24, 1986	9.65
	Feb 21	7.07		Feb 21	9.07		Feb 21	9.52
	Mar 20	6.89		Mar 20, 1986	8.73		Mar 20	9.18
	Apr 23	6.83		Apr 23	8.56		Apr 23	8.63
	May 14	6.13		May 14	8.08		May 14	7.96
	Jun 23	6.40		Jun 23	8.04		Jun 23	7.75
	Jul 28	6.63		Jul 28	8.04		Jul 28	7.65
	Sep 22	5.84		Sep 22	7.45		Sep 22	7.20
	Nov 20	7.40		Nov 20	9.07		Nov 20	9.53
	Dec 17	7.78		Dec 17	9.31		Dec 17	9.92
	Jan 22, 1987	7.93		Jan 22, 1987	9.48		Jan 20, 1987	10.12
	Feb 18	7.75		Feb 18	9.42		Feb 17	9.98
	Mar 16	7.62		Mar 16	9.22		Mar 16	9.86
	Apr 23	7.65		Apr 23	9.18		Apr 22	9.58
	Mar 14, 1989	8.05		Mar 14, 1989	9.59		Mar 15, 1989	10.37

PRELIMINARY SUBJECT TO REVISIONS

Table 2.--*Observed water levels in observation and domestic wells*

Well iden- tifier	Date	Water level	Well iden- tifier	Date	Water level	Well iden- tifer	Date	Water level
M10-85	Feb 20, 1985	9.72	M11-85	Feb 20, 1985	10.94	M12-85	Feb 20, 1985	11.52
	21	9.72		21	10.94		21	11.52
	May 11	9.09		May 11	9.96		May 10	10.68
	Jun 09	8.06		Jun 09	11.81		Jun 09	9.24
	Aug 02	8.34		Aug 02	7.83		Aug 02	9.82
	29	7.93		29	7.56		29	9.73
	30	7.24		30	6.72		30	9.61
	Sep 21	7.08		Sep 21	6.76		Sep 21	9.50
	Oct 16	7.72		Oct 16	9.47		Oct 16	10.12
	Nov 15	8.20		Nov 15	10.27		Nov 15	10.86
	Dec 13	8.55		Dec 13	10.92		Dec 13	11.52
	Jan 24, 1986	9.23		Jan 24, 1986	10.65		Jan 24, 1986	11.15
	Feb 21	9.17		Feb 21	10.44		Feb 21	10.98
	Mar 20	8.83		Mar 20, 1986	9.98		Mar 20	10.53
	Apr 23	8.68		Apr 23	9.34		Apr 23	10.13
	May 14	8.22		May 14	8.64		May 14	9.53
	Jun 23	8.05		Jun 23	8.11		Jun 23	9.13
	Jul 28	8.05		Jul 28	8.01		Jul 28	9.08
	Sep 22	7.67		Sep 22	7.79		Sep 22	8.83
	Nov 20	9.34		Nov 19	10.58		Nov 20	11.06
	Dec 17	9.52		Dec 17	10.92		Dec 17	11.30
	Jan 22, 1987	9.68		Jan 20, 1987	10.83		Jan 20, 1987	11.38
	Feb 18	9.70		Feb 17	11.01		Feb 18	11.50
	Mar 16	9.52		Mar 16	10.81		Mar 16	11.26
	Apr 22	9.37		Apr 22	10.38		Apr 23	11.01
				Mar 18, 1989	11.10			
M1	Nov 19, 1986	12.01	M2	Nov 20, 1986	10.55	M3	Nov 20, 1986	10.73
	Dec 17	12.69		Dec 17	10.84		Dec 17	11.02
	Jan 20, 1987	12.72		Jan 20, 1987	11.01		Jan 20, 1987	11.22
	Feb 17	12.55		Feb 17	10.94		Feb 17	11.16
	Mar 16	12.39		Mar 16	10.76		Mar 16	10.96
	Apr 22	12.08		Apr 22	10.48		Apr 22	10.67
M4	Nov 20, 1986	10.91	M5	Nov 19, 1986	10.94	M6.1	Nov 20, 1986	10.51
	Dec 17	11.07		Dec 17	11.27		Dec 17	10.89
	Jan 20, 1987	11.28		Jan 20, 1987	11.50		Jan 20, 1987	11.04
	Feb 17	11.19		Feb 17	11.40		Feb 17	10.95
	Mar 16	11.01		Mar 16	11.20		Mar 16	10.76
	Apr 22	10.68		Apr 22	10.72		Apr 22	10.48
	Mar 17, 1989	11.2						

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Table 2.--*Observed water levels in observation and domestic wells*

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifier	Date	Water level
M6.2	Nov 20, 1986	10.53	M7.1	Nov 19, 1986	11.16	M7.2	Mar 16, 1987	11.33
	Dec 17	10.79		Dec 17	11.42		Apr 22	10.82
	Jan 20, 1987	10.98		Jan 20, 1987	11.67			
	Feb 17	10.89		Feb 17	11.56			
	Mar 16	10.72		Mar 16	11.38			
	Apr 22	10.38		Apr 22	10.97			
	Mar 17, 1989	11.03						
M8	Nov 20, 1986	11.32	M9	Nov 20, 1986	11.28	M10	Nov 20, 1986	11.03
	Dec 17	11.75		Dec 17	11.62		Dec 17	11.41
	Jan 20, 1987	11.92		Jan 20, 1987	11.70		Jan 20, 1987	11.61
	Feb 17	11.81		Feb 19	11.71		Feb 17	11.50
	18	11.82		Mar 16	11.53		Mar 16	11.32
	Mar 16	11.64		Apr 22	11.13		Apr 22	10.95
	Apr 22	11.14						
M11	Nov 20, 1986	10.89	M12	Nov 19, 1986	11.13	M13	Nov 19, 1986	11.15
	Dec 17	11.23		Dec 17	11.46		Dec 17	11.58
	Jan 20, 1987	11.45		Jan 20, 1987	11.63		Jan 20, 1987	11.83
	Feb 17	11.35		Feb 17	11.57		Feb 17	11.72
	Mar 16	11.19		Mar 16	11.40		Mar 16	11.53
	Apr 22	10.87		Apr 22	11.05		Apr 22	11.17
	Mar 17, 1989	11.56		Mar 18, 1989	11.69		Mar 16, 1989	11.90
M14	Nov 20, 1986	9.58	M16	Nov 19, 1986	10.99	M17	Nov 20, 1986	11.35
	Dec 17	9.88		Dec 17	11.42		Dec 17	11.73
	Jan 20, 1987	10.09		Jan 20, 1987	11.63		Jan 20, 1987	11.97
	Feb 17	9.92		Feb 17	11.52		Feb 17	11.86
	18	9.93		Mar 16	11.34		Mar 16	11.64
	Mar 16	9.76		Apr 22	10.80		Apr 22	11.12
	Apr 22	9.43		Mar 18, 1989	11.59		Mar 17, 1989	12.02
	Mar 16, 1989	10.14						
M18	Nov 20, 1986	10.99	M19	Nov 20, 1986	11.38	M20	Nov 20, 1986	11.21
	Dec 17	11.36		Dec 17	11.69		Dec 17	11.62
	Jan 20, 1987	11.58		Jan 20, 1987	11.90		Jan 20, 1987	11.88
	Feb 17	11.46		Feb 17	11.77		Feb 17	11.75
	Mar 16	11.26		Mar 16	11.61		Mar 16	11.53
	Apr 22	10.84		Apr 22	11.16		Apr 22	10.92
	Mar 17, 1989	11.70		Mar 15, 1989	12.08		Mar 17, 1989	12.00
M21	Nov 20, 1986	11.49	M22	Nov 20, 1986	10.79	M23	Nov 20, 1986	10.10
	Dec 17	11.88		Dec 17	11.03		Dec 17	10.39
	Jan 20, 1987	12.15		Jan 21, 1987	11.33		Jan 22, 1987	10.60
	Feb 17	11.90		Feb 17	11.13		Feb 18	10.53
	Mar 16	11.71		Mar 16	10.95		Mar 16	10.32
	Apr 22	11.31		Apr 22	10.47		Apr 22	10.02
							Mar 16, 1989	10.64

Table 7.--*Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued*

Well identi- fier	Date	Benzene	Toluene	Ethyl- benzene	Total xyl- lenes	Naph- thalene	1,2,3- Tri- methyl- benzene	1,2,4- Tri- methyl- benzene	1,3,5- Tri- methyl- benzene	1,2,3,4- Tetra- methyl- benzene	1,2,3,5- Tetra- methyl- benzene
D14	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D15	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D16	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D17	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D18	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D19	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D20	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D21	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D22	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D23	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D24	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D25	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D26	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D27	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D28	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D29	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D30	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D31	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND

Table 7.--*Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued*

Well identi-fier	Date	Benzene	Toluene	Ethyl-benzene	Total xyl-lenes	Naph-thalene	1,2,3-Tri-methyl-benzene	1,2,4-Tri-methyl-benzene	1,3,5-Tri-methyl-benzene	1,2,3,4-Tetra-methyl-benzene	1,2,3,5-Tetra-methyl-benzene
T16	06-25-86	1.2	0.06	0.1	T	1.6	T	T	0	--	0.4
T17	05-13-86	T	0	ND	0	ND	ND	0	ND	ND	ND
T18	05-13-86	T	0	T	.04	0	ND	0	ND	ND	ND
T19	04-30-86	15	.6	T	.8	--	0	0	0	T	0
T20	05-13-86	T	T	.03	.12	0	ND	T	ND	ND	ND
T21	05-13-86	170	2.8	38	970	300	39	820	420	47	94
T22	04-27-86	670	1,600	260	4,900	--	370	1,600	720	410	330
T23	04-30-86	0	T	T	T	--	0	T	T	T	0
T24	04-30-86	0	0	0	T	--	T	T	T	T	T
T25	04-30-86	850	2,100	2,200	11,300	--	660	3,800	1400	760	410
T26	04-30-86	0	0	0	T	--	0	T	T	T	T
T27	04-30-86	75	4	2	7	--	0	0	8	7	14
T28	06-25-86	.9	.05	.05	T	.4	0	0	0	--	T
T29	06-25-86	1.0	.1	T	0	0	0	0	0	--	0
T30	06-25-86	1.5	.08	T	0	T	ND	0	ND	--	ND
T31	06-25-86	0	T	0	0	T	ND	ND	ND	--	ND
T32	06-25-86	3.1	.2	.3	0	2.1	0	0	0	--	.2
T33	06-25-86	31	.3	.09	36.2	2	11	11	.9	--	15
T34	06-25-86	240	92	280	4,200	970	820	3,400	1,100	--	930
T35	06-25-86	110	43	13	2,620	770	420	1,900	590	--	230
T36	06-25-86	31	1	8.7	8	63	7.3	49	ND	--	15
T37	06-25-86	0	.05	0	0	0	ND	ND	ND	--	ND
T38	06-25-86	0.7	T	T	0	0	ND	0	ND	--	ND
T39	06-25-86	120	43	110	420	280	76	350	81	--	97
T40	06-25-86	T	.2	T	T	0	0	0	0	--	ND
T41	06-25-86	30	.4	.1	22.2	74	2.4	T	36	--	10
T42	06-25-86	16	.8	.6	.5	66	19	T	.5	--	.8
D1	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D2	08-27-85	10	ND	ND	1.2	1.0	--	1.4	ND	ND	.26
D3	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D4	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D5	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D6	08-27-85	26	ND	4.7	3.53	12	--	ND	ND	.4	1.5
D7	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D8	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D9	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D10	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D11	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D12	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D13	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND

Table 7.--*Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued*

Well identi- fier	Date	Benzene	Toluene	Ethyl- benzene	Total xyl- lenes	Naph- thalene	1,2,3- Tri- methyl- benzene	1,2,4- Tri- methyl- benzene	1,3,5- Tri- methyl- benzene	1,2,3,4- Tetra- methyl- benzene	1,2,3,5- Tetra- methyl- benzene
M7.2	11-17-86	1700	7100	3000	8500	480	340	1,600	390	--	110
M8	11-17-86	1.3	NQ	.1	.05	.4	NQ	.1	NQ	--	.02
M9	11-17-86	130	51	180	500	58	55	190	51	--	18
M11	11-18-86	100	2.2	190	53	110	4.4	45	20	--	14
M12	11-18-86	380	490	1,900	5,900	550	450	2,100	640	--	260
M13	11-20-86	34	.5	47	7.3	7.9	4.1	5.9	.5	--	1.5
M14	11-20-86	NAB	NAB	NQ	NQ	NQ	ND	ND	ND	--	ND
M16	11-17-86	1,500	980	1,400	4,000	180	100	460	100	--	24
M18	11-18-86	150	17	430	500	94	66	320	100	--	52
M19	11-18-86	.4	.02	.05	.01	NQ	ND	.02	ND	--	ND
M22	11-20-86	NAB	NAB	NQ	NQ	NQ	ND	NQ	ND	--	ND
M23	11-18-86	250	17	490	200	160	30	180	33	--	44
M24	11-18-86	1,600	280	3,000	9,600	770	520	2,200	660	--	220
M18	11-18-86	150	17	430	500	94	66	320	100	--	52
M19	11-18-86	.4	.02	.05	.01	NQ	ND	.02	ND	--	ND
M22	11-20-86	NAB	NAB	NQ	NQ	NQ	ND	NQ	ND	--	ND
M23	11-18-86	250	17	490	200	160	30	180	33	--	44
M24	11-18-86	1,600	280	3,000	9,600	770	520	2,200	660	--	220
M29	11-19-86	NAB	.1	NQ	NQ	1.1	NQ	.1	NQ	--	NQ
M30	11-20-86	1.5	NAB	NQ	NQ	NAB	ND	NQ	NQ	--	ND
M31	11-19-86	.4	.1	.2	.11	.5	ND	NQ	ND	--	NQ
M34	11-20-86	NAB	NAB	NQ	NQ	ND	ND	NQ	ND	--	ND
M36	04-30-86	150	210	220	590	--	100	130	260	210	110
	06-25-86	370	320	ND	4,800	460	490	1,700	720	--	200
M37	04-30-86	T	6	7	46	--	3	14	5	T	T
T1	08-29-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T2	08-29-85	2.3	ND	ND	.17	ND	--	ND	ND	ND	ND
T3	08-29-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T4	08-29-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T5	08-29-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T6	08-29-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T7	08-29-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T8	08-30-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T9	08-30-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T10	08-30-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T11	08-30-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T12	08-30-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T13	08-30-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T14	05-13-86	T	.2	ND	120	13	20	39	59	6.5	14
T15	05-13-86	100	24	78	630	150	67	310	200	27	62

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Table 7.--*Concentrations of volatile organic compounds in ground water, August 1985 through November 1986*

[Data from the ground-water toxics study, analyzed by OGC; concentrations are blank-corrected and are in micrograms per liter; ND, concentration is below limit of detection, see text and table A3; 0 indicates compound detected, but not above blank levels; --, compound not specifically analyzed for; NQ, compound peak present at proper retention time, but only one or two characteristic ions were present; NAB, concentration not above background (compound's characteristic ions were identified, but quantitative level was not greater than the average of travel blanks plus three standard deviations of the travel blanks); T, concentration is more than twice blank level, but less than twice the blank level plus three blank level standard deviations] .

Well identi- fier	Date	Benzene	Toluene	Ethyl- benzene	Total xyl- lenes	Naph- thalene	1,2,3- Tri- methyl- benzene	1,2,4- Tri- methyl- benzene	1,3,5- Tri- methyl- benzene	1,2,3,4- Tetra- methyl- benzene	1,2,3,5- Tetra- methyl- benzene
M1-82	08-28-85	ND	ND	ND	ND	2.8	--	ND	25	5.6	8.6
	11-18-86	170	6.5	530	110	130	13	97	53	--	28
M2-82	08-27-85	3,300	11,000	910	10,500	400	--	1,500	620	55	130
	11-18-86	1100	3200	1700	4400	230	180	830	210	--	65
M3-82	08-28-85	800	2,600	150	8,200	740	--	2,400	930	180	380
	05-13-86	280	1,500	240	3,800	280	230	990	310	82	180
M1-85	08-26-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
	11-19-86	NAB	.2	NQ	NQ	ND	ND	NQ	ND	--	ND
M2-85	08-26-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
M3-85	08-26-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
M4-85	08-26-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
M5-85	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
M6-85	08-26-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
M7-85	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
M8-85	08-27-85	ND	ND	ND	1.0	3.0	--	.13	ND	.2	.66
	06-25-86	0	ND	0	0	ND	T	ND	ND	--	ND
	11-20-86	6.5	NAB	.1	NQ	NQ	ND	ND	NQ	--	ND
M9-85	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
	11-19-86	NAB	NAB	ND	NQ	ND	ND	NQ	ND	--	ND
M10-85	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
	06-25-86	.4	ND	0	0	ND	ND	ND	ND	--	ND
	11-19-86	NAB	NAB	ND	NAB	NAB	ND	ND	NAB	--	ND
M11-85	08-27-85	1,000	3,400	220	7,300	440	--	1,200	420	46	81
	05-13-86	240	5,500	1,600	11,900	950	780	2,500	780	94	190
	11-17-86	570	5000	2700	7900	530	320	1,400	330	--	88
M12-85	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
	11-20-86	NAB	NAB	NQ	NQ	NQ	ND	NQ	ND	--	ND
M2	11-20-86	.7	NAB	NQ	NQ	NQ	NQ	.1	.01	--	NQ
M4	11-18-86	23	1.0	90	15	32	1.9	17	20	--	7.2
M6.1	11-20-86	NAB	NAB	NQ	NQ	.8	NQ	.02	NQ	--	NQ
M6.2	11-20-86	16	2.9	70	2.5	8.6	.9	3.4	NQ	--	2.1
M7.1	11-20-86	NAB	.32	NQ	3.2	NQ	.52	.1	.32	--	NQ

Table 9.--*Concentrations of inorganic compounds and dissolved organic carbon in ground water, November 1986 and March 1989--Cont.*

Well identifier	Manganese, dissolved (µg/L as Mn)	Molybdenum, dissolved (µg/L as Mo)	Nickel, dissolved (µg/L as Ni)	Silver, dissolved (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)	Carbon, organic dissolved (mg/L as C)
M1-82	1,600	<10	--	--	120	<6	5	1.6
M2-82	1,900	<10	--	--	140	<6	8	2.1
								4.1
M3-82	--	--	--	--	--	--	--	7.5
M1-85	<1	<10	--	--	95	<6	8	1.2
	16	<10	<10	<1	87	<6	130	.9
M5-85	2	<10	<10	<1	110	<6	52	1.0
M6-85	--	--	--	--	--	--	--	.9
M7-85	--	--	--	--	--	--	--	11
M8-85	--	--	--	--	--	--	--	.6
M9-85	28	<10	--	--	100	<6	<3	1.1
	85	<10	<10	<1	100	<6	100	1.1
M10-85	<1	<10	--	--	120	<6	<3	1.2
M11-85	2,400	<10	--	--	110	<6	6	2.9
	1,900	<10	<10	<1	130	<6	5	2.8
M4	3,400	<10	--	--	140	<6	7	2.3
M6.2	--	--	--	--	--	--	--	81
M7.2	2,300	<10	--	--	150	<6	10	3.4
M8	3	<10	--	--	100	<6	10	1.2
M9	1,300	<10	--	--	120	<6	10	1.6
M11	4,700	<10	--	--	140	<6	11	1.8
								1.7
M12	2,500	<10	--	--	150	<6	9	3.4
	--	--	--	--	--	--	--	4.7
M13	--	--	--	--	--	--	--	2.2
M14	--	--	--	--	--	--	--	1.5
M16	3,000	<10	--	--	170	<6	6	3.0
								2.4
M17	--	--	--	--	--	--	--	5.5
M18	2,300	<10	--	--	130	<6	5	2.0
	2,800	<10	<10	<1	150	<6	69	1.9
M19	26	<10	--	--	100	<6	<3	1.8
								0.8
M20	--	--	--	--	--	--	--	2.4
M23	5,600	<10	--	--	200	<6	7	3.7
	--	--	--	--	--	--	--	9.8
M24	3,700	<10	--	--	170	<6	4	3.4
M26	--	--	--	--	--	--	--	2.8
M27	--	--	--	--	--	--	--	2.1
M29	1,900	<10	--	--	120	<6	7	1.2
								.9
M30	14	<10	<10	2	120	<6	5	.8
M31	840	<10	--	--	110	<6	<3	1.2
M34	--	--	--	--	--	--	--	1.0

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Table 9.--*Concentrations of inorganic compounds and dissolved organic carbon in ground water, November 1986 and March 1989--Cont.*

Well identifier	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Bromide, dissolved (mg/L as Br)	Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 °C, dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3 dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Phosphorus ortho, dissolved (mg/L as P)
M1-82	6.2	0.2	0.026	37	--	190	<0.10	<0.01	0.03
M2-82	6.9	.2	.032	40	--	213	<.10	.09	<.01
M3-82	--	--	--	--	--	--	--	--	--
M1-85	5.4	.2	.034	26	--	157	.68	<.01	.02
	6.2	.2	--	25	136	145	.91	<.01	.02
M5-85	6.5	.2	--	33	166	176	.64	<.01	.02
M6-85	--	--	--	--	--	--	--	--	--
M7-85	--	--	--	--	--	--	--	--	--
M8-85	--	--	--	--	--	--	--	--	--
M9-85	5.8	.2	.033	33	--	169	.49	<.01	.02
	6.7	.2	--	32	168	171	.50	<.01	.06
M10-85	8.6	.2	.039	30	--	190	1.8	<.01	.02
M11-85	6.1	.2	.039	40	--	196	<.10	.06	.02
	7.1	.2	--	36	186	200	.10	.08	.06
M4	7.2	.2	.037	43	--	227	<.10	.15	<.01
M6.2	--	--	--	--	--	--	--	--	--
M7.2	7.1	.2	.019	44	--	242	<.10	.16	<.01
M8	5.6	.2	.034	32	--	170	1.1	<.01	.02
M9	6.1	.2	.027	34	--	190	<.10	.03	<.01
M11	6.7	.2	.031	39	--	210	<.10	.03	.02
M12	6.4	.2	.020	43	--	224	<.10	.13	<.01
M13	--	--	--	--	--	--	--	--	--
M14	--	--	--	--	--	--	--	--	--
M16	7.9	.2	.030	44	--	242	<.10	.12	<.01
M17	--	--	--	--	--	--	--	--	--
M18	6.0	.2	.026	41	--	208	<.10	.11	<.01
	7.0	.2	--	38	209	227	<.10	.10	.05
M19	5.6	.2	.028	32	--	171	1.3	<.01	.04
M20	--	--	--	--	--	--	--	--	--
M23	10	.2	.029	50	--	274	<.10	.07	<.01
M24	7.7	.2	.019	48	--	255	<.10	.18	<.01
M26	--	--	--	--	--	--	--	--	--
M27	--	--	--	--	--	--	--	--	--
M29	6.3	.2	.033	34	--	183	<.10	.01	.02
M30	6.9	.2	--	32	172	188	.93	<.01	.05
M31	6.7	.2	.033	32	--	174	.54	<.01	<.01
M34	--	--	--	--	--	--	--	--	--

PRELIMINARY SUBJECT TO REVISIONS

Table 9.--*Concentrations of inorganic compounds and dissolved organic carbon in ground water, November 1986 and March 1989--Cont.*

Well identi- fier	Calcium, dis- solved (mg/L as Ca)	Magne- sium, dis- solved (mg/L as Mg)	Sodium dis- solved (mg/L as Na)	Sodium percent	Sodium ad- sorp- tion ratio	Potas- sium, dis- solved (mg/L as K)	Alka- linity, field (mg/L as $CaCO_3$)	Sulfate, dis- solved (mg/L as SO_4)
M1-82	31	10	13	19	0.5	3.3	131	8.5
M2-82	34	11	12	16	.5	3.3	156	5.8
	--	--	--	--	--	--	160	--
M3-82	--	--	--	--	--	--	206	--
M1-85	26	8.5	11	19	.5	2.3	103	12
	23	7.5	12	22	.6	2.4	89	11
M5-85	29	9.5	13	20	.6	2.2	113	12
M6-85	--	--	--	--	--	--	117	--
M7-85	--	--	--	--	--	--	122	--
M8-85	--	--	--	--	--	--	109	--
M9-85	27	8.9	12	20	.5	2.6	108	12
	27	8.9	12	20	.5	2.5	112	12
M10-85	32	10	14	20	.6	2.6	116	15
M11-85	27	8.9	11	18	.5	2.7	125	19
	31	10	12	18	.5	2.3	140	11
M4	30	9.6	17	24	.7	3.7	151	16
M6.2	--	--	--	--	--	--	116	--
M7.2	37	12	13	16	.5	3.4	185	2.3
M8	27	8.9	12	19	.5	3.3	105	13
M9	29	9.6	12	18	.5	3.2	133	13
M11	33	10	14	19	.6	3.5	148	8.3
	--	--	--	--	--	--	124	--
M12	35	11	13	17	.5	3.5	164	4.0
	--	--	--	--	--	--	118	--
M13	--	--	--	--	--	--	113	--
M14	--	--	--	--	--	--	115	--
M16	38	12	14	17	.5	3.8	172	7.6
	--	--	--	--	--	--	131	--
M17	--	--	--	--	--	--	144	--
M18	30	9.8	12	18	.5	3.3	149	5.5
	32	11	12	17	.5	2.6	132	34
M19	26	8.7	13	21	.6	2.7	105	14
	--	--	--	--	--	--	91	--
M20	--	--	--	--	--	--	113	--
M23	45	14	15	16	.5	3.9	193	8.4
	--	--	--	--	--	--	135	--
M24	38	12	15	18	.6	3.7	190	2.9
M26	--	--	--	--	--	--	110	--
M27	--	--	--	--	--	--	115	--
M29	28	8.8	13	20	.6	3.5	120	14
	--	--	--	--	--	--	114	--
M30	31	10	13	19	.5	2.7	128	11
M31	28	9.1	12	19	.5	2.6	113	12
M34	--	--	--	--	--	--	109	--

PRELIMINARY SUBJECT TO REVISIONS

Table 9.--*Concentrations of inorganic compounds and dissolved organic carbon in ground water, November 1986 and March 1989*

[Data are from ground-water toxics study and 1989 study, analyzed by NWQL; concentrations are in mg/L, milligrams per liter or µg/L, micrograms per liter, unless otherwise noted: --, not analyzed].

Well identifier	Date	Time	Specific conductance (µs/cm)	pH (standard units)	Temperature (°C)	Turbidity (NTU)	Oxygen, dissolved (mg/L)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L as $CaCO_3$)
M1-82	11-18-86	1215	280	6.8	15.0	--	<0.5	120	0
M2-82	11-18-86	1430	320	6.7	14.0	--	< .3	130	0
	03-18-89	1630	323	6.8	14.0	--	.0	--	--
M3-82	03-18-89	1030	389	6.3	13.5	--	.0	--	--
M1-85	11-19-86	1230	238	6.7	14.5	--	5.7	100	0
	03-13-89	1015	208	6.9	11.5	1.7	8.5	88	0
M5-85	03-13-89	1715	252	6.7	9.5	27	3.1	110	0
M6-85	03-13-89	1500	262	6.7	12.5	--	1.8	--	--
M7-85	03-14-89	0930	278	6.7	10.5	--	1.2	--	--
M8-85	03-14-89	1500	235	6.6	13.5	--	1.6	--	--
M9-85	11-19-86	1130	254	6.5	14.0	--	.4	100	0
	03-15-89	1515	249	6.5	13.0	5.2	.2	100	0
M10-85	11-19-86	1000	298	6.6	14.5	--	2.2	120	5
M11-85	11-17-86	1155	264	6.6	16.0	--	.0	100	0
	03-18-89	1530	292	6.6	15.0	19	.2	120	0
M4	11-18-86	1110	313	6.6	15.5	--	1.2	110	0
M6.2	03-17-89	1610	258	6.6	13.5	--	1.2	--	--
M7.2	11-17-86	0945	352	6.4	15.5	--	.0	140	0
M8	11-17-86	1450	247	6.6	14.5	--	1.7	100	0
M9	11-17-86	1555	279	6.6	15.0	--	.0	110	0
M11	11-18-86	1000	307	6.6	15.0	--	.3	120	0
	03-17-89	1330	265	6.6	13.5	--	.2	--	--
M12	11-18-86	1345	323	6.5	16.0	--	.0	130	0
	03-18-89	0900	280	6.4	13.0	--	.0	--	--
M13	03-16-89	1200	252	6.6	13.5	--	1.2	--	--
M14	03-16-89	0915	246	6.6	11.5	--	.2	--	--
M16	11-17-86	1115	342	6.7	16.0	--	.0	140	0
	03-18-89	1215	259	6.7	15.0	--	.0	--	--
M17	03-17-89	1200	282	6.5	13.0	--	1.0	--	--
M18	11-18-86	0930	292	6.6	15.0	--	.7	120	0
	03-17-89	1030	319	6.7	13.0	40	.0	130	0
M19	11-18-86	0805	257	6.6	15.0	--	2.7	100	0
	03-15-89	1800	236	6.6	10.5	--	3.5	--	--
M20	03-17-89	0845	328	6.5	12.5	--	3.5	--	--
M23	11-18-86	1630	390	6.7	16.0	--	.7	170	0
	03-16-89	1700	280	6.8	12.0	--	.4	--	--
M24	11-18-86	1430	365	6.5	15.0	--	.0	140	0
M26	03-16-89	1600	268	6.6	12.0	--	2.2	--	--
M27	03-16-89	1450	248	6.6	13.0	--	.2	--	--
M29	11-19-86	0830	259	6.6	14.5	--	.3	110	0
	03-15-89	1100	250	6.6	9.5	--	1.1	--	--
M30	03-14-89	1730	268	6.6	12.0	.4	.8	120	0
M31	11-19-86	0930	261	6.5	15.0	--	.3	110	0
M34	03-14-89	1130	242	6.7	13.0	--	2.5	--	--

Table 6.--*Concentrations of volatile organic compounds in ground water, October 1984 through June 1986*

[Data from the insurance company study, analyzed by a private laboratory; concentrations are in micrograms per liter; ND, below the detection limit of 1 microgram per liter unless otherwise indicated; --, not analyzed]

Well identifier	Date	Benzene	Toluene	Total xylenes	Total hydrocarbons (as gasoline)
M1-85	2-21-85	ND	ND	ND	ND
	5-10-85	ND	ND	ND	ND
M2-85	2-21-85	ND	ND	ND	ND
	5-10-85	ND	ND	ND	ND
M3-85	2-21-85	ND	ND	ND	ND
	5-11-85	ND	ND	ND	ND
M4-85	2-21-85	ND	ND	ND	ND
	5-11-85	ND	ND	ND	ND
M5-85	2-21-85	ND	ND	ND	ND
	5-10-85	ND	ND	ND	ND
M6-85	2-21-85	ND	ND	ND	ND
	5-10-85	ND	ND	ND	ND
M7-85	2-21-85	ND	ND	ND	ND
	5-11-85	ND	ND	ND	ND
	8-27-85	ND	ND	ND	ND
	12-16-85	ND	ND	ND	ND
	6-20-86	ND	ND	ND	ND
M8-85	2-21-85	ND	ND	ND	ND
	5-11-85	ND	ND	ND	ND
	8-27-85	96	1	9	230
	6-20-86	ND	ND	ND	ND
M9-85	2-21-85	ND	ND	ND	ND
	5-11-85	ND	ND	ND	ND
	12-16-85	ND	ND	ND	ND
	6-20-86	ND	ND	ND	ND
M10-85	2-21-85	ND	ND	ND	ND
	5-11-85	ND	2	5	17
	8-27-85	ND	ND	ND	ND
	12-16-85	ND	ND	ND	ND
	6-20-86	ND	ND	ND	ND
M11-85	2-21-85	1,460	5,300	6,260	23,400
	5-11-85	1,240[a]	5,850[a]	13,940[a]	33,000[a]
	8-27-85	920	1,100	6,300	12,000
	12-16-85	710	1,100	750	28,000
	6-20-86	680	7,000	18,000	45,000
M12-85	2-21-85	ND	ND	ND	ND
	5-10-85	ND	ND	ND	ND
D3	2-19-85	ND	ND	ND	ND
	3-25-85	ND	ND	ND	ND
	5-10-85	ND	ND	ND	ND
	6-25-85	ND	ND	ND	ND
	7-25-85	ND	ND	ND	ND
	12-16-85	ND	ND	ND	ND
	6-20-86	ND	ND	ND	ND
D5	2-19-85	ND	ND	ND	ND
D6	10-02-84	<0.5	<0.5	0.9	--
	2-19-85	ND	ND	ND	ND
D10	10-02-84	<0.5	<0.5	<0.5	--
	2-19-85	ND	ND	5	14
	3-25-85	28	680	980	3,120
	5-10-85	ND	1	4	17
D11	10-02-84	<.5	<.5	<.5	--
D12	2-19-85	ND	ND	ND	ND
D13	2-19-85	ND	ND	ND	ND
D14	2-19-85	ND	ND	ND	ND
D15	10-02-84	<0.5	<0.5	<0.5	--
D16	2-19-85	ND	ND	ND	ND
D17	10-02-84	40	70	45	--
	2-19-85	ND	ND	ND	ND

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[a] Average of two values

Table 5.--*Target compounds in water analyzed for volatile organic compounds by the purge and trap method--Continued*

Compound	Chemical Abstract Services Registry Number
1,1-Dichloroethane	75-34-3
1,2-Dichloroethane	107-06-2
1,1-Dichloroethene	75-35-4
cis-1,2-Dichloroethene	156-59-4
trans-1,2-Dichloroethene	156-60-5
1,2-Dichloropropane	78-87-5
1,3-Dichloropropane	142-28-9
2,2-Dichloropropane	590-20-7
1,1-Dichloropropene	563-58-6
Ethylbenzene	100-41-4
Hexachlorobutadiene	87-68-3
Isopropylbenzene	98-82-8
p-Isopropyltoluene	99-87-6
Methylene chloride	75-09-2
Naphthalene	91-20-3
n-Propylbenzene	105-65-1
Styrene	100-42-5
1,1,1,2-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethene	127-18-4
Toluene	108-88-3
1,2,3-Trichlorobenzene	87-61-6
1,2,4-Trichlorobenzene	120-82-1
1,1,1-Trichloroethane	71-55-6
1,1,2-trichloroethane	79-00-5
Trichloroethene	79-01-6
Trichlorofluoromethane	75-69-4
1,2,3-Trichloropropane	96-18-4
1,2,4-Trimethylbenzene	95-63-6
1,3,5-Trimethylbenzene	108-67-8
Vinyl chloride	75-01-4
o-Xylene	95-47-6
m-Xylene	108-38-3
p-Xylene	106-42-3
1,2,3,5-Tetramethylbenzene[1]	527-53-7
1,2,3,4-Tetramethylbenzene[1]	488-23-3
2-Ethyl-1-methylbenzene[1]	611-14-3
1,2,3-Trimethylbenzene[1]	526-73-8
1,4-Dimethyl-2-ethylbenzene[1,2]	175-88-89

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[1] Standards for the quantification of this compound were added to the laboratory procedure of EPA Method 524.2

[2] This compound co-elutes with 1,3-Dimethyl-4-ethylbenzene

Table 5.--*Target compounds in water analyzed for volatile organic compounds by the purge and trap method*

Compound	Chemical Abstract Services Registry Number
<u>Ground-water Toxics Study</u>	
Benzene	71-43-2
Toluene	108-88-3
Ethylene bromide	106-93-4
Ethylbenzene	100-41-4
m-Xylene	108-38-3
o-Xylene	95-47-6
p-Xylene	106-42-3
n-Propylbenzene	105-65-1
1,2,3-Trimethylbenzene	526-73-8
1,2,4-Trimethylbenzene	95-63-6
1,3,5-Trimethylbenzene	108-67-8
t-Butylbenzene	98-06-6
Isobutylbenzene	538-93-2
sec-Butylbenzene	135-98-8
1-Isopropyl-4-methylbenzene	99-87-6
n-Butylbenzene	104-51-8
1,2,3,5-Tetramethylbenzene	527-53-7
1,2,3,4-Tetramethylbenzene	488-23-3
Naphthalene	91-20-3
2-Ethyl-1-methylbenzene	611-14-3
1,4-Dimethyl-2-ethylbenzene	175-88-89
1,3-Dimethyl-4-ethylbenzene	874-41-9
<u>March 1989 Study</u>	
Benzene	71-43-2
Bromobenzene	108-43-2
Bromochloromethane	74-97-5
Bromodichloromethane	75-27-4
Bromoform	75-25-2
Bromomethane	74-83-9
n-Butylbenzene	104-51-8
sec-Butylbenzene	135-98-8
tert-Butylbenzene	98-06-6
Carbon tetrachloride	56-23-5
Chlorobenzene	108-90-7
Chloroethane	75-00-3
Chloroform	67-66-3
Chloromethane	74-87-3
2-Chlorotoluene	95-49-8
4-Chlorotoluene	106-43-4
Chlorodibromomethane	124-48-1
1,2-Dibromo-3-chloropropane	96-12-8
1,2-Dibromoethane	106-93-4
Dibromomethane	74-95-3
1,2-Dichlorobenzene	95-50-1
1,3-Dichlorobenzene	541-73-1
1,4-Dichlorobenzene	106-46-7
Dichlorodifluoromethane	75-71-8

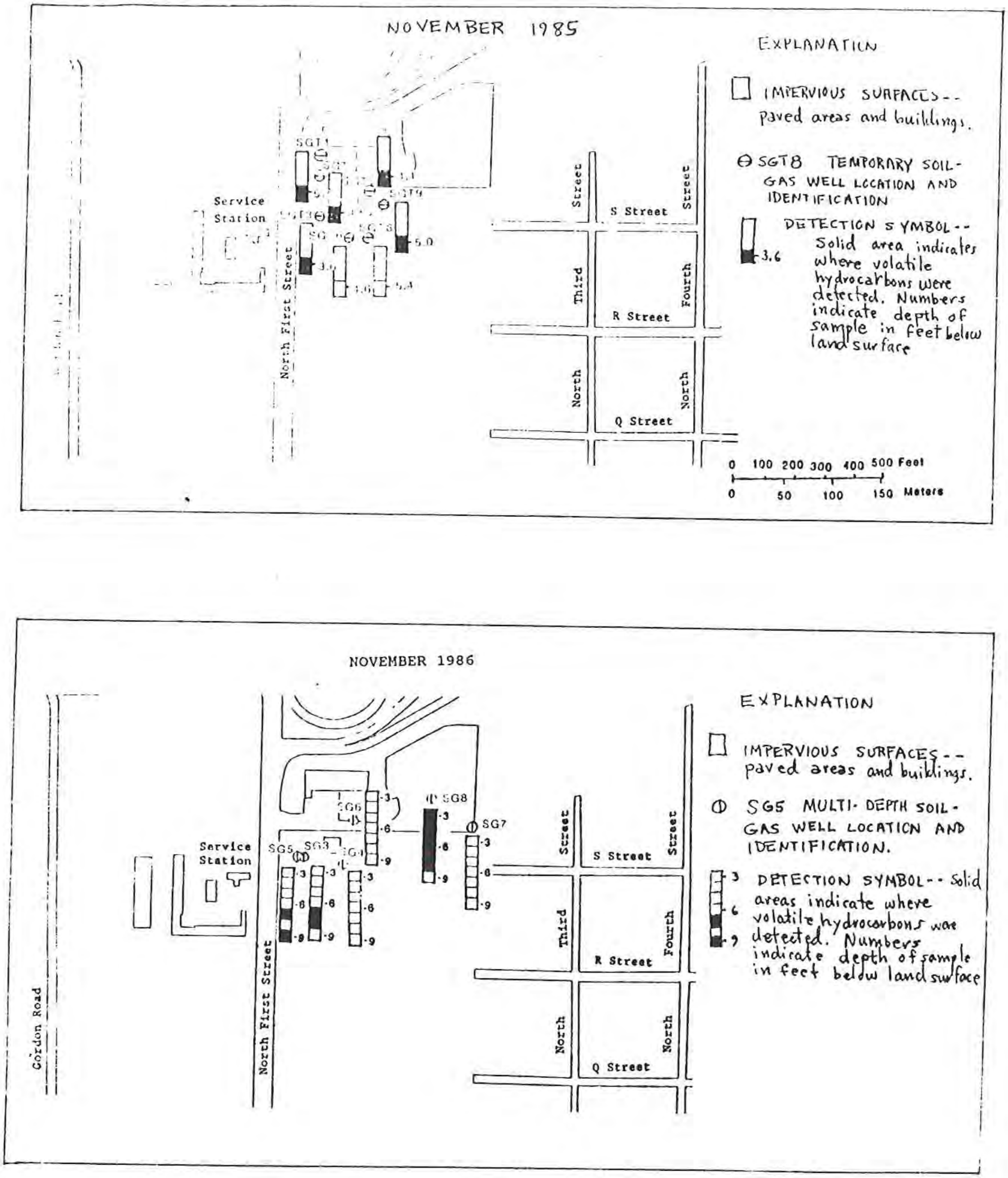

Figure 16.-- Locations of temporary soil-gas samples collected November 1985 and multi-depth soil-gas samples collected November 1986 [Data from the ground-water toxics study].

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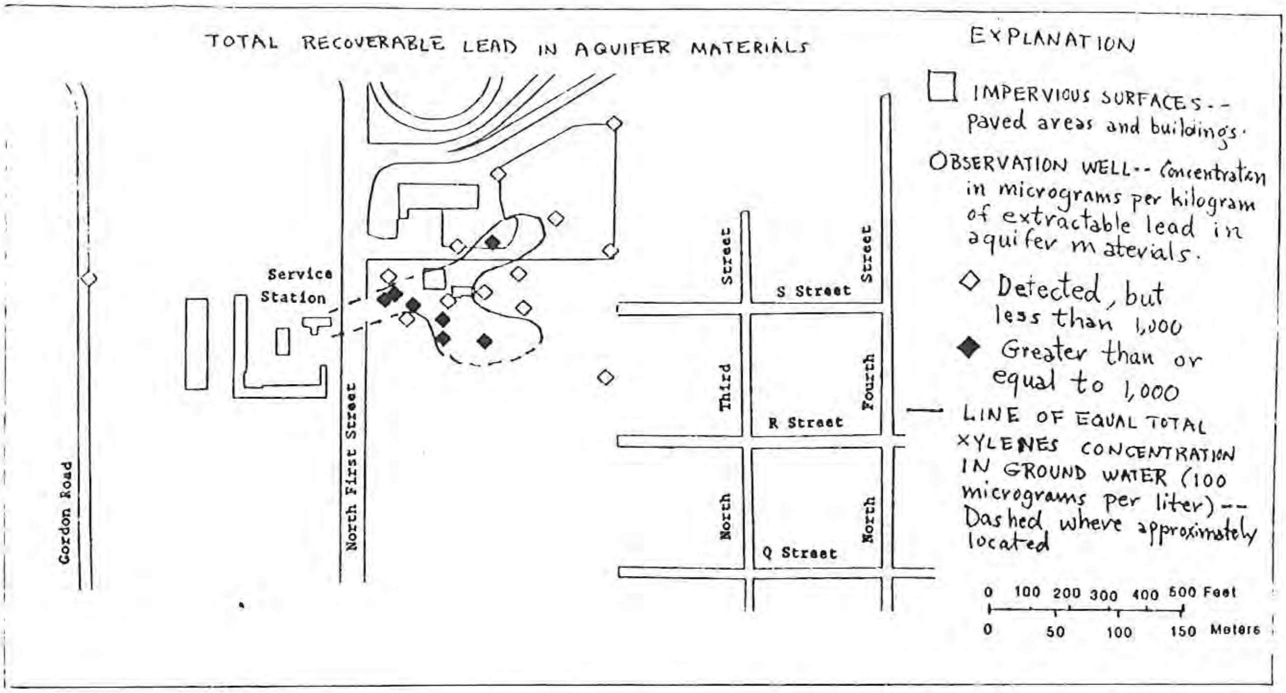

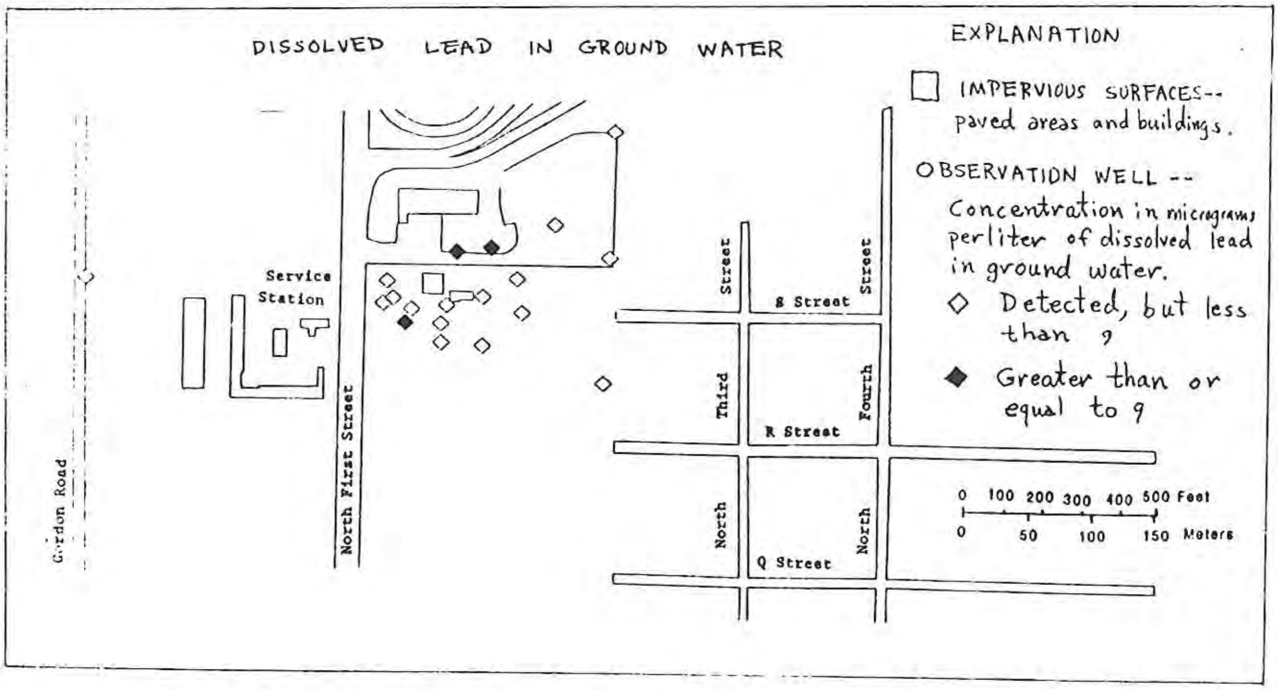

Figure 15.-- Concentrations of total-recoverable lead in aquifer material and dissolved lead in ground water, November 1986 [data from the ground-water toxics study].

PRELIMINARY SUBJECT TO REVISIONS

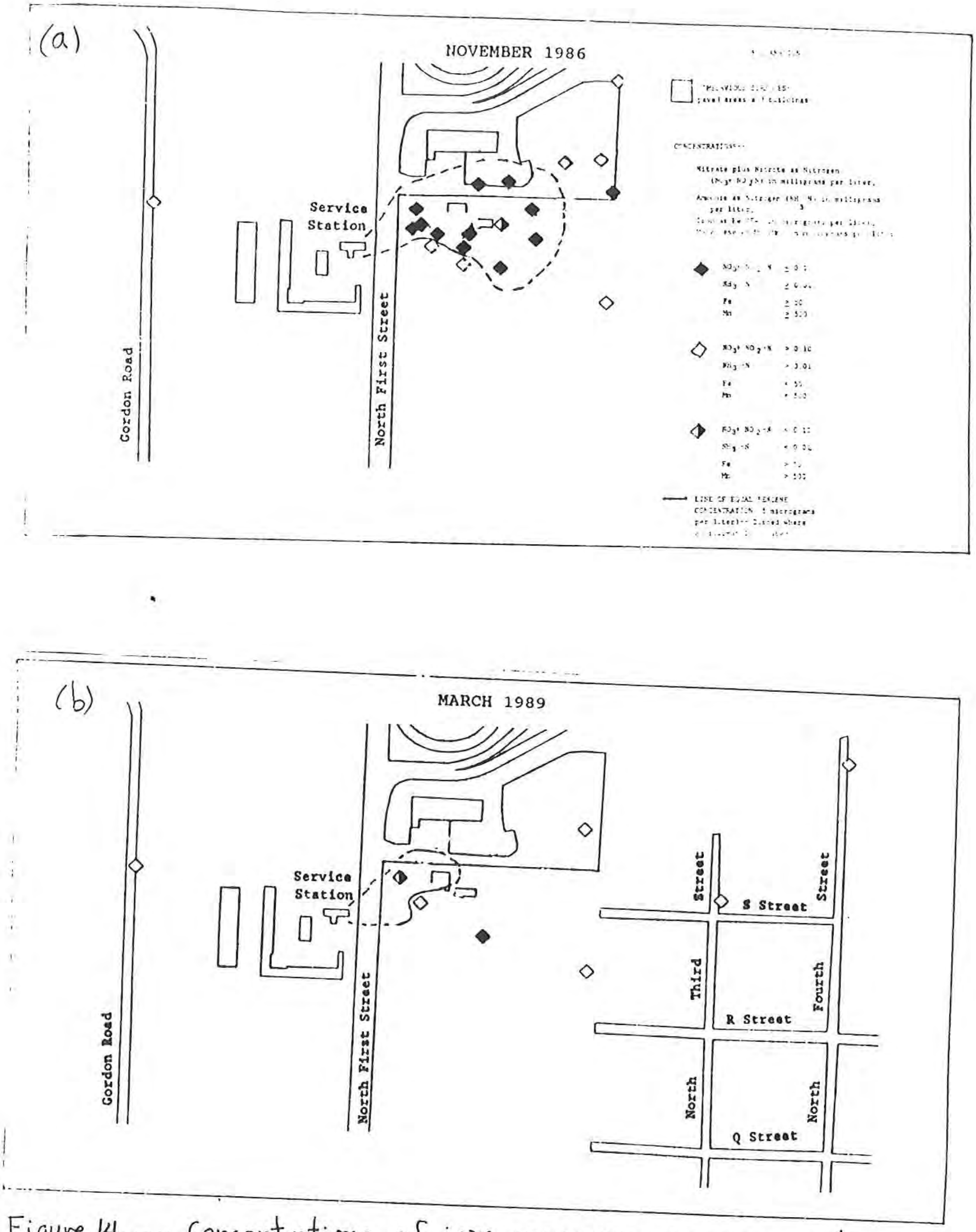

Figure 14.-- Concentrations of iron, manganese, ammonia and nitrate plus nitrite in ground water, November 1986 through March 1989 [data from (a) the ground-water toxics study and (b) 1989 study].

PRELIMINARY SUBJECT TO REVISIONS

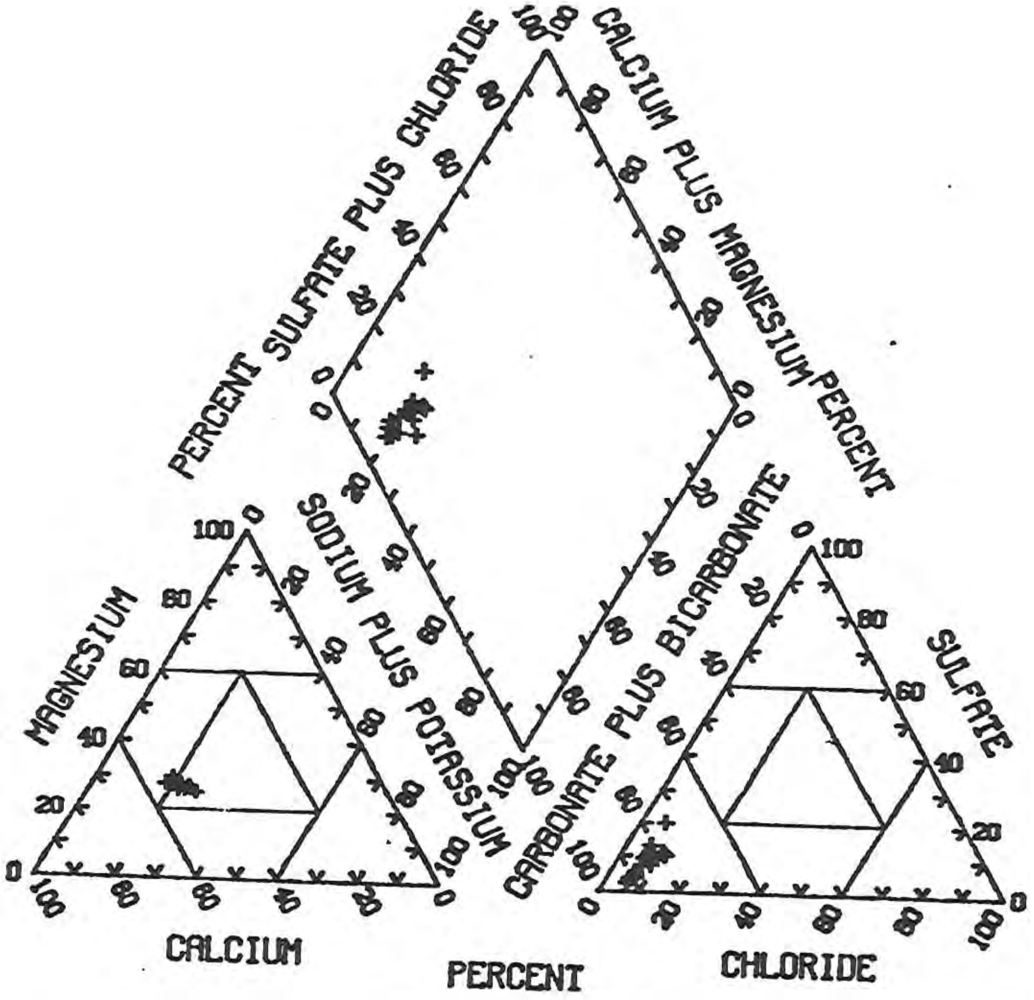

Figure 13.-- Percentage of major ions in ground water, November, 1986 and March 1989 [data from the ground-water toxics study and 1989 study].

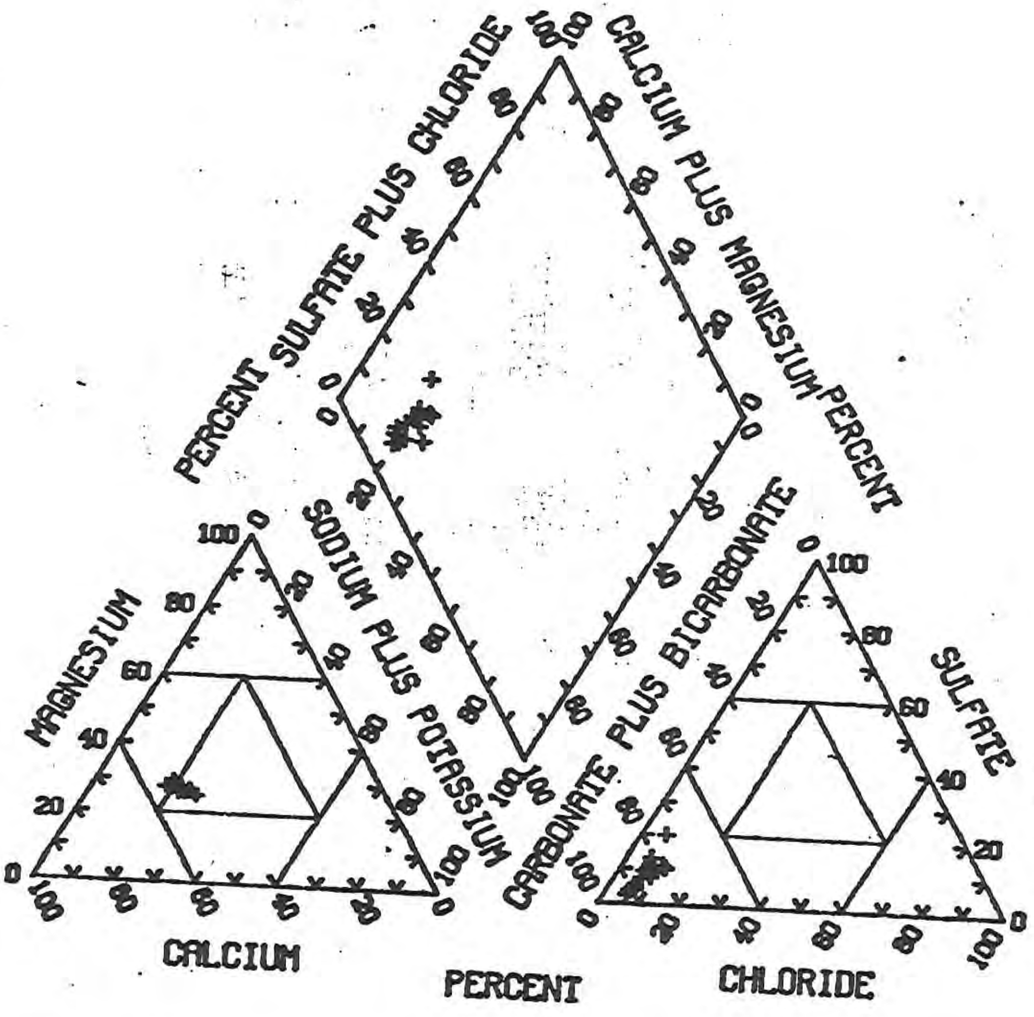

Figure 13. -- Percentage of major ions in ground water, November, 1986 and March 1989 data from the ground-water toxics study

1986 study??

PRELIMINARY SUBJECT TO REVISIONS

Table 12.--Observed water levels in observation and domestic wells

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifer	Date	Water level
M24	Nov 20, 1986	9.11	M25	Nov 20, 1986	9.35	M26	Nov 20, 1986	9.38
	Dec 17	9.40		Dec 17	9.66		Dec 17	9.65
	Jan 22, 1987	9.66		Jan 22, 1987	9.94		Jan 22, 1987	9.91
	Feb 18	9.58		Feb 18	9.81		Feb 18	9.84
	Mar 16	9.54		Mar 16	9.58		Mar 16	9.63
	Apr 22	9.05		Apr 22	9.26		Apr 22	9.33
M27	Nov 20, 1986	9.73	M28	Nov 20, 1986	13.69	M29	Nov 20, 1986	10.19
	Dec 17	9.91		Dec 17	14.24		Dec 17	10.37
	Jan 22, 1987	10.20		18	14.19		Jan 22, 1987	10.72
	Feb 18	10.14		Jan 22, 1987	14.19		Feb 18	10.65
	Mar 16	9.92		Feb 18	14.13		Mar 16	10.56
	Apr 22	9.67		Mar 16	13.88		Apr 22	10.24
	Mar 16, 1989	9.21		Apr 22	13.35		Mar 15, 1989	10.84
				Mar 15, 1989	13.97			
M30	Nov 20, 1986	9.94	M31	Nov 20, 1986	10.74	M33	Nov 20, 1986	9.15
	Dec 17	10.20		Dec 17	10.99		Dec 18	9.46
	Jan 22, 1987	10.32		Jan 22, 1987	11.19		Jan 22, 1987	9.64
	Feb 18	10.33		Feb 18	11.14		Feb 18	9.59
	Mar 16	10.23		Mar 16	10.92		Mar 16	9.44
	Apr 22	9.90		Apr 22	10.65		Apr 23	9.27
	Mar 14, 1989	10.47		Mar 15, 1989	11.31			
M34	Nov 20, 1986	8.19	M35	Nov 20, 1986	11.22	D32	Jul 28, 1986	8.15
	Dec 18	8.37		Dec 17	11.47		Sep 22	8.07
	Jan 22, 1987	8.51		Jan 22, 1987	11.71		Nov 20	11.61
	Feb 18	8.52		Feb 18	11.41		Dec 17	12.04
	Mar 16	8.33		Mar 16	11.44		Jan 21, 1987	12.36
	Apr 23	8.24		Apr 23	11.17		Feb 18	12.23
	Mar 14, 1989	8.65					Mar 16	11.94
							Apr 23	9.09
M36	May 14, 1986	9.46	M37	May 14, 1986	9.05	M38	Nov 20, 1986	8.17
	Jun 23	9.08		Jun 23	8.78		Dec 17	9.41
	Jul 28	9.01		Jul 28	8.76		Jan 22, 1987	8.80
	Sep 22	8.71		Sep 22	8.45		Feb 18	9.34
	Nov 19	10.64		Nov 20	11.34		Mar 16	9.13
	Dec 17	11.17		Dec 17	10.82		Apr 23	9.11
	18	11.17		Jan 22, 1987	10.78			
	Jan 20, 1987	11.36		Feb 18	10.73			
	Feb 17	11.29		Mar 16	10.56			
	Mar 16	12.28		Apr 22	10.35			
	Apr 22	11.94						
M39	Jan 20, 1987	11.02	M40	Jan 21, 1987	12.85			
	Feb 18	11.07		Feb 18	11.89			
	Mar 16	10.81		Mar 16	11.73			
	Apr 23	10.69		Apr 23	11.70			

Table 12. -Observed water levels in observation and domestic wells

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifier	Date	Water level
M6.2	Nov 20, 1986	10.53	M7.1	Nov 19, 1986	11.16	M7.2	Mar 16, 1987	11.33
	Dec 17	10.79		Dec 17	11.42		Apr 22	10.82
	Jan 20, 1987	10.98		Jan 20, 1987	11.67			
	Feb 17	10.89		Feb 17	11.56			
	Mar 16	10.72		Mar 16	11.38			
	Apr 22	10.38		Apr 22	10.97			
	Mar 17, 1989	11.03						
M8	Nov 20, 1986	11.32	M9	Nov 20, 1986	11.28	M10	Nov 20, 1986	11.03
	Dec 17	11.75		Dec 17	11.62		Dec 17	11.41
	Jan 20, 1987	11.92		Jan 20, 1987	11.70		Jan 20, 1987	11.61
	Feb 17	11.81		Feb 19	11.71		Feb 17	11.50
	18	11.82		Mar 16	11.53		Mar 16	11.32
	Mar 16	11.64		Apr 22	11.13		Apr 22	10.95
	Apr 22	11.14						
M11	Nov 20, 1986	10.89	M12	Nov 19, 1986	11.13	M13	Nov 19, 1986	11.15
	Dec 17	11.23		Dec 17	11.46		Dec 17	11.58
	Jan 20, 1987	11.45		Jan 20, 1987	11.63		Jan 20, 1987	11.83
	Feb 17	11.35		Feb 17	11.57		Feb 17	11.72
	Mar 16	11.19		Mar 16	11.40		Mar 16	11.53
	Apr 22	10.87		Apr 22	11.05		Apr 22	11.17
	Mar 17, 1989	11.56		Mar 18, 1989	11.69		Mar 16, 1989	11.90
M14	Nov 20, 1986	9.58	M16	Nov 19, 1986	10.99	M17	Nov 20, 1986	11.35
	Dec 17	9.88		Dec 17	11.42		Dec 17	11.73
	Jan 20, 1987	10.09		Jan 20, 1987	11.63		Jan 20, 1987	11.97
	Feb 17	9.92		Feb 17	11.52		Feb 17	11.86
	18	9.93		Mar 16	11.34		Mar 16	11.64
	Mar 16	9.76		Apr 22	10.80		Apr 22	11.12
	Apr 22	9.43		Mar 18, 1989	11.59		Mar 17, 1989	12.02
	Mar 16, 1989	10.14						
M18	Nov 20, 1986	10.99	M19	Nov 20, 1986	11.38	M20	Nov 20, 1986	11.21
	Dec 17	11.36		Dec 17	11.69		Dec 17	11.62
	Jan 20, 1987	11.58		Jan 20, 1987	11.90		Jan 20, 1987	11.88
	Feb 17	11.46		Feb 17	11.77		Feb 17	11.75
	Mar 16	11.26		Mar 16	11.61		Mar 16	11.53
	Apr 22	10.84		Apr 22	11.16		Apr 22	10.92
	Mar 17, 1989	11.70		Mar 15, 1989	12.08		Mar 17, 1989	12.00
M21	Nov 20, 1986	11.49	M22	Nov 20, 1986	10.79	M23	Nov 20, 1986	10.10
	Dec 17	11.88		Dec 17	11.03		Dec 17	10.39
	Jan 20, 1987	12.15		Jan 21, 1987	11.33		Jan 22, 1987	10.60
	Feb 17	11.90		Feb 17	11.13		Feb 18	10.53
	Mar 16	11.71		Mar 16	10.95		Mar 16	10.32
	Apr 22	11.31		Apr 22	10.47		Apr 22	10.02
							Mar 16, 1989	10.64

Table 12. Observed water levels in observation and domestic wells

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifier	Date	Water level
M10-85	Feb 20, 1985	9.72	M11-85	Feb 20, 1985	10.94	M12-85	Feb 20, 1985	11.52
	21	9.72		21	10.94		21	11.52
	May 11	9.09		May 11	9.96		May 10	10.68
	Jun 09	8.06		Jun 09	11.81		Jun 09	9.24
	Aug 02	8.34		Aug 02	7.83		Aug 02	9.82
	29	7.93		29	7.56		29	9.73
	30	7.24		30	6.72		30	9.61
	Sep 21	7.08		Sep 21	6.76		Sep 21	9.50
	Oct 16	7.72		Oct 16	9.47		Oct 16	10.12
	Nov 15	8.20		Nov 15	10.27		Nov 15	10.86
	Dec 13	8.55		Dec 13	10.92		Dec 13	11.52
	Jan 24, 1986	9.23		Jan 24, 1986	10.65		Jan 24, 1986	11.15
	Feb 21	9.17		Feb 21	10.44		Feb 21	10.98
	Mar 20	8.83		Mar 20, 1986	9.98		Mar 20	10.53
	Apr 23	8.68		Apr 23	9.34		Apr 23	10.13
	May 14	8.22		May 14	8.64		May 14	9.53
	Jun 23	8.05		Jun 23	8.11		Jun 23	9.13
	Jul 28	8.05		Jul 28	8.01		Jul 28	9.08
	Sep 22	7.67		Sep 22	7.79		Sep 22	8.83
	Nov 20	9.34		Nov 19	10.58		Nov 20	11.06
	Dec 17	9.52		Dec 17	10.92		Dec 17	11.30
	Jan 22, 1987	9.68		Jan 20, 1987	10.83		Jan 20, 1987	11.38
	Feb 18	9.70		Feb 17	11.01		Feb 18	11.50
	Mar 16	9.52		Mar 16	10.81		Mar 16	11.26
	Apr 22	9.37		Apr 22	10.38		Apr 23	11.01
				Mar 18, 1989	11.10			
M1	Nov 19, 1986	12.01	M2	Nov 20, 1986	10.55	M3	Nov 20, 1986	10.73
	Dec 17	12.69		Dec 17	10.84		Dec 17	11.02
	Jan 20, 1987	12.72		Jan 20, 1987	11.01		Jan 20, 1987	11.22
	Feb 17	12.55		Feb 17	10.94		Feb 17	11.16
	Mar 16	12.39		Mar 16	10.76		Mar 16	10.96
	Apr 22	12.08		Apr 22	10.48		Apr 22	10.67
M4	Nov 20, 1986	10.91	M5	Nov 19, 1986	10.94	M6.1	Nov 20, 1986	10.51
	Dec 17	11.07		Dec 17	11.27		Dec 17	10.89
	Jan 20, 1987	11.28		Jan 20, 1987	11.50		Jan 20, 1987	11.04
	Feb 17	11.19		Feb 17	11.40		Feb 17	10.95
	Mar 16	11.01		Mar 16	11.20		Mar 16	10.76
	Apr 22	10.68		Apr 22	10.72		Apr 22	10.48
	Mar 17, 1989	11.2						

Table 12.--Observed water levels in observation and domestic wells

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifer	Date	Water level
M4-85	Feb 20, 1985	8.95	M5-85	Feb 20, 1985	5.39	M6-85	Feb 20, 1985	7.55
	21	8.95		21	5.38		21	7.55
	May 11	7.91		May 10	5.17		May 10	7.25
	Jun 09	5.83		Jun 09	4.69		Jun 09	6.61
	Aug 02	6.12		Aug 02	5.04		Aug 02	7.14
	29	6.31		29	5.13		29	7.48
	30	6.07		30	4.91		30	6.89
	Sep 21	6.04		Sep 21	4.89		Sep 21	6.88
	Oct 16	7.10		Oct 16	4.67		Oct 16	6.66
	Nov 15	8.09		Nov 15	5.23		Nov 15	7.88
	Dec 13	8.90		Dec 13	5.39		Dec 13	8.01
	Jan 24, 1986	8.69		Jan 21, 1986	5.05		Jan 24, 1986	7.64
	Feb 21	8.58		Feb 21	4.90		Feb 21	7.36
	Mar 20	8.15		Mar 20, 1986	4.85		Mar 20	7.25
	Apr 23	6.96		Apr 23	5.02		Apr 23	7.14
	May 14	6.07		May 14	4.79		May 14	6.70
	Jun 23	5.40		Jun 23	5.02		Jun 23	7.16
	Jul 28	5.07		Jul 28	5.10		Jul 28	7.34
	Sep 22	4.94		Sep 22	4.56		Sep 22	6.37
	Nov 20	8.55		Nov 20	5.30		Nov 20	7.72
	Dec 17	8.98		Dec 18	5.49		Dec 17	8.11
	Jan 21, 1987	9.26		Jan 22, 1987	5.56		Jan 22, 1987	8.31
	Feb 17	9.04		Feb 18	5.48		Feb 18	8.03
	Mar 16	8.92		Mar 16	5.32		Mar 16	7.87
	Apr 23	8.27		Apr 23	5.46		Apr 23	7.93
				Mar 13, 1989	5.64		Mar 13, 1989	8.52
M7-85	Feb 20, 1985	7.40	M8-85	Feb 20, 1985	9.47	M9-85	Feb 20, 1985	9.81
	21	7.43		21	9.49		21	9.81
	May 11	7.13		May 11	8.92		May 11	9.07
	Jun 09	6.09		Jun 09	7.92		Jun 09	7.88
	Aug 02	6.72		Aug 02	8.43		Aug 02	8.22
	29	6.79		29	8.50		29	8.32
	30	5.63		30	7.33		30	8.11
	Sep 21	6.09		Sep 21	7.93		Sep 21	8.02
	Oct 16	6.40		Oct 16	8.38		Oct 16	8.43
	Nov 15	7.42		Nov 15	8.99		Nov 15	9.19
	Dec 13	7.66		Dec 13	9.29		Dec 13	9.50
	Jan 24, 1986	7.14		Jan 24, 1986	9.17		Jan 24, 1986	9.65
	Feb 21	7.07		Feb 21	9.07		Feb 21	9.52
	Mar 20	6.89		Mar 20, 1986	8.73		Mar 20	9.18
	Apr 23	6.83		Apr 23	8.56		Apr 23	8.63
	May 14	6.13		May 14	8.08		May 14	7.96
	Jun 23	6.40		Jun 23	8.04		Jun 23	7.75
	Jul 28	6.63		Jul 28	8.04		Jul 28	7.65
	Sep 22	5.84		Sep 22	7.45		Sep 22	7.20
	Nov 20	7.40		Nov 20	9.07		Nov 20	9.53
	Dec 17	7.78		Dec 17	9.31		Dec 17	9.92
	Jan 22, 1987	7.93		Jan 22, 1987	9.48		Jan 20, 1987	10.12
	Feb 18	7.75		Feb 18	9.42		Feb 17	9.98
	Mar 16	7.62		Mar 16	9.22		Mar 16	9.86
	Apr 23	7.65		Apr 23	9.18		Apr 22	9.58
	Mar 14, 1989	8.05		Mar 14, 1989	9.59		Mar 15, 1989	10.37

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Table 12.--Observed water levels in observation and domestic wells

[Water levels are in feet below land surface (table 2)]

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifier	Date	Water level
M1-82	Feb 21, 1985	11.37	M2-82	Feb 21, 1985	11.48	M3-82	Feb 21, 1985	10.05
	May 11	10.57		May 11	10.55		May 11	9.23
	Aug 29	8.84		Aug 29	9.47		Aug 29	8.05
	Apr 23, 1986	10.00		Apr 23, 1986	9.88		Apr 23, 1986	8.61
	May 14	9.36		May 14	9.12		May 14	7.96
	Jun 23	9.00		Jun 23	8.54		Jun 23	7.51
	Jul 28	8.91		Jul 28	8.40		Jul 28	7.45
	Sep 22	8.69		Sep 22	8.25		Sep 22	7.23
	Nov 19	11.12		Nov 19	11.01		Nov 19	9.76
	Dec 17	11.46		Dec 17	11.40		Dec 17	10.03
	Jan 20, 1987	11.67		Jan 20, 1987	11.60		Jan 22, 1987	10.23
	Feb 17	11.58		Feb 17	11.46		Feb 17	10.15
	Mar 16	11.39		Mar 16	11.32		Mar 16	9.96
	Apr 22	11.05		Apr 22	10.86		Apr 22	9.67
				Mar 18, 1989	11.65		Mar 18, 1989	10.16
M1-85	Feb 21, 1985	12.9	M2-85	Feb 20, 1985	6.22	M3-85	Feb 20, 1985	7.98
	May 10	11.58		21	6.27		21	8.07
	Jun 09	9.37		May 10	6.11		May 11	7.60
	Aug 02	9.84		Jun 09	5.37		Jun 09	6.64
	29	9.95		Aug 02	5.66		Aug 02	7.14
	30	9.69		29	5.72		29	7.28
	Sep 21	9.68		30	5.58		30	7.04
	Oct 16	10.91		Sep 21	5.57		Sep 21	6.98
	Nov 15	11.86		Oct 16	5.44		Oct 16	6.51
	Dec 13	12.69		Nov 15	6.29		Nov 15	7.20
	Jan 24, 1986	12.24		Jan 24, 1986	6.06		Dec 13	8.00
	Feb 21	11.99		Feb 21	5.87		Jan 24, 1986	8.10
	Mar 20	11.59		Mar 20	5.67		Feb 21	7.88
	Apr 23	10.58		Apr 23	5.67		Mar 20	7.76
	May 14	9.72		May 14, 1986	5.67		Apr 23	7.40
	Jun 23	9.11		Jun 23	6.34		May 14	6.86
	Jul 28	9.00		Jul 28	6.60		Jun 23	7.13
	Sep 22	8.96		Sep 22	5.51		Jul 28	7.17
	Nov 20	12.48		Nov 20	6.62		Sep 22	6.44
	Dec 17	12.85		Dec 18	7.04		Nov 20	8.96
	Jan 21, 1987	13.17		Jan 22, 1987	7.18		Dec 17	8.68
	Feb 18	13.05		Feb 17	6.64		Jan 22, 1987	8.66
	Mar 16	12.75		Mar 16	6.24		Feb 18	8.59
	Apr 23	12.25		Apr 23	6.66		Mar 16	8.40
	Mar 13, 1989	13.33		Mar 14, 1989	9.14		Apr 23	8.38

Table 2.--*Observed water levels in observation and domestic wells*

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifier	Date	Water level
M24	Nov 20, 1986	9.11	M25	Nov 20, 1986	9.35	M26	Nov 20, 1986	9.38
	Dec 17	9.40		Dec 17	9.66		Dec 17	9.65
	Jan 22, 1987	9.66		Jan 22, 1987	9.94		Jan 22, 1987	9.91
	Feb 18	9.58		Feb 18	9.81		Feb 18	9.84
	Mar 16	9.54		Mar 16	9.58		Mar 16	9.63
	Apr 22	9.05		Apr 22	9.26		Apr 22	9.33
M27	Nov 20, 1986	9.73	M28	Nov 20, 1986	13.69	M29	Nov 20, 1986	10.19
	Dec 17	9.91		Dec 17	14.24		Dec 17	10.37
	Jan 22, 1987	10.20		18	14.19		Jan 22, 1987	10.72
	Feb 18	10.14		Jan 22, 1987	14.19		Feb 18	10.65
	Mar 16	9.92		Feb 18	14.13		Mar 16	10.56
	Apr 22	9.67		Mar 16	13.88		Apr 22	10.24
	Mar 16, 1989	9.21		Apr 22	13.35		Mar 15, 1989	10.84
				Mar 15, 1989	13.97			
M30	Nov 20, 1986	9.94	M31	Nov 20, 1986	10.74	M33	Nov 20, 1986	9.15
	Dec 17	10.20		Dec 17	10.99		Dec 18	9.46
	Jan 22, 1987	10.32		Jan 22, 1987	11.19		Jan 22, 1987	9.64
	Feb 18	10.33		Feb 18	11.14		Feb 18	9.59
	Mar 16	10.23		Mar 16	10.92		Mar 16	9.44
	Apr 22	9.90		Apr 22	10.65		Apr 23	9.27
	Mar 14, 1989	10.47		Mar 15, 1989	11.31			
M34	Nov 20, 1986	8.19	M35	Nov 20, 1986	11.22	D32	Jul 28, 1986	8.15
	Dec 18	8.37		Dec 17	11.47		Sep 22	8.07
	Jan 22, 1987	8.51		Jan 22, 1987	11.71		Nov 20	11.61
	Feb 18	8.52		Feb 18	11.41		Dec 17	12.04
	Mar 16	8.33		Mar 16	11.44		Jan 21, 1987	12.36
	Apr 23	8.24		Apr 23	11.17		Feb 18	12.23
	Mar 14, 1989	8.65					Mar 16	11.94
							Apr 23	9.09
M36	May 14, 1986	9.46	M37	May 14, 1986	9.05	M38	Nov 20, 1986	8.17
	Jun 23	9.08		Jun 23	8.78		Dec 17	9.41
	Jul 28	9.01		Jul 28	8.76		Jan 22, 1987	8.80
	Sep 22	8.71		Sep 22	8.45		Feb 18	9.34
	Nov 19	10.64		Nov 20	11.34		Mar 16	9.13
	Dec 17	11.17		Dec 17	10.82		Apr 23	9.11
	18	11.17		Jan 22, 1987	10.78			
	Jan 20, 1987	11.36		Feb 18	10.73			
	Feb 17	11.29		Mar 16	10.56			
	Mar 16	12.28		Apr 22	10.35			
	Apr 22	11.94						
M39	Jan 20, 1987	11.02	M40	Jan 21, 1987	12.85			
	Feb 18	11.07		Feb 18	11.89			
	Mar 16	10.81		Mar 16	11.73			
	Apr 23	10.69		Apr 23	11.70			

PRELIMINARY SUBJECT TO REVISIONS

Table 3.--*Physical properties of selected aromatic hydrocarbons*

[Solubilities at 20 °C unless otherwise indicated; mg/L, milligrams per liter; mm, millimeters; (K_{ow}), octanol-water partition coefficients; --, not available; from Weast, 1982, Verschueren, 1983, and MacKay and Shiu, 1982]

Compound	Aqueous solubility (mg/L)	Vapor pressure (mm of Mercury)	Log K_{ow}	Molecular weight
Benzene	1,780	76	2.13	78.11
Toluene	515	22	2.69	92.13
o-Xylene	175	5	2.77	106.17
m-Xylene	196	6	3.20	106.17
p-Xylene	198 (at 25 °C)	6.5	3.15	106.17
Ethylbenzene	152	7	3.15	106.17
Naphthalene	34.4	0.05	3.37	128.17

PRELIMINARY SUBJECT TO REVISIONS

Table 4.--*Wells and well identifiers used during this report*

[N/A, not available; land surface elevation is in feet above sea level; depth, in feet below land surface, indicates screened interval or bottom depth of an open-ended casing; letters in well identifiers in this report signify the following: M, observation well; T, temporary well; D, domestic well; SG, multidepth soil-gas well; SGT, temporary soil-gas well. All domestic wells were sampled at an outside spigot unless suffixed with a K (sampled at kitchen sink) or I (irrigation well, sampled at wellhead)]

Site identifiers			Land surface elevation	Depth	Comments
This report	WATSTORE	Other reports			
M1-82	13N/18E-12R01	1	1078.06	6.0 - 15.6	
M2-82	13N/18E-12R02	2	1077.93	6.6 - 16.1	Identified as 3-82 (Fish, 1987)
M3-82	13N/18E-12R03	3	1076.86	6.0 - 15.8	
M1-85	13N/18E-12R04	1-85, MW-1	1080.48	6.0 - 21.0	
M2-85	13N/19E-07N01	2-85, MW-2	1067.51	3.5 - 18.5	
M3-85	13N/19E-07N02	3-85, MW-3	1072.62	4.1 - 19.1	
M4-85	13N/18E-12R05	4-85, MW-4	1075.66	4.1 - 19.1	
M5-85	13N/19E-07N03	5-85, MW-5	1069.66	1.8 - 16.8	
M6-85	13N/19E-07N04	6-85, MW-6	1071.52	4.3 - 19.4	
M7-85	13N/19E-07N05	7-85, MW-7	1072.48	4.2 - 19.2	
M8-85	13N/19E-07N06	8-85, MW-8	1075.70	5.0 - 20.0	
M9-85	13N/18E-12R06	9-85, MW-9	1075.48	4.8 - 19.8	
M10-85	13N/18E-12R07	10-85, MW-1	1076.37	4.3 - 19.3	
M11-85	13N/18E-12R08	11-85, MW-11	1077.67	5.5 - 20.5	
M12-85	13N/18E-12R09	12-85, MW-12	1078.49	6.4 - 21.4	
M1	13N/18E-12R12	T1	1077.43	55.0 - 58.0	
M2	13N/18E-12R13	T2	1077.65	28.0 - 30.0	SG1 also in same borehole
M3	13N/18E-12R14	T3	1077.65	28.0 - 30.0	SG2 also in same borehole
M4	13N/18E-12R15	T4	1077.02	3.8 - 12.0	
M5	13N/18E-12R16	T5	1078.39	13.9 - 15.9	SG3 also in same borehole
M6.1	13N/18E-12R17	T6.1	1077.39	44.6 - 46.6	[Piezometers M6.1 and M6.2 are in the same hole]
M6.2	13N/18E-12R18	T6.2	1077.11	7.6 - 13.6	
M7.1	13N/18E-12R19	T7.1	1078.11	30.3 - 32.3	[Piezometers M7.1 and M7.2 are in the same hole]
M7.2	13N/18E-12R20	T7.2	1078.11	7.3 - 13.3	
M8	13N/18E-12R21	T8	1078.22	8.4 - 14.4	
M9	13N/18E-12R22	T9	1078.07	7.0 - 13.0	
M10	13N/18E-12R23	T10	1077.81	8.3 - 14.3	
M11	13N/18E-12R24	T11	1077.65	8.4 - 14.2	
M12	13N/18E-12R25	T12	1078.09	7.4 - 13.4	
M13	13N/18E-12R26	T13	1078.09	30.5 - 32.3	SG4 also in same borehole
M14	13N/18E-12R27	T14	1076.14	6.8 - 12.8	
M16	13N/18E-12R28	T16	1078.09	7.9 - 13.9	
M17	13N/18E-12R29	T17	1078.36	7.7 - 13.7	
M18	13N/18E-12R30	T18	1077.70	7.1 - 13.1	
M19	13N/18E-12R31	T19	1078.12	7.8 - 13.8	
M20	13N/18E-12R32	T20	1078.26	7.2 - 13.2	
M21	13N/18E-12R33	T21	1077.70	56.3 - 58.3	
M22	13N/18E-12R34	T22	1077.50	6.7 - 12.7	
M23	13N/18E-12R39	B1	1077.10	6.5 - 12.5	
M24	13N/18E-12R40	B2	1076.16	7.6 - 13.6	
M25	13N/18E-12R41	B3	1076.08	30.3 - 32.3	SG6 also in same borehole
M26	13N/18E-12R42	B4	1076.58	8.0 - 14.0	
M27	13N/18E-12R43	B5	1076.79	9.0 - 18.0	
M28	13N/18E-12R35	S1	1077.03	54.0 - 56.5	SG7 also in same borehole
M29	13N/18E-12R36	S2	1076.99	7.7 - 16.8	
M30	13N/18E-12R37	S3	1076.89	7.8 - 16.8	
M31	13N/18E-12R38	S4	1077.74	8.6 - 17.4	
M33	13N/19E-07N08	H1	1075.13	55.0 - 57.0	
M34	13N/19E-07N09	H2	1075.02	8.6 - 14.6	

PRELIMINARY SUBJECT TO REVISIONS

Table 4.--*Wells and well identifiers used during this this report--Continued*

Site identifiers					
This report	WATSTORE	Other reports	Land surface elevation	Depth	Comments
D8	13N/19E-07N25	H3-11-(I)		20	
D9	13N/19E-07N26	H4-07		20	
D10	13N/19E-07N27	H4-08		80	
D11	13N/19E-07N28	H4-11		65	
D12	13N/19E-07N29	H6-05		18	
D13	13N/19E-07N30	H6-04-(I)		25	
D14	13N/19E-07N31	H6-03-(I)		N/A	
D15	13N/19E-07N32	H6-01		N/A	
D16	13N/19E-07N33	H5-06		N/A	
D17	13N/19E-07N34	H5-05-(I)		28	
D18	13N/19E-07N35	H5-04-(I)		28	
D19	13N/19E-07N36	H5-02		N/A	
D20	13N/19E-07N02	IK6-06-(I)		30	
D21	13N/19E-07N37	B2-05		N/A	
D22	13N/19E-07N38	B2-03		21	
D23	13N/19E-07N39	B2-01		N/A	
D24	13N/19E-07N40	B1-04		36	
D25	13N/19E-07N41	B1-01		26	
D26	13N/19E-07N42	B3-05		N/A	
D27	13N/19E-07N43	B3-03		N/A	
D28	13N/19E-07N44	B3-01		30	
D29	13N/19E-07N45	B4-06		38	
D30	13N/19E-07N46	B4-05		N/A	
D31	13N/19E-07N47	B4-01		N/A	
D32	13N/18E-12R97	Mesa	1079.47	N/A	(Water levels only)
SG1	13N/18E-12R91	T2	1077.43		Sampling tubes installed above the well screem M2)
SG2	13N/18E-12R92	T3	1077.65		Sampling tubes installed above the well screen (M3)
SG3	13N/18E-12R93	T5	1078.02		Sampling tubes installed above the well screen (M5)
SG4	13N/18E-12R94	T13	1078.09		Sampling tubes installed above the well screen (M13)
SG5	13N/18E-12R87	T15	1078.19		Multidepth soil-gas sampler only
SG6	13N/18E-12R95	B3	1076.08		Sampling tubes installed above the well screen (M25)
SG7	13N/18E-12R96	S1	1077.03		Sampling tubes installed above the well screen (M28)
SG8	13N/18E-12R88	S5	1077.65		Multidepth soil-gas sampler only
SGT1	13N/18E-12R81	1-9		5.67	
SGT2	13N/18E-12R81	1-7		3.46	
SGT3	13N/18E-12R79	1-4		3.59	
SGT4	13N/18E-12R78	1-2		4 to 5 (estimated)	
SGT5	13N/18E-12R82	2-5		3.47	
SGT6	13N/18E-12R83	3-2		4.58	
SGT7	13N/18E-12R84	4-6		4.10	
SGT8	13N/18E-12R85	4-2		5.35	
SGT9	13N/18E-12R86	5-5		4.96	

Table 4.--*Wells and well identifiers used during this this report--Continued*

Site identifiers			Land surface elevation	Depth	Comments
This report	WATSTORE	Other reports			
M35	13N/18E-12R11	WS1	1078.63	57.0 - 59.0	
M36	13N/18E-12R44	T1, GS1	1077.85	6.0 - 13.0	Estimated screen interval
M37	13N/18E-12R45	B1, GS2	1077.53	6.0 - 13.0	Identified as GS1 (Fish, 1987)
M38	13N/19E-07N07	3/R	1072.58	54.2 - 56.2	
M39	13N/18E-12J03	HWY1	1078.22	N/A	
M40	13N/19E-07M01	HWY2	1078.35	N/A	
T1	13N/19E-07M04	8T1-1			
T2	13N/19E-07N10	8T1-2			
T3	13N/19E-07N11	8T1-3			
T4	13N/18E-12R46	8T1-4			
T5	13N/18E-12R47	8T1-5			
T6	13N/18E-12R48	8T1-6			
T7	13N/19E-07N12	8T2-2			
T8	13N/19E-07N13	8T2-3			
T9	13N/19E-07N14	8T2-4			
T10	13N/19E-07N15	8T2-5			
T11	13N/19E-07N16	8T2-6			
T12	13N/19E-07N17	8T2-7			
T13	13N/19E-07N18	8T2-8			
T14	13N/18E-12R51	7-5			
T15	13N/18E-12R52	8-5			
T16	13N/18E-12R53	9-7.5			
T17	13N/18E-12R54	8-4			
T18	13N/18E-12R55	9-4			
T19	13N/18E-12R56	1.5-1.5			
T20	13N/18E-12R57	8-3			
T21	13N/18E-12R58	7-4			
T22	13N/18E-12R59	5-3			
T23	13N/18E-12R60	5-2			
T24	13N/18R-12R61	4-2			
T25	13N/18E-12R62	4-3			
T26	13N/18E-12R63	3-2			
T27	13N/18E-12R64	3-3			
T28	13N/18E-12R65	6-7			
T29	13N/18E-12R66	1-8			
T30	13N/18E-12R67	1-9			
T31	13N/18E-12R68	1-10			
T32	13N/18E-12R69	6-8			
T33	13N/18E-12R70	6-9			
T34	13N/18E-12R71	4-8			
T35	13N/18E-12R72	4-9			
T36	13N/18E-12R73	11-8.5			
T37	13N/18E-12R74	11-9.5			
T38	13N/18E-12R75	11-7.5			
T39	13N/18E-12R76	9-8.5			
T40	13N/18E-12R77	9-9.5			
T41	13N/18E-12R89	(1 m north of M36)	1078		
T42	13N/18E-12R90	(1.3 m south of M36)	1078		
D1	13N/19E-07M03	H1-01		25	
D2	13N/19E-07N19	H4-03-(I)		20	
D3	13N/19E-07N20	H4-06-(K)		28	
D4	13N/19E-07N21	H4-06-(I)		13	
D5	13N/19E-07N22	H4-01		N/A	
D6	13N/19E-07N23	H3-08-(I), H3-07-(I)		70	
D7	13N/19E-07N24	H3-10-(I), H3-09-(I)		20	

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Table A7.--*Concentrations of inorganic and dissolved-organic carbon quality-assurance samples, March 1989--Continued*

Sample or well identifier	Date	Beryllium, dissolved (µg/L as Be)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)	Lithium, dissolved (µg/L as Li)	Manganese, dissolved (µg/L as Mn)
M18	03-17-89	<0.5	<1	<5	4	<10	7,300	<10	6	2,800
M18 (D)	03-17-89	<.5	<1	<5	<3	<10	7,200	<10	5	2,800
ER4	03-15-89	<.5	<1	<5	<3	<10	5	<10	<4	<1

Sample of well identifier	Date	Molybdenum, dissolved (µg/L as Mo)	Nickel, dissolved (µg/L as Ni)	Silver, dissolved (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)	Carbon, dissolved organic (mg/L as C)
M18	03-17-89	<10	<10	<1	150	<6	69	1.9
M18 (D)	03-17-89	<10	<10	<1	150	<6	230	2.0
ER4	03-15-89	<10	<10	<1	<1	<6	<3	.3

Table A7.--*Concentrations of inorganic and dissolved-organic carbon quality-assurance samples, March 1989*

[Data from 1989 study, laboratory data analyzed by NWQL; ER, equipment-rinse blank, de-ionized water; D, duplicate sample; mg/L, milligrams per liter; or µg/L, milligrams per liter]

Well or sample identifier	Date	Specific conductance (µs/cm)	Lab specific conductance (µs/cm)	pH (standard units)	Lab pH (standard units)	Temperature water (°C)	Turbidity (NTU)	Oxygen, dissolved (mg/L)	Hardness (mg/L as CaCO$_3$)	Hardness, noncarbonate (mg/L as CaCO$_3$)
M18	03-17-89	319	307	6.7	6.9	13.0	40	0.0	130	0
M18 (D)	03-17-89	--	307	--	6.7	--	33	--	130	0
ER4	03-15-89	--	--	--	7.2	--	.3	--	0	0

Sample or well identifier	Date	Calcium dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium percent	Sodium adsorption ratio	Potassium, dissolved (mg/L as K)	Alkalinity, field (mg/L as CaCO$_3$)	Alkalinity, laboratory (mg/L as CaCO$_3$)	Sulfate, dissolved (mg/L as SO$_4$)
M18	03-17-89	32	11	12	17	0.5	2.6	132	113	34
M18 (D)	03-17-89	32	11	12	17	.5	2.6	--	113	34
ER4	03-15-89	.03	.05	<.2	--	--	.1	--	2	<.2

Sample or well identifier	Date	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO$_2$)	Solids, residue at 180 °C dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO$_2$+NO$_3$, dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Phosphorus ortho, dissolved (mg/L as P)	Barium, dissolved (µg/L as Ba
M18	03-17-89	7.0	0.2	38	209	227	<0.10	0.10	0.05	18
M18 (D)	03-17-89	7.0	.2	38	208	227	<.10	.11	.05	19
ER4	03-15-89	<.1	.1	<.01	<1	--	<.10	<.01	<.01	<2

Table A6.--*Comparison of field and laboratory determinations of specific conductance, pH, and alkalinity, November 1986 and March 1989*

[Data from ground-water toxics study and 1989 study, laboratory data analyzed by NWQL; µs/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, not analyzed]

		Specific conductance in µs/cm		pH in standard units		Alkalinity in mg/L as $CaCO_3$	
Well identifier	Date	Field	Lab	Field	Lab	Field	Lab
M1-82	11-18-86	280	279	6.8	6.9	131	--
M2-82	11-18-86	320	303	6.7	6.8	156	--
M1-85	11-19-86	238	239	6.7	6.9	103	--
	03-13-89	208	222	6.9	7.0	89	90
M5-85	03-13-89	252	265	6.7	6.8	113	114
M9-85	11-19-86	254	254	6.5	6.9	108	--
	03-15-89	249	260	6.6	6.7	112	111
M10-85	11-19-86	298	293	6.6	6.8	116	--
M11-85	11-17-86	264	251	6.6	6.8	125	--
	03-18-89	292	295	6.6	6.8	140	134
M4	11-18-86	313	295	6.6	6.8	151	--
M7.2	11-17-86	352	336	6.4	6.6	185	--
M8	11-17-86	247	245	6.6	6.8	105	--
M9	11-17-86	279	272	6.6	6.9	133	--
M11	11-18-86	307	298	6.6	6.9	148	--
M12	11-18-86	323	303	6.5	6.7	164	--
M16	11-17-86	342	329	6.7	6.8	172	--
M18	11-18-86	292	271	6.6	6.8	149	--
	03-17-89	319	307	6.7	6.9	132	113
M19	11-18-86	257	251	6.6	6.9	105	--
M23	11-18-86	390	385	6.7	6.8	193	--
M24	11-18-86	365	332	6.5	6.7	190	--
M29	11-19-86	259	258	6.6	6.8	120	--
M30	03-14-89	268	284	6.6	6.6	128	122
M31	11-19-86	261	261	6.5	6.8	113	--

Table A5.--*Concentrations of volatile organic compounds in quality-assurance samples, February 23 through March 17, 1989--Continued*

Sample or well identifier	Date	1,2-Dichloropropane	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Dichlorodifluoromethane	trans-1,3-Dichloropropene	cis-1,3-Dichloropropene	Vinyl Chloride	Trichloroethylene	1,2-Dichloroethene	Styrene
M8-85	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M8-85 (FS1)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.6
M8-85 (FS2)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.0
M8-85 (LS)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.8
M18	03-17-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M18 (D)	03-17-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL1	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL2	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL3	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL5	03-13-89	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER1	02-23-89	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND
ER2	02-23-89	ND	ND	ND	ND	ND	ND	ND	.5	ND	ND
ER3	02-23-89	ND	ND	ND	ND	ND	ND	ND	.2	ND	ND
ERB4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ERB5	03-13-89	.3	ND	ND	ND	ND	ND	ND	ND	ND	ND

Sample or well identifier	Date	1,1-Dichloro propene	2,2-Dichloropropane	1,3-Dichloropropane	ortho-Chlorotoluene	para-Chlorotoluene	1,2,3-Trichloropropane	1,1,1,2-Tetrachloroethane	1,2-Dibromoethane	Bromobenzene
M8-85	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
M8-85 (FS1)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	8.7
M8-85 (FS2)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	7.1
M8-85 (LS)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	7.7
M18	03-17-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
M18 (D)	03-17-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL1	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL2	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL3	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL5	03-13-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER1	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER2	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER3	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
ERB4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
ERB5	03-16-89	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table A4.--*Comparison of means and standard deviations of standard hydrocarbon compound concentrations, November 1985*

[Data from the ground-water toxics study, analyzed by OGC; concentrations in micrograms per liter; standard solutions prepared from materials supplied by the U.S. Environmental Protection Agency- Environmental Monitoring Services Laboratory, Cincinati, OH (EPA)]

		EPA	GWTP	
Standard solution	Compound	Concentration	Concentration	One standard deviation
I	Benzene	10,000	12,000	±1,800
	Toluene	10,000	11,000	± 540
	m+p-Xylene	10,000	9,700	± 680
	o-Xylene	5,000	5,100	± 320
II	Benzene	10,000	12,000	± 800
	o-Xylene	10,000	9,500	± 560
III	Toluene	10,000	11,000	± 480
	m+p-Xylene	10,000	10,000	± 720

Table A3.--*Mean and standard deviations of trip blanks, August 26-30 1985*

[Data from the ground-water toxics study, analyzed by OGC; n, number of replicates; concentrations are in micrograms per liter].

Parameter	Benzene	Toluene	Ethyl-benzene	m+p Xylene	o-Xylene	n-Propyl-benzene	1,3,5-Tri-methyl-benzene
Mean (n = 6)	0.87	0.49	0.032	0.041	0.025	0.0024	0.017
Standard deviation	± .11	± .10	± .015	± .015	± .0071	± .0047	± .0096

Parameter	1,2,4-Tri-methyl-benzene	Iso-butyl-benzene	sec-Butyl-benzene	n-Butyl-benzene	1,2,3,5-Tetra-methyl-benzene	1,2,3,4-Tetra-methyl-benzene	Naph-thalene
Mean (n = 6)	0.053	0.0046	0.006	0.019	0.009	0.014	0.20
Standard deviation	± .017	± .0082	± .0089	± .011	± .014	± .016	± .29

Table A2.--*Concentrations of volatile organic compounds in quality-assurance samples, August 27, 1985*

[Concentrations are in micrograms per liter; ND, below the limit of detection of 1 microgram per liter for the insurance company study (ICS), see text for discussion of limit of detections for Ground-Water Toxics Study (GWTS)].

Well identi-	Benzene		Toluene		Total xylenes	
fier	ICS	GWTS	ICS	GWTS	ICS	GWTS
M7-85	ND	ND	ND	ND	ND	ND
M8-85	96	ND	1	ND	9	ND
M10-85	ND	ND	ND	ND	ND	ND
M11-85	920	1,000	1,100	3,400	6,300	7,300

Table A1.--*Concentrations of volatile organic compounds in quality-assurance samples, May 1985 through June 1986*

[Data from the insurance company study, analyzed by a private laboratory; concentrations are in micrograms per liter; ND, below the detection limit of 1 microgram per liter; D, duplicate sample]

Sample or well identifier	Date	Benzene	Toluene	Total xylenes
Field blank	5-10-85	ND	ND	ND
Field blank	5-11-85	ND	ND	ND
M11-85	5-11-85	1,380	7,700	12,990
M11-85 (D)	5-11-85	1,090	4,000	14,900
Lab blank	12-16-85	ND	ND	ND
Lab blank	6-27-86	ND	ND	ND

Table 9.--*Concentrations of inorganic compounds and dissolved organic carbon in ground water, November 1986 and March 1989--Cont.*

Well identifier	Barium, dissolved (µg/L as Ba)	Beryllium, dissolved (µg/L as Be)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Cobalt, dissolved (µg/L as Co)	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)	Lithium, dissolved (µg/L as Li)
M1-82	11	<0.5	<1	--	<3	<10	65	<10	5
M2-82	16	<.5	<1	--	<3	<10	4,000	<10	5
M3-82	--	--	--	--	--	--	--	--	--
M1-85	7	<.5	<1	--	<3	<10	3	<10	5
	8	<.5	<1	<5	<3	<10	15	<10	<4
M5-85	9	<.5	<1	<5	<3	<10	14	<10	<4
M6-85	--	--	--	--	--	--	--	--	--
M7-85	--	--	--	--	--	--	--	--	--
M8-85	--	--	--	--	--	--	--	--	--
M9-85	8	<.5	<1	--	<3	<10	<3	<10	5
	9	<.5	<1	<5	<3	<10	11	<10	<4
M10-85	10	<.5	<1	--	<3	<10	<3	<10	6
M11-85	13	<.5	<1	--	<3	<10	3,400	<10	<4
	16	<.5	<1	<5	<3	<10	3,700	10	<4
M4	16	<.5	1	--	<3	<10	6,200	<10	4
M6.2	--	--	--	--	--	--	--	--	--
M7.2	17	<.5	1	--	<3	<10	9,100	<10	5
M8	8	<.5	<1	--	<3	<10	12	<10	4
M9	12	<.5	<1	--	<3	<10	1,500	<10	4
M11	21	<.5	<1	--	<3	<10	1,700	<10	4
M12	14	<.5	<1	--	<3	<10	6,400	10	5
M13	--	--	--	--	--	--	--	--	--
M14	--	--	--	--	--	--	--	--	--
M16	11	<.5	1	--	<3	<10	7,400	<10	6
M17	--	--	--	--	--	--	--	--	--
M18	12	<.5	<1	--	<3	<10	8,100	<10	4
	18	<.5	<1	<5	4	<10	7,300	<10	6
M19	10	<.5	<1	--	<3	<10	7	<10	5
M20	--	--	--	--	--	--	--	--	--
M23	22	<.5	<1	--	<3	<10	5,800	<10	5
M24	20	<.5	<1	--	<3	<10	9,700	<10	5
M26	--	--	--	--	--	--	--	--	--
M27	--	--	--	--	--	--	--	--	--
M29	15	<.5	<1	--	<3	<10	1,300	<10	4
M30	10	<.5	<1	<5	<3	<10	7	<10	<4
M31	11	<.5	<1	--	<3	<10	10	<10	5
M34	--	--	--	--	--	--	--	--	--

Table 8.--*Concentrations of volatile organic compounds in ground water, March, 1989*

[Data from the 1989 study, analyzed by NWQL; concentrations are in micrograms per liter; ND, below the detection limit of 0.2 micrograms per liter, unless otherwise noted]

Well identifier	Benzene	Toluene	Ethylbenzene	Total xylenes	Naphthalene	1,3,5-Trimethylbenzene	2-Ethyl-1-methylbenzene	1,2,4-Trimethylbenzene	1,2,3-Trimethylbenzene
M2-82	ND	ND	ND	ND	ND	ND	5.7	ND	1.7
M3-82	17	1.6	ND	1,500	19	280	240	300	200
M1-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M5-85	ND	ND	ND	ND	.2	ND	ND	ND	.2
M6-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M7-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M8-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M9-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M11-85	23	ND	3.6	320	62	160	130	150	95
M4	ND	ND	ND	ND	ND	ND	ND	ND	ND
M6.2	ND	ND	ND	ND	ND	ND	ND	ND	ND
M11	ND	ND	ND	ND	ND	ND	ND	ND	ND
M12	ND	ND	ND	ND	ND	ND	ND	ND	ND
M13	ND	ND	ND	ND	ND	ND	ND	ND	ND
M14	ND	ND	ND	ND	.2	ND	ND	ND	ND
M16	68	15	ND	820	130	60	79	49	86
M17	75	.3	ND	.5	44	ND	49	.5	.3
M18	ND	ND	.2	.2	ND	ND	3.2	ND	.3
M19	ND	ND	ND	ND	ND	ND	ND	ND	ND
M20	ND	ND	ND	ND	.3	ND	ND	ND	ND
M23	.3	ND	ND	ND	ND	ND	.4	ND	ND
M26	ND	ND	ND	ND	.2	ND	ND	ND	ND
M27	.3	ND	ND	ND	ND	ND	.4	ND	ND
M29	1.0	ND	ND	ND	ND	ND	ND	ND	ND
M30	ND	ND	ND	ND	ND	ND	ND	ND	ND
M31	ND	ND	ND	ND	ND	ND	ND	ND	ND
M34	ND	ND	ND	ND	ND	ND	ND	ND	ND

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Table 7.--*Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued*

Well identi-fier	n-Propyl-benzene	Iso-butyl-benzene	sec-Butyl-benzene	n-Butyl-benzene	Ethyl-ene-bromide	t-Butyl-benzene	1-Iso-propyl-4-methyl-benzene	2-Ethyl 1-methyl-benzene	1,4-Di-methyl-ethyl-benzene	1,4-Di-methyl-2-ethyl-benzene	1,3-Di-methyl,4-ethyl-benzene
D24	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D25	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D26	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D27	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D28	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D29	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D30	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D31	ND	ND	ND	ND	ND	ND	ND	--	--	--	--

Table 7.--*Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued*

Well identi-fier	n-Propyl-benzene	Iso-butyl-benzene	sec-Butyl-benzene	n-Butyl-benzene	Ethyl-ene-bromide	t-Butyl-benzene	1-Iso-propyl-4-methyl-benzene	2-Ethyl 1-methyl-benzene	1,4-Di-methyl-ethyl-benzene	1,4-Di-methyl-2-ethyl-benzene	1,3-Di-methyl,4-ethyl-benzene
T27	--	--	--	--	--	--	--	170	--	0	--
T28	--	--	--	--	--	--	--	T	--	0.02	T
T29	--	--	--	--	--	--	--	0	--	0	ND
T30	--	--	--	--	--	--	--	0	--	ND	ND
T31	--	--	--	--	--	--	--	ND	--	ND	ND
T32	--	--	--	--	--	--	--	2	--	ND	0.06
T33	--	--	--	--	--	--	--	110	--	--	36
T34	--	--	--	--	--	--	--	740	--	510	530
T35	--	--	--	--	--	--	--	470	--	140	130
T36	--	--	--	--	--	--	--	77	--	12	4.6
T37	--	--	--	--	--	--	--	0	--	ND	ND
T38	--	--	--	--	--	--	--	ND	--	ND	ND
T39	--	--	--	--	--	--	--	170	--	55	39
T40	--	--	--	--	--	--	--	0	--	ND	0
T41	--	--	--	--	--	--	--	56	--	1.8	8.0
T42	--	--	--	--	--	--	--	110	--	0	5.5
D1	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D2	0.11	0.38	0.93	0.29	ND	ND	ND	--	--	--	--
D3	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D4	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D5	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D6	1.7	0.32	0.70	0.45	ND	ND	ND	--	--	--	--
D7	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D8	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D9	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D10	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D11	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D12	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D13	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D14	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D15	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D16	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D17	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D18	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D19	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D20	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D21	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D22	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D23	ND	ND	ND	ND	ND	ND	ND	--	--	--	--

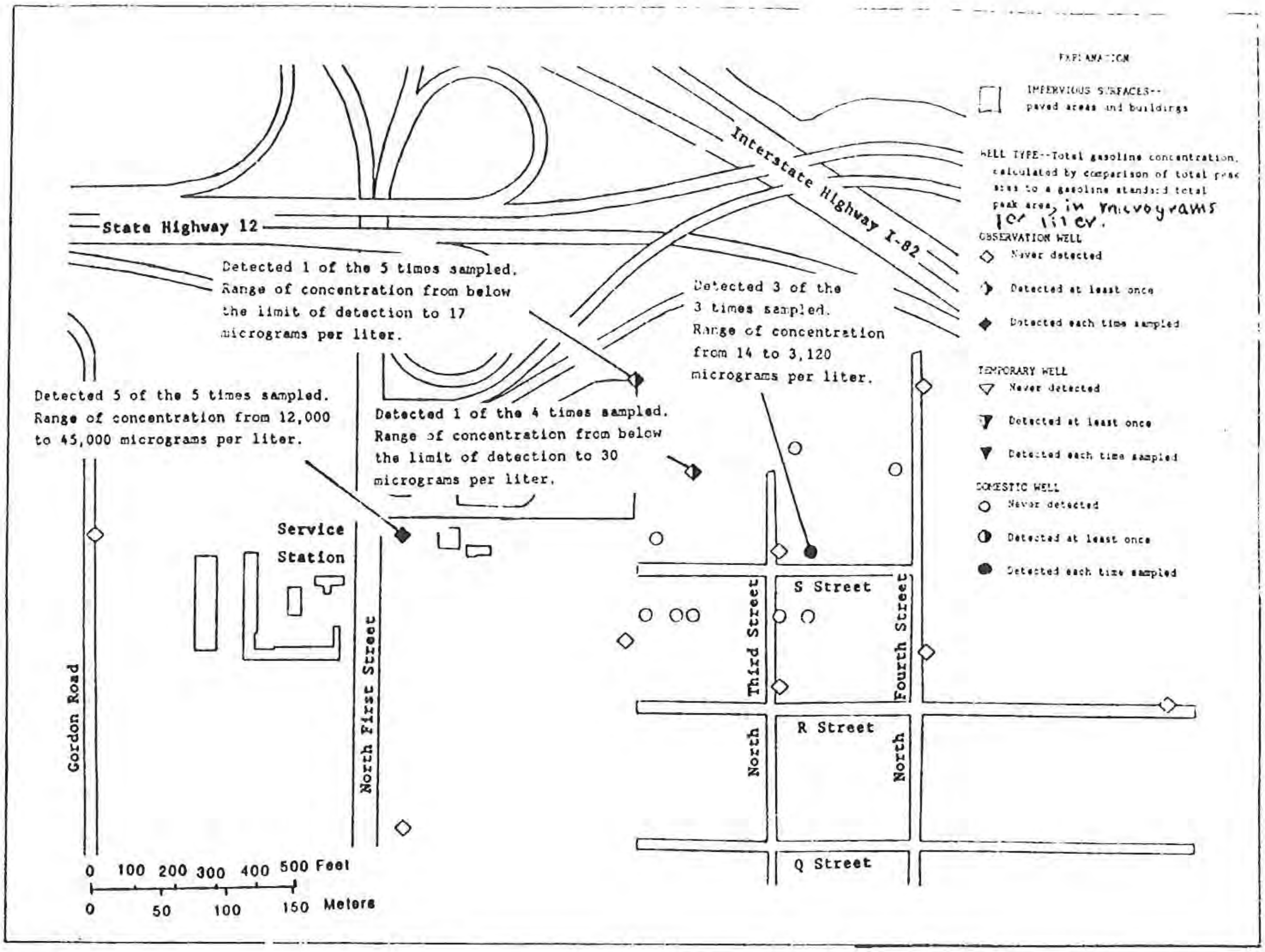
Table 7.--*Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued*

Well identi-fier	n-Propyl-benzene	Iso-butyl-benzene	sec-Butyl-benzene	n-Butyl-benzene	Ethyl-ene-bromide	t-Butyl-benzene	1-Iso-propyl-4-methyl-benzene	2-Ethyl 1-methyl-benzene	1,4-Di-methyl-ethyl-benzene	1,4-Di-methyl-2-ethyl-benzene	1,3-Di-methyl,4-ethyl-benzene
M16	--	--	--	--	--	--	--	110	37	--	--
M18	--	--	--	--	--	--	--	110	76	--	--
M19	--	--	--	--	--	--	--	NQ	ND	--	--
M22	--	--	--	--	--	--	--	ND	ND	--	--
M23	--	--	--	--	--	--	--	140	59	--	--
M24	--	--	--	--	--	--	--	550	280	--	--
M29	--	--	--	--	--	--	--	NQ	NQ	--	--
M30	--	--	--	--	--	--	--	ND	ND	--	--
M31	--	--	--	--	--	--	--	.2	ND	--	--
M34	--	--	--	--	--	--	--	ND	ND	--	--
M36	--	--	--	--	--	--	--	140	--	60	--
M36	--	--	--	--	--	--	--	560	--	130	110
M37	--	--	--	--	--	--	--	3	--	T	--
T1	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T2	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T3	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T4	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T5	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T6	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T7	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T8	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T9	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T10	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T11	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T12	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T13	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T14	--	--	--	--	--	--	--	50	--	7.8	--
T15	--	--	--	--	--	--	--	170	--	49	--
T16	--	--	--	--	--	--	--	.4	--	.2	0.1
T17	--	--	--	--	--	--	--	ND	--	ND	--
T18	--	--	--	--	--	--	--	.03	--	ND	--
T19	--	--	--	--	--	--	--	18	--	0	--
T20	--	--	--	--	--	--	--	.03	--	ND	--
T21	--	--	--	--	--	--	--	320	--	77	--
T22	--	--	--	--	--	--	--	830	--	120	--
T23	--	--	--	--	--	--	--	T	--	0	--
T24	--	--	--	--	--	--	--	0	--	T	--
T25	--	--	--	--	--	--	--	1,400	--	280	--
T26	--	--	--	--	--	--	--	0	--	0	--

Table 7.--*Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued*

Well identi- fier	n- Propyl- benzene	Iso- butyl- benzene	sec- Butyl- benzene	n- Butyl- benzene	Ethyl- ene- bromide	t- Butyl- benzene	1-Iso- propyl- 4-methyl- benzene	2-Ethyl 1-methyl- benzene	1,4-Di- methyl- ethyl- benzene	1,4-Di- methyl- 2-ethyl- benzene	1,3-Di- methyl,4- ethyl- benzene
M1-82	ND	ND	ND	1.2	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	110	45	--	--
M2-82	130	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	190	97	--	--
M3-82	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	250	--	76	--
M1-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	ND	ND	--	--
M2-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
M3-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
M4-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
M5-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
M6-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
M7-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
M8-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	0.8	--	ND	ND
	--	--	--	--	--	--	--	NQ	ND	--	--
M9-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	NQ	ND	--	--
M10-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	ND	--	ND	ND
	--	--	--	--	--	--	--	ND	ND	--	--
M11-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	680	--	120	--
	--	--	--	--	--	--	--	300	120	--	--
M12-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	ND	ND	--	--
M2	--	--	--	--	--	--	--	0.2	NQ	--	--
M4	--	--	--	--	--	--	--	19	14	--	--
M6.1	--	--	--	--	--	--	--	NQ	NQ	--	--
M6.2	--	--	--	--	--	--	--	19	4.4	--	--
M7.1	--	--	--	--	--	--	--	0.44	ND	--	--
M7.2	--	--	--	--	--	--	--	340	160	--	--
M8	--	--	--	--	--	--	--	0.05	0.05	--	--
M9	--	--	--	--	--	--	--	66	31	--	--
M11	--	--	--	--	--	--	--	56	23	--	--
M12	--	--	--	--	--	--	--	500	380	--	--
M13	--	--	--	--	--	--	--	8.7	2.3	--	--
M14	--	--	--	--	--	--	--	NQ	ND	--	--

PRELIMINARY SUBJECT TO REVISIONS



Detected 1 of the 5 times sampled. Range of concentration from below the limit of detection to 17 micrograms per liter.

Detected 3 of the 3 times sampled. Range of concentration from 14 to 3,120 micrograms per liter.

Detected 5 of the 5 times sampled. Range of concentration from 12,000 to 45,000 micrograms per liter.

Detected 1 of the 4 times sampled. Range of concentration from below the limit of detection to 30 micrograms per liter.

Figure 12.-- Concentrations of total gasoline in ground water, February 1985 through May 1986 [data from the insurance company study].

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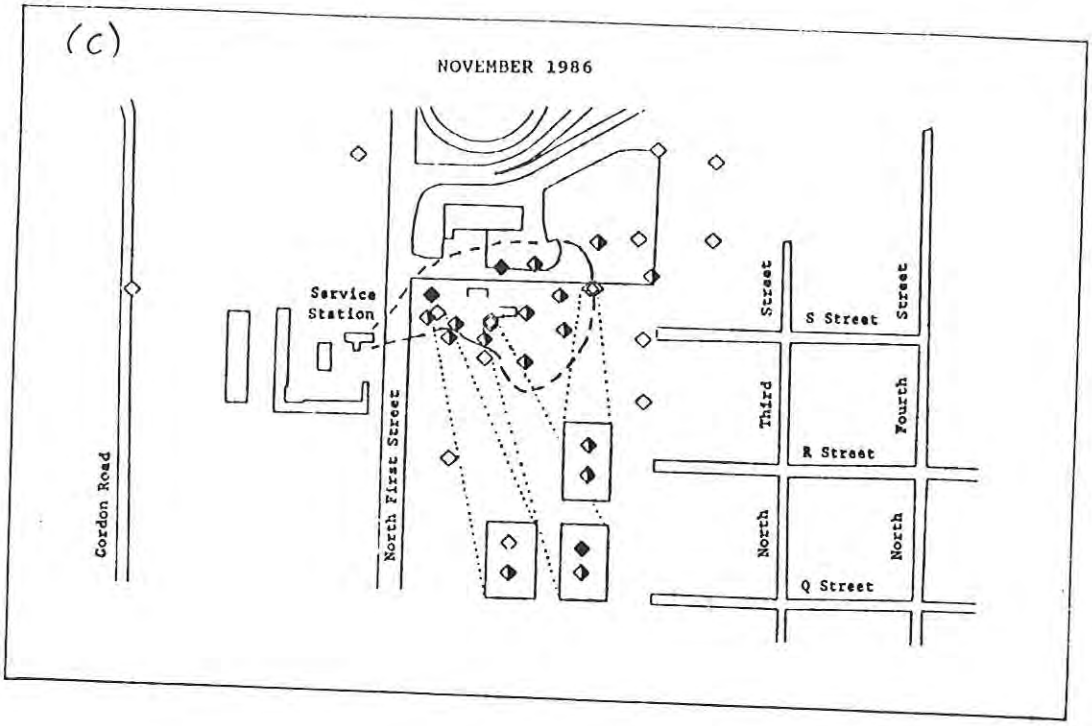
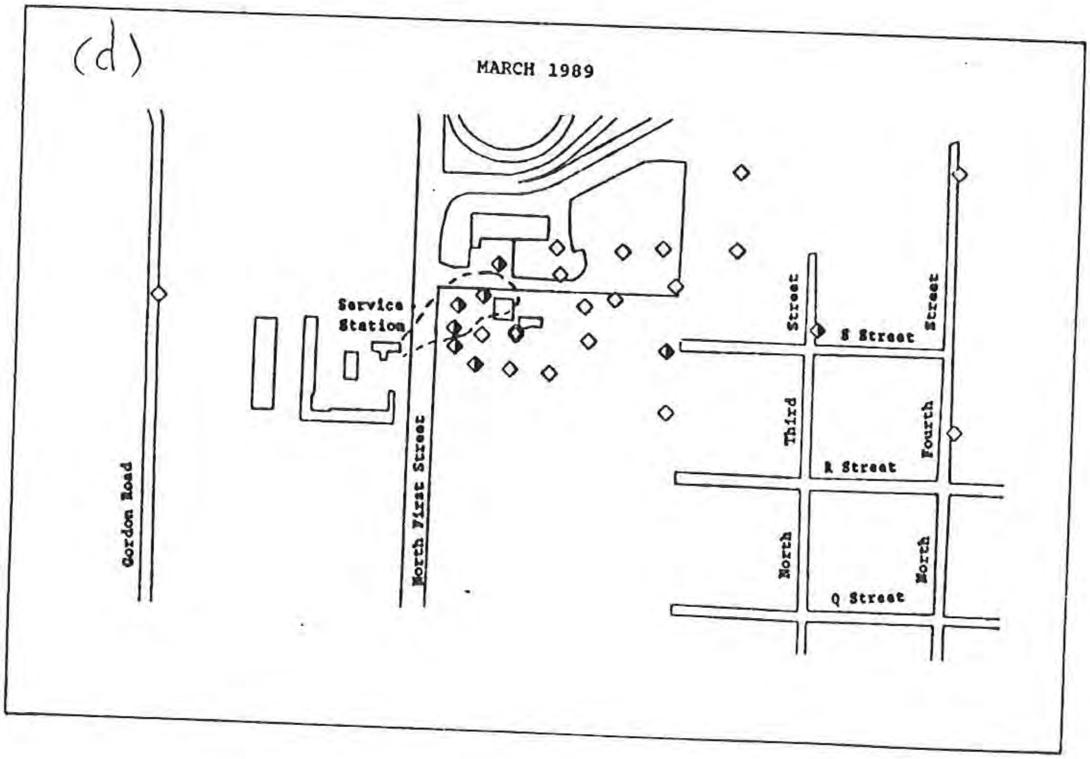
(c)



(d)



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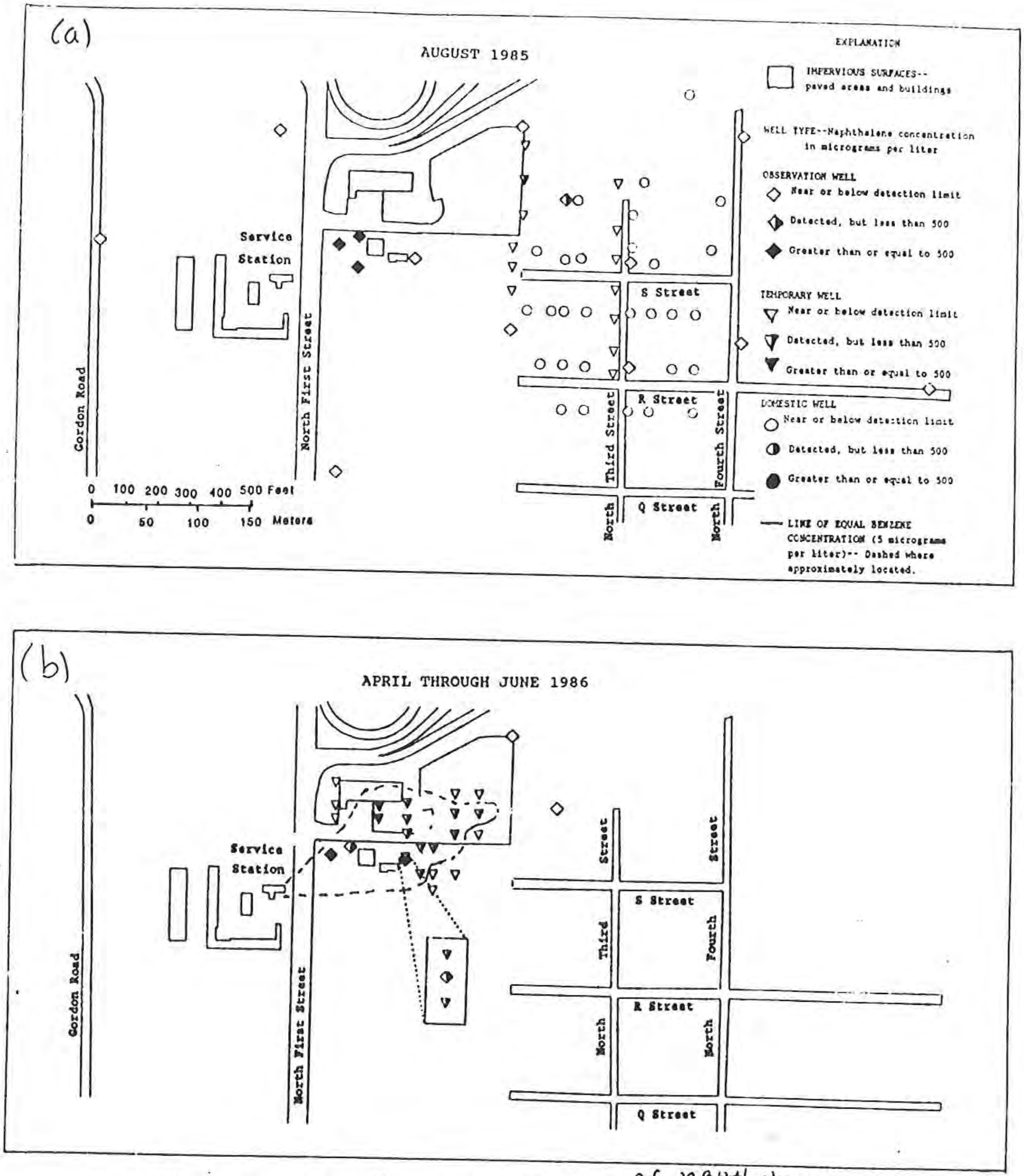
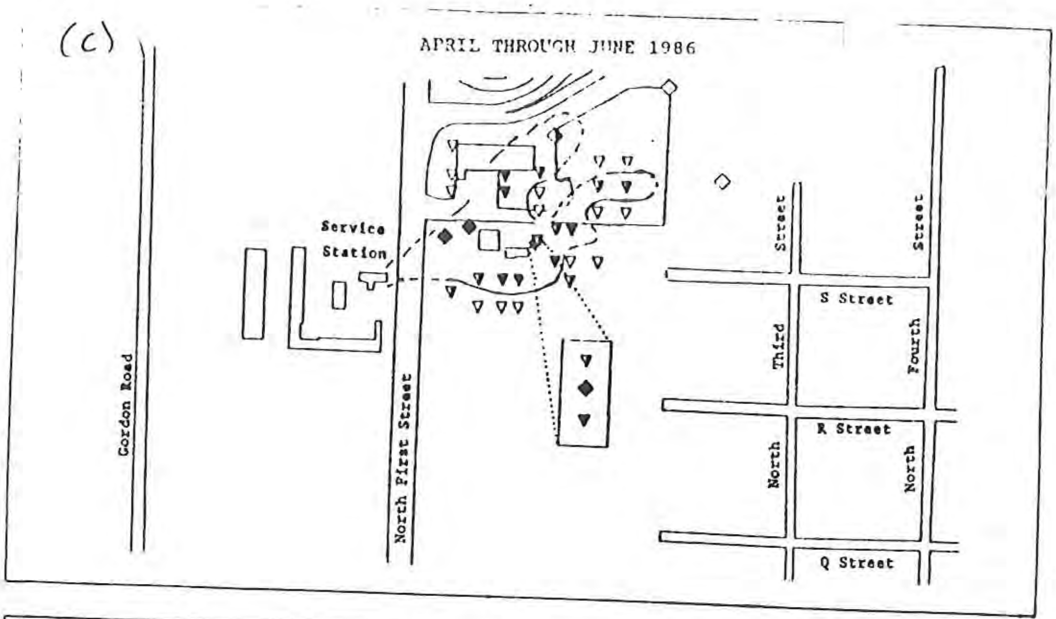


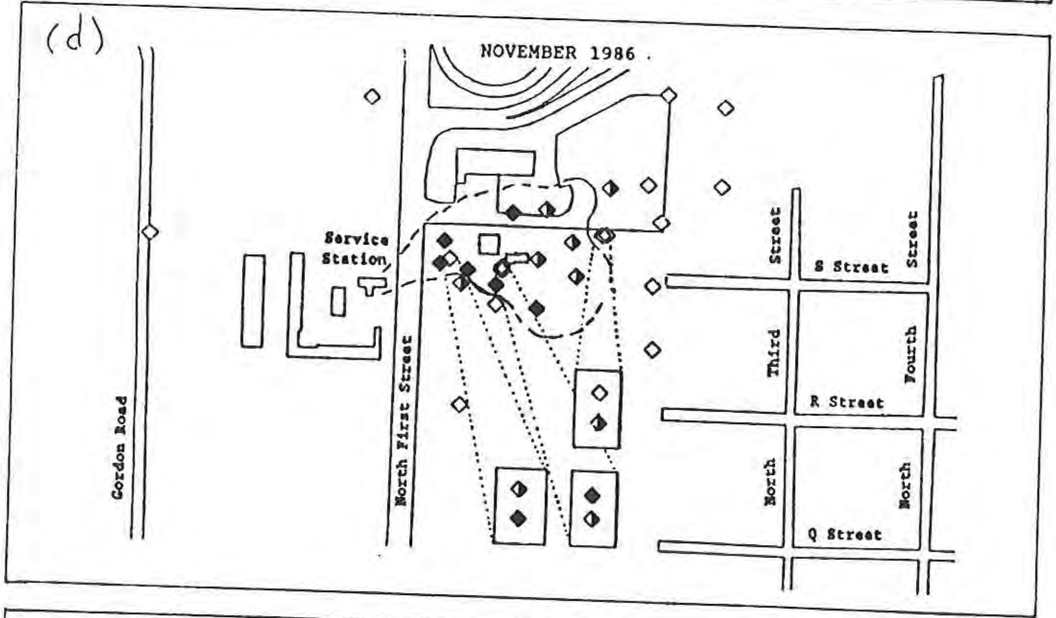
Figure 11.-- ~~Naphthalene~~ Concentrations of napthalene in ground water, August 1985 through March 1989 [data from (a) - (c) the ground-water toxics study, and (d) the 1989 study].

PRELIMINARY SUBJECT TO REVISIONS

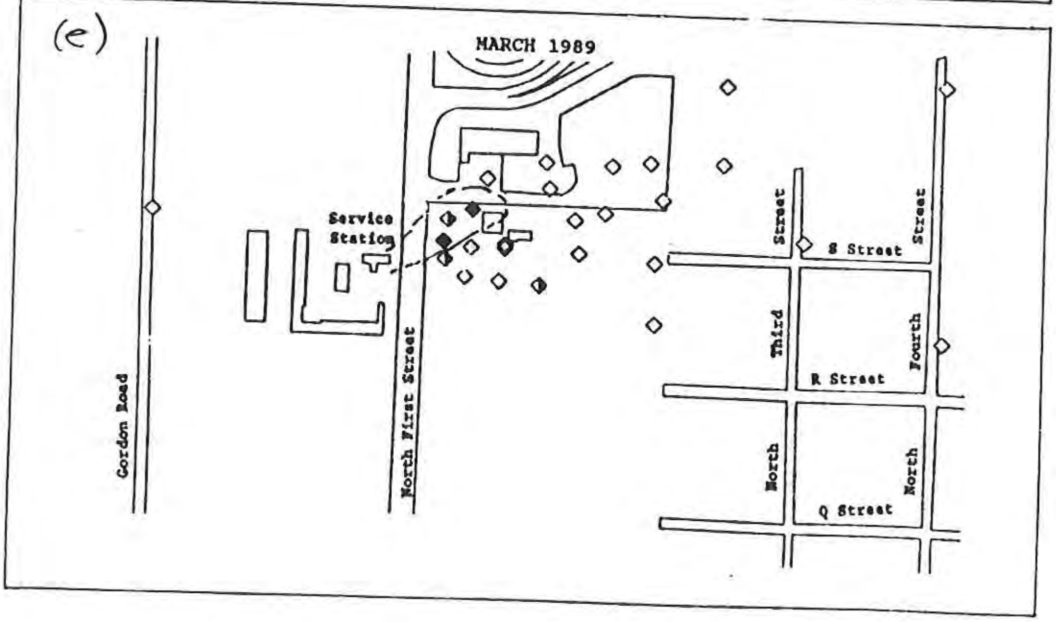
(c)


APRIL THROUGH JUNE 1986

(d)


NOVEMBER 1986

(e)


MARCH 1989

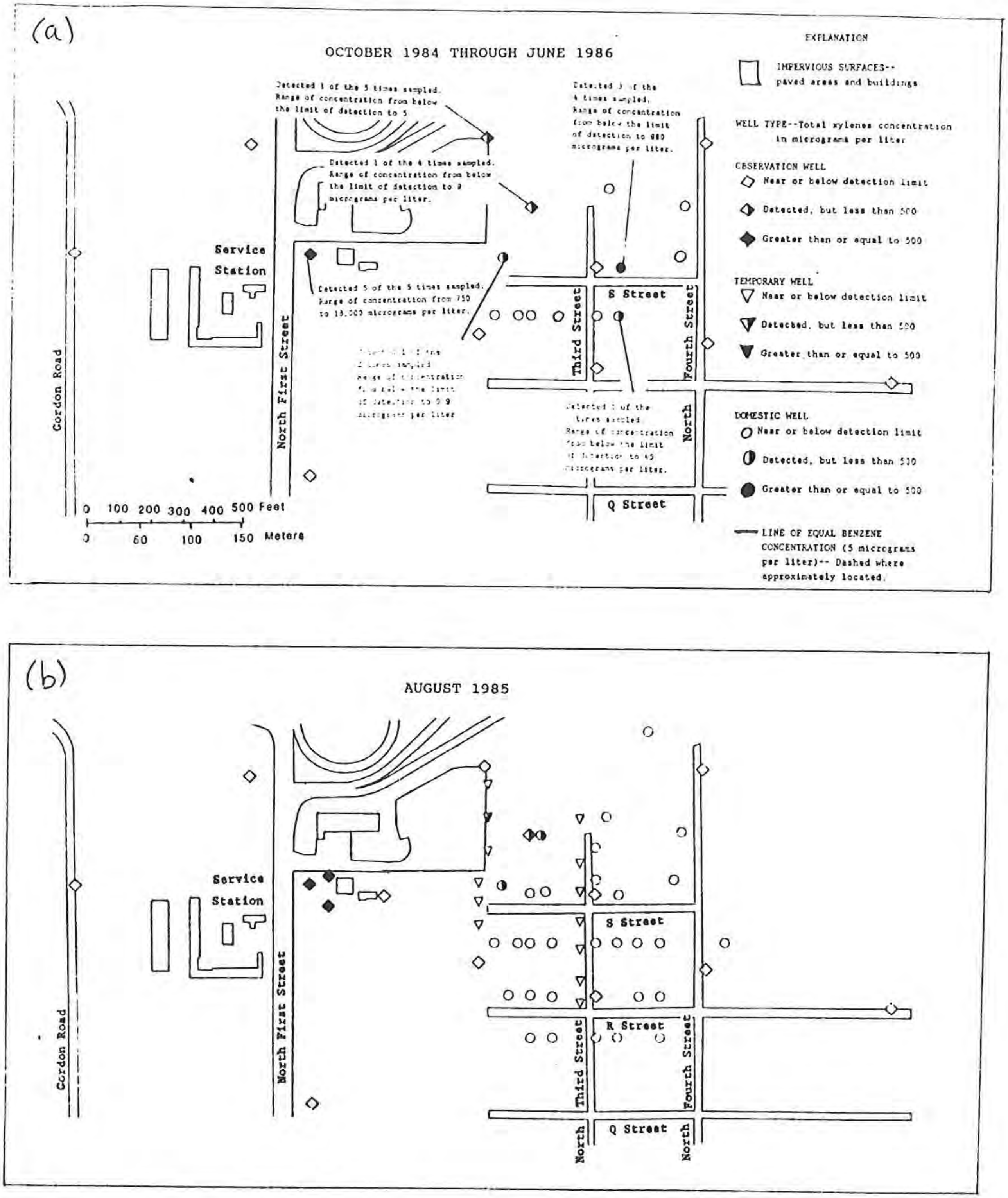
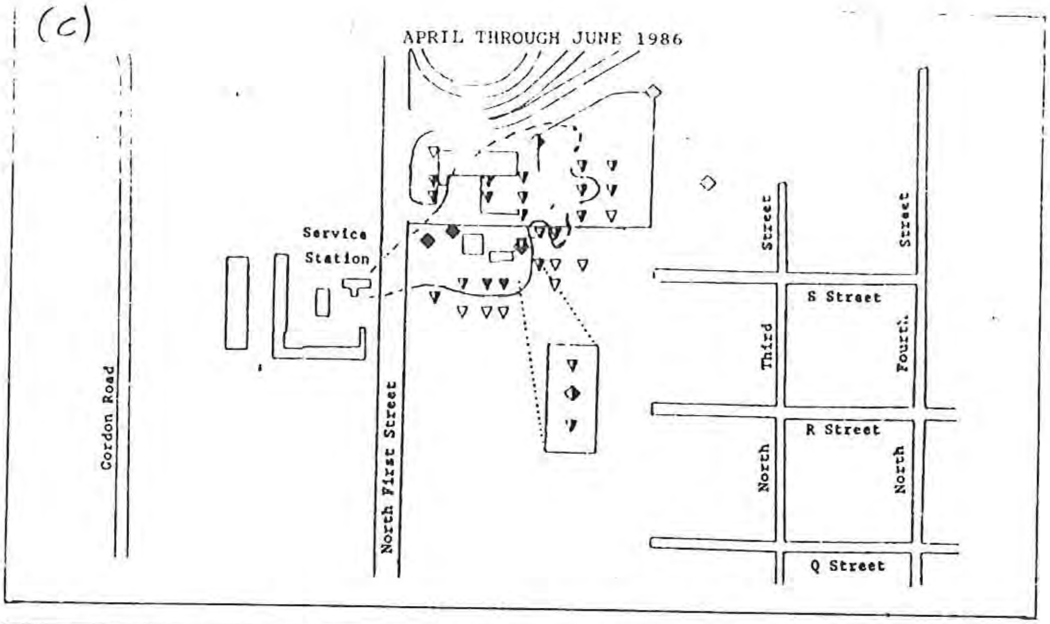


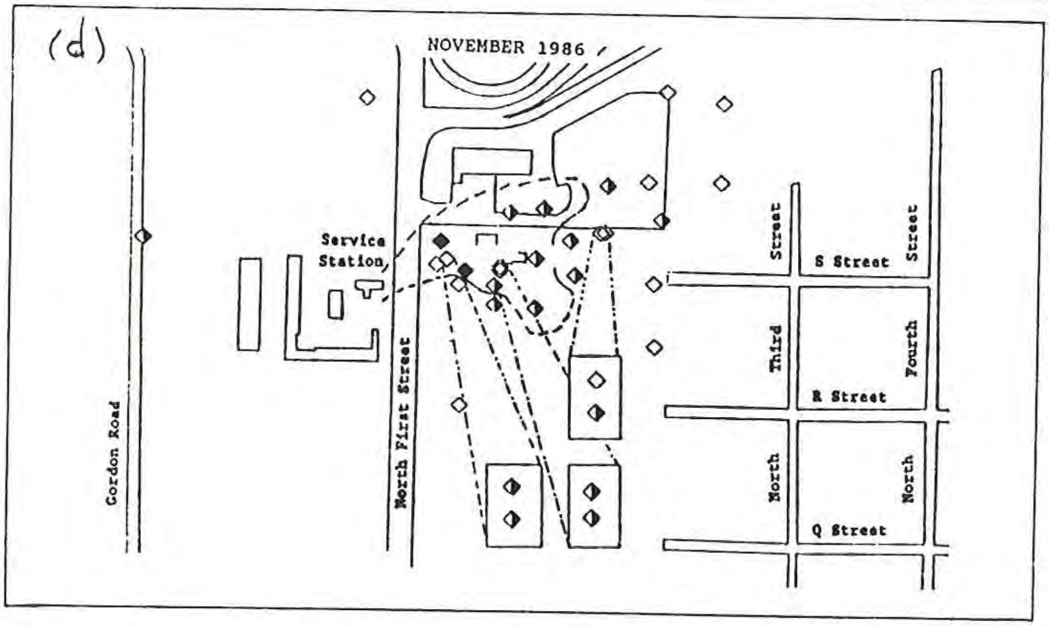
Figure 10.--Concentrations of total xylenes in ground water, October 1984 through March 1989 [data from (a) the insurance company study, (b)-(d) the ground-water toxics study, and (e) the 1989 study].

PRELIMINARY SUBJECT TO REVISIONS

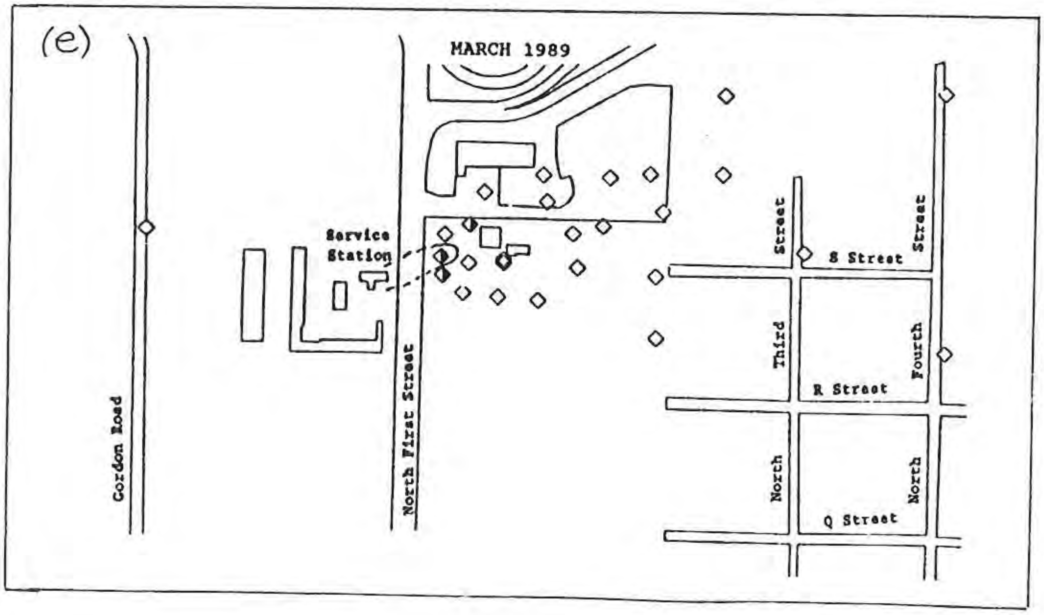
(c)



(d)



(e)



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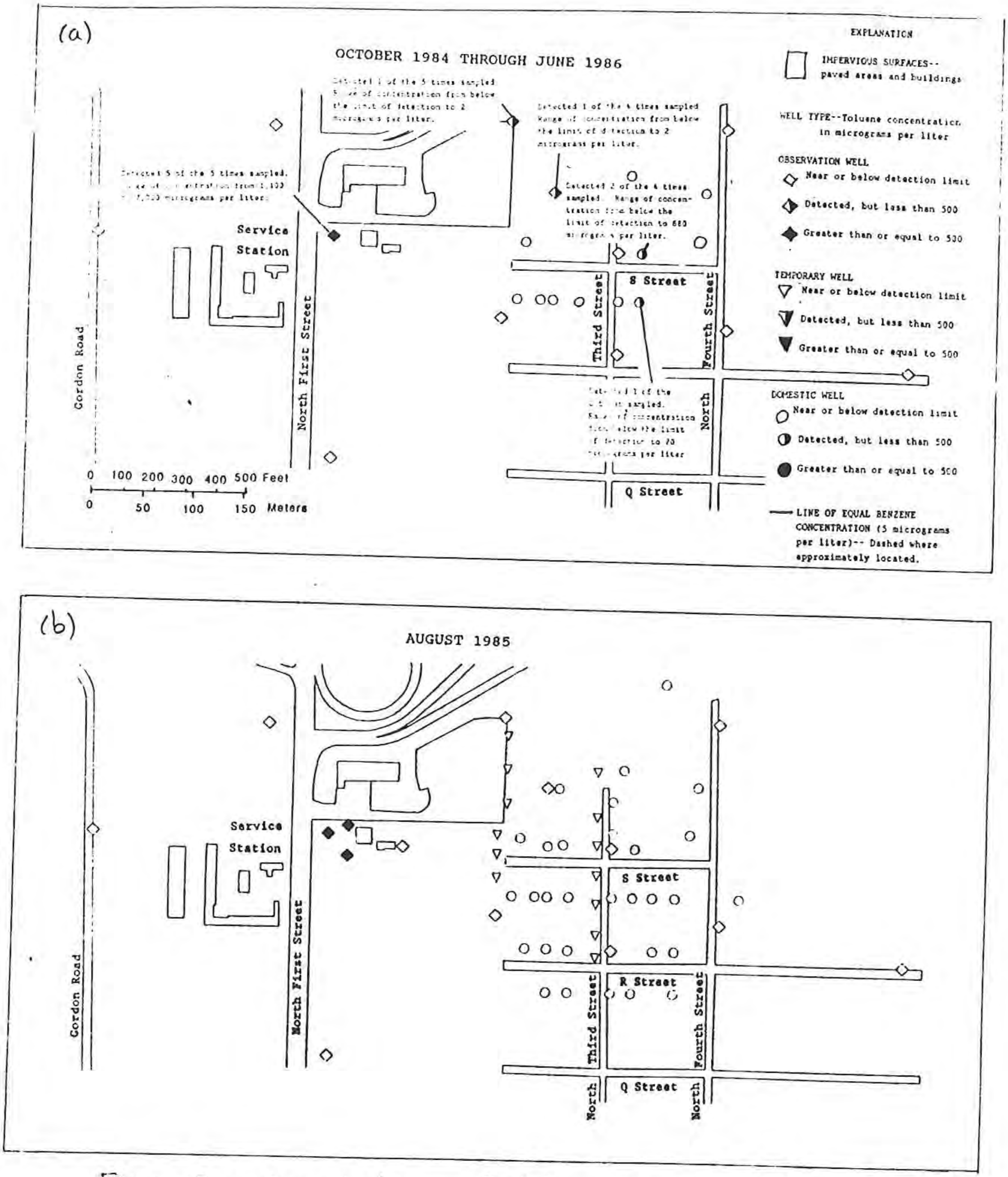
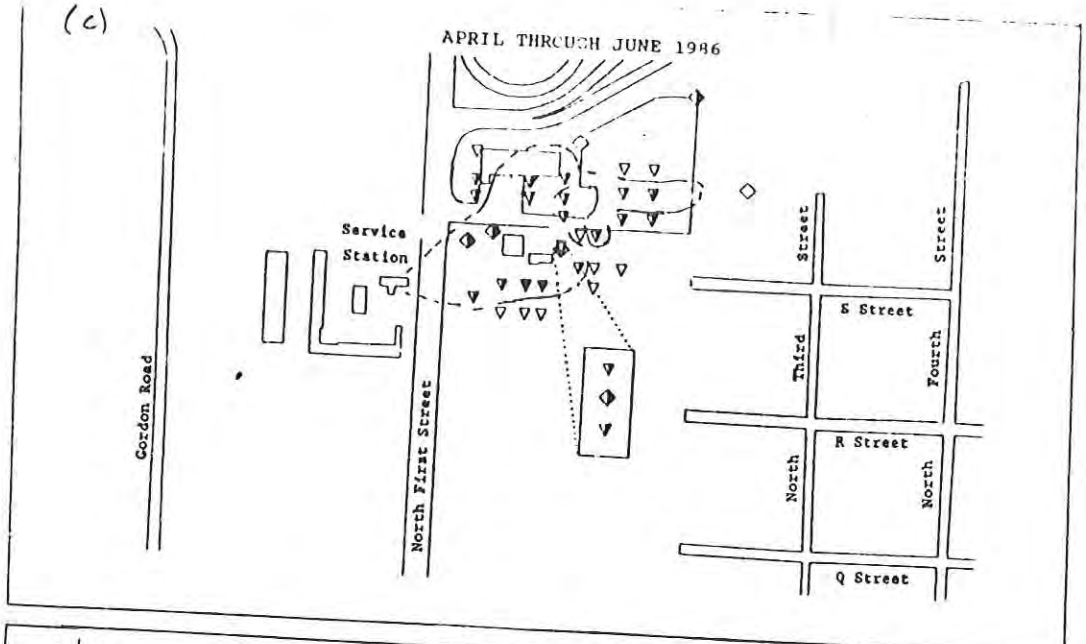


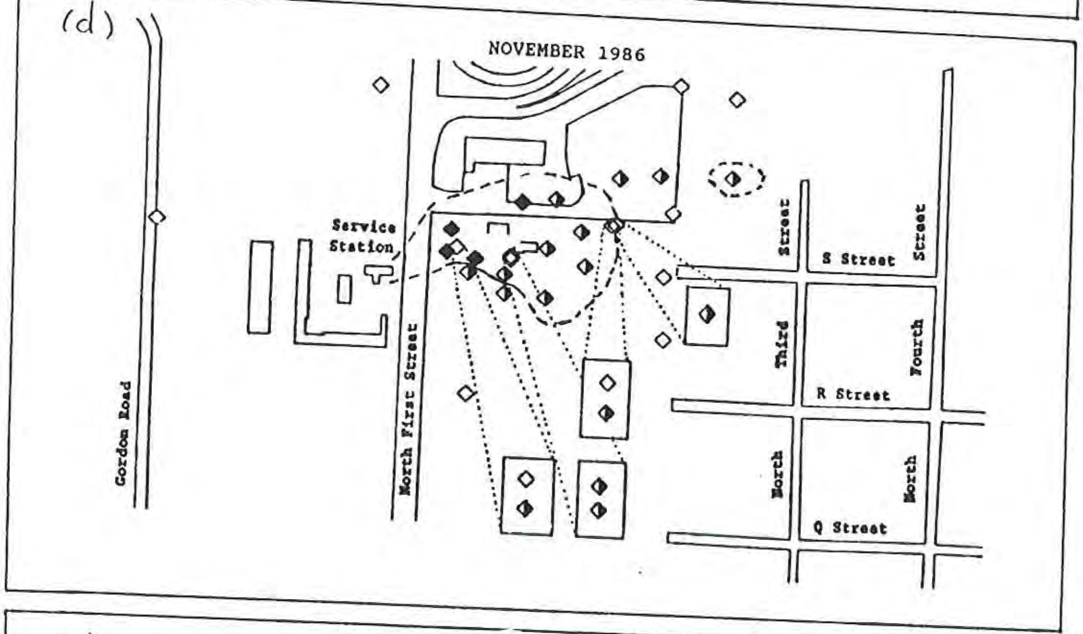
Figure 9.-- Concentrations of toluene in ground water, October 1984 through March 1989 [data from (a) the insurance company study, (b)-(d) ground-water toxics study, and (e) the 1989 study].

PRELIMINARY SUBJECT TO REVISIONS

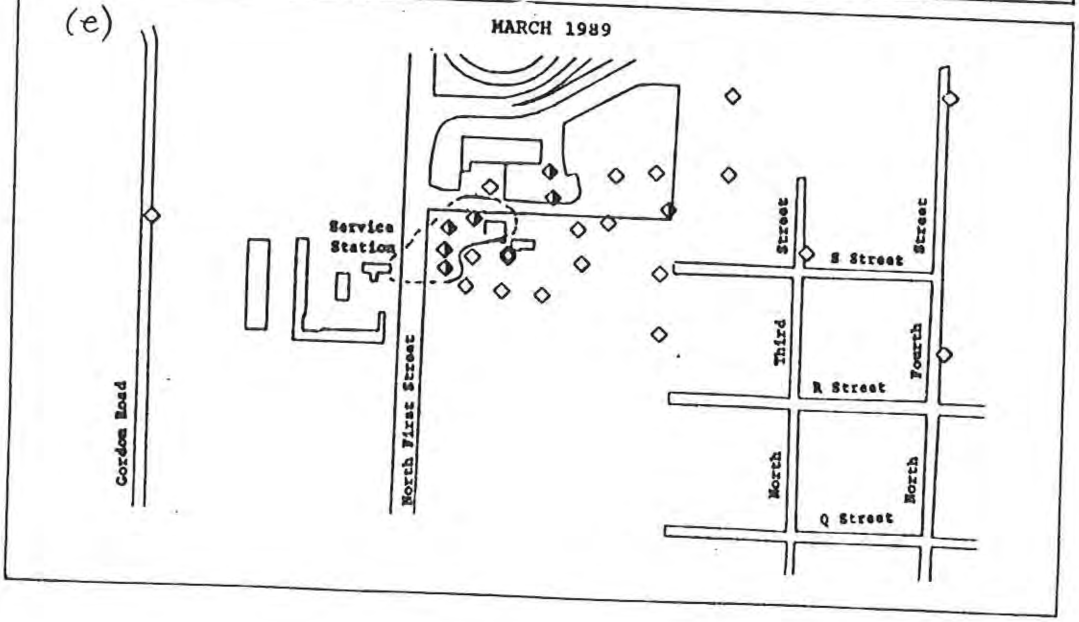
(c)

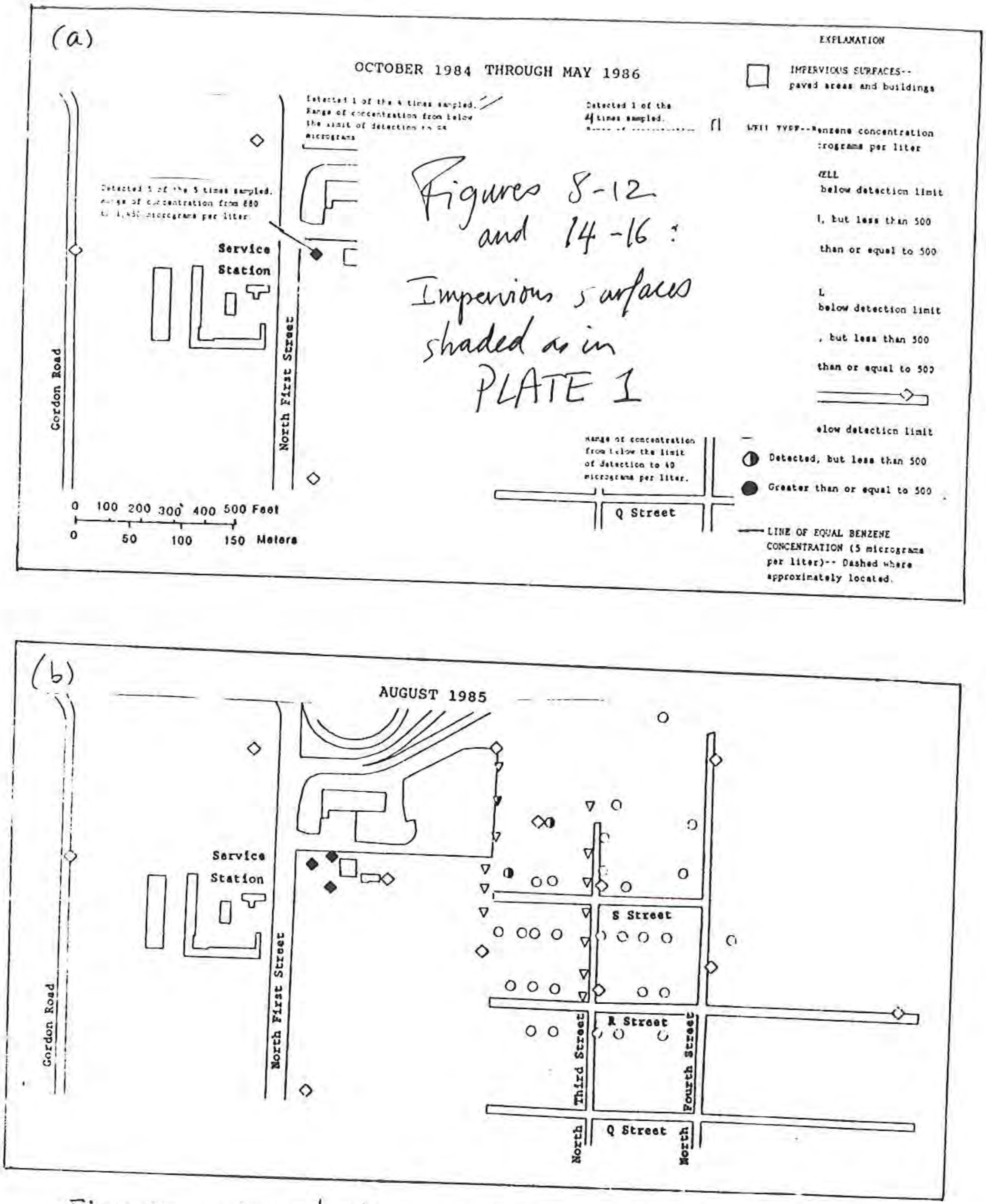

APRIL THROUGH JUNE 1986
Service Station
Gordon Road
North First Street
Third Street
Fourth Street
North
S Street
R Street
Q Street

(d)


NOVEMBER 1986
Service Station
Gordon Road
North First Street
Third Street
Fourth Street
North
S Street
R Street
Q Street

(e)


MARCH 1989
Service Station
Gordon Road
North First Street
Third Street
Fourth Street
North
S Street
R Street
Q Street



Figures 8-12 and 14-16: Impervious surfaces shaded as in PLATE 1

Figure 8.-- Concentrations of benzene in ground water, October 1984 through March 1987 [data from (a) the insurance company study, (b-d) ground-water toxics study, and (e) 1989 study].

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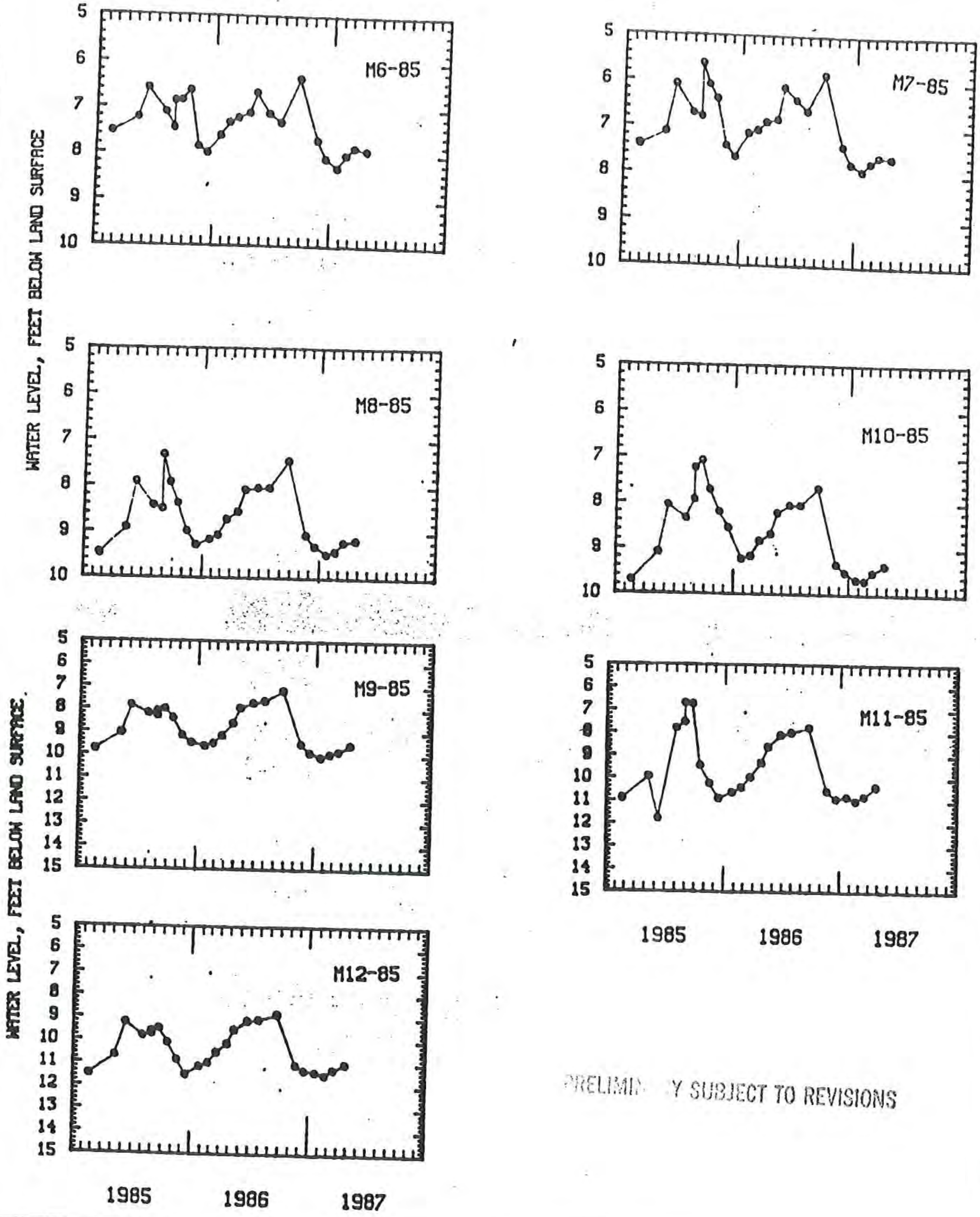

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FIGURE 7. — CONTINUED

see 1st page

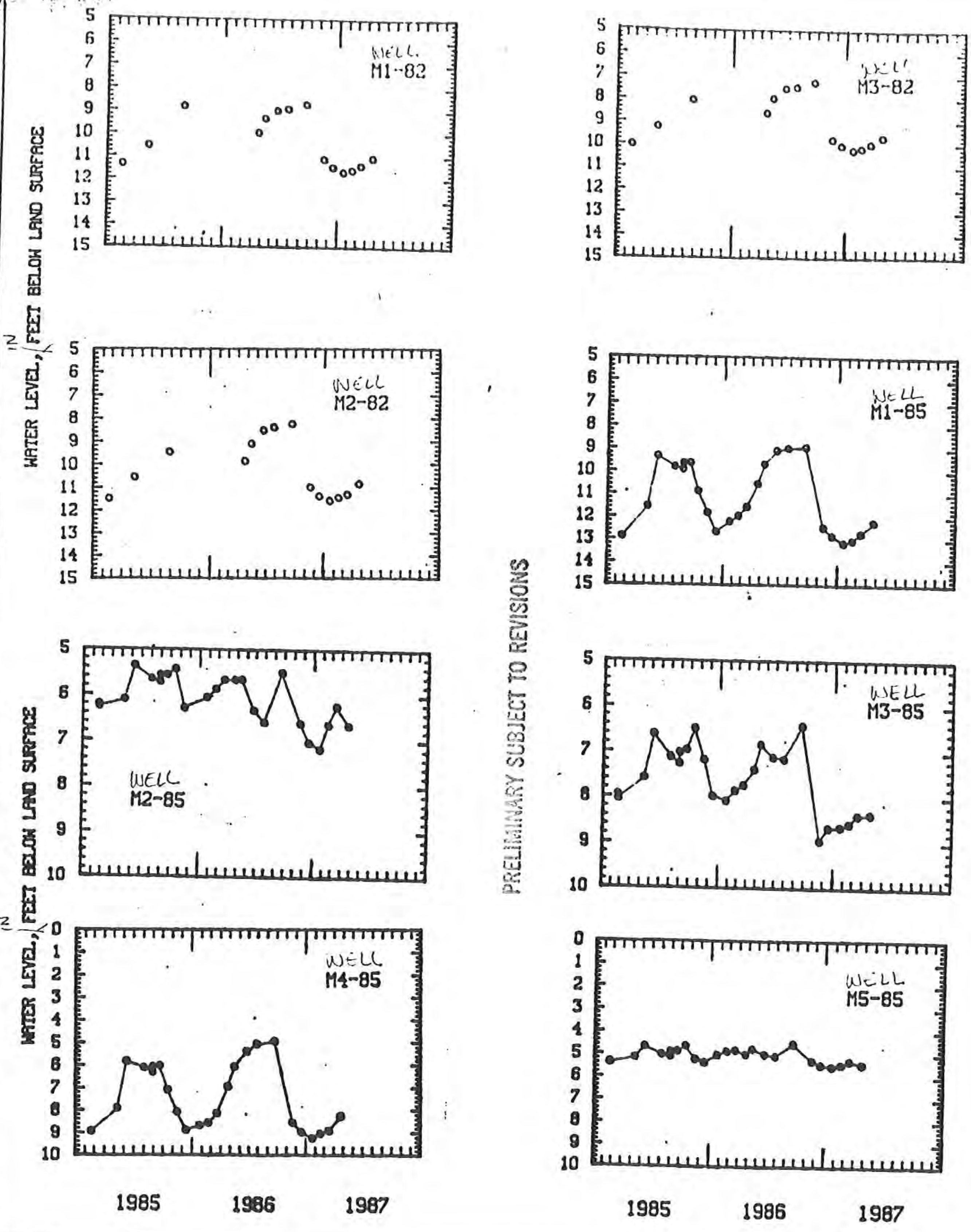

Figure 7. -- Observed water levels ~~for~~ IN observation wells with a 2-year period of record collection (Wells with water-level measurements made at intervals greater than 2 months are shown as points without a connecting line.)

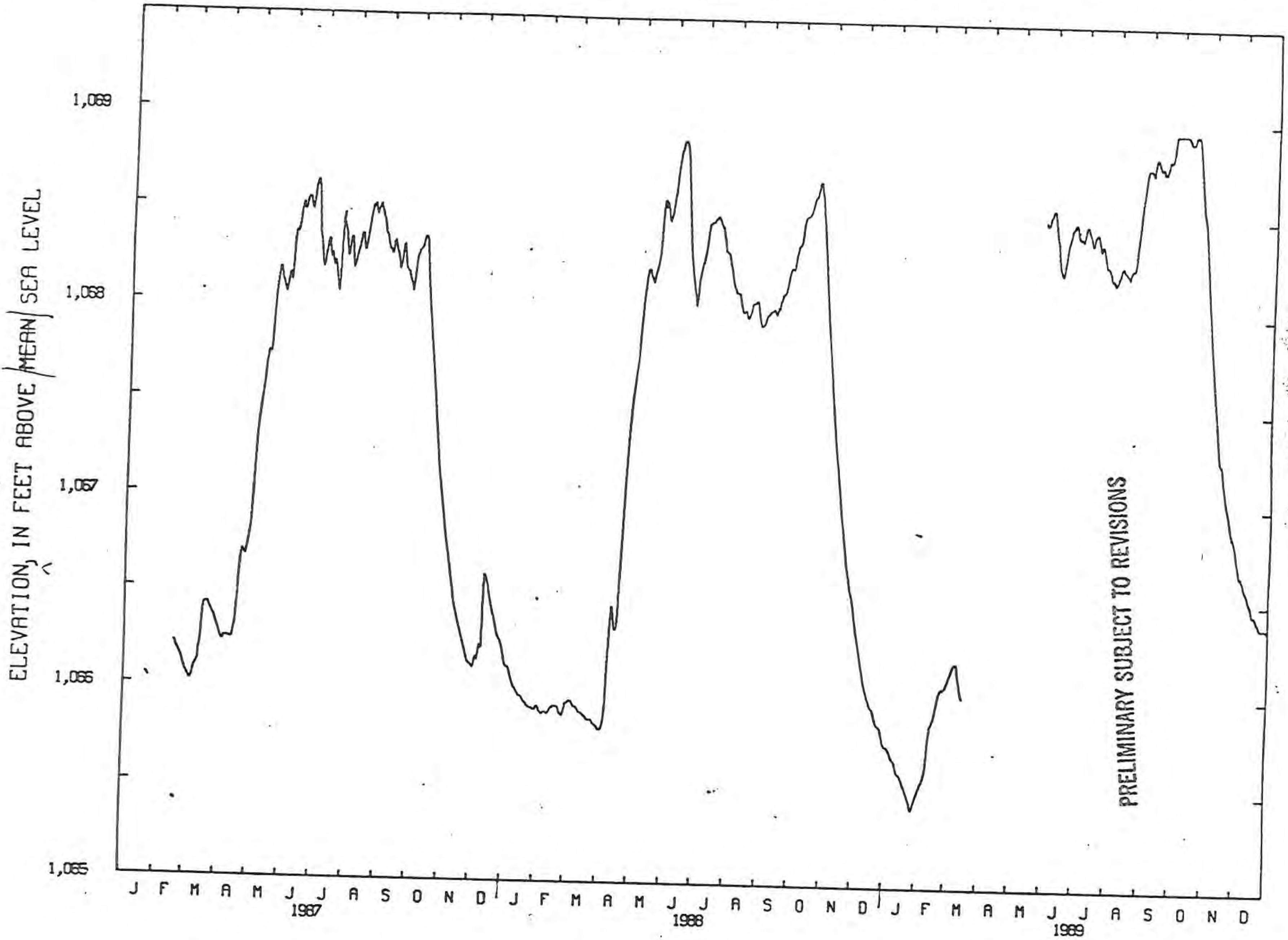

Figure 6.-- Mean daily observed water levels in well M14, 1987 through 1989. Land surface elevation is 1076.14 feet above sea level.

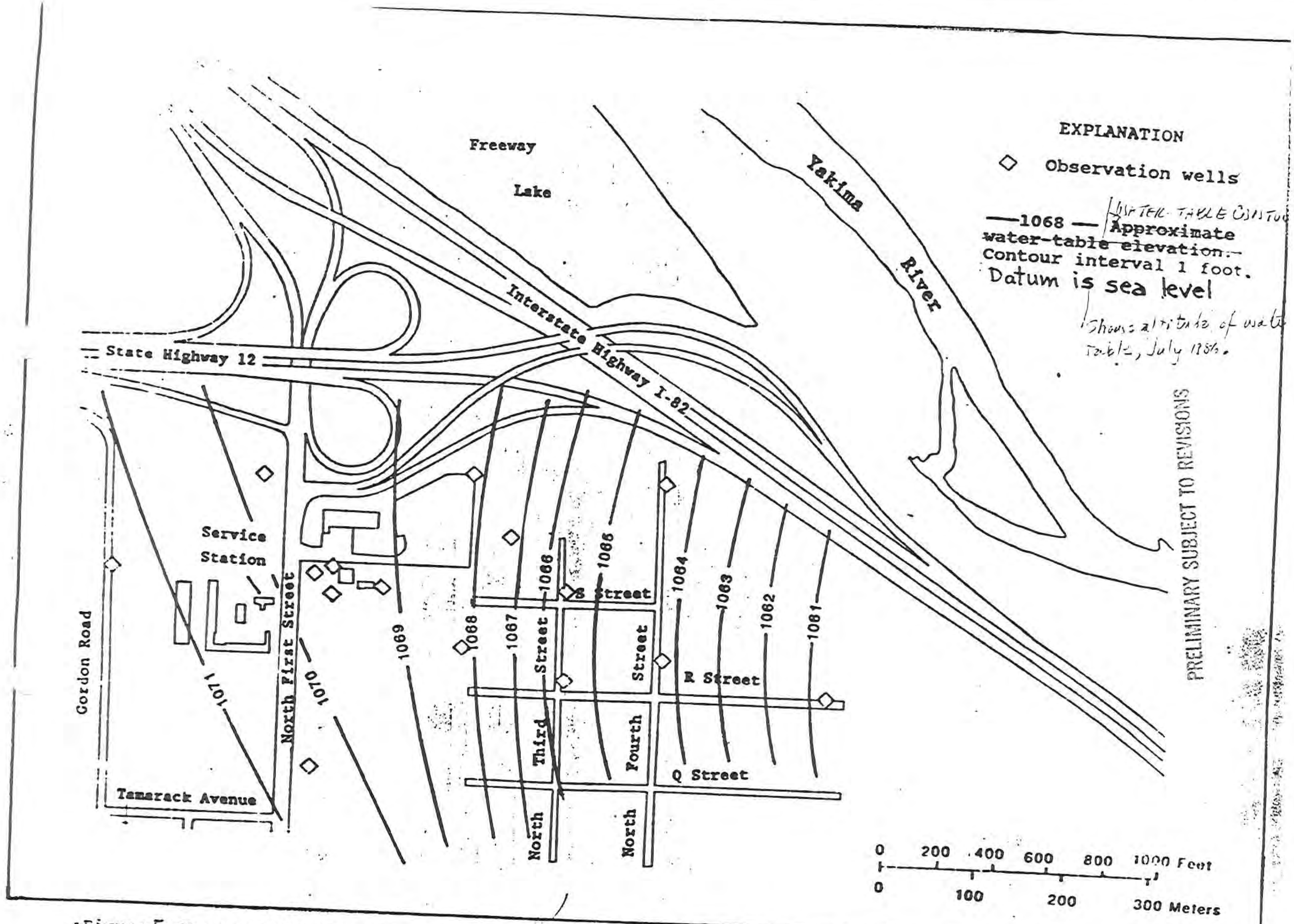

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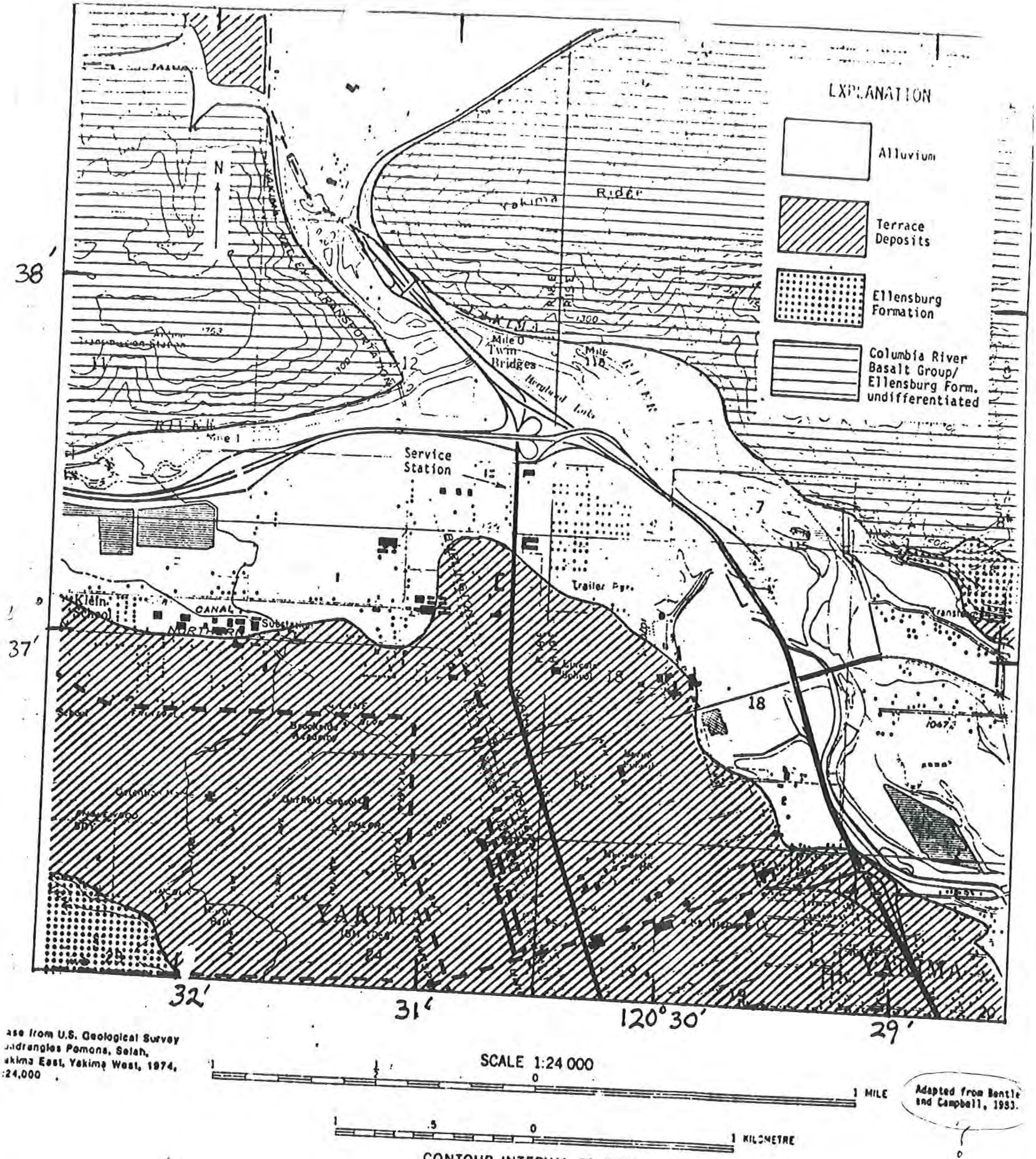
Figure 5.--Water-table elevations for July, 1986 at the study site.



ase from U.S. Geological Survey
uadrangles Pomona, Selah,
akima East, Yakima West, 1974,
:24,000

Adapted from Bentley and Campbell, 1983.

CONTOUR INTERVAL 20 FEET
DATUM IS SEA LEVEL

Figure 4.--Surficial geology near the study site

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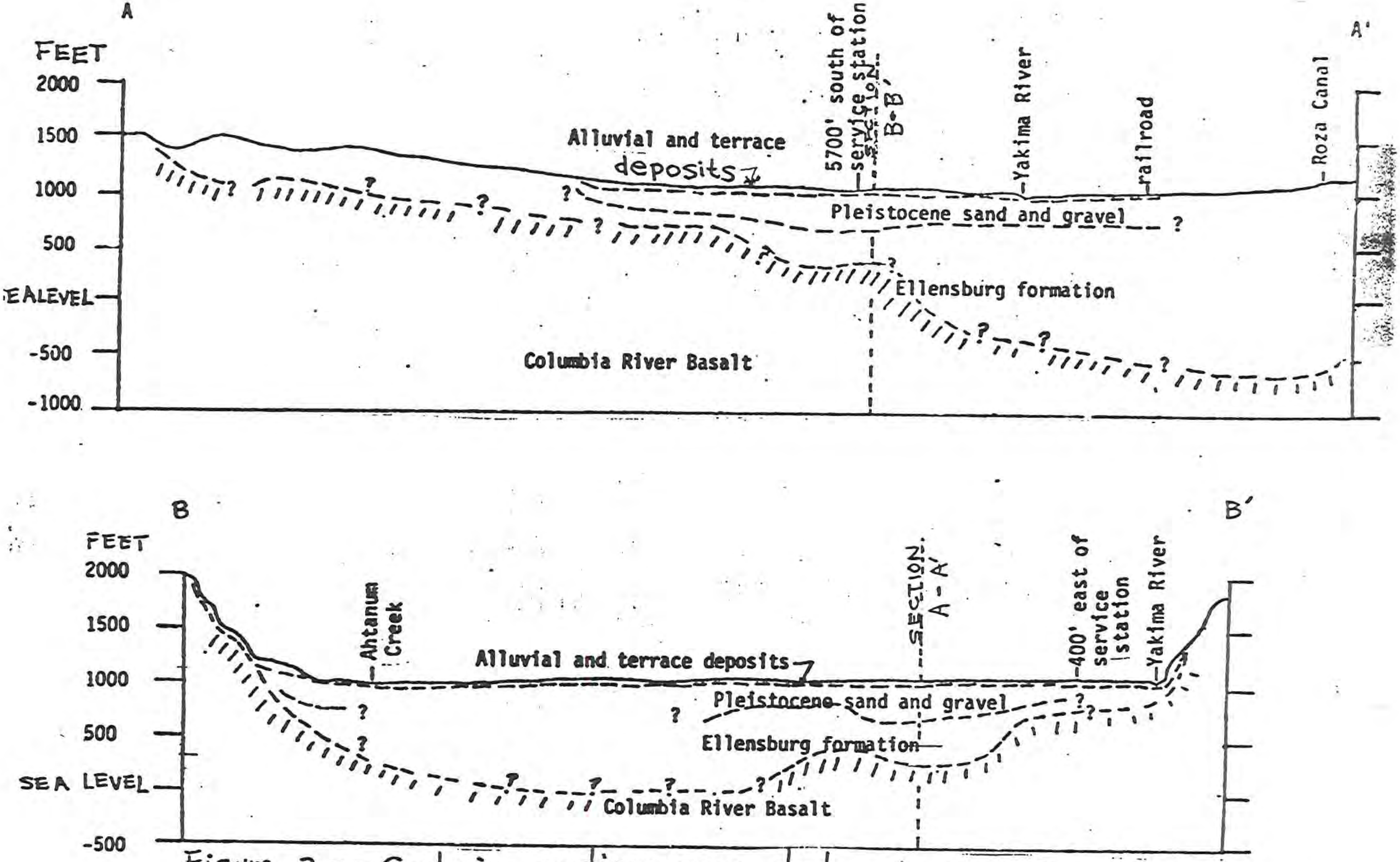
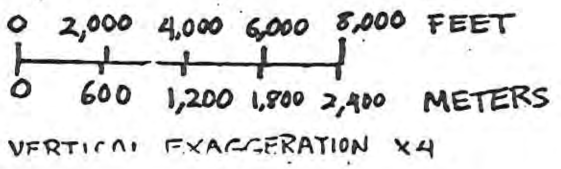
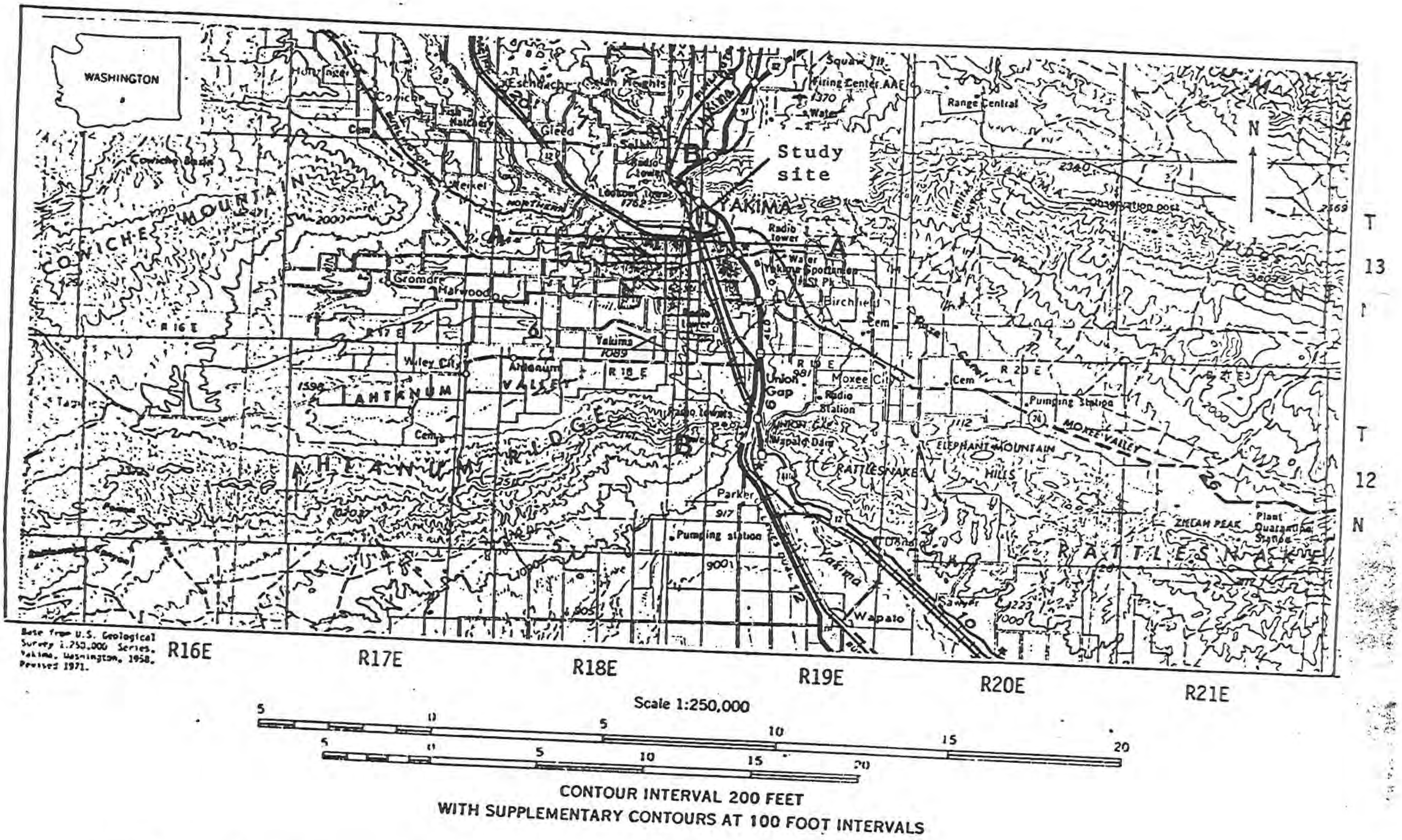


Figure 3.-- Geologic sections near study site. See figure 2 for locations of sections. Geology based on well logs. Pleistocene sand and gravel shown on section only.



PRELIMINARY



Base from U.S. Geological Survey 1:250,000 Series, Yakima, Washington, 1958, Revised 1971.

Figure 2.--Subbasin formed by the Ahtanum and Moxee Valleys, Washington. Cross-sections A-A' and B-B' shown on figure 3.

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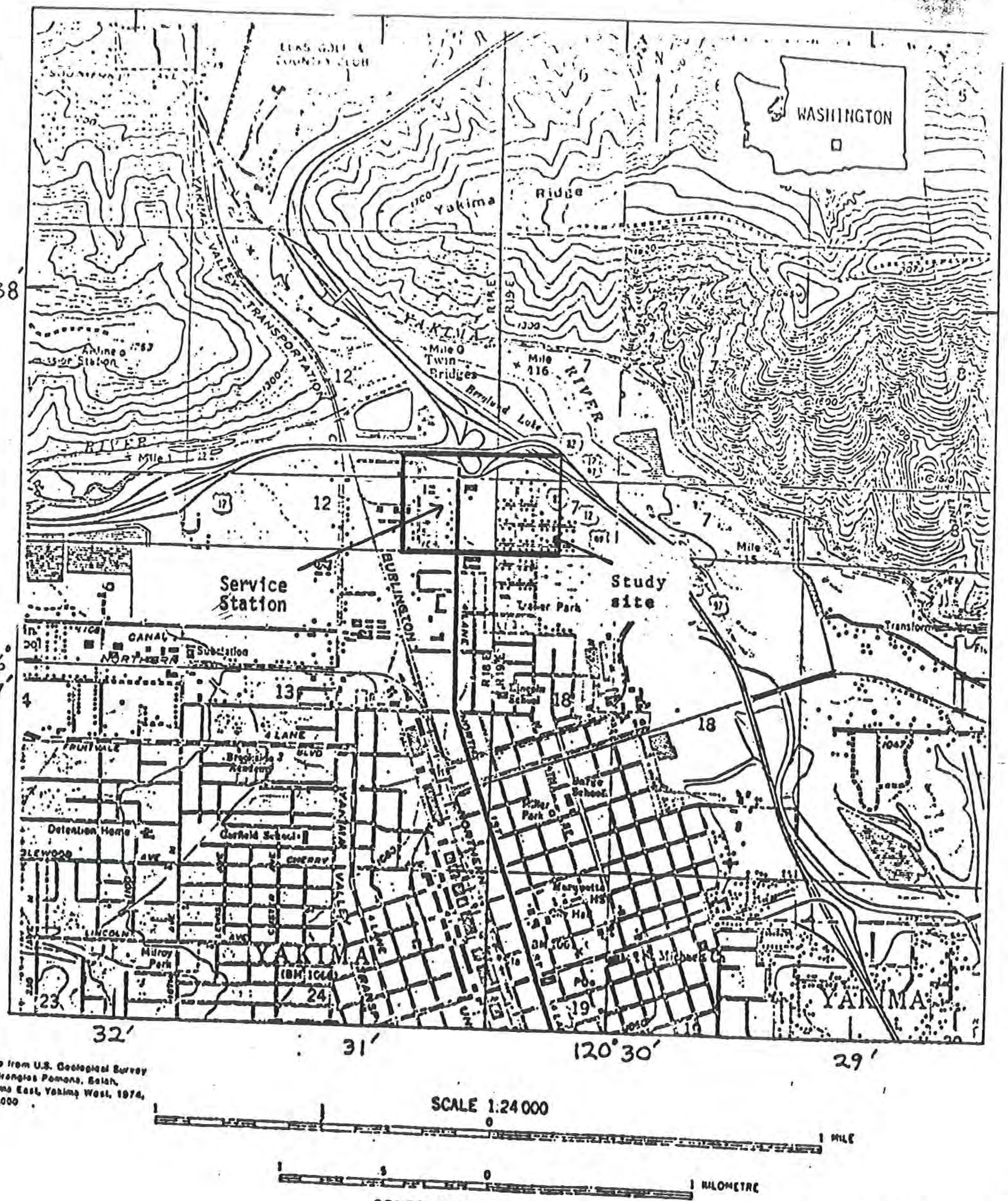

Base from U.S. Geological Survey quadrangles Pomona, Selah, Yakima East, Yakima West, 1974, 1:24,000

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Figure 1.--Location of the gasoline and diesel-fuel leak site at Yakima, Washington.

Tiger No. 1st St.

Friday,
Dec. 7, 1990

RECEIVED
DEC 10 1990
DEPARTMENT OF ECOLOGY
CENTRAL REGION OFFICE

Mike,

I'm enclosing 3 data packets of lithology for ~~the~~ Yakima Gas wells, a summary of the USGS data, and a copy of Plate 1. The USGS wells (which were drilled by a contractor & prob. (may have ?) should have been filed by him) are referenced by their field names, which are x-ref. in Table 2 (encl.). Field-name ~~term~~inology used BX (Bekins), SX (Safeway), TX (Thunderbird property), etc.

I would appreciate it if you return Plate 1 with your review of the report, and please feel free to call if you have any questions.

Regards!
Rick Wagner
US Geological Survey
Tacoma, WA

P.S. – Also enclosed is a key for USGS wells.

1/14/87
JB Jeather

Summary notes for visual examination of Yakima Gas & Oil Spill Samples

Field logs were compiled by Tacoma USGS personnel during drilling in Sept-Oct 1986. The bulk of the holes were logged by RC Jane, however, at least four others logged individual holes, resulting in some differences in log format and descriptions

Holes were drilled by a private contractor using a rotary drill rig equipped with a down hole hammer. Individual holes were 6 inch diameter where by a 6 inch diameter casing was advanced by driving at two foot intervals. Samples were blown out when drill bit was advanced two feet below bottom of casing and drive shoe (samples were churned in the process). Samples taken from above the water table were generally winnowed of fines by high air pressure and thus blown away. Samples from this interval thus are biased. (Samples below the water table were winnowed of fines by water) JBJ 1/30/87

Visual examination was made in the office using 2 to 3 power magnifying glass-fluorescent light combination supplemented by (10X) hand lenses and 10-20 power binocular microscope.
Visual exam led to estimates of the proportions of clay, silt, sand, and gravel size materials, and median size of the gravel and sand fractions. Samples were matched for gross color to the GSA color chart and recorded. Estimates of the composition of both clasts and sand fraction were attempted but not generally maintained. In general quartz and feldspar (potash light color) combined make up less than 20% of typical sample, quartz 5-10%, feldspar 5-10%, quartz appeared to be secondary in white to clear, light colored translucent grains. Feldspar appeared to be lithic fragments of (felsic) granitic & quartzofeldspathic metamorphic Rxs / lithic material

were generally distributed in the ranges given below

[Basalt → 60-80%
Andesite
Andesite breccia 5-15% (Distinctive dark green clasts)
Sandstone (volcanic?) 2-5%
Claystone (slate) 2-5%] Mafic to intermediate

[Granite 3-10%
Quartzo feldspathic (MRFS).] Felsic.

References to the rounding and angularity of rock chips in samples and the proportion of each in sample were also noted. In general angular chips indicated clasts originally in the pebble and cobble size range. The greater the proportion of angular chips to rounded chips probably indicates that clasts in the source sediments were greater than 3cm in size (upper part of pebble range to cobbles

Many of the holes were drilled much deeper than the final completed holes. In such cases native materials taken from the hole were used to backfill refill the test hole to the screen depth. If these holes were in the plume it is possible the lower part of the site is contaminated by materials from upper part of hole.

Table 2.--Wells and well identifiers used during this this report

[N/A, not available; land surface elevation is in feet above sea level; depth, in feet below land surface, indicates screened interval or bottom depth of an open-ended casing; letters in well identifiers in this report signify the following: M, observation well; T, temporary well; D, domestic well; SG, multi-depth soil-gas well; SGT, temporary soil-gas well. All domestic wells were sampled at an outside spigot unless suffixed with a K (sampled at kitchen sink), or I (irrigation well, sampled at wellhead)].

Site identifiers			Land surface elevation	Depth	Comments
This report	WATSTORE	Other reports			
M1-82	13N/18E-12R01	1	1078.06	6.0 - 15.6	
M2-82	13N/18E-12R02	2	1077.93	6.6 - 16.1	Identified as 3-82 (Fish, 1987)
M3-82	13N/18E-12R03	3	1076.86	6.0 - 15.8	
M1-85	13N/18E-12R04	1-85, MW-1	1080.48	6.0 - 21.0	
M2-85	13N/19E-07N01	2-85, MW-2	1067.51	3.5 - 18.5	
M3-85	13N/19E-07N02	3-85, MW-3	1072.62	4.1 - 19.1	
M4-85	13N/18E-12R05	4-85, MW-4	1075.66	4.1 - 19.1	
M5-85	13N/19E-07N03	5-85, MW-5	1069.66	1.8 - 16.8	
M6-85	13N/19E-07N04	6-85, MW-6	1071.52	4.3 - 19.4	
M7-85	13N/19E-07N05	7-85, MW-7	1072.48	4.2 - 19.2	
M8-85	13N/19E-07N06	8-85, MW-8	1075.70	5.0 - 20.0	
M9-85	13N/18E-12R06	9-85, MW-9	1075.48	4.8 - 19.8	
M10-85	13N/18E-12R07	10-85, MW-1	1076.37	4.3 - 19.3	
M11-85	13N/18E-12R08	11-85, MW-11	1077.67	5.5 - 20.5	
M12-85	13N/18E-12R09	12-85, MW-12	1078.49	6.4 - 21.4	
M1	13N/18E-12R12	T1	1077.43	55.0 - 58.0	
M2	13N/18E-12R13	T2	1077.65	28.0 - 30.0	SG1 also in same borehole
M3	13N/18E-12R14	T3	1077.65	28.0 - 30.0	SG2 also in same borehole
M4	13N/18E-12R15	T4	1077.02	3.8 - 12.0	
M5	13N/18E-12R16	T5	1078.39	13.9 - 15.9	SG3 also in same borehole
M6.1	13N/18E-12R17	T6.1	1077.39	44.6 - 46.6	[Piezometers M6.1 and M6.2 are in the same hole]
M6.2	13N/18E-12R18	T6.2	1077.11	7.6 - 13.6	
M7.1	13N/18E-12R19	T7.1	1078.11	30.3 - 32.3	[Piezometers M7.1 and M7.2 are in the same hole]
M7.2	13N/18E-12R20	T7.2	1078.11	7.3 - 13.3	
M8	13N/18E-12R21	T8	1078.22	8.4 - 14.4	
M9	13N/18E-12R22	T9	1078.07	7.0 - 13.0	
M10	13N/18E-12R23	T10	1077.81	8.3 - 14.3	
M11	13N/18E-12R24	T11	1077.65	8.4 - 14.2	
M12	13N/18E-12R25	T12	1078.09	7.4 - 13.4	
M13	13N/18E-12R26	T13	1078.09	30.5 - 32.3	SG4 also in same borehole
M14	13N/18E-12R27	T14	1076.14	6.8 - 12.8	
M16	13N/18E-12R28	T16	1078.09	7.9 - 13.9	
M17	13N/18E-12R29	T17	1078.36	7.7 - 13.7	
M18	13N/18E-12R30	T18	1077.70	7.1 - 13.1	
M19	13N/18E-12R31	T19	1078.12	7.8 - 13.8	
M20	13N/18E-12R32	T20	1078.26	7.2 - 13.2	
M21	13N/18E-12R33	T21	1077.70	56.3 - 58.3	
M22	13N/18E-12R34	T22	1077.50	6.7 - 12.7	
M23	13N/18E-12R39	B1	1077.10	6.5 - 12.5	
M24	13N/18E-12R40	B2	1076.16	7.6 - 13.6	
M25	13N/18E-12R41	B3	1076.08	30.3 - 32.3	SG6 also in same borehole
M26	13N/18E-12R42	B4	1076.58	8.0 - 14.0	
M27	13N/18E-12R43	B5	1076.79	9.0 - 18.0	
M28	13N/18E-12R35	S1	1077.03	54.0 - 56.5	SG7 also in same borehole
M29	13N/18E-12R36	S2	1076.99	7.7 - 16.8	
M30	13N/18E-12R37	S3	1076.89	7.8 - 16.8	
M31	13N/18E-12R38	S4	1077.74	8.6 - 17.4	
M33	13N/19E-07N08	H1	1075.13	55.0 - 57.0	
M34	13N/19E-07N09	H2	1075.02	8.6 - 14.6	
M35	13N/18E-12R11	WS1	1078.63	57.0 - 59.0	
M36	13N/18E-12R44	T1, GS1	1077.85	6.0 - 13.0	Estimated screen interval
M37	13N/18E-12R45	B1, GS2	1077.53	6.0 - 13.0	Identified as GS1 (Fish, 1987)
M38	13N/19E-07N07	3/R	1072.58	54.2 - 56.2	
M39	13N/18E-12J03	HWY1	1078.22	N/A	
M40	13N/19E-07M01	HWY2	1078.35	N/A	
T1	13N/19E-07M04	8T1-1			
T2	13N/19E-07N10	8T1-2			
T3	13N/19E-07N11	8T1-3			
T4	13N/18E-12R46	8T1-4			
T5	13N/18E-12R47	8T1-5			
T6	13N/18E-12R48	8T1-6			
T7	13N/19E-07N12	8T2-2			
T8	13N/19E-07N13	8T2-3			
T9	13N/19E-07N14	8T2-4			
T10	13N/19E-07N15	8T2-5			
T11	13N/19E-07N16	8T2-6			
T12	13N/19E-07N17	8T2-7			
T13	13N/19E-07N18	8T2-8			
T14	13N/18E-12R51	7-5			
T15	13N/18E-12R52	8-5			
T16	13N/18E-12R53	9-7.5			
T17	13N/18E-12R54	8-4			
T18	13N/18E-12R55	9-4			
T19	13N/18E-12R56	1.5-1.5			

PRELIMINARY SUBJECT TO REVISIONS

Table 2.--Wells and well identifiers used during this this report--Continued

Site identifiers			Land surface elevation	Depth	Comments
This report	WATSTORE	Other reports			
T20	13N/18E-12R57	8-3			
T21	13N/18E-12R58	7-4			
T22	13N/18E-12R59	5-3			
T23	13N/18E-12R60	5-2			
T24	13N/18R-12R61	4-2			
T25	13N/18E-12R62	4-3			
T26	13N/18E-12R63	3-2			
T27	13N/18E-12R64	3-3			
T28	13N/18E-12R65	6-7			
T29	13N/18E-12R66	1-8			
T30	13N/18E-12R67	1-9			
T31	13N/18E-12R68	1-10			
T32	13N/18E-12R69	6-8			
T33	13N/18E-12R70	6-9			
T34	13N/18E-12R71	4-8			
T35	13N/18E-12R72	4-9			
T36	13N/18E-12R73	11-8.5			
T37	13N/18E-12R74	11-9.5			
T38	13N/18E-12R75	11-7.5			
T39	13N/18E-12R76	9-8.5			
T40	13N/18E-12R77	9-9.5			
T41	13N/18E-12R89	(1 m north of M36)	1078		
T42	13N/18E-12R90	(1.3 m south of M36)	1078		
D1	13N/19E-07M03	H1-01		25	
D2	13N/19E-07N19	H4-03-(I)		20	
D3	13N/19E-07N20	H4-06-(K)		28	
D4	13N/19E-07N21	H4-06-(I)		13	
D5	13N/19E-07N22	H4-01		N/A	
D6	13N/19E-07N23	H3-08-(I), H3-07-(I)		70	
D7	13N/19E-07N24	H3-10-(I), H3-09-(I)		20	
D8	13N/19E-07N25	H3-11-(I)		20	
D9	13N/19E-07N26	H4-07		20	
D10	13N/19E-07N27	H4-08		80	
D11	13N/19E-07N28	H4-11		65	
D12	13N/19E-07N29	H6-05		18	
D13	13N/19E-07N30	H6-04-(I)		25	
D14	13N/19E-07N31	H6-03-(I)		N/A	
D15	13N/19E-07N32	H6-01		N/A	
D16	13N/19E-07N33	H5-06		N/A	
D17	13N/19E-07N34	H5-05-(I)		28	
D18	13N/19E-07N35	H5-04-(I)		28	
D19	13N/19E-07N36	H5-02		N/A	
D20	13N/19E-07N02	IK6-06-(I)		30	
D21	13N/19E-07N37	B2-05		N/A	
D22	13N/19E-07N38	B2-03		21	
D23	13N/19E-07N39	B2-01		N/A	
D24	13N/19E-07N40	B1-04		36	
D25	13N/19E-07N41	B1-01		26	
D26	13N/19E-07N42	B3-05		N/A	
D27	13N/19E-07N43	B3-03		N/A	
D28	13N/19E-07N44	B3-01		30	
D29	13N/19E-07N45	B4-06		38	
D30	13N/19E-07N46	B4-05		N/A	
D31	13N/19E-07N47	B4-01		N/A	
D32	13N/18E-12R97	Mesa	1079.47	N/A	(Water levels only)
SG1	13N/18E-12R91	T2	1077.43		Sampling tubes installed above the well screem M2)
SG2	13N/18E-12R92	T3	1077.65		Sampling tubes installed above the well screen (M3)
SG3	13N/18E-12R93	T5	1078.02		Sampling tubes installed above the well screen (M5)
SG4	13N/18E-12R94	T13	1078.09		Sampling tubes installed above the well screen (M13)
SG5	13N/18E-12R87	T15	1078.19		Multi-depth soil-gas sampler only
SG6	13N/18E-12R95	B3	1076.08		Sampling tubes installed above the well screen (M25)
SG7	13N/18E-12R96	S1	1077.03		Sampling tubes installed above the well screen (M28)
SG8	13N/18E-12R88	S5	1077.65		Multi-depth soil-gas sampler only
SGT1	13N/18E-12R81	1-9		5.67	
SGT2	13N/18E-12R81	1-7		3.46	
SGT3	13N/18E-12R79	1-4		3.59	
SGT4	13N/18E-12R78	1-2		4 to 5 (estimated)	
SGT5	13N/18E-12R82	2-5		3.47	
SGT6	13N/18E-12R83	3-2		4.58	
SGT7	13N/18E-12R84	4-6		4.10	
SGT8	13N/18E-12R85	4-2		5.35	
SGT9	13N/18E-12R86	5-5		4.96	

PRELIMINARY SUBJECT TO REVISIONS

APPENDIX I

BORING LOGS

JOB NO 120-12955 VERTICAL SCALE BORING NO

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

SURFACE ELEVATION 1080.5

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	SILTY SAND W/A GRAVEL TO A LITTLE GRAVEL, cobbles above 4', brownish gray, moist to wet (SM)	COARSE ALLUVIUM					
					1	CT	
					2	CT	
				▼			
13	SAND W/A LITTLE GRAVEL, AND WITH GRAVEL BELOW 19', medium to coarse grained, brownish gray, waterbearing						
					3	CT	
	*Drilling slurry						
21	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
11-18	3:00	17'	17'		to	9' *
11-18	4:15	21'	17'		to	9' *
11-20	9:00		See Note		to	
					to	

START 11-17-84 COMPLETE 11-18-8

METHOD 6DC 0-17' @ 4:00

CT (Cable Tool) 0-21'

CREW CHIEF Mason

JOB NO 120-12955 VERTICAL SCALE 1" = 3' BORING NO 2-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

DEPTH IN FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1067.5'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	SANDY LEAN CLAY W/A LITTLE GRAVEL, dark brown (CL)	MIXED ALLUVIUM			1	CT	
6	CLAYEY SAND W/A LITTLE GRAVEL, dark brown (SC)			▼	2	CT	
10	SILTY SAND W/A LITTLE GRAVEL, brownish gray, wet (SM/SC)				3	CT	
12	CLAYEY SAND W/A LITTLE GRAVEL, brownish gray with a little reddish brown and green below about 17' (SC)				4	CT	
20	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
1-7	3:00	17'	19'		to	7'
1-8	8:00	20'	19'		to	NMR
1-8	2:00		SEE NOTE		to	
					to	

START 1-7-85 COMPLETE 1-8-85

METHOD 6DC 0-19' @ 8:00

CT (Cable Tool) 0-21'

CREW CHIEF Mason

JOB NO 120-12955 VERTICAL SCALE 1" = 3' BORING NO 3-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

DEPTH IN FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1072.6'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	LEAN CLAY, dark brown (CL)	FINE ALLUVIUM		▼	1	CT	
9	CLAYEY SAND W/GRAVEL, brown (SC)	MIXED ALLUVIUM			2	CT	
15	SILTY SAND W/A LITTLE GRAVEL, brownish gray, wet (SM)	COARSE ALLUVIUM			3	CT	
16	SAND W/SILT AND GRAVEL, medium to coarse grained, brownish gray, waterbearing (SP-SM)				4	CT	
21	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
1-9	12:30	16'	16'		to	8'
1-10	1:00		SEE NOTE		to	
					to	
					to	

START 1-9-85 COMPLETE 1-10-85

METHOD 6DC 0-19' @ 8:30

CT (Cable Tool) 0-21'

CREW CHIEF Mason

JOB NO 12U-12955 VERTICAL SCALE 1" = 3' BORING NO 9-05

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

DEPTH IN FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1075.7'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	SANDY LEAN CLAY W/A LITTLE GRAVEL, dark brown (CL)	MIXED ALLUVIUM			1	CT	
4	CLAYEY SAND W/GRAVEL, brown (SC)				2	CT	
7	SILTY SAND W/A LITTLE GRAVEL, grayish brown, wet (SM)	COARSE ALLUVIUM		▼	3	CT	
11	SAND W/SILT AND GRAVEL, grayish brown, waterbearing (SP-SM)				4	CT	
21	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-14	2:00		SEE NOTE		to	
					to	

START 1-10-85 COMPLETE 1-14-85

METHOD 6DC 0-20' @ 8:30

CT (Cable Tool) 0-21'

CREW CHIEF Mason

882 CROMWELL AVENUE SOIL EXPLORATION COMPANY ST PAUL MN 55114

JOB NO 120-12955 VERTICAL SCALE 1" = 3' BORING NO 5-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

DEPTH IN FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1069.7'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	CLAYEY SAND W/A LITTLE GRAVEL, brown (SC)	MIXED ALLUVIUM			1	CT	
4	SILTY SAND W/A LITTLE GRAVEL, grayish brown, moist to wet (SM)	COARSE ALLUVIUM		▽	2	CT	
10	SILTY SAND W/GRAVEL, brownish gray, wet (SM)				3	CT	
14	SANDW/SILT AND A LITTLE GRAVEL, medium to fine grained, grayish brown, waterbearing (SP-SM)				4	CT	
18	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-16	9:00		SEE NOTE		to	
					to	

START 1-14-85 COMPLETE 1-15-85

METHOD 6DC 0-17' @ 2:00

CT (Cable Tool) 0-18'

CREW CHIEF Mason

662 CROMWELL AVENUE SOIL EXPLORATION COMPANY ST PAUL MN 55114

SE-V-10(84-8)-8

JOB NO

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

DEPTH IN FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1071.4'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	LEAN CLAY W/A LITTLE GRAVEL, dark brown (CL)	FINE ALLUVIUM					
					1	CT	
6	SANDY LEAN CLAY W/A LITTLE GRAVEL, brown (CL/SC)	MIXED ALLUVIUM		▼			
					2	CT	
13	SILTY SAND W/A LITTLE GRAVEL, brownish gray, wet (SM)	COARSE ALLUVIUM					
					3	CT	
					4	CT	
21	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-18	1:00		SEE NOTE		to	
					to	

START 1-17-85 COMPLETE 1-18-85

METHOD 6DC 0-19' @ 10:00

CT (Cable Tool) 0-21'

CREW CHIEF Mason

JOB NO 120-12955

VERTICAL SCALE 1" = 5'

BORING NO [illegible]

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

DEPTH IN FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1072.5'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	CLAYEY SAND W/A LITTLE GRAVEL, some cobbles, brownish gray (SC)	MIXED ALLUVIUM			1	CT	
				▼	2	CT	
12	SILTY SAND W/GRAVEL, brownish gray, wet (SM)	COARSE ALLUVIUM			3	CT	
18	SAND W/SILT AND A LITTLE GRAVEL, medium to fine grained, grayish brown, waterbearing (SP-SM)				4	CT	
20	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-22	3:30		SEE NOTE		to	
					to	

START 1-21-85 COMPLETE 1-22-85

METHOD 6DC 0-18' @ 1:00

CT (Cable Tool) 0-20'

CREW CHIEF Mason

JOB NO 120-12955 VERTICAL SCALE 1" = 3' BORING NO 0-05

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

SURFACE ELEVATION 1075.8'

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	CLAYEY SAND W/A LITTLE GRAVEL, dark brown (SC)	MIXED ALLUVIUM					
					1	CT	
6	SILTY SAND W/A LITTLE GRAVEL, some cobbles, moist to wet, brownish gray (SM/SC)	COARSE ALLUVIUM					
				▼			
					2	CT	
14	SILTY SAND W/GRAVEL, a few cobbles, brownish gray, wet (SM)						
					3	CT	
					4	CT	Slight gasoilne odor
22	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
2-14	3:00		SEE NOTE		to	
					to	

START 2-13-85 COMPLETE 2-14-85

METHOD 6DC 0-20' @ 1:00

CT (Cable Tool) 0-22'

CREW CHIEF Mason

JOB NO 120-12955
VERTICAL SCALE 1" = 3'
BORING NO 9-85
PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

DEPTH IN FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1075.8'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	LEAN CLAY, dark brown (CL)	FINE ALLUVIUM			1	CT	
6	CLAYEY SAND W/GRAVEL, grayish brown (SC)	MIXED ALLUVIUM		▼	2	CT	
12	SILTY SAND W/GRAVEL, brownish gray, wet (SM)	COARSE ALLUVIUM			3	CT	
17	SAND W/SILT AND GRAVEL, medium grained, brownish gray, water-bearing (SP-SM)				4	CT	
21	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-24	3:00		SEE NOTE		to	
					to	

START 1-23-85 COMPLETE 1-24-85
METHOD 6DC 0-20' @ 1:00
CT (Cable Tool) 0-21'
CREW CHIEF Mason

662 CROMWELL AVENUE SOIL EXPLORATION COMPANY ST PAUL MN 55114

SE-V-10(84-8)-8

JOB NO 120-12955 VERTICAL SCALE 1" = 3' BORING NO 10-85

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

SURFACE ELEVATION 1076.3'

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	CLAYEY SAND W/GRAVEL, COBBLES AND BOULDERS, brownish gray (may be fill) (SC)	FILL OR MIXED ALLUVIUM			1	CT	
7	SILTY GRAVEL, brownish gray, wet (GM)	COARSE ALLUVIUM		▼	2	CT	
14	SAND W/SILT AND GRAVEL, brownish gray, waterbearing (SP-SM)				3	CT	
18	SILTY SAND W/A LITTLE GRAVEL, brownish gray, wet (SM)				4	CT	
21	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-29	11:30		SEE NOTE		to	
					to	

START 1-25-85 COMPLETE 1-28-85

METHOD 6DC 0-20' @ 3:00

CT (Cable Tool) 0-21'

CREW CHIEF Mason

JOB NO 120-12955 VERTICAL SCALE [illegible] BORING NO [illegible]

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

SURFACE ELEVATION 1077.7'

DEPTH IN FEET	DESCRIPTION OF MATERIAL	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	SILTY CLAY W/SAND, dark brown (CL-ML)	FINE ALLUVIUM			1	CT	
6	CLAYEY SAND W/GRAVEL, brownish gray (SC/SM)	MIXED ALLUVIUM		▼	2	CT	Strong gasoline odor
12	SILTY SAND W/A LITTLE GRAVEL, brownish gray, wet (SM/SP)	COARSE ALLUVIUM			3	CT	Slight gasoline odor
18	SAND W/SILT AND A LITTLE GRAVEL, medium grained, brown, water-bearing (SP-SM)				4	CT	
22	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
1-31	11:00		SEE NOTE		to	
					to	

START 1-29-85 COMPLETE 1-30-85 @ 3:00

METHOD 6DC 0-20'

CT (Cable Tool) 0-22'

CREW CHIEF Mason

JOB NO 120-12955 VERTICAL SCALE 1" = 3' BORING NO [illegible]

PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

DEPTH IN FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1078.6'	GEOLOGIC ORIGIN	N	WL	SAMPLE NO	SAMPLE TYPE	COMMENTS
	LEAN CLAY, dark brown (CL)	FINE ALLUVIUM			1	CT	
5	CLAYEY SAND W/GRAVEL, a few cobbles, brownish gray (SC)	MIXED ALLUVIUM			2	CT	Very slight gasoline odor
				▼			
					3	CT	Very slight gasoline odor
17	SILTY SAND W/GRAVEL, grayish brown, wet (SM)	COARSE ALLUVIUM					
					4	CT	
22	End of Boring Note: Monitoring well installed in boring. See attached "Installation of Monitoring Well" sheet.						

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	BAILED DEPTHS	WATER LEVEL
					to	
					to	
2-20	2:00		SEE NOTE		to	
					to	

START 2-19-85 COMPLETE 2-20-85

METHOD 6DC 0-20' @ 1:00

CT (Cable Tool) 0-22'

CREW CHIEF Mason

APPENDIX VI

MONITORING WELL CONSTRUCTION SHEETS

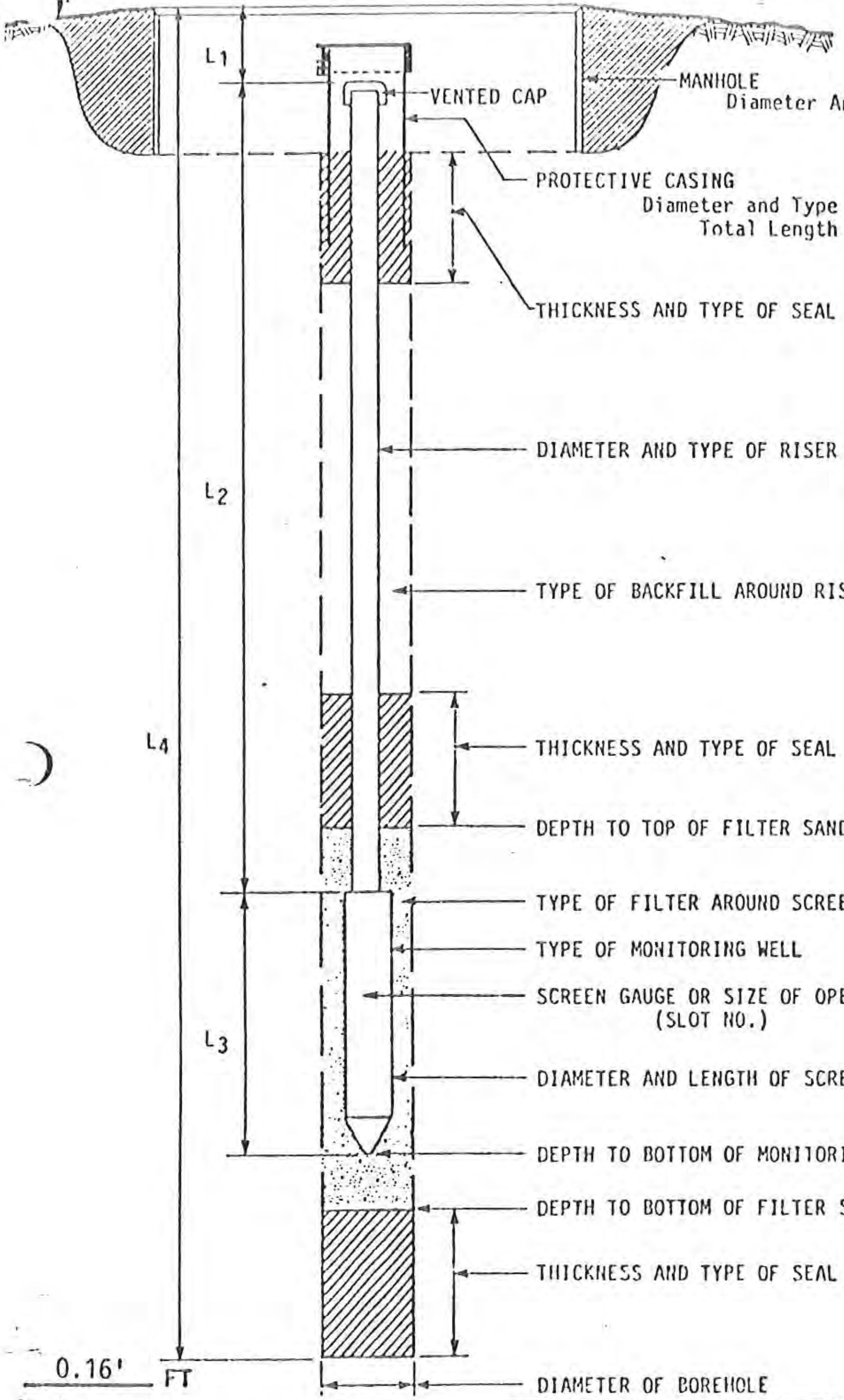
JOB NO. 120-12955

MONITORING WELL NO. 1-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1080.5'

TOP OF RISER ELEVATION 1080.34'
(With Cap Removed)



VENTED CAP

MANHOLE
Diameter And Type 12" steel
Depth 5"

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 4' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL

DEPTH TO TOP OF FILTER SAND 4'

TYPE OF FILTER AROUND SCREEN Filter Grout

TYPE OF MONITORING WELL 2' FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 21.0'

DEPTH TO BOTTOM OF FILTER SAND 21.0'

THICKNESS AND TYPE OF SEAL None

DIAMETER OF BOREHOLE 6"

0.16' FT

5.84' FT

15' FT

21' FT

MONITORING WELL WATER LEVEL MEASUREMENTS			
DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
11-20-84	9:00am	13.0'	
1-7-85	10:18	12.60'	

(1) DEPTH BELOW TOP OF RISER PIPE

ALLATION COMPLETED:

Time

soil exploration company

INSTALLATION OF MONITORING WELL

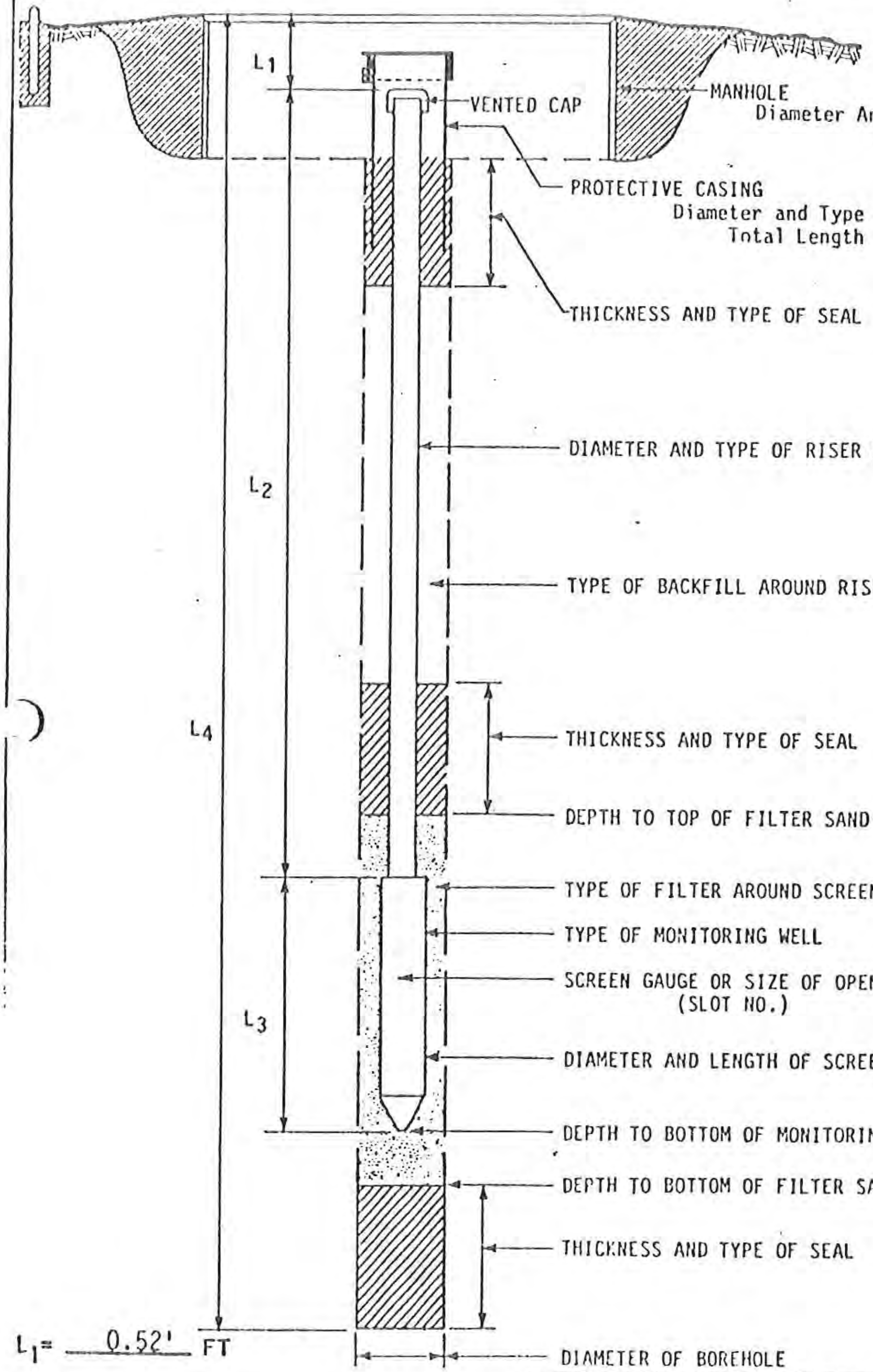
JOB NO. 120-12955

MONITORING WELL NO. 2-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1067.5'

TOP OF RISER ELEVATION 1066.98' (With Cap Removed)



MANHOLE Diameter And Type 12" steel

Depth 5"

PROTECTIVE CASING Diameter and Type 6" steel

Total Length 2'

THICKNESS AND TYPE OF SEAL 2.5' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 2.5'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 18.52'

DEPTH TO BOTTOM OF FILTER SAND 20.0'

THICKNESS AND TYPE OF SEAL None

DIAMETER OF BOREHOLE 6"

L_1= 0.52' FT

L_2= 3' FT

= 15' FT

L_4= 20.0' FT

MONITORING WELL WATER LEVEL MEASUREMENTS			
DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-21-85	9:10 am	5.79'	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:

Date 1-8-85 Time 2:00 pm

soil exploration company

INSTALLATION OF MONITORING WELL

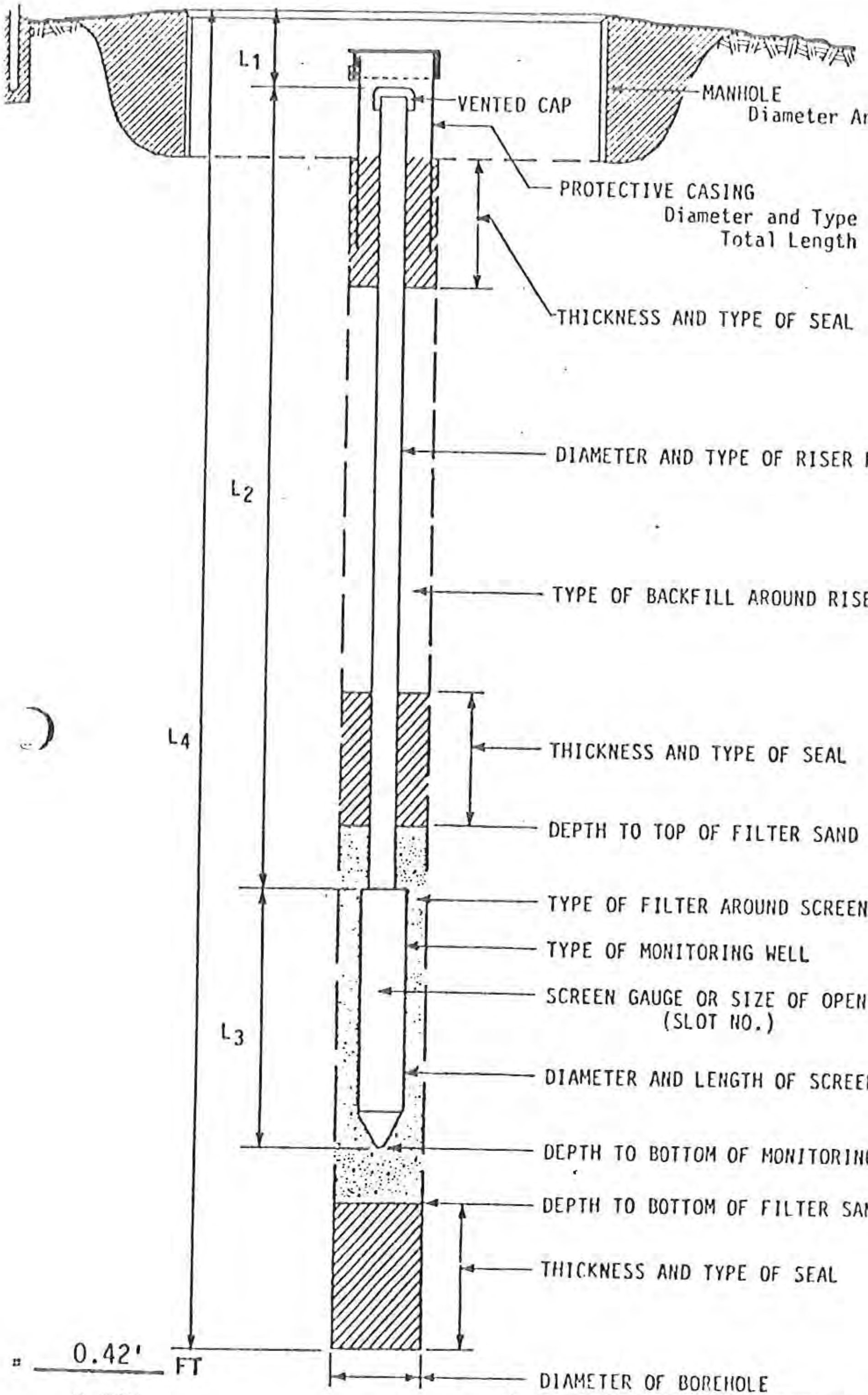
JOB NO. 120-12955

MONITORING WELL NO. 3-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1072.6'

TOP OF RISER ELEVATION 1072.18'
(With Cap Removed)



VENTED CAP

MANHOLE
Diameter And Type 12" steel
Depth 5"

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 3' Grout

DIAMETER AND TYPE OF RISER PIPE s" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL --

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 19.12'

DEPTH TO BOTTOM OF FILTER SAND 21.0'

THICKNESS AND TYPE OF SEAL None

DIAMETER OF BOREHOLE 6"

= 0.42' FT

= 3.70' FT

15' FT

= 21' FT

MONITORING WELL WATER LEVEL MEASUREMENTS			
DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-21-85	9:28 am	7.69'	

(1) DEPTH BELOW TOP OF RISER PIPE

ALLATION COMPLETED:
1-10-85 Time 1:00 pm

soil exploration company

INSTALLATION OF MONITORING WELL

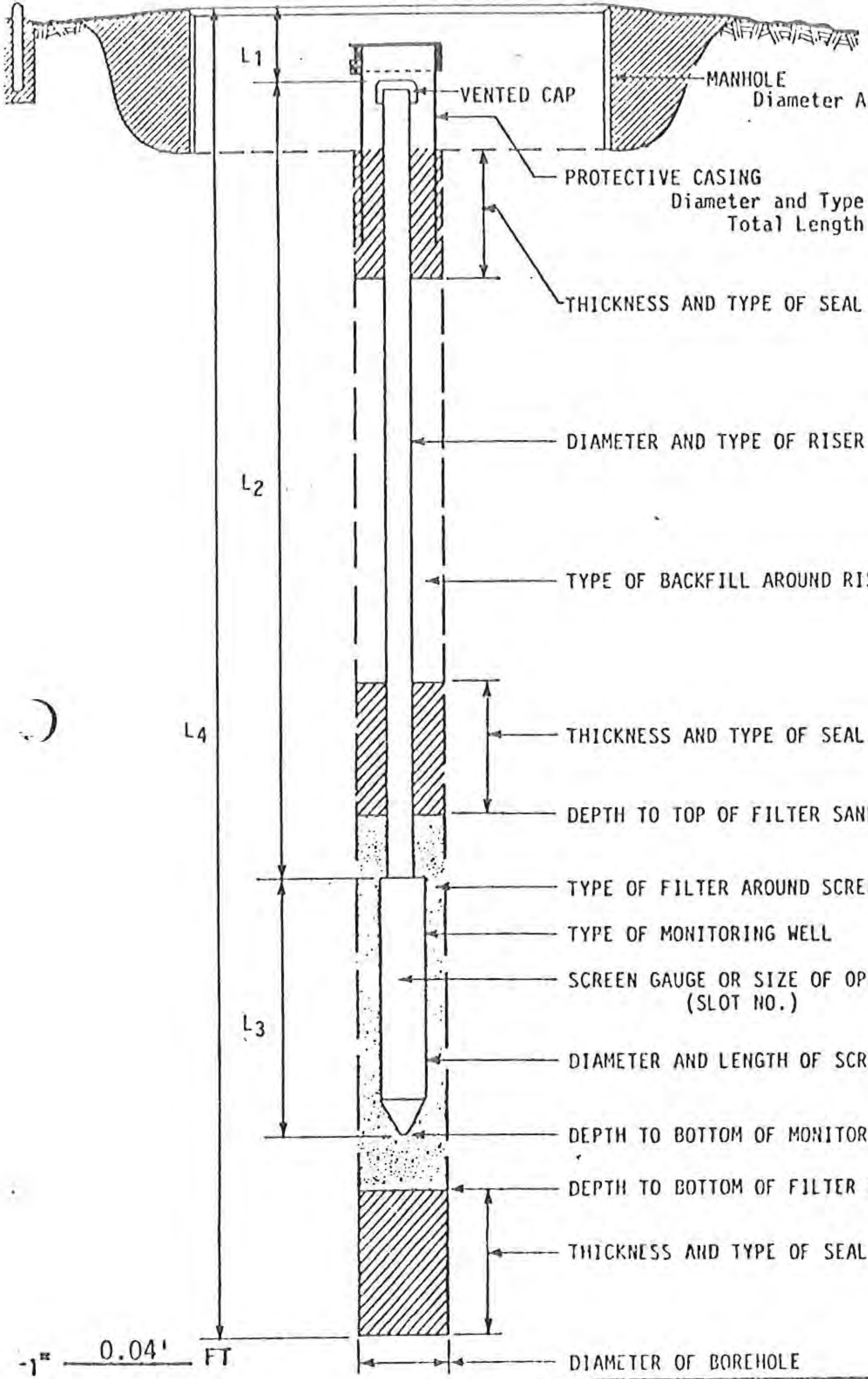
JOB NO. 120-12955

MONITORING WELL NO. 4-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1075.7'

TOP OF RISER ELEVATION 1075.74' (With Cap Removed)



MANHOLE Diameter And Type N/A

Depth N/A

PROTECTIVE CASING Diameter and Type 6" steel

Total Length 2'

THICKNESS AND TYPE OF SEAL 3' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 19.94'

DEPTH TO BOTTOM OF FILTER SAND 21.0'

THICKNESS AND TYPE OF SEAL -

DIAMETER OF BOREHOLE 6"

-$_1$= 0.04' FT

-$_2$= 4.90' FT

) 15' FT

L_4= 21' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	12:00	9.00'	
2-21-85	12:00	9.00'	

(1) DEPTH BELOW TOP OF RISER PIPE.

ISTALLATION COMPLETED:

ate 1-14-85 Time 2:00 pm

SOIL EXPLORATION COMPANY

INSTALLATION OF MONITORING WELL

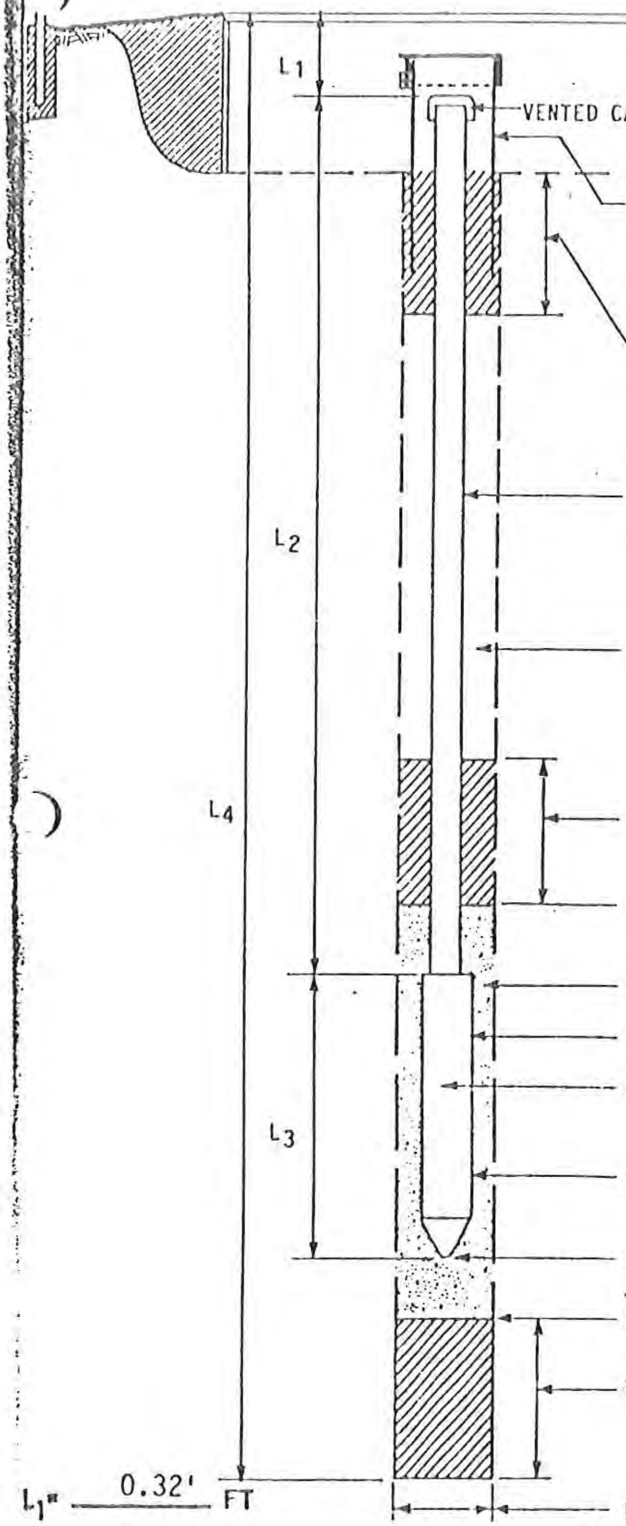
JOB NO. 120-12955

MONITORING WELL NO. 5-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1069.7'

TOP OF RISER ELEVATION 1069.38'
(With Cap Removed)



MANHOLE
Diameter And Type 12" steel
Depth 5"

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 1.0' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 1.0'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 16.82'

DEPTH TO BOTTOM OF FILTER SAND 18.0'

THICKNESS AND TYPE OF SEAL None

DIAMETER OF BOREHOLE 6"

L_1= 0.32' FT

L_2= 1.5' FT

15' FT

L_4= 18' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	10:18 am	5.11'	
2-21-85	9:49	5.10	

(1) DEPTH BELOW TOP OF RISER PIPE

NSTALLATION COMPLETED:

Date ________ Time ________

soil exploration company

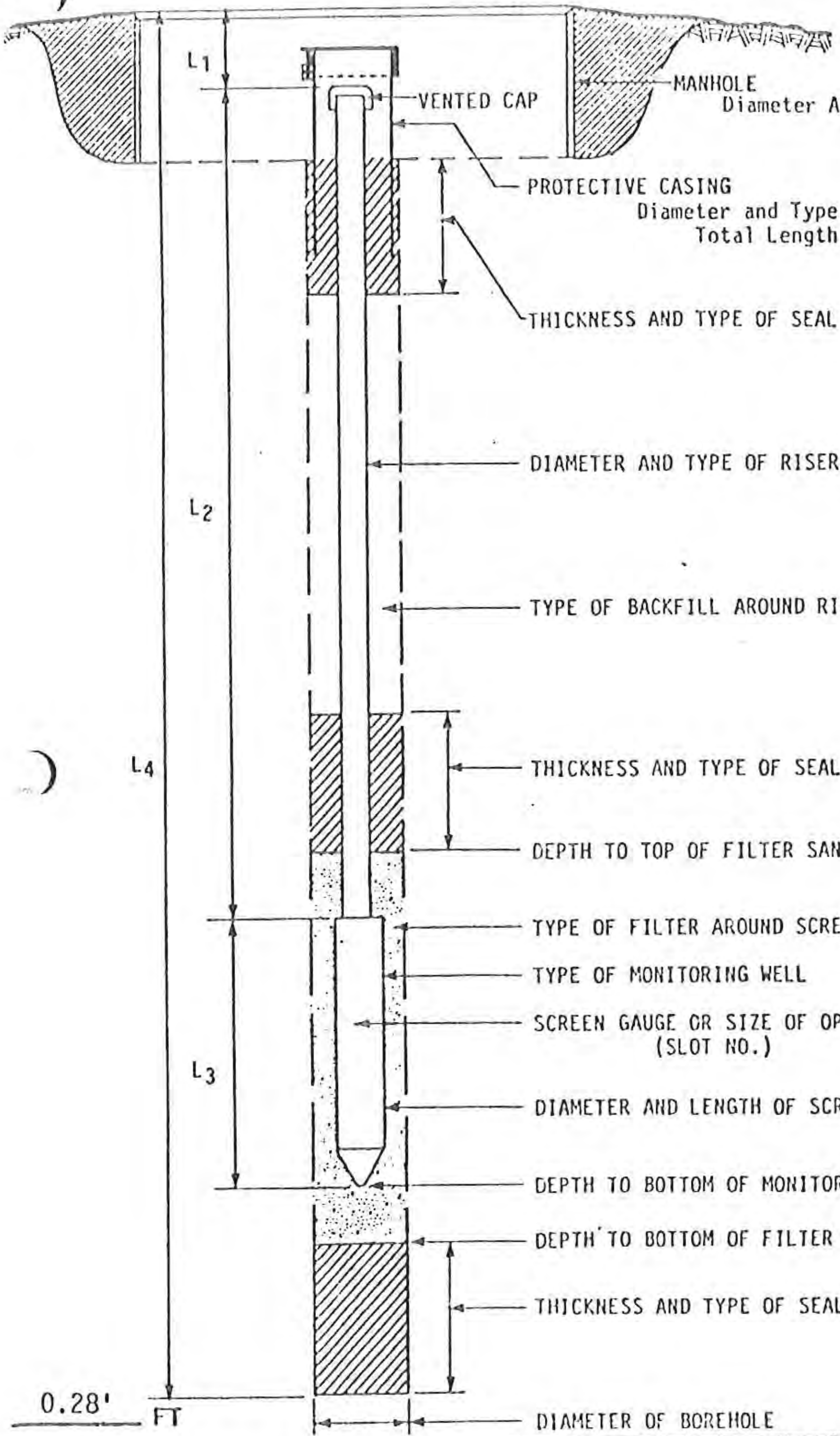
B NO. 120-12955

MONITORING WELL NO. 6-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1071.4'

TOP OF RISER ELEVATION 1071.12'
(With Cap Removed)



MANHOLE Diameter And Type 12" steel

Depth 5"

PROTECTIVE CASING Diameter and Type 6" steel

Total Length 2'

THICKNESS AND TYPE OF SEAL 2' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 2'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 19.28'

DEPTH TO BOTTOM OF FILTER SAND 21.0'

THICKNESS AND TYPE OF SEAL -

DIAMETER OF BOREHOLE 6"

0.28' FT

4' FT

15' FT

12' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	10:42am	7.17'	
2-21-85	10:07	7.17'	

(1) DEPTH BELOW TOP OF RISER PIPE

LLATION COMPLETED: 1-18-85 Time 1:00 pm

soil exploration company

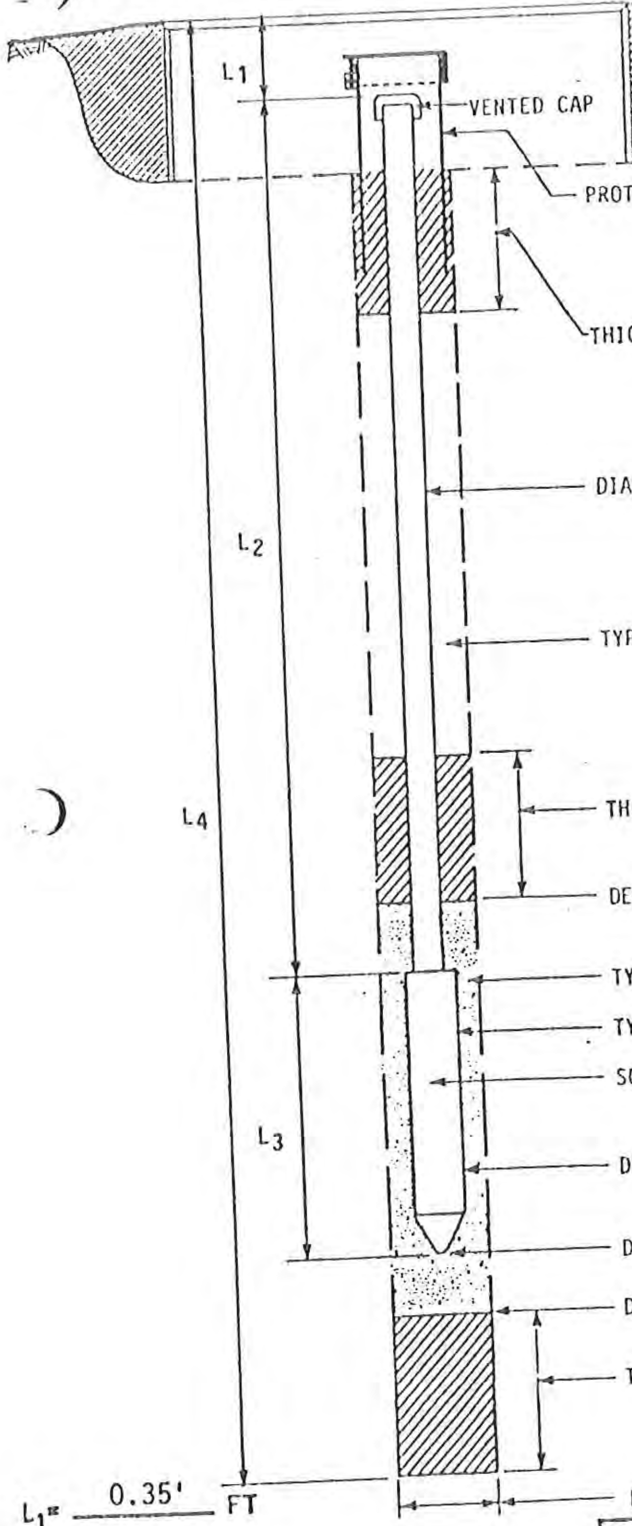
OB NO. 120-12955

MONITORING WELL NO. 7-S5

ARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1072.5'

TOP OF RISER ELEVATION 1072.15'
(With Cap Removed)



MANHOLE
Diameter And Type 12" steel
Depth 5"

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 2' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 2'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 19.25'.

DEPTH TO BOTTOM OF FILTER SAND 20.0'

THICKNESS AND TYPE OF SEAL -

DIAMETER OF BOREHOLE 6"

L1= 0.35' FT

L2= 3.90'' FT

15' FT

L4= 20' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	11:17am	7.11'	
2-21-85	10:22	7.15'	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date 1-22-85 Time 3:30 pm

SOIL EXPLORATION COMPANY

INSTALLATION OF MONITORING WELL

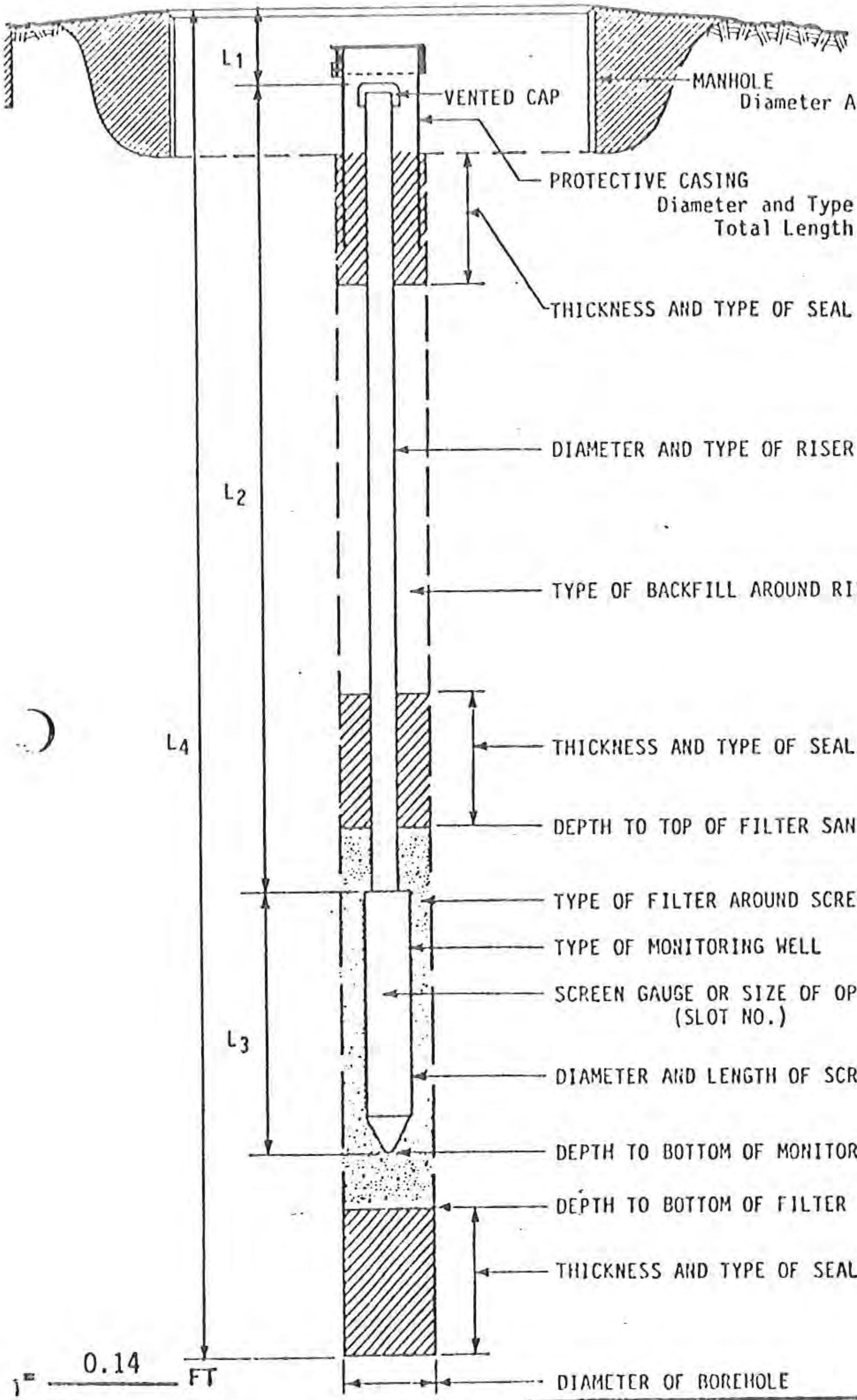
JOB NO. 120-12995

MONITORING WELL NO. 8-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1075.8'

TOP OF RISER ELEVATION 1075.66' (With Cap Removed)



MANHOLE Diameter And Type N/A

Depth N/A

PROTECTIVE CASING Diameter and Type 6" steel

Total Length 2'

THICKNESS AND TYPE OF SEAL 3' grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter gravel

THICKNESS AND TYPE OF SEAL None

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 slot

DIAMETER AND LENGTH OF SCREEN 2" x 15'

DEPTH TO BOTTOM OF MONITORING WELL 20.04'

DEPTH TO BOTTOM OF FILTER SAND 22.0'

THICKNESS AND TYPE OF SEAL None

DIAMETER OF BOREHOLE 6"

1= 0.14 FT

2= 4.90 FT

15.0 FT

4= 22.0 FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	11:53	9.51	
2-21-85	10:40	9.51	

(1) DEPTH BELOW TOP OF RISER PIPE

STALLATION COMPLETED:

te 2/14/85 Time 3:00 PM

soil exploration company

INSTALLATION OF MONITORING WELL

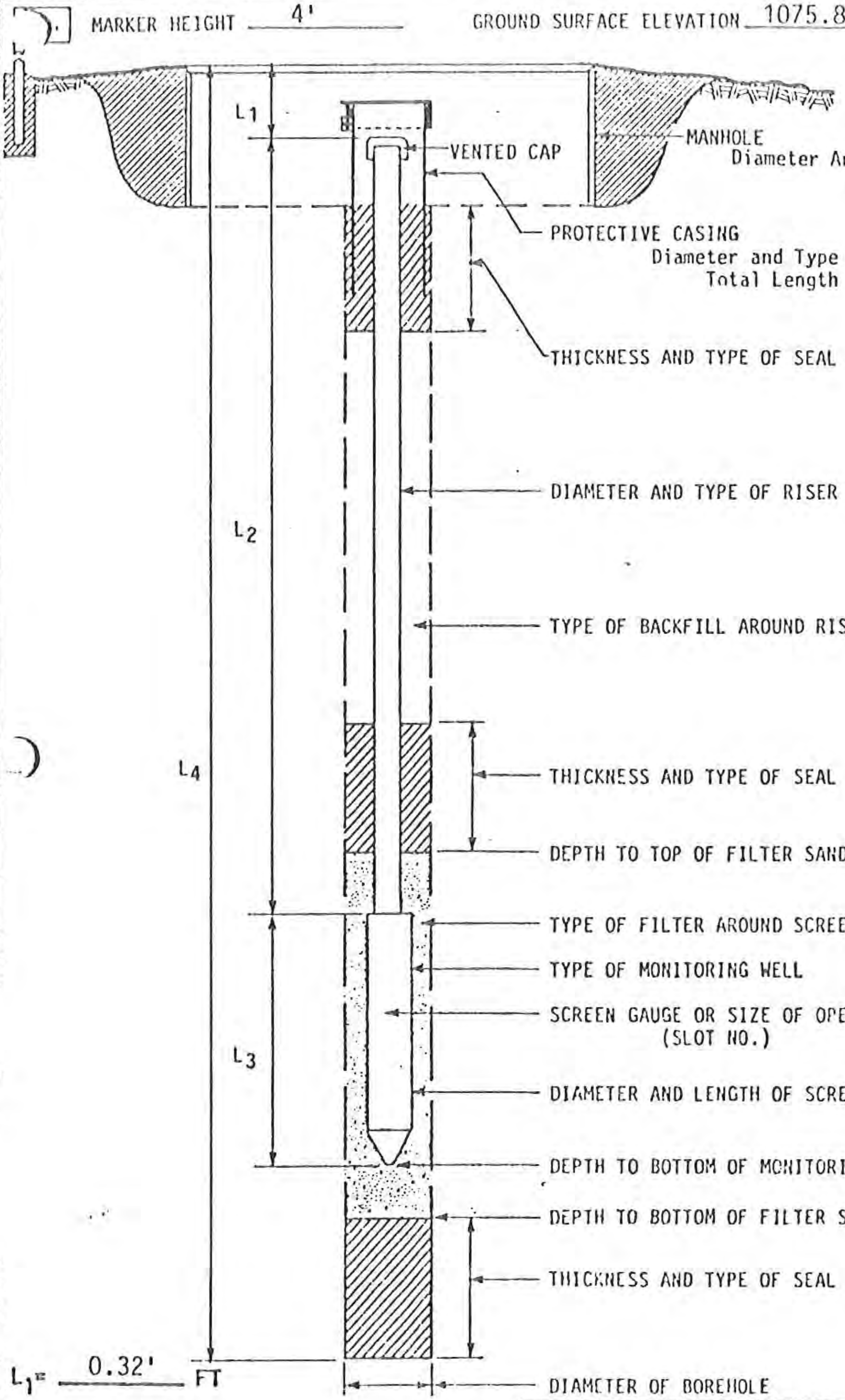
JOB NO. 120-12955

MONITORING WELL NO. 9-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1075.8'

TOP OF RISER ELEVATION 1075.48' (With Cap Removed)



MANHOLE Diameter And Type N/A

Depth N/A

PROTECTIVE CASING Diameter and Type 6" steel

Total Length 2'

THICKNESS AND TYPE OF SEAL N/A

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 19.82'

DEPTH TO BOTTOM OF FILTER SAND 21.0'

THICKNESS AND TYPE OF SEAL -

DIAMETER OF BOREHOLE 6"

L1= 0.32' FT

L2= 4.50' FT

L3= 15' FT

L4= 21' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	1:38pm	9.54'	
2-21-85	11:35am	9.54'	

(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:

Date 1-24-85 Time 3:00 pm

soil exploration company

INSTALLATION OF MONITORING WELL

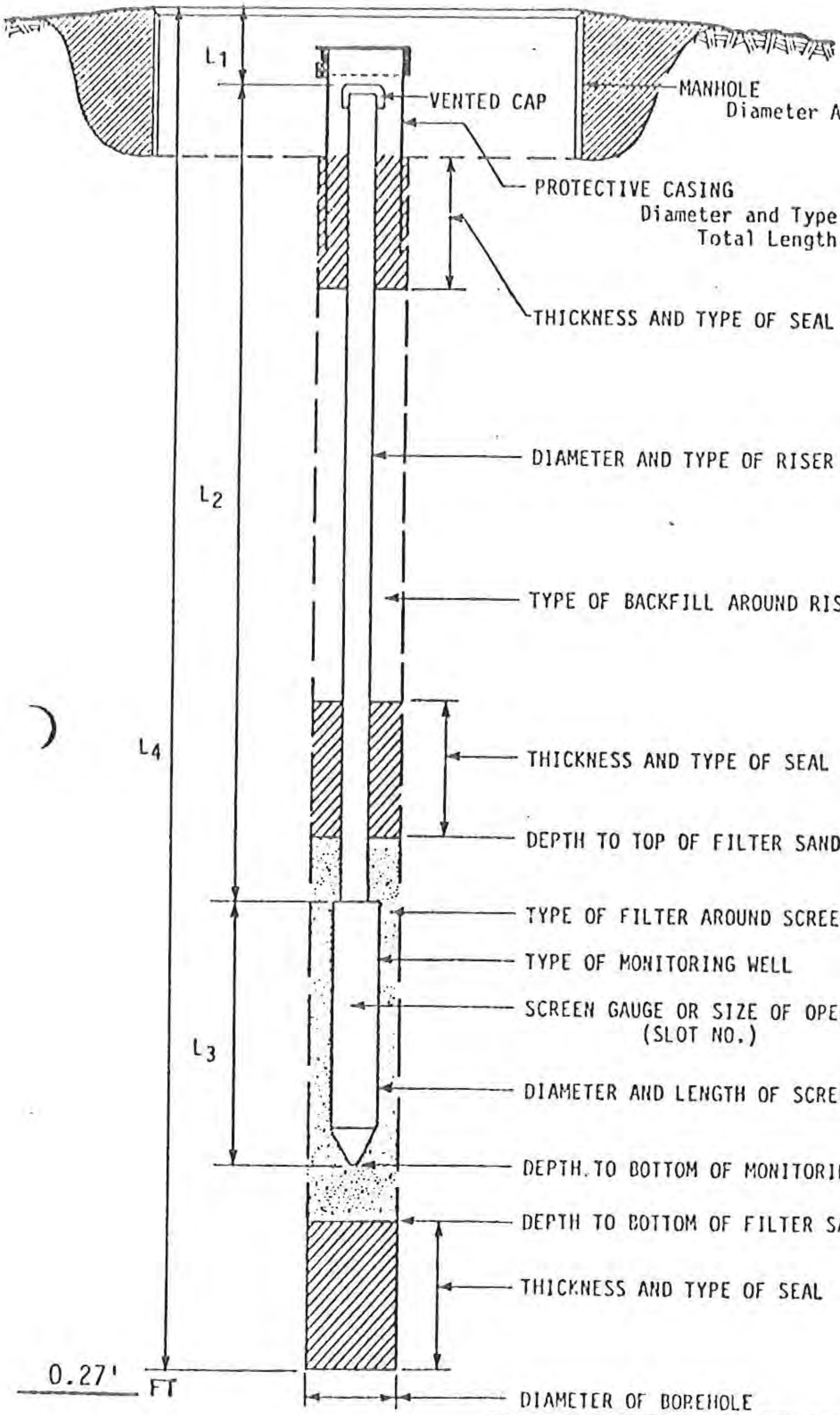
JOB NO. 120-12955

MONITORING WELL NO. 10-85

ARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1076.3'

TOP OF RISER ELEVATION 1076.03'
(With Cap Removed)



MANHOLE
Diameter And Type 12" steel
Depth 5"

PROTECTIVE CASING
Diameter and Type 6"steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 3' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 Slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 19.27'

DEPTH TO BOTTOM OF FILTER SAND 21.0'

THICKNESS AND TYPE OF SEAL -

DIAMETER OF BOREHOLE 6"

0.27' FT

4' FT

5' FT

21' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	2:12 pm	9.38'	
2-21-85	12:45	9.38	

(1) DEPTH BELOW TOP OF RISER PIPE

LLATION COMPLETED: 1-29-85 Time 11:30

soil exploration company

INSTALLATION OF MONITORING WELL

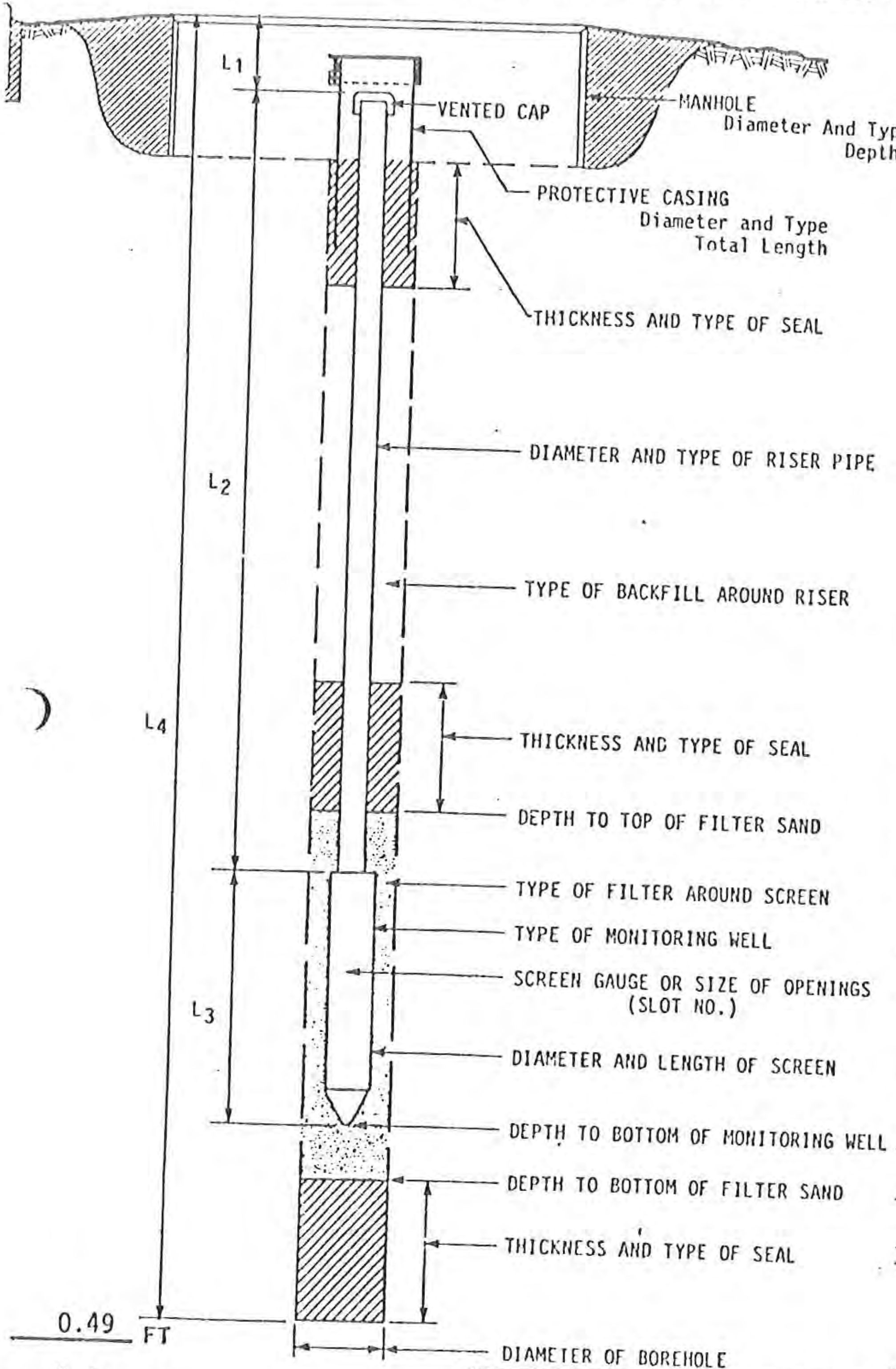
JOB NO. 120-12955

MONITORING WELL NO. 11-85

). MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1077.7'

TOP OF RISER ELEVATION 1077.21' (With Cap Removed)



MANHOLE
Diameter And Type N/A
Depth N/A

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 3' grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter gravel

THICKNESS AND TYPE OF SEAL None

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 slot

DIAMETER AND LENGTH OF SCREEN 2" x 15'

DEPTH TO BOTTOM OF MONITORING WELL 20.49'

DEPTH TO BOTTOM OF FILTER SAND 22.0'

THICKNESS AND TYPE OF SEAL None

DIAMETER OF BOREHOLE 6"

0.49 FT
5.0 FT
15.0 FT
22.0 FT

MONITORING WELL WATER LEVEL MEASUREMENTS			
DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	3:12pm	10.48	
2-21-85	3:00pm	10.48	

(1) DEPTH BELOW TOP OF RISER PIPE

LLATION COMPLETED:
1-31-85 Time 10:00 am

SOIL EXPLORATION COMPANY

INSTALLATION OF MONITORING WELL

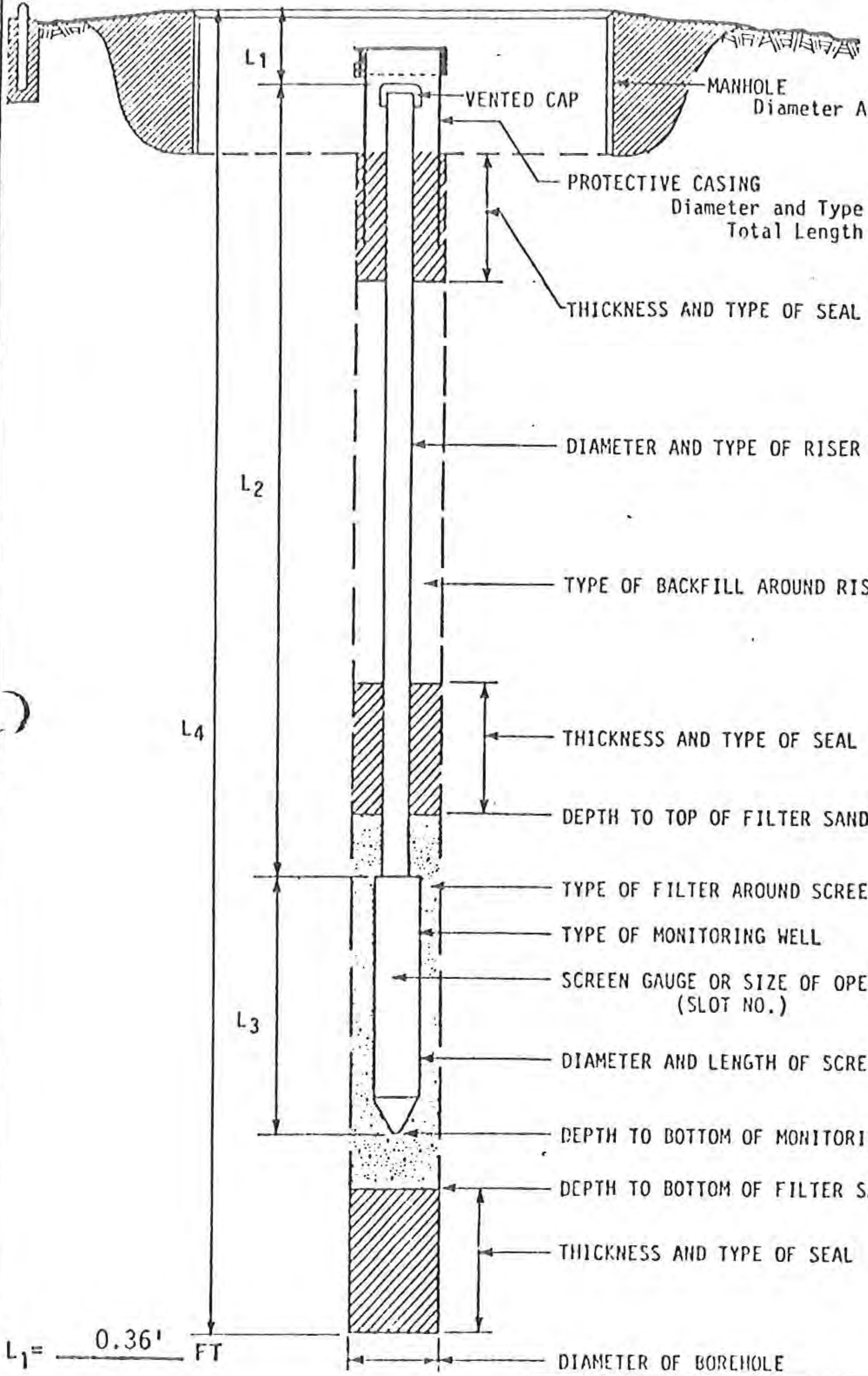
JOB NO. 120-12955

MONITORING WELL NO. 12-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1078.6'

TOP OF RISER ELEVATION 1078.24'
(With Cap Removed)



VENTED CAP

MANHOLE
Diameter And Type 12"steel
Depth 5"

PROTECTIVE CASING
Diameter and Type 6" steel
Total Length 2'

THICKNESS AND TYPE OF SEAL 3' Grout

DIAMETER AND TYPE OF RISER PIPE 2" FT PVC

TYPE OF BACKFILL AROUND RISER Filter Gravel

THICKNESS AND TYPE OF SEAL -

DEPTH TO TOP OF FILTER SAND 3'

TYPE OF FILTER AROUND SCREEN Filter Gravel

TYPE OF MONITORING WELL 2" FT PVC

SCREEN GAUGE OR SIZE OF OPENINGS (SLOT NO.) #10 slot

DIAMETER AND LENGTH OF SCREEN 2" X 15'

DEPTH TO BOTTOM OF MONITORING WELL 21.36'

DEPTH TO BOTTOM OF FILTER SAND 22.0'

THICKNESS AND TYPE OF SEAL -

DIAMETER OF BOREHOLE 6"

L_1= 0.36' FT

L_2= 6' FT

L_3= 15' FT

L_4= 22' FT

MONITORING WELL WATER LEVEL MEASUREMENTS

DATE	TIME	WATER LEVEL (1)	OBSERVATIONS
2-20-85	3:12	10.48'	
2-12-85	3:00	10.48	

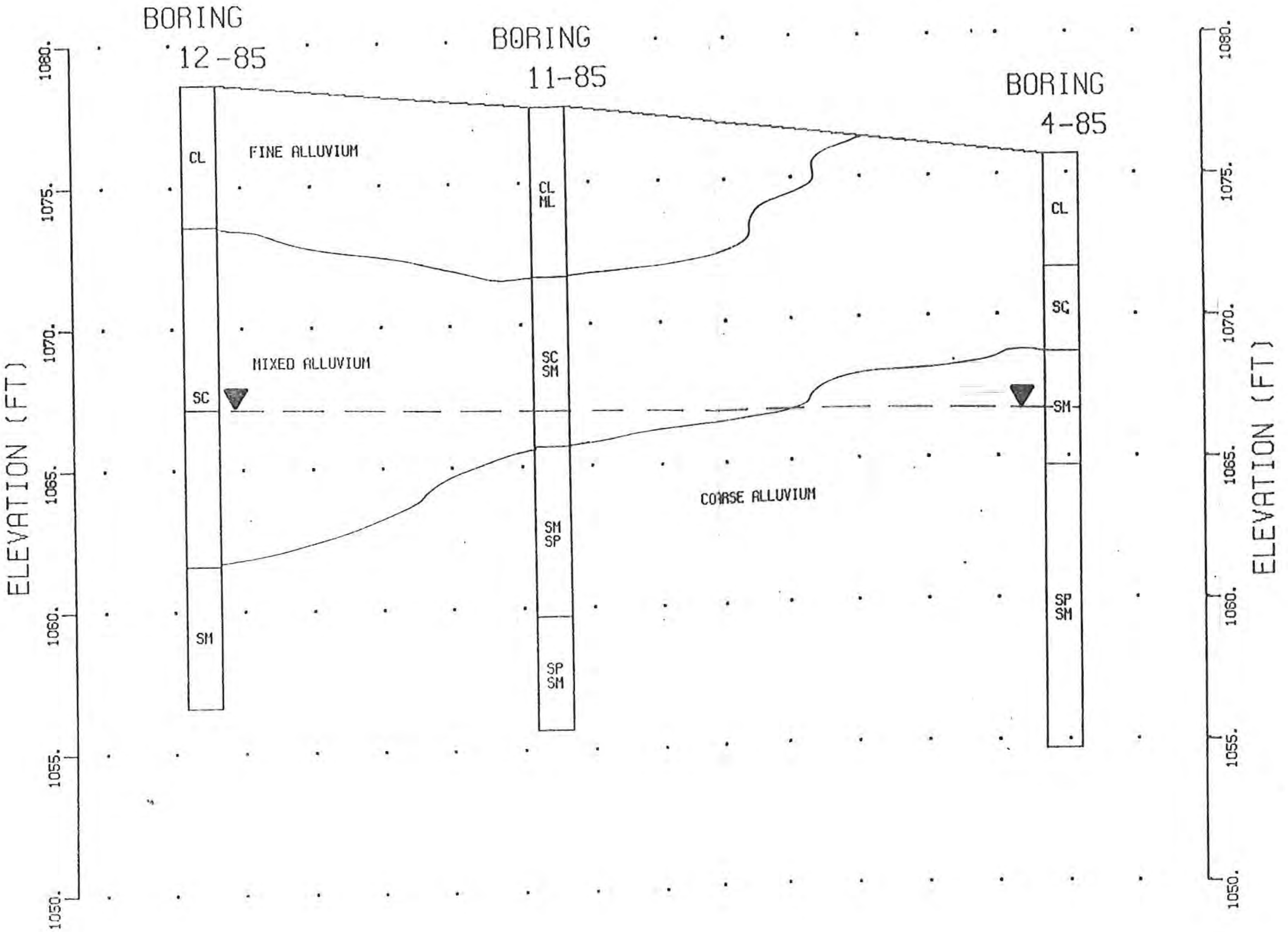
(1) DEPTH BELOW TOP OF RISER PIPE

INSTALLATION COMPLETED:
Date 2-20-85 Time 2:00 pm

soil exploration
company

A ⟷ A'

CROSS SECTION LOCATIONS SHOWN ON FIGURE #2



NOTE: EXCEPT AT BORING LOCATIONS THE GROUND SURFACE, WATER LEVEL, AND BOUNDARIES BETWEEN SOIL LAYERS ARE INFERRED.

FIGURE #3

SOIL PROFILE

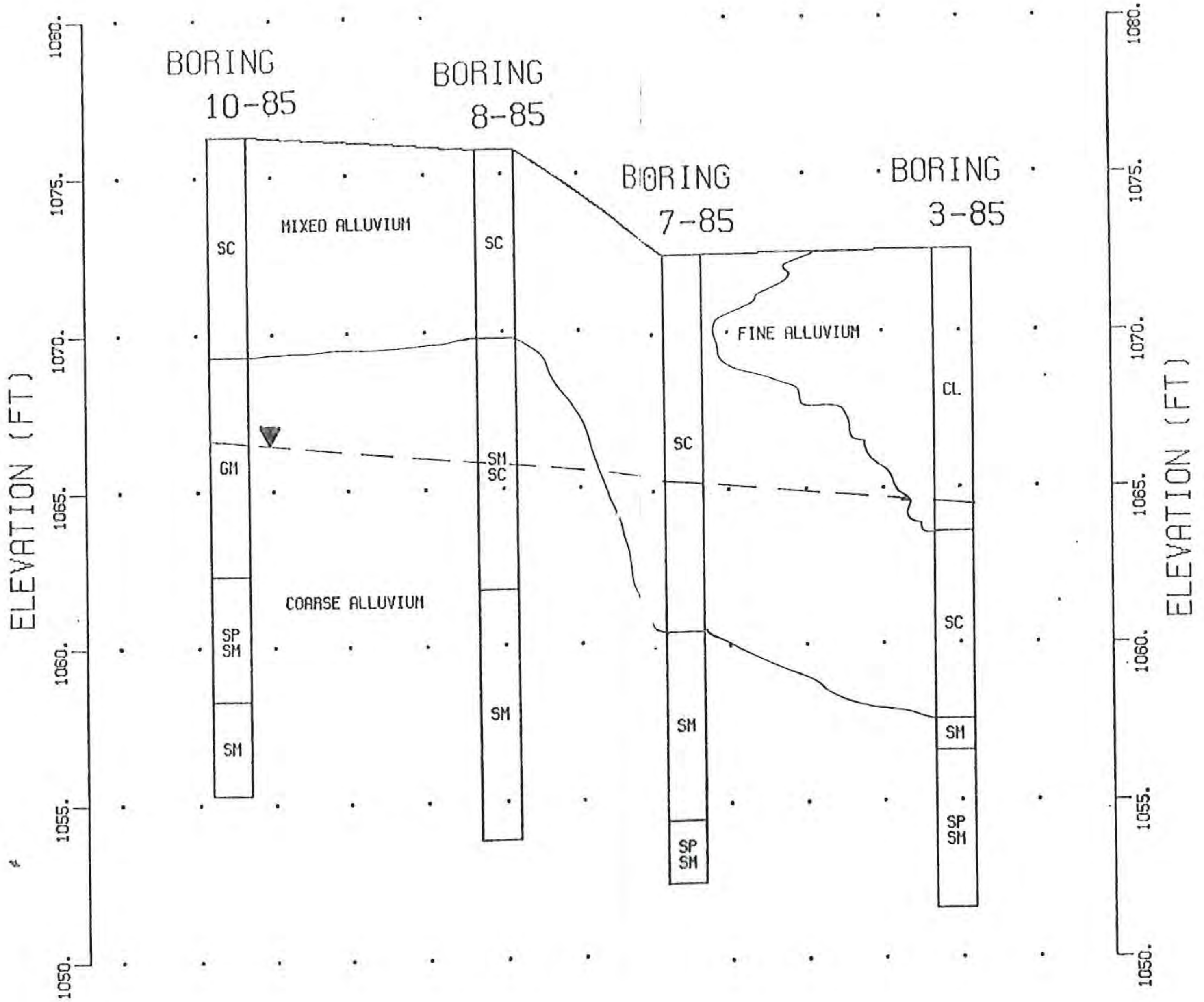
GASOLINE SPILL INVESTIGATION
YAKIMA, WASHINGTON
W.O. 120-12955

SOIL EXPLORATION COMPANY

SCALE: VERT: 1 IN = 5. FT
HORZ: 1 IN = 200. FT

B ←→ B'

CROSS SECTION LOCATIONS SHOWN ON FIGURE #2



NOTE: EXCEPT AT BORING LOCATIONS THE GROUND SURFACE, WATER LEVEL, AND BOUNDARIES BETWEEN SOIL LAYERS ARE INFERRED.

FIGURE #4

SOIL PROFILE

GASOLINE SPILL INVESTIGATION
YAKIMA, WASHINGTON
W.O. 120-12955

SOIL EXPLORATION COMPANY

SCALE: VERT: 1 IN = 5. FT
HORZ: 1 IN = 200. FT

C ↔ C'

CROSS SECTION LOCATIONS SHOWN ON FIGURE #2

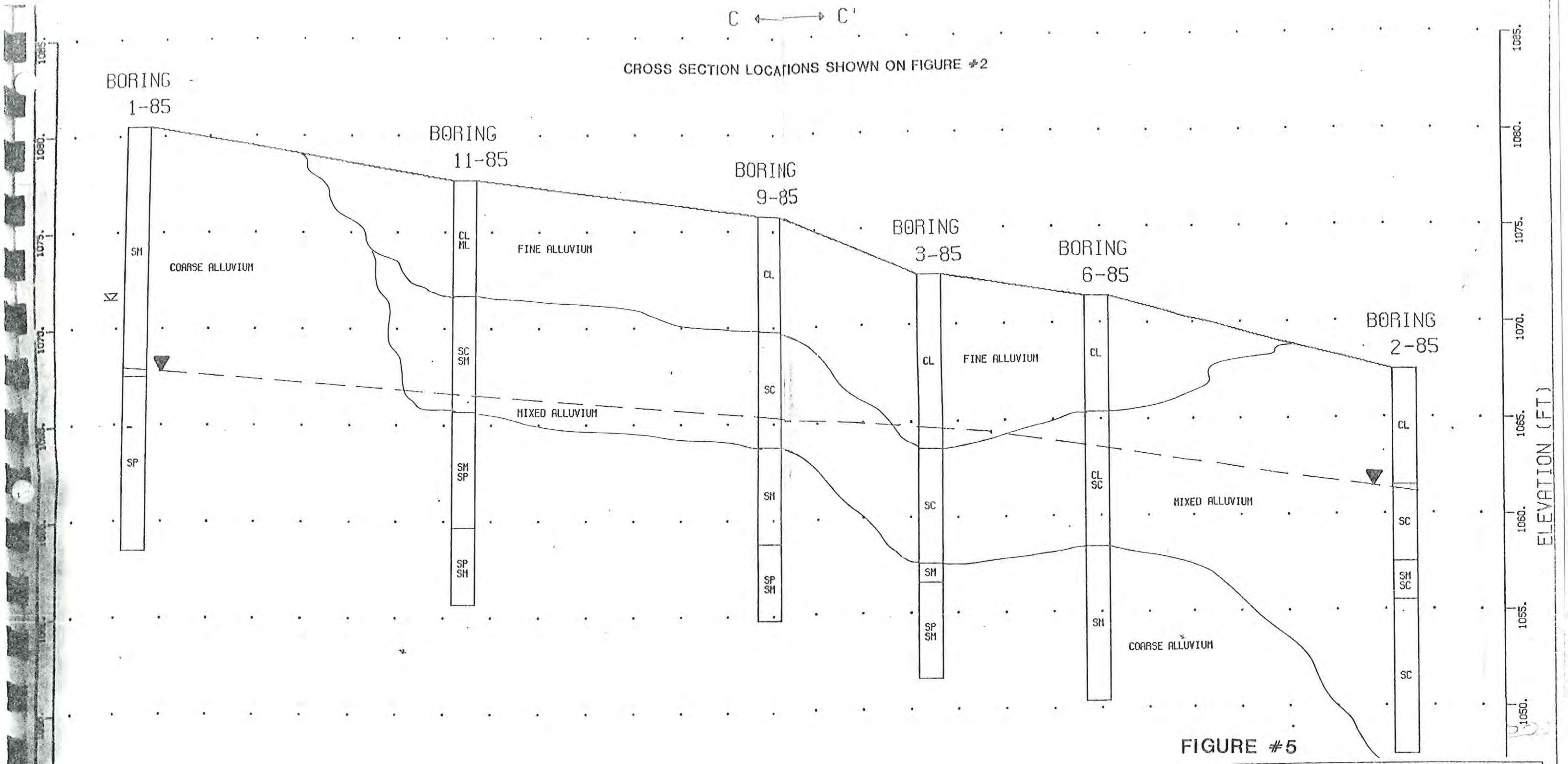


FIGURE #5

NOTE: EXCEPT AT BORING LOCATIONS THE GROUND SURFACE, WATER LEVEL, AND BOUNDARIES BETWEEN SOIL LAYERS ARE INFERRED.

SOIL PROFILE

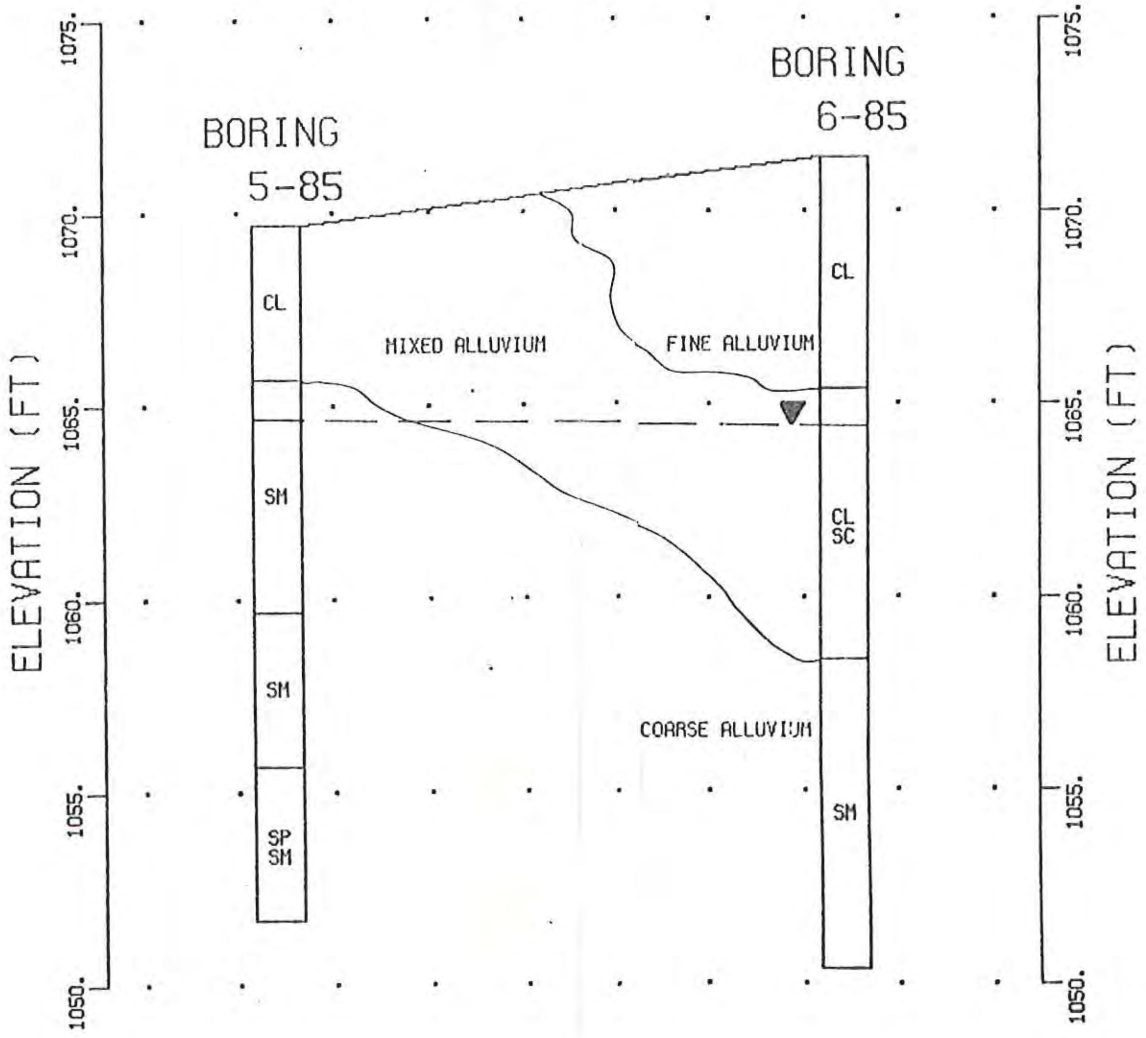
GASOLINE SPILL INVESTIGATION
YAKIMA, WASHINGTON
W.O. 120-12955

SOIL EXPLORATION COMPANY

SCALE: VERT: 1 IN = 5. FT
HORZ: 1 IN = 200. FT

D ↔ D'

CROSS SECTION LOCATIONS SHOWN ON FIGURE #2



NOTE: EXCEPT AT BORING LOCATIONS THE GROUND SURFACE, WATER LEVEL, AND BOUNDARIES BETWEEN SOIL LAYERS ARE INFERRED.

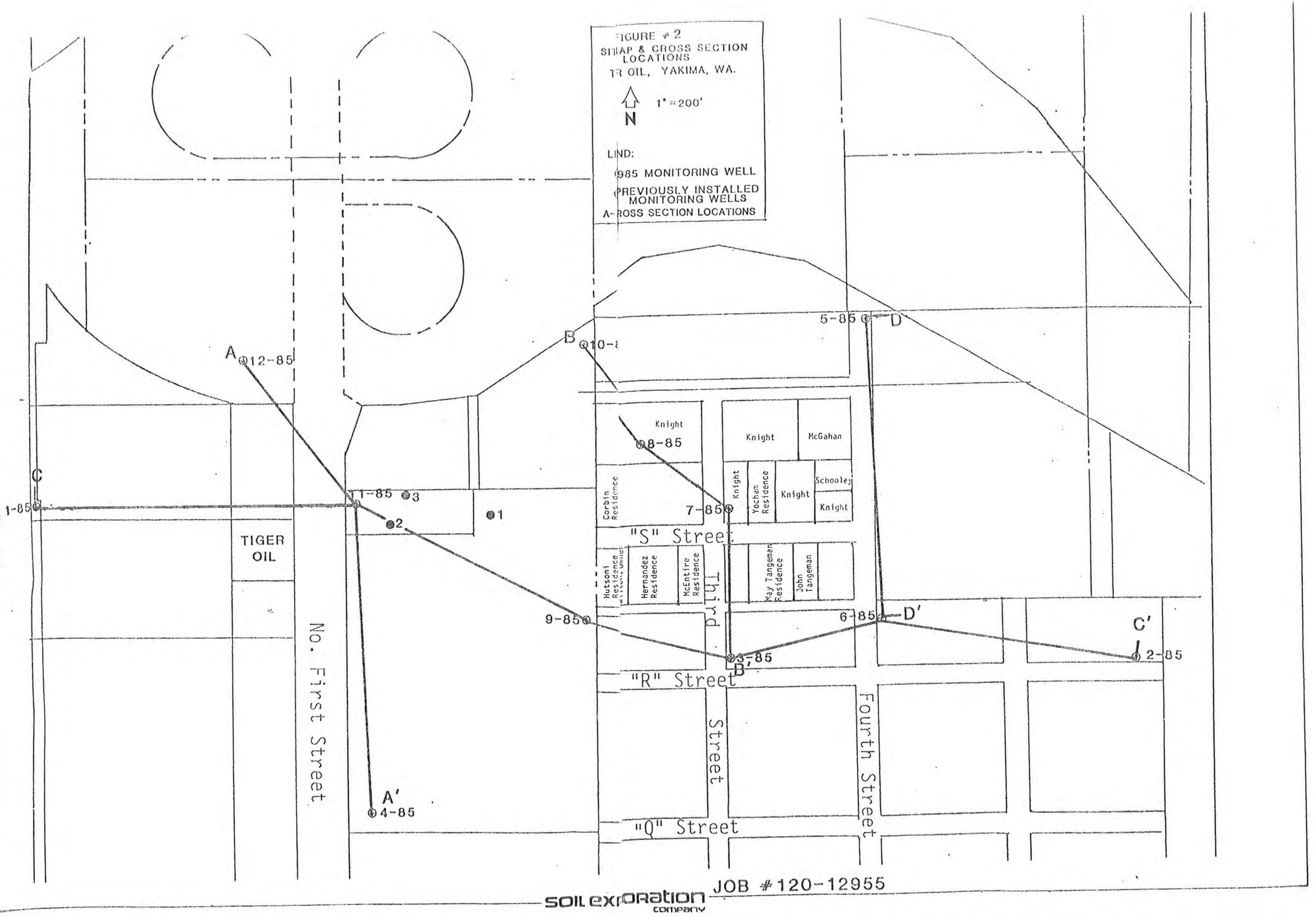
FIGURE #6

SOIL PROFILE

GASOLINE SPILL INVESTIGATION
YAKIMA, WASHINGTON
W.O. 120-12955

SOIL EXPLORATION COMPANY

SCALE: VERT: 1 IN = 5. FT
HORZ: 1 IN = 200. FT



IGURE # 2
SI MAP & CROSS SECTION LOCATIONS
T R OIL, YAKIMA, WA.

JOB #120-12955

soil exploration company

T-7.1 FIELD LOG

Location YAKMA WASHINGTON Date 9-29-86 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist ______

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
					See T-7.2 FOR FINISH	0-20 See Log T-5	
5							
10					2" PVC CASING (29' LONG)		
15				14.0'	NATURAL SAND CUTTINGS		
20				20.7		20-22' Sand, fine to medium coarse, gravel to ½"; Clay, gray.	. Sand and gravel 20 - 36
						22-24' Sand, fine to coarse, gravel to ⅜"; some clay, gray.	
25						24-26' Sand, fine to coarse, gravel to ¼, clay gray/brown.	
				27.8		26-28' Sand, fine to very coarse, gravel to ¼" (but less than above), clay, brown.	
30				29.8	NATURAL SAND.	28-30' Sand, fine to very coarse, gravel to ½", clay, dark brown.	
						30-32' Same	
35						32-34' Sand, fine to very coarse, gravel to ¼-⅜", clay, light brown-grayish.	
				36.3		34-36' Sand, fine to very coarse, clay, grayish; gravel to ¼". Fragments of cobbles and pebbles up to ½".	
					2'FT 0.01 SLOT PVC SCREEN	36' Sand, fine to very coarse, mostly medium to coarse; gravel to ¼" few fragments; Clay, light brown to grayish.	

Location ______ Date ______ Local well number T-6.2

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist D.S. Peterson

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

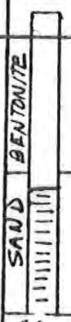
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	-2.2'	Lithologic description	Summary log
						See T-2 FOR LOG	
5							
				7.0 7.65			
10							
				13.65	6' OF 0.01 SLOT PVC SCREEN		
					NATURAL FILL 13.65 TO 32.95	PIEZOMETERS T-6.1 T-6.2 ARE IN SAME 6" ? HOLE.	
						(NOTE: BECAUSE THERE IS NO BENTONITE IN INTERVAL BETWEEN 32.95 FT AND 7.0 IT IS POSSIBLE THAT HEAD FOR INTERVAL IS COMPOSITE FOR INTERVAL.)	



Sheet ___ of ___

T-6.1 FIELD LOG
REWRITTEN BY JBG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist D.B. Sapik

Lithologic Symbols

☐ ☐ ☐

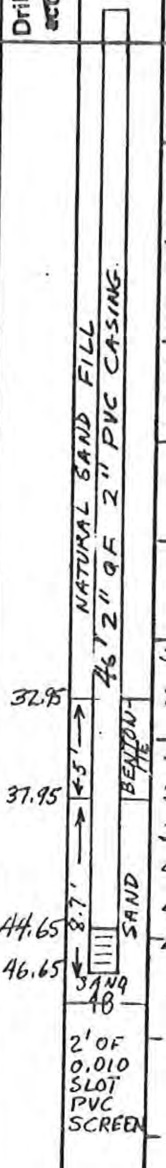
☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______
Twsp. ______
Sec.

Depth	Scale	Sample	Graphic log	Drill action	-1.35'	Lithologic description	Summary log
0						See T-2 for 0-30'	
5							
10							
15							
20							
25							
30						30-32' Gravel, clasts to 3/4"; sand, medium to coarse; clay light brown.	Gravel, sand and clay 30-32'
				32.95		32-34' Sand, fine to coarse; gravel to 1/8"; clay dark brown and gray.	Sand, gravel clay 32-48
35						34-36' Sand, fine to coarse, gravel to 1"; clay light brown and gray.	
				37.95		36-38' Sand, medium to coarse, gravel to 1/4"; clay light brown and gray clay	
40						38-40 Sand, fine to very coarse, gravel to 1/2", clay, gray	
						40-42' Sand, medium to coarse, gravel to 1/4", clay gray.	
						42-44' Sand, medium to coarse, gravel to 1/2", clay light brown to gray.	
45				44.65		44-46' Sand, fine to coarse, gravel to 1/2", clay gray.	
				46.65		46-48' Sand, fine to coarse, gravel to 1/2", clay gray.	



T-5 FIELD LOG

Location ____ Date ____ Local well number ____

County ____ Map ____ Scale ____ Lat. ____ Long. ____

District ____ Project number ____ Altitude ____

Driller ____ Helper ____ Geologist 0-8' D.S Sapik & 8' To Peterson S Peterson

Rge. ____

Twsp. ____

Sec. ____

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Clay & silt with some gravel to ¼".	Clay and silt, gravelly 0-2
						2-5 Fine sand to gravel (Max ½")	Sand and gravel 2-5'
5							
		▨	CORE 8.2-9.3			6-7 Gravel (¼") to cobbles (rock chips) 7 Gravel to ¼" with fine sand. 8.2 to 9.2' Cobbly coarse gravel with little clayey fine sand.	Gravel sandy cobbly 5-9.2
10		▨				10-12 Very coarse sand and medium gravel some silt and fine sand; light brown water (mafic clasts)	Sand and gravel 9.2-14
		▨				12-14 Medium sand and gravel, black and gray. Sewer like smell and heavy gas smell.	Diesel or sewer smell
15		▨				14.' Clayey silt, grey with much medium gravel, black. Gas smell.	Silt, clayey, gravelly 14-16 (Gas smell)
		▨				16-18' Gravel, very to coarse, cemented silt to sand, medium, matrix. Gas smell	Gravel silty, sandy 16-18 (Gas smell); 17-18' much water
20					2' FT 0.010 SLOT SCREEN PVC	18-20 Same as above; 17-18' much water	

LOG INDICATES BOREHOLE DEPTH 18'
DIAGRAM IN FIELD BOOK SAYS 17'
TOP OF SCREEN LISTED AS 13.5 FT
PLUS 2 FT OF SCREEN SUGGESTS
DEPTH OF CASING ONLY 15.5 FT. TO
BOTTOM

T-4 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist DB. Sapik

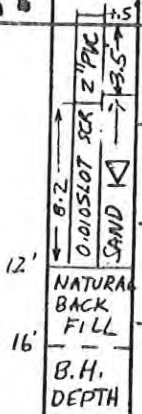
Lithologic Symbols

Abbreviations						
clay	c	cobbles	cob	sandy	sdy	
silt	st	boulders	b	fine	f	
sand	s	clayey	cly	medium	m	
gravel	g	silty	sty	coarse	co	

Rge. ______

Twsp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						Same as T-3	
5							
10							
				12'			
				16'			
						WELL LOCATED 2' FROM T-3, (TOO CLOSE) DURING DRILLING AIR PRESS RELEASED THROUGH T-3 BORE HOLE.	



T-3 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist D. B Sapik ?

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	?	Lithologic description	Summary log
						0-6'. Clay to medium sand	Clay sandy ? 0-6
5						6-8' gravel	Gravel 6-8
						8-10' Sand	Sand 8-10
10					Caved in (Bentonite ?)	10-12' Sand and gravel	Sand and gravel
						12-14' Sand and gravel - hard drilling	
15						14-16' Sand and gravel (clasts > than 1") (hard drilling; large chips)	
						16-18' Sand and gravel, rounded pebbles up to 1" at 17'.	
20						18-22 Fine sand to gravel	
						22-24' Coase sand and gravel, some chips.	
25						24-26' Clay, fine to coarse sand	Clay, sandy. 24-26
				Sand Pack	28 Sand	26-28' Clay, fine sand, gravel to ¼"	
30					30 ↑ 0.010 SLOT SCREEN	28-30' Medium sand, clay, gravel to ½"	Sand, clayey, gravelly. 28-30
35					BORE HOLE TO 35'		

T-2 - FIELD LOG

Location YAKIMA, WASH Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist D.S Peterson

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy		
silt	st	boulders	b	fine	f		
sand	s	clayey	cly	medium	m		
gravel	g	silty	sty	coarse	co		

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
			TOP 8' BEING USED FOR OGC MULTILEVEL SAMPLES			0-6' Soil, clayey some silt.	Soil, clayey, silty
5		▨					
						7-8' Cobbles (drilling much harder) fragmented gravel.	gravel, cobbly
10		▨			2" PVC PIPE	10' Silty fine to very coarse sand with very fine to fine gravel. Sand grains generally quartz, gravel clasts are basaltic.	sand, silty, gravelly
		▨				12' Medium to coarse sand, some silt, and fine gravel, black	
15		▨				14' Silty sand with fine to coarse gravel. darker than above.	
		▨				16' Some as above	
20		▨				18' Clay and silt with some sand brown and black.	Clay and silt, sandy
						20' Same as 18'.	Sand, silty, gravelly.
25		▨		BENTONITE SEAL QUESTIONABLE MAY HAVE BRIDGED JOINT MAY LEAK	SAND PACK	25' Silty sand (coarser than above) with very fine gravel	
30		▨			2FT 0.010 SLOT PVC SCREEN	30' Same as above	
		▨				32' Same as above but entered medium gravel zone.	Gravel, sandy ? bottom of hole

T-1 FIELD

Location Yakima, Wash Date ____ Local well number ____

County ____ Map ____ Scale ____ Lat. ____ Long. ____

District ____ Project number ____ Altitude ____

Driller ____ Helper ____ Geologist D.S. Peterson

Rge. ____

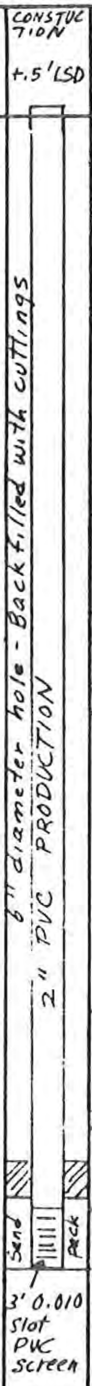
Twp. ____

Sec. ____

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co



Depth	Drill action	Lithologic description	Summary log
		0-3'. Soil, very silty and clayey No samples	Silt, clayey
		3-6'. Increasing pebbles No samples	
5		6-7'. Cobbles with very coarse sand and fine gravel	Gravel, cobbly and sandy
10		10'. Change, much silt and fine sand with medium gravel, also cobbles still present. (brown silt, darker sands).	Silt, sandy gravelly and cobbly.
15		15' Sand, fine to very coarse, clay, silt, fine. gravel, some cobbles	Sand, clayey, silty and gravelly
		17' Change to much more silt and fine sand.	Sand, silty.
20		20' Silt, fine to very coarse sand, very fine gravel some cobbles, clay?	Silt, sandy, gravelly
25		25' Medium sand to fine gravel, some silt. (brown to dark gray)	Sand and gravel, silty.
		28' Water changed in color from light muddy brown to reddish brown.	
30		30' Silt, some fine to very coarse sand and fine gravel. Gravel contains quartz, mafics feldspar variable dark colors	Silt, sandy, gravelly
		34' Water turns muddy brown again.	
35		35' Silty medium sand, some clay and fine gravel.	Sand, silty, gravelly
40		40' Silty fine to coarse sand, some cobbles, some clay(?) (brown and black). Water turning bluish (Gas slick?)	
45		45' Silt, some fine to medium sand and pebble gravel (gravel clasts black and green).	Silt, sandy, gravelly
50		50' Silt, fine to coarse sand and fine gravel Gravel clasts mostly mafic. Water very blue.	
55	Bentonite	55' Silty medium sand, dark gray to black, and fine gravel, black.	Sand, silty, gravelly
		58' Same as above, bottom of hole	Bottom of hole

9-330
(Rev. 9-67)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

File No. 2012

YAKIMA OIL & GAS SPILL

WELL NUMBER	ALTITUDE OF LSD NGVD	ALTITUDE OF MP NGVD	DEPTH OF HOLE AT TIME OF DRILLING	ALTITUDE OF BOTTOM AT TIME OF DRILL.	DEPTH TO BOTTOM OF SCREEN	ALTITUDE OF BOTTOM OF SCREEN	DEPTH TO TOP OF SCREEN	ALTITUDE OF TOP OF SCREEN	LENGTH OF SCREEN IN FEET	BOTTOM OF BENTONITE SEAL		
T-15			18.3								Soil Gas W Not finished	
T-16			18.3		13.9		7.9		6.0	4.8		
T-17			18.3		13.7		7.7		6.0	4.9		
T-18			18.3		13.1		7.1		6.0	4.7		
T-19			18.3		13.8		7.8		6.0	5.7		
T-20			18.3		13.2		7.2		6.0	6.2?		
T-21			58.3		58.3		56.3		2.0	51.3		
T-22			18.3		12.7		6.7		6.0	6.6		
B-1			18.3	← NO SEAL →	12.5		6.5		6.0	5.5		
B-2			18.7	DITTO	13.6		7.6		6.0	5.0		
B-3			38.0		32.3		30.3		2.0	15.5		
B-4			18.4		14.0		8.0		6.0	4.0		
B-5			18.3		18.0		9.0		9.0	6.0		
S-1			52.0		57±		53		2.5			
S-2			18.3		16.85		7.7		9.0	7.5?		
S-3			18.3		16.8		7.8		9.0	5.6		
S-4			17.4		17.4		8.65		9.0	4.8		
S-5			18.3		<16.0						Soil Gas Well Not completed	
H-1			58.		57.02		55.02		2	49.0		
H-2			18.3		14.60		8.60		6.0	5.5		
GS-1			15.0		14.?		~7.0		7.0	~6.0		
GS-2			[illegible] 17		13		6.0		7.0	~3+		
3/R MESA			58.5		56.21		54.21		2.0	46.0		
WS 1			58.		57.98		55.98		2.0	50.0		

9-280
(Rev. 9-67)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

File No. 1 of 2

YAKIMA OIL & GAS SPILL

Well Number	Altitude of LSD (NGVD)	Altitude of MP NGVD	DEPTH OF HOLE AT TIME OF DRILLING (FT)		DEPTH TO BOTTOM OF SCREEN	ALTITUDE OF BOTTOM OF SCREEN	DEPTH TO TOP OF SCREEN	ALTITUDE OF TOP OF SCREEN	LENGTH OF SCREEN	BOTTOM OF BENTONITE SEAL		
1-85	1080.48	1080.349	21.0		18.52		5.84		15.0	NONE —		
2-85			20.0		20		3.0		15.0	—		
3-85			21.0		19.12		3.7		15.0	—		
4-85			21.0		19.94		4.9		15.0	—		
5-85			18.0		16.82		1.5		15.0	—		
6-85			21.0		19.28		4.0		15.0	—		
7-85			20.0		19.25		3.9		15.0	—		
8-85			22.0		20.04		4.9		15.0	—		
9-85			21.0		19.82		4.5		15.0	—		
10-85			21.0		19.27		4.0		15.0	—		
11-85			22.0		20.49		5.0		15.0	—		
12-85			22.0		21.36		6.0		15.0	—		
1-82										—		
2-82										—		
3-82										—		
T-1			58.0		58.0		55.0		3.0	54-55		
T-2			32.0		30.0		28.0		2.0	27	JOINT B[illegible] AT DEPTH OF 8' WHEN DP [illegible] MAY LEAK	
T-3			33.0		30.0		28.0		2.0	26	OGC SAMPLERS UPPER 8 FT - CAVED ??	
T-4			16.0		12.0		3.8		8.2	3.5	WELL TOO CLOSE TO T3 HOLE COMMUNICATE	
T-5			17 20.0		15.5		13.5		2.0	12.5?		
T-6.1			48.0		46.65		44.65		2.0	32.95 37.95		
T-6.2			(32.95)	← No PLUG →	13.65		7.65		6.0	—		
T-7.1			36.3		32.3		30.3		2.0	25.0		
T-7.2			[illegible] to 14.		13.3		7.3		6.0	—		
T-8			18.3		14.35		8.35		6.0	—		
T-9			18.3		13.04		7.04		6.0	5.0		
T-10			12.3		14.3		8.3		6.0	5.3		
T-11			18.3		14.2		8.2		6.0	5.6		
T-12			18.3		13.4		7.4		6.0	6.2		
T-13			33 > 36.		32.2		30.5		2.0	Not finished	OGC will finish	
T-14			18.3		12.8		6.8		6.0	4.1		

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1 of 1

3-R FIELD LOG

Location ______ Date 10-10-86 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron Lane

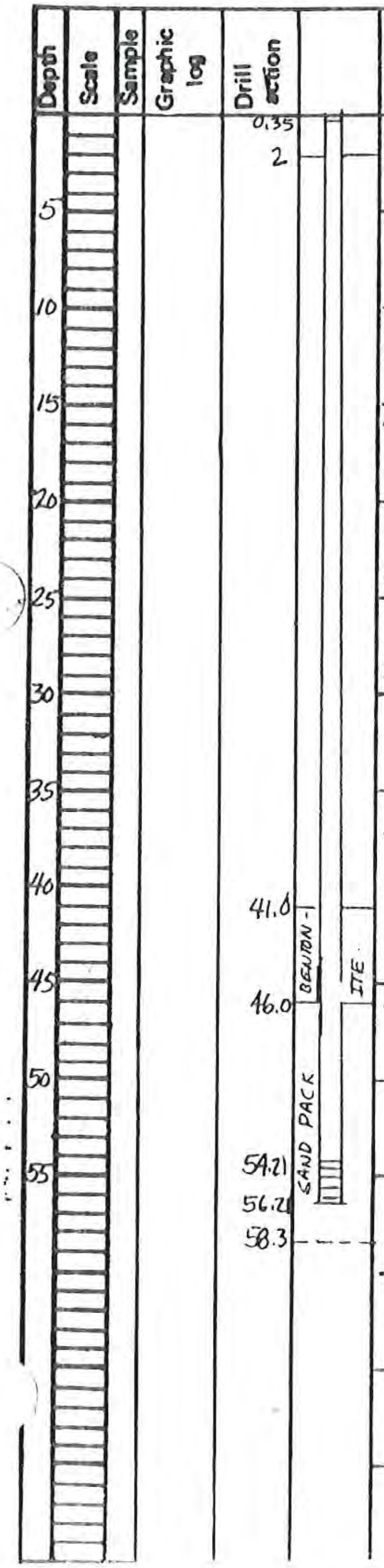
Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______ Sec. ______



Lithologic description	Summary log
0-2' Clayey silty fine sand, brown. 2-4' Clayey silty fine to med. sand and some gravel (To ¼") brown. 4-9' Clayey silty fine to medium sand, brown.	Sand, fine, clayey, silty 0-9
9'-10' Fine to coarse sand, gravel to ½", grayish brown. 10'-16' fine to coarse sand, gravel to ½" grayish brown, some clay and silt. 16-24 Same but with coarser gravel fragments in ¾ to 1" range. Drilling as if coarse gravel to cobbly gravel. 24-28' Same but more sand less gravel and gravel to ½" 28'-36 clayey Silty fine to coarse sand, gravel to 3/4", brownish gray. Drills as if coarse gravel and cobbles	Sand and gravel 9-36
36-44' Clayey silty fine to coarse sand, very little gravel (To ½") brownish gray H_2O temperature is 15°C, Drilling and driving is easier.	Sand, fine to coarse, clayey silty. 36-44
44'-58.3' As above but drilling is harder coarse gravel and cobbles.	Sand and gravel cobbly 44-58.3

Location ______ Date ______ Loca well number H-2 [illegible]

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist GLT&JCE

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG 0.5' BELOW LSD.	Lithologic description	Summary log
				0.5		0-4' Soil, brown silt some sand	Soil, silt sandy 0-4
					NF		
5				4.6 5.5	B	4-6' Gravel, some silt and sond brown 6-8' Gravel, cobbly a little silt and sand.	Gravel, cobbly, silty sandy 4-12
						8-12' Gravel, hard drilling (cobbles ?) gravel at 10-12' may be coarser	
10					SAND PACK		
						12-16' Gravel, sand some silt, brown. H2O in cuttings between 12-14'	Sand and gravel 12-18
15				14.6	NAT. FILL	16-18' Sand and gravel, some silt. More sand than in previous (12-16') samples (50/50)	
				18'			

Sheet ____ of ____

H-1 FIELD LOG

Location ____________ Date 5-3-86 ____________ Local well number ____________

County ____________ Map ____________ Scale ____________ Lat. ____________ Long. ____________

District ____________ Project number ____________ Altitude ____________

Driller ____________ Helper ____________ Geologist JLE & GLT

Lithologic Symbols

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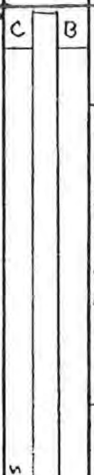
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____

Twsp. ____

Sec. ____

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG 0.45	Lithologic description	Summary log
				0.45 2.0		0-6' Silt with some sand	,Silt, sandy 0-6
5						6-8' Gravel, some sand silt and cobbles	Gravel cobbly sandy 6-12
10						8-10' Cobble gravel some sand.	
						10-12 Cobbly gravel with sand and silt.	
						12-14' Gravel, sand some silt	sand and gravel, silty 12-2
15						14-16 Sand and gravel, some silt	
						16-18' Sand some gravel and silt	
						18-20' Gravel, sand some silt	
20						20-24' Sand, some gravel and silt. less sand than 16-18'	Sand, silty, gravelly 20-3
25						24-26 Sand, some small gravel and silt.	
						26-30 Sand, some gravel and silt. Color change silt changed from brown to gray.	
30						30-36' Gravel and sand, black, some silt (maybe clay)	Gravel and sand, silty 30-3
35						36-41' Gravel, black, some sand, gray silt.	Gravel, sandy silty 36-4
40						40-42' Sand and gravel (50/50) black some gray silt.	Sand and gravel, silty. 40-4
				44.0		42-44' Sand, black; some gravel, gray silt.	Sand, gravelly 42-44
45				49.0		44-50 Gravel, black some black sand and gray silt. Some larger material also.	Gravel, silty, sandy cobbly 44-52
50						50-52 Gravel, black, some black sand, gray silt.	
						52-56' Sand, black some gravel, silt	Sand, gravelly, silty 52-56
55				55.02 59.02		56-58' Sand, black gravel (large broken material) a bit of silt.	Sand and gravel, silty cobbly 56-58

5-5 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Rge. ______ Twsp. ______ Sec. ______

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-1' Black top and fill	Black top and fill 0-1
						1-2' Silty clayey fine to coarse sand, dark brown.	Sand, fine to coarse, silty, clayey 1-4
5						2-4' Same as above.	Sand and gravel, cobbly, silty, clayey. 4-18
						4-6' Medium to coarse sand and gravel (fragments to ½") gray. Drill sounds as if in cobble gravel. Strong diesel odor.	
10						6-8' Same as above. Some silt or clay (rock powder blowing from hole)	
						8-10' Same as above, Color changing to brownish gray.	
15						10-12' Fine to coarse, sand and gravel, fragments to ½", grayish brown.	
						12-14" Same as above.	
				18.3 B.H.		14-16' Silty fine to coarse sand and gravel to ½", grayish brown; saturated about 15 feet.	
						16-18' Same as above	
						Lost hole trying to set casing - redrilled. OGC personnell finished.	

S-4 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C Lane

Rge. ______ Twsp. ______ Sec.

Lithologic Symbols

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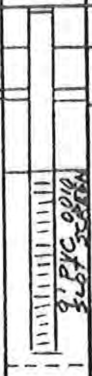
Abbreviations

clay	c	cobbles	cob	sandy	sdy		
silt	st	boulders	b	fine	f		
sand	s	clayey	cly	medium	m		
gravel	g	silty	sty	coarse	co		

Depth | Scale | Sample | Graphic log | Drill action

Depth: 5, 10, 15

Drill action: 0.25, 2.0, 4.2, 4.85, 8.65, 18.0 17.4 BH



Lithologic description

0-1'	Blacktop and fill.
1-2'	Silty clayey fine sand to gravel (≤ 1/4"), dark brownish gray.
2-4'	Same as above.
4-6'	Medium to coarse sand and gravel, to 3/8" (Cobble Fragments), some silt and clay (blows away in wind).
6-8'	Same as above.
8-10'	Same as above
10-12'	Same as above except color has changed to reddish brown and gray.
12-14'	Silty fine to coarse sand and gravel to 1/2", dark grayish brown. Saturated, diesel fuel odor.
14-16'	Same as above.
16-18	Same as above.

Summary log

Asphalt and fill

Sand, fine clayey, silty 1-4

Sand and gravel (cobbly) 4-18

S-3 FIELD LOG

Location ____________ Date ____________ Local well number ____________

County ____________ Map ____________ Scale ____________ Lat. ____________ Long. ____________

District ____________ Project number ____________ Altitude ____________

Driller ____________ Helper ____________ Geologist Ron Lane

Lithologic Symbols

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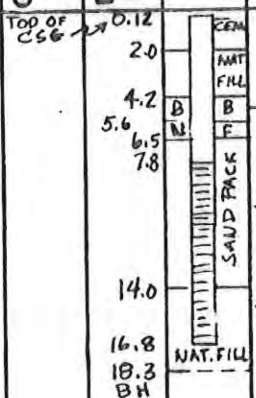
Abbreviations

clay	c	cobbles	cob	sandy	sdy		
silt	st	boulders	b	fine	f		
sand	s	clayey	cly	medium	m		
gravel	g	silty	sty	coarse	co		

Rge. ____

Twsp. ____ Sec. ____

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log



Lithologic description

0-1' Black top and parking lot fill

1-2' Silty, clayey fine sand, gravel to ¼", dark brown

2-5' Same as above

5-6' Gravel, gray, fragments to ½" and med to coarse sand.

6-8' Same as above

8-10' Same

10-12 gravel (< ½") grayish, silt to fine and medium sand, grayish brown

12-14' Same as above but saturated at about 14'

14-16' Gravel (≤ ½") grayish and silt with fine to coarse sand, brown. Saturated

16-18' Silt and fine to coarse sand, dark brown, gravel (≤ ½"), gray-brownish. Saturated.

Summary log

Blacktop-fill.	0-1
Sand, fine, silty, clayey	1-5
gravel, sandy	5-16
Sand, silty, gravelly	16-18

S-2 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron Lane

Lithologic Symbols

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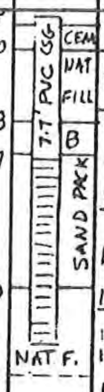
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______

Sec. ______



Depth	Scale	Sample	Graphic log	Drill action	Lithologic description
			Top of CSG	0.15	0-1' Blacktop of parking lot and fill.
				2.0	1-2' Silty clayey fine sand, dark brown
					2-4' Same but fragments to ½". Cobble gravel at about 3½'
5				5.8	4-6' Cobble gravel, fragments to ½", clean.
				7.5 7.7	6-8' Upper as above gray. lower, fine to coarse sand, grayish brown.
10			∇		8-10' Coarse sand gravel to ¼" with fragments, light dull gray.
					10-12' Same as above, but wet, dark gray
15				14.0	12-14' Silt and brown fine sand and gravel (<½") some fine to medium sand gray, saturated. Hydrocarbon odor.
				16.85	14-16' Same as above
				18.3	16-18' Same as above

Summary log

Black top and fill	0-1
Sand, fine, silty and clayey	1-3½
Gravel, cobbly, sandy	3½-7
Sand and gravel	7 – 18

Sheet ___ of ___

S 1 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist DS. Peterson

Lithologic Symbols

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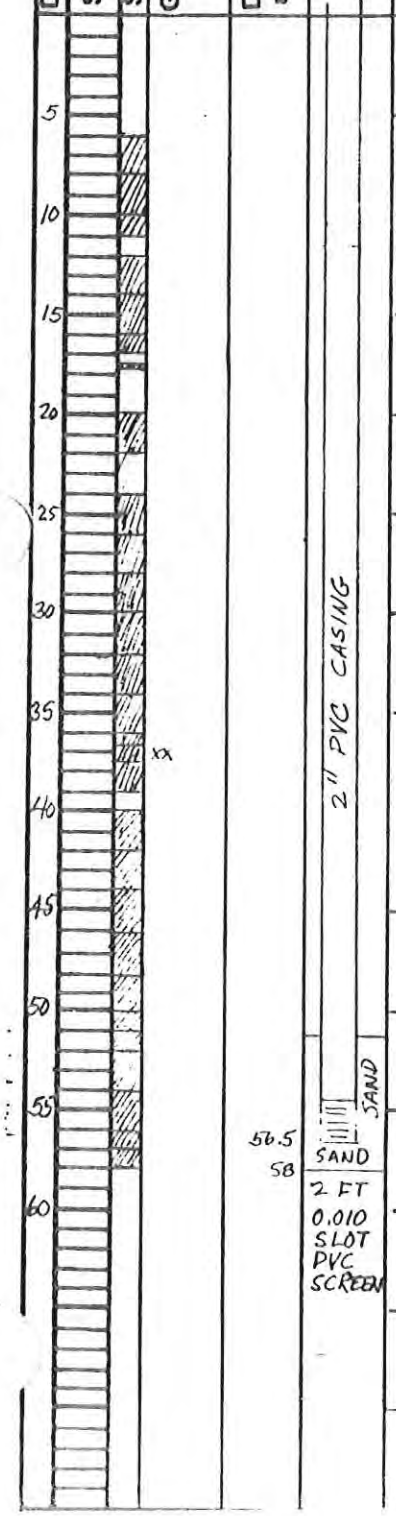
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log



Lithologic description

Asphalt surface
0-4' Soil, silty clayey

6-8' Silt and gravel, fine, dark.
Gravel, coarse, rounded clasts to 15mm.
8-10' Sand, medium to coarse, clayey, brown; with gravel, fine, black
11' Same as above
12-14' Same as above but wet. Water Sample
14-16' Silty (brown water) sand, medium to coarse, dark with gravel, fine, black.
16-17' Gravel, coarse with silt fine gravel; dark green to black
17.5' Water dark brown, very silty coarse sand with very fine to coarse gravel
20-22' Sand and gravel, silty; water less brown
23'

Summary log

Asphalt surface
Soil, silty clayey 0-7'
Gravel 7-8
Sand, clayey, gravelly 8-16
Gravel, silty sandy. 16-20'
Sand and gravel silty 20-22'

B-5 FIELD LOG

Location ______ Date 10-1-86 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron Lane

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec.

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
			TOP OF CSG	0.15	8.85' PVC CSG CEM	0-2' Clayey silt, dark brown.	silt, clayey 0-3
				2.0	NF	2-4' Clay, silt some gravel (< ½") dark brown.	Gravel/cobbly 3-6
5				4.0 6.0	B	4-6' Cobbles and coarse grave [Cobbles at 5') fragments to ½", some silt to coarse sand, gray.	
						6-8' Same	Sand and gravel 6-17
10				9.0	SAND	8-10' Fine sand to gravel (≤ ¼"), gray, wet.	
				13.5		10-12 Fine sand to ½" gravel, some fragments > ½", grayish brown, dry.	
15					NAT FILL	12-14' Same as above.	
				18.0 18.3 BH		14-16' Fine sand to ½" gravel, grayish brown. No fragments more sand than above.	Sand, fine to coarse, gravelly 17-18
						16-18' Same as above, but more moist, plus brown fine to coarse sand at 17+ and beyond	
						18' to BH Fine to coarse sand, some fine gravel, saturated.	

____ of ____

B-4 FIELD LOG

Location ____________ Date ____________ Local well number ____________

County ____________ Map ____________ Scale ____________ Lat. ____________ Long. ____________

District ____________ Project number ____________ Altitude ____________

Driller ____________ Helper ____________ Geologist Ron Lane

Lithologic Symbols

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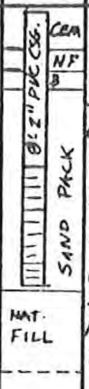
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____ Twsp. ____ Sec. ____

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
				T.C. .15	CEM	0-1' Blacktop and parking lot fill.	Blacktop and fill 0-1
				2.0	NF	1-4' Silty clay, fine to medium sand and gravel (to ½"), dark gray	Clay, silty, sandy gravelly 1-4
				3.2 4.0	B	4-6' Fine sand and gravel (to ¼"), dark gray	Sand and gravel 4-6
5							
						6-8' Gravel (returns = fragments to ½") light gray Drill sounds as if in cobble gravel.	Gravel, cobbly, sandy 6-18.4
				8.0	SAND PACK	8-10' Same as above but finer. Medium sand to ¼" fragments.	
10						10-12' Same as above	
						12-14' Same as above	
15						14-15.7 Similar, but fine in fine to coarse sand range. Saturated. Dark brown	
					NAT. FILL	15.7-16 No samples, no changes. No odor.	
				18.4 BH.		16-18' Same as above.	



E-3 FIELD LOG

Location ________ Date ________ Local well number ________

County ________ Map ________ Scale ________ Lat. ________ Long. ________

District ________ Project number ________ Altitude ________

Driller ________ Helper ________ Geologist Ron Lane

Rge. ________

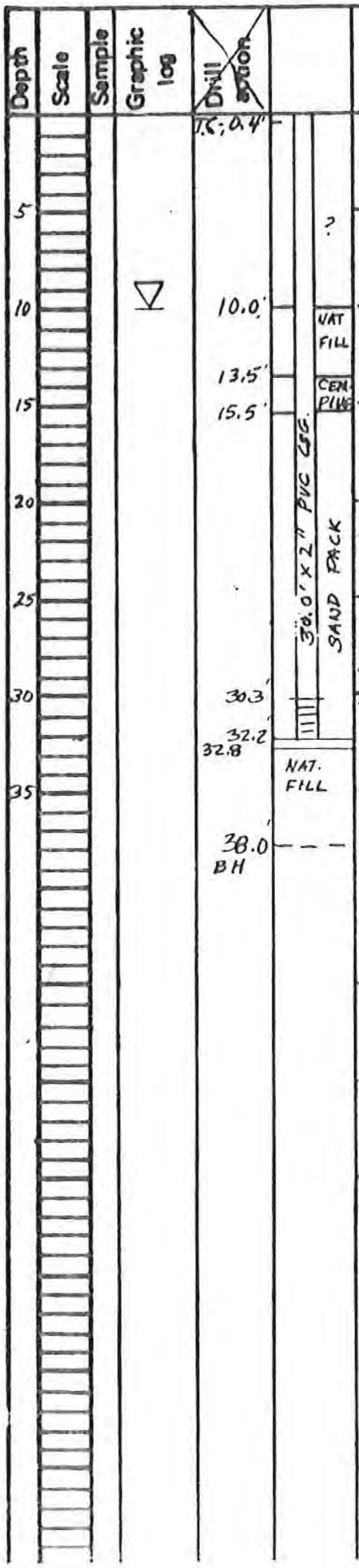
Twsp. ________

Sec. ________

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co



Lithologic description

0-2' Sand, clayey silt, dark brown

2-4' Silty, fine to coarse, sand, fragments to ½" Drill sound, cobble gravel.

4-6 gravel, fragments to ½", most < ¼", Some medium to coarse sand, some rock dust?. gray. Drill sound as if in cobble gravel

6-8' Same as above

8-10' Silty fine to coarse sand to gravel. Fragments to ½" Strong gas or diesal odor. H_2O at 10'.

10-12' Silty fine to coarse sand, some fine gravels Strong gas odor.

12-14' Silty coarse sand to gravel, fragments to ¼ Dark gray. Gas odor decreasing?

14-16' Silty fine sand to fine gravel (< ¼"), dark gray

16-18' Same as above gravel to ¼" dark brown

18-20' Silty fine to coarse sand, gravel (Fragments to ½"), dark brown.

20-22' Silty fine to coarse sand and gravel, (clasts to ½") dark brown. Less odor.

22-24' Same as above, more sand, less gravel and silt.

24-26' Same as above.

26-28' Silty fine to coarse sand and fine gravel (< ¼") dark brown. Strong diesel fuel odor.

28-30' Same as above but at 30' distinct change to light brown color. Foam on water and strong odor of organic decay

30-32' Silty fine sand to coarse sand gravel (¼ to ½" range), dull grayish brown

32-34' Same as above

34-36' Same as above

36-38' Fine to coarse sand, mostly medium to coarse sand, no gravel, dark gray.

Summary log

Sand, silty, clayey	0-3'
Gravel, cobbly	3-8'
Sand and gravel	8-36
Sand, fine to coarse	36-38

B-2 FIELD

Location YAKIMA, WASH Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron Lane

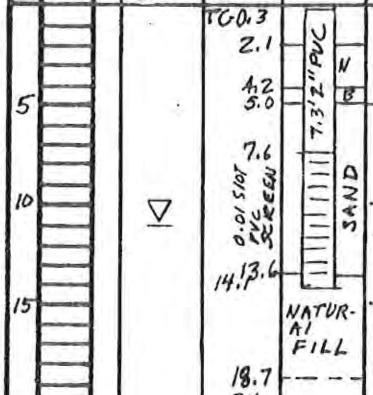
Rge. ______ Twsp. ______ Sec. ______

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth **Scale** **Sample** **Graphic log** **Drill action**



Lithologic description

0-2'	Dark brown clayey silt.
2-4'	Same as above but gravel to 1¼", fragments to ¼". Cobble and coarse gravel drill action. (possible parking lot fill?)
4-6+	Sand, fine to coarse, mostly fragments to ¼" - Drill still hitting cobbles. Some fines (clay and silt) being blown away
6-8'	Sand, fine to coarse, fragments to ½" Drill still in cobbles. Silt and clay still being blown away
8-10'	Sand, fine to coarse, dark gray and gravel to ¼". No clay in exhaust (returns)
10-12'	Silt, sand, fine to coarse, gravel with fragments to ¼", dark gray, saturated
12-14'	Same as above but few fines more gravel fragments.
14-16'	Same as above, but much more fines and less gravel fragments
16-17.5'	Silt, coarse sand, gravel with fragments to ½-1", dark gray.
17.5-18.7'	Similar to above, but lacks fines, dark brown. Much evidence of gasoline.

Summary log

Silt, clayey	0-3
Gravel, cobbly clayey silty	3-8
Sand and gravel, silty	8-18.7

B1 FELDS

Location YAKIMA, WASHINGTON Date ________ Local well number ________

County ________ Map ________ Scale ________ Lat. ________ Long. ________

District ________ Project number ________ Altitude ________

Driller ________ Helper ________ Geologist ________

Rge. ____ Twsp. ____ Sec. ____

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
			TOP OF CSG.	0.3	B	0-2' Light brown very fine sand and silt.	sand very fine and silt 0-4
				2.0	DRL 6'x2" PVC CUT	2-4 Light brown fine sand and silt some brown clay.	
5				4.5 5.5	B	4-6 Gray fine-coarse sand and gravel, fragments to ¼". Drill sounds like coarse gravel or cobbles.	Sand and gravel 4-9
				6.5 6'x2" 0.01 SLOT PVC SCREEN	SAND PACK	6-8' Same except gravel to ¼"-⅜"; Fragments (few) to ½".	
10						8-9' Sand, medium to coarse, some fine, less sand than above, gravel > ¼" more gravel than above Fe in fragments	
				12.5	BACK FILL - DRILL CUTTINGS	9-10' Sand medium to coarse, brown to gray, very little fine gravel to ¼", No fragments. Clay ?, Silt ?.	Sand, medium to coarse 9-10
15						10-12 Sand fine to coarse, gray, with clay and. silt; gravel, gray brown, Fragment to ½". Drill hitting cobbles and boulders.	Sand and gravel 10-18.4
				18.3			
						12-14' Sand, fine to coarse, very little gravel, clay, gray brown.	
						14-16 Sand, fine to coarse and gravel to ½", some fragments, clay/silt gray	
						16-18.4 Sand, fine, silt and gravel to ¼", brownish gray to grayish brown	

T-22 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C.Lane

Rge. ______

Twp. ______

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG -0.43'	Lithologic description	Summary log
					B. CEM	0-7' Silty clayey fine sand, brown.	Sand, silty, clayey 0-7'
				2.5	N F		
5					B		
				6.6 6.7	SAND PACK	7-12' Silty clayey fine sand to gravel (to ½") brownish gray. Drill is hitting cobbles	Sand and gravel, silty 7-18.3
10							
				12.7	NAT. FILL	12-14' Silty fine sand to gravel, brownish gray. Drill is in fine gravel.	
15						14-16' Same as above but grayish brown color	
						16-183' Same but reddish brown	
				18.3			

T-22 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Lithologic Symbols

☐ ☐ ☐

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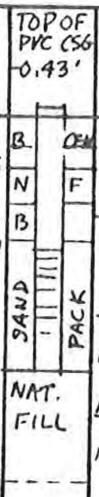
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______



Depth	Scale	Sample	Graphic log	Drill action	Lithologic description	Summary log
				2.5	0-7' Silty clayey fine sand, brown.	Sand, silty, clayey 0-7'
5				6.6 6.7		
10					7-12' Silty clayey fine sand to gravel (to ½") brownish gray. Drill is hitting cobbles	Sand and gravel, silty 7-18.3
				12.7	12-14' Silty fine sand to gravel; brownish gray. Drill is in fine gravel.	
15					14-16' Same as above but grayish brown color 16-18.3' Same but reddish brown	
				18.3		

T-21 FIELD LOG

Location ______________ Date ______________ Local well number ______________

County ______________ Map ______________ Scale ______________ Lat. ______________ Long. ______________

District ______________ Project number ______________ Altitude ______________

Driller ______________ Helper ______________ Geologist Ron C Lane

Lithologic Symbols

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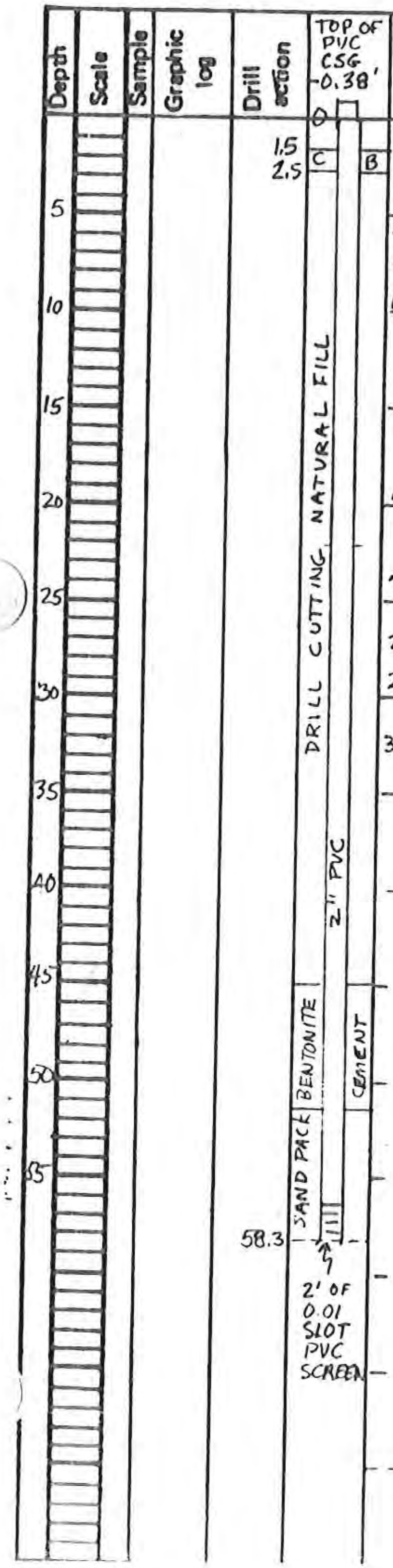
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______

Sec. ______



Lithologic description	Summary log
0-5' Silty clayey fine sand, brown.	Sand, silty, clayey 0-5
5-6' gravel, cobbly (Drill rig) fragments to ½"	Gravel, cobbly 5-6
6-10' Silty fine to coarse sand, gravel (to ½") grayish brown. Cobbly drilling 10-18' Same but brownish gray, saturated between 12 and 14 feet	Sand and gravel, silty cobbly 6-18
18-24' Silty fine to coarse sand, gravel (to ½") grayish brown. No cobbles 24-26' Silty fine to coarse sand, gravel (to ½") brownish gray 26-28 Same except grayish brown 28-32' Same except brownish gray 32-58.3' Same, except more clay, color dull gray to blackish gray/brownish gray	Sand and gravel (more clay in samples below 32') 18-58

Sheet ___ of ___

Location ______ Date ______ Local well number T-20 FIELD LOG

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C, Lane

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy		
silt	st	boulders	b	fine	f		
sand	s	clayey	cly	medium	m		
gravel	g	silty	sty	coarse	co		

Rge. ______ Twp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG 0.3 BELOW LSD	Lithologic description	Summary log
				0.3		0-2' Silty clayey fine sand, brown.	Sand, fine, silty, clayey, 0-2
5				2.0	NAT FIL	2'-4' Silty, clayey, fine to coarse sand and gravel (fragments to ½") Could be Cobbles	Sand and gravel silty clayey cobbly 2-11.5
				5.2 ?	B	4-6' Same as above but gravel to ⅛"; Cobbles still present.	
				7.2	SAND PACK	6-8' Same as above. Drill still sounds as if in Cobbles.	
10						8-10' Silty, fine to coarse sand, gray brown and gravel (To ½") gray, black, Cobbles. Frags are basaltic.	
						10-11.5' Same as above	
15				13.2	NATURAL FILL	11.5-12' Silty sandy gravel (To ½") grayish brown.	Sand and gravel, silty 11.5-18
						12-14' Sand, fine to coarse, gravel (to ½") grayish brown, saturated at about 13 feet.	
				18.3		14-18' Same as above	

T-19 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C Lane

Lithologic Symbols

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Abbreviations

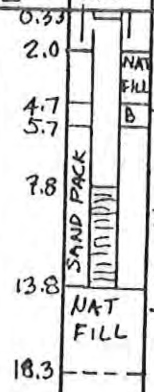
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG 0.33' BELOW LSD
5					
10					
15					



Lithologic description

0-2' Silty clayey fine sand, light brown.

2'-4' Fine to coarse sand, gravel (to ½") Drill sound as if in cobble gravel

4-6' fine sand to gravel (to ½") as above Drill sound as if in cobbles

6-8' Same as above.

8-9.5' Same as above

9.5-10' Similar but contains brown clayey silt. Drill still sounds cobbly.

10-12' Same as above

12-14' Silty sandy gravel (to ½") gravel to 1¼ moist, brownish gray.

14-16' Silty fine to coarse sand gravel (to ¾") brownish. Saturated at 14'

16-18' Similar but color is reddish brownish gray

Summary log

Sand, silty clayey	0-2
Sand and gravel	2-9.5
Sand and gravel clayey and silty.	9.5-18

T-18 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C Lane

Lithologic Symbols

☐ ☐ ☐
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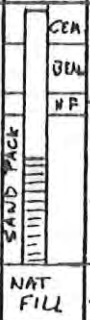
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______
Twp. ______
Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
				TC 0.4		0-2' Silty clayey fine sand, brown.	Sand, silty clayey 0-8
				2.0		2'-4' Same as above (clayey lumps)	
5				4.7 5.7		4-6' Same as above lots of clay could be silty sandy clay.	
				7.1		6-8' Same as above.	
10						8'-10' Same as above but drill sounds like in cobble gravel. Grayish brown.	Sand silty clayey and cobble gravel 8-10
				13.1		10-12' Silty clayey fine sand to gravel (fragments to 1/2") Drill sound like in cobble gravel. Grayish brown.	Sand and gravel 10-18
15						12-14' Sand, coarse, gravel (to ½") some fine to medium sand, brownish gray. Wet at 14'	
				18.3		14'-18 Silty clayey fine sand to gravel brownish gray, as above but more fines and larger fragments At 18'+ water color became reddish brown	



T-17 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Rge. ______ Twp. ______ Sec. ______

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG 0.42	Lithologic description	Summary log
				0	CEM B.	0-2' Clayey silty fine sand, gravel to 1" Drill sounds like cobble gravel	sand, clayey, silty, gravelly, cobbly 0-4'
				2.5	NAT FILL	2-4' Same as above.	
5				4.2 4.9	B	4-6 Fine to coarse sand, gravel (to ½") grayish brown. Drill sound like cobble gravel.	Sand and gravel 4-18
				7.7	SAND PACK		
10						6-10' Same as above.	
						10'-12' Med to coarse sand (less than above) gravel with frags ½ (more than above) Drill still sound like cobble gravel.	
15				13.7		12'-14' Same as above. Saturated	
					NAT FILL	14'-16' Silty fine to coarse sand and gravel (to ½") brawnish gray.	
				18.3		16-18 Same as above but gravel to 1"+.	

T-16 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Rge. ______

Twsp. ______ Sec. ______

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action	Top OF CSG, 0.5'	Lithologic description	Summary log
					CEM + B	0-2' Silty clayey fine to medium sand, brown gravel fragments to 1/8", gray. Drill sounds cobbly gravel	Sand, silty clayey. gravelly, cobbly 0 - 14
5				3.1 4.8 5.3	B F	2-6' Silty clayey sand as above. Fine sand to 1/2" gravel. Drill cobble gravel. 4 to 6' Brownish gray.	
					SAND PACK	6-12' Same as above	
10						12' 14' Same as above, saturated. Sample 12.5'	
15				13.9	NAT FILL	14'-18' Fine to coarse sand, some silty gravel to 1/2"+ brownish gray.	Sand, silty gravelly 14-18
				18.3			

T-15 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Rge. ______

Twsp. ______

Sec. ______

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Silty clayey fine sand, gravel to ½", dark brown. Drill sound like cobble gravel.	Sand, fine, silty clayey 0-4.5
5						2-4.5' Same as above	
						4.5'-9.5' Gravel, fragments to ¼", fine sand, cobbles	Gravel, sandy, cobbly 4.5-9.5
10						9.5-10' Fine sand to gravel (>½") dark brownish gray. H_2O at about 10'	Sand and gravel 9.5-18
						10-12' Silty fine sand to ½" gravel, brownish gray, saturated. More fines than above. Some cobbles.	
15						12-16 Same as above.	
				18.0		16-18' Same as above but some fragments in 3/4 to 1" size.	
					To be completed by OSC		

T-14 FIELD LOG

Location ________ Date 12-23-86 Local well number ________

County ________ Map ________ Scale ________ Lat. ________ Long. ________

District ________ Project number ________ Altitude ________

Driller ________ Helper ________ Geologist Ron C. Lane

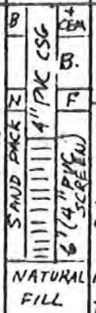
Rge. ________

Twsp. ________ Sec. ________

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co



Depth	Scale	Sample	Graphic log	Drill action	Lithologic description	Summary log
				1.7	0-2' Clayey silty fine sand, brown	Sand, silty clayey 0-7
					2'-4' Same	
5				4.1	4-6' Same but much more clay (lumps)	
				5.3 6.8	6-8' Clayey silty fine sand as above, medium to coarse sand, gravel (with fragments to ½") gray. Drill sounds like cobble gravel	Sand and gravel 7-18
10					8-10' Fine to coarse sand and gravel (Fragments to ½"+) gray.	
				12.8	10-12' fine sand to gravel (½"), grayish brown	Gasoline sheen on water
15					12-14' Same as above. Saturated gasoline. sheen on H₂O.	
				18.3	4-18' Same as above.	

T-13 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Lithologic Symbols

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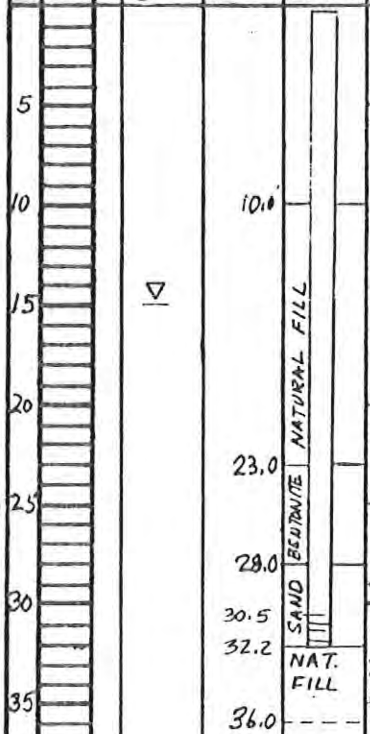
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______ Sec. ______

Depth | Scale | Sample | Graphic log | Drill action | TOP OF CSG. 0.45 BELOW LSD



Lithologic description

0-1' Black top.
1-2' Clayey silty fine sand
2-4' Clayey silty fine sand, dark brown
4-5' As above fine sand.
5-6' Gravel gray (fragments are sandsize to ½" Some clay. Drill sounds cobble gravel.
6-8' Fine sand to gravel, fragments to 1". Some clay and silt, brownish gray. Drill sounds like cobble gravel.
8-10' Same as above
10-12' Same as above, but brownish gray, strong gas odor
12-14' Same as above but more silt and clay No H_2O yet
14-16' Silty fine to coarse sand, gravel fragments to ½", grayish dark brown. H_2O at 15'
16-18' Same as above
18-20' Same as above, but color is reddish brown.
20-26' Same as above.
26-28' Same as above with more silt and fine sand. Color less medium to gray brown
28-30' Silt to gravel (to ½") as above, medium brown.
30-32' Same as above
32-34' Same as above, color gray brown
34-36' Same as above, grayish brown

Summary log

Blacktop	0-1
Sand, clayey, silty	1-5
Gravel, sandy	5-6
Sand and gravel, clayey, silty.	6-14
Sand, silty, gravelly	14-36

T-12 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist ______

Lithologic Symbols

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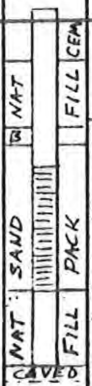
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	TOP OF CSG -0.45'	Lithologic description	Summary log
						0-1' Blacktop and fill.	Blacktop and fill 0-1
				2.0		1-2' Silty clayey fine sand, medium dark brown.	Sand, fine, silty, clayey 1-6
						2-4' Same as above.	
5				5.3 6.2		4-6' Same as above	
				7.4		6-8' Coarse sand to gravel (To ¼") dull gray well sorted. Drill sounds like cobble gravel.	Sand and gravel, silty 6-18
10						8-10' Fine to coarse sand and gravel (to ½"), some silt, brownish gray. Drill sounds like cobble gravel.	Gasoline odor reported
				13.4		10-12' Fine to coarse sand, (Fragments to ¼"), grayish brown. Drill sounds indicate cobbles. Strong gasoline odor.	
15				17.4 18.3 BH.		12-14' Silty, fine to coarse sand, gravel to 3/8", dark grayish brown. Saturated and strong gasoline smell.	
						14-16' Similar to above, but dark grayish brown and black, saturated	
						16-18' Medium to coarse sand and some fine sand and silt, gravel to 1", reddish brown.	

Location ____________ Date 10-6-86 ____________ Local well number T-11 FIELD LOG

County ____________ Map ____________ Scale ____________ Lat. ____________ Long. ____________

District ____________ Project number ____________ Altitude ____________

Driller ____________ Helper ____________ Geologist Ron C. Lane

Rge. ____

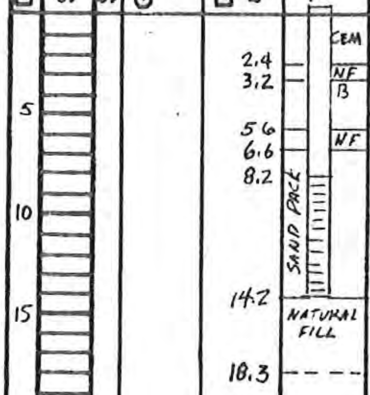
Twsp. ____ Sec. ____

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth | Scale | Sample | Graphic log | Drill action | TOP OF CSG -0.45'



Lithologic description

0-2' Silty clay fine sand, dark brown

2-4' Silty fine to medium sand tan to light brown.

4-6' Sand as above, tan, with gravel to 1/4" gray.

6-8' Gravel (to 1/4") gray, some tan sand.

8-10' Silty fine to coarse sand, tannish gray gravel with fragments to 1/4" gray.

10-12' Fine to coarse sand and gravel (to 1/4") grayis brown.

12-14' Fine to coarse sand, gravel (to 1/4") brownish gray.

14-16' Fine to coarse sand and gravel, grayish brown saturated.

16-18' Similar to above but more reddish especially H_2O.

Summary log	
Clay, silty, sandy	0-2
Sand, fine to medium, silty, gravelly	2-6
Gravel, sandy	6-8
Sand and gravel	8-18

T-10-FIELD LOG

Location ______ Date 10-3-96 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist RC Lane

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	TOP OF CSG. -0.45	Lithologic description	Summary log
				1.6'	(2") PVC CSG	0-2' Silty, clayey, fine sand, dark brown.	Sand, fine, silty, clayey 0-2
					? B	2-4' Silty, clayey fine to coarse sand and gravel fragments to ½". Drill sounds like cobble gravel.	Sand and gravel, silty clayey 2-16
5				5.3'	8.75' SAND PACK	4-6' Same as above but brownish gray. Very little silt or other fines	
				8.3		6-8' Same as above	
10						8-10' Seme as above.	
						10-13.5' Silty clayey fine to coarse sand, gravel (Fragments to ⅛") grayish brown.	Sand, clayey, silty, gravelly 10-13.5
15				14.3	UAT FILL	13.5-18.3' Silts fine to coarse sand, gravel grayish brown, saturated.	Sand, silty gravelly 13.5-18
				18.3 BH			

Location ______ Date ______ Local well number T-9 FIELD LOG

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Lithologic Symbols

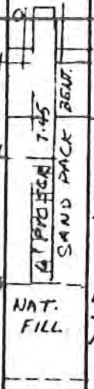
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	Top of CSG -0.41'	Lithologic description	Summary log
				1.6 2.4		0-2' silty, clayey, fine to medium sand, dark brown.	Sand, silty, clayey 0-6
5				5.0		2-6' silty, clayey fine to medium sand dark brown; gravel fragments to 3/8". Sounds like cobble gravel.	
				7.04		6-8' Silty, clayey fine to coarse sand; gravel fragments to 3/4" (cobble gravel)	Sand, gravelly, silty clayey 6-18 cobbly
10						8-10' Same as above	
						10-12' Same as above	
				13.04		12-14 Same as above	
15						14-16 Same as above	
				18.3		16-18 Same as above.	

T-8

Location ____________ Date ____________ Local well number ____________

County ____________ Map ____________ Scale ____________ Lat. ____________ Long. ____________

District ____________ Project number ____________ Altitude ____________

Driller ____________ Helper ____________ Geologist Ron C. Lane

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____

Twsp. ____ Sec. ____

Depth	Scale	Sample	Graphic log	Drill action	TOC -.0.65	Lithologic description	Summary log
				0	4" PVC SCR	0-2' Drilling with water. silty clayey fine sand, dark brown.	Sand, silty, clayey 0-3
5				3.8	SAND PACK	2-4' Sity clayey fine, to coarse sand dark brown, gravel with fragments to 1/4", cobbles or coarse gravel	Sand and gravel, clayey, silty, cobbly 3-18.3
						4-6' Same as above but fragments ≤ 3/4"	
				8.35		6-8' Same as above, but color grayish brown.	
10						8-10' Same as above.	
						10-18.3' Same as above.	
15				14.35	NAT FILL		
				18.3			

Sheet ___ of ___

T-7.2

Location ________ Date ________ Local well number ________

County ________ Map ________ Scale ________ Lat. ________ Long. ________

District ________ Project number ________ Altitude ________

Driller ________ Helper ________ Geologist ________

Lithologic Symbols

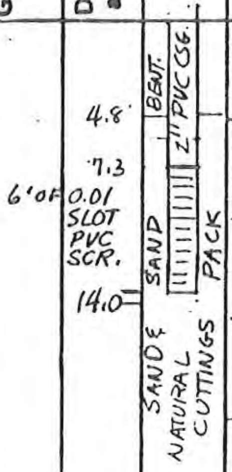
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ________

Twp. ________

Sec. ________



Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						SEE LOG T-5 0-20'	

T-6 SAMPLE LOG

Location ______ Date 1-12-87 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JB GONTHIER

Rge. ______ Twsp. ______ Sec. ______

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth | Scale | Sample | Graphic log | Drill action

5 10 15 20 25 30 35 40 45

Lithologic description

30-32' Gravel (70%), sandy (30%): dusky yellowish brown [10YR 2/2 (WET)]. Clasts to 1.2cm most (60%) round and subround. Gravel median 5mm, sand 0.75mm. Matrix (20%) quartz and feldspars (felsic). Remainder is mafic (basalt) and lithic material.

32-34' Sand (70%) gravelly (30%: dusky yellowish brown (10YR 2/2, WET). Clasts to 1.5cm, 50% rounded to subround. Gravel median; 4mm; sand .5mm.

34-36' Gravel (70%) sandy (30%): olive black (5Y. 2/1, WET). Clasts to 4cm; 50% are angular chips. Gravel median, 8 mm; sand 0.35mm.

36-38 Gravel (80%) sandy (20%); olive black (5Y 2/1, WET). Clasts to 1.3cm, 60% angular. Gravel median, 5mm; sand .5mm.

38-40' Gravel as above.
40-42' Gravel as above.
42-44' Sand (70%) gravelly; olive black (5Y 2/1, WET). Clasts to 2cm; 80% angular. Gravel median 8mm; sand 0.5mm.

' Sand (70%), gravelly; as above.
DITTO

46-48 Sand (50%) and gravel (50%); olive black (5Y 2/1, WET). Clasts to 2.5cm, 70% angular chips. Gravel median, 5mm; sand 0.5mm.

46-48' water sample has colloidal cloud, cream colored; may be clay and colloidal gel.

Summary log

See T-2

Gravel, sandy	30-32
Sand, gravelly	32-34
Gravel, sandy	34-42
Sand, gravelly	42-48

T·5 sample 107

Location ______ Date 1-12-[illegible] Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JB GONTHIER

Lithologic Symbols

Abbreviations

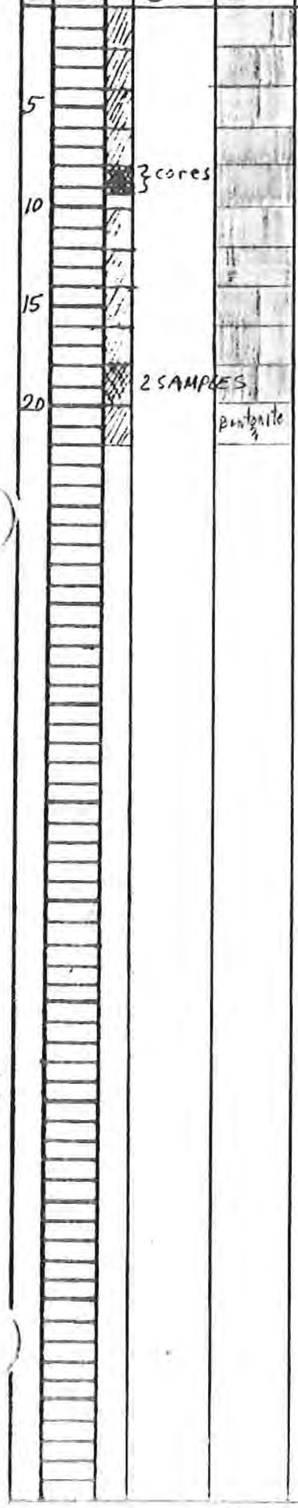
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec.

Depth | Scale | Sample | Graphic log | Drill action



Lithologic description

0-2' Mud (70%) silty (5%) sandy (10%) gravelly (15%) organic; earthy odor; dusky brown (5YR 2/2, WET).

2-4' Gravel (55%) silty (5%) sandy (40% dark yellowish brown (10YR 4/2, DRY): Clasts to 2cm, 60% angular chips coated with silt. Gravel median 3mm; sand 1.0mm

4-6' Gravel (55%), silty (25%), sandy (20%) dusk yellow brown (5YR 2/2, MOIST). Silty balled soil clods to 4cm. Clasts to 1.5cm all are angular chips of basalt. Gravel median 6mm, sand ?.

6-8' Gravel (100%); dark gray (N3, DRY). Clasts to 2.5cm all are angula chips. 75% are basaltic.

8-10' Jar MT.

8.4-8.7' Core sample - Gravel (00%) angular fragments silt covered, dark yellowish brown (10YR 5/2 DRY). Clasts to 5cm rounded and broken. Mostly basaltic, but contains variety of lithic types.

8.7-9.0' Core sample. Gravel 90% sand (10%) dusky yellowish brown (10YR 5/2, DRY). Clasts to 4cm, bulk are angular, however there are more intact rounded pebbles present. variety of lithic types present.

9.0-9.3 Core sample, as above

10-12' Gravel (70%) muddy 5% silty (5%), sandy (20%); olive gray (5Y 4/1, WET). Clasts to 1.5cm. 30% are angular remainder round to subround. Gravel median 4mm sand 0.5mm.

12-14' Sand (70%), gravelly 30%; dusky yellowish brown (10YR 2/2, WET). Clasts to 1cm, most rounded. Gravel median, 3mm, sand 0.5mm.

14-16' Gravel (55%) muddy, (3%) silty (5%), sandy (37%); dusky yellowis brown (10YR 2/2, WET). Clasts to 2cm, most rounded mud covered. Gravel median 8mm. sand 0.5mm, (Possible petroleum).

16-18 Gravel (55%) as above but only damp.

18-20' A Gravel as above but wet + less muddy

18-20' B Gravel as above but little muddier.

20-22' Clay (bentonite?); grayish yellow green (5GY 7/2, WET). Sticky, dense, plastic, greasy.

Summary log

Mud, silty, sandy, gravelly 0-2

Gravel, silty, sandy 2 - 12

Sand, 12 - 14

Gravel, silty, sandy 14 - 20

? clay, bentonite 20 - 22

There are discrepancies as to hole depth in this well between 17-22. Clay in 20-22; appears to be bentonite and is only site that had bentonite or good clay in entire set of samples JBG

T-3 Sample ..

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J.B. GONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______ Sec.

Depth | Scale | Sample | Graphic log | Drill action

5
10
15
20
25
30

Lithologic description

0-2' Sand, very fine (40%) silt (35%), clay (25%), dark yellowish brown (10YR 4/2, DRY)

2-4' Silt (60%), gravelly (30%), clayey (10%), grayish brown (5YR 3/2, MOIST). Clasts up to 1cm, basaltic

4-6' Gravel, (65%) sandy (30%) silty (5%); Dark yellowish brown (10YR 4/2 DRY). Clasts to 2cm, basaltic and mafic volcanic 85%, angular. Sand median, very fine.

6-8' Gravel (60%), sandy (30%) silty (10%); (10YR 4/2, DRY) Clasts up to 2cm, angular, 80-90% mafic volcanics (basaltic). gravel median, 4mm; sand median 0.25mm. Poorly sorted.

8-10' Sand (60%) gravelly (40%), Olive gray (5YR 3/2, MOIST). Clasts up to 1cm, subround to angular basaltic. Gravel median 3mm, sand median .5mm. Presence of light feldspars and possibly quartz grains gives salt and pepper flecks to sample.

10-12' Gravel (60%) sandy (40%), olive gray (5Y 3/2, MOIST). Clasts up to 2.5cm, angular and subrounded. Gravel median 5mm., sand 1mm. Basaltic clasts 65%, 35% other ie felsic volcanic(?).

12-14' Sand (60%), gravelly (40%); Olive gray (5Y 3/2, moist). Clasts to 1cm, angular and rounded. mafic volcanics 70%, other 30%. Gravel median 5mm, sand 0.5mm.

14'-16' Sand (60%), gravelly (40%) same as 12-14'.

16-18' Gravel (60%), sandy 40%, olive gray (5Y 3/2, MOIST) Clasts angular to 2cm, basaltic, 85%. Gravel median 5mm, sand median 1mm.

18-20' Sand (60%) gravelly (40%), Olive gray (5Y 3/2, MOIST) Clasts to 1cm, subround to angular, basaltic. Gravel med 3mm; sand, .5mm.

20-22 Sand (55%), gravelly (45%), olive gray (5Y 3/2, MOIST). Clasts up to 2cm, mostly rounded to subround some angular chips, basaltic (>70%). Gravel median 3mm; sand 0.5mm.

22-24 Gravel (75%), sandy (25%); olive gray (5Y 3/2, WET) Clasts to 1.5cm dominantly angular, mafic volcanics 50%, felsic granitic and MRFs 30%, other 20%(?). Gravel med 5mm, sand, 1mm.

24-26' Gravel (50%), sandy (50%); olive gray (5Y 3/2, MOIST). Clasts to 1cm, dominantly subround, basaltic 70% ±. Gravel median, 3mm; sand, 0.25mm.

26-28' Gravel (75%) clayey (5-10%) sandy (20%). grayish olive (10Y 4/2, WET). Clasts, to 1cm, dominantly angular, heavily coated with wet clay. Gravel median 5mm., Sand, 0.25mm.

28-30' Gravel (55%), sandy 45%; Olive gray (5Y 3/2, MOIST) Clasts to 2cm. dominant subround basaltic. Gravel median 5mm; Sand, 1mm.

30-32 Gravel (75%), sandy (20%) silty (5%); olive gray (5Y 3/2, WET). Clasts to 3cm, angular, basaltic 80%. Gravel median 1cm, and 1mm)

Summary log

Sand, clayey silty	0-2
Silt, clayey, gravelly	2-4
Gravel, silty, sandy	4-8
Sand, gravelly	8-10
Gravel, sandy	10-12
Sand, gravelly	12-16
Gravel, sandy	16-18
Sand, gravelly	18-22
Gravel, sand	22-32

T-2 SAMPLE LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J.B. GONTHIER

Lithologic Symbols

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Abbreviations

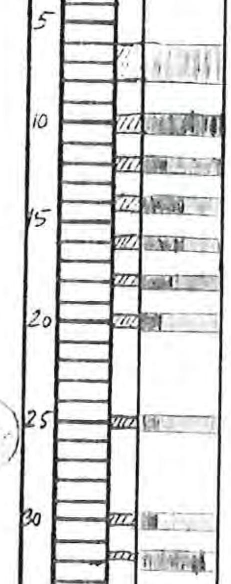
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec.

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-6' No Samples	
						6-8' Silt, clayey, sandy; dark yellowish brown (10YR 4/2, DRY).	Silt, clayey, sandy
						10' Gravel (85%), sandy (8%), silty (7%); dusky yellowish brown (10YR 2/2, DRY). Clasts are up to 2cm, angular, basaltic (80%) Median grain size, 5mm.	Gravel, sandy
						12' Sand; medium (60%), gravelly (30%), silty (10%). dark yellowish brown. Clasts up to 2.5cm angular, basaltic 70%, mafic volcanics 20%. Poorl sorted.	Sand; gravelly, silty.
						14' Gravel (55%) sandy (45%); olive black (5Y 2/1, DRY). Clasts to 2.5cm, angular, median .75 mm, basaltic 70%, 30% other. Sand median 0.5mm.	Gravel, sandy
						16' Gravel (50%), silty (5%) sandy 45%; olive gray (5YR 2/1, MOIST). Clasts up to 1cm, 70-80% basaltic, angular to subround. Gravel median 2mm, Sand median 0.5mm.	Sand, gravelly
						18' Sand, coarse (60%) gravelly (40%); brownish black (5YR 2/1, MOIST). Clasts up to 1cm, rounded to angular, 60% basaltic poorly sorted	
						20' Sand, medium (70%) gravelly (30%); olive black 5Y 2/1, MOIST) Clasts to 4 mm, rounded to subangular, median size 2mm. basaltic 50% other ? Sand has considerable feldspar and qtz. 25%	Gravel, sandy
						25' Sand, medium (70%) gravelly (30%); Olive black 5Y 2/1, MOIST), Clasts to 1cm, angular, basaltic 70%. Sand median 0.5mm.	
						30' Sand, medium (70%) gravelly 30% (Same as above	
						32' Gravel (75%), sandy (20%) silty (5%); Olive black. Clasts 2cm very angular, 80% basaltic. Median gravel 6mm; sand .25mm.	



samples only view under binocular Micro: or al

TI-SAMPLE LOG

Location ______ Date 12/12/86 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J GONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

MRF = Metamorphic rock Fragments

Rge. ______ Twp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log Log by Ron Lane
							0-3 Soil, silty & clayey
5							
		1				Gravel, granule-to pebble, grayish black, angular to subround (Many clasts appear to be broken by drill bit) poorly sorted. Clasts 60% basalt, 10% granitic 30% MRFs (?).	large cobbles vcosd & f-grav.
10		2				Gravel, granule some pebbles. black (wet), angular (clasts appear as if crushed rock, clasts 80% basalt, andesite, granitic 10%, MRF 5%	silt and fine sd. w/med gravel cobbles
15		3				Gravel, sandy, some pebbles (5-10%), olive drab (wet) subround to sub angular, poorly sorted, large clasts are mostly basaltic, in finer grained sd qtz and feldspar 20 to 25% granitic present too.	Sand, f to vco., clay & st, f gravel some cobbles 17' st and f sand.
20		4				Gravel, granule to pebble, some fine-to very coarse sand, grayish black, angular (many clasts broken). Clasts are mafic basalt & andesite (70%), MRF's (30%).	st, fine to v.co. sd, vfg, some cob
25		5				Gravel, sandy, pebbles to 15mm, sand very coarse to fine (25%); poorly sorted; subangular to subround; Clasts 50% basaltic, 25% granitic to diorite, 26% MRF.	Med sd to f gravel some st. 28 color change [illegible] or to red brown.
30		6				Gravel, sandy; dark brown -to olive ((wet)); subround; poorly sorted; sand fraction 50% quartz, clasts are basalt (50%) granitic (25-30%) MRFs	st. some fine to vco sd and fg.
35		7				Gravel, sandy; dark brown to olive (wet); pebbles to 20mm (many angular as if crushed); poorly sorted; sand (45%) coarse to very fine; consists of 50% qtz, 20% feldspar. Clasts 50% basalt, 25% granitic, 25 MRF.	Mud becomes brown again fine to co. sand some fine gravel clayey and silty (silty med sand)
40		8				Sand, gravelley; dark brown to olive (wet). pebbles to 20mm (some angular); sub angular to sub round; poorly sorted; Clasts 50% basaltic, 25% co. igneous, 25% MRF.	silty fine to co s some broken cobbles some clay. Water blue
45		9				Gravel, sandy (sand about 30%). dark gray (wet) pebbles to @ 30 mm, poorly sorted, angular to sub round, Clasts 50% basaltic, 20% granitic, 10% ash (light)	silt some fine to med gravel
50		10				Gravel, sandy (25%), dark gray, dry, angular, many broken fragments, poorly sorted Range from silt to to 2cm, median about 3 mm. Clasts 60% basaltic; 10% granitic, 20% MRFs 10% gabbroic	Some st. and f. to co sand w gravel mostly fine
55		11a&b	—		11a	Sand, gravelly (slightly silty) Sand about 55%, dark gray (dry), angular to sub round; poorly sorted, angular to sub angular. Clasts 70% basaltic, granitic 10%; 20% MRF.	Silty med sand, fine gravel, dark gray to black.
					11b	Sand, gravelly slightly silty; dark grey (dry) angular to sub angular, poorly sorted; Clasts 70% basaltic, 20 mafic granite, 10% MRF.	
58		12			12	Sand, gravelly, slightly silty; med grain size about 2mm.) dark gray; poorly sorted (max size 2.5cm). Clasts 70% basaltic, 10% granitic, MRFs 20%	

Location
County
District
Driller

Lithologic Symbols

CLAY	SILT	S
GRAVEL		

On original, there are coded as follows
green [clay] red [silt] yellow [sand]
[gravel] brown

Sec.

Depth	Scale	Sample	Graphic log	Drill action
		0	100%	
		100%		
5				
		1		
10		2		
15		3		
20		4		
25		5		
30		6		
35		7		
40		8		
45		9		
50		10		
55		11a		
58		12		

① Gravel, granule-to pebble, grayish black, angular to subround (Many clasts appear to be broken by drill bit) poorly sorted. Clasts 60% basalt, 10% granitic 30% MRFs (?). — Gravel, Sandy

② Gravel, granule some pebbles black (wet), angular (clasts appear as if crushed rock, clasts 80% basalt, andesite?, granitic 10%, MRF 5%

③ Gravel, sandy, some pebbles (5-10%), olive drab (wet) sub round to sub angular, poorly sorted. Large clasts are mostly basaltic, in finer grained sd qtz and feldspar 20 to 25% granitic present too.

④ Gravel, granule to pebble, some fine- to very coarse sand, grayish black angular (many clasts broken). Clasts are mafic basaltic andesite (70%), MRF's (3%).

⑤ Gravel, sandy, pebbles to 15mm, sand very coarse to fine (25%); poorly sorted; subangular to subround; Clasts 50% basaltic, 25% granitic to diorite, 25% MRF.

⑥ Gravel, sandy; dark brown - to olive, (wet) subround; poorly sorted. Sand fraction 50% quartz, clasts are basalt (50%) granitic (25-30%) MRFs

⑦ Gravel, sandy; dark brown to olive (wet); pebbles to 20mm (many angular as if crushed); poorly sorted; sand (45%) coarse to very fine, consists of 60% qtz, 20 Feldspar Clasts 50% basalt, 25% granitic, 25 MRF.

⑧ Sand, gravelley; dark brown to olive (wet). pebbles to 20mm (some angular) sub angular to sub round; poorly sorted; Clasts 50% basaltic, 25% co. igneous, 25% MRF. — Sand, gravelly

⑨ Gravel, sandy (sand about 30%) dark gray (wet) pebbles to @ 30mm, poorly sorted, angular to sub round, Clasts 50% basaltic, 20% granitic, 10% ash (light) — Gravel, sandy

⑩ Gravel, sandy 25%, dark gray, dry, angular, many broken fragments, poorly sorted Range from silt to 2cm, median about 5mm. Clasts 60% basaltic; 10% granitic, 20% MRF 10% gabbroic

(11a) Sand, gravelly (slightly silty) Sand about 55%, dark gray (dry), angular to sub round; poorly sorted, angular to subangular. Clasts 70% basaltic; granitic 10%; 20% MRF. — Sand, gravelly.

(11b) Sand, gravelly slightly silty; dark grey (dry) angular to sub angular, poorly sorted; Clasts 70% basaltic, 20 mafic granite, 10% MRF.

(12) Sand, gravelly, slightly silty; med grain size about 2mm, dark gray; poorly sorted (max size 2.5cm) Clasts 70% basaltic, 10% [illegible] MRF 20%

3/R [illegible]

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J.B. GONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Twsp. ______ Rge. ______ Sec.

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log

34-36' Gravel, 70%) Sandy (30%), greenish black (5G 2/1, WET). Clasts to 5cm, angular (most), basaltic. Gravel, median 2cm, Sand 1mm. Matrix 30% felsic

36-38' Sand (65%) gravelly (35%); (5G 2/1 WET) Clasts to 3cm (most are rounded), mafic 60% felsic 40%. Gravel median, 3mm; sand 1mm. Matrix 45% felsic, 55% mafic.

38-40' Sand (65%), silty (5%), gravelly (30%) (5G 2/1 WET). Clasts to 3cm, most are rounded, mafic 70%. Gravel median 4mm; Sand .75mm. Matrix 40-50% felsic.

40-42' Sand (65%), gravelly (35%) H2O turbid; (5G 2/1, WET) Clasts to 2cm, most broken), Gravel median, 4mm; sand .75mm. Matrix 30-40% felsic.

42-44' Sand (50%) and gravel (50%) silty (1-2%); (5G 2/1, WET) H2O Clear. Clasts to 1.5cm, much angular fragments, 70% mafic. Gravel median, 5mm; sand, .5mm. Matrix 40-50% felsic

44-46' Gravel (80%) sandy (20%) (H2O clear); (5G 2/1, WET). Clasts to 2cm, angular 90%, mafic 80%. Gravel median .75mm; sand 1.5mm.

46-48' Gravel (60%), sandy (40%), olive gray (5Y 4/1 WET). Clasts to 3cm, 50% rounded 50% angular, mafic (60%) felsic. Gravel median 6mm; sand .5mm. Matrix 30-40% felsic

48-50' Gravel (65%) sandy (35%), H2O turbid. greenish black (5G 2/1, WET). Clasts to 2cm, 50% angular 50% rounded, mafic 70%. Gravel, median, 5mm; Sand .75mm. Matrix 40% felsic

50-52' Gravel (80%) sandy (20%), H2O very clear olive black (5Y 2/1, WET). Clasts to 2.5cm, nearly all are angular basalt frags. Gravel median 8mm, sand 1mm.

52-54' Gravel (70%), sandy (30%); H2O Clear, olive black (5Y 2/1, WET), Clasts to 7cm, 60% subround to round 40% angular, basaltic. Gravel median 1cm; sand 0.5mm Dry color, dark gray (N3)

54-56' Gravel (80%), sandy (20%). H2O clear; olive black (5Y 2/1) WET, Clasts to 3cm, mostly rounded (60%), basaltic and intermediate volcanics (?) some MRFS. Gravel median 5mm; sand 1mm.

56-58 Gravel (70%), sandy (30%); H2O clear, olive black (5Y 2/1, WET). Clasts to 3cm rounded 60%, fragments 30%; basaltic and intermediate volcanics. Gravel median 4mm; sand 0.4mm

Friday, Dec. 7 1990

Mike,

WS-1 SAMPLE LOGS

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JB SONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						34-36' Gravel (70%), sandy (30%); olive black (5Y 2/1, WET). Clasts to 1.5cm, 70% are angular chips; most are basaltic. Gravel median 3mm; sand 0.5mm. 36-38' Gravel, sandy (as above). Percent of angular chip less. 38-40' Gravel (70%), sandy (30%), olive black (5Y 2/1, WET). Clasts to 3cm, 70% are angular chips; most are basaltic. Gravel median 5mm; sand 0.35mm. 40-42' Gravel sandy (as above) Clasts slightly larger. 42-44' Gravel sandy (as above) fewer angular chips 44-46' Gravel, sandy (as above). angular chips as in 38-40'. 46-48' Gravel sandy (as above). 48-50' Gravel, sandy (as above) 50-52' Gravel, sandy (as above) 52-54' Gravel, sandy (as above) 54-56 Gravel sandy (as above). 56-58' Gravel (80%, sandy (20%); greenish black (5GY 2/1, WET). Clasts to 2.5 cm, 70% are angular chips; 70% basaltic, 20% lithic felsic. Gravel median, 1cm, sand 1.5mm, Matrix quartz 5-10% (opaline) 5-10% feldspar (lithic granitic).	

Sheet ___ of ___

[illegible] SAMPLE LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J.B. GONTHIER

Rge. ______

Twsp. ______ Sec. ______

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action
5				
10				
15				
20				
25				
30				
35				
40				
45				
50				
55				

Lithologic description

0-2' Mud (85%), sandy 15%) olive gray (5GY 4/1, WET). Grity (silt 25%).

2-4' No sample jar marked but MT.

4-6' Mud (95%) sandy (5%); olive gray (5GY 4/1, WET). Silt (30%).

6-8' Gravel (75%) muddy (5%) sandy (20%); olive gray (5Y 4/1, WET); Clasts to 2cm, 80% are angular chips, 70-80% are basaltic and andesitic. Gravel median 4mm; sand 0.2mm

8-10' Gravel (80%), muddy (2%), sand (18%); dark greenish gray (5GY 4/1, WET). Clasts 80-90% are angular chips, 80% are basaltic. Gravel median 5mm; sand 0.08 mm.

10-12' Gravel as above slightly coaser

12-14' Gravel as above 75% of clasts are angular chips.

14-16' Gravel as above, less silt and clay

16-18' Gravel (65%), sandy (35%); brownish black (5YR 3/1, WET). Clasts to 2cm, 60% are angular chips, 70% are basaltic (55%) and andesitic (15%). Gravel median, 3mm; sand 0.5mm.

18-20' Gravel as above except angular chips appear to be fewer

20-22' Gravel (85%), sandy (15%); olive gray (5Y 4/1, WET). Clasts to 1.5cm, 60% are angular chips, 70% are basaltic and andesitic. Gravel median 4-5mm; sand, 0.5mm. Matrix 10-20% lithic felsic.

22-24' Gravel (70%), sandy (30%) olive gray (5Y 4/1, WET). Clasts to 1.5cm, 75% are rounded and subround. Gravel median, 3mm; sand 0.35mm.

24-26' Gravel as above

26-28' Gravel (80%) sand (20%); greenish black (5G 2/1, WET) Clasts to 1.5cm; 70% are angular chips; 90% are basaltic (60%) and andesitic

28-30' Gravel (60%) sand (40%); olive black (5Y 2/1, WET). Clasts to 3cm; 65 to 70% angular chip, 60% are basatic. Gravel median, 2.5mm; sand 0.5mm.

30-32' Gravel ([illegible]%) sandy (20%); olive black (5Y 2/1, WET). Clasts to 1.5cm, 60-70% angular chip 70% basaltic.

[illegible] median [illegible] sand [illegible] mm.

[illegible]

Summary log

Mud, sandy silty	0-6
Gravel, sandy	6-32
sand and gravel	32-34
Gravel, sandy	34-52

[illegible] 2 of 2
H-1 [illegible]

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JB GONTHIER

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______
Twsp. ______
Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						38-40' gravel 90% sandy (10%); greenish black (5GY 2/1; WET). Clasts to 3cm; mafic, up to 50% angular chips. Gravel median 5mm; sand 0.5mm.	
						40-42' Gravel (70%), sandy (30%); grayish black (N2, WET). Clasts to 2.5cm; 50% angular chips, 65% basaltic, 30% mafic to intermediate lithic. Gravel median 4mm; sand .5 mm.	
						42-44 Gravel (55%) sandy (45%); grayish black (N2, WET). Clasts up to 2cm rounded to subround a few angular, basaltic (50-70%); lithic (25-35%) mafic to intermediate. Gravel, median 4mm.; sand 0.5mm. Qtz 8%; Feldspar 10%.	
						44-46' Gravel (80%); sandy (20%). grayish black (N2, WET) Clasts to 1.5cm; 50% are angular chips; basaltic 70%; 30% lithic mafic and intermediate. Gravel median, 5mm sand .5mm. Qtz sand 5-10%, Feldspar 8% ±.	
						46-48' Gravel as above.	
						48-50' Gravel as above slightly coarser	
						50-52' Gravel as above still coarser with more angular chips than above.	
						52-54' Gravel (60%) + sandy (40%); greenish black (5GY 2/1, WET). Clasts to 2.5cm; angular chips 25%; subround to round other. basaltic (70%); mafic and intermediate lithic clasts (30%). Gravel median 4mm. sand .5mm. sand = Qtz 5-8%, Feldspar 5 to 8%, other = lithic.	
						54-56'	
						56-58' Gravel (60%); sandy (40%), greenish black (5GY 2/1, WET)	

1 of 2

H/5[illegible]

Location ______ Date [illegible]-87 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JB GONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec.

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log	
5 10 15 20 25 30 35 40 45 50 55						0-2' Mud, silty sandy; dusky brown (5YR 2/2, WET); some rootlets. 2-4' Mud, silty; dusky yellowish brown (10YR 2/2, WET). 4-6' Mud, sandy gravelly (5%); dusky yellowish brown (10YR 2/2, WET, 6-8' Gravel (95%), sandy; dusky yellowish, brown (10YR, 2/2, WET). Clasts to 3cm 50% are angular chips from larger pebbles and cobbles; 50% basaltic, 25% felsic, 25% intermediate. 8-10' Gravel, as above (si[illegible], sandy). 75% of clasts are angular chips; 80% are mafic. 10-12' Gravel, as above. 12-14 Ditto more mud. 3% [illegible] total 14-16' Gravel (60%) sandy (35%); dark yellowish brown (10YR 2/2, WET); Clasts to 4cm, 55% are angular; 70% mafic. Gravel median 6mm; sand 0.25mm. 16-18' Sand (60%) gravelly (40%); dark yellowish brown (10YR 3/2 (WET). Clasts to 4 cm, most are subround to round, basaltic? ~~Gravel median, 5mm; sand, .5mm.~~ 18-20' Gravel 60%, silty (3% sandy (37%), dusky brown (5YR 2/2, WET). Clasts to 4cm, basaltic and intermediate (80%) ; 40% angular chips. Gravel median 5mm; sand 0.25. 20-22 Sand (70%), gravelly (30%); olive black (5Y 2/1, WET). Clasts up to 2cm; few angular, basaltic. Gravel median 3mm, sand 0.5mm. 22-24' Sand as above. 24-26' Sand, as above 26-28' Gravel (70%) sandy (28%); dark gray (N3, WET). Clasts to 2cm. mostly rounded and subround. Gravel median 5mm, sand 0.5 mm. Clasts consist several mafic and intermediate colored rock types 28-30' Gravel (55%), sandy (45%), dark gray (N3, WET). Clasts to 2cm. about 50% are angular chips. mafic to intermediate colored and composition. Gravel median 3mm; sand 0.5mm. 30-32' Gravel (80%) sandy (15%) greenish black (5G 2/1, WET). Clasts to 4cm, mafic to intermediate, 80% are angular chips. Gravel median, 5mm; sand 0.25 mm. 32-34' Gravel (60), sandy (40%); greenish black (5G 2/1, WET). Clasts to 3cm, basaltic (mafic), 40% are angular chips Gravel median, 4mm sand 0.5mm 34-36' Gravel (60%) and sand (40%); grayish black (N2, WET). Clasts to 2cm mafic 40% are angular chips Gravel median 4mm; sand 0.5mm 36-38' Gravel (75% sand [illegible] (5G 2/1 WET) [illegible]	Mud, silty sandy gravelly Gravel, sandy silty Sand, gravelly Gravel, sandy silty Sand, gravelly Gravel, sandy	0-6 6-16 16-18 18-20 20-26 26-58

SOIL GAS WELL
S-5 SAMPLE LOG

Location ______ Date 1-9-87 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J B GONTHIER

Lithologic Symbols

☐ ☐ ☐
☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______
Twsp. ______
Sec. ______

Depth | Scale | Sample | Graphic log | Drill action

5
10
15

Lithologic description

0-1' No recorery
1-2' Mud, silty (20%) sandy (5%), organic, olive black. (5GY 2/1, MOIST.)

2-4' Mud as above.
4-6' Gravel (95%), silty (5%); dark gray (N3 DRY). Clasts to 2cm, 70% angular chips from pebbles and cobbles. Gravel median 7mm.
6-8' Gravel (70%) sandy (30%); dark gray (N3, DRY). Clasts to 2.5 cm; 50% are angular chips, remainder is round and subround.
8-10' Gravel as above.

10-12 Gravel as above
12-14 Gravel as above.

14-16 Gravel (70%), silty (5%), sandy 25%; olive gray (5Y 4/1, WET). Clasts to 2cm; 80% are angular chips from pebbles or cobbles. Gravel median 7mm; sand 0.125mm.
16-18' Gravel (80%) silty 3% sandy (17%) olive gray (5Y4/1, WET). Clasts to 3cm; 60% are angular chips. Gravel median, 1cm; sand 0.25mm

Summary log

No Sample	0-1
Mud, silty, sandy organic	1-4
Gravel, sandy	4-18

S-4 SAMPLE LOG

Location ______ Date 1-9-87 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J B GONTHIER

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-1' No recovery	silt, [illegible] [illegible] 0-4
						1-2' Silt, clayey, sandy, gravelly (10%), olive, black (5GY 2/1, DAMP); ; strong earthy odor	
5						2-4' Silt (50%) clayey sandy (20%) gravelly 30%; olive gray (5Y 4/1, DAMP). Closts to 2cm, several are asphalt covered. and angular. Gravel median 8mm. sand 0.08mm.	gravel, sandy, silty 4-18
10						4-6' Gravel (85%), sandy (15%); medium dark gray (N3, DRY). Clasts to 2cm; 50% are angular chips, remainder rounded and subround. Gravel median 8MM; sand 0.85 mm.	
15						6-8' Gravel (90%) as above.	
						8-10' Gravel 90% as above clasts coarser (1cm).	
						10-12' Gravel (85%) sandy (15%) as above. more rounded clast.	
						12-14' Gravel 80%, silty (5%), sandy (15%); olive gray (5Y 4/1, WET). Clasts to 2.5 cm, 85% angular chips. Gravel median 1cm; sand .125mm.	
						14-16' Gravel (60%), sandy (40%), alive gray (5Y 2/1, WET). Clasts to 2cm, 50% are angular chips. Gravel median 7.5mm, sand 0.35mm.	
						16-18' Gravel (60%), sandy (40%) as above.	

S-3 SAMPLE LOG

Location ____________ Date ____________ Local well number ____________

County ____________ Map ____________ Scale ____________ Lat. ____________ Long. ____________

District ____________ Project number ____________ Altitude ____________

Driller ____________ Helper ____________ Geologist JB GONTHIER

Lithologic Symbols

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☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____ Twsp. ____ Sec.

Depth	Scale	Sample	Graphic log	Drill action	Lithologic description	Summary log
					0-1' No recovery	No sample 0-1
					1-2' silt, clayey sandy gravelly; olive gray (5Y 4/1, DAMP). Clasts to 2cm; 3 of the clasts are asphaltic, all are angular. (F.11?)	silt, clayey sandy gravelly 1-4
5					2-4' As above more gravel, strong earthy odor	
					4-6' Gravel (60%) silty (30%) sandy 10%. olive black (5Y 2/1, DRY—DAMP. Clast to 2cm; 60% angular chip. Some clasts asphaltic.	Gravel, silty, sandy 4-16
10					6-8' Gravel (85%). sandy (15%); dark gray (N3, DRY). Clasts to 2.5cm; 75% are angular chips; Gravel median 1cm; sand 1.0mm.	
					8-10' Gravel as above slightly more sand.	
					10-12' As above	
15					12-14' Gravel (85%) silty (2%) sandy (13%); olive gray (5Y 4/1, DRY). Clasts to 2.5cm; silt coated. 50% are angular chips. Gravel median 1cm; sand 0.5mm.	
					14-16. Gravel as above wet, olive black (5Y 2/1, WET).	
					16-18' sand (50%) and gravel (50%); olive black (5Y 2/1, WET). Clasts up to 2.5cm; 60% are angular chips. Gravel median 6mm, sand 0.75mm.	Sand and gravel 16-18

S-Z SAMPLE LOG

Location ______ Date 1-12-87 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J B GONTHIER

Lithologic Symbols

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☐ ☐ ☐

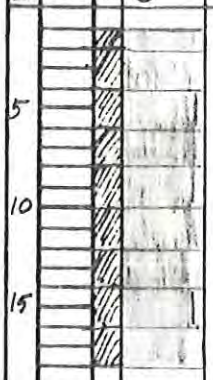
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______ Sec. ______

Depth | Scale | Sample | Graphic log | Drill action



Lithologic description

0-1' No sample - Blactop (ASPHALT).

1-2'. Silt, clayey (2%), sandy (5%); dusky yellowish brown (10YR 2/2, DRY).

2-4' Silt and gravel; dusky yellowish brown (10YR 2/2, DRY). Clasts to 2cm, 50% broken; MIXED lithic types

4-6' Gravel (95%) silty, sandy; medium dark gray (N4, DRY). Clasts to 2.5cm, 80% are angular chips; basaltic. Gravel median 1cm.

6-8' - Gravel as above

8-10' Gravel as above

10-12 - Gravel (95%), silty 3% sandy (2%); olive gray, silt covered clasts (5Y 4/1, DRY to DAMP). Clasts to 2cm; 90% are angular fragments of larger clasts. Gravel median 1cm.

12-14' Gravel (85%) sandy (15%); olive black (5Y 2/1, WET). Clasts to 3cm; 95% are angular chip or fragments. Gravel median 7.5mm. sand 0.75mm.

14-16' Gravel (90%), sandy (10%); olive black (5Y 2/1 WET). Clasts to 2.5cm, 60% angular. Gravel median, 8mm; sand 0.35mm.

16-18' Gravel (70%), sandy (30%); olive black (5Y 2/1, WET). Clasts to 2.5cm, 50% angular. Gravel median 1cm; sand 0.5mm.

Summary log

No sample	0-1'
Silt, clayey sandy	1-3'
Gravel, sandy	3-18'

5-1, SAMPLE LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist GONTHIER

Lithologic Symbols

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☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						34-36' Gravel (80%), sandy (20%); olive black (5Y2/1 WET), Clasts to 3cm, 60% angular, basaltic. Gravel median 6-8 mm, sand, 1.0mm.	
						32' Sand (80%), gravelly (20%); olive black (5YR 2/1, WET). Clasts to 1.3cm, mostly sub round, basaltic. Sand median .5mm, Gravel 2.5mm.	
						36-38' Gravel (80%), sandy (20%); olive black (5Y 2/1, WET). Clasts to 3.5cm mostly subround basaltic. Gravel median, 1cm; sand, 1.0 MM	
						38-40' Gravel (70%), sandy (30%); olive black (5Y 2/1, WET). Clasts to 1.5cm, 50% angular, basaltic. Gravel median 5mm; sand 1.0 mm.	
						40-42' Gravel (75%), sandy (25%); olive black (5Y 2/1, WET). Clasts to 2.5cm, 50% angular, basaltic. Gravel median (5mm); sand 1.0 mm.	
						42-44' Gravel (80%), sandy (20%); olive black (5Y2/1, WET). Clasts to 2cm, > 50% angular, basaltic. Gravel median, 4mm; sand, 1.0mm.	
						44-46' Gravel (50%) and sand (50%); olive black (5Y 2/1, WET). Clasts to 2cm, mostly subround. Gravel, median, 4mm; Sand 0.8 mm.	
						46-48' Gravel (75%), sandy (25%); greenish black (5GY 2/1, WET). Clasts to 1.5cm, >50% angular, basaltic. Gravel median, 5mm; Sand, 1.0mm.	
						48-50' Sand (60%) gravelly (40%); greenish black (5G 2/1, WET). Clasts to 1cm, angular and sub round (50-50), basaltic. Gravel median, 3mm; sand 1.0 mm.	
						50-51' Gravel (60%), sandy (40%) greenish black (5G 2/1, WET). Clasts to 3cm, angular and sub angular (50-50); basaltic. Gravel median, 1cm; sand, 1.0 mm.	
						51-54' Gravel, (55%) sandy (45%), greenish black (5G 2/1, WET). Clasts to 3cm, angular 80%; basaltic. Gravel median, 5mm, sand 0.5mm.	
						54-56' Gravel (75%), sandy (25%); greenish black (5G 2/1, WET). Clasts to 3cm, angular (80%); basaltic. Gravel median, 7 mm; sand 1.0 mm.	
						57-58' Sand (65%), gravelly (35%); greenish black (5G 2/1, WET). Clasts to 2cm, angular, basaltic. Gravel median 1cm (erratics), sand 1.0 mm.	
						56-57' Gravel (60%), sandy (40%); Greenish black (5G 2/1, WET). Clasts to 3cm, subround >70%, basaltic >10%. Gravel median 5mm, sand 1.0 mm.	

mis-labeled probably ??

S-1 Sample log

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J. B GONTHIER

Rge. ______ Twsp. ______ Sec.

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth | Scale | Sample | Graphic log | Drill action

Depth: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55

Lithologic description

0-6 No sample.

6-8' Gravel, silty; olive gray (5Y 3/2, DAMP), Clasts up to 2.5 cm most rolled in ~~sort~~ silty soil before being blown from hole. Gravel median 5mm. Silt covers clasts.

8-10' Gravel 50% silty (10%) sandy 40%; grayish olive (10Y 4/2, dry) Clasts To 2.5cm, rounded and angular (30%) covered with silt; basaltic Gravel median, 4mm; sand .5mm.

10-12' Gravel 60%, sandy 35%, silty (5%); olive grey. (5Y 4/1, DRY). Clasts to 2cm, angular 60% subround 75% → 30%, basaltic. Gravel median, 4mm, sand, .5mm.

12-14' Gravel 70%, sandy (25%); olive gray (5Y 3/2, WET). Clasts to 2cm, angular 50% subround 50%, basaltic. Gravel median, 5mm, sand .5mm.

14-16' Gravel (70%), sandy (25%); olive gray (5Y 3/2, WET) Clasts to 2cm, angular 70%; basaltic. Gravel median, 8mm; sand .25mm.

16-17' Gravel (80%) silty (5%) sandy (15%); olive gray (5Y 3/2, WET). Clasts up to 3cm angular 50%, basaltic > 70%. Gravel median 4mm; sand 0.25mm.

17.5' Gravel (65%), sandy (35%), olive gray (5Y 3/2, WET). Clasts to 3cm mostly rounded to subround, basaltic 60%. Gravel median 6mm; sand (1 mm).

18-22' Sand (55%), gravelly (45%); olive gray (5Y 3/2 WET). Clasts to 1.5cm, mostly rounded, basaltic. Gravel median, 3mm; sand 1mm.

22-24' Sand (60%), gravelly (40%); olive gray (5Y 3/2, WET). Clasts to 1.5 cm, mostly rounded To subround, basaltic. Gravel median, 3mm, sand 0.18mm.

24-26' Sand (75%), gravelly (25%); olive gray (5Y 3/2, WET). Clasts to 7mm, subround, basaltic. Sand median .75mm, Gravel 2.5mm.

26-28' Gravel (60%), sandy (40%); olive gray (5Y 3/2, WET). Clasts to 3cm., angular and subround, basaltic 45% granitic 30%, MRF's 25%. Gravel median, 4mm sand, 1.0mm.

28-30' Gravel (80%) sandy (20%), olive gray (5Y 4/1, WET) Clasts to 2cm, subround some angular basaltic. Gravel median, 5mm; sand 1.0mm.

30-32' Gravel (80%), sandy (20%); olive gray (5Y 4/1, WET) Clasts to 2cm., 40% angular remainder sub-round to round, basaltic Gravel median 5mm, sand .5mm

32-34' Gravel (60%), sandy (40%). olive black (5Y 2/1, WET) Clasts to 2cm, 60% angular, basaltic. Gravel median 5mm; sand [illegible]

Summary log

Soil silty clayey

Gravel, silty, sandy 6 - 17.5'

Sand, gravelly 17.5 - 26

Gravel, silty, sandy 26 - 37'

~~Sand, gravelly 37 - 38'~~

Gravel, sand

Sand, gravel 48 - 50'

Gravel, sandy

~~Sand, gravelly 57 - 58'~~

Bottom of hole

1 of 2
3/R [illegible]

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J B GONTHIER

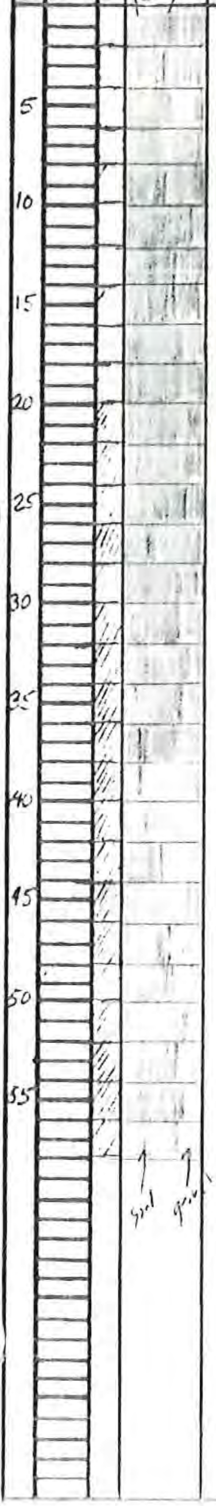
Rge. ______ Twsp. ______ Sec. ______

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth | Scale | Sample | Graphic log | Drill action



Lithologic description

0-2 , Jar full of H2O with 1 inch of sediment. Sediment layered 30% clay, 30% silt, 40% very fine sand. Grayish brown (5YR 3/2, H2O)

2-4 (Same as above H2O) Clay (15%) silt (30%) very fine to fine sand (50%) medium sand 5% Few clasts to 1cm.

4-6' Sand very fine to medium, clayey and silty. Jar full of H2O, some clasts, pale yellowish brown (5YR 5/2) water.

6-8 S. Hard very fin sand. Jar full of H2O.

8-10 Gravel and sand, clayey and silty; pale yellowish brown (10YR 5/2). No place to decant H2O.

10-12 Grave 90%, sandy 10%, olive black, Clasts to 2cm, 90% angular, mafic 80%. Gravel median 7-8mm. Sand 1.5mm

12-14' Gravel 65%, sandy 35%; olive black (5Y 2/1, WET) Clasts to 5.0 cm. (1), 50% angular, 50% sub round and round, 80% mafic Gravel median 5mm; sand 1.0mm. Matrix 70% mafic 30% felsic.

14-16' Gravel (65%) sandy (35%). greenish black (5G 2/1, WET). Clasts to 3cm, 85% mafic 15% felsic, angular 50% and subround 50%, Gravel median 5mm, sand .5mm. Matrix 40% felsic.

16-18' Gravel (75%) sandy (25%. Greenish black (5G 2/1, WET). Clasts to 3cm, 70% angular, 60% mafic 40% felsic, Gravel median gravel 8mm; sand, 1.5mm. Water muddy

18-20 Gravel (75%) silty (2%) sandy (23%; greenish gray (5G 5/1, WET) Clasts up to 1.5cm well rounded. mafic 70%. Gravel median 6mm; sand 0.35mm.

20-22 Gravel (85%) sandy (15%). dark greenish gray (5G 3/1, WET). Clasts to 6 cm, mafic 50% angular 50% rounded, Gravel median 8mm, sand .5mm.

22-24. Gravel (85%); sandy (15%); greenish black (5G 2/1, WET) Clasts to 2cm, >60% angular, basaltic 60% intermediate 20% felsic 20%. Gravel median 4mm; sand 0.5mm. Matrix 20% Felsic

24-26' Gravel (80%) silty (5%) sandy (15%); dark greenish black (5G 3/1, WET); Clasts to 3cm; 30% angular, 65% basaltic, 35% intermediate and felsic. Gravel median, 4mm, Sand .25mm. Matrix 50% felsic

26-28 Sand (60%), gravelly (40%); greenish black, (5G 3/1, WET). Clasts to 2cm (few), subround. 70% mafic. Gravel median 3mm; sand 0.7mm.

28-30' Gravel 70%, silty (<5%) sandy 25%; dark brownish gray (5G 3/1, WET). Clasts to 4cm basaltic, 40% angular, Gravel median 8mm, sand .5mm. Water turbid

30-32' Gravel 70%, sandy (30%). (5G 3/1, WET). Clasts to 4 cm, 30% angular, basaltic 70%. Gravel median 1cm; sand .5mm. Water less turbid than above

3[illegible] [illegible] sandy (15%). (5G 3/1, WET). [illegible] are angular, [illegible] basalt. [illegible]

Summary log

Sand very fine, clayey and silty	0-8
Gravel, sandy	8-26
Sand, gravelly	26-28
Gravel, sandy	28-36
Sand, gravelly	36-44
Gravel, sandy	44-58

Sheet 1 of ______

Location ______ Date ______ Local well number H-2 [illegible]

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J. B. S[illegible]ER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Soil, muddy silt; dusky yellowish brown (10YR 2/2, WET). Organic, much organic debris and rootlets.	Mud, silty 0-4
5						2-4' Mud, silty; dusky yellowish brown (10YR 2/2, MOIST). Plastic.	
10						4-6' Gravel (40%), muddy (15%), sandy 35%; dark yellowish brown (10YR 4/2, WET). Clasts to 2cm mostly chips angular.	Gravel clayey silty sandy 4-18
15						6-8' Gravel (80%), silty (5%), sand, (15%). Dark yellowish brown (10YR 3/2; MOIST) Clasts to 3cm about 50% are angular fragments of larger pebbles and cobbles. Gravel median 1cm; Sand (0.125 mm).	
						8-10' Gravel (70%), silty (5%), sandy (25%); dusky yellowish brown (10YR 2/2, MOIST). Clasts to 3cm. more than 50% angular chips. Basaltic	
						10-12' Same as above.	
						12-14' Gravel (60%) muddy (15%) sandy (25%); dark yellowish brown (10YR 3/2, WET). Clasts to 3cm. Gravel, median, 3mm, sand, .125mm.	
						14-16' Gravel (75%) silty (5%), sandy (20%). dusky yellowish brown (10YR 2/2, WET). Clasts to 3cm, 80% are angular chips basaltic (mafic)	
						16-18' Gravel, (75%) silty (3%), sandy (22%). dark yellowish brown. (10YR 3/2, WET). Clasts to 3cm 50% angular chips others are rounded. 50% are basaltic 25% felsic, 25% intermediate. Gravel median, 6mm; sand .25mm.	

B-I SAMPLE LOG

Location ______________ Date ______________ Local well number ______________

County ______________ Map ______________ Scale ______________ Lat. ______________ Long. ______________

District ______________ Project number ______________ Altitude ______________

Driller ______________ Helper ______________ Geologist ______________

Lithologic Symbols

☐ ☐ ☐

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Silt, clayey (4%), sandy (5%); brownish Black (5YR 2/1, DAMP). Clods 1-2cm and ~~dry~~ silty organic soil.	Silt, clayey, sandy 0-2
5						2-4' Sand (60%) silty, gravelly (30%); dark yellowish brown (10YR 3/2, DRY), Clasts to 2cm, angular. Sand median 0.1 mm; gravel 3mm.	Sand, silty, gravelly 2-4
10						4-6' Gravel (85%), sandy (15%); medium dark gray (N4, DRY). Clasts angular to 2cm; angular chips 80%+. Gravel median 7.5mm; sand 0.5mm.	Gravel, sandy 4-16
						6-8' Gravel as above	
						8-10 Gravel as above, damp; olive gray Clasts silt and sand covered cloded.	
						10-12 Gravel as above dry; olive gray (5Y 4/1) dry	
						12-14 Gravel 90% silty (4%) sandy (6%); olive gray (5Y 4/1, DRY). Clasts to 3cm. 70% angular chips. Gravel median 1cm; sand 0.125mm.	
15						14-16 Sand (45%) silty (20%) gravelly (35%); olive gray (5Y 4/1, DAMP). Clasts to 1cm 50% angular chips. Gravel median 3mm; sand 0.10mm.	
						16-17.5 Sand (40%) silty (30%), gravelly (30%); olive gray (5Y 4/1, WET). Clasts to 2cm, angular 40% (?). Gravel median 5mm; sand 0.1mm	Sand, silty, gravelly 16-18
						17.5 Sand (70%), silty 25% gravelly (5%); olive gray (5Y 4/1, WET). Sand median 0.08mm.	

B-4 SAMPLE LO

Location ______ Date 1-12-87 Local well number ______
County ______ Map ______ Scale ______ Lat. ______ Long. ______
District ______ Project number ______ Altitude ______
Driller ______ Helper ______ Geologist J.B. GONTHIER
Rge. ______ Twsp. ______ Sec. ______

Lithologic Symbols

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☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth | Scale | Sample | Graphic log | Drill action

5
10
15

Lithologic description

0-1' No sample- BLACK TOP

1-2' Silt, clayey(4-5%), sandy (5-10%) gravelly 5%; olive black (5Y 2/1, DAMP). Clods with pebbles

2-4' Silt, clayey (4%), sandy(8%) gravelly (25%). olive gray (5Y 4/1, DAMP). Clasts are angular chips; Gravel Median 7.5mm.

4-6' Sand and gravel (50% each); olive gray, (5Y 4/1, DAMP). Clasts to 1.3CM, angular (80%). Gravel median 3mm; sand 0.75 mm.

6-8' Gravel(100%); medium dark gray (N4, DRY) Clasts to 2.5 cm; 40% rounded.

8-10' Gravel(95%) sandy (5%); medium dark gray (N4, DRY). Clasts to 2.5CM. 75% angular. Gravel median, 3mm; sand 0.5mm.

10'-12 Gravel as above coarser grained.

12-14' Gravel as above

14-15.7 Gravel as above

15.7-16 Gravel(45%). muddy(5%), silty(10%), sandy 40%; olive black (5Y 2/1, WET). Clasts to 2.5cm. Gravel median 5mm; sand .45mm.

16-18' Gravel(80%), sandy(20%); olive black (5Y 2/1, WET). Clasts to 2cm, 50% angular. Gravel median 7.5 mm; sand 0.5mm.

Summary log

Blacktop	0-1
silt, clayey, sandy, gravelly	1-4
Sand and gravel	4-6
Gravel, sandy, (silty)	6-18

B-3 [illegible]

Location ______ Date 1-12-87 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J.B. GONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						34-36' Sand ~~as above~~ (60%) muddy (2%) gravelly (37%). Olive black (5Y 2/1, WET). Clasts to 2.5 cm, 50% angular. Gravel median 5mm, sand 0.4mm.	
						36-38' Sand (85%) gravelly (15%); greenish black (5G 2/1, WET). Clasts to 2.5cm, Gravel median 1cm; sand 0.5mm.	

B-3 SAMPLE LOG

Location ______ Date 1-12-87 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J. B. GONTHIER

Lithologic Symbols

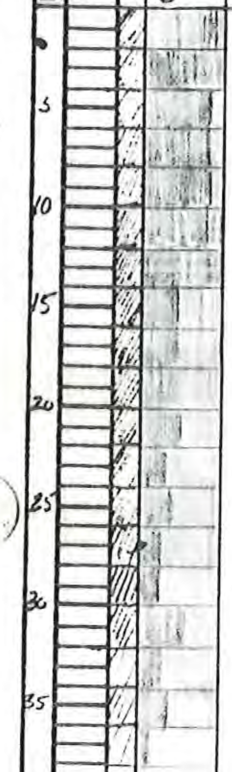
Abbreviations

clay	c	cobbles	cob	sandy	sdy		
silt	st	boulders	b	fine	f		
sand	s	clayey	cly	medium	m		
gravel	g	silty	sty	coarse	co		

Rge. ______

Twsp. ______ Sec.

Depth | Scale | Sample | Graphic log | Drill action



Lithologic description

0-2 Silt, muddy, sandy. brownish black (5YR 2/1, DRY-DAMP). Clods to 4cm break explosively.

2-4' Gravel, silty (35%); olive gray (5Y 4/1, DRY). Clasts to 1.5cm; very angular chips basaltic. Gravel median 75mm;

4-6' Gravel 85%, sandy, (15%); medium dark gray (N4, DRY). Clasts to 2 cm; 90% are angular chips of larger cobbles; 85% are basaltic. Gravel median 6 mm

6-8' Gravel as above very strong diesel fuel odor. Very muddy looking.

8-10' Gravel as above, very strong diesel ODOR.

10-12 Gravel (85%), silty (3%) and sandy (12%); olive gray (5Y 4/1, DRY). Clasts to 1.5cm, 90% angular chips silt covered. Gravel median 8mm, sand 1.0 mm.

12-14' Gravel 40%, silty (25%), sandy (35%); olive black (5Y 2/1, WET). Clasts to 1.5cm; Gravel median 4mm; Sand

14-16' Gravel (40%), silty (35%) sandy (25%). olive black

16-18' Gravel as above.

18-20' Gravel as above

20-22 Gravel and sand (50%); olive black (5Y 2/1, WET). Clasts to 1.5cm 50% angular. Gravel median 5mm; sand 0.5mm

22-24 Sand (70%), gravelly (30%); olive black (5Y 2/1, WET). Clasts to 3cm, 50% angular Gravel median 5mm; sand 0.5mm.

24-26' Sand (55%), gravel (45%): olive black (5Y 2/1, WET). Clasts to 3cm. 50% angular Gravel median, 6mm; sand 0.75mm.

26-28' Sand (75%) gravelly (25%): olive black (5Y 2/1, WET). Clasts to 1.5cm. Gravel median 3mm; Sand 0.6mm

28-30' Sand as above

30-32' Gravel (55%), silt, 2%, sandy 45%: olive black (5Y 2/1, WET). Clasts to 1.5 cm, 75% angular chips. Gravel median 6mm, sand 0.5mm.

32-34' Sand (75%), gravelly (28%); water muddy olive black (5Y 2/1, WET). Clasts to 2.5cm, [illegible] Gravel median 4 mm; sand [illegible]

Summary log	
Silt, muddy, sandy	0-2
Gravel (silty upper part) sandy	2-6
Gravel, sandy (strong diesel oil odor)	6-10
Gravel, sandy	10-12
Gravel, silty, sandy	12-20
Sand and gravel	20-22
Sand, gravelly	22-30
Gravel, sandy	30-32
Sand, gravelly	32-38

B-2 SAMPLE LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist GONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec.

Depth	Scale	Sample	Graphic log	Drill action
5				
10				
15				

Lithologic description

0-2' Silt, clayey sandy silt; dusky yellowish brown (10YR 2/2; MOIST). Balled up into 5mm balls, gritty. Clasts, broken from elsewhere.

2-4' Mix of above soil and gravel, olive gray (5Y 3/2, DRY & DAMP) Clasts to 2cm, angular 70%, rounded 30%. Gravel median 8 mm.

4-6' Gravel (80%), sandy (20%); medium light gray (N6, DRY). Clasts to 2cm; angular 50%, subround and round 50%, basaltic 70%, granitic 20%; 10% MRF. Gravel, median, 6 mm, sand 0.5 mm.

6-8' Gravel (80%), sand (20%); light olive gray. (5Y 5/2, DRY). Clasts up to 2.5cm., angular 60-70%, basaltic. Gravel 5mm, sand, 1mm.

8-10' Gravel (75%), sandy 25%); light olive gray clasts coated with, clayey silt and very fine sand. up to 1.5cm; 60% subround 40% angular. Gravel median, 1cm; sand 0.8 mm.

10-12' Gravel 60%, silty (5%), sandy (35%, clasts up to 1cm, subrounded 60-70%, basaltic, Gravel median 4mm; sand .5mm.

12-14' Gravel (60%), silty (10%), sandy (30%); olive gray (5Y 3/2, WET). Clasts up to 1cm; rounded to subround 70%, basaltic. Gravel, median (4mm); sand .8 mm.

14-16' Sand (55%), gravelly 45% olive gray (5Y 3/2, MOIST). Clasts to 1.5cm, mostly subround, basaltic. Gravel median 3mm; sand, 1mm.

16-17.5' Gravel (70%), silty (5%), sandy (25%); olive gray (5Y 3/2, WET). Clasts to 3cm, mostly subround, basaltic. Gravel, median 6mm, sand .5 mm.

17.5-18.7 Sand (75%), gravelly (25%); olive gray (5Y 3/2, MOIST). Clasts to 3cm (erratic) most rounded. Gravel median 3mm; sand 1mm.

Summary log

silt, clayey, sandy	0-3?
gravel, sandy	3-14
sand, gravelly	14-16
Gravel, sandy	16-17.5
sand, gravelly	17.5-18.7

[illegible]

Location ____ Date ____ Local well number ____

County ____ Map ____ Scale ____ Lat. ____ Long. ____

District ____ Project number ____ Altitude ____

Driller ____ Helper ____ Geologist GONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____

Twsp. ____

Sec.

Depth | Scale | Sample | Graphic log | Drill action

5

10

15

Lithologic description

0-2' Silt (60%), sandy (40%), dusky yellowish brown (10YR 2/2, MOIST); contains rootlets and wood fragments. Sand median in very fine sand range. Clods into angular platy fragments

2-4' Silt 60%, sandy (40%), dark yellowish brown (10YR 4/2 DRY). Three or four clasts to 1cm. Sand median is very fine sand. No organic debris.

4-6' Sand (70%) gravelly (30%); olive gray (5Y 3/2, MOIST). Clasts to 1cm, angular and subround, basaltic >70%. Gravel median (3mm), sand .5mm.

6-8' Gravel (50%), Sandy (50%); olive black (5Y2/1, MOIST) Clasts to 2cm, rounded and angular. basaltic. Gravel median, 5mm, sand 1mm.

8-9' Gravel (60%), sandy (40%). olive black (5Y2/1, MOIST), Clasts to 2.0cm, angular, basaltic, Gravel median, 4mm; sand, 1mm.

9-10' Gravel (70%), sandy (30%); olive black (5Y2/1, WET) Clasts to 1.2cm, angular 50% to rounded 50%, basaltic, Gravel median 5mm, sand 1mm.

10-12 Gravel; (75%) sandy 25%; olive black (5Y2/1, WET. Clasts to 1cm., 25% are angular chips, 75% basaltic. Gravel median 4mm, sand 1.5mm

12-14' Sand (55%), gravelly (45%); olive black (5Y2/1, MOIST). Clast to 1.5cm, rounded, basaltic. Gravel median, 4mm, sand 1mm.

14-16' Gravel (70%), silty (5%) Sandy 25%; olive black (5Y2/2, WET). Clasts to 1.5cm angular >50%, subround 30 to 40%, basaltic >70%, gravel median 5mm; sand 0.5mm.

16-18' Gravel (70%), silty (5%), sandy (25%), grayish olive (10Y 4/2, WET). Clasts to 2cm, angular 60%, round to subround 50%. Gravel median, 8mm; sand 0.5mm.

Summary log

silt, sandy	0-4
Sand, gravelly	4-6
Gravel, sandy	6-12
Sand, gravelly	12-14
Gravel sandy	14-18'

T-22 SAMPLE LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J. B. GONTHIER

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec.

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log	
						0-2 Soil dusky yellowish brown (10YR 2/2, WET) much organic debris mostly grassy.	Soil, organic	0-2
						2-4' Mud, silty, sandy, dark yellowish brown (10YR 4/2, WET): minor organic debris.	Mud, silty sand	2-6
5						4-6' Mud, silty; dark yellowish brown (10YR 4/2, WET)		
10						6-8' Gravel (85%) silty (3%) sandy (12%): (dusky yellowish brown (10YR 3/2, WET). Clasts up to 2cm, mostly fragments of basaltic pebbles or cobbles, H₂O muddy.	Gravel, sandy cobbly	6-18
15						8-10' Gravel (95%): ~~dark~~ dusky brown (5YR 2/2, WET) clasts to 3cm, mostly chips from pebbles ~~and cobbles, basaltic~~, some intermediate volcanics.		
						10-12' Gravel (90%) silty (3%) sandy (7%): dusky to yellowish brown (10YR 2/2, WET). Clasts to 2cm; mostly chips from basalt pebbles and cobbles,		
						12-14' Gravel (75%), silty (8%) sandy (17%): dark yellowish brown (10YR 4/2, MOIST). Clasts rolled in silt and sand, clasts up to 3cm; mostly sub round to round; few angular, Gravel median 7mm, sand 0.25.		
						14-16' Gravel (75%) silty (4%), sandy (21%): dark yellowish brown (10YR 3/2, WET). Clasts to 3cm; about 80% angular fragments basaltic (80%) 20% felsic. Gravel, median 1cm: sand 05 mm.		
						16-18' Gravel (50%), silty (7%) sandy 43%; H2O muddy; dark yellowish brown (10YR 3/2, WET). Clasts to 3cm, mostly subround to round few angular fragments; basaltic 60%: 30% felsic MRFS (10%). Gravel, median, 5mm; sand 0.5mm.		

3 of 3

T-21 SAMPLE

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JB GONTHIER

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						56-58' Gravel (70%), silty (10%) sandy (20%), olive black (5Y 2/1, WET). Clasts to 2cm, few angular chip ~~most~~ (40%); most 60% subround to round. Gravel median 9mm; sand 0.35mm.	

2 of 3
T-21 SAMPLE LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JB GONTHIER

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log

30-32" Gravel 70%, sandy (30%); greenish black (5GY 3/2, WET). Clasts to 2cm, 60% angular chips; basaltic 75%. Gravel median, 3-4mm; sand 0.5mm.

32 34' Gravel as above (65%).

34 36' Gravel (80%), sandy (20%); greenish black (5GY 3/2, WET), Clasts 3cm; basaltic 70%, 35% angular chips. Gravel median, 4mm; Sand 0.35mm.

36-38' Gravel as above silty.

38-40' Sand 60%, gravelly; olive black (5Y 2/1, WET). Clasts to 1cm, subround to round; 50% basaltic, (35%) lithic mafic to intermediate. Gravel median, 3mm; Sand 1.5mm. Matrix 10% quartz 10% Feldspar.

40-42' Gravel (80%) sandy (20%); brownish black (5YR 2/1, WET). Clasts To 2.5cm, 80% are angular chip, 80% are basaltic. Gravel median 1mm, sand 1.5mm. Matrix 10% quartz, 10% feldspathic, remainder is lithic.

42-44' Gravel (70%), silty (5%) sandy (25%), dusky yellowish brown (10YR 2/2, WET). Clasts to 3cm, 60% are angular chips; 80% are basaltic, Gravel median; 4mm; sand (.25mm). Matrix 5 to 10% each quartz and feldspar.

44-46' Gravel (80%), sandy (20%); olive black (5Y 2/1, WET); Clasts to 1.5cm, most (80%) are angular chips; basaltic Gravel median 7.5mm; sand .5mm; Matrix 5 to 10% each of quartz and feldspar.

46-48' Gravel 55%, sandy (45%); water turbid; dusky yellowish brown (10YR 2/2, WET); Clasts to 4cm; 30 to 40% angular chips. Gravel median 4mm; sand 0.45. Chips many 30% are pale green sandstone. perhaps from singlar clast.

48-50' Gravel, sandy (as above)

50-52 Gravel, sandy (as above) clasts to 2cm.

52-54' Sand 75%, silty (5%) gravelly (20%); dark yellowish brown (10YR 3/2, WET). clasts up to 3.5cm, angular chips, basaltic. Sand median, 0.25mm; gravel 1cm. Water turbid.

54-56' Sand (55%), gravelly (45%); dusky yellowish brown (10YR 2/2, WET). Clasts to [illegible] round and subround; [illegible] angular [illegible] [illegible] Sand [illegible]

T-21 SAMPLE LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J B GONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec.

Depth | Scale | Sample | Graphic log | Drill action

5 10 15 20 25 30 35 40 45 50 55

Lithologic description	Summary log	
0-2' (Plastic bag) Soil, clayey; dusky yellowish brown (10YR 2/2, WET) 2-4' Mud, silty (3%); dusky yellowish brown (10YR 2/2, WET) (sandy (20%))	Soil, mud, silty sandy	0-4
4-6 Gravel (60%) muddy (20%) dark yellowish brown (10YR 3/2, WET). Clasts to 3.5cm, most are angular chips. 6-8' Gravel (75%), muddy (10%) sandy (15%); dark yellowish brown (10YR 1/2, WET). Clasts to 2cm, most are angular chips, Gravel median 3mm, sand 0.125mm. Basaltic (65%) and mafic lithic 8-10' Gravel (80%), silty (3%) sandy (17%); dusky yellowish brown (10YR 2/2, WET). Clasts to 2cm, most angular (80%) chips, 80% basaltic, 20% lithic intermediate to felsic Gravel median, 3mm; sand .15mm. 10-12' Gravel (90%) sandy (10%); dusky yellowish brown (10YR 2/2; WET). Clasts to 2cm; 80-90% are angular chips; basaltic. 12-14' Gravel (65%) sandy (35%); dusky yellowish brown (10YR 2/2), WET). Clasts to 3cm., 50% are angular chips., basaltic + other dark lithics. Gravel median, 4mm; sand 0.5mm. 14-16'' Gravel, 80%) sandy (20%); dusky yellowish brown (10YR 2/2, WET). Clasts to 4cm, 55% angular chips, basaltic 70%, 20% felsic lithic. Gravel median 6-7mm; sand 0.125mm. 16-18' Gravel (60%) sandy (40%); dusky yellowish brown (10YR 2/2, WET). Clasts to 2cm; 60% angular chips; basaltic 70%; 20% other lithic, 10% qtz and Feldspar.	Gravel, sandy	4-38
	Sand, gravelly	38-40
18-20' Gravel (55%), sandy (45%); dusky yellowish brown (10YR 4/2). Clasts up to 3cm; rounded to sub round 65% basaltic 35% felsic lithic. Gravel median, 4mm; sand 0.5mm. 20-22' Gravel (65%), sandy (35%), dark yellowish brown (10YR 4/2, WET). Clasts up to 1.5cm, round and subround (80%), basaltic (55%); 35% felsic lithic; Gravel median 4mm, sand (.35mm).	Gravel, sandy	40-52
	Sand, gravelly	52-56
22-24' Gravel (60%) sand (40%). Dark yellowish brow (10YR 3/2, WET. Clasts to 3cm; 45% are angular chips, 70% basalic. others are felsic to intermediate. Gravel median 5mm; sand 0.5mm.	Gravel, silty sandy	56-58
24-26' Gravel (70%), sandy (30%); greenish black (5GY 2/1, WET). Clasts to 3cm; 75% basaltic 30-40% are angular chips Gravel median 4mm; sand 0.35mm. 26-28' Gravel (65%) sandy (35%); olive gray (5Y 4/1, WET). Clasts up to 2cm; 30% are angular chips, basaltic ([illegible]), Gravel median 4mm, sand [illegible] mm. [illegible]' Gravel 55 [illegible]		

T 20 SAMPLE LOG

Location ____ Date -2-87 Local well number ____

County ____ Map ____ Scale ____ Lat. ____ Long. ____

District ____ Project number ____ Altitude ____

Driller ____ Helper ____ Geologist J. R. GONTHIER

Rge. ____ Twsp. ____ Sec.

Lithologic Symbols

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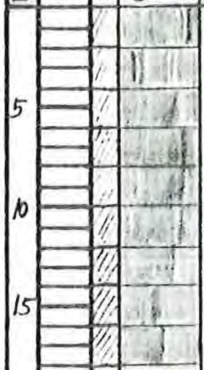
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth | Scale | Sample | Graphic log | Drill action | | Lithologic description | Summary log



Lithologic description

0-2' Silt (80%) sandy (10%) gravelly (10%), dusky yellow (5Y 5/4, DRY). Clasts to 1cm; 50% areangular chips.

2-4' Sand (45%), siltx (25%) gravelly (30%); light olive gray (5Y 3/2, DRY). Clasts to 2.5cm, 65% are rounded 35 angular chips. Sand median, 0.125 mm; Gravel 1cm.

4-6' Gravel 70%, siltx (10%), sandy (20%); olive gray (5GY 2/1; Dry to Moist). Clasts to 1.5cm, most (80%) are angular chips; most are basaltic (60%). Gravel median, 5mm, sand 0.125.

6-8' Gravel (85%), sandy (15%); olive gray (5Y 4/1, DRY), Clasts up to 2cm; 90% are angular chips; 8% are basaltic. Gravel med 4mm; sand 0.5mm.

8-10' Gravel (85%), sandy (15%); dark greenish gray (5G 4/1, DRY). Clast to 2cm, 80% are angular; 80% are basaltic. Gravel median, 1cm; sand 1.5mm.

10-12' Gravel as above slightly coarser.

12-14' Gravel (75%) sandy; olive black (5Y 2/1, WET). Clasts up to 2.5 cm; 90% are angular chips, basaltic. Gravel median, 4mm; sand .5.

14-16 Gravel (55%), sandy (45%); olive gray (5Y 2/1, WET). Clasts to 2.5cm; most 65% subround to round. Gravel median, 4mm; sand 0.5mm.

16-18' Gravel (60%), muddy (15%) sandy (25%), Light olive gray (5Y 5/2, WET). Clasts to 3cm, 75 to 80% are angular chips, basaltic (70%). Gravel median 3mm; sand 0.125.

Summary log

Silt, sandy, gravelly	0-2
Sand, silty gravelly	2-4
Gravel, sandy silty	4-18

T-19 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JB SONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log	
						0-2' Silt(80%), sandy(10%) gravelly (10%); Light olive gray (5Y 5/2, DRY). Clasts to 2cm most are angular, gravel median 2.5 mm., sand 0.08 mm.	silt, sandy gravelly	0-2
5						2-4' Gravel(95%), sandy(5%); greenish black (5GY 2/1, DRY). Clasts to 3cm, 90% are angular chips, 70% are basaltic. Gravel median, 7.5 mm, sand 1.5mm.	Gravel, sandy	2-18
10 15						4-6' Gravel(95%); sand (5%); medium dark gray (N4, DRY). Clasts to 1.5cm, 80to90% are angular chips; 85% are basaltic or andesitic lithic & Gravel median 4mm; sand, 1.5mm.		
						6-8' Gravel(75%), sandy (25%); medium dark gray(N4 DRY). Clasts to 2cm, 90% are angular chips, 80 are basaltic and andesitic. Gravel median 3mm; sand 1mm.		
						8-10' Gravel(95%), sandy(5%); olive gray (5Y 4/1, DRY). Clasts to 2cm, 60% are angular chips, 75% are basaltic and andesitic. Gravel median, 5mm; sand 1.5mm.		
						10-12' Gravel(80%), sandy (20%); olive gray(5Y 4/1, DRY). Clasts to 1.5 cm, 70% are angular chips, 80% are basaltic and andesitic. Gravel median, 4mm; sand, 1.0 mm.		
						12-14' Gravel(98%), silty(2%), olive gray (5Y 4/1, DRY) Clasts to 4cm, 80% are angular chips, all are silt covered		
						14-16' Gravel (70%), muddy, (10%) sandy (20%); grayish olive green (5GY 3/2, WET). Clasts to 2cm, 70% are angular chips; 80% are basaltic and andesitic. Gravel median 7.5cm, sand 0.125 mm.		
						16-18' Gravel(85%), silty (5%) sandy 10%; Olive gray (5Y 4/1, WET). Clasts to 3cm, 85% are angular chips. 70-80% are basaltic and andesitic		

Location ______ Date ______ Local well number T-18 SAMPLE LOG

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J.B. GONTHIER

Rge. ______

Twsp. ______ Sec.

Lithologic Symbols

MUD	SAND	
SILT	GRAVEL	

Abbreviations

clay	c	cobbles	cob	sandy	sdy		
silt	st	boulders	b	fine	f		
sand	s	clayey	cly	medium	m		
gravel	g	silty	sty	coarse	co		

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Mud, silty. dusky yellowish brown (10YR 2/2, MOIST).	Silt, clayey, sandy. 0 - 10
5						2-4' Silt, clayey, dark yellowish brown (10 YR 3/2, DRY).	
						4-6' Silt, clayey and sandy; (as above darker color.	
10						6-8' Silt (60%), clayey (5%) sandy (35%); moderate brown (5 YR 3/4, MOIST).	Gravel, sandy 10 - 18
15						8-10' Silt (60%), clayey (5%) sandy (35%), as above (MOIST)	
						10-12' Gravel (65%), silty (5%), sandy (30%); dark yellowish brown (10YR 4/2 DRY). Clasts to 3cm; 50% are angular chips; 80% are basaltic. Gravel median 7 mm; sand 0.5mm.	
						12-14' Gravel (85%), sandy (15%); light olive gray (5Y 4/2, DRY). Clasts to 2cm, 85% are angular chips, 70 to 80% are basaltic. Gravel median 7mm; sand 0.5mm.	
						14-16' Gravel (80%), muddy (5%) sandy (15%); olive gray (5Y 3/2, MOIST). Clasts to 3cm; 40% are angular chips, Gravel median 7 mm; sand 0.125mm.	
						16-18' Gravel (80%), muddy (5%) sandy 15%, as above.	

T 17 SAMPLE 103

Location ______ Date 1/8/87 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J GONTHIER

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______

Sec.

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Mud, silty; dusky brown (5YR 2/2, WET), some organic debris.	Mud, silty, sandy. 0-4'
5						2-4' Mud, silty (90%) sandy (10%). (5YR 2/2, WET), Some organic debris.	
10						4-6' Gravel (70%) sandy (30%); dusky yellowish brown (10YR 2/2, WET). Clasts to 2.5cm, most are angular chips. Basaltic 20%. Gravel median 8mm; sand 0.5mm.	Gravel, sandy 4-18'
15						6-8' Gravel (70%), sandy (30%); dusky yellowish brown (10YR 2/2, WET). Clasts to 2cm, 80% are angular chips; 80% basaltic. Gravel, median 4mm; sand 0.5mm.	
						8-10' Gravel (70%), sandy 30%, as above; one clast 3.5cm.	
						10-12' Gravel (95%), sandy (5%); olive black (5Y 2/1, WET). Clasts up to 2cm; 90% are angular chips, 80% are basaltic. Gravel median, 7.5cm; sand 1.0mm.	
						12-14' Gravel (90%) sandy (10%); olive black (5Y 2/1, WET). Clasts to 2cm, 80% are angular chips.	
						14-16' Gravel (70%) muddy (5%) sandy (20%); dusky yellow green (5GY 4/2, WET) Clasts to 1.5cm, all are angular chips. Gravel median, 4mm; sand 0.125mm.	
						16-18' Gravel (60%), muddy (15%) sandy (25%); dusky yellow green (5GY 4/2, WET) Clasts to 3cm, 60% are angular chips. Gravel med (5mm); sand 0.4mm.	

T 16 SAMPLE LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J.B. GONTHIER

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Gravel(65%), silty (20%) sandy 15%; dark yellowish brown (10YR 4/2, DRY). Clasts to 4cm, 30% are angular and silt covered; basatic (70%).	Gravel, silty, sandy 0-18'
5						2-4' Gravel(90%), sandy(10%); dark gray(N 3 DRY). Clasts to 2cm, 80 to 90% are angular chips, 80% are basaltic. Gravel median, 4mm; sand 0.75mm.	
10						4-6' Gravel, sandy (as above)	
						6-8' Gravel, sandy (as above)	
15						8-10' Grave, sandy (as above).	
						10-12' Gravel(90%), sand (10%) as above; olive black (5Y 2/1, WET); Diesel oil smell.	
						12'-14' Gravel(65%), sandy(35%); olive black (5Y 2/1, WET). Clasts to 2cm; 60% angular chip. Gravel median 3mm; sand 0.5mm.	
						14'-16' Gravel, sandy as above.	
						16-18' Gravel(90%) sandy (30%); olive black (5Y 2/1, WET). Clasts to 4.5cm; 60% angular chips. Gravel median 1cm; sand .6mm.	

T-15 SAMPLE LOG

Location ____ Date ____ Local well number ____

County ____ Map ____ Scale ____ Lat. ____ Long. ____

District ____ Project number ____ Altitude ____

Driller ____ Helper ____ Geologist J.B. GONTHIER

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____ Twsp. ____ Sec. ____

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Silt, clayey and gravelly, some rootlets, dusky yellowish brown (10YR 2/2, MOIST). Clasts to cm.	silt, clayey, gravelly 0-4'
5						2-4' Silt, clayey and sandy, dusky yellowish brown (10YR 2/2, MOIST)	Gravel, sandy 4-12'
10				D		4-6' Gravel 80%, sandy (20%); dark gray (N3, DRY). Clasts to 1.2cm, most are angular chips, basaltic. Gravel median, 3mm; Sand 0.75mm.	DIESEL FUEL ODOR-TURGID SAMPLE
				D		6-8' Gravel 85% sandy 15% as above slightly coarser grained (chips 80-90%)	
15				D		8-10' Gravel sandy as above, greenish black (5GY 2/1, WET).	
						10-12' Gravel (70%) muddy (10%) sandy (20%); very turbid, diesel fuel (?) smell. Medium dark gray. Clasts to 1.5cm, 80+% are angular chips. Gravel median 8mm; sand 0.5mm	
						12-14' Gravel (70%) muddy (10%) silty (5-10%) sandy (10%) as above.	
						14-16' Gravel (as above), Clasts to 3cm.	
						16-18 Gravel (as above) but slightly less turgid perhaps no or less fuel?	

SAMPLE LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J B GONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Silt, clayey and sandy: dark yellowish brown (10 YR 3/2, DRY).	silt, clayey and sandy 0-6
5						2-4' Silt, clayey and sandy (3%); moderate brown (5YR 3/2, DAMP)	
						4-6' Silt, clayey and sandy, as above slightly darker and more moist.	Gravel, sandy 6-18
10 15						6-8' Gravel (80%), sandy (18%) [some silt]; dark yellowish brown (10YR 3/2, DRY). Clasts to 2cm, about 35% angular chips, most are basaltic. Gravel median, 6mm; sand, 0.125mm.	
						8-10' Gravel (60%); silty (5%) sandy (35%); dark yellowish brown (10XR 3/2, DAMP). Clasts to 3.5cm, 40 to 60% angular chips. Gravel median 7mm, sand 0.125.	
						10-12' Gravel (80%), sand (15%) silt (5%): dark yellowish brown (10YR 3/2, DRY); Gravel median 5mm; sand (0.125mm).	
						12-14' Gravel (65%) muddy (10%) silty (0%) sandy 20%, dark yellowish brown (10YR 3/2, WET). Gravel median, 5mm; sand 0.5mm.	
						14-16' Gravel (60%), sandy (40%), olive black (5Y 2/1, WET). Clasts to 1.5cm, 85% are angular chips, basaltic gravel median 4mm; sand 1.0mm.	
						16-18' Gravel (75%) sandy (25%), olive black, (5Y 2/1, WET). Clasts to 2.5cm, 80% are angular chips, basaltic. Gravel median, 1cm; sand 0.5mm.	

T-13 SAMPLE LOG

Location ______ Date 1-9-86 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JB GONTHIER

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						28-30' Gravel(70%) muddy (10%), silty(5%), sandy(15%) similar to above; clasts to 3cm, most 55% are rounded to sub angular.	
						30-32' Gravel 80%, silty(2%) sandy (18%), olive black (5Y 2/1, WET). Clasts to 2 cm, 70% are angular chips. Gravel median, 6mm; sand, 0.35 mm. Felsic clasts 20% of total.	
						32-34' Gravel as above; less silt.	
						34-36 Gravel (80%): sandy(20%); olive black (5Y 2/1, WET); clasts to 1.3cm; 95% are angular basaltic chips from same boulder? Gravel median 4mm; sand 0.25%	
						36-38' Gravel (65%) sandy (35%); olive black (5Y 2/1, WET). Clasts to 4cm, most are angular chips variable shade. Gravel, median 1cm; sand 0.35mm.	

T-13 SAMPLE LOG

Location ______ Date 1-9-86 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J. B GONTHIER

Lithologic Symbols

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Abbreviations

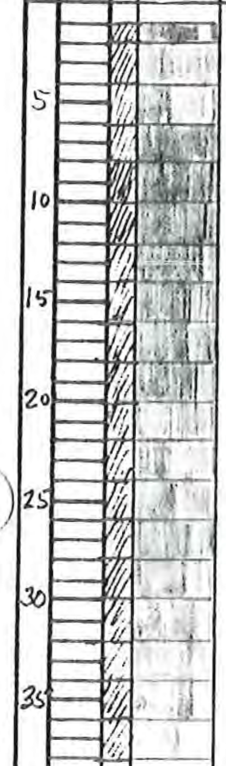
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth | Scale | Sample | Graphic log | Drill action



Lithologic description

0-1' No sample

1-2' Gravel (75%), silty (10%) sandy (15%); dark yellowish brown (10YR 3/2, DAMP), Clasts to 2.5cm silt covered. Gravel median, 1cm. sand 0.08mm.

2-4' Silt, (75%) sandy (25%). dark yellowish brown. sand is very fine sand <1.125 mm. (10YR 4/2, MOIST)

4-6' Sand (50%), silty (10%) gravelly (40%); dusky yellowish brown (10YR 2/2, DRY)

6-8' Gravel (80%) sandy (20%); dark gray (N3, DRY) Clasts to 2cm, 85% are angular Chips most of these are basaltic. Gravel median, 4mm; sand .75mm.

8-10' Gravel (95%), sandy (05%), olive gray (5Y 4/1, DRY). Clasts to 2.5cm, 75% are angular chips; basaltic. Gravel median. 1cm.

10-12' Gravel (85%) sandy (15%); medium dark gray (N4, DRY), Clasts to 2cm, 85% are angular chips, these are basaltic. Gravel median 1cm; sand 1.0mm.

12-14' Gravel (85%), sandy 15%. (as above)

14-16' Gravel (70%), muddy (5%) silty (10%) sandy (20%) very turgid, diesel smell (weak); olive gray (5Y 4/2, WET). Clasts to 3cm, angular chips

16-18' Gravel (70%) muddy (5%), silty (10%) sandy (20%). (as above)

18-20' Gravel (80%) silty (3%) sandy (17%); olive gray (5Y 4/2, WET). Clasts to 1.5 cm, 70% are anguler chips; 70% basaltic. Gravel median 4mm; sand 0.5mm.

20'-22' as above slightly siltier

22'-24' Sand 55% silty (3%), gravelly (42%); brownish black (5YR 2/1, WET). Clasts to 2cm; angular chips sand median .35mm; gravel 5mm.

24-26 Sand (50%) and gravel (50%); olive black (5Y 2/1, WET. Clasts to 2.5cm 95% are angular chips. Gravel median 7.5mm. sand .35mm. Major 5 to 10% each of quartz and feldspar.

26-28 Gravel (70%) muddy 4% silty 7% sandy (19%); [illegible] gray 5Y 4/2 WET)' Clasts [illegible] angular ch [illegible]

Summary log

Asphalt	0-1
Gravel, silty, sandy (Fill?)	1-2
Silt, sandy	2-4
Sand, silty, gravelly	4-6
Gravel, sandy, clayey silty	6-22
Sand, silty, gravelly	22-24
Sand and gravelly	24-26
Gravel, sandy, muddy, silty.	26-32

1-12 SAMPLE LOG

Location ______ Date 1-7-85 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J B GONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______ Twsp. ______ Sec.

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-1' No sample	No sample (asphalt) 0-1
						1-2' Silt, clayey (5%) sandy (5%); dark yellowish brown (10 YR 3/2, MOIST).	Silt, clayey, sandy 2-4
5						2-4' Silt, clodded some gravel, dark yellowish brown (10 YR 3/2, MOIST)	
10						4-6' Gravel (90%), sandy (10%); medium dark gray (N4, DRY). clasts to 2.5cm. ~~80~~ 75 90% are angular basalt chips. Gravel median 5mm; sand 10mm.	Gravel, sandy, silty 4-18
						6-8' Gravel as above slightly coarser.	STRONG DIESEL ODOR
15						8-12 Gravel as above chips much smaller however.	
						12-14' Gravel (70%), silty (5%), and sandy (25%) diesel oder, turgid looking; olive gray. Clasts to 1.5cm. Like an emulsion of clay and oil.	
						14-16' Gravel (80%), sandy (20%); olive black (5Y 2/1, WET), Clasts to 2cm; most are angular basalt chip. gravel median 8mm; sand .05mm.	
						16-18' Gravel as above, larger clasts, less angular.	

T-11 SAMPLE LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J.B. GONTHIER

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth | Scale | Sample | Graphic log | Drill action

5

10

15

	Lithologic description
0-2'	Soil, silty, organic; brownish black (5YR 2/1, DRY).
2-4'	Silt, clayey (4%) sandy (5%); dark yellowish brown (10 YR 4/2, DRY); some rootlets.
4-6'	Silt (50% and gravel (50%), dark yellowish brown (10 YR 4/2, DRY). Clasts to 2.2cm; 90% are angular chips. Gravel median, 1cm.
6-8'	Gravel (80%) silty (3%) sandy (17%); brownish gray (5YR 4/1, DRY).
8-10	Gravel, as above slightly finer
10-12	Gravel, as above.
12-14	Gravel, as above
14-16	Gravel (70%), clayey, silty, sandy (20%), very turgid appearing, olive gray (5Y 4/1, WET). Clasts to 1.5cm, angular chips. Gravel median 7mm; sand 0.125mm.
16-18'	Gravel (70%) clayey (3%) silty (3%) sandy (24%), dusky brown (5YR 2/2, WET) Water rusty or muddy dark brown. Clasts to 1.5cm rounded clasts are broken. Gravel median 5mm; sand 0.125mm.

Summary log	
Silt, clayey organic	0-5
Gravel, clayey, silty, Sandy	5-18'

Location ______ Date ______ Local well number T 10 S R [illegible] E [illegible]

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JB GONTHIER

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Silt, clayey and sandy. some rootlets. dark yellowish brown (10YR 4/2, DRY).	silt, clayey, sandy 0-2
5						2-4' Gravel (75%) silty 10%) sandy (15%); dark yellowish brown (10YR 4/2, DRY). Clasts to 2cm, 60% are angular chips. Gravel median 7mm; sand 0.35mm.	Gravel, silty, sandy 2-18
10						4-6' Gravel (85%), sandy (15%); medium gray (N3, DRY). Clasts 2.5cm, 70% are angular chips, basaltic. Gravel median 5mm; sand 1.0mm.	
15						6-8' Gravel as above fewer angular clasts. 50% are rounded.	
						8-10' Gravel as above, more angular chips slightly coarser.	
						10-12' Gravel as above slightly finer.	
						12-14' Gravel (50%) silty (20%) sandy (30%); olive gray (5Y 4/1, DRY). Clasts to 2cm; 60% rounded to subround, silt covered. Gravel median 7.5mm; sand 0.125mm	
						14-16' Gravel as above, wet, less silt, more sand	
						16-18' Gravel as above.	

T-9 SAMPLE LOG

Location ____ Date ____ Local well number ____

County ____ Map ____ Scale ____ Lat. ____ Long. ____

District ____ Project number ____ Altitude ____

Driller ____ Helper ____ Geologist JB GONTHIER

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____

Twsp. ____

Sec.

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Mud, silty and sandy; dusky yellowish brown (10YR 2/2, MOIST).	Mud silty sandy gravelly 0-5
						2-4' Mud, silty, sandy, gravelly (20%); dusk yellowish brown (10YR 2/2, MOIST).	
5						4-6' Gravel (60%), muddy 10%, silty 5% sandy 25%; dusk yellowish brown (10YR 2/2 WET). Clasts to 3cm, 50% round or sub round other angular. Gravel median, 1cm; sand 0.15mm.	Gravel, muddy, silty 5-6 Sand, muddy, silty, gravelly 6-12
10						6-8' Sand (60%); muddy (5%) silty (10%) gravelly (35%); dusky yellowish brown (10YR 2/2 WET). Clasts To 2.5cm, angular. Gravel median, 1cm; sand .5mm.	
15						8-10' Sand 40%, muddy (15%), silty 15%, gravelly (30%); dusky yellowish brown (10YR 2/2, WET) Clasts to 1.5cm angular, Gravel median (1cm); sand 0.1mm.	
						10-12' Sand (60%) silty (5%) gravelly (35%); dusky yellowish brown (10YR 2/2 WET). Clasts to 1cm, Gravel median (3.mm) sand .5mm.	
						12-14' Gravel (80%), sandy (20%); dusky yellowish brown (10YR 2/2, WET). Clasts to 1.5cm, 90% angular chips; Gravel median, 8mm; Sand 0.2mm.	Gravel, sandy 12-18'
						14-16' Gravel (60%) sandy (40%); dusky yellowish brown (10YR 2/2; WET). Clasts to 2.5cm, 60% angular chips others are subround and round. Gravel median 6mm; Sand .5mm.	
						16-18' Gravel (75%), sandy (25%); dusky yellowish brown (10YR 2/2, WET). Clasts to 3cm, 65% are angular chip. gravel median, 8mm; sand 1.0mm.	

T-7 SAMPLE LOG

Location ______ Date 2-87 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist ______

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log

Depth: 5, 10, 15, 20, 25, 30, 35

Lithologic description

20-22' Sand (80%) gravelly; dusky yellowish brown (10YR 2/2, WET). Clasts to 1.5cm. 50% angular chips. Gravel median 5mm. Sand 0.35mm. Sand 20% is quartz and feldspar; salt and pepper; remainder is lithic particles

22-24' Gravel (55%), sandy (45%); dusky yellowish brown (10YR 2/2, WET). Clasts to 2cm; 50% are angular chips of larger pebbles. Gravel median 4mm; sand 0.5 mm.

24-26' Gravel as above Clasts to 3cm.

26-28' Gravel as above clasts to 1.5cm.

28-30' Gravel (65%), sandy (35%); dark yellowish brown (10YR 4/2, WET). Clasts to 2cm, 40% angular fragments of granule and pebbles. 40% are basaltic, 20% are quartz or feldspar; 40% are other mafic to felsic lithics. Gravel median 3mm, sand .75mm.

30-32' Gravel as above except 3% mud. (10YR 2/2)

32-34' Gravel 55%, sandy 45%; dusky yellowish brown (10YR 2/2, WET). Clasts to 3cm 40% angular fragments of 1 to 2cm pebbles. Gravel median 6mm, sand 0.5mm.

34-36' Gravel as above.

Sample 9 No depth listed (36-38') Gravel 70%, sandy (30%); dusky yellowish brown (10YR 2/2, WET). Clasts to 2cm. 70% rounded. Gravel median 5mm; sand 0.5mm.

Summary log

Sand, gravelly	20-22
Gravel, sandy	22-36

T-8, SAMPLE LOGS

Location ____ Date ____ Local well number ____

County ____ Map ____ Scale ____ Lat. ____ Long. ____

District ____ Project number ____ Altitude ____

Driller ____ Helper ____ Geologist J B GONTHIER

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____

Twsp. ____ Sec. ____

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description
						0-2' Mud, silty sandy; some organic rootlets. Dusky yellowish brown; (10YR 3/2, WET)
5						2-4' Gravel (35% muddy (30%) silty 20% sandy 15%); dusky yellowish brown (10YR 3/2, WET). Clasts to 3cm, angular.
10						4-6' Gravel, (75%) sandy (23%) silty (2%); (10YR 3/2 WET) dusky yellowish brown. Clasts to 2cm; 90% are angular chips, basaltic. Gravel Median 1cm; sand 0.125 mm.
15						6-8' Gravel (85%) sandy (15%); olive black (5Y 2/1, WET). Clasts to 2cm, 90% are angular basalt chip. Gravel median, 75mm; sand, 0.5.
						8-10' Gravel 50%, silty (5%) sandy (45%); olive black (5Y 2/1, WET). Clasts to 2cm. 60% angular remainder subround. Gravel median 4mm; sand .75 mm.
						10-12' Gravel (50%) silty (5%) sandy (45%) as above.
						12-14' Sand (60%), gravelly (40%); olive black. (5Y 2/1, WET). Clasts to 3cm, some angular. Gravel median 5mm; Sand .7mm.
						14-16' Gravel (65%) sandy (35%); olive black (5Y 2/1, WET) Clasts to 3cm, most are angular chips from pebbles. Gravel median, 7.5mm; sand, 0.5mm.
						16-18' Gravel as above.

Summary log	
Mud, silty, sandy, organic	0-3'
Gravel, sandy, silty	3-12
Sand and gravel, silty	12-14
Gravel, sandy	14-18

United States Department of the Interior

TAKE PRIDE IN AMERICA

GEOLOGICAL SURVEY
Water Resources Division
Pacific Northwest District
Washington Office
1201 Pacific Avenue - Suite 600
Tacoma, Washington 98402

OCT 29 1990

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Mr. Peter Kmet, Supervisor
Washington State Department of Ecology
Landfill Site Cleanup Section
Hazardous Waste Investigations and
Cleanup Program
7272 Cleanwater Lane
Olympia, Washington 98501

Dear Pete:

Enclosed is a preliminary copy of a report titled "Contamination of Ground Water by Gasoline and Diesel Fuel at a Site in Yakima" by R. J. Wagner and J. C. Ebbert. This is a provisional draft subject to revision and therefore, the information is not available to the public, pending approval of the Director of the U.S. Geological Survey. We would like to have someone from DOE review the report. Recently, Mike Cochran, from your Yakima office, has expressed interest in the findings in this report. Perhaps he would be an appropriate person to do the review. Please include all attached forms when you return the report. Thank you.

Sincerely yours,

Charles H. Swift, III
Acting State Chief

Enclosures

Preliminary, Subject to Revisions, 10/24/90

CONTAMINATION OF GROUND WATER BY GASOLINE AND DIESEL FUEL AT A SITE IN YAKIMA, WASHINGTON

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report __-____

Prepared in cooperation with
STATE OF WASHINGTON DEPARTMENT OF ECOLOGY

CONTAMINATION OF GROUND WATER BY GASOLINE AND DIESEL FUEL AT A SITE IN YAKIMA, WASHINGTON

By Richard J. Wagner and J. C. Ebbert

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Tacoma, Washington
1990

Preliminary, Subject to Revisions, 10/24/90

DEPARTMENT OF THE INTERIOR

MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY

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[Plate in pocket at end of report]

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CONVERSION FACTORS

For the convenience of readers who may prefer to use metric units rather than the inch-pound units used in this report, values may be converted by using the following factors:

Multiply inch-pound units	By	To obtain metric units
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer(km^2)
gallon (gal)	3.785	liter (L)
micromho per centimeter at 25 degrees Celsius (μmho/cm at 25 °Celsius)		microsiemen per centimeter at 25 degrees Celsius (μS/cm at 25 °C)

Sea Level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929(--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called Sea Level Datum of 1929.

Degrees Celsius (°C)	°F = 9/5 °C + 32	to Degrees Fahrenheit (°F)

CONTAMINATION OF GROUND WATER BY GASOLINE AND DIESEL FUEL AT A SITE IN YAKIMA, WASHINGTON

By Richard J. Wagner and J. C. Ebbert

ABSTRACT

Following the discovery by the Washington State Department of Ecology of a gasoline and diesel-fuel leak at a service station in Yakima, Washington, an unsuccessful attempt was made at recovering the petroleum product. Several studies were designed to monitor the petroleum compounds dissolved in ground water, and from 1985 through 1989, data were collected from observation wells that were drilled near the site of the leak. From February 1985 to November 1986, petroleum-related compounds dissolved in ground water were found consistently, and at relatively large concentrations, in wells near the service station. Petroleum-related compounds were also found sporadically, and in smaller concentrations, in domestic wells as far as 1,500 feet down-gradient of the service station. Sampling results from data collected in March 1989 indicate that concentrations of petroleum-related compounds dissolved in ground water have decreased in magnitude and areal extent.

INTRODUCTION

In 1980, 1981, and 1982, the residents of a neighborhood in the northeast part of Yakima, Washington, complained to the Washington State Department of Ecology (WDOE) about the odor and taste of gasoline in water from their domestic or irrigation wells, which are open to a shallow, unconfined ground-water system. The WDOE investigated the complaints and determined that the source of the gasoline and diesel fuel was leakage near the land surface from improperly installed pump delivery lines at a service station located on North First Street (fig. 1). New delivery lines and storage tanks had been installed at the station in May and June 1979. Leak tests, reported to have been performed at that time and again in December 1980, did not reveal any leaks. Additional tests, conducted in September 1982 as a result of the complaints from private well owners, revealed leaks in the delivery lines, which were repaired immediately.

An audit of gasoline and diesel fuel inventory records, conducted by representatives of the service station, indicated that about 5,970 gallons of leaded gasoline and 1,740 gallons of diesel fuel were lost during the period from September 1981 through October 1982. This represents an average leakage rate of 550 gallons of product per month. If the leak began shortly after the December 1980 test, then about 12,000 gallons could have been lost during the 22-month period from the time of the test to the repair of the leaks. If the December 1980 test was invalid, and the system leaked during the entire 40-month period from the time of installation, then the product loss may have been as much as 22,000 gallons.

An insurance company, representing the service station, initiated an attempt to recover the lost gasoline and diesel fuel in 1982-83 because of the potential to further contaminate drinking water. At least 13 observation wells and two recovery wells were installed on, or adjacent to, the service station property. Three of the observation wells contained several inches of free product, pure gasoline or diesel fuel, floating on top of the water. The recovery operation was discontinued because only 40 gallons of free product were recovered. All but three of the wells were subsequently destroyed. In the summer of 1985, most homes having affected wells were connected to alternate water supplies.

Purpose and Scope

The purpose of this report is to present and compare current and past distributions and concentrations of petroleum-related compounds in ground water near the site of the gasoline and diesel-fuel leak on North First Street in Yakima, Washington. This report presents data collected during a March 1989 sampling study, during 1985 to 1987, as a part of the Ground-Water Toxics Study, and during 1985 through 1986 as a part of the insurance company study. Data collected by the three sampling studies are presented in tabular form. Comparisons are made by presenting distributions of selected compounds in map formats. Sampling procedures and laboratory methods that were used by the three studies are also described.

Description of the Study Area

The City of Yakima is the commercial center for the Yakima River valley, a major agricultural area within south-central Washington. The service station on North First Street where the gasoline and diesel-fuel leak occurred, is located approximately 2,000 feet southwest of the Yakima River (fig. 1). Land use in the vicinity of the service station consists of some orchards and vacant lots interspersed among commercial and residential properties.

The general direction of ground-water flow is eastward from the service station to the river. The subsurface geologic materials immediately underlying the area consist predominantly of coarse-grained alluvial deposits. The water table is approximately 10 feet below land surface. Additional information on the geohydrology is given in the section "Geohydrologic Setting".

Annual precipitation in the valley is about 8 inches (U.S. Department of Commerce, 1987), with more than half of this occurring during the winter months as snow. Potential evapotranspiration, using a modified Blaney-Criddle calculation (U.S. Department of Agriculture, 1970), is approximately 38 inches annually. Consequently, crops require extensive irrigation. Most irrigation water is diverted surface water, but some is pumped ground water. The main municipal water supply for the city of Yakima is surface water; however, some individual residences and small water purveyors rely on ground water.

Geohydrologic Setting

The study area in Yakima, Washington, is located in the Ahtanum-Moxee subbasin (fig. 2), which lies along an east-west oriented alluvial valley between two similarly oriented basalt ridges: Cowiche Mountain and Yakima Ridge on the north, and Ahtanum Ridge and Rattlesnake Hills on the south. The valley lies along a broad structural syncline, is approximately 7 miles wide and 40 miles long, and has a relatively flat alluvial surface that ranges between 1,000 and 1,500 feet in elevation. The basalt ridges on either side of the valley were formed by anticlinal upwarp, are much narrower than the valley, and range between 2,000 and 3,000 feet in elevation. Perennial east-west oriented streams flow along the valley from both directions towards the valley center and empty into the perennial north-south, through-flowing Yakima River. A significant summer inflow of water into the higher parts of the valley comes by way of irrigation canals fed by dam-regulated flow along the Yakima River and its tributaries upstream of the study area.

Folded and faulted basalts are exposed along the anticlinal ridges and are found at depths of 300 to 1,000 feet beneath the snyclinal valley (fig. 3). The basalt flows belong to the Columbia River Group (table 3), and they are interbedded with, and underlie, a thick section of clastic rocks of debris-flow, lacustrine, and fluvial origin located along the valley axis. The oldest of these clastic units, the Ellensburg Formation (table 3), is from 100 to perhaps 1,000 feet thick in the valley and is dominated by semiconsolidated laharic (volcanically generated debris flow) fine to coarse clastics. Above these beds lie about 100 to 500 feet of Pleistocene glaciofluvial fine-grained lake, and coarser-grained river-laid clastics.

Above these, and comprising much of the surficial material at and near the study site, are 50 to 75 feet of Holocene unconsolidated alluvial sands and gravels laid down beneath the present flood plain by the Yakima River and beneath adjacent terraces by streams older, and perhaps larger, than the present Yakima River. The clasts within these two recent alluvial deposits are dominantly of volcanic (andesitic and basaltic) composition.

The shallow stratigraphy of the study site was determined by descriptive geologic logs from recent drilling of observation wells (fig. 4). In general, the lithologic descriptions show an upper 15- to 20-foot-thick alluvial depositional unit beneath the present flood plain, with about 5 feet of clay, silt, and sand at the surface (overbank deposits), and 10 feet of sandy, coarse gravels and cobbles below the overbank deposits. The lower contact of this upper unit is indistinct, but it overlies 30 to 50 feet of lower, older gravels and sands, probably deposited in similar environments. At normal stages of flow, the Yakima River is flowing within the upper fluvial unit, and perhaps within the top of the gravel layer of these fluvial deposits. There is a good permeable connection between the Yakima River and the adjacent water-table aquifer within these recent fluvial deposits. The ground-water-quality data at the site indicate that the leaked gasoline and diesel fuel, and the dispersed dissolved compounds downgradient of the leak, are wholly contained within the upper and lower Holocene alluvial deposits.

[illegible] section theory [illegible] this discussion [illegible]

There is upward ground-water flow from the basalts through the Ellensburg clastics into Holocene alluvium and into the perennial drainages, including the Yakima River (fig. 4). Locally, the ground-water flow is generally eastward flow (fig. 5) from the leak site toward the Yakima River. In general, the water table lies 7 to 12 feet beneath ground level. The upper sand, silt, and clay of the alluvium is unsaturated, and the lower parts of the coarser-grained alluvium is saturated.

Continuous hydrographs of two water-table wells document annual fluctuations of 2 to 3 feet, and there are two unequal annual peaks. One peak is in early spring, coincident with maximum vertical recharge from precipitation, and a second peak is in the late summer and early fall, coincident with upgradient recharge from irrigation returns and canal leakage (fig. 6 and table 12).

Data Collection

Three studies have been conducted since the gasoline and diesel fuel recovery program was discontinued. The first study, under the general direction of the insurance company, consisted of several phases with different contractors. Three wells still remained from the original recovery program at the end of 1984 (M1-82 through M3-82, pl. 1). In December 1984, 12 new observation wells (M1-85 through M12-85, pl. 1) were drilled. Beginning in February 1985, water levels were measured, and selected observation and domestic wells were sampled at 3-month intervals to determine the direction of ground-water flow and concentrations of petroleum-related compounds in ground water.

[illegible]

The second study, which started in 1985, was conducted by the U.S. Geological Survey (USGS) and the Oregon Graduate Center (OGC) as part of the U.S. Geological Survey Toxic Waste--Ground-Water Toxics Study. This study was initiated to determine the transport and fate of gasoline and diesel fuel in a subsurface environment. The study was aborted in 1987, and no data or results were published. During this USGS study, ground-water samples were collected on three different occasions, and soil-gas samples and samples of aquifer material were collected one time each. In August 1985, water samples were analyzed for petroleum-related hydrocarbons. In November 1985, soil-gas samples were collected, using driven probes, and analyzed for petroleum-related hydrocarbons. From April through June of 1986, water samples were collected from selected domestic and observation wells, and from temporary wells driven to the water table and pulled out after sampling. In late summer and early fall of 1986, 32 observation wells and 8 multilevel soil-gas sampling tubes were installed. In November 1986, water samples were collected from the new, larger network of observation wells. All samples were analyzed for volatile hydrocarbons and dissolved oxygen, and selected samples were analyzed for trace metals and common ions. In November 1986, samples of ground water and aquifer material were collected from selected observation wells and analyzed for lead. During the Ground-Water Toxics Study, water levels were measured monthly over the 2-year period from February 1985 to April 1987. Water-level recorders, which were installed in M8 and M14, have operated continuously from January 1987 to the present (1990).

how were they drilled? same? for wells mentioned above. If air rotary, were they filtered

The third study was conducted in cooperation with WDOE to determine the current distributions and concentrations of petroleum-related compounds in ground water. In March 1989, ground-water samples were collected from 27 observation wells and were analyzed for volatile hydrocarbons. Samples from six wells were analyzed for trace metals and common ions. Water levels were measured at the time the samples were taken.

The results and additional information on the conduct of this, and the other two sampling programs, are given in the sections "Sampling Studies, Field Techniques, and Laboratory Procedures," and "Chemistry of Ground Water, Soil Gas, and Aquifer Materials".

Processes Affecting the Fate and Distribution of Petroleum Hydrocarbons in a Subsurface Environment

Both gasoline and diesel fuel are petroleum products and are mixtures of numerous organic compounds with different physical and chemical properties. The fate and distribution of the individual compounds in a subsurface environment are governed to a large extent by these properties. For example, the aromatic hydrocarbons are the most water-soluble components of gasoline and diesel fuel and are relatively easily dissolved and transported in ground water. Selected properties of some of the major compounds in gasoline and diesel fuel are given in table 1.

After the spill or leak of a liquid petroleum product, some of it will flow through the unsaturated zone to the water table by gravity, and some of it will be held in the unsaturated zone by surface tension. The petroleum that reaches the water table will float and spread on top of the water table because it is less dense than water. The transport of hydrocarbon compounds by ground water initially will be limited to those which can be dissolved in ground water at the petroleum-water interface. Once dissolved in ground water, compounds may be transported by advection and dispersed horizontally and vertically in the ground water.

Seasonal variations in the water-table elevation can increase dispersion and dissolution of hydrocarbon compounds in the ground water. When the water table rises, some of the petroleum will remain trapped in the interstitial pores by surface tension below the rising interface (Schwille, 1981). When the water table falls, some water is trapped above the falling interface. This sequence of events substantially increases the vertical distance over which the petroleum is dispersed and provides additional surface area for the dissolution of hydrocarbon compounds into ground water. During periods of ground-water recharge, downward percolating ground water can dissolve hydrocarbons from the petroleum trapped in the unsaturated zone.

The relative proportions of various petroleum hydrocarbons dissolved in the ground water also are affected by volatilization, biodegradation, and sorption. The low-molecular-weight hydrocarbon compounds can volatilize from the petroleum product or from the ground water and diffuse into the unsaturated zone. The presence of hydrocarbon gases in the unsaturated zone is sometimes used to indicate the presence of petroleum hydrocarbons in ground water.

Some hydrocarbons preferentially sorb to soil particles. These compounds are not as readily transported as those in the gas phase or the ground water. Some sediment characteristics that affect sorption are grain size and organic content.

A variety of naturally occurring soil microbes can, under favorable conditions, degrade hydrocarbon compounds found in gasoline and diesel fuel. Biodegradation is most efficient under aerobic conditions with sufficient supplies of nitrogen and phosphorus, a near-neutral pH, and warm soil temperatures. Under these conditions, some hydrocarbon compounds can be completely degraded into carbon dioxide and water (Atlas, 1981). Anaerobic biodegradation of petroleum hydrocarbons also has been observed, but generally at lower rates than aerobic biodegradation (Healy and Daughton, 1986).

Acknowledgments

Clar Pratt, Alan Newman, and William Meyers of the WDOE provided much background information about the Yakima site. Dr. James F. Pankow, professor at the Oregon Graduate Center (OGC) and director of the OGC Water Research Laboratory in Portland, Oregon, provided technical advice, as well as planning and executing much of the reconnaissance sampling. J.R. McPherson and Lorne M. Isabelle of OGC analyzed the volatile organic compounds in the 1985-86 reconnaissance water samples, and William Fish coordinated the program for the analysis of lead in the aquifer material and in water. Mark S. Mason, of Soil Exploration Company, St. Paul, Minnesota, provided information about their drilling program. Michael Schroeder and the staff at the U.S. Geological Survey National Water Quality Laboratory (NWQL) provided technical advice and assistance for the 1989 sampling. Brooke Connor and Donna Rose of NWQL analyzed the volatile organic compounds sampled in 1989. Valuable assistance for the quality assurance program used during the 1989 reconnaissance was provided by Mark Sandstrom of the NWQL Methods Research and Development Section.

Appreciation also is extended to the many property owners who granted access to land, private wells, and monitoring wells during the samplings.

Well-Identification System

Wells in this report are referenced by identification numbers that are listed in table 2. Their locations are shown on plate 1. The table cross-references these identification numbers with the station name stored in WATSTORE, the U.S. Geological Survey computer data base, and identifiers used in correspondence and progress reports during previous studies. The identification numbers in this report are prefixed by an M for observation wells, D for domestic wells, T for temporary wells installed for the collection of water samples, SG for multidepth soil-gas wells, and SGT for temporary wells installed for the collection of soil-gas samples. The temporary water wells and soil-gas wells were removed immediately after sample collection.

[illegible] some way [illegible] the well [illegible] same [illegible] between [illegible] nomenclature [illegible] reports. [illegible] study [illegible] table [illegible]

SAMPLING STUDIES, FIELD TECHNIQUES, AND LABORATORY PROCEDURES

Field and laboratory methods used during the three studies were, in general, quite similar, and the methods are detailed for comparative purposes. Field and laboratory methods are discussed separately, and quality assurance procedures and results are given in Appendix A.

Ground-Water Sampling

When were water samples collected, i.e. what time of year?

Insurance Company Study

Twelve observation wells were installed using a cable-tool drilling rig. Wells were constructed with 2-inch diameter, flush-threaded, PVC (polyvinyl chloride) casing and 15 feet of PVC screen, 10 feet of which extended below the water table. Water samples were collected from the wells using bottom-filling Teflon bailers. A minimum of three casing volumes of water are pumped from a well before a ground-water sample was collected. Water samples from domestic wells were collected from cold-water faucets that were allowed to run at a rate of about 1 gallon per minute for a 30-minute period prior to sampling. The samples were non-filtered and non-aerated. All samples were preserved on ice and transported into a private laboratory for analysis.

— [illegible] how [illegible] these wells were constructed. If the BTEX [illegible] [illegible] [illegible] water table it may not be detected in wells used —

Ground-Water Toxics Study

The Ground-Water Toxics Study included three water-sampling periods with different objectives. The first sampling was done (August 1985) to determine the farthest extent of dissolved hydrocarbon movement in the ground water.

The second sampling (April through June 1986) with additional temporary wells to better delineate the extent of dissolved hydrocarbons and to determine appropriate sites for 34 additional observation wells. In the third sampling period (November 1986), samples were collected from some of the new observation wells.

was the air filtered before it went into the well?

The additional 34 observation wells were drilled using the air-rotary method. The wells were constructed of 2-inch PVC casing, with 3- to 5-foot lengths of 0.10-inch slotted PVC screen at the bottom. Most screens were set so that the middle part of the screen was close to the surface of the water table at the time of drilling. Sections of PVC casing were welded together rather than cemented to prevent contamination by solvents used in the cement. The annulus around each screen was packed with sand to a depth of several feet above the screen and then sealed to the surface with bentonite or a bentonite and cement mix. Several deeper wells that were drilled below the water table were packed with sand several feet above the screen, backfilled with clean cuttings, and then surface sealed with a bentonite and cement mix. The wells were developed by pumping.

how was it determined they were clean

In the spring of 1985, staff of the Oregon Graduate Center collected ground-water samples from 28 temporary wells. The wells were installed by jackhammering a steel drive tube to a depth 2 feet below the water table and then removing the tube with a railroad jack. A 3-foot length of 3/8-inch flexible tubing was attached to the top of a 3/8-inch stainless steel pipe and lowered down the hole to collect a sample, a vacuum was applied when the pipe was a few inches below the water table, the flexible tubing was then bent and clamped, and the pipe was lifted out of the hole. Two 14-mL (milliliter) sample vials were filled. The sample vials were filled by slowly releasing the clamp, and the vials were stored on ice for later analysis. Some modifications to this sample collection procedure were made during the course of the study. To prevent borehole collapse upon removal of the steel drive tube, a perforated tip was attached to the end of the tube and the tube was left in the hole during sample collection. Also, samples were collected by securing the sample vial at the end of a thin stainless steel rod and lowering the vial to the water table directly through the driven hollow tube. All downhole tools that were used in this phase were cleaned with a methanol solution and dried with an electric hair dryer.

Bottom-filling glass bailers were used to collect water samples from observation wells for the analysis of volatile hydrocarbons. Before each sample was collected, five casing volumes were pumped from the well. Prior to sampling each well, the bailer was rinsed with a 10-percent methanol solution and an acetone-hexane mixture (60 to 40, by volume). Remaining solvent residues were then removed from the bailer by baking in an oven, by heating with an electric hair dryer, or by aspirating with a vacuum pump. The cleaned sampler was then rinsed by bailing three times from the well. A sample vial was filled from the fourth bailing and packed in ice until analysis. The technique used to collect samples from domestic wells was similar to that used during the insurance company study. All volatile hydrocarbon water samples collected were analyzed by the staff from the Oregon Graduate Center.

1989 Study

The procedure used to sample observation wells in the 1989 study was nearly identical to that used during the Ground-Water Toxics Study. One difference was that the bailer was rinsed with organic-free water after the acetone-hexane rinse. Also, the bailer was routinely baked in an oven at 105 °C for 1/2 hour after the organic-free water rinse. Results of tests to check the adequacy of the cleaning procedure are given in Appendix A.

Samples collected were analyzed by the U.S. Geological Survey National Water Quality Laboratory (NWQL) in Arvada, Colorado. Field quality-assurance procedures included duplicate samples, field blanks, and field-spiked samples with known amounts of target compounds. These procedures are described in Appendix A.

Ground-Water Analysis Methods

All three studies utilized similar gas-chromatographic techniques for determining concentrations of volatile hydrocarbons in ground-water samples. Differences in techniques are noted below and references are given for more details. Analyses performed by Oregon Graduate Center produced concentrations that were blank-corrected, as referenced in Appendix A. Analyses performed by the other studies were not blank-corrected.

Insurance Company Study

Samples were analyzed for benzene, toluene, and total xylenes (the sum of the meta, para, and ortho isomers), and a value was calculated for total hydrocarbons expressed as gasoline. Samples were analyzed using a Tekmar LSC-2[1] liquid sample concentrator linked to a Perkin-Elmer Sigma 300 gas chromatograph with flame ionization detection (FID), on a 6-foot stainless steel column with SP-1000 100/120 mesh packing. Total xylenes, benzene, and toluene were identified by retention time and quantified by comparison with known standards using an SP-4000 data system. Total gasoline concentrations were calculated by comparison of total peak area to a gasoline standard total peak area.

Ground-Water Toxics Study

The analytical method utilized by Oregon Graduate Center was purge and trap with whole-column cryotrapping. This method was employed with fused-silica, capillary-column gas chromatography (GC), as developed by Pankow and Rosen (1984) and optimized by Pankow (1986). Both FID and mass spectrometric (MS) detection were utilized. The purge and trap device used was a Chemical Data Systems Model 320 concentrator. The GC/MS used was a Hewlett-Packard

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[1] Use of brand, firm, or trade names is for identification purposes only and does not endorse use of any product by the U.S. Geological Survey

5790A GC interfaced to a Finnigan 4000 MS/DS (data system) system. The carrier flow from the capillary column exiting the GC was split, approximately half of the flow directed into the MS source, and the remainder to a FID housed in a Hewlett-Packard 5700A GC.

Normally, a 5.0-mL aliquot of sample was loaded into the sparging vessel and each aliquot was spiked with 10 µL (microliter) of an internal standard solution in methanol. In the case of highly contaminated samples, smaller sample aliquots were loaded into the sparging vessel and organic-free water was added to produce 5.0 mL of diluted sample for analysis. Samples were analyzed for a set of 18 target compounds (table 4) known to be components of gasoline and diesel fuel. During sample analysis, standards containing known concentrations of target and internal standards compounds were routinely run. Replicates of the samples were run back, a day apart, and in one case, 6 days apart.

T4

Sample concentrations were computed based on the appropriate sample and standard peak areas and were blank-corrected using replicate values of blanks, duplicates, and standards. The internal-standard compounds served to compensate for any variations in the purging efficiencies and the system response. The response factors were assumed to be linear over the concentration range of interest.

1989 Study

The method utilized by the NWQL to analyze samples was purge and trap. This method was employed with gas chromatography and electron impact mass spectrometry (GC/MS) as per EPA Method 524.2 (U.S. Environmental Protection

Agency, 1988a), and the list of volatile organic compounds targeted by this analytical method was modified by adding standards for the quantification of five compounds in addition to those targeted by EPA Method 524.2 (table 4). The purge and trap device used was a Tekmar LSC 2000 with an ALS 2016 and ALS 2032. The 25-mL sample was purged for 11 minutes at ambient temperature with a gas flow of 40 mL per minute, desorbed at 180 °C for 4 minutes onto a 30 meter x 0.53 mm ID DB-624 megabore column, and baked at 225 °C for 15 minutes. The gas chromatograph was a Varian 3400. The temperature program of the GC was an increase from 10 °C to 160 °C, at a rate of 6 degrees per minute, with 10 °C held for five minutes, and 160 °C held for one minute. The megabore column was coupled directly to the mass spectrometer, which was set to analyze from 45 to 300 atomic mass units with a scan time of 1 second. A Finnigan Incos 50 MS/DS was used to run most of the samples, and a Hewlett-Packard HP5996A MS/DS was used for those samples on which a library search was performed. Ten percent of the samples were run in duplicate, and 10 percent of the less-contaminated samples were spiked with a solution containing the target compounds. Additional quality assurance measures included daily blanks, daily instrument tuning, and quality control check samples.

A library search was performed on selected analyses in an attempt to identify non-target compounds. Spectra corresponding to gas-chromatographic peak maxima were compared with National Bureau of Standards library reference spectra using a computer library search. The best library matches were selected according to a "reliability factor"--a parameter used by the library search algorithm to indicate the quality of the match between the sample and library spectra. The best computer matches were compared with the sample spectrum manually to attempt the best possible tentative identification.

Soil Gas

Samples of soil gas, the gas in the pore spaces in the soils and sediments above the water table, were collected from temporary-driven sampling tubes and from permanent wells in which multidepth sampling tubes were installed. Samples from the temporary-driven wells were taken from locations with the lowest expected concentrations and then from locations where larger concentrations were expected. A 6-foot-long stainless steel casing tube was driven to a depth of 5.5 feet below land surface and then backed out a few inches. Then, a 7-foot stainless steel sampling tube was inserted 1 inch beyond the bottom of the casing tube. Two hundred mL of soil gas were drawn through the sampling tube with a vacuum pump. A Tenax-GC sample cartridge was then placed in line and the system was pumped for about 12 minutes at a rate of about 40 mL per minute. The sample cartridge was then removed, the ends were capped, and the sample was stored in an organic-free environment prior to analysis.

Sampling techniques and analytical methods for multidepth wells were the same as for the temporary driven wells. The stainless steel sampling tubes each extended to a specified depth, were surrounded with sand, and were sealed from each other with concrete.

Soil-gas analysis was done by adsorption/thermal desorption with whole-column cryotrapping, using FID and MS detection. The Tenax-GC cartridges needed no sample preparation prior to desorption. The cartridge was placed in the desorption apparatus and purged for 10 minutes with a backflow of helium to remove the oxygen and most of the methanol. The cartridge was desorbed at

250 °C for 10 minutes at 30 psi, with the column temperature held at -80 °C. After desorption, the column temperature was raised rapidly to 0 °C, and then raised to 250 °C, at 10 °C per minute for the data acquisition. Additional details are given by Ligocki and Pankow (1985).

Aquifer Materials

In November 1986, samples of both solid aquifer material and water were collected from selected observation wells. Concentrations of lead dissolved in water, and lead adsorbed onto the surface of the less-than-63-µm (micrometer) fraction of the aquifer material, were determined. Because samples of aquifer material could not be obtained easily by coring, due to the cobblely nature of the deposits, samples of fine-grained aquifer materials that had passed through well screens after installation of the well were obtained by placing a pump intake near the bottom of the well. Approximately 5 gallons of sediment-laden water were pumped from each undeveloped well and collected in a clean plastic bucket. The sediment was separated by settling, dewatered by filtering into a firm cake, placed in a polyethylene bag, and stored on ice. The firm cake was then processed by mixing with water and wet-sieving through a 63-µm polypropylene sieve. The less-than-63-µm fraction was filtered to a moist cake, subsampled, and digested by a weak method. The samples were then analyzed in the same manner as the filtered ground water (Fish, 1987). After developing the well by pumping at 10 gallons per minute for 20 to 30 minutes, ground-water samples were collected by pumping through acid-washed Tygon tubing and filtering through acid-washed 0.1 µm (pore-size) membrane filters into acid-washed polypropylene bottles.

CHEMISTRY OF GROUND WATER, SOIL GAS, AND AQUIFER MATERIALS

Common Constituents and Trace Metals in Ground Water

The shallow ground water near the study site is predominantly of the calcium-magnesium bicarbonate type (see fig. 7 and table 5). Specific conductance values ranged from 208 to 390 µS/cm (microsiemens per centimeter) at 25 °C, and values of pH ranged from 6.3 to 6.9. Dissolved-oxygen concentrations were low, with a median value of 0.6 mg/L (milligrams per liter). Dissolved oxygen concentrations upgradient of the spill site (M1-85) ranged from 6.3 to 6.8 mg/L; whereas the ground water contained little or no oxygen at sites M2-82, M3-82, M11-85, M12, M16, and M18. Concentrations of metals were generally less than 0.10 mg/L and did not exceed the MCL (Maximum Contaminant Level) for drinking water, except for dissolved manganese, which exceeded the secondary MCL at 15 sites (U.S. Environmental Protection Agency, 1988b).

Organic Compounds in Ground Water

Insurance Company Study

During the insurance company study, at least one of the three target compounds (benzene, toluene and total xylenes) was detected at least once in four of the 21 wells (figs. 8 to 12 and table 6). Target compounds were detected consistently, and at relatively large concentrations, in water from well M11-85, located about 150 feet from the leak site. Target compounds were consistently detected in only one domestic well, D10, located about 1,200 feet downgradient, but concentrations were smaller than in M11-85. Target compounds were detected in wells M8-85 and M10-85, located about 900 feet downgradient of the leak site, but the occurrences were sporadic and concentrations were relatively small. The wells used in this study were too widely separated to define in detail the distributions of hydrocarbon compounds in ground water.

Ground-Water Toxics Study

During the Ground-Water Toxics Study, ground-water samples were analyzed for up to 23 aromatic hydrocarbons, primarily alkylated-benzenes (table 4). All but six of the compounds were identified in ground water. Concentrations of compounds found during the different sampling periods of this study are given in table 7. Because of changes in analytical methods during the course of the study, not all of the target compounds were analyzed in each of the sampling periods. Furthermore, the method for reporting analytical results when concentrations were near background or detection levels differed among sampling periods.

Data for benzene, toluene, naphthalene, and total xylenes are shown in figures 8 through 11. These four compounds are some of the more water-soluble aromatic compounds in gasoline (table 1), and their presence and concentrations compare well with the presence of other target compounds. Concentration isopleths of 5 µg/L (micrograms per liter) are shown for each of the four compounds, and the symbols identify locations where concentrations are greater or less than 500 µg/L. A value of 5 µg/L was chosen as the isopleth concentration because it is an order of magnitude greater than the

[illegible] citation for
[illegible] = see MCL in
[illegible] FB (1989)

level of detection for most compounds and, consequently, there is a high certainty of detection at this concentration, eliminating any doubt of trace detections at or near the detection level. The isopleth concentration is significant because it is also the drinking water MCL for benzene (U.S. Environmental Protection Agency, 1988c). An MCL does not exist for toluene, naphthalene, or total xylenes, but there is a proposed MCL for toluene of 2,000 µg/L and a secondary MCL for total xylenes of 10,000 µg/L.

During the first sampling period in August 1985, detectable concentrations of benzene, toluene, naphthalene, and total xylenes were identified in samples from 5 of 15 insurance company observation wells, 1 of 13 temporary wells, and 2 of 31 domestic wells (table 7). Although petroleum-related compounds were detected as far as 1,000 feet from the service station, concentrations of individual compounds exceeded 500 µg/L only in samples from the three wells closest to the service station (figs. 8 to 11). A petroleum sheen was noted on samples from two of these three wells (M3-82 and M11-85), indicating the presence of free product.

During the second sampling, from April through June 1986, detectable concentrations of benzene, toluene, naphthalene, or total xylenes were found in the samples from 5 of 6 insurance company observation wells and at all 29 of the temporary wells. Observed concentrations of benzene, toluene, naphthalene, and total xylenes (figs. 8 to 11) indicate that some of the dissolved compounds had migrated in an east-north easterly direction.

During the third sampling in November 1986, benzene, toluene, naphthalene, or total xylenes were detected in samples from 5 of 8 insurance company observation wells and in 18 of the 23 observation wells installed during this study (pl. 1 and table 2). Concentrations of some of these four compounds exceeded 500 µg/L at eight of the observation wells within 400 feet of the service station (figs. 8 to 11).

it would be nice to have a cross section through these wells, with the vertical distributions & geology

The vertical distribution of hydrocarbons dissolved in ground water was also investigated. Observation wells which penetrated deeper into the aquifer, M2, M6.1, M7.1, and M13 (pl. 1 and table 2) were sampled in November 1986. Observation wells M6.1 and M7.1 are paired with shallow wells, M6.2 and M7.2, respectively. Observation wells M6.1 and M6.2 were installed in the same hole about 1,300 feet downgradient of the service station, with M6.1 extending to 46 feet below land surface and the latter well screened at the water table. Observation wells M7.1 and M7.2 are a similar pair installed in a hole about 500 feet downgradient from the service station. Benzene, toluene, naphthalene, total xylenes, ethyl benzene, and other alkyl benzenes were detected in all the deeper observation wells that were sampled. Concentrations of dissolved hydrocarbons in the ground water from observations wells M2 and M6.2 were less than 1 µg/L; whereas, observation well M7.1 had a concentration of 3.2 µg/L total xylenes. Concentrations of dissolved hydrocarbons in ground water from observation well M13 ranged from 0.5 to 47 µg/L. The concentrations of dissolved hydrocarbons in ground water from deeper wells range from one to more than three orders of magnitude smaller in comparison to the concentrations of hydrocarbons dissolved in ground water from observation wells at the water-table surface. The major portion of the leaked gasoline and diesel fuel dissolved in the ground water appears to be

any possible way to estimate the volume dissolved & the volume still trapped in the vadose near the surface of the water table. Further, the migration of dissolved hydrocarbons in the ground water is preferentially in a horizontal downgradient direction.

1989 Study

Concentrations of volatile organic compounds in ground-water samples collected in 1989 indicate that there are still dissolved components of gasoline and diesel fuel in the ground water (table 8, figs. 8 to 11). Concentrations of benzene, toluene, naphthalene, and total xylenes greater than the detection limit of 0.2 µg/L were found in ground-water samples from 11 of the 27 sampled wells. Concentrations exceeded 500 µg/L for only total xylenes at two wells, M3-82 and M16. Significant amounts of toluene and other alkyl benzenes were also found at these two wells and at M11-85, but concentrations for all compounds were less than 500 µg/L.

In March 1989, concentrations of petroleum-related compounds in ground water were less than in March? 1985 and March? 1986 (tables 6 and 7, figs. 8 to 11). Consequently, the concentrations of petroleum-related products dissolved in ground water appear to be decreasing, and the area within specific concentration isopleths also appears to be decreasing. However, one should not ignore the fact that concentrations probably change seasonally because of the seasonal rise and fall of the water-table elevation, and the above conclusion is based on a single sampling in 1989.

[illegible]

– [illegible] additional sampling in [illegible] would improve results? [illegible] you need a longer term sampling scheme?

Lead in Ground Water and Aquifer Materials

Concentrations of lead in the filtered ground-water samples ranged from 1.4 to 10.1 µg/L (table 9). These concentrations are less than the EPA drinking-water MCL of 50 µg/L (U.S. Environmental Protection Agency, 1988c). Samples of aquifer material contained lead with concentrations 30 to 10,000 times greater than in ground-water samples on a per weight basis (table 9). Because of the large affinity of the divalent lead ion for sediment, it is not unusual to find small concentrations of lead in ground water and large concentrations of lead in sediments. As a result of this affinity, inorganic lead is relatively immobile in ground water.

There is little or no correlation between concentrations of lead in soil and in ground water (correlation coefficient = -0.19). Fish (1987) used these concentrations to calculate apparent distribution coefficients, which were then used to calculate values of retardation factors. A distribution coefficient is the equilibrium concentration of a solute sorbed to the aquifer material and divided by the concentration in solution; a retardation factor is the ratio of the average velocity of water to the average velocity of a solute where movement is retarded by sorption to the soil matrix (see for example, Freeze and Cherry, 1979, p. 404). Fish (1987) obtained retardation factors that ranged from 136 to 31,600. Because this variability did not match any apparent variability in the aquifer materials, he concluded that a simple adsorption or ion-exchange model does not explain the distribution of lead between the solid and aqueous phases. Calculations by Fish (1987) indicate that the observed concentrations of lead in the ground water were near the limit of solubility for $PbCo_3$. Therefore, precipitation of $PbCO_3$ may control the concentration of lead in ground water. Because the area with elevated concentrations of lead in the aquifer materials is similar to the area with elevated levels of aromatic hydrocarbons dissolved in ground water (fig 13), the source of the lead is probably lead additives in gasoline, tetraethyl and tetramethyl lead.

– is it possible to determine the vertical distribution of lead in the seds? I know your sampling procedure may not allow it unless some of the wells were deeper. I'm wondering if the lead may act as a sinker?

The similarity between spatial distributions of lead in the aquifer materials and some of the aromatic compounds dissolved in ground water suggests that some of the lead has moved in approximately the same direction as some of the aromatic compounds dissolved in the ground water (Fish, 1987). Consequently, the lead is, or has been, more mobile than the retardation factors imply. There are several possible modes of transport. Shortly after the gasoline leak, the lead could have been transported as part of the free product. It could have been transported by ground water when in the more soluble alkyl lead phase, which subsequently degraded to inorganic lead that precipitated out of solution. The lead in the aquifer materials also could have been transported by collodial-size particles (Fish, 1987).

Soil Gas

In November 1985, soil-gas samples were collected from seven temporary wells, SGT1 through SGT3 and SGT6 through SGT9 (fig. 14). Although plans were made to collect samples from about 25 wells, problems with frozen ground and cobbly soil resulted in fewer samples collected than planned. Also, because of problems with internal standards, concentrations of compounds detected in the soil-gas samples were qualitative and not quantitative.

T11

In November 1986, soil-gas samples were collected from six multidepth soil-gas tubes (fig. 14, table 11). Target compounds (table 10) and mixed alkanes were detected at some depths at three of the six wells, SG3, SG5, and SG8 (fig. 14). With the exception of toluene and several alkyl benzenes that were found at mid-depths of 3 to 6 feet below land surface in SG8, most compounds were detected only close to the water table, at the deepest levels from which samples were withdrawn (table 11). This is consistent with the steep concentration gradients of concentrations in soil gas near the water table that have been found by others (see for example, Hult and Grabbe, 1985).

T10

Target compounds (table 10) were detected in samples from wells SGT2 and SGT7. Also, chromatographs for samples from wells SGT1, SGT3, and SGT9 contained peaks that are indicative of likely degradation products of aromatic hydrocarbon compounds (J.R. McPherson, Oregon Graduate Center, Beverton, Oregon, verbal commun., 1989). Soil gas from wells SGT6 and SGT8 did not contain detectable amounts of hydrocarbon compounds. Although gas samples were collected from wells SGT4 and SGT5, difficulties with collection and analyses of samples from these two wells preclude making any statements about the presence or absence of hydrocarbon compounds in soil gas at these two sites. These two wells are not shown in figure 14.

SUMMARY AND CONCLUSIONS

An estimated 12,000 to 22,000 gallons of gasoline and diesel fuel were leaked to unsaturated sediments and shallow ground water from an improperly installed delivery line at a service station in Yakima, Washington. Data indicate the fuel leak is contained within unconsolidated sediments and shallow ground water 7 to 12 feet below land surface.

Unsuccessful attempts in 1982-83 at recovery of fuel in the ground were followed by a study in 1985, under the direction of an insurance company, to monitor the presence of dissolved hydrocarbons in ground water. From August 1985 through November 1986, in a separate study by the U.S. Geological Survey, dissolved hydrocarbons and lead were determined in ground water and soil gas was determined in the unsaturated sediments. The gasoline leak in Yakima was selected to be a part of a national study of ground-water sites contaminated by toxic compounds, but the study was aborted before an interpretive phase was completed. Fine-grained sediments in the aquifer were also analyzed for lead. In this study, data were collected in March 1989 to determine the concentrations and areal extent of dissolved hydrocarbons in ground water, and results from these two previous studies were compiled and analyzed.

All three studies utilized similar gas-chromatographic techniques for determining concentrations of volatile hydrocarbons benzene, toluene, naphthalene, and total xylenes in shallow ground water for five sampling periods beginning in 1985. A large concentration of 600 µg/L toluene and 980 µg/L of total xylenes was found in one domestic well about 1,200 feet downgradient of the leak, but water in other domestic wells sampled beginning in 1985 had hydrocarbon concentrations that were all less than 500 µg/L. Samples collected from 1985 to 1986 indicate dissolved hydrocarbons in observation wells commonly exceeded 500 µg/L at distances of 150 to 500 feet downgradient from the gasoline leak. Soil-gas samples taken in November 1986 indicated dissolved hydrocarbons were detected only close to the water table.

In March 1989, concentrations of dissolved hydrocarbons apparently had decreased in magnitude and areal extent in shallow ground water near the water table. Concentrations of dissolved hydrocarbons were less than 500 µg/L and did not exceed distances of 300 to 750 feet from the source of the leak. Isopleths of 5 µg/L of each of the four hydrocarbons plotted on areal distribution maps also support the decrease in dissolved hydrocarbons. In contrast, during the sample periods of November 1986 and earlier, hydrocarbon concentrations of 5 µg/L ranged from 600 to 1,000 feet from the source of the leak. Sampling in March 1989 showed the 5 µg/L isopleth no farther than 350 feet from the original source of the leak. In general, however, dissolved components of gasoline and diesel fuel remained in ground water and about 40 percent of the observation wells sampled had benzene, toluene, and naphthalene concentrations that were greater than the detection limit of 0.2 µg/L. The decrease in dissolved hydrocarbons in the shallow ground water since 1985 and 1986 are due to natural dispersal, volatilization, or biodegradation. Concentrations of dissolved lead in ground water were small for the five sample periods from 1985-1989. These concentrations were 1.4 to 10.1 µg/L and less than the MCL of 50 µg/L for drinking water. Lead has a high affinity for soils and is relatively immobile in ground water. However, concentrations of lead in aquifer sediments suggest lead has moved in the aquifer in the same direction as the dissolved hydrocarbons have moved.

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APPENDIX A: QUALITY ASSURANCE

The quality of the data from all three studies cited in this report appears to be good. Differences between concentrations in duplicate samples are within reasonable limits and concentrations of standards, spiked samples, and blank samples were satisfactory (see tables A1 to A6).

Insurance Company Study

The quality assurance portion of the insurance company study consisted of field blanks, lab blanks, and duplicate samples. Concentrations of benzene, toluene, and total xylenes in field and laboratory blanks were less than the detection limit of 1 microgram per liter (table A1). Replicate analyses of a sample from observation well M11-85 indicate good reproducibility for all compounds except toluene. On August 27, 1985, personnel from the insurance company study and the ground-water toxics study independently collected samples from four wells and the samples were analyzed by their respective laboratories (see table A2). The agreement between the two sets of results is good except for the concentration of benzene in the samples from well M8-85,and perhaps the concentration of toluene in the samples from M11-85. Differences between other concentrations can easily be attributed to variabilities in sample collection and analysis.

TA1

TA2

Ground-Water Toxics Study

The quality assurance during the ground-water toxics study consisted of collecting duplicate samples, doing replicate analysis, and analyzing trip-blank samples. Organic-free blank water for trip blanks and sample dilutions was prepared in the laboratory. The replicate analyses of trip blanks and duplicate samples were used for the calculation of statistical limits of detection. Mean and standard deviation of concentrations detected in the trip blanks are listed in table A3. Sample results were correspondingly blank-corrected. Concentrations determined for mixtures of standard solutions supplied by the U.S. Environmental Protection Agency are compared with concentrations in the standards (table A4).

1989 Study

Organic Constituents

The quality assurance during the 1989 study consisted of collecting duplicate samples and equipment-rinse samples, using blank-water samples and trip-blank samples, and spiking samples with identical concentrations of target compounds in the field and in the laboratory. The blank water used during the current program was commercially available, organic-free water. Equipment-rinse samples consisted of 40 mL of this water that was passed through the sampler after cleaning. Tests were made to check the adequacy of the cleaning procedure prior to field sampling and also during the sampling period.

Samples of the blank water, blank water from an equipment rinse, and blank water from an equipment rinse after baking the sampler were analyzed for volatile hydrocarbon compounds (table A5). The blank water contained relatively small concentrations of methylene chloride and chloroform.

Compounds tentatively identified using a NBS library search routinely were hexane and methylcyclopentane. Equipment-rinse blanks contained small concentrations of benzene, toluene, total xylenes, and larger concentrations of methylene chloride and chloroform. The equipment-rinse blanks also contained relatively large concentrations of compounds that were tentatively identified as hexane, methylcyclopentane, 3-methylpentane, and acetone. Equipment-rinse blanks that were passed through the sampler after it was baked at 105 °C contained only small concentrations of chloroform, dichlorobromomethane, dibromochloromethane, and 1,2-dichloropropane. This poses no problem with the interpretation of petroleum-related hydrocarbons in the ground-water samples.

Trip blanks were collected with the intention of analyzing the samples only if a problem was suspected in collection or processing techniques. Because no anomalous results were found, the trip blanks were not analyzed. Sample results for the 1989 study are not blank-corrected.

One set of replicate samples from observation well M8-85 was spiked in the field with target compounds to check the effective recovery of compounds from a field-matrix sample. An extra sample also was sent to the laboratory for spiking in the laboratory (table A5). The difference in recovery between the field spikes and the lab spikes ranges from +25 to -7 percent, with an average difference for FS1 of 4 percent and an average of 12 percent for FS2. These differences are considered to be normal.

Inorganic Constituents

Various sums, differences, and ratios, based on aquatic chemistry principles, were computed for each inorganic sample. These computations check the consistency between constituent concentrations in a sample and provide a gross check in the accuracy and completeness of the analysis. Two of the most useful computations are the cation-anion balance and calculated dissolved-solids concentration, which are defined in the following paragraphs.

The cation-anion balance is the difference, in percent, between the sums of the concentrations of cations and anions, expressed in milliequilevants. Ideally, this value is zero, but non-zero values occur when a cation or anion concentration is in error, or when the concentration of a significant ion (often a metal) is not determined. The acceptable difference varies with the total sum of cations and anions. The differences ranged from 0.0 to 5.97 percent.

Calculated solids is the dissolved-solids concentration determined by summing the concentrations of cations, anions, silica, and other major dissolved constituents. This value is theoretically equal to the dissolved-solids concentration determined in the laboratory by residue upon evaporation. Differences usually are due to errors in analyses of the various cations or anions (which may be verified by the cation-anion balance), or errors in the laboratory-determined dissolved-solids concentration. For analyses at the study site, differences between the calculated and analyzed dissolved solids ranged from 2 to 9 percent.

The primary controls on field values of pH, specific conductance, dissolved oxygen, and temperature are proper instrument calibration and field procedures. However, pH and specific conductance also are determined in the laboratory. Differences between laboratory and field specific conductances were less than 5 percent in all cases (table A6).

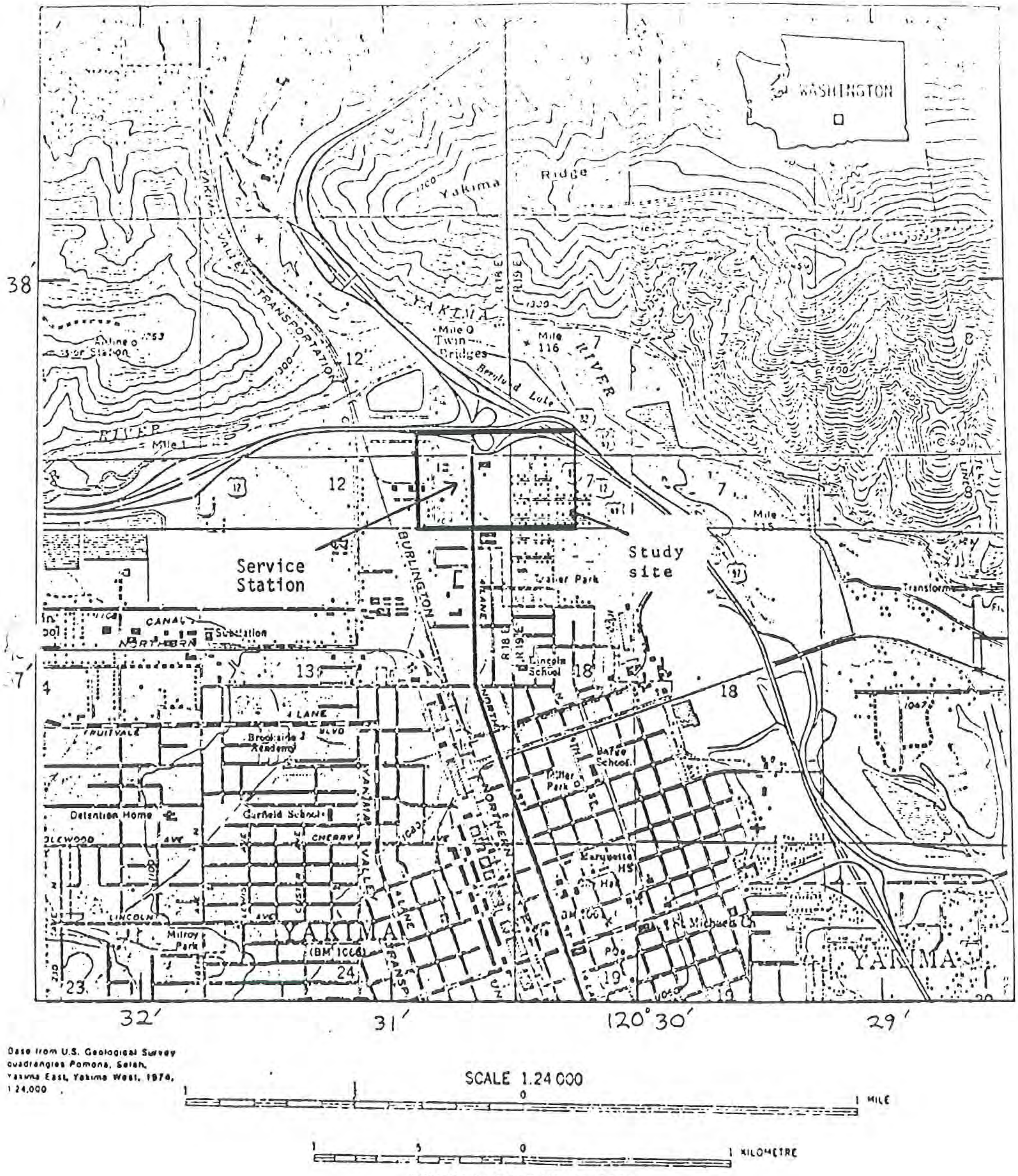
TA6

Field and laboratory pH differed by more than 0.2 units for only three out of 18 samples and none of these differences are more than 0.5 units. Because pH and specific conductance can change during the time between the field and laboratory determinations, these comparisons must be considered approximations at best, but the good agreement generally serves to confirm the field values.

Field determinations of bicarbonate and carbonate concentrations were checked by calculating alkalinities from them and comparing the results to laboratory-determined alkalinities. Field and laboratory alkalinities differed by more than 5 percent for only one of six samples.

TA7

Duplicate samples were collected and analyzed for both inorganic and organic constituents during the current study (table A7). Dissolved zinc is the only constituent where duplicate sample results do not agree. The ground water sampled at the site contained particulate matter which could be variable from one sample to another (see turbidity values, table A6). Upon acidification, colloidal zinc would be transformed into the dissolved state.



Base from U.S. Geological Survey
quadrangles Pomona, Selah,
Yakima East, Yakima West, 1974,
1:24,000

Figure 1.--Location of the gasoline and diesel-fuel leak site at Yakima, Washington.

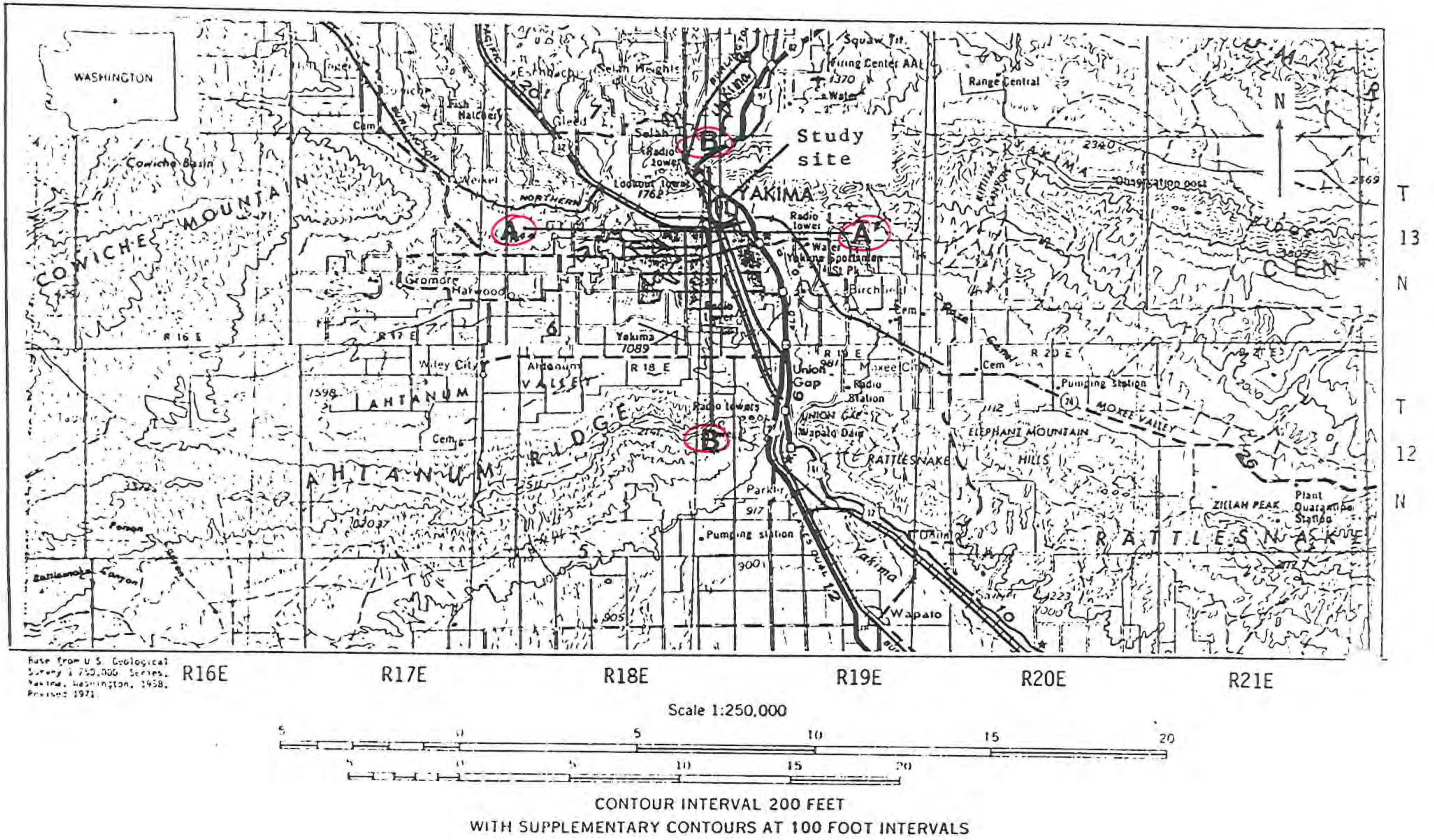


Figure 2.--Subbasin formed by the Ahtanum and Moxee Valleys, Washington. Cross-sections A-A' and B-B' shown on figure 3.

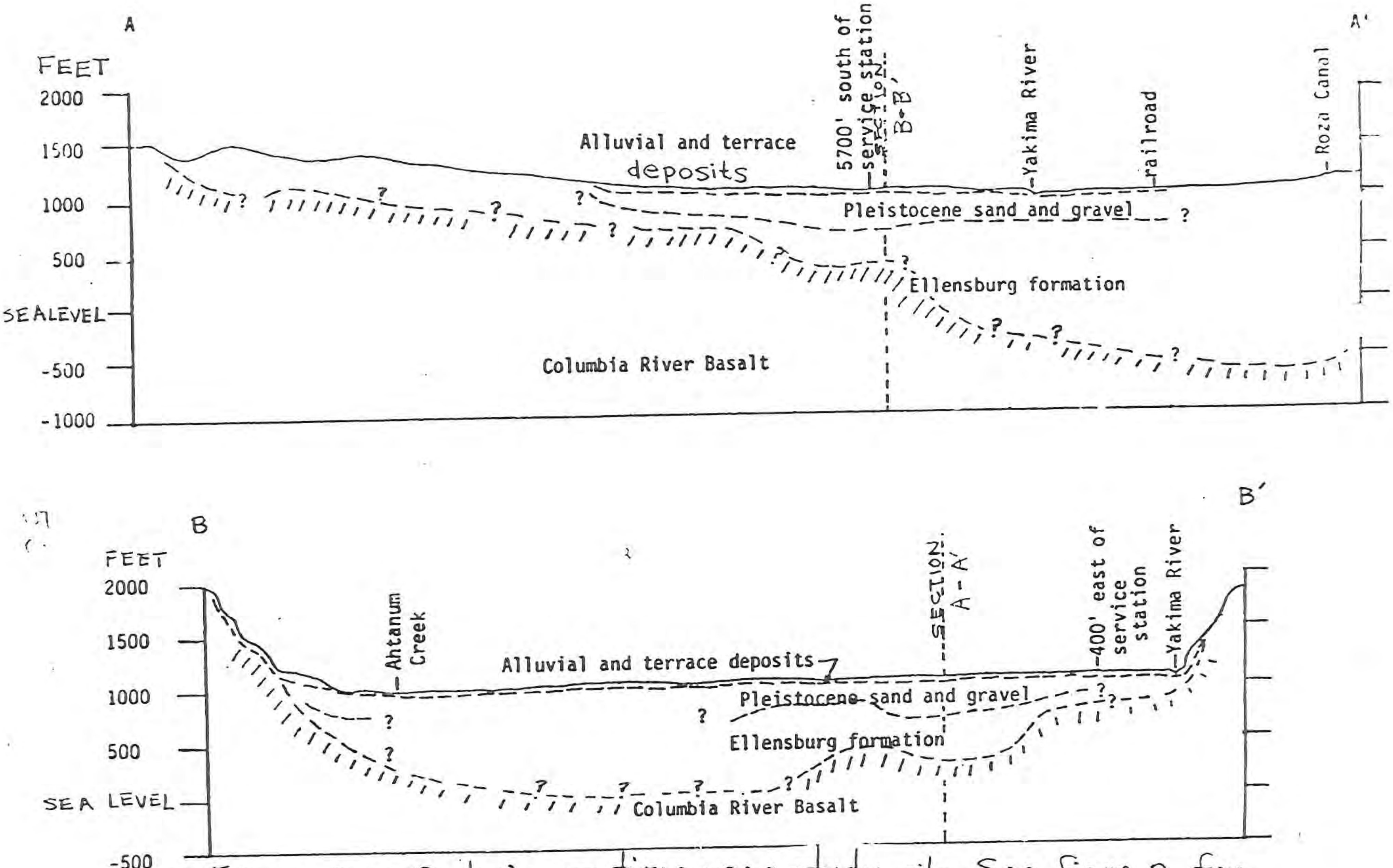
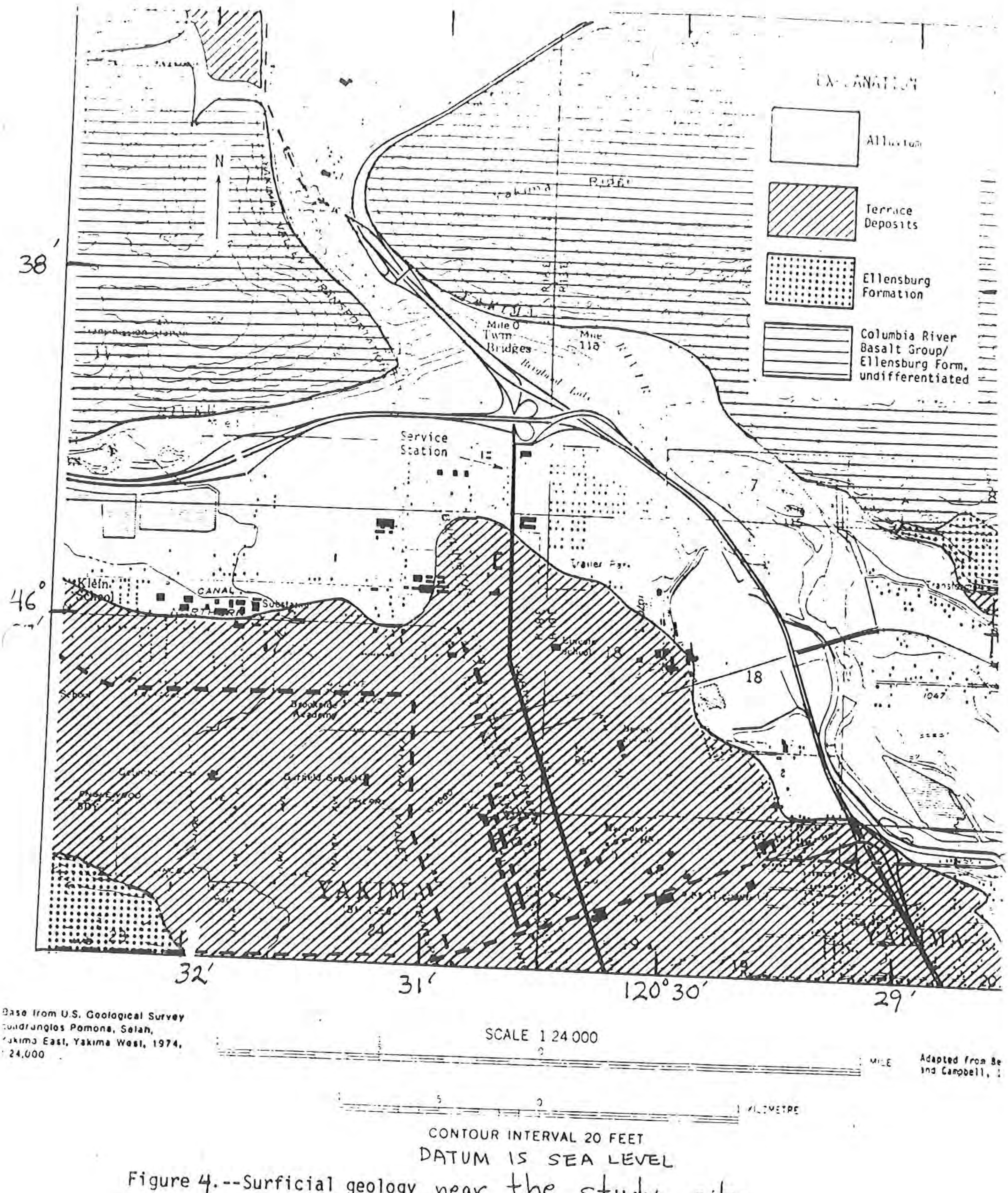


Figure 3.-- Geologic sections near study site. See figure 2 for locations of sections. Geology based on well logs. Pleistocene sand and gravel shown on section only.

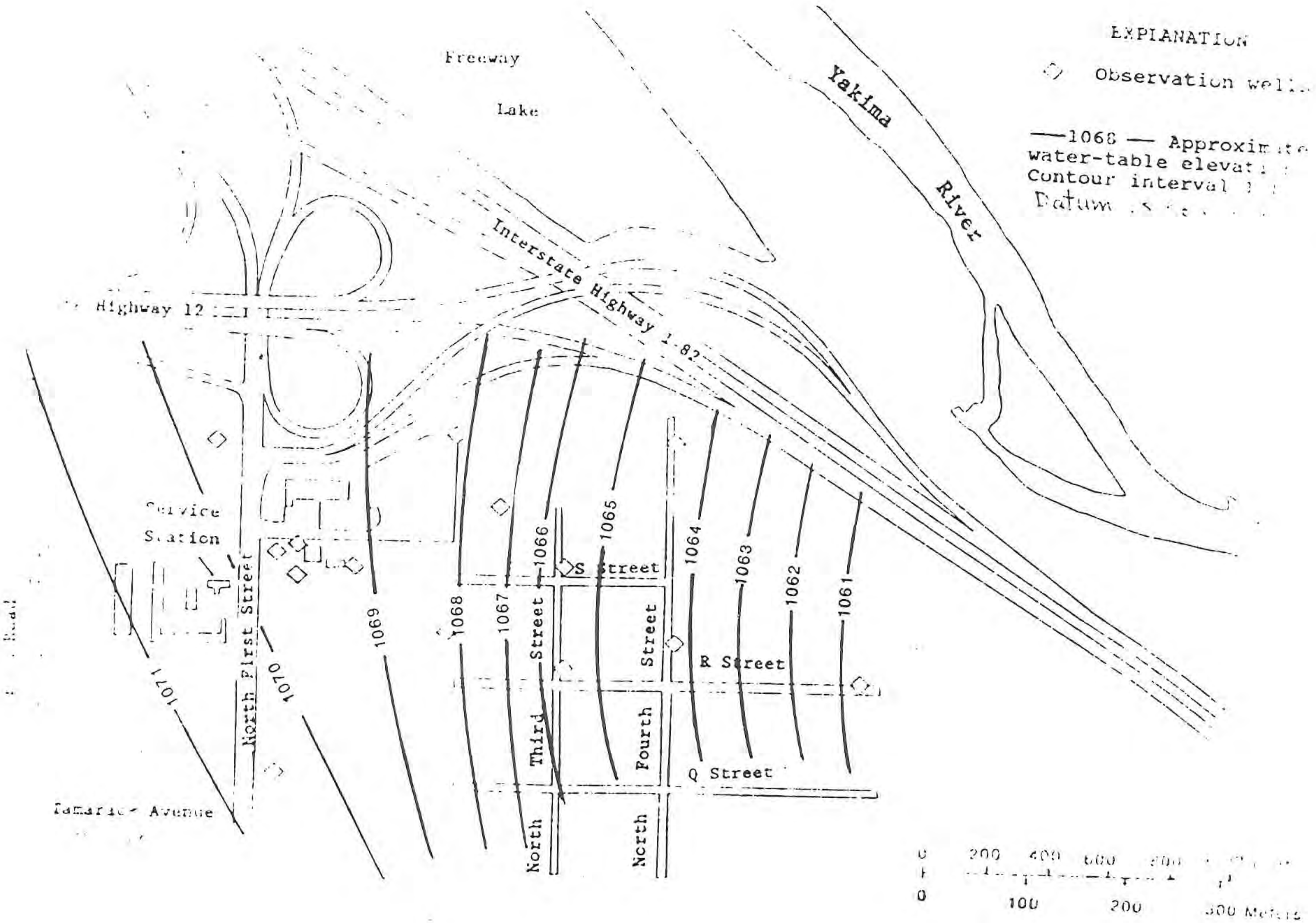
would be nice to locate + label a few of the key wells used in these x-sects.



Base from U.S. Geological Survey
Quadrangles Pomona, Selah,
Yakima East, Yakima West, 1974,
1 24,000

Adapted from Be
and Campbell,

Figure 4.--Surficial geology near the study site



5.-- [illegible] July, 1986 at the study site

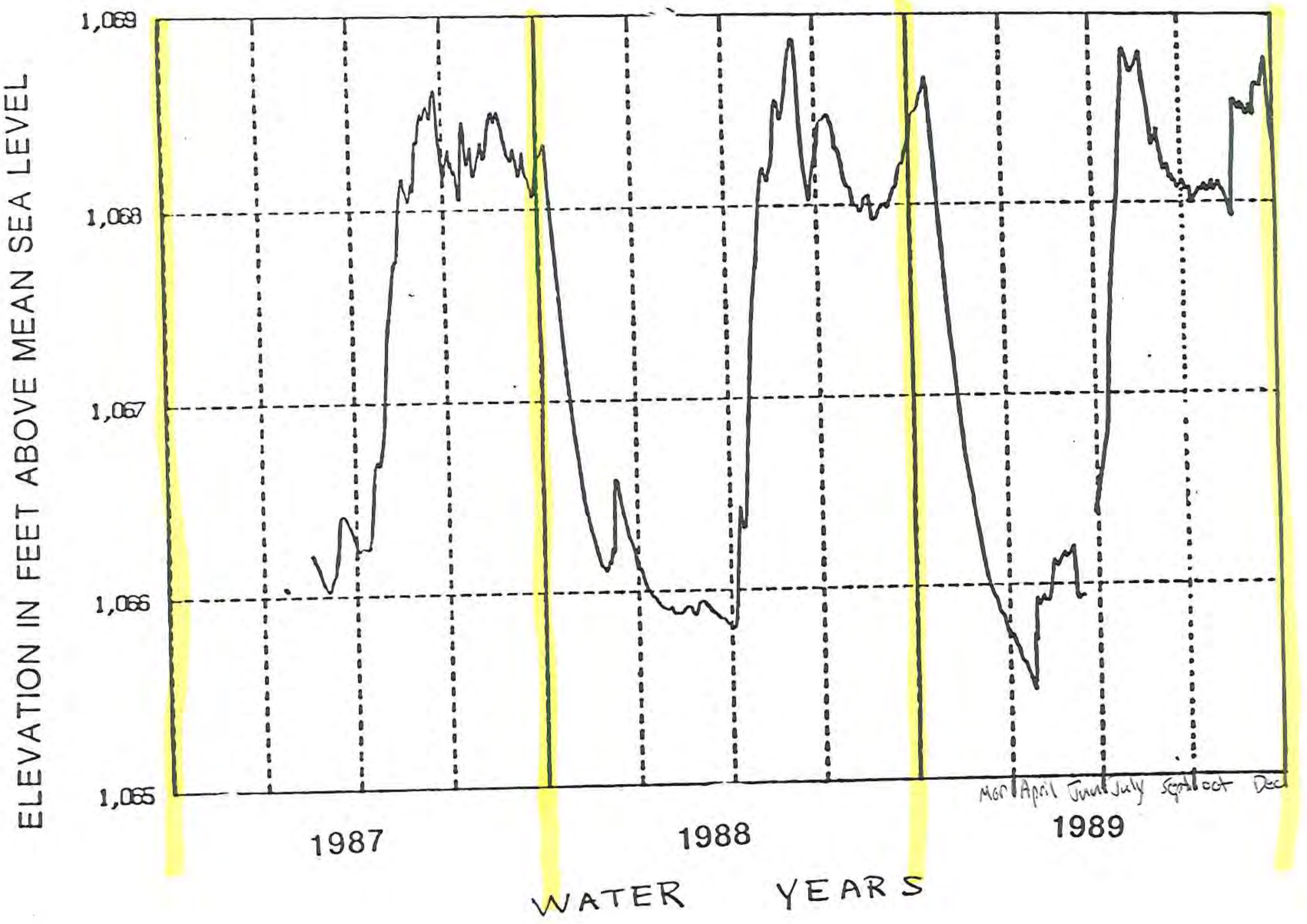


Figure 6.-- Mean daily observed water levels in well M14, water years 1987 through 1989. Water year ending september 30. Land surface elevation is 1076.14 feet above sea level.

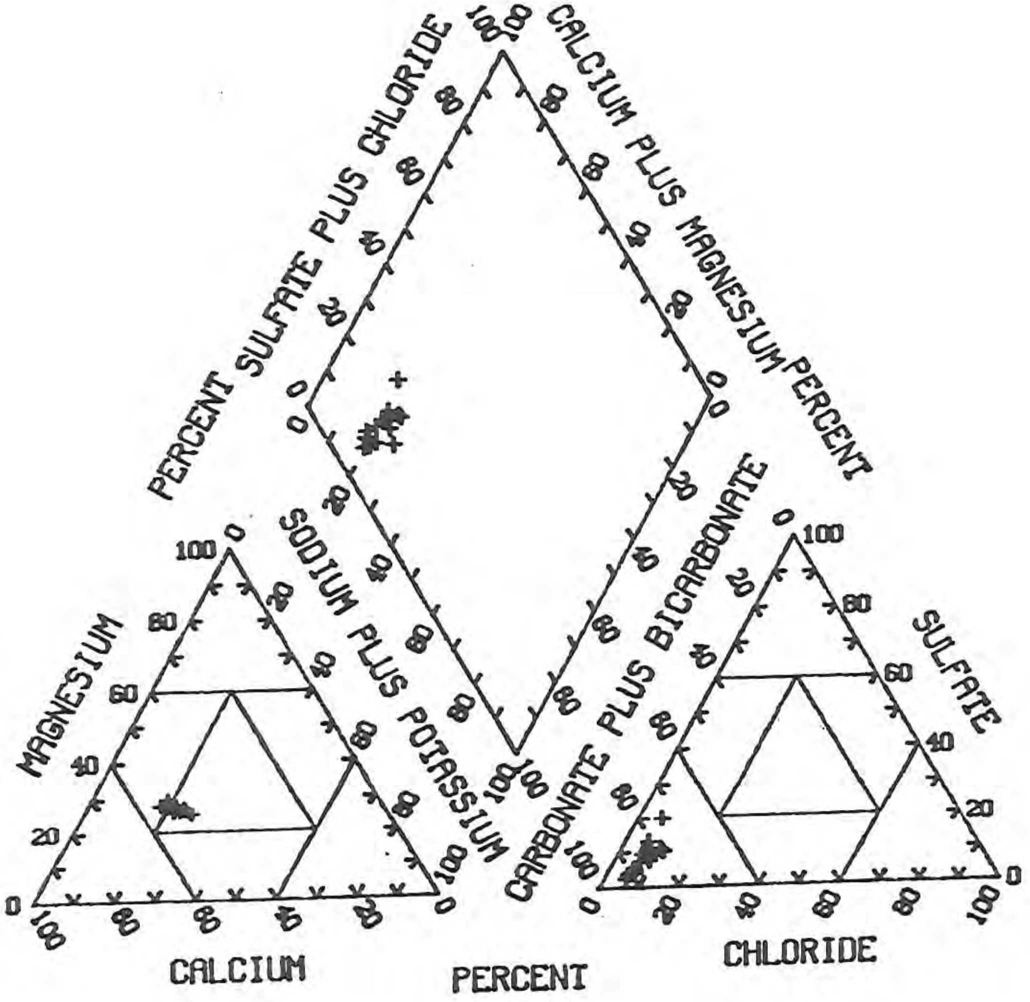
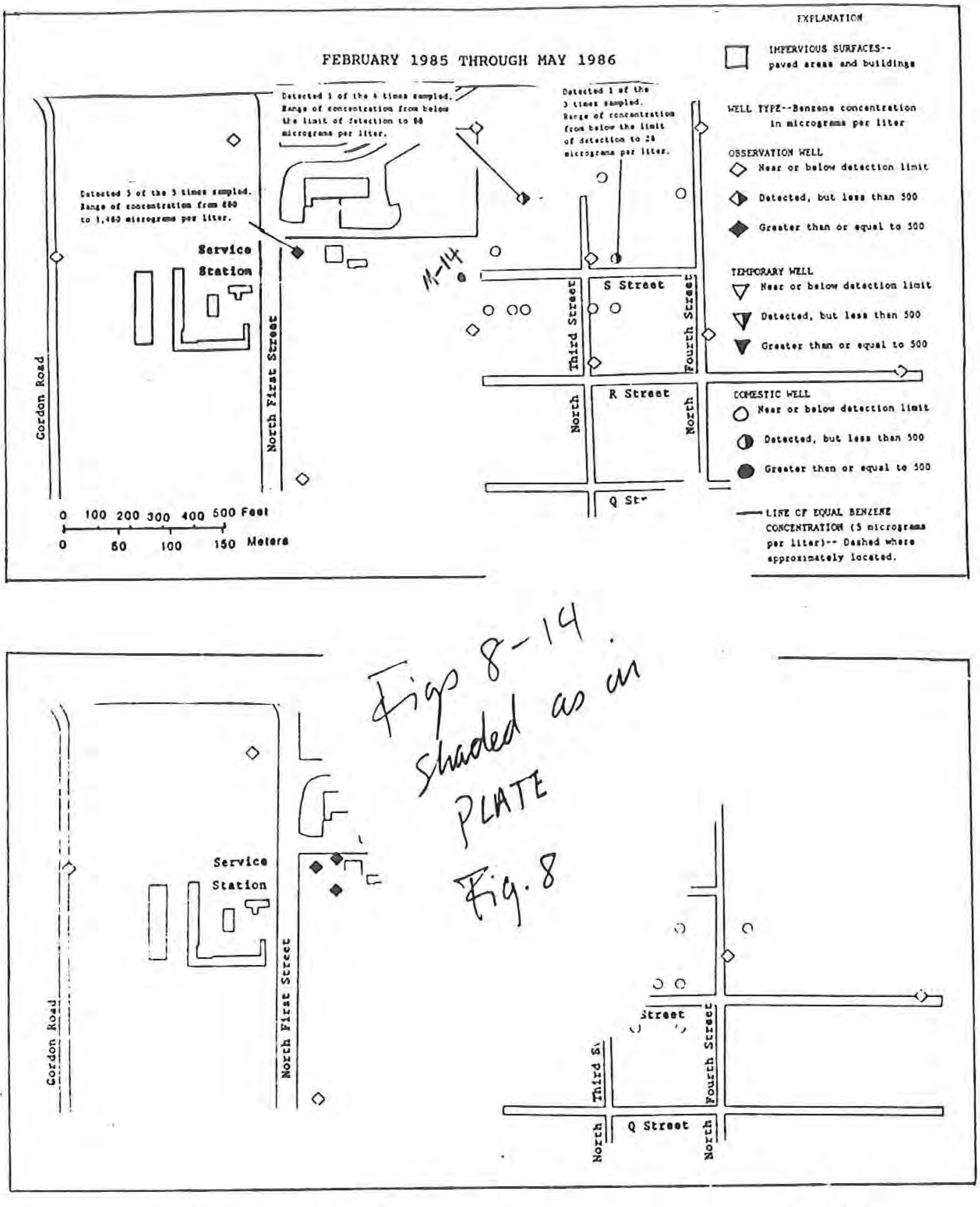


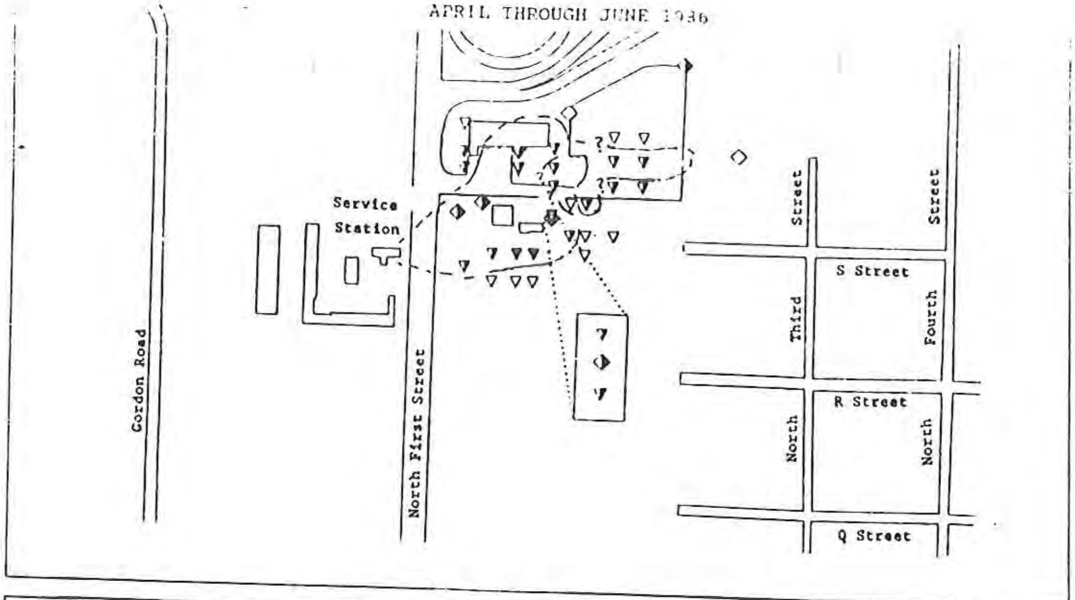
Figure 7.-- Percentage of major ions in ground water,
1986 and March 1989.



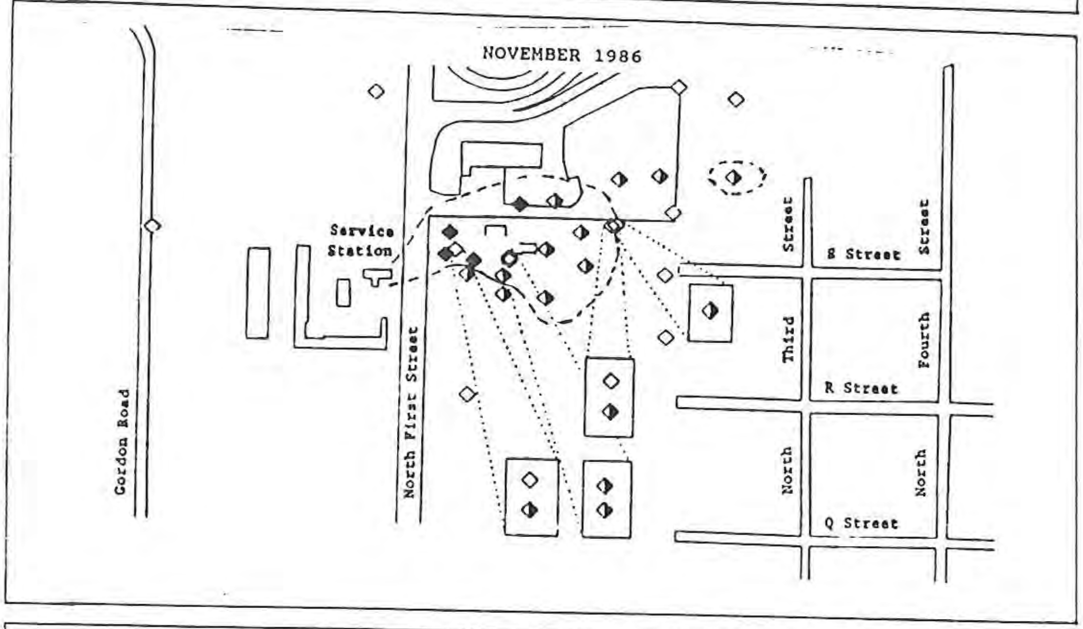
Figs 8-14.
shaded as in
PLATE
Fig. 8

Figure 8.-- Concentrations of benzene in ground water, February 1985 through March 1989.

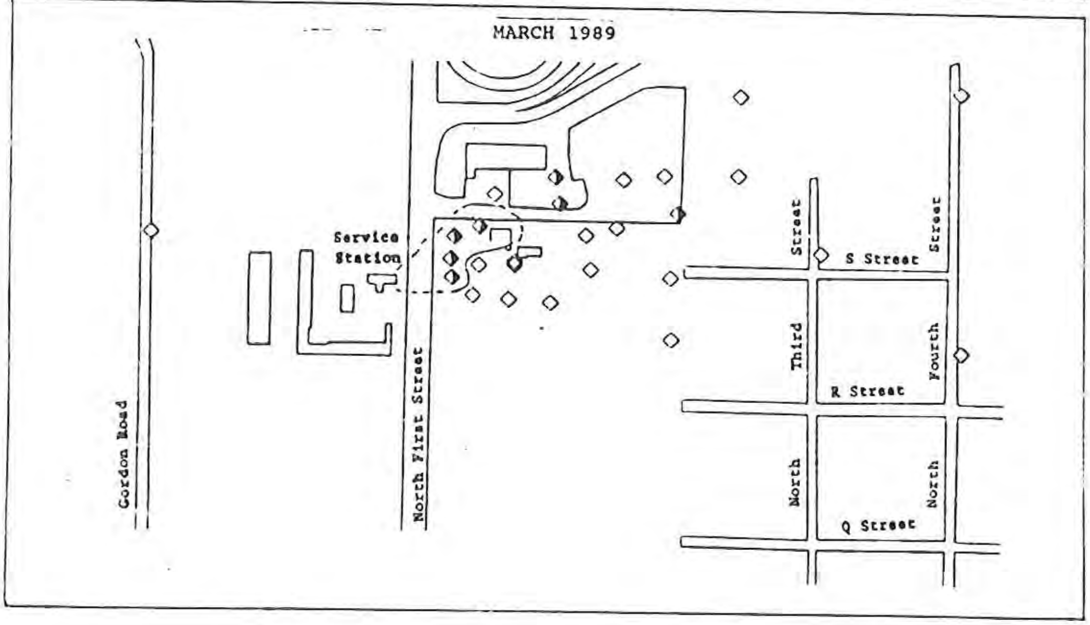
APRIL THROUGH JUNE 1986



NOVEMBER 1986



MARCH 1989



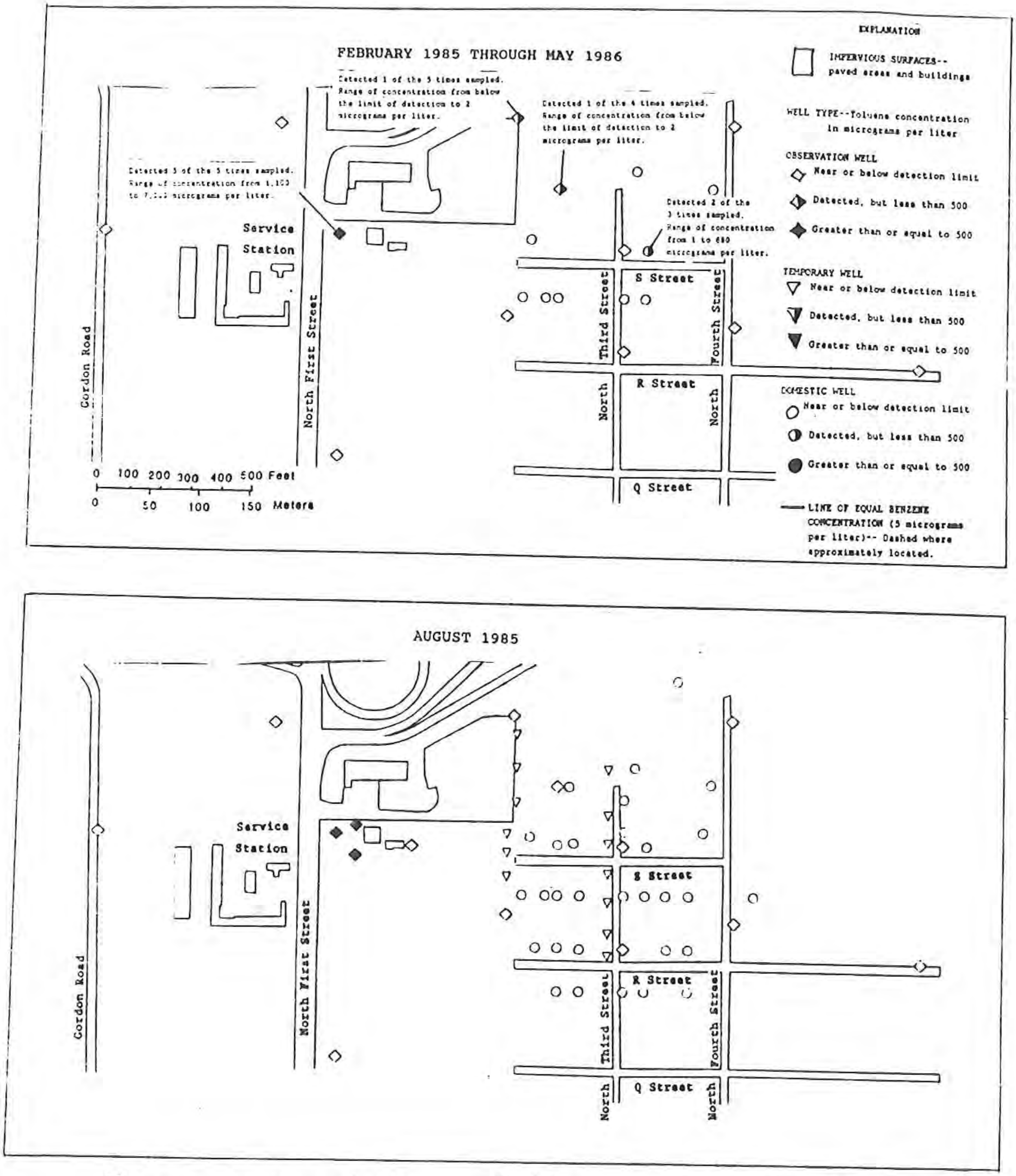
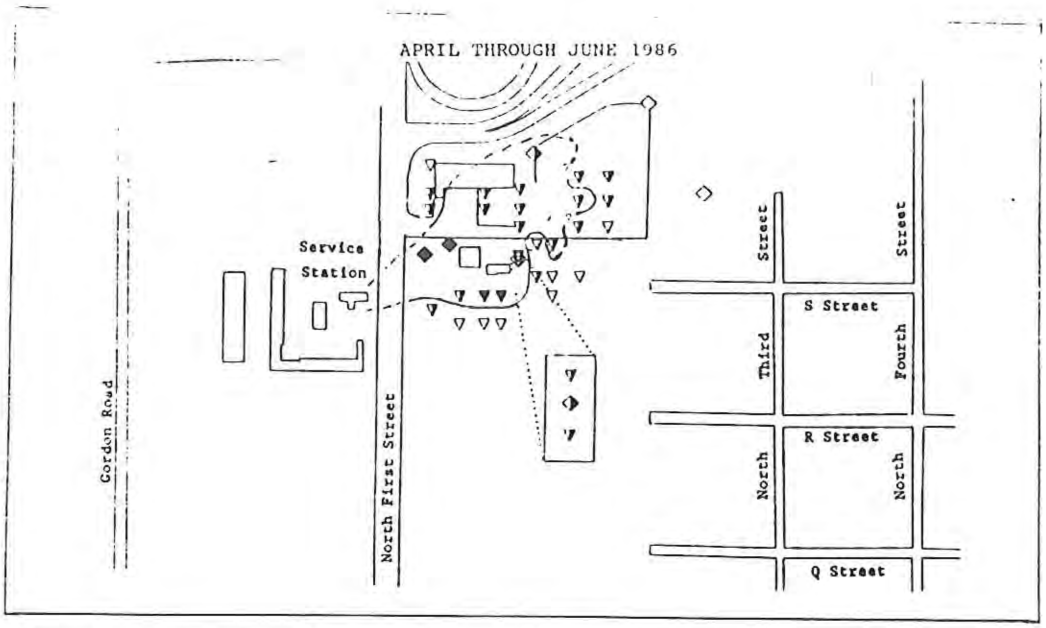
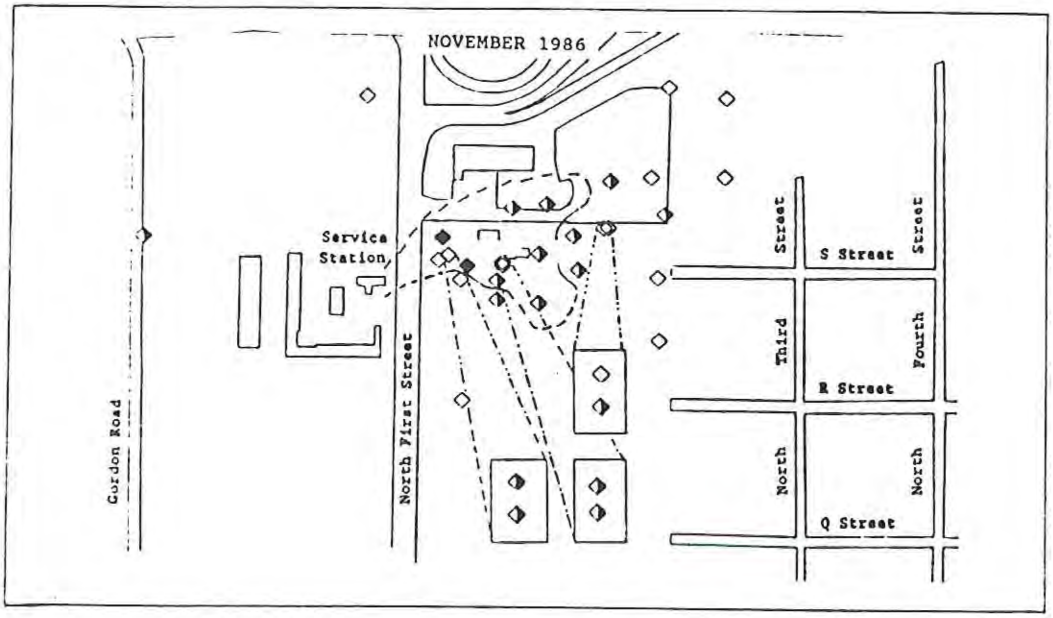
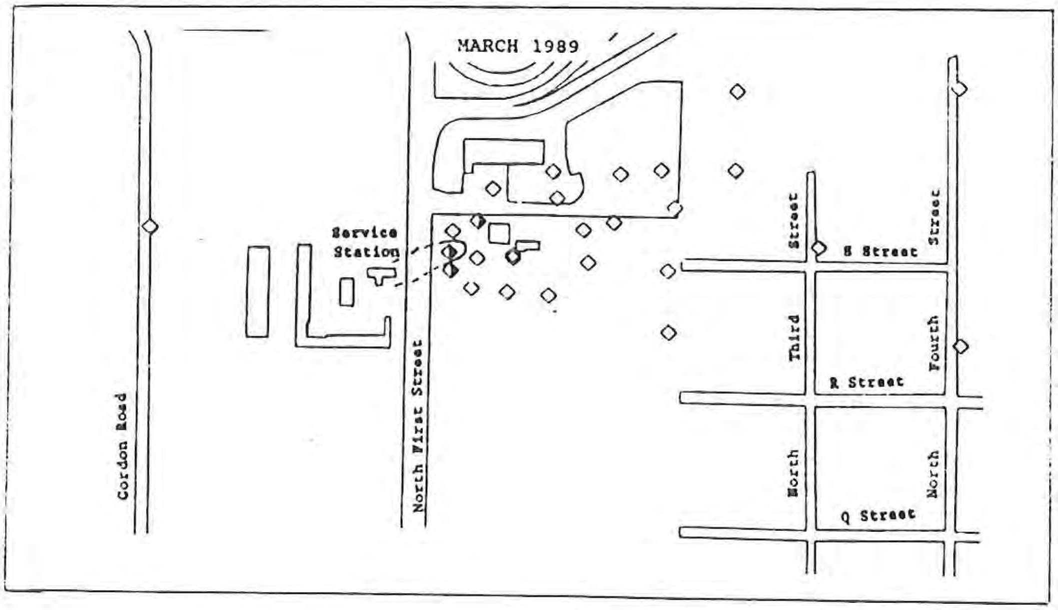


Figure 9.-- Concentrations of toluene in ground water, February 1985 through March 1989.


APRIL THROUGH JUNE 1986


NOVEMBER 1986


MARCH 1989

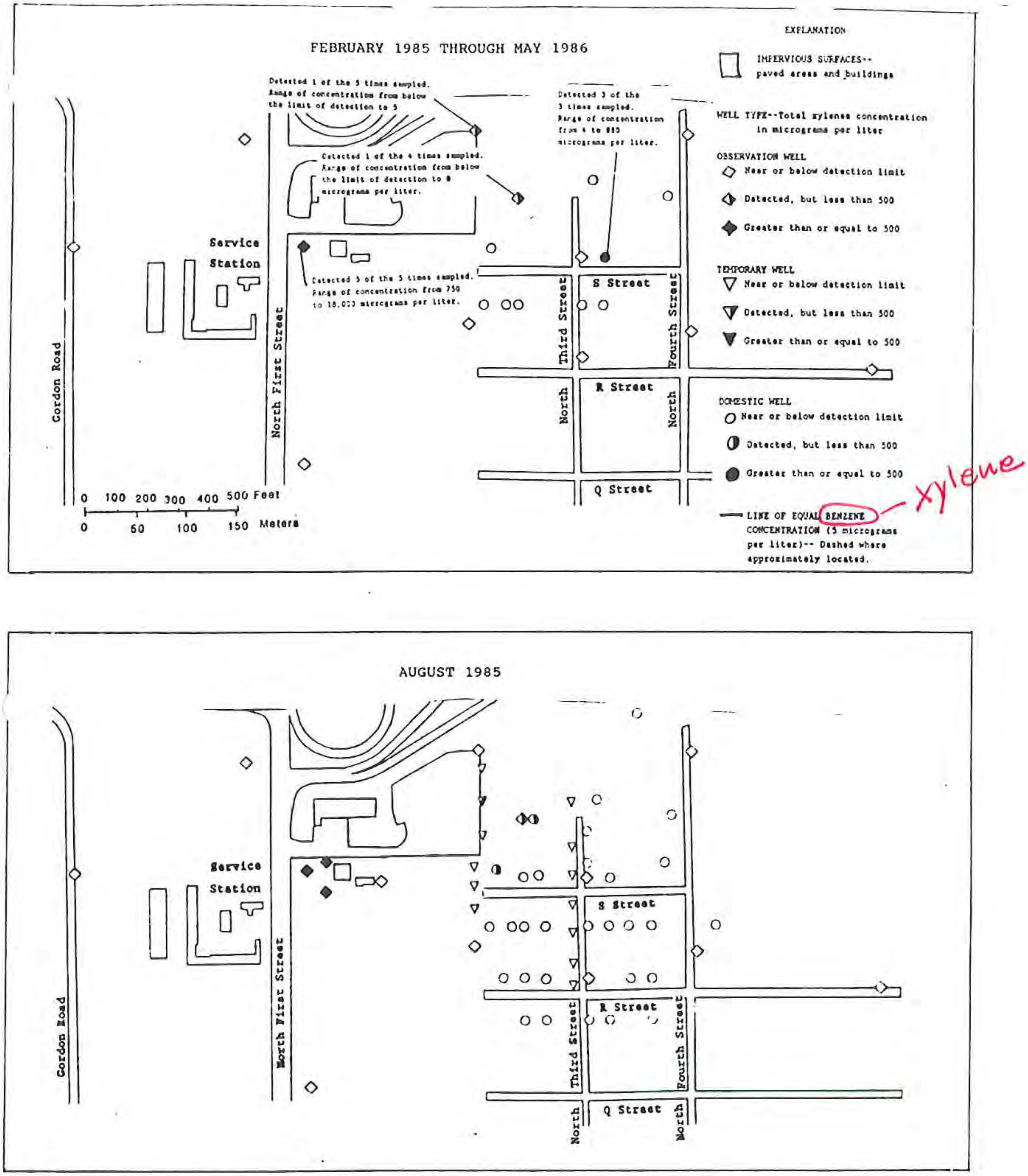
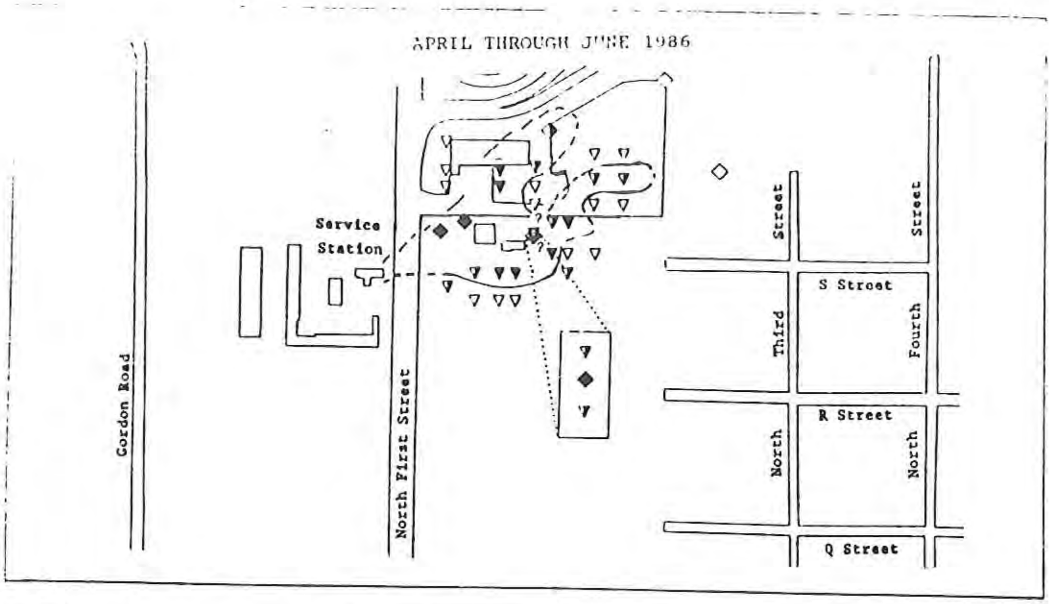
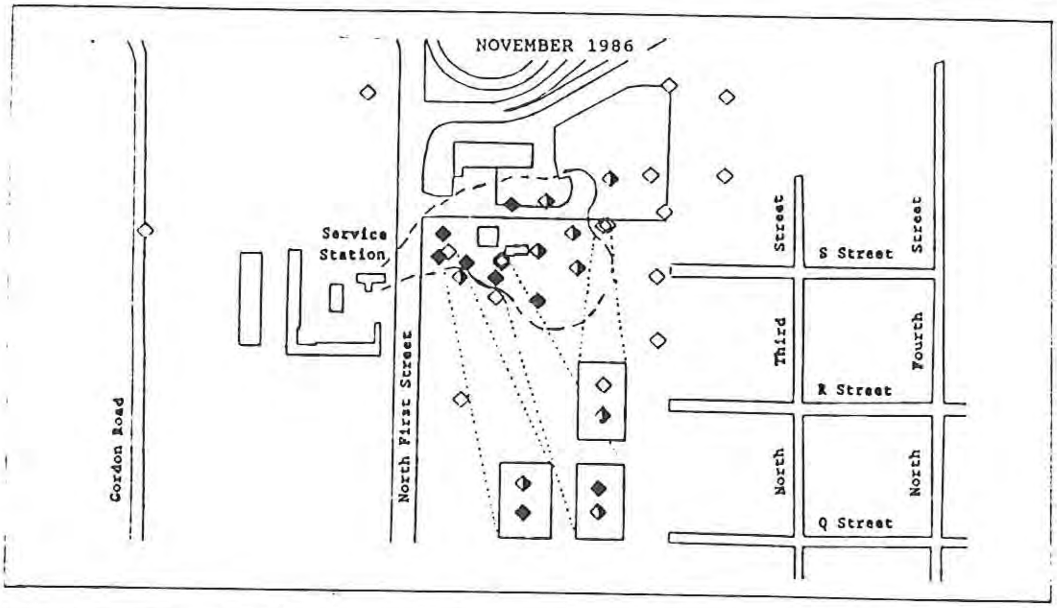
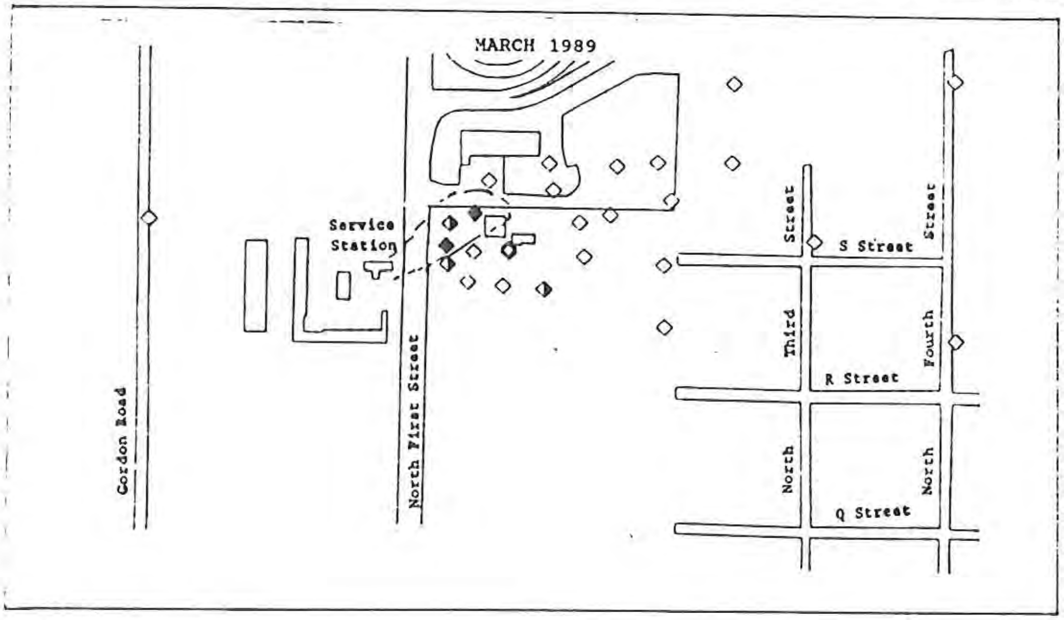


Figure 10.--Concentrations of total xylenes in ground water, February 1985 through March 1989.


APRIL THROUGH JUNE 1986


NOVEMBER 1986


MARCH 1989

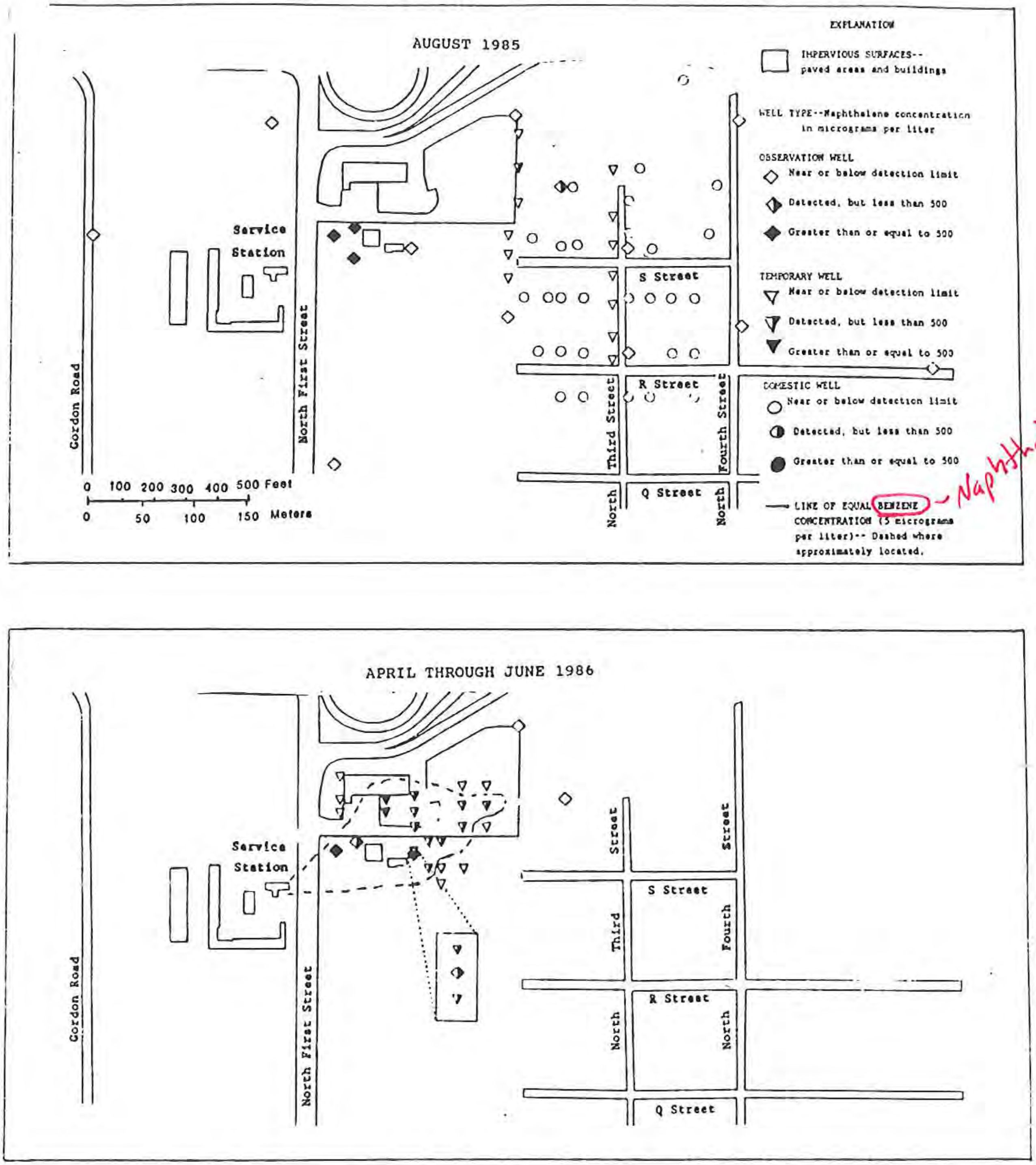
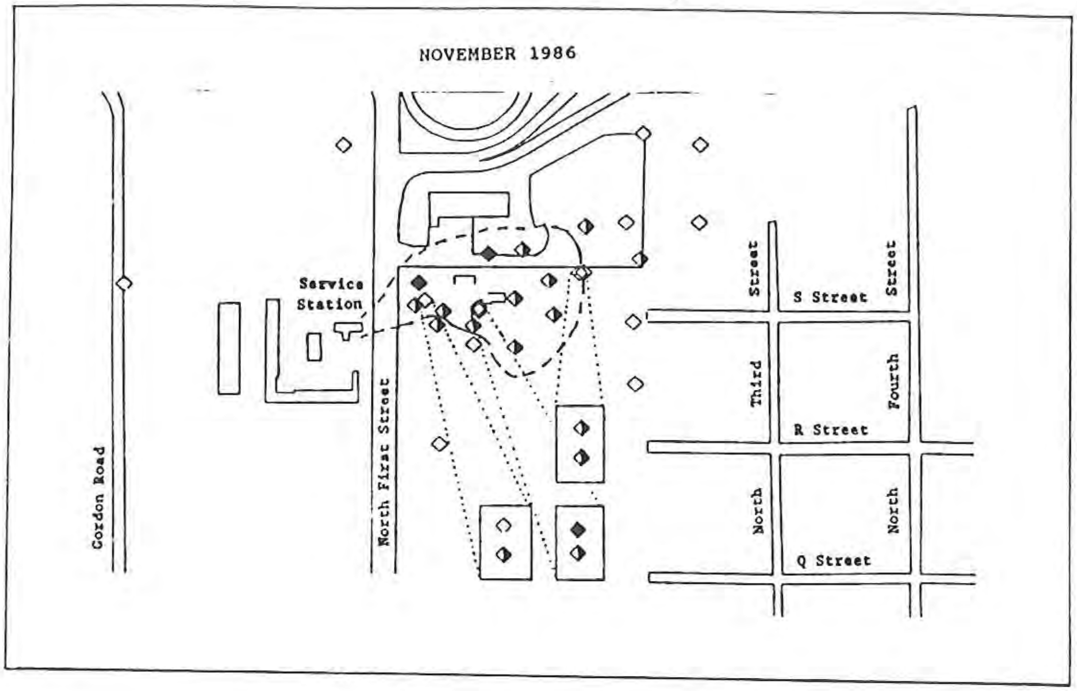
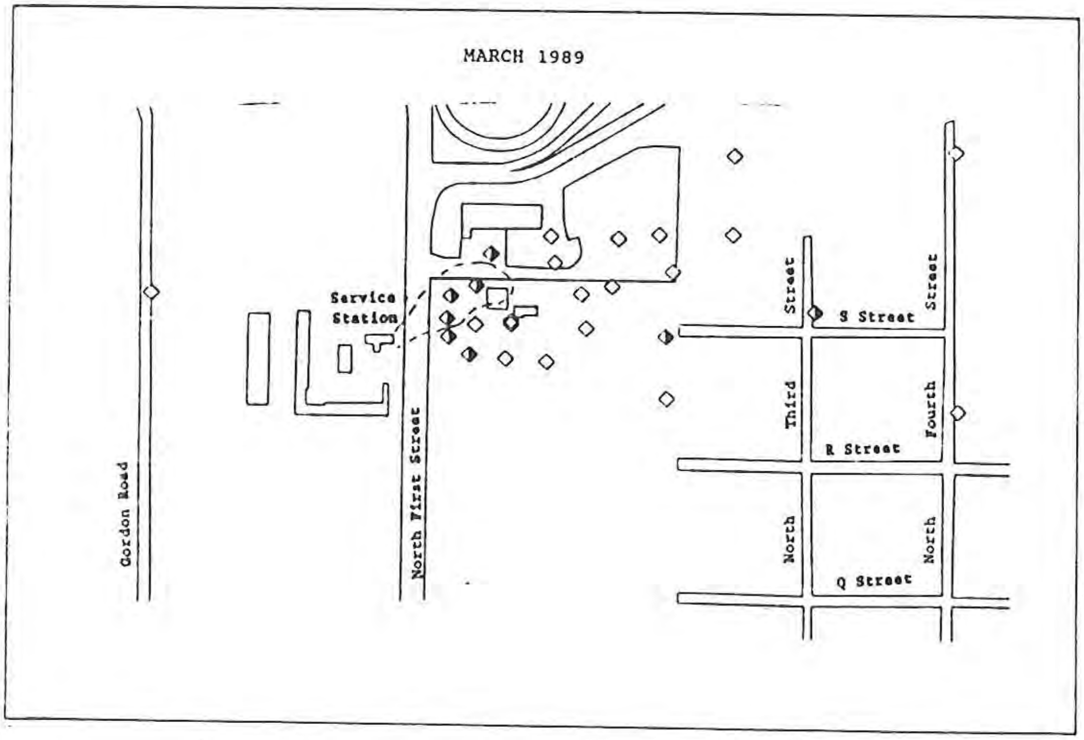


Figure 11.-- Naphthalene concentrations in ground water, August 1985 through March 1989.



NOVEMBER 1986



MARCH 1989

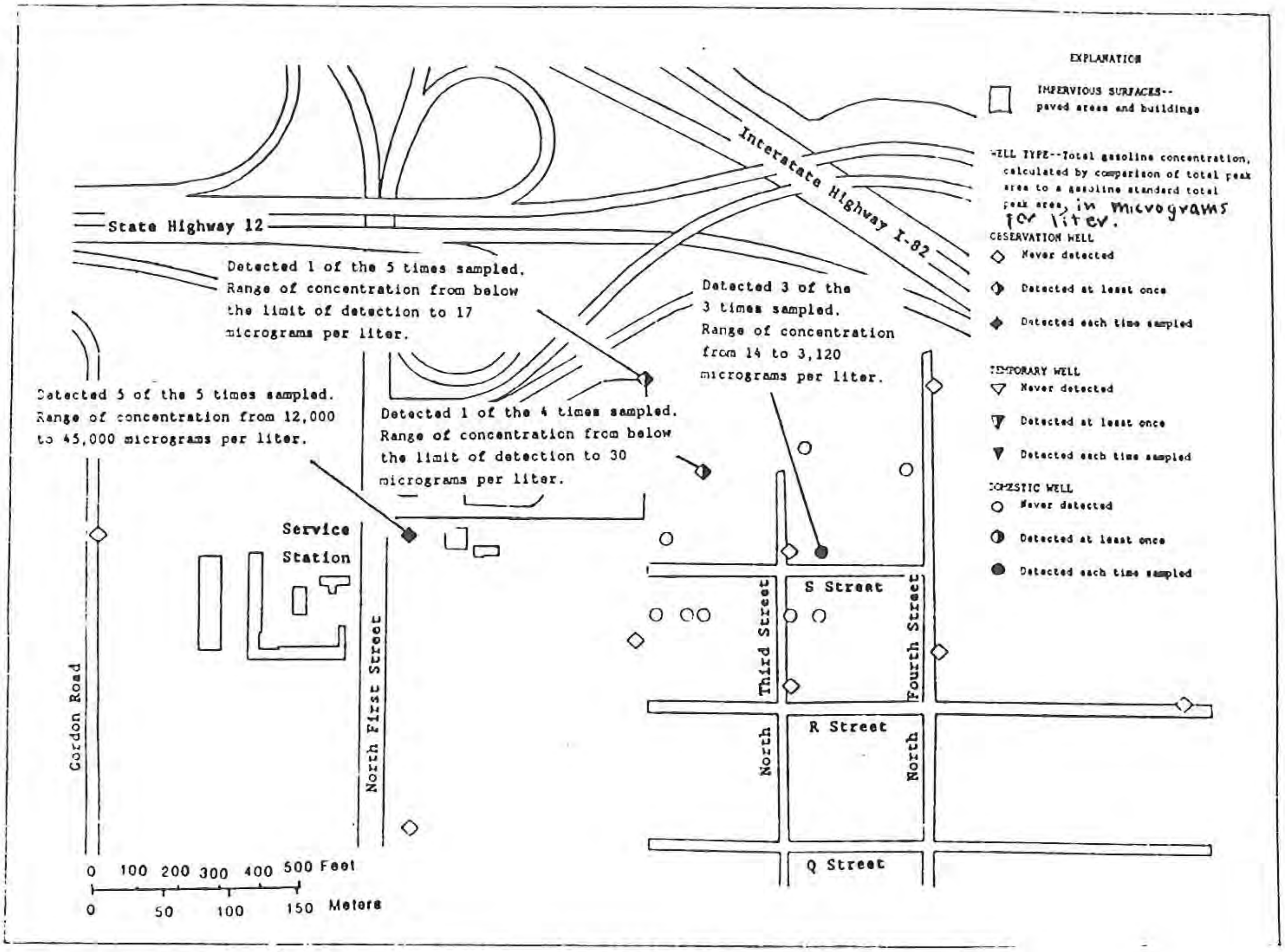


Figure 12.-- Concentrations of total gasoline in ground water, February 1985 through May 1986.

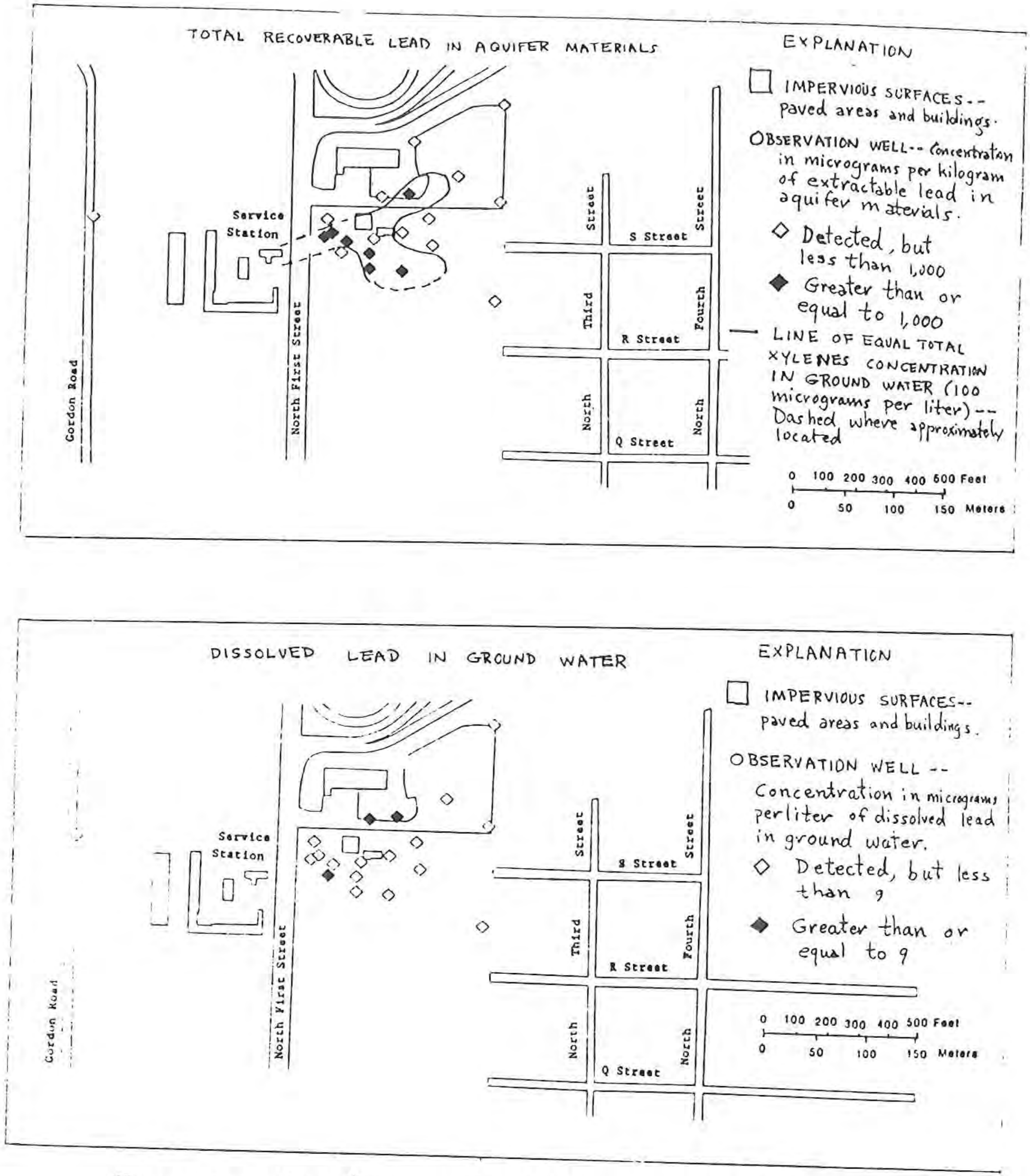
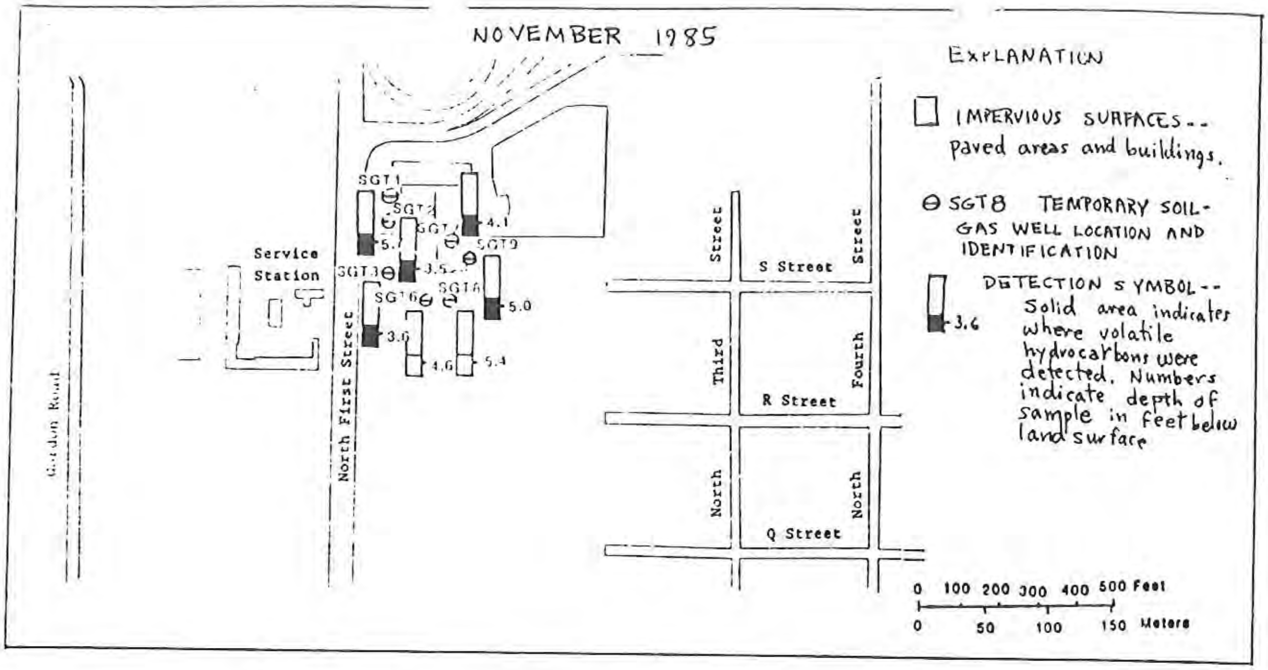


Figure 13.-- Concentrations of total-recoverable lead in aquifer material and dissolved lead in ground water, November 1986.



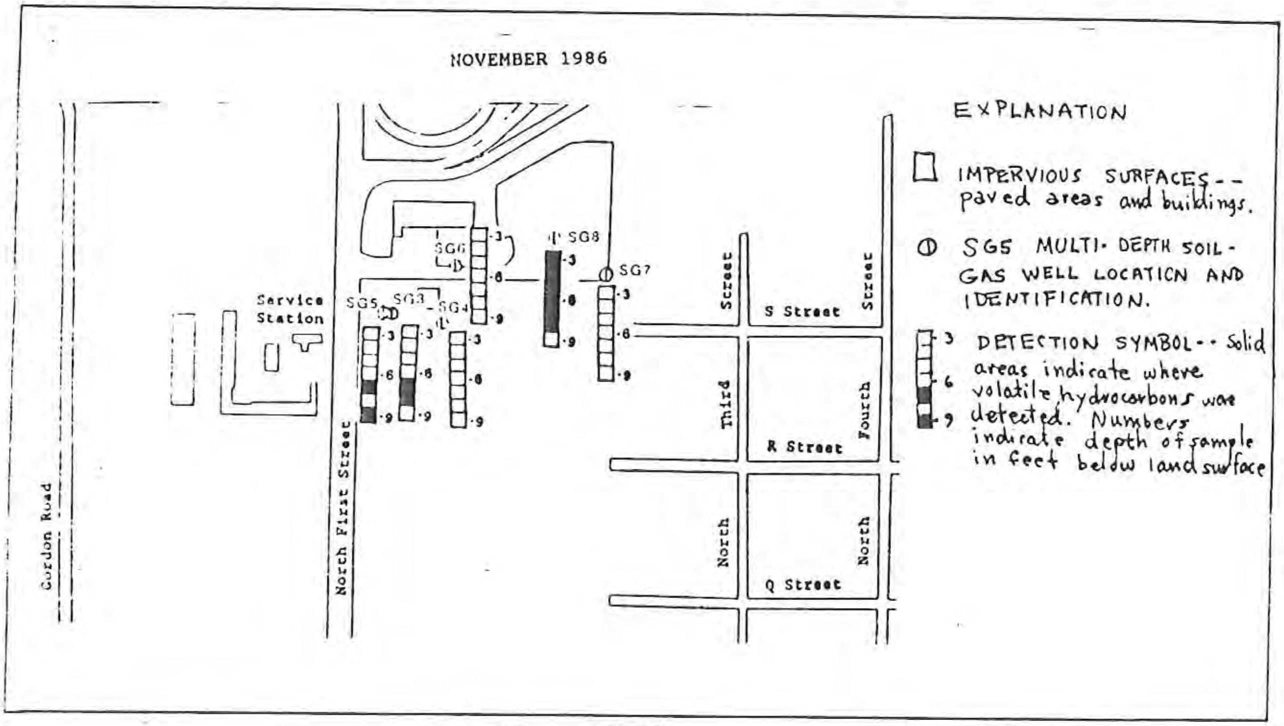


Figure 14.-- Locations of temporary soil-gas samples collected November 1985 and multi-depth soil-gas samples collected November 1986.

Table 1.--Physical properties of selected aromatic hydrocarbons

[Solubilities at 20 °C unless otherwise indicated; mg/L, milligrams per liter; mm, millimeters; (K_{ow}), octanol-water partition coefficients; --, not available; from Weast, 1982 and Verschueren, 1983]

Compound	Aqueous solubility (mg/L)	Vapor pressure (mm of Mercury)	Log K_{ow}	Molecular weight
Benzene	1,780	76	2.13	78.11
Toluene	515	22	2.69	92.13
o-Xylene	175	5	2.77	106.17
m-Xylene	--	6	3.20	106.17
p-Xylene	198 (at 25 °C)	6.5	3.15	106.17
Ethylbenzene	152	7	3.15	106.17
Naphthalene	34.4	0.05	3.37	128.17

PRELIMINARY SUBJECT TO REVISIONS

Tabl --Wells and well identifiers used during th eport

[N/A, not available; land surface elevation is in feet above sea level; depth, in feet below land surface, indicates screened interval or bottom depth of an open-ended casing; letters in well identifiers in this report signify the following: M, observation well; T, temporary well; D, domestic well; SG, multidepth soil-gas well; SGT, temporary soil-gas well. All domestic wells were sampled at an outside spigot unless suffixed with a K (sampled at kitchen sink) or I (irrigation well, sampled at wellhead)]

Site identifiers			Land surface elevation	Depth	Comments
This report	WATSTORE	Other reports			
M1-82	13N/18E-12R01	1	1078.06	6.0 - 15.6	
M2-82	13N/18E-12R02	2	1077.93	6.6 - 16.1	Identified as 3-82 (Fish, 1987)
M3-82	13N/18E-12R03	3	1076.86	6.0 - 15.8	
M1-85	13N/18E-12R04	1-85, MW-1	1080.48	6.0 - 21.0	
M2-85	13N/19E-07N01	2-85, MW-2	1067.51	3.5 - 18.5	
M3-85	13N/19E-07N02	3-85, MW-3	1072.62	4.1 - 19.1	
M4-85	13N/18E-12R05	4-85, MW-4	1075.66	4.1 - 19.1	
M5-85	13N/19E-07N03	5-85, MW-5	1069.66	1.8 - 16.8	
M6-85	13N/19E-07N04	6-85, MW-6	1071.52	4.3 - 19.4	
M7-85	13N/19E-07N05	7-85, MW-7	1072.48	4.2 - 19.2	
M8-85	13N/19E-07N06	8-85, MW-8	1075.70	5.0 - 20.0	
M9-85	13N/18E-12R06	9-85, MW-9	1075.48	4.8 - 19.8	
M10-85	13N/18E-12R07	10-85, MW-1	1076.37	4.3 - 19.3	
M11-85	13N/18E-12R08	11-85, MW-11	1077.67	5.5 - 20.5	
M12-85	13N/18E-12R09	12-85, MW-12	1078.49	6.4 - 21.4	
M1	13N/18E-12R12	T1	1077.43	55.0 - 58.0	
M2	13N/18E-12R13	T2	1077.65	28.0 - 30.0	SG1 also in same borehole
M3	13N/18E-12R14	T3	1077.65	28.0 - 30.0	SG2 also in same borehole
M4	13N/18E-12R15	T4	1077.02	3.8 - 12.0	
M5	13N/18E-12R16	T5	1078.39	13.9 - 15.9	SG3 also in same borehole
M6.1	13N/18E-12R17	T6.1	1077.39	44.6 - 46.6	[Piezometers M6.1 and M6.2 are in the same hole]
M6.2	13N/18E-12R18	T6.2	1077.11	7.6 - 13.6	
M7.1	13N/18E-12R19	T7.1	1078.11	30.3 - 32.3	[Piezometers M7.1 and M7.2 are in the same hole]
M7.2	13N/18E-12R20	T7.2	1078.11	7.3 - 13.3	
M8	13N/18E-12R21	T8	1078.22	8.4 - 14.4	
M9	13N/18E-12R22	T9	1078.07	7.0 - 13.0	
M10	13N/18E-12R23	T10	1077.81	8.3 - 14.3	
M11	13N/18E-12R24	T11	1077.65	8.4 - 14.2	
M12	13N/18E-12R25	T12	1078.09	7.4 - 13.4	
M13	13N/18E-12R26	T13	1078.09	30.5 - 32.3	SG4 also in same borehole
M14	13N/18E-12R27	T14	1076.14	6.8 - 12.8	
M16	13N/18E-12R28	T16	1078.09	7.9 - 13.9	
M17	13N/18E-12R29	T17	1078.36	7.7 - 13.7	
M18	13N/18E-12R30	T18	1077.70	7.1 - 13.1	
M19	13N/18E-12R31	T19	1078.12	7.8 - 13.8	
M20	13N/18E-12R32	T20	1078.26	7.2 - 13.2	
M21	13N/18E-12R33	T21	1077.70	56.3 - 58.3	
M22	13N/18E-12R34	T22	1077.50	6.7 - 12.7	
M23	13N/18E-12R39	B1	1077.10	6.5 - 12.5	
M24	13N/18E-12R40	B2	1076.16	7.6 - 13.6	
M25	13N/18E-12R41	B3	1076.08	30.3 - 32.3	SG6 also in same borehole
M26	13N/18E-12R42	B4	1076.58	8.0 - 14.0	
M27	13N/18E-12R43	B5	1076.79	9.0 - 18.0	
M28	13N/18E-12R35	S1	1077.03	54.0 - 56.5	SG7 also in same borehole
M29	13N/18E-12R36	S2	1076.99	7.7 - 16.8	
M30	13N/18E-12R37	S3	1076.89	7.8 - 16.8	
M31	13N/18E-12R38	S4	1077.74	8.6 - 17.4	
M33	13N/19E-07N08	H1	1075.13	55.0 - 57.0	
M34	13N/19E-07N09	H2	1075.02	8.6 - 14.6	

PRELIMINARY SUBJECT TO REVISIONS

Table 2.--Wells and well identifiers used during this this report--Continued

Site identifiers			Land surface elevation	Depth	Comments
This report	WATSTORE	Other reports			
M35	13N/18E-12R11	WS1	1078.63	57.0 - 59.0	
M36	13N/18E-12R44	T1, GS1	1077.85	6.0 - 13.0	Estimated screen interval
M37	13N/18E-12R45	B1, GS2	1077.53	6.0 - 13.0	Identified as GS1 (Fish, 1987)
M38	13N/19E-07N07	3/R	1072.58	54.2 - 56.2	
M39	13N/18E-12J03	HWY1	1078.22	N/A	
M40	13N/19E-07M01	HWY2	1078.35	N/A	
T1	13N/19E-07M04	8T1-1			
T2	13N/19E-07N10	8T1-2			
T3	13N/19E-07N11	8T1-3			
T4	13N/18E-12R46	8T1-4			
T5	13N/18E-12R47	8T1-5			
T6	13N/18E-12R48	8T1-6			
T7	13N/19E-07N12	8T2-2			
T8	13N/19E-07N13	8T2-3			
T9	13N/19E-07N14	8T2-4			
T10	13N/19E-07N15	8T2-5			
T11	13N/19E-07N16	8T2-6			
T12	13N/19E-07N17	8T2-7			
T13	13N/19E-07N18	8T2-8			
T14	13N/18E-12R51	7-5			
T15	13N/18E-12R52	8-5			
T16	13N/18E-12R53	9-7.5			
T17	13N/18E-12R54	8-4			
T18	13N/18E-12R55	9-4			
T19	13N/18E-12R56	1.5-1.5			
T20	13N/18E-12R57	8-3			
T21	13N/18E-12R58	7-4			
T22	13N/18E-12R59	5-3			
T23	13N/18E-12R60	5-2			
T24	13N/18R-12R61	4-2			
T25	13N/18E-12R62	4-3			
T26	13N/18E-12R63	3-2			
T27	13N/18E-12R64	3-3			
T28	13N/18E-12R65	6-7			
T29	13N/18E-12R66	1-8			
T30	13N/18E-12R67	1-9			
T31	13N/18E-12R68	1-10			
T32	13N/18E-12R69	6-8			
T33	13N/18E-12R70	6-9			
T34	13N/18E-12R71	4-8			
T35	13N/18E-12R72	4-9			
T36	13N/18E-12R73	11-8.5			
T37	13N/18E-12R74	11-9.5			
T38	13N/18E-12R75	11-7.5			
T39	13N/18E-12R76	9-8.5			
T40	13N/18E-12R77	9-9.5			
T41	13N/18E-12R89	(1 m north of M36)	1078		
T42	13N/18E-12R90	(1.3 m south of M36)	1078		
D1	13N/19E-07M03	H1-01		25	
D2	13N/19E-07N19	H4-03-(I)		20	
D3	13N/19E-07N20	H4-06-(K)		28	
D4	13N/19E-07N21	H4-06-(I)		13	
D5	13N/19E-07N22	H4-01		N/A	
D6	13N/19E-07N23	H3-08-(I), H3-07-(I)		70	
D7	13N/19E-07N24	H3-10-(I), H3-09-(I)		20	

PRELIMINARY SUBJECT TO REVISIONS

Table 2.--We s and well identifiers used during this this ort--Continued

Site identifiers			Land surface elevation	Depth	Comments
This report	WATSTORE	Other reports			
D8	13N/19E-07N25	H3-11-(I)		20	
D9	13N/19E-07N26	H4-07		20	
D10	13N/19E-07N27	H4-08		80	
D11	13N/19E-07N28	H4-11		65	
D12	13N/19E-07N29	H6-05		18	
D13	13N/19E-07N30	H6-04-(I)		25	
D14	13N/19E-07N31	H6-03-(I)		N/A	
D15	13N/19E-07N32	H6-01		N/A	
D16	13N/19E-07N33	H5-06		N/A	
D17	13N/19E-07N34	H5-05-(I)		28	
D18	13N/19E-07N35	H5-04-(I)		28	
D19	13N/19E-07N36	H5-02		N/A	
D20	13N/19E-07N02	IK6-06-(I)		30	
D21	13N/19E-07N37	B2-05		N/A	
D22	13N/19E-07N38	B2-03		21	
D23	13N/19E-07N39	B2-01		N/A	
D24	13N/19E-07N40	B1-04		36	
D25	13N/19E-07N41	B1-01		26	
D26	13N/19E-07N42	B3-05		N/A	
D27	13N/19E-07N43	B3-03		N/A	
D28	13N/19E-07N44	B3-01		30	
D29	13N/19E-07N45	B4-06		38	
D30	13N/19E-07N46	B4-05		N/A	
D31	13N/19E-07N47	B4-01		N/A	
D32	13N/18E-12R97	Mesa	1079.47	N/A	(Water levels only)
SG1	13N/18E-12R91	T2	1077.43		Sampling tubes installed above the well screem M2)
SG2	13N/18E-12R92	T3	1077.65		Sampling tubes installed above the well screen (M3)
SG3	13N/18E-12R93	T5	1078.02		Sampling tubes installed above the well screen (M5)
SG4	13N/18E-12R94	T13	1078.09		Sampling tubes installed above the well screen (M13)
SG5	13N/18E-12R87	T15	1078.19		Multidepth soil-gas sampler only
SG6	13N/18E-12R95	B3	1076.08		Sampling tubes installed above the well screen (M25)
SG7	13N/18E-12R96	S1	1077.03		Sampling tubes installed above the well screen (M28)
SG8	13N/18E-12R88	S5	1077.65		Multidepth soil-gas sampler only
SGT1	13N/18E-12R81	1-9		5.67	
SGT2	13N/18E-12R81	1-7		3.46	
SGT3	13N/18E-12R79	1-4		3.59	
SGT4	13N/18E-12R78	1-2		4 to 5 (estimated)	
SGT5	13N/18E-12R82	2-5		3.47	
SGT6	13N/18E-12R83	3-2		4.58	
SGT7	13N/18E-12R84	4-6		4.10	
SGT8	13N/18E-12R85	4-2		5.35	
SGT9	13N/18E-12R86	5-5		4.96	

Table 3.--Major hydrogeologic units in the Ahtanum-Moxee subbasin, Washington

System	Series	Group	Formation	Hydrogeologic description
Quaternary	Holocene			Alluvium and terrace deposits consisting principally of unconsolidated stream deposits of silt, sand, and gravel, with cobbles throughout. Locally lacustrine, paludal, and eolian deposits occur. Generally, deposit is a thin mantle less than 50 feet thick, but known to reach 165 feet thick at one point in subbasin. Estimates of porosity range from 15 to 25 percent and from 0.4 to 86 feet per day hydraulic conductivity.
	Pleistocene			Coarse sand and gravel deposits including large amounts of cemented mixture of basaltic gravel, sand, silt, and clay. Locally contains discontinous and unconsolidated bodies of glacial fluvial and lacustrine deposits. Up to 500 feet in thickness. In general unit has low permeability except in unconsolidated sections.
Tertiary	Micocene to Pliocene		Ellensburg	A thick sequence of stream- and lake-deposited silt, sand, and gravel which is composed chiefly of volcanic ash, pumice, and hornblende andesite. Thickness exceeds 1,000 feet in some parts of subbasin. It has moderate to high porosity and low to medium permeability, and provides a large amount of effective storage. Permeable strata form important aquifers. Unit includes all conformably underlying sediments of similar lithology that intertongue with flows of the Columbia River Basalt.
		Columbia River Basalt	Saddle Mountains Wanapum Grande Ronde	Sequence of dark lava flows which contains some interbedded lake- and stream-deposited materials. Individual lava flows range from less than 20 to over 200 feet in thickness. The maximum thickness of the Columbia River Basalt exceeds 4,000 feet in the Yakima River Basin. Water generally moves along the interflow zones, which are more permeable than the massive centers of the flood. The porosity of this formation probably ranges from 5 to 10 percent, and its permeability ranges from low to very high. Provides a large quantity of effective ground-water storage and includes some important aquifers.

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Table 4.--Target compounds in water analyzed for volatile organic compounds by the purge and trap method

Compound	Chemical Abstract Services Registry Number
Ground-water Toxics Study	
Benzene	71-43-2
Toluene	108-88-3
Ethylene bromide	106-93-4
Ethylbenzene	100-41-4
m-Xylene	108-38-3
o-Xylene	95-47-6
p-Xylene	106-42-3
n-Propylbenzene	105-65-1
1,2,3-Trimethylbenzene	526-73-8
1,2,4-Trimethylbenzene	95-63-6
1,3,5-Trimethylbenzene	108-67-8
t-Butylbenzene	98-06-6
Isobutylbenzene	538-93-2
sec-Butylbenzene	135-98-8
1-Isopropyl-4-methylbenzene	99-87-6
n-Butylbenzene	104-51-8
1,2,3,5-Tetramethylbenzene	527-53-7
1,2,3,4-Tetramethylbenzene	488-23-3
Naphthalene	91-20-3
2-Ethyl-1-methylbenzene	611-14-3
1,4-Dimethyl-2-ethylbenzene	175-88-89
1,3-Dimethyl-4-ethylbenzene	874-41-9
March 1989 Study	
Benzene	71-43-2
Bromobenzene	108-43-2
Bromochloromethane	74-97-5
Bromodichloromethane	75-27-4
Bromoform	75-25-2
Bromomethane	74-83-9
n-Butylbenzene	104-51-8
sec-Butylbenzene	135-98-8
tert-Butylbenzene	98-06-6
Carbon tetrachloride	56-23-5
Chlorobenzene	108-90-7
Chloroethane	75-00-3
Chloroform	67-66-3
Chloromethane	74-87-3
2-Chlorotoluene	95-49-8
4-Chlorotoluene	106-43-4
Dibromochloromethane	124-48-1
1,2-Dibromo-3-chloropropane	96-12-8
1,2-Dibromoethane	106-93-4
Dibromomethane	74-95-3
1,2-Dichlorobenzene	95-50-1
1,3-Dichlorobenzene	541-73-1
1,4-Dichlorobenzene	106-46-7
Dichlorodifluoromethane	75-71-8

Table 4.--Target compounds in water analyzed for volatile organic compounds by the purge and trap method--Continued

Compound	Chemical Abstract Services Registry Number
1,1-Dichloroethane	75-34-3
1,2-Dichloroethane	107-06-2
1,1-Dichloroethene	75-35-4
cis-1,2-Dichloroethene	156-59-4
trans-1,2-Dichloroethene	156-60-5
1,2-Dichloropropane	78-87-5
1,3-Dichloropropane	142-28-9
2,2-Dichloropropane	590-20-7
1,1-Dichloropropene	563-58-6
Ethylbenzene	100-41-4
Hexachlorobutadiene	87-68-3
Isopropylbenzene	98-82-8
p-Isopropyltoluene	99-87-6
Methylene chloride	75-09-2
Naphthalene	91-20-3
n-Propylbenzene	105-65-1
Styrene	100-42-5
1,1,1,2-Tetrachloroethane	630-20-6
1,1,2,2-Tetrachloroethane	79-34-5
Tetrachloroethene	127-18-4
Toluene	108-88-3
1,2,3-Trichlorobenzene	87-61-6
1,2,4-Trichlorobenzene	120-82-1
1,1,1-Trichloroethane	71-55-6
1,1,2-trichloroethane	79-00-5
Trichloroethene	79-01-6
Trichlorofluoromethane	75-69-4
1,2,3-Trichloropropane	96-18-4
1,2,4-Trimethylbenzene	95-63-6
1,3,5-Trimethylbenzene	108-67-8
Vinyl chloride	75-01-4
o-Xylene	95-47-6
m-Xylene	108-38-3
p-Xylene	106-42-3
1,2,3,5-Tetramethylbenzene[1]	527-53-7
1,2,3,4-Tetramethylbenzene[1]	488-23-3
2-Ethyl-1-methylbenzene[1]	611-14-3
1,2,3-Trimethylbenzene[1]	526-73-8
1,4-Dimethyl-2-ethylbenzene[1,2]	175-88-89

[1] Standards for the quantification of this compound were added to the laboratory procedure of EPA Method 524.2

[2] This compound co-elutes with 1,3-Dimethyl-4-ethylbenzene

Table 5.--Concentrations of inorganic compounds in ground water, November 1986 and March 1989

[Concentrations are in mg/L, milligrams per liter or µg/L, micrograms per liter, unless otherwise noted: --, not analyzed].

Well identifier	Date	Time	Specific conductance (µs/cm)	pH (standard units)	Temperature (°C)	Turbidity (NTU)	Oxygen, dissolved (mg/L)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L as $CaCO_3$)
M1-82	11-18-86	1215	280	6.8	15.0	--	<0.5	120	0
M2-82	11-18-86	1430	320	6.7	14.0	--	<0.3	130	0
M1-85	11-19-86	1230	238	6.7	14.5	--	5.7	100	0
	03-13-89	1015	208	6.9	11.5	1.7	8.5	88	0
M5-85	03-13-89	1715	252	6.7	9.5	27	3.1	110	0
M9-85	11-19-86	1130	254	6.5	14.0	--	0.4	100	0
	03-15-89	1515	249	6.5	13.0	5.2	0.2	100	0
M10-85	11-19-86	1000	298	6.6	14.5	--	2.2	120	5
M11-85	11-17-86	1155	264	6.6	16.0	--	0.0	100	0
	03-18-89	1530	292	6.6	15.0	19	0.2	120	0
M4	11-18-86	1110	313	6.6	15.5	--	1.2	110	0
M7.2	11-17-86	0945	352	6.4	15.5	--	0.0	140	0
M8	11-17-86	1450	247	6.6	14.5	--	1.7	100	0
M9	11-17-86	1555	279	6.6	15.0	--	0.0	110	0
M11	11-18-86	1000	307	6.6	15.0	--	0.3	120	0
M12	11-18-86	1345	323	6.5	16.0	--	0.0	130	0
M16	11-17-86	1115	342	6.7	16.0	--	0.0	140	0
M18	11-18-86	0930	292	6.6	15.0	--	0.7	120	0
	03-17-89	1030	319	6.7	13.0	40	0.0	130	0
M19	11-18-86	0805	257	6.6	15.0	--	2.7	100	0
M23	11-18-86	1630	390	6.7	16.0	--	0.7	170	0
M24	11-18-86	1430	365	6.5	15.0	--	0.0	140	0
M29	11-19-86	0830	259	6.6	14.5	--	0.3	110	0
M30	03-14-89	1730	268	6.6	12.0	0.4	0.8	120	0
M31	11-19-86	0930	261	6.5	15.0	--	0.3	110	0

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Table 5.--Concentrations of inorganic compounds in ground water, November 1986 and March 1989--Cont.

Well identifier	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium dissolved (mg/L as Na)	Sodium percent	Sodium adsorption ratio	Potassium, dissolved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)
M1-82	31	10	13	19	0.5	3.3	131	8.5
M2-82	34	11	12	16	0.5	3.3	156	5.8
M1-85	26	8.5	11	19	0.5	2.3	103	12
	23	7.5	12	22	0.6	2.4	89	11
M5-85	29	9.5	13	20	0.6	2.2	113	12
M9-85	27	8.9	12	20	0.5	2.6	108	12
	27	8.9	12	20	0.5	2.5	112	12
M10-85	32	10	14	20	0.6	2.6	116	15
M11-85	27	8.9	11	18	0.5	2.7	125	19
	31	10	12	18	0.5	2.3	140	11
M4	30	9.6	17	24	0.7	3.7	151	16
M7.2	37	12	13	16	0.5	3.4	185	2.3
M8	27	8.9	12	19	0.5	3.3	105	13
M9	29	9.6	12	18	0.5	3.2	133	13
M11	33	10	14	19	0.6	3.5	148	8.3
M12	35	11	13	17	0.5	3.5	164	4.0
M16	38	12	14	17	0.5	3.8	172	7.6
M18	30	9.8	12	18	0.5	3.3	149	5.5
	32	11	12	17	0.5	2.6	132	34
M19	26	8.7	13	21	0.6	2.7	105	14
M23	45	14	15	16	0.5	3.9	193	8.4
M24	38	12	15	18	0.6	3.7	190	2.9
M29	28	8.8	13	20	0.6	3.5	120	14
M30	31	10	13	19	0.5	2.7	128	11
M31	28	9.1	12	19	0.5	2.6	113	12

Table 5.--Concentrations of inorganic compounds in ground water, November 1986 and March 1989--Cont.

Well identi-fier	Chlo-ride, dis-solved (mg/L as Cl)	Fluo-ride, dis-solved (mg/L as F)	Bromide, dis-solved (mg/L as Br)	Silica, dis-solved (mg/L as SiO_2)	Solids, residue at 180 °C, dis-solved (mg/L)	Solids, sum of consti-tuents, dis-solved (mg/L)	Nitro-gen, NO_2+NO_3 dis-solved (mg/L as N)	Nitro-gen, ammonia, dis-solved (mg/L as N)	Phos-phorus ortho, dis-solved (mg/L as P)
M1-82	6.2	0.2	0.026	37	--	190	<0.10	<0.01	0.03
M2-82	6.9	0.2	0.032	40	--	213	<0.10	0.09	<0.01
M1-85	5.4	0.2	0.034	26	--	157	0.68	<0.01	0.02
	6.2	0.2	--	25	136	145	0.91	<0.01	0.02
M5-85	6.5	0.2	--	33	166	176	0.64	<0.01	0.02
M9-85	5.8	0.2	0.033	33	--	169	0.49	<0.01	0.02
	6.7	0.2	--	32	168	171	0.50	<0.01	0.06
M10-85	8.6	0.2	0.039	30	--	190	1.8	<0.01	0.02
M11-85	6.1	0.2	0.039	40	--	196	<0.10	0.06	0.02
	7.1	0.2	--	36	186	200	0.10	0.08	0.06
M4	7.2	0.2	0.037	43	--	227	<0.10	0.15	<0.01
M7.2	7.1	0.2	0.019	44	--	242	<0.10	0.16	<0.01
M8	5.6	0.2	0.034	32	--	170	1.1	<0.01	0.02
M9	6.1	0.2	0.027	34	--	190	<0.10	0.03	<0.01
M11	6.7	0.2	0.031	39	--	210	<0.10	0.03	0.02
M12	6.4	0.2	0.020	43	--	224	<0.10	0.13	<0.01
M16	7.9	0.2	0.030	44	--	242	<0.10	0.12	<0.01
M18	6.0	0.2	0.026	41	--	208	<0.10	0.11	<0.01
	7.0	0.2	--	38	209	227	<0.10	0.10	0.05
M19	5.6	0.2	0.028	32	--	171	1.3	<0.01	0.04
M23	10	0.2	0.029	50	--	274	<0.10	0.07	<0.01
M24	7.7	0.2	0.019	48	--	255	<0.10	0.18	<0.01
M29	6.3	0.2	0.033	34	--	183	<0.10	0.01	0.02
M30	6.9	0.2	--	32	172	188	0.93	<0.01	0.05
M31	6.7	0.2	0.033	32	--	174	0.54	<0.01	<0.01

[illegible] SUBJECT TO REVISION

Table 5.--Concentrations of inorganic compounds in ground water, November 1986 and March 1989--Cont.

Well identifier	Barium, dissolved (μg/L as Ba)	Beryllium, dissolved (μg/L as Be)	Cadmium, dissolved (μg/L as Cd)	Chromium, dissolved (μg/L as Cr)	Cobalt, dissolved (μg/L as Co)	Copper, dissolved (μg/L as Cu)	Iron, dissolved (μg/L as Fe)	Lead, dissolved (μg/L as Pb)	Lithium, dissolved (μg/L as Li)
M1-82	11	<0.5	<1	--	<3	<10	65	<10	5
M2-82	16	<0.5	<1	--	<3	<10	4,000	<10	5
M1-85	7	<0.5	<1	--	<3	<10	3	<10	5
	8	<0.5	<1	<5	<3	<10	15	<10	<4
M5-85	9	<0.5	<1	<5	<3	<10	14	<10	<4
M9-85	8	<0.5	<1	--	<3	<10	<3	<10	5
	9	<0.5	<1	<5	<3	<10	11	<10	<4
M10-85	10	<0.5	<1	--	<3	<10	<3	<10	6
M11-85	13	<0.5	<1	--	<3	<10	3,400	<10	<4
	16	<0.5	<1	<5	<3	<10	3,700	10	<4
M4	16	<0.5	1	--	<3	<10	6,200	<10	4
M7.2	17	<0.5	1	--	<3	<10	9,100	<10	5
M8	8	<0.5	<1	--	<3	<10	12	<10	4
M9	12	<0.5	<1	--	<3	<10	1,500	<10	4
M11	21	<0.5	<1	--	<3	<10	1,700	<10	4
M12	14	<0.5	<1	--	<3	<10	6,400	10	5
M16	11	<0.5	1	--	<3	<10	7,400	<10	6
M18	12	<0.5	<1	--	<3	<10	8,100	<10	4
	18	<0.5	<1	<5	4	<10	7,300	<10	6
M19	10	<0.5	<1	--	<3	<10	7	<10	5
M23	22	<0.5	<1	--	<3	<10	5,800	<10	5
M24	20	<0.5	<1	--	<3	<10	9,700	<10	5
M29	15	<0.5	<1	--	<3	<10	1,300	<10	4
M30	10	<0.5	<1	<5	<3	<10	7	<10	<4
M31	11	<0.5	<1	--	<3	<10	10	<10	5

Table 5.--Concentrations of inorganic compounds in ground water, November 1986 and March 1989--Cont.

Well identifier	Manganese, dissolved (µg/L as Mn)	Molybdenum, dissolved (µg/L as Mo)	Nickel, dissolved (µg/L as Ni)	Silver, dissolved (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Vanadium, dissolved (µg/L as V)	Zinc, dissolved (µg/L as Zn)
M1-82	1,600	<10	--	--	120	<6	5
M2-82	1,900	<10	--	--	140	<6	8
M1-85	<1	<10	--	--	95	<6	8
	16	<10	<10	<1	87	<6	130
M5-85	2	<10	<10	<1	110	<6	52
M9-85	28	<10	--	--	100	<6	<3
	85	<10	<10	<1	100	<6	100
M10-85	<1	<10	--	--	120	<6	<3
M11-85	2,400	<10	--	--	110	<6	6
	1,900	<10	<10	<1	130	<6	5
M4	3,400	<10	--	--	140	<6	7
M7.2	2,300	<10	--	--	150	<6	10
M8	3	<10	--	--	100	<6	10
M9	1,300	<10	--	--	120	<6	10
M11	4,700	<10	--	--	140	<6	11
M12	2,500	<10	--	--	150	<6	9
M16	3,000	<10	--	--	170	<6	6
M18	2,300	<10	--	--	130	<6	5
	2,800	<10	<10	<1	150	<6	69
M19	26	<10	--	--	100	<6	<3
M23	5,600	<10	--	--	200	<6	7
M24	3,700	<10	--	--	170	<6	4
M29	1,900	<10	--	--	120	<6	7
M30	14	<10	<10	2	120	<6	5
M31	840	<10	--	--	110	<6	<3

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Table 6.--Concentrations o atile organic compounds in ground water, February 1985 through June 1986

[Concentrations are in micrograms per liter; ND, below the detection limit of 1 microgram per liter].

Well identifier	Date	Benzene	Toluene	Total xylenes	Total hydrocarbons (as gasoline)
M1-85	2-21-85	ND	ND	ND	ND
	5-10-85	ND	ND	ND	ND
M2-85	2-21-85	ND	ND	ND	ND
	5-10-85	ND	ND	ND	ND
M3-85	2-21-85	ND	ND	ND	ND
	5-11-85	ND	ND	ND	ND
M4-85	2-21-85	ND	ND	ND	ND
	5-11-85	ND	ND	ND	ND
M5-85	2-21-85	ND	ND	ND	ND
	5-10-85	ND	ND	ND	ND
M6-85	2-21-85	ND	ND	ND	ND
	5-10-85	ND	ND	ND	ND
M7-85	2-21-85	ND	ND	ND	ND
	5-11-85	ND	ND	ND	ND
	8-27-85	ND	ND	ND	ND
	12-16-85	ND	ND	ND	ND
	6-20-86	ND	ND	ND	ND
M8-85	2-21-85	ND	ND	ND	ND
	5-11-85	ND	ND	ND	ND
	8-27-85	96	1	9	230
	6-20-86	ND	ND	ND	ND
M9-85	2-21-85	ND	ND	ND	ND
	5-11-85	ND	ND	ND	ND
	12-16-85	ND	ND	ND	ND
	6-20-86	ND	ND	ND	ND
M10-85	2-21-85	ND	ND	ND	ND
	5-11-85	ND	2	5	17
	8-27-85	ND	ND	ND	ND
	12-16-85	ND	ND	ND	ND
	6-20-86	ND	ND	ND	ND
M11-85	2-21-85	1,460	5,300	6,260	23,400
	5-11-85	1,240[a]	5,850[a]	13,940[a]	33,000[a]
	8-27-85	920	1,100	6,300	12,000
	12-16-85	710	1,100	750	28,000
	6-20-86	680	7,000	18,000	45,000
M12-85	2-21-85	ND	ND	ND	ND
	5-10-85	ND	ND	ND	ND
D3	2-19-85	ND	ND	ND	ND
	3-25-85	ND	ND	ND	ND
	5-10-85	ND	ND	ND	ND
	6-25-85	ND	ND	ND	ND
	7-25-85	ND	ND	ND	ND
	12-16-85	ND	ND	ND	ND
	6-20-86	ND	ND	ND	ND
D5	2-19-85	ND	ND	ND	ND
D6	2-19-85	ND	ND	ND	ND
D10	2-19-85	ND	ND	5	14
	3-25-85	28	680	980	3,120
	5-10-85	ND	1	4	17
D12	2-19-85	ND	ND	ND	ND
D13	2-19-85	ND	ND	ND	ND
D14	2-19-85	ND	ND	ND	ND
D16	2-19-85	ND	ND	ND	ND
D17	2-19-85	ND	ND	ND	ND

[a] Average of two values

Table 7.--Concentrations of volatile organic compounds in ground water, August 1985 through November 1986

[Concentrations are blank-corrected and are in micrograms per liter; ND, concentration is below limit of detection, see text and table A3; 0 indicates compound detected, but not above blank levels; --, compound not specifically analyzed for; NQ, compound peak present at proper retention time, but only one or two characteristic ions were present; NAB, concentration not above background (compound's characteristic ions were identified, but quantitative level was not greater than the average of travel blanks plus three standard deviations of the travel blanks); T, concentration is more than twice blank level, but less than twice the blank level plus three blank level standard deviations] .

Well identifier	Date	Benzene	Toluene	Ethylbenzene	Total xylenes	Naphthalene	1,2,3-Trimethylbenzene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	1,2,3,4-Tetramethylbenzene	1,2,3,5-Tetramethylbenzene
M1-82	08-28-85	ND	ND	ND	ND	2.8	--	ND	25	5.6	8.6
	11-18-86	170	6.5	530	110	130	13	97	53	--	28
M2-82	08-27-85	3,300	11,000	910	10,500	400	--	1,500	620	55	130
	11-18-86	1100	3200	1700	4400	230	180	830	210	--	65
M3-82	08-28-85	800	2,600	150	8,200	740	--	2,400	930	180	380
	05-13-86	280	1,500	240	3,800	280	230	990	310	82	180
M1-85	08-26-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
	11-19-86	NAB	0.2	NQ	NQ	ND	ND	NQ	ND	--	ND
M2-85	08-26-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
M3-85	08-26-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
M4-85	08-26-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
M5-85	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
M6-85	08-26-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
M7-85	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
M8-85	08-27-85	ND	ND	ND	1.0	3.0	--	0.13	ND	0.2	0.66
	06-25-86	0	ND	0	0	ND	T	ND	ND	--	ND
	11-20-86	6.5	NAB	0.1	NQ	NQ	ND	ND	NQ	--	ND
M9-85	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
	11-19-86	NAB	NAB	ND	NQ	ND	ND	NQ	ND	--	ND
M10-85	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
	06-25-86	0.4	ND	0	0	ND	ND	ND	ND	--	ND
	11-19-86	NAB	NAB	ND	NAB	NAB	ND	ND	NAB	--	ND
M11-85	08-27-85	1,000	3,400	220	7,300	440	--	1,200	420	46	81
	05-13-86	240	5,500	1,600	11,900	950	780	2,500	780	94	190
	11-17-86	570	5000	2700	7900	530	320	1,400	330	--	88
M12-85	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
	11-20-86	NAB	NAB	NQ	NQ	NQ	ND	NQ	ND	--	ND
M2	11-20-86	0.7	NAB	NQ	NQ	NQ	NQ	0.1	0.01	--	NQ
M4	11-18-86	23	1.0	90	15	32	1.9	17	20	--	7.2
M6.1	11-20-86	NAB	NAB	NQ	NQ	0.8	NQ	0.02	NQ	--	NQ
M6.2	11-20-86	16	2.9	70	2.5	8.6	0.9	3.4	NQ	--	2.1
M7.1	11-20-86	NAB	0.32	NQ	3.2	NQ	0.52	0.1	0.32	--	NQ

PRELIMINARY SUBJECT TO REVISIONS

Table 7.--Concentrations of volatile organic compounds in ground water, August 1995 through November 1986--Continued

Well identi-fier	Date	Benzene	Toluene	Ethyl-benzene	Total xyl-lenes	Naph-thalene	1,2,3-Tri-methyl-benzene	1,2,4-Tri-methyl-benzene	1,3,5-Tri-methyl-benzene	1,2,3,4-Tetra-methyl-benzene	1,2,3,5-Tetra-methyl-benzene
M7.2	11-17-86	1700	7100	3000	8500	480	340	1,600	390	--	110
M8	11-17-86	1.3	NQ	0.1	0.05	0.4	NQ	0.1	NQ	--	0.02
M9	11-17-86	130	51	180	500	58	55	190	51	--	18
M11	11-18-86	100	2.2	190	53	110	4.4	45	20	--	14
M12	11-18-86	380	490	1,900	5,900	550	450	2,100	640	--	260
M13	11-20-86	34	0.5	47	7.3	7.9	4.1	5.9	0.5	--	1.5
M14	11-20-86	NAB	NAB	NQ	NQ	NQ	ND	ND	ND	--	ND
M16	11-17-86	1,500	980	1,400	4,000	180	100	460	100	--	24
M18	11-18-86	150	17	430	500	94	66	320	100	--	52
M19	11-18-86	0.4	0.02	0.05	0.01	NQ	ND	0.02	ND	--	ND
M22	11-20-86	NAB	NAB	NQ	NQ	NQ	ND	NQ	ND	--	ND
M23	11-18-86	250	17	490	200	160	30	180	33	--	44
M24	11-18-86	1,600	280	3,000	9,600	770	520	2,200	660	--	720
M18	11-18-86	150	17	430	500	94	66	320	100	--	52
M19	11-18-86	0.4	0.02	0.05	0.01	NQ	ND	0.02	ND	--	ND
M22	11-20-86	NAB	NAB	NQ	NQ	NQ	ND	NQ	ND	--	ND
M23	11-18-86	250	17	490	200	160	30	180	33	--	44
M24	11-18-86	1,600	280	3,000	9,600	770	520	2,200	660	--	220
M29	11-19-86	NAB	0.1	NQ	NQ	1.1	NQ	0.1	NQ	--	NQ
M30	11-20-86	1.5	NAB	NQ	NQ	NAB	ND	NQ	NQ	--	ND
M31	11-19-86	0.4	0.1	0.2	0.11	0.5	ND	NQ	ND	--	NQ
M34	11-20-86	NAB	NAB	NQ	NQ	ND	ND	NQ	ND	--	ND
M36	04-30-86	150	210	220	590	--	100	130	260	210	110
	06-25-86	370	320	ND	4,800	460	490	1,700	720	--	200
M37	04-30-86	T	6	7	46	--	3	14	5	T	T
T1	08-29-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T2	08-29-85	2.3	ND	ND	0.17	ND	--	ND	ND	ND	ND
T3	08-29-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T4	08-29-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T5	08-29-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T6	08-29-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T7	08-29-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T8	08-30-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T9	08-30-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T10	08-30-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T11	08-30-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T12	08-30-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T13	08-30-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
T14	05-13-86	T	0.2	ND	120	13	20	39	59	6.5	14
T15	05-13-86	100	24	78	630	150	67	310	200	27	62

Table 7.--Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued

Well identi-fier	Date	Benzene	Toluene	Ethyl-benzene	Total xyl-lenes	Naph-thalene	1,2,3-Tri-methyl-benzene	1,2,4-Tri-methyl-benzene	1,3,5-Tri-methyl-benzene	1,2,3,4-Tetra-methyl-benzene	1,2,3,5-Tetra-methyl-benzene
T16	06-25-86	1.2	0.06	0.1	T	1.6	T	T	0	--	0.4
T17	05-13-86	T	0	ND	0	ND	ND	0	ND	ND	ND
T18	05-13-86	T	0	T	0.04	0	ND	0	ND	ND	ND
T19	04-30-86	15	0.6	T	0.8	--	0	0	0	T	0
T20	05-13-86	T	T	0.03	0.12	0	ND	T	ND	ND	ND
T21	05-13-86	170	2.8	38	970	300	39	820	420	47	94
T22	04-27-86	670	1,600	260	4,900	--	370	1,600	720	410	330
T23	04-30-86	0	T	T	T	--	0	T	T	T	0
T24	04-30-86	0	0	0	T	--	T	T	T	T	T
T25	04-30-86	850	2,100	2,200	11,300	--	660	3,800	1400	760	410
T26	04-30-86	0	0	0	T	--	0	T	T	T	T
T27	04-30-86	75	4	2	7	--	0	0	8	7	14
T28	06-25-86	0.9	0.05	0.05	T	0.4	0	0	0	--	T
T29	06-25-86	1.0	0.1	T	0	0	0	0	0	--	0
T30	06-25-86	1.5	0.08	T	0	T	ND	0	ND	--	ND
T31	06-25-86	0	T	0	0	T	ND	ND	ND	--	ND
T32	06-25-86	3.1	0.2	0.3	0	2.1	0	0	0	--	0.2
T33	06-25-86	31	0.3	0.09	36.2	2	11	11	0.9	--	15
T34	06-25-86	240	92	280	4,200	970	820	3,400	1,100	--	930
T35	06-25-86	110	43	13	2,620	770	420	1,900	590	--	230
T36	06-25-86	31	1	8.7	8	63	7.3	49	ND	--	15
T37	06-25-86	0	0.05	0	0	0	ND	ND	ND	--	ND
T38	06-25-86	0.7	T	T	0	0	ND	0	ND	--	ND
T39	06-25-86	120	43	110	420	280	76	350	81	--	97
T40	06-25-86	T	0.2	T	T	0	0	0	0	--	ND
T41	06-25-86	30	0.4	0.1	22.2	74	2.4	T	36	--	10
T42	06-25-86	16	0.8	0.6	0.5	66	19	T	0.5	--	0.8
D1	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D2	08-27-85	10	ND	ND	1.2	1.0	--	1.4	ND	ND	0.26
D3	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D4	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D5	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D6	08-27-85	26	ND	4.7	3.53	12	--	ND	ND	0.4	1.5
D7	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D8	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D9	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D10	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D11	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D12	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D13	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND

PRELIMINARY SUBJECT TO REVISIONS

Table 7.--Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued

Well identi-fier	Date	Benzene	Toluene	Ethyl-benzene	Total xyl-lenes	Naph-thalene	1,2,3-Tri-methyl-benzene	1,2,4-Tri-methyl-benzene	1,3,5-Tri-methyl-benzene	1,2,3,4-Tetra-methyl-benzene	1,2,3,5-Tetra-methyl-benzene
D14	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D15	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D16	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D17	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D18	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D19	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D20	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D21	08-27-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D22	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D23	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D24	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D25	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D26	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D27	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D28	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D29	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D30	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND
D31	08-28-85	ND	ND	ND	ND	ND	--	ND	ND	ND	ND

Table 7.--Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued

Well identi-fier	n-Propyl-benzene	Iso-butyl-benzene	sec-Butyl-benzene	n-Butyl-benzene	Ethyl-ene-bromide	t-Butyl-benzene	1-Iso-propyl-4-methyl-benzene	2-Ethyl 1-methyl-benzene	1,4-Di-methyl-ethyl-benzene	1,4-Di-methyl-2-ethyl-benzene	1,3-Di-methyl,4-ethyl-benzene
M1-82	ND	ND	ND	1.2	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	110	45	--	--
M2-82	130	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	190	97	--	--
M3-82	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	250	--	76	--
M1-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	ND	ND	--	--
M2-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
M3-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
M4-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
M5-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
M6-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
M7-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
M8-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	0.8	--	ND	ND
	--	--	--	--	--	--	--	NQ	ND	--	--
M9-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	NQ	ND	--	--
M10-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	ND	--	ND	ND
	--	--	--	--	--	--	--	ND	ND	--	--
M11-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	680	--	120	--
	--	--	--	--	--	--	--	300	120	--	--
M12-85	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
	--	--	--	--	--	--	--	ND	ND	--	--
M2	--	--	--	--	--	--	--	0.2	NQ	--	--
M4	--	--	--	--	--	--	--	19	14	--	--
M6.1	--	--	--	--	--	--	--	NQ	NQ	--	--
M6.2	--	--	--	--	--	--	--	19	4.4	--	--
M7.1	--	--	--	--	--	--	--	0.44	ND	--	--
M7.2	--	--	--	--	--	--	--	340	160	--	--
M8	--	--	--	--	--	--	--	0.05	0.05	--	--
M9	--	--	--	--	--	--	--	66	31	--	--
M11	--	--	--	--	--	--	--	56	23	--	--
M12	--	--	--	--	--	--	--	500	380	--	--
M13	--	--	--	--	--	--	--	8.7	2.3	--	--
M14	--	--	--	--	--	--	--	NQ	ND	--	--

Table 7.--Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued

Well identi-fier	n-Propyl-benzene	Iso-butyl-benzene	sec-Butyl-benzene	n-Butyl-benzene	Ethyl-ene-bromide	t-Butyl-benzene	1-Iso-propyl-4-methyl-benzene	2-Ethyl 1-methyl-benzene	1,4-Di-methyl-ethyl-benzene	1,4-Di-methyl-2-ethyl-benzene	1,3-Di-methyl,4-ethyl-benzene
M16	--	--	--	--	--	--	--	110	37	--	--
M18	--	--	--	--	--	--	--	110	76	--	--
M19	--	--	--	--	--	--	--	NQ	ND	--	--
M22	--	--	--	--	--	--	--	ND	ND	--	--
M23	--	--	--	--	--	--	--	140	59	--	--
M24	--	--	--	--	--	--	--	550	280	--	--
M29	--	--	--	--	--	--	--	NQ	NQ	--	--
M30	--	--	--	--	--	--	--	ND	ND	--	--
M31	--	--	--	--	--	--	--	0.2	ND	--	--
M34	--	--	--	--	--	--	--	ND	ND	--	--
M36	--	--	--	--	--	--	--	140	--	60	--
M36	--	--	--	--	--	--	--	560	--	130	110
M37	--	--	--	--	--	--	--	3	--	T	--
T1	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T2	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T3	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T4	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T5	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T6	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T7	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T8	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T9	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T10	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T11	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T12	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T13	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
T14	--	--	--	--	--	--	--	50	--	7.8	--
T15	--	--	--	--	--	--	--	170	--	49	--
T16	--	--	--	--	--	--	--	0.4	--	0.2	0.1
T17	--	--	--	--	--	--	--	ND	--	ND	--
T18	--	--	--	--	--	--	--	0.03	--	ND	--
T19	--	--	--	--	--	--	--	18	--	0	--
T20	--	--	--	--	--	--	--	0.03	--	ND	--
T21	--	--	--	--	--	--	--	320	--	77	--
T22	--	--	--	--	--	--	--	830	--	120	--
T23	--	--	--	--	--	--	--	T	--	0	--
T24	--	--	--	--	--	--	--	0	--	T	--
T25	--	--	--	--	--	--	--	1,400	--	280	--
T26	--	--	--	--	--	--	--	0	--	0	--

PRELIMINARY SUBJECT TO REVISIONS

Table 7.--Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued

Well identi-fier	n-Propyl-benzene	Iso-butyl-benzene	sec-Butyl-benzene	n-Butyl-benzene	Ethyl-ene-bromide	t-Butyl-benzene	1-Iso-propyl-4-methyl-benzene	2-Ethyl 1-methyl-benzene	1,4-Di-methyl-ethyl-benzene	1,4-Di-methyl-2-ethyl-benzene	1,3-Di-methyl,4-ethyl-benzene
T27	--	--	--	--	--	--	--	170	--	0	--
T28	--	--	--	--	--	--	--	T	--	0.02	T
T29	--	--	--	--	--	--	--	0	--	0	ND
T30	--	--	--	--	--	--	--	0	--	ND	ND
T31	--	--	--	--	--	--	--	ND	--	ND	ND
T32	--	--	--	--	--	--	--	2	--	ND	0.06
T33	--	--	--	--	--	--	--	110	--	--	36
T34	--	--	--	--	--	--	--	740	--	510	530
T35	--	--	--	--	--	--	--	470	--	140	130
T36	--	--	--	--	--	--	--	77	--	12	4.6
T37	--	--	--	--	--	--	--	0	--	ND	ND
T38	--	--	--	--	--	--	--	ND	--	ND	ND
T39	--	--	--	--	--	--	--	170	--	55	39
T40	--	--	--	--	--	--	--	0	--	ND	0
T41	--	--	--	--	--	--	--	56	--	1.8	8.0
T42	--	--	--	--	--	--	--	110	--	0	5.5
D1	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D2	0.11	0.38	0.93	0.29	ND	ND	ND	--	--	--	--
D3	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D4	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D5	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D6	1.7	0.32	0.70	0.45	ND	ND	ND	--	--	--	--
D7	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D8	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D9	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D10	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D11	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D12	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D13	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D14	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D15	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D16	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D17	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D18	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D19	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D20	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D21	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D22	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D23	ND	ND	ND	ND	ND	ND	ND	--	--	--	--

PRELIMINARY SUBJECT TO REVISIONS

Table 7.--Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued

Well identi-fier	n-Propyl-benzene	Iso-butyl-benzene	sec-Butyl-benzene	n-Butyl-benzene	Ethyl-ene-bromide	t-Butyl-benzene	1-Iso-propyl-4-methyl-benzene	2-Ethyl 1-methyl-benzene	1,4-Di-methyl-ethyl-benzene	1,4-Di-methyl-2-ethyl-benzene	1,3-Di-methyl,4-ethyl-benzene
D24	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D25	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D26	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D27	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D28	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D29	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D30	ND	ND	ND	ND	ND	ND	ND	--	--	--	--
D31	ND	ND	ND	ND	ND	ND	ND	--	--	--	--

Table 8.--Concentrations of volatile organic compounds in ground water, March, 1989

[All concentrations are in microgram per liter; ND, below the detection limit
0.2 micrograms of 0.2 micrograms per liter, unless otherwise noted]

Well identifier	Benzene	Toluene	Ethylbenzene	Total xylenes	Naphthalene	1,3,5-Trimethylbenzene	2-Ethyl-1-methylbenzene	1,2,4-Trimethylbenzene	1,2,3-Trimethylbenzene
M2-82	ND	ND	ND	ND	ND	ND	5.7	ND	1.7
M3-82	17	1.6	ND	1500	19	280	240	300	200
M1-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M5-85	ND	ND	ND	ND	0.2	ND	ND	ND	0.2
M6-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M7-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M8-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M9-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M11-85	23	ND	3.6	320	62	160	130	150	95
M4	ND	ND	ND	ND	ND	ND	ND	ND	ND
M6.2	ND	ND	ND	ND	ND	ND	ND	ND	ND
M11	ND	ND	ND	ND	ND	ND	ND	ND	ND
M12	ND	ND	ND	ND	ND	ND	ND	ND	ND
M13	ND	ND	ND	ND	ND	ND	ND	ND	ND
M14	ND	ND	ND	ND	0.2	ND	ND	ND	ND
M16	68	15	ND	820	130	60	79	49	86
M17	75	0.3	ND	0.5	44	ND	49	0.5	0.3
M18	ND	ND	0.2	0.2	ND	ND	3.2	ND	0.3
M19	ND	ND	ND	ND	ND	ND	ND	ND	ND
M20	ND	ND	ND	ND	0.3	ND	ND	ND	ND
M23	0.3	ND	ND	ND	ND	ND	0.4	ND	ND
M26	ND	ND	ND	ND	0.2	ND	ND	ND	ND
M27	0.3	ND	ND	ND	ND	ND	0.4	ND	ND
M29	1.0	ND	ND	ND	ND	ND	ND	ND	ND
M30	ND	ND	ND	ND	ND	ND	ND	ND	ND
M31	ND	ND	ND	ND	ND	ND	ND	ND	ND
M34	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 8.--Concentrations of volatile organic compounds in ground water, March, 1989--Cont.

Well identifier	1,2,3,5-Tetramethylbenzene	1,4-Dimethyl-2-ethylbenzene	1,2,3,4 Tetramethylbenzene	p-Isopropyltoluene	Isopropylbenzene	Dibromomethane	Dichlorobromomethane	Carbontetrachloride	Sec-Butylbenzene	1,3-Dimethyl-2-ethylbenzene
M2-82	ND	ND	0.9	ND	ND	ND	ND	ND	ND	0.8
M3-82	150	100	58	2.1	ND	ND	ND	ND	ND	4.7
M1-85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M5-85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M6-85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M7-85	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND
M8-85	ND	ND	ND	ND	ND	ND	ND	0.3	ND	ND
M9-85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M11-85	140	13	50	11	2.3	ND	ND	ND	0.8	2.0
M4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M6.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M16	36	20	14	3.5	ND	ND	ND	ND	ND	1.1
M17	ND	3.1	4.0	0.2	7.5	ND	ND	ND	1.4	2.0
M18	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.8
M19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M23	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.4
M26	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M27	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.3
M29	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M31	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M34	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 8.--Concentrations of volatile organic compounds in ground water, March, 1989--Cont.

Well identifier	1,2-Dichloroethane	Bromoform	Chlorodibromomethane	Chloroform	Chlorobenzene	Chloroethane	Methylbromide	Methylchloride	Methylene chloride	n-Propylbenzene	n-Butylbenzene
M2-82	0.7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M3-82	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M1-85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M5-85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M6-85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M7-85	ND	ND	ND	2.5	ND	ND	ND	ND	ND	ND	ND
M8-85	ND	ND	ND	5.3	ND	ND	ND	ND	ND	ND	ND
M9-85	ND	ND	ND	0.8	ND	ND	ND	ND	ND	ND	ND
M11-85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M4	ND	ND	ND	82	ND	ND	ND	ND	6.3	ND	ND
M6.2	ND	ND	ND	27	ND	ND	ND	ND	0.8	ND	ND
M11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M13	ND	ND	ND	0.2	ND	ND	ND	ND	ND	ND	ND
M14	ND	ND	ND	0.4	ND	ND	ND	ND	ND	ND	ND
M16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M17	0.3	ND	ND	4.5	ND	ND	ND	ND	ND	0.2	0.5
M18	ND	ND	ND	0.5	ND	ND	ND	ND	ND	ND	ND
M19	ND	ND	ND	0.8	ND	ND	ND	ND	ND	ND	ND
M20	ND	ND	ND	1.4	ND	ND	ND	ND	ND	ND	ND
M23	ND	ND	ND	1.8	ND	ND	ND	ND	ND	ND	ND
M26	ND	ND	ND	0.7	ND	ND	ND	ND	ND	ND	ND
M27	ND	ND	ND	0.4	ND	ND	ND	ND	ND	ND	ND
M29	ND	ND	ND	1.4	ND	ND	ND	ND	ND	ND	ND
M30	ND	ND	ND	0.9	ND	ND	ND	ND	ND	ND	ND
M31	ND	ND	ND	2.4	ND	ND	ND	0.6	ND	ND	ND
M34	ND	ND	ND	2.2	ND	ND	ND	ND	ND	ND	ND

Table 8.--Concentrations of volatile organic compounds in ground water, March, 1989--Cont.

Well identifier	Tetrachloroethylene	Trichlorofluoromethane	1,1-Dichloroethane	1,1-Dichloroethylene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1,2,2 Tetrachloroethane	1,2-Dichlorobenzene	1,2-Dichloropropane
M2-82	ND	ND	ND	ND	ND	ND	ND	ND	ND
M3-82	ND	ND	ND	ND	ND	ND	ND	ND	ND
M1-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M5-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M6-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M7-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M8-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M9-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M11-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M4	ND	ND	ND	ND	ND	ND	ND	ND	ND
M6.2	ND	ND	ND	ND	ND	ND	ND	ND	ND
M11	ND	ND	ND	ND	ND	ND	ND	ND	ND
M12	ND	ND	ND	ND	ND	ND	ND	ND	ND
M13	ND	ND	ND	ND	ND	ND	ND	ND	ND
M14	ND	ND	ND	ND	ND	ND	ND	ND	ND
M16	ND	ND	ND	ND	ND	ND	ND	ND	ND
M17	ND	ND	ND	ND	ND	ND	ND	ND	ND
M18	ND	ND	ND	ND	ND	ND	ND	ND	ND
M19	ND	ND	ND	ND	ND	ND	ND	ND	ND
M20	ND	ND	ND	ND	ND	ND	ND	ND	ND
M23	ND	ND	ND	ND	ND	ND	ND	ND	ND
M26	ND	ND	ND	ND	ND	ND	ND	ND	ND
M27	ND	ND	ND	ND	ND	ND	ND	ND	ND
M29	ND	ND	ND	ND	ND	ND	ND	ND	ND
M30	ND	ND	ND	ND	ND	ND	ND	ND	ND
M31	ND	ND	ND	ND	ND	ND	ND	ND	ND
M34	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 8.--Concentrations of volatile organic compounds in ground water, March, 1989--Continued

Well identifier	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Dichlorodifluoromethane	trans-1,3-Dichloropropene	cis-1,3-Dichloropropene	Vinyl chloride	Trichloroethylene	1,2-Dichloroethene	Styrene
M2-82	ND	ND	ND	ND	ND	ND	ND	ND	ND
M3-82	ND	ND	ND	ND	ND	ND	ND	ND	ND
M1-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M5-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M6-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M7-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M8-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M9-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M11-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M4	ND	ND	ND	ND	ND	ND	ND	ND	ND
M6.2	ND	ND	ND	ND	ND	ND	ND	ND	ND
M11	ND	ND	ND	ND	ND	ND	ND	ND	ND
M12	ND	ND	ND	ND	ND	ND	ND	ND	ND
M13	ND	ND	ND	ND	ND	ND	ND	ND	ND
M14	ND	ND	ND	ND	ND	ND	ND	ND	ND
M16	ND	ND	ND	ND	ND	ND	<0.3	ND	ND
M17	ND	ND	ND	ND	ND	ND	ND	ND	ND
M18	ND	ND	ND	ND	ND	ND	ND	ND	ND
M19	ND	ND	ND	ND	ND	ND	ND	ND	ND
M20	ND	ND	ND	ND	ND	ND	ND	ND	ND
M23	ND	ND	ND	ND	ND	ND	ND	ND	ND
M26	ND	ND	ND	ND	ND	ND	ND	ND	ND
M27	ND	ND	ND	ND	ND	ND	ND	ND	ND
M29	ND	ND	ND	ND	ND	ND	0.3	ND	ND
M30	ND	ND	ND	ND	ND	ND	ND	ND	ND
M31	ND	ND	ND	ND	ND	ND	ND	ND	ND
M34	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 8.--Concentrations of volatile organic compounds in ground water, March, 1989--Continued

Well identifier	1,1-Dichloropropene	2,2-Dichloropropane	1,3-Dichloropropane	ortho-Chlorotoluene	para-Chlorotoluene	1,2,3-Trichloropropane	1,1,1,2-Tetrachloroethane	1,2-Dibromoethane	Bromobenzene
M2-82	ND	ND	ND	ND	ND	ND	ND	ND	ND
M3-82	ND	ND	ND	ND	ND	ND	ND	ND	ND
M1-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M5-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M6-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M7-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M8-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M9-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M11-85	ND	ND	ND	ND	ND	ND	ND	ND	ND
M4	ND	ND	ND	ND	ND	ND	ND	ND	ND
M6.2	ND	ND	ND	ND	ND	ND	ND	ND	ND
M11	ND	ND	ND	ND	ND	ND	ND	ND	ND
M12	ND	ND	ND	ND	ND	ND	ND	ND	ND
M13	ND	ND	ND	ND	ND	ND	ND	ND	ND
M14	ND	ND	ND	ND	ND	ND	ND	ND	ND
M16	ND	ND	ND	ND	ND	ND	ND	ND	ND
M17	ND	ND	ND	ND	ND	ND	ND	ND	ND
M18	ND	ND	ND	ND	ND	ND	ND	ND	ND
M19	ND	ND	ND	ND	ND	ND	ND	ND	ND
M20	ND	ND	ND	ND	ND	ND	ND	ND	ND
M23	ND	ND	ND	ND	ND	ND	ND	ND	ND
M26	ND	ND	ND	ND	ND	ND	ND	ND	ND
M27	ND	ND	ND	ND	ND	ND	ND	ND	ND
M29	ND	ND	ND	ND	ND	ND	ND	ND	ND
M30	ND	ND	ND	ND	ND	ND	ND	ND	ND
M31	ND	ND	ND	ND	ND	ND	ND	ND	ND
M34	ND	ND	ND	ND	ND	ND	ND	ND	ND

Table 9.--Concentrations of extractable lead in aquifer materials and dissolved lead in ground water, November 1986

[µg/kg, micrograms per kilogram; µg/L, micrograms per liter; soil extracts are for the size fraction less than 63 micrometers; NS, not sampled].

Well identi-fier	Dissolved lead in ground water (µg/L)	Extractable lead in aquifer materials (µg/kg)
M1-82	1.8	310
M2-82	2.8	7,610
M1-85	1.4	270
M9-85	1.8	310
M10-85	1.5	40
M11-85	5.3	590
M4	6.0	410
M7	7.2	6,100
M8	9.3	540
M9	5.3	4,870
M11	1.8	200
M12	3.9	890
M16	3.4	20,270
M18	2.4	6,890
M19	1.4	19,150
M23	9.2	4,360
M24	10.1	340
M29	7.4	520
M31	2.4	330
M37	NS	890

Table 10.--Target compounds for the analysis of volatile organic compounds in soil gas, November 1986

Compound	Chemical Abstract Service registry number
Benzene	71-43-2
Toluene	108-88-3
n-Octane	111-65-9
Ethylbenzene	100-41-4
m-Xylene	108-38-3
o-Xylene	95-47-6
1,3,5-Trimethylbenzene	108-67-8
n-Decane	124-18-5
1,2,4-Trimethylbenzene	95-63-6
1,2,3,5-Tetramethylbenzene	527-53-7
1,2,3,4-Tetramethylbenzene	488-23-3
n-Dodecane	112-40-3
Naphthalene	91-20-3

Table 11.--Concentrations of volatile organic compounds in soil gas, November 1986

[All concentrations are in parts per billion, by volume; ND, below limit of detection; NQ, not quantified due to high background noise; L, low concentrations of alkanes, not quantified; H, high concentrations of alkanes, not quantified (if quantified, applies to target compound n-Octane); depth in feet below land surface of soil-gas sample tubes; water levels are in feet below land surface, water level from H16 is used for SG5; land-surface available from table 2].

Well identi-fier	Depth	Benzene	Toluene	Ethyl-benzene	Total xylenes	Naph-thalene	1,3,5-Tri-methyl-benzene	Water-level
SG3	7	ND	ND	ND	ND	6,500	ND	10.94
	8	5,340	4,470	610	9,960	14,600	2,970	
SG4	2	ND	ND	ND	ND	ND	ND	11.15
	4	ND	ND	ND	ND	360	ND	
	6	ND	ND	ND	ND	ND	ND	
	8	410	ND	ND	450	750	460	
SG5	1	ND	ND	ND	ND	ND	ND	10.99
	2	ND	ND	ND	ND	ND	ND	
	3	ND	ND	ND	ND	ND	ND	
	4	ND	ND	ND	ND	ND	ND	
	5	ND	ND	ND	ND	ND	ND	
	6	ND	ND	ND	ND	ND	ND	
	7	ND	ND	ND	210	ND	430	
	9	230,000	300,000	83,000	460,000	ND	26,000	
SG6	5	ND	ND	ND	ND	ND	ND	9.35
SG7	6	ND	ND	ND	ND	ND	ND	13.69
	7	ND	ND	ND	ND	ND	ND	
SG8	1	ND	ND	ND	ND	ND	ND	
	2	ND	ND	ND	ND	ND	ND	
	3	ND	230	ND	ND	ND	ND	
	4	540	ND	ND	ND	ND	ND	
	5	ND	ND	ND	ND	ND	ND	
	6	ND	570	ND	ND	ND	ND	
	7	ND	ND	ND	ND	ND	ND	
	8	ND	ND	ND	ND	ND	ND	
	9	***(Sample tube clogged/in water)***						

Table 11.--Concentrations of volatile organic compounds in soil gas, November 1986--Cont.

Well identifier	Depth	2-Ethyl-1-methyl-benzene	1,2,4-Tri-methyl-benzene	1,2,3-Tri-methyl-benzene	1,2,3,5-Tetra-methyl-benzene	1,4-Di-methyl-2-ethyl-benzene	1,3-Di-methyl,4-ethyl-benzene	Mixed alkanes (or n-Octane)
SG3	7	ND	ND	ND	580	790	ND	ND
	8	1,720	7,030	2,470	5,920	8,620	ND	940
SG4	2	ND	ND	ND	ND	ND	ND	ND
	4	ND	30	130	750	1,260	ND	ND
	6	ND	ND	ND	ND	ND	ND	ND
	8	ND	ND	ND	ND	ND	ND	ND
SG5	1	D	ND	ND	ND	ND	ND	ND
	2	ND	ND	ND	ND	ND	ND	ND
	3	ND	ND	ND	ND	ND	ND	ND
	4	ND	ND	ND	ND	ND	ND	ND
	5	ND	ND	ND	ND	ND	ND	ND
	6	ND	ND	ND	ND	ND	ND	ND
	7	ND	ND	ND	ND	ND	ND	ND
	9	5,820	56,500	25,200	3,950	9,180	ND	NQ
SG6	5	ND	ND	ND	ND	ND	ND	L
SG7	6	ND	ND	ND	ND	ND	ND	ND
	7	ND	ND	ND	ND	ND	ND	ND
SG8	1	ND	ND	ND	ND	ND	ND	ND
	2	ND	ND	ND	ND	ND	ND	ND
	3	ND	ND	ND	390	320	ND	L
	4	ND	ND	ND	120	ND	ND	H
	5	ND	ND	ND	160	ND	ND	H
	6	ND	ND	ND	150	ND	ND	L
	7	ND	ND	ND	ND	ND	ND	L
	8	ND	ND	ND	ND	ND	ND	L
	9	*** (Sample tube clogged/in water)***						

Table 12.--Observed water levels in observation and domestic wells

[Water levels are in feet below land surface (table 2)]

Well iden-tifier	Date	Water level	Well iden-tifier	Date	Water level	Well iden-tifer	Date	Water level
M1-82	Feb 21, 1985	11.37	M2-82	Feb 21, 1985	11.48	M3-82	Feb 21, 1985	10.05
	May 11	10.57		May 11	10.55		May 11	9.23
	Aug 29	8.84		Aug 29	9.47		Aug 29	8.05
	Apr 23, 1986	10.00		Apr 23, 1986	9.88		Apr 23, 1986	8.61
	May 14	9.36		May 14	9.12		May 14	7.96
	Jun 23	9.00		Jun 23	8.54		Jun 23	7.51
	Jul 28	8.91		Jul 28	8.40		Jul 28	7.45
	Sep 22	8.69		Sep 22	8.25		Sep 22	7.23
	Nov 19	11.12		Nov 19	11.01		Nov 19	9.76
	Dec 17	11.46		Dec 17	11.40		Dec 17	10.03
	Jan 20, 1987	11.67		Jan 20, 1987	11.60		Jan 22, 1987	10.23
	Feb 17	11.58		Feb 17	11.46		Feb 17	10.15
	Mar 16	11.39		Mar 16	11.32		Mar 16	9.96
	Apr 22	11.05		Apr 22	10.86		Apr 22	9.67
				Mar 18, 1989	11.65		Mar 18, 1989	10.16
M1-85	Feb 21, 1985	12.9	M2-85	Feb 20, 1985	6.22	M3-85	Feb 20, 1985	7.98
	May 10	11.58		21	6.27		21	8.07
	Jun 09	9.37		May 10	6.11		May 11	7.60
	Aug 02	9.84		Jun 09	5.37		Jun 09	6.64
	29	9.95		Aug 02	5.66		Aug 02	7.14
	30	9.69		29	5.72		29	7.28
	Sep 21	9.68		30	5.58		30	7.04
	Oct 16	10.91		Sep 21	5.57		Sep 21	6.98
	Nov 15	11.86		Oct 16	5.44		Oct 16	6.51
	Dec 13	12.69		Nov 15	6.29		Nov 15	7.20
	Jan 24, 1986	12.24		Jan 24, 1986	6.06		Dec 13	8.00
	Feb 21	11.99		Feb 21	5.87		Jan 24, 1986	8.10
	Mar 20	11.59		Mar 20	5.67		Feb 21	7.88
	Apr 23	10.58		Apr 23	5.67		Mar 20	7.76
	May 14	9.72		May 14, 1986	5.67		Apr 23	7.40
	Jun 23	9.11		Jun 23	6.34		May 14	6.86
	Jul 28	9.00		Jul 28	6.60		Jun 23	7.13
	Sep 22	8.96		Sep 22	5.51		Jul 28	7.17
	Nov 20	12.48		Nov 20	6.62		Sep 22	6.44
	Dec 17	12.85		Dec 18	7.04		Nov 20	8.96
	Jan 21, 1987	13.17		Jan 22, 1987	7.18		Dec 17	8.68
	Feb 18	13.05		Feb 17	6.64		Jan 22, 1987	8.66
	Mar 16	12.75		Mar 16	6.24		Feb 18	8.59
	Apr 23	12.25		Apr 23	6.66		Mar 16	8.40
	Mar 13, 1989	13.33		Mar 14, 1989	9.14		Apr 23	8.38

Table 12.--Observed water levels in observation and domestic wells

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifer	Date	Water level
M4-85	Feb 20, 1985	8.95	M5-85	Feb 20, 1985	5.39	M6-85	Feb 20, 1985	7.55
	21	8.95		21	5.38		21	7.55
	May 11	7.91		May 10	5.17		May 10	7.25
	Jun 09	5.83		Jun 09	4.69		Jun 09	6.61
	Aug 02	6.12		Aug 02	5.04		Aug 02	7.14
	29	6.31		29	5.13		29	7.48
	30	6.07		30	4.91		30	6.89
	Sep 21	6.04		Sep 21	4.89		Sep 21	6.88
	Oct 16	7.10		Oct 16	4.67		Oct 16	6.66
	Nov 15	8.09		Nov 15	5.23		Nov 15	7.88
	Dec 13	8.90		Dec 13	5.39		Dec 13	8.01
	Jan 24, 1986	8.69		Jan 21, 1986	5.05		Jan 24, 1986	7.64
	Feb 21	8.58		Feb 21	4.90		Feb 21	7.36
	Mar 20	8.15		Mar 20, 1986	4.85		Mar 20	7.25
	Apr 23	6.96		Apr 23	5.02		Apr 23	7.14
	May 14	6.07		May 14	4.79		May 14	6.70
	Jun 23	5.40		Jun 23	5.02		Jun 23	7.16
	Jul 28	5.07		Jul 28	5.10		Jul 28	7.34
	Sep 22	4.94		Sep 22	4.56		Sep 22	6.37
	Nov 20	8.55		Nov 20	5.30		Nov 20	7.72
	Dec 17	8.98		Dec 18	5.49		Dec 17	8.11
	Jan 21, 1987	9.26		Jan 22, 1987	5.56		Jan 22, 1987	8.31
	Feb 17	9.04		Feb 18	5.48		Feb 18	8.03
	Mar 16	8.92		Mar 16	5.32		Mar 16	7.87
	Apr 23	8.27		Apr 23	5.46		Apr 23	7.93
				Mar 13, 1989	5.64		Mar 13, 1989	8.52
M7-85	Feb 20, 1985	7.40	M8-85	Feb 20, 1985	9.47	M9-85	Feb 20, 1985	9.81
	21	7.43		21	9.49		21	9.81
	May 11	7.13		May 11	8.92		May 11	9.07
	Jun 09	6.09		Jun 09	7.92		Jun 09	7.88
	Aug 02	6.72		Aug 02	8.43		Aug 02	8.22
	29	6.79		29	8.50		29	8.32
	30	5.63		30	7.33		30	8.11
	Sep 21	6.09		Sep 21	7.93		Sep 21	8.02
	Oct 16	6.40		Oct 16	8.38		Oct 16	8.43
	Nov 15	7.42		Nov 15	8.99		Nov 15	9.19
	Dec 13	7.66		Dec 13	9.29		Dec 13	9.50
	Jan 24, 1986	7.14		Jan 24, 1986	9.17		Jan 24, 1986	9.65
	Feb 21	7.07		Feb 21	9.07		Feb 21	9.52
	Mar 20	6.89		Mar 20, 1986	8.73		Mar 20	9.18
	Apr 23	6.83		Apr 23	8.56		Apr 23	8.63
	May 14	6.13		May 14	8.08		May 14	7.96
	Jun 23	6.40		Jun 23	8.04		Jun 23	7.75
	Jul 28	6.63		Jul 28	8.04		Jul 28	7.65
	Sep 22	5.84		Sep 22	7.45		Sep 22	7.20
	Nov 20	7.40		Nov 20	9.07		Nov 20	9.53
	Dec 17	7.78		Dec 17	9.31		Dec 17	9.92
	Jan 22, 1987	7.93		Jan 22, 1987	9.48		Jan 20, 1987	10.12
	Feb 18	7.75		Feb 18	9.42		Feb 17	9.98
	Mar 16	7.62		Mar 16	9.22		Mar 16	9.86
	Apr 23	7.65		Apr 23	9.18		Apr 22	9.58
	Mar 14, 1989	8.05		Mar 14, 1989	9.59		Mar 15, 1989	10.37

Table 12.--Observed water levels in observation and domestic wells

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifer	Date	Water level
M10-85	Feb 20, 1985	9.72	M11-85	Feb 20, 1985	10.94	M12-85	Feb 20, 1985	11.52
	21	9.72		21	10.94		21	11.52
	May 11	9.09		May 11	9.96		May 10	10.68
	Jun 09	8.06		Jun 09	11.81		Jun 09	9.24
	Aug 02	8.34		Aug 02	7.83		Aug 02	9.82
	29	7.93		29	7.56		29	9.73
	30	7.24		30	6.72		30	9.61
	Sep 21	7.08		Sep 21	6.76		Sep 21	9.50
	Oct 16	7.72		Oct 16	9.47		Oct 16	10.12
	Nov 15	8.20		Nov 15	10.27		Nov 15	10.86
	Dec 13	8.55		Dec 13	10.92		Dec 13	11.52
	Jan 24, 1986	9.23		Jan 24, 1986	10.65		Jan 24, 1986	11.15
	Feb 21	9.17		Feb 21	10.44		Feb 21	10.98
	Mar 20	8.83		Mar 20, 1986	9.98		Mar 20	10.53
	Apr 23	8.68		Apr 23	9.34		Apr 23	10.13
	May 14	8.22		May 14	8.64		May 14	9.53
	Jun 23	8.05		Jun 23	8.11		Jun 23	9.13
	Jul 28	8.05		Jul 28	8.01		Jul 28	9.08
	Sep 22	7.67		Sep 22	7.79		Sep 22	8.83
	Nov 20	9.34		Nov 19	10.58		Nov 20	11.06
	Dec 17	9.52		Dec 17	10.92		Dec 17	11.30
	Jan 22, 1987	9.68		Jan 20, 1987	10.83		Jan 20, 1987	11.38
	Feb 18	9.70		Feb 17	11.01		Feb 18	11.50
	Mar 16	9.52		Mar 16	10.81		Mar 16	11.26
	Apr 22	9.37		Apr 22	10.38		Apr 23	11.01
				Mar 18, 1989	11.10			
M1	Nov 19, 1986	12.01	M2	Nov 20, 1986	10.55	M3	Nov 20, 1986	10.73
	Dec 17	12.69		Dec 17	10.84		Dec 17	11.02
	Jan 20, 1987	12.72		Jan 20, 1987	11.01		Jan 20, 1987	11.22
	Feb 17	12.55		Feb 17	10.94		Feb 17	11.16
	Mar 16	12.39		Mar 16	10.76		Mar 16	10.96
	Apr 22	12.08		Apr 22	10.48		Apr 22	10.67
M4	Nov 20, 1986	10.91	M5	Nov 19, 1986	10.94	M6.1	Nov 20, 1986	10.51
	Dec 17	11.07		Dec 17	11.27		Dec 17	10.89
	Jan 20, 1987	11.28		Jan 20, 1987	11.50		Jan 20, 1987	11.04
	Feb 17	11.19		Feb 17	11.40		Feb 17	10.95
	Mar 16	11.01		Mar 16	11.20		Mar 16	10.76
	Apr 22	10.68		Apr 22	10.72		Apr 22	10.48
	Mar 17, 1989	11.2						

Table 12.--Observed water levels in observation and domestic wells

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifer	Date	Water level
M6.2	Nov 20, 1986	10.53	M7.1	Nov 19, 1986	11.16	M7.2	Mar 16, 1987	11.33
	Dec 17	10.79		Dec 17	11.42		Apr 22	10.82
	Jan 20, 1987	10.98		Jan 20, 1987	11.67			
	Feb 17	10.89		Feb 17	11.56			
	Mar 16	10.72		Mar 16	11.38			
	Apr 22	10.38		Apr 22	10.97			
	Mar 17, 1989	11.03						
M8	Nov 20, 1986	11.32	M9	Nov 20, 1986	11.28	M10	Nov 20, 1986	11.03
	Dec 17	11.75		Dec 17	11.62		Dec 17	11.41
	Jan 20, 1987	11.92		Jan 20, 1987	11.70		Jan 20, 1987	11.61
	Feb 17	11.81		Feb 19	11.71		Feb 17	11.50
	18	11.82		Mar 16	11.53		Mar 16	11.32
	Mar 16	11.64		Apr 22	11.13		Apr 22	10.95
	Apr 22	11.14						
M11	Nov 20, 1986	10.89	M12	Nov 19, 1986	11.13	M13	Nov 19, 1986	11.15
	Dec 17	11.23		Dec 17	11.46		Dec 17	11.58
	Jan 20, 1987	11.45		Jan 20, 1987	11.63		Jan 20, 1987	11.83
	Feb 17	11.35		Feb 17	11.57		Feb 17	11.72
	Mar 16	11.19		Mar 16	11.40		Mar 16	11.53
	Apr 22	10.87		Apr 22	11.05		Apr 22	11.17
	Mar 17, 1989	11.56		Mar 18, 1989	11.69		Mar 16, 1989	11.90
M14	Nov 20, 1986	9.58	M16	Nov 19, 1986	10.99	M17	Nov 20, 1986	11.35
	Dec 17	9.88		Dec 17	11.42		Dec 17	11.73
	Jan 20, 1987	10.09		Jan 20, 1987	11.63		Jan 20, 1987	11.97
	Feb 17	9.92		Feb 17	11.52		Feb 17	11.86
	18	9.93		Mar 16	11.34		Mar 16	11.64
	Mar 16	9.76		Apr 22	10.80		Apr 22	11.12
	Apr 22	9.43		Mar 18, 1989	11.59		Mar 17, 1989	12.02
	Mar 16, 1989	10.14						
M18	Nov 20, 1986	10.99	M19	Nov 20, 1986	11.38	M20	Nov 20, 1986	11.21
	Dec 17	11.36		Dec 17	11.69		Dec 17	11.62
	Jan 20, 1987	11.58		Jan 20, 1987	11.90		Jan 20, 1987	11.88
	Feb 17	11.46		Feb 17	11.77		Feb 17	11.75
	Mar 16	11.26		Mar 16	11.61		Mar 16	11.53
	Apr 22	10.84		Apr 22	11.16		Apr 22	10.92
	Mar 17, 1989	11.70		Mar 15, 1989	12.08		Mar 17, 1989	12.00
M21	Nov 20, 1986	11.49	M22	Nov 20, 1986	10.79	M23	Nov 20, 1986	10.10
	Dec 17	11.88		Dec 17	11.03		Dec 17	10.39
	Jan 20, 1987	12.15		Jan 21, 1987	11.33		Jan 22, 1987	10.60
	Feb 17	11.90		Feb 17	11.13		Feb 18	10.53
	Mar 16	11.71		Mar 16	10.95		Mar 16	10.32
	Apr 22	11.31		Apr 22	10.47		Apr 22	10.02
							Mar 16, 1989	10.64

Table 12.--Observed water levels in observation and domestic wells

Well identifier	Date	Water level	Well identifier	Date	Water level	Well identifier	Date	Water level
M24	Nov 20, 1986	9.11	M25	Nov 20, 1986	9.35	M26	Nov 20, 1986	9.38
	Dec 17	9.40		Dec 17	9.66		Dec 17	9.65
	Jan 22, 1987	9.66		Jan 22, 1987	9.94		Jan 22, 1987	9.91
	Feb 18	9.58		Feb 18	9.81		Feb 18	9.84
	Mar 16	9.54		Mar 16	9.58		Mar 16	9.63
	Apr 22	9.05		Apr 22	9.26		Apr 22	9.33
M27	Nov 20, 1986	9.73	M28	Nov 20, 1986	13.69	M29	Nov 20, 1986	10.19
	Dec 17	9.91		Dec 17	14.24		Dec 17	10.37
	Jan 22, 1987	10.20		18	14.19		Jan 22, 1987	10.72
	Feb 18	10.14		Jan 22, 1987	14.19		Feb 18	10.65
	Mar 16	9.92		Feb 18	14.13		Mar 16	10.56
	Apr 22	9.67		Mar 16	13.88		Apr 22	10.24
	Mar 16, 1989	9.21		Apr 22	13.35		Mar 15, 1989	10.84
				Mar 15, 1989	13.97			
M30	Nov 20, 1986	9.94	M31	Nov 20, 1986	10.74	M33	Nov 20, 1986	9.15
	Dec 17	10.20		Dec 17	10.99		Dec 18	9.46
	Jan 22, 1987	10.32		Jan 22, 1987	11.19		Jan 22, 1987	9.64
	Feb 18	10.33		Feb 18	11.14		Feb 18	9.59
	Mar 16	10.23		Mar 16	10.92		Mar 16	9.44
	Apr 22	9.90		Apr 22	10.65		Apr 23	9.27
	Mar 14, 1989	10.47		Mar 15, 1989	11.31			
M34	Nov 20, 1986	8.19	M35	Nov 20, 1986	11.22	D32	Jul 28, 1986	8.15
	Dec 18	8.37		Dec 17	11.47		Sep 22	8.07
	Jan 22, 1987	8.51		Jan 22, 1987	11.71		Nov 20	11.61
	Feb 18	8.52		Feb 18	11.41		Dec 17	12.04
	Mar 16	8.33		Mar 16	11.44		Jan 21, 1987	12.36
	Apr 23	8.24		Apr 23	11.17		Feb 18	12.23
	Mar 14, 1989	8.65					Mar 16	11.94
							Apr 23	9.09
M36	May 14, 1986	9.46	M37	May 14, 1986	9.05	M38	Nov 20, 1986	8.17
	Jun 23	9.08		Jun 23	8.78		Dec 17	9.41
	Jul 28	9.01		Jul 28	8.76		Jan 22, 1987	8.80
	Sep 22	8.71		Sep 22	8.45		Feb 18	9.34
	Nov 19	10.64		Nov 20	11.34		Mar 16	9.13
	Dec 17	11.17		Dec 17	10.82		Apr 23	9.11
	18	11.17		Jan 22, 1987	10.78			
	Jan 20, 1987	11.36		Feb 18	10.73			
	Feb 17	11.29		Mar 16	10.56			
	Mar 16	12.28		Apr 22	10.35			
	Apr 22	11.94						
M39	Jan 20, 1987	11.02	M40	Jan 21, 1987	12.85			
	Feb 18	11.07		Feb 18	11.89			
	Mar 16	10.81		Mar 16	11.73			
	Apr 23	10.69		Apr 23	11.70			

Table A1.--Concentrations of volatile organic compounds in quality-assurance samples, May 1985 through June 1986

[Concentrations are in micrograms per liter; ND, below the detection limit of 1 microgram per liter].

Sample or well identifier	Date	Benzene	Toluene	Total xylenes
Field blank	5-10-85	ND	ND	ND
Field blank	5-11-85	ND	ND	ND
M11-85	5-11-85	1,380	7,700	12,990
M11-85	5-11-85	1,090	4,000	14,900
Lab blank	12-16-85	ND	ND	ND
Lab blank	6-27-86	ND	ND	ND

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Table A2.--Concentrations of volatile organic compounds in quality-assurance samples, August 27, 1985

[Concentrations are in micrograms per liter; ND, below the limit of detection of 1 microgram per liter for the insurance company study (ICS), see text for discussion of limit of detections for Ground-Water Toxics Study (GWTS)].

Well identifier	Benzene		Toluene		Total xylenes	
	ICS	GWTS	ICS	GWTS	ICS	GWTS
M7-85	ND	ND	ND	ND	ND	ND
M8-85	96	ND	1	ND	9	ND
M10-85	ND	ND	ND	ND	ND	ND
M11-85	920	1,000	1,100	3,400	6,300	7,300

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Table A3.--Mean and standard deviations of trip blanks, August 26-30 1985

[Concentrations are in micrograms per liter].

Parameter	Benzene	Toluene	Ethyl-benzene	m+p Xylene	o-Xylene	n-Propyl-benzene	1,3,5-Tri-methyl-benzene
Mean	0.87	0.49	0.032	0.041	0.025	0.0024	0.017
Standard deviation	±0.11	±0.10	±0.015	±0.015	±0.0071	±0.0047	±0.0096

Parameter	1,2,4-Tri-methyl-benzene	Iso-butyl-benzene	sec-Butyl-benzene	n-Butyl-benzene	1,2,3,5-Tetra-methyl-benzene	1,2,3,4-Tetra-methyl-benzene	Naph-thalene
Mean	0.053	0.0046	0.006	0.019	0.009	0.014	0.20
Standard deviation	±0.017	±0.0082	±0.0089	±0.011	±0.014	±0.016	±0.29

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Table A4.--Comparison of means and standard deviations of standard hydrocarbon compound concentrations, November 1985

[Concentrations in micrograms per liter; standard solutions prepared from materials supplied by the U.S. Environmental Protection Agency-Environmental Monitoring Services Laboratory, Cincinati, OH (EPA)]

		EPA	GWTP	
Standard solution	Compound	Concentration	Concentration	One standard deviation
I	Benzene	10,000	12,000	±1,800
	Toluene	10,000	11,000	± 540
	m+p-Xylene	10,000	9,700	± 680
	o-Xylene	5,000	5,100	± 320
II	Benzene	10,000	12,000	± 800
	o-Xylene	10,000	9,500	± 560
III	Toluene	10,000	11,000	± 480
	m+p-Xylene	10,000	10,000	± 720

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Table A5.--Concentrations of volatile organic compounds in quality-assurance samples, February 23 through March 17, 1989

[Equivalent spikes containing benzene, toluene, ethylbenzene, m-xylene, naphthalene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, p-isopropyltoluene, 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene, n-butylbenzene, styrene, and bromobenzene: FS1 and FS2 are field and LS is laboratory; D, duplicate sample; BL, blank-water sample; ER, equipment-rinse sample; ERB, baked-equipment rinse sample; concentrations are in micrograms per liter; ND, below the detection limit of 0.2 micrograms per liter]

Sample or well identifier	Date	Benzene	Toluene	Ethylbenzene	Total xylenes	Naphthalene	1,3,5-Trimethylbenzene	2-Ethyl-1-methylbenzene	1,2,3-Trimethylbenzene	1,2,4-Trimethylbenzene	1,2,3,5-Tetramethylbenzene
M8-85	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M8-85 (FS1)	03-14-89	6.6	6.9	7.6	7.4	9.8	7.7	ND	ND	7.6	ND
M8-85 (FS2)	03-14-89	5.2	5.2	5.9	5.8	9.4	6.5	ND	ND	6.4	ND
M8-85 (LS)	03-14-89	8.6	8.2	8.7	8.3	9.4	8.7	ND	ND	8.5	ND
M18	03-17-89	ND	ND	0.2	0.2	ND	ND	3.2	0.3	ND	ND
M18 (D)	03-17-89	0.4	ND	0.4	0.3	ND	ND	5.4	0.4	ND	ND
BL1	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL2	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL3	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL5	03-13-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER1	02-23-89	0.2	0.2	ND	0.1[a]	ND	ND	ND	ND	ND	ND
ER2	02-23-89	0.4	0.4	ND	0.3	ND	ND	ND	ND	ND	ND
ER3	02-23-89	0.2	0.2	ND	ND	ND	ND	ND	ND	ND	ND
RB4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ERB5	03-13-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

Sample or well identifier	Date	1,4-Dimethyl-2-ethylbenzene	1,2,3,4-Tetramethylbenzene	p-Isopropyltoluene	Isopropylbenzene	Dibromomethane	Dichlorobromomethane	Carbontetrachloride	sec-Butylbenzene	1,2,3-Trichlorobenzene	1,2,4-Trichloro benzene
M8-85	03-14-89	ND	ND	ND	ND	ND	ND	0.3	ND	ND	ND
M8-85 (FS1)	03-14-89	ND	ND	6.6	ND	ND	ND	ND	ND	9.4	8.8
M8-85 (FS2)	03-14-89	ND	ND	5.8	ND	ND	ND	ND	ND	8.2	7.1
M*-85 (LS)	03-14-89	ND	ND	7.9	ND	ND	ND	ND	ND	8.1	7.9
M18	03-17-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M18 (D)	03-17-89	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND
BL1	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL2	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL3	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL5	03-13-89	ND	ND	ND	ND	ND	0.5	ND	ND	ND	ND
RB4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ERB5	03-13-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
		ND	ND	ND	ND	ND	0.5	ND	ND	ND	ND

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Table A5.--Concentrations of volatile organic compounds in quality-assurance samples, February 23 through March 17, 1989--Continued

Sample or well identifier	Date	1,3-Dimethyl-2-ethylbenzene	1,2-Dichloroethane	Bromoform	Chlorodibromomethane	Chloroform	Chlorobenzene	Chloroethane	Methylbromide	Methylchloride	Methylene chloride
M8-85	03-14-89	ND	ND	ND	ND	5.3	ND	ND	ND	ND	ND
M8-85 (FS1)	03-14-89	ND	ND	ND	ND	1.4	ND	ND	ND	ND	ND
M8-85 (FS2)	03-14-89	ND	ND	ND	ND	1.4	ND	ND	ND	ND	ND
M8-85 (LS)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M18	03-17-89	0.8	ND	ND	ND	0.5	ND	ND	ND	ND	ND
M18 (D)	03-17-89	0.9	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL1	02-23-89	ND	ND	ND	ND	1.4	ND	ND	ND	ND	0.4
BL2	02-23-89	ND	ND	ND	ND	1.5	ND	ND	ND	ND	0.6
BL3	02-23-89	ND	ND	ND	ND	1.6	ND	ND	ND	ND	0.5
BL4	03-06-89	ND	ND	ND	ND	1.3	ND	ND	ND	ND	ND
BL5	03-13-89	ND	ND	ND	0.2	3.7	ND	ND	ND	ND	0.2
ER1	02-23-89	ND	ND	ND	ND	61	ND	ND	ND	ND	2.6
ER2	02-23-89	ND	ND	ND	ND	148	ND	ND	ND	ND	5.3
ER3	02-23-89	ND	ND	ND	ND	57	ND	ND	ND	ND	2.7
ERB4	03-06-89	ND	ND	ND	ND	1.3	ND	ND	ND	ND	ND
ERB5	03-13-89	ND	ND	ND	0.2	3.2	ND	ND	ND	ND	ND

Sample or well identifier	Date	n-Propylbenzene	n-Butylbenzene	Tetrachloroethylene	Trichlorofluoromethane	1,1-Dichloroethane	1,1-Dichloroethylene	1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1,2,2-Tetrachloroethan	1,2-Dichlorobenzene
M8-85	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M8-85 (FS1)	03-14-89	ND	6.2	ND	ND	ND	ND	ND	ND	ND	ND
M8-85 (FS2)	03-14-89	ND	5.4	ND	ND	ND	ND	ND	ND	ND	ND
M8-85 (LS)	03-14-89	ND	8.2	ND	ND	ND	ND	ND	ND	ND	ND
M18	03-17-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M18 (D)	03-17-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL1	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL2	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL3	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL5	03-13-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER1	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER2	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER3	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ERB4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ERB5	03-13-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

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Table A5.--Concentrations of volatile organic compounds in quality-assurance samples, February 23 through March 17, 1989--Continued

Sample or well identifier	Date	1,2-Dichloropropane	1,3-Dichlorobenzene	1,4-Dichlorobenzene	Dichlorodifluoromethane	trans-1,3-Dichloropropene	cis-1,3-Dichloropropene	Vinyl Chloride	Trichloroethylene	1,2-Dichloroethene	Styrene
M8-85	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M8-85 (FS1)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.6
M8-85 (FS2)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	7.0
M8-85 (LS)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.8
M18	03-17-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
M18 (D)	03-17-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL1	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL2	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL3	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL5	03-13-89	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER1	02-23-89	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND
ER2	02-23-89	ND	ND	ND	ND	ND	ND	ND	0.5	ND	ND
ER3	02-23-89	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND
ERB4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
ERB5	03-13-89	0.3	ND	ND	ND	ND	ND	ND	ND	ND	ND

Sample or well identifier	Date	1,1-Dichloro propene	2,2-Dichloropropane	1,3-Dichloropropane	ortho-Chlorotoluene	para-Chlorotoluene	1,2,3-Trichloropropane	1,1,1,2-Tetrachloroethane	1,2-Dibromoethane	Bromobenzene
M8-85	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
M8-85 (FS1)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	8.7
M8-85 (FS2)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	7.1
M8-85 (LS)	03-14-89	ND	ND	ND	ND	ND	ND	ND	ND	7.7
M18	03-17-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
M18 (D)	03-17-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL1	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL2	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL3	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
BL5	03-13-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER1	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER2	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER3	02-23-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
ER4	03-06-89	ND	ND	ND	ND	ND	ND	ND	ND	ND
ERB5	03-16-89	ND	ND	ND	ND	ND	ND	ND	ND	ND

PRELIMINARY SUBJECT TO REVISIONS

Table A5.--Concentrations of volatile organic compounds in quality-assurance samples, February 23 through March 17, 1989--Continued

Sample or well identifier	Tentatively identified organic compounds			
	Hexane	Methyl-cyclo-pentane	3-Methyl-pentane	Acetone
M8-85	ND	ND	ND	ND
M8-85 (FS1)	ND	ND	ND	ND
M8-85 (FS2)	ND	ND	ND	ND
M8-85 (FS3)	ND	ND	ND	ND
M18	ND	ND	ND	ND
M18 (D)	ND	ND	ND	ND
BL1	0.7	1.2	ND	ND
BL2	1.0	0.9	ND	ND
BL3	0.9	1.0	ND	ND
BL4	ND	ND	ND	ND
BL5	ND	ND	ND	ND
ER1	6	57	2.4	0.5
ER2	18	166	5.9	0.6
ER3	57	57	2.5	0.7
ERB4	ND	ND	ND	ND
ERB5	ND	ND	ND	ND

---

[a] Laboratory quantified compound detection, even though below the reported detection limit of 0.2 micrograms per liter.

[b] Tentatively identified organic compound; the reported concentration generally is accurate to one order of magnitude.

PRELIMINARY SUBJECT TO REVISIONS

Table A6.--Concentrations of inorganic and dissolved-organic carbon quality-assurance samples, March 1989.

[ER, equipment-rinse blank, de-ionized water; D, duplicate sample; mg/L, milligrams per liter; or µg/L, milligrams per liter]

Well or sample identifier	Date	Specific conductance (µs/cm)	Lab specific conductance (µs/cm)	pH (standard units)	Lab pH (standard units)	Temperature water (°C)	Turbidity (NTU)	Oxygen, dissolved (mg/L)	Hardness (mg/L as $CaCO_3$)	Hardness, noncarbonate (mg/L as $CaCO_3$)
M18	03-17-89	319	307	6.7	6.9	13.0	40	0.0	130	0
M18D	03-17-89	--	307	--	6.7	--	33	--	130	0
ER4	03-15-89	--	--	--	7.2	--	0.3	--	0	0

Sample or well identifier	Date	Calcium dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sodium percent	Sodium adsorption ratio	Potassium, dissolved (mg/L as K)	Alkalinity, field (mg/L as $CaCO_3$)	Alkalinity, laboratory (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)
M18	03-17-89	32	11	12	17	0.5	2.6	132	113	34
M18 (D)	03-17-89	32	11	12	17	0.5	2.6	--	113	34
ER4	03-15-89	0.03	0.05	<0.2	--	--	0.1	--	2	<0.2

Sample or well identifier	Date	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 °C dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3, dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Phosphorus ortho, dissolved (mg/L as P)	Barium, dissolved (µg/L as Ba
M18	03-17-89	7.0	0.2	38	209	227	<0.10	0.10	0.05	18
M18 (D)	03-17-89	7.0	0.2	38	208	227	<0.10	0.11	0.05	19
ER4	03-15-89	<0.1	0.1	<0.01	<1	--	<0.10	<0.01	<0.01	<2

PRELIMINARY SUBJECT TO REVISIONS

Table A6.--Concentrations of inorganic and dissolved-organic carbon quality-assurance samples, March 1989--Continued

Sample or well identifier	Date	Beryllium, dissolved (μg/L as Be)	Cadmium, dissolved (μg/L as Cd)	Chromium, dissolved (μg/L as Cr)	Cobalt, dissolved (μg/L as Co)	Copper, dissolved (μg/L as Cu)	Iron, dissolved (μg/L as Fe)	Lead, dissolved (μg/L as Pb)	Lithium, dissolved (μg/L as Li)	Manganese, dissolved (μg/L as Mn)
M18	03-17-89	<0.5	<1	<5	4	<10	7,300	<10	6	2,800
M18 (D)	03-17-89	<0.5	<1	<5	<3	<10	7,200	<10	5	2,800
ER4	03-15-89	<0.5	<1	<5	<3	<10	5	<10	<4	<1

Sample of well identifier	Date	Molybdenum, dissolved (μg/L as Mo)	Nickel, dissolved (μg/L as Ni)	Silver, dissolved (μg/L as Ag)	Strontium, dissolved (μg/L as Sr)	Vanadium, dissolved (μg/L as V)	Zinc, dissolved (μg/L as Zn)	Carbon, dissolved organic (mg/L as C)
M18	03-17-89	<10	<10	<1	150	<6	69	1.9
M18 (D)	03-17-89	<10	<10	<1	150	<6	230	2.0
ER4	03-15-89	<10	<10	<1	<1	<6	<3	0.3

Table A7.--Comparison of field and laboratory determinations of specific conductance, pH, and alkalinity, November 1986 and March 1989

[μs/cm, microsiemens per centimeter; mg/L, milligrams per liter; --, not analyzed]

		Specific conductance in μs/cm		pH in standard units		Alkalinity in mg/L as $CaCO_3$	
Well identifier	Date	Field	Lab	Field	Lab	Field	Lab
M1-82	11-18-86	280	279	6.8	6.9	131	--
M2-82	11-18-86	320	303	6.7	6.8	156	--
M1-85	11-19-86	238	239	6.7	6.9	103	--
	03-13-89	208	222	6.9	7.0	89	90
M5-85	03-13-89	252	265	6.7	6.8	113	114
M9-85	11-19-86	254	254	6.5	6.9	108	--
	03-15-89	249	260	6.6	6.7	112	111
M10-85	11-19-86	298	293	6.6	6.8	116	--
M11-85	11-17-86	264	251	6.6	6.8	125	--
	03-18-89	292	295	6.6	6.8	140	134
M4	11-18-86	313	295	6.6	6.8	151	--
M7.2	11-17-86	352	336	6.4	6.6	185	--
M8	11-17-86	247	245	6.6	6.8	105	--
M9	11-17-86	279	272	6.6	6.9	133	--
M11	11-18-86	307	298	6.6	6.9	148	--
M12	11-18-86	323	303	6.5	6.7	164	--
M16	11-17-86	342	329	6.7	6.8	172	--
M18	11-18-86	292	271	6.6	6.8	149	--
	03-17-89	319	307	6.7	6.9	132	113
M19	11-18-86	257	251	6.6	6.9	105	--
M23	11-18-86	390	385	6.7	6.8	193	--
M24	11-18-86	365	332	6.5	6.7	190	--
M29	11-19-86	259	258	6.6	6.8	120	--
M30	03-14-89	268	284	6.6	6.6	128	122
M31	11-19-86	261	261	6.5	6.8	113	--

[redacted]

File
N. 1st
Spill

March 3, 1849

United States Department of the Interior

GEOLOGICAL SURVEY

Water Resources Division
Pacific Northwest District
Washington Office
1201 Pacific Avenue - Suite 600
Tacoma, Washington 98402

May 5, 1987

RECEIVED
MAY 11 1987
DEPARTMENT OF ECOLOGY
CENTRAL REGION OFFICE

Mr. Clar Pratt
Washington State Department of
Ecology
3601 W. Washington
Yakima, Washington 98902

Dear Mr. Pratt:

I have enclosed the additional materials pertaining to the Yakima Gasoline study that you requested during our meeting of April 22. Included are the logs for the observation wells that we installed during September of 1986 and the site and background information that we included in the work plan for the study.

Because we are no longer funded to work at the site, we must remove the observation wells. Please let me know which, if any, of these wells that you would like left in place. At that time, we will transfer responsibility for the ultimate removal of wells left in place to the Department of Ecology.

Please call me at (206) 593-6510 if you have any questions.

Sincerely,

James C. Ebbert

James C. Ebbert
Hydrologist

Enclosure

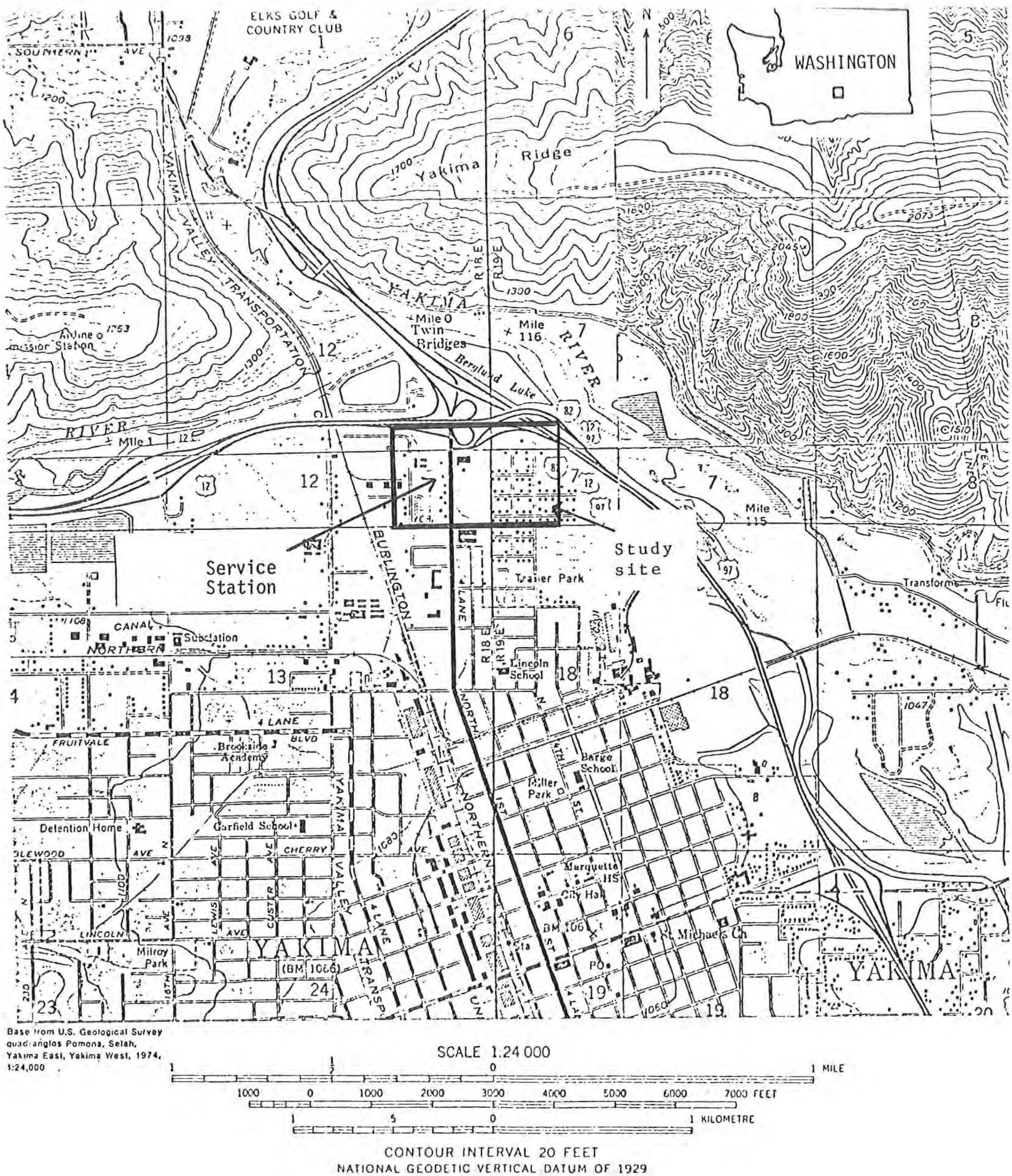
DESCRIPTION OF THE YAKIMA STUDY SITE

Yakima is the commercial center for a major agricultural area within south-central Washington. The service station on North First Street where the gasoline and diesel-oil leak occurred is located approximately 2,000 feet southwest of the Yakima River (see fig. 1). Land use in the vicinity of the service station is mixed commercial, residential, and vacant. The subsurface zone immediately underlying the gasoline and diesel oil spill consists of alluvial deposits. Depth from the ground surface to the water table is approximately 10 feet.

Background

In 1980, 1981, and 1982, complaints about the odor and taste of gasoline in water from domestic wells located up to 1,000 feet east of the service station were reported to the State of Washington Department of Ecology (WDOE). The WDOE investigated the reports and determined that the source of contamination was a service station located on North First Street (see fig. 1). More than a dozen households reported contamination of domestic and irrigation supplies, and starting in 1982, outside sources of drinking water were provided for some residents.

New storage tanks and product delivery lines were installed at the station in May and June 1979. Because of improper installation, some of the delivery lines leaked near the ground surface where the lines connect to the dispensers. Leak tests were reported to have been performed at that time,



Base from U.S. Geological Survey quadrangles Pomona, Selah, Yakima East, Yakima West, 1974, 1:24,000

Figure 1.--Location of the gasoline and diesel-oil spill site at Yakima, Washington.

and no leaks were found. In December 1980, an air-pressure test of the system was conducted as part of routine testing and again no leaks were reported. As a result of the complaints from private well owners, hydrostatic pressure tests were conducted in September 1982. These tests revealed leaks in the delivery lines, which were repaired immediately.

An estimate of the volume of product lost for the period from September 1981 through October 1982 was made from an audit of inventory records. The audit indicated a total loss of 5,970 gallons of leaded gasoline and 1,740 gallons of diesel oil, or an average combined loss of 550 gallons per month. If the 1980 air-pressure test was accurate, a potential loss of about 12,000 gallons could have occurred during the 22-month period from the time of the pressure test to the correction of the leaks. If the pressure test was inaccurate, then the product loss may have been as much as 22,000 gallons during the entire 40-month period from the time of installation of the tanks and delivery lines to the repair of the lines.

Because of the threat to drinking water, the insurance company representing the service station made an attempt to recover the gasoline and diesel oil in 1982-83. At least 13 observation wells and two recovery wells were installed on or adjacent to the service station property in 1982 (fig. 2). Three of the observation wells contained several inches of free product. The recovery operation was discontinued after 2 months because only 40 gallons of free product were recovered, at a reported cost of $100,000. All but three of the wells were subsequently destroyed.

fig 2

In 1985, the insurance company began a ground-water monitoring program. From December 1984 to February 1985, 12 observations wells were added to the three remaining from 1982 (fig. 3). At 3-month intervals beginning in February 1985, water levels were measured and selected wells were sampled to determine concentrations of hydrocarbon compounds in ground water. This monitoring program lasted for about 1 year, and these wells are now used by the U.S. Geological Survey.

fig 3

In the summer of 1985, most homes having affected wells were connected to city water supplies at a cost to the city of about $175,000. Because of the cost of the unsuccessful cleanup effort, and because uncontaminated drinking water supplies were secured, no further remedial action is anticipated.

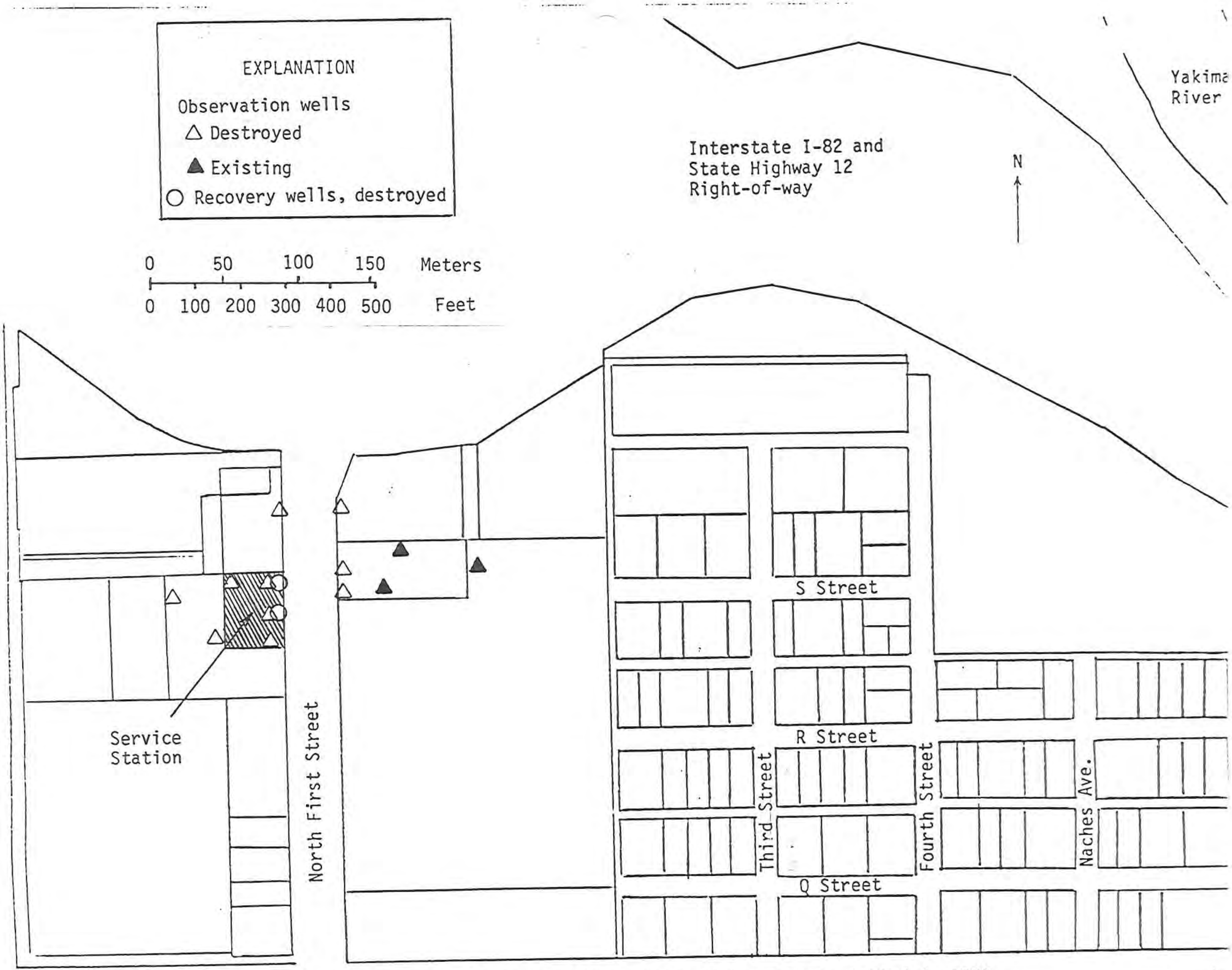


Figure 2.-- Locations of the observation and recovery wells installed in 1982.

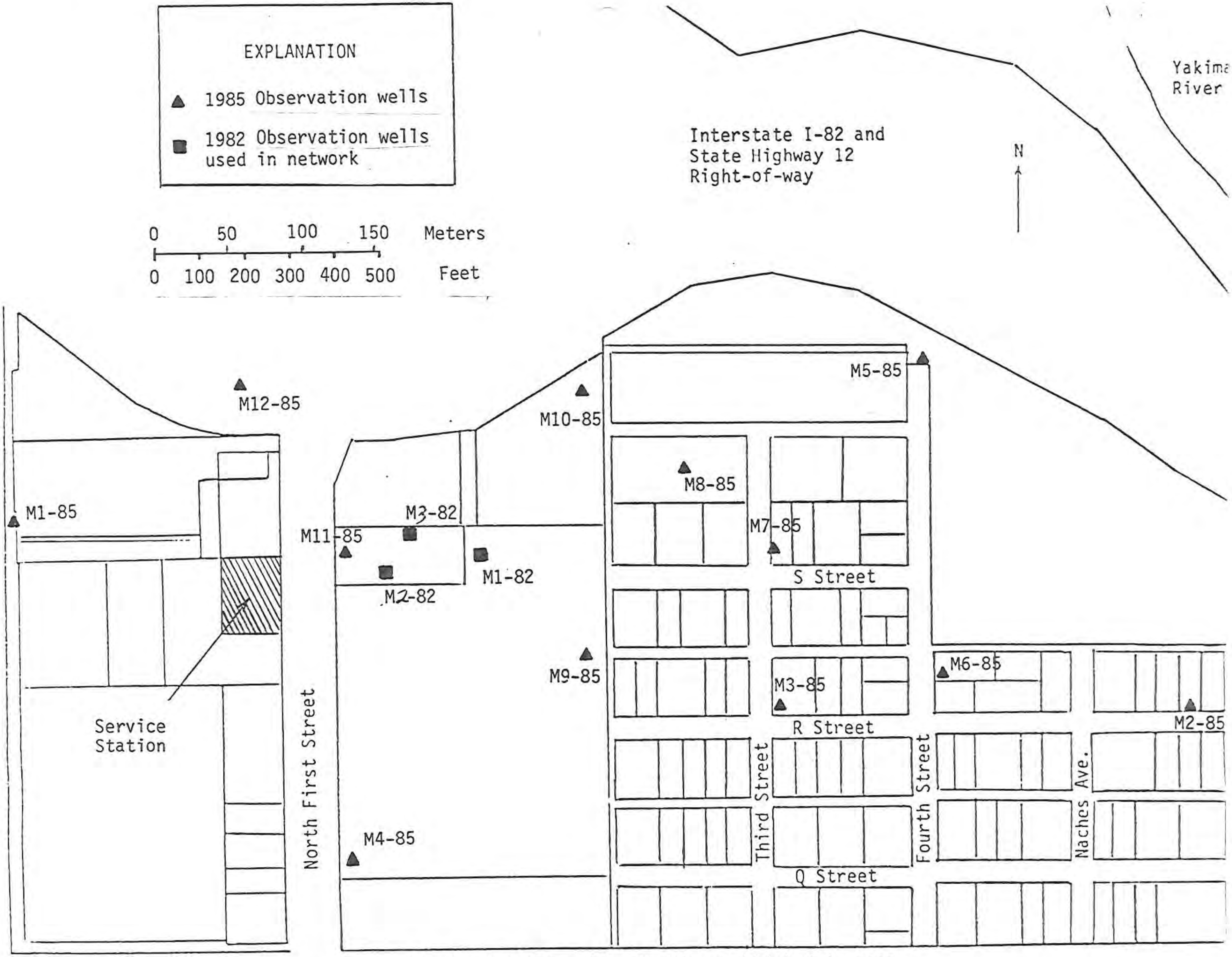


Figure 3.--Observation well network established in 1985.

Results of Reconnaissance Investigations

Reconnaissance investigations to determine the approximate areal extent of the gasoline and diesel oil contamination in ground water were conducted by the U.S. Geological Survey and the Oregon Graduate Center (OGC). Results indicate that the more water-soluble compounds in gasoline and diesel oil, the aromatic hydrocarbons, have migrated approximately 1,000 feet from the station, generally in an east-north easterly direction.

In August 1985, ground-water samples at the water table were collected from the 15 previously installed observation wells and from 14 temporary holes. The site numbers for the observation wells and temporary holes have the prefix letters M and T, respectively, in figure 9. All the observation wells were constructed with PVC casing and screens. The temporary holes were installed by driving a steel rod to the water table using a jackhammer. Ground-water samples were collected from the temporary holes by bailing through a stainless steel tube that was inserted after removal of the drive rod. Additionally, 31 domestic wells, shown with the prefix letter D in figure 9, were sampled. Typically these extend 10 to 20 feet below the water table with an open-end steel casing. Therefore, hydrocarbon concentrations in the domestic wells may not be the same as those at the water table.

fig 9

Ground-water samples were analyzed for 17 aromatic hydrocarbons, primarily alkylated benzenes (table 2). Fourteen of the compounds were identified in samples from eight of the sampling sites. Of these compounds,

table 2

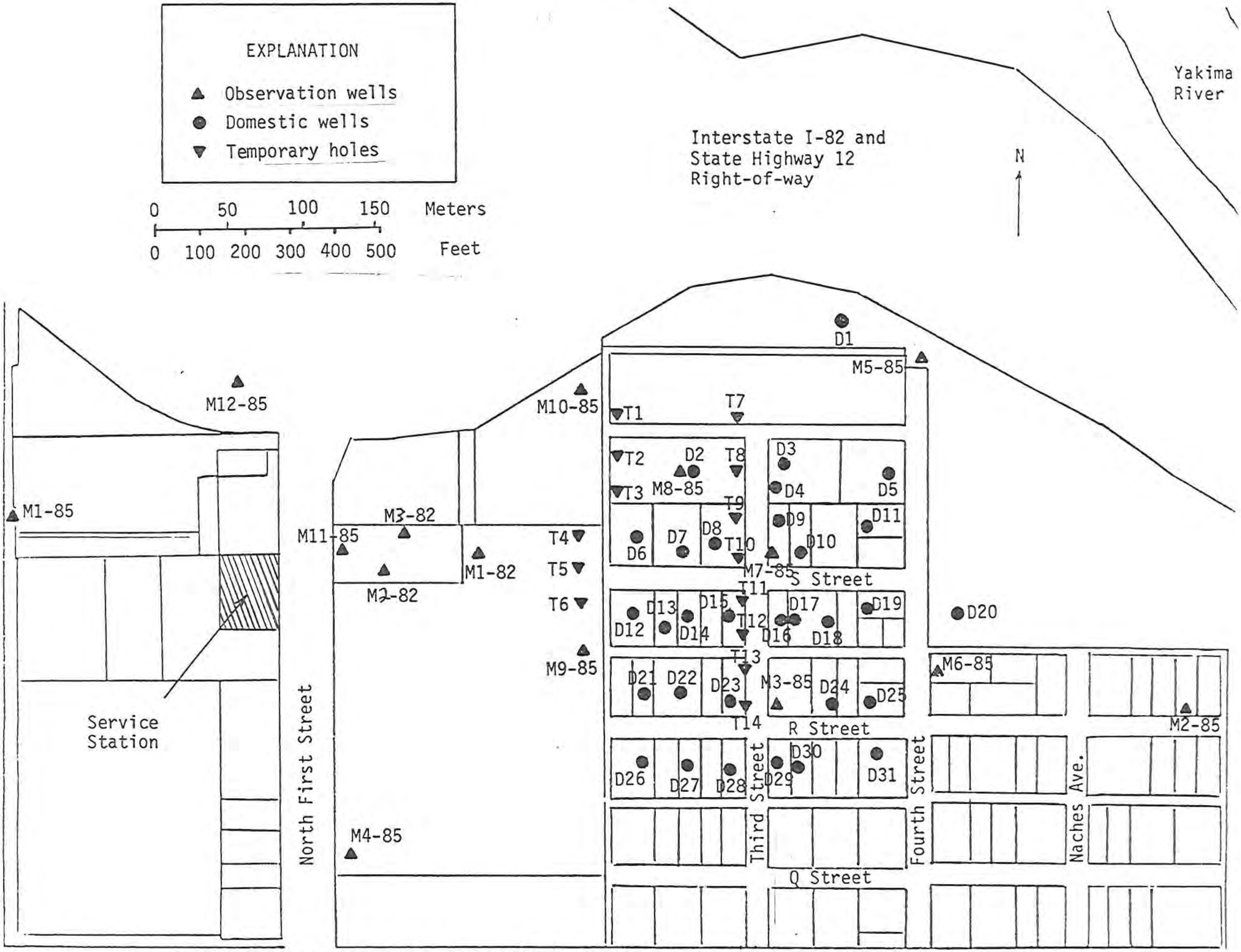


Figure 9.--Wells sampled by the U. S. Geological Survey and Oregon Graduate Center in August 1985.

TABLE 2.—Concentrations of aromatic hydrocarbons compounds in ground water sampled during August 1985[1]

[concentrations in micrograms per liter]

Compound	Site number							
	M8-85	M11-85	M1-82	M2-82	M3-82	T-1	D-2	D-6
Benzene	ND	1,000	ND	3,300	800	2.3	10	26
Toluene	ND	3,400	ND	11,000	2,600	ND	ND	ND
Ethylene bromide	ND	ND	ND	ND	ND	ND	ND	ND
Ethyl benzene	ND	220	ND	910	150	ND	ND	4.7
m+p-Xylene	ND	5,200	ND	7,500	5,700	ND	ND	.33
o-Xylene	1.0	2,100	ND	3,000	2,500	.17	1.2	3.2
n-Propyl benzene	ND	ND	ND	130	ND	ND	.11	1.7
1,3,5-Trimethyl benzene	ND	420	25	620	930	ND	ND	ND
1,2,4-Trimethyl benzene	.13	1,200	ND	1,500	2,400	ND	1.4	5.9
t-Butyl benzene	ND	ND	ND	ND	ND	ND	ND	ND
Isobutyl benzene	ND	ND	ND	ND	ND	ND	.38	.32
sec-Butyl benzene	ND	ND	ND	ND	ND	ND	.93	.70
1-Isopropyl-4-methyl benzene	ND	ND	ND	ND	ND	ND	ND	ND
n-Butyl benzene	ND	ND	1.2	ND	ND	ND	.29	.45
1,2,3,5-Tetramethyl benzene	.66	81	8.6	130	380	ND	.26	1.5
1,2,3,4-Tetramethyl benzene	.2	46	5.6	55	180	ND	ND	.40
Naphthalene	3.0	440	2.8	400	740	ND	1.0	12

[1] Wells sampled by the U.S. Geological Survey and the Oregon Graduate Center. Only those wells where compound concentrations were above quantifiable limits appear in the table. ND indicates a concentration below quantifiable limits.

fig 10

detectable concentrations of benzene and naphthalene were found farthest from the service station, and their concentrations in ground water are shown in figure 10. Although benzene and naphthalene were detected in water collected approximately 1,000 feet northeast of the station, concentrations exceeded 100 ug/L (micrograms per liter) in only the three wells closest to the service station. A petroleum sheen was noted on samples from two of the three wells indicating the presence of free product. The migration of aromatic hydrocarbons in the direction of the Bekins and Safeway properties (fig. 10) is of interest because these two properties are partially paved. The pavement may affect the movement and concentrations of volatile organic compounds in the unsaturated zone under these areas.

fig 11

In November 1985, the OGC collected and analyzed gas samples from depths of 3.5 to 5.7 feet in the unsaturated zone. Due to complications, including a severe snowstorm, only nine samples were collected, and all were on the Bekins property or on the northwest corner of the Thunderbird property (fig. 11). Preliminary results indicate the possible presence of volatile organic compounds in all but two of the samples, and those were collected from the most southerly locations (fig. 11). These data support the conclusions drawn from the ground-water data, which indicate that the direction of migration is toward the east-northeast from the service station. This direction of movement is consistent with the direction of ground-water flow, as indicated by the water-level data (fig. 8).

During the period April through June 1986, additional reconnaissance samples were collected to better define concentrations of aromatic-hydrocarbon compounds in ground water under the Bekins, Safeway, and

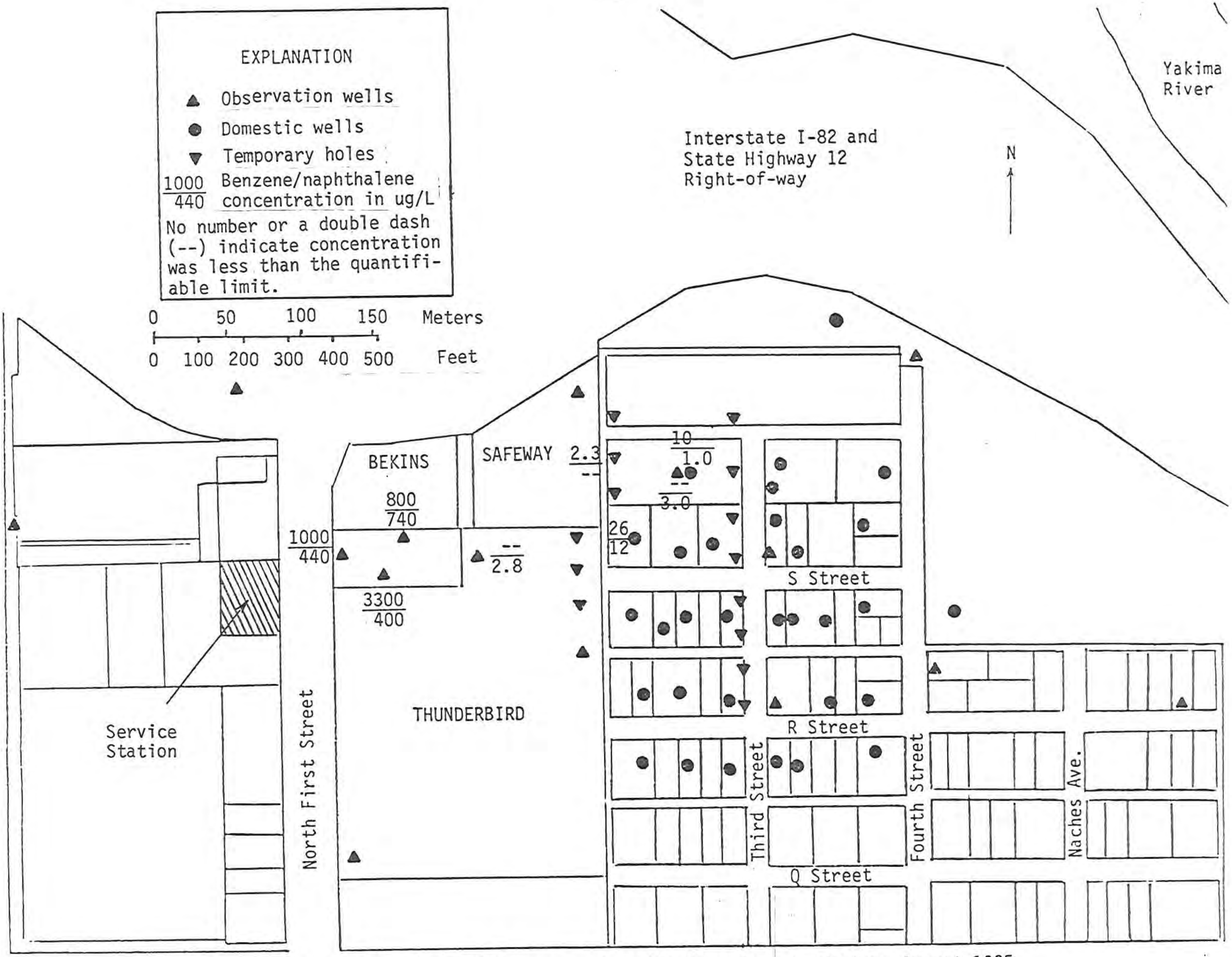


Figure 10.--Concentrations of benzene and naphthalene in groundwater, August 1985.

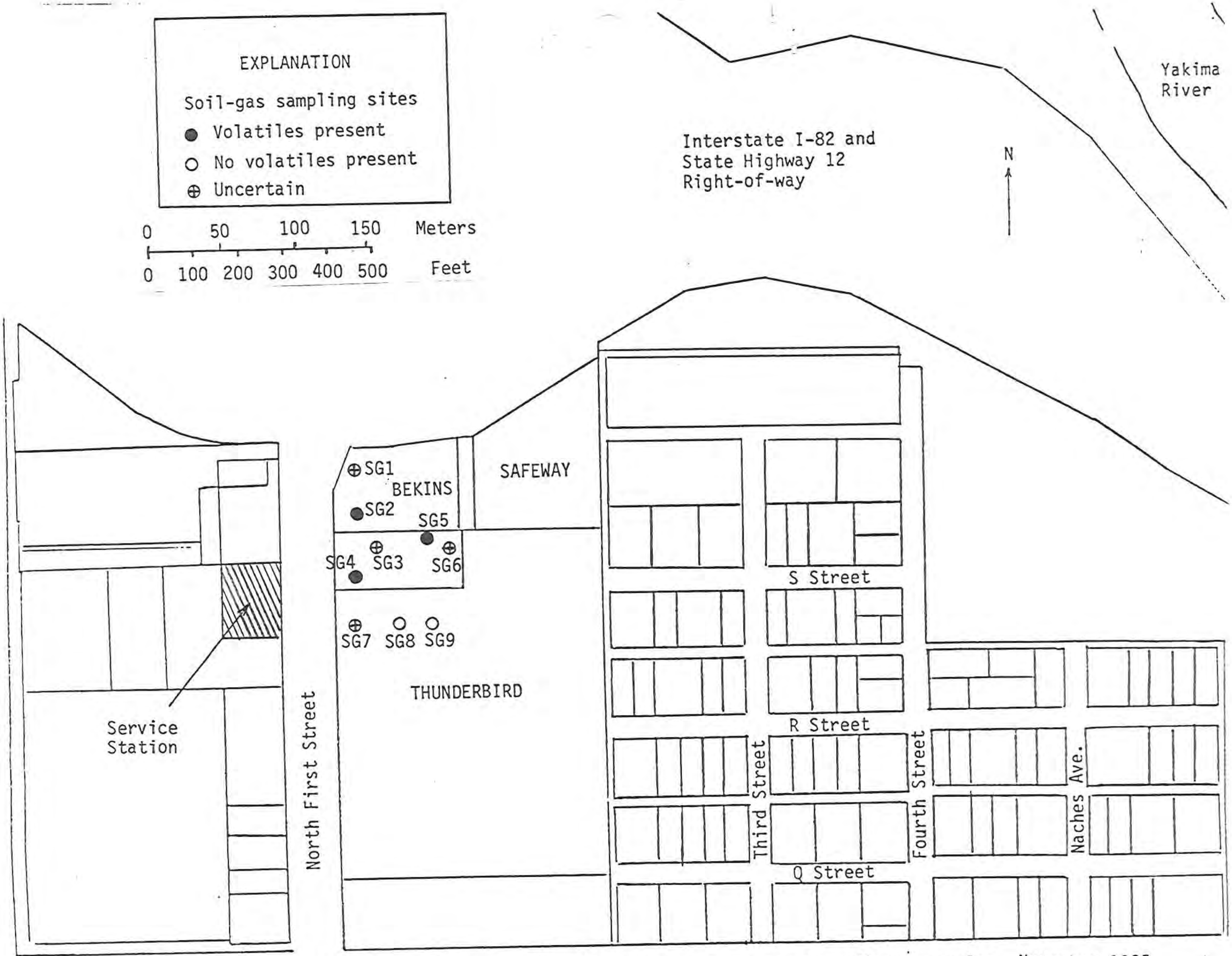


Figure 11.--Qualitative results of the testing for volatile organic compounds in soil-gas samples, November 1985.

Thunderbird properties. The data, as represented by concentrations of benzene and naphthalene (fig. 12), support previous conclusions that some of the dissolved hydrocarbon compounds are migrating in an east-north easterly direction. The need to install observation wells on the Bekins and Safeway properties was also established.

fig 12

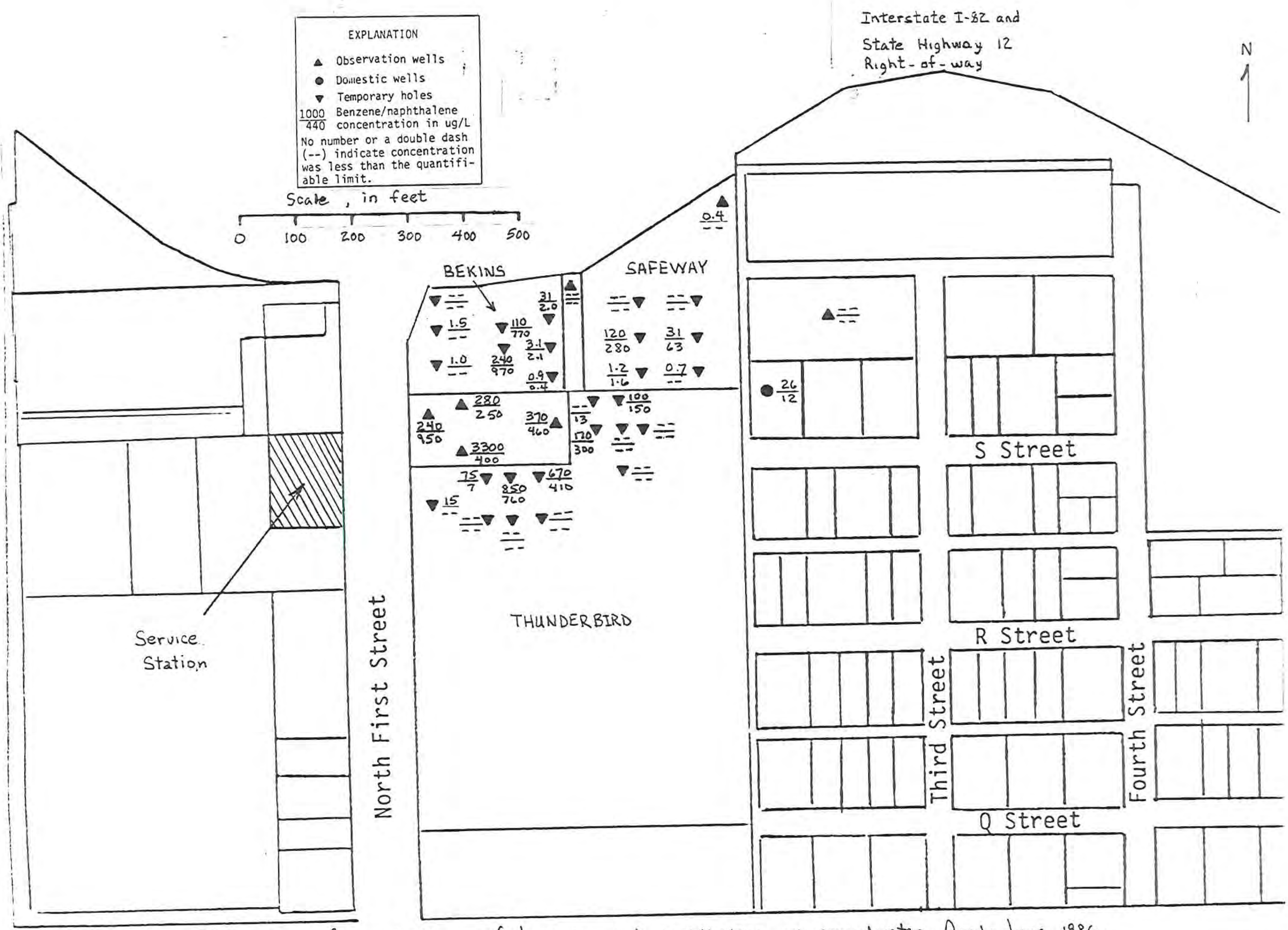


Figure 12. -- Concentrations of benzene and naphthalene in groundwater, April-June 1986.

Installation of observation wells and Soil-Gas Sampling Devices

In September 1986, 34 observation wells and eight soil-gas sampling devices were installed at the Yakima site. The resulting network of observation wells (fig. 13) also includes those previously installed by consultants. Some of the 34 wells installed by the U.S. Geological Survey were screened below the water table to investigate the downward migration of hydrocarbon compounds and to determine vertical head gradients.

fig 13

The soil-gas sampling devices (fig. 14) were installed by the Oregon Graduate Center for the collection of data to determine fluxes of volatile-hydrocarbon compounds, oxygen, carbon dioxide, and methane in the unsaturated zone. This element of research as well as others are described in the following sections.

fig 14

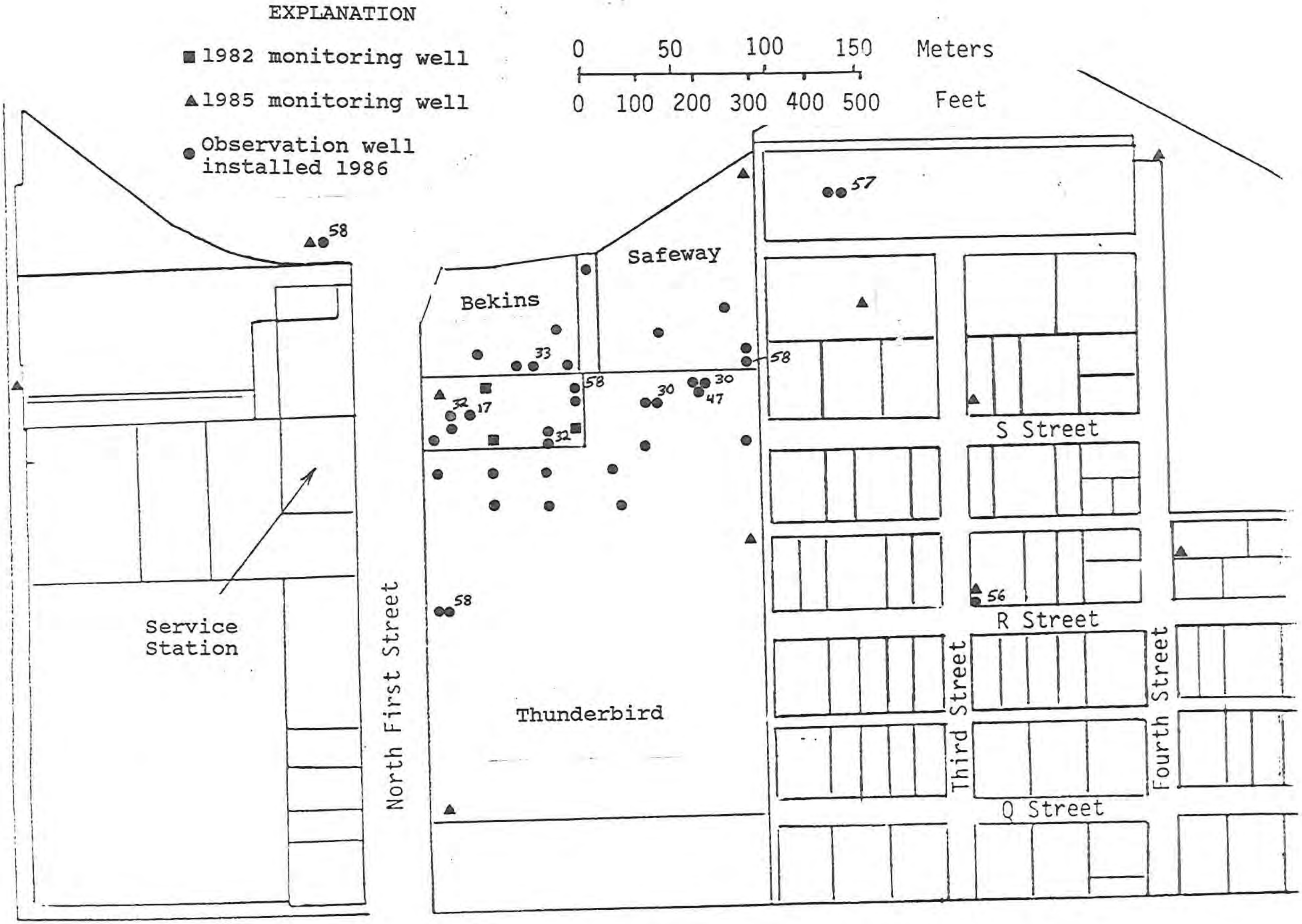


Figure 13.-- Observation-well network as of October 1986. All wells are screened at the water table unless the depth, in feet, is otherwise indicated.

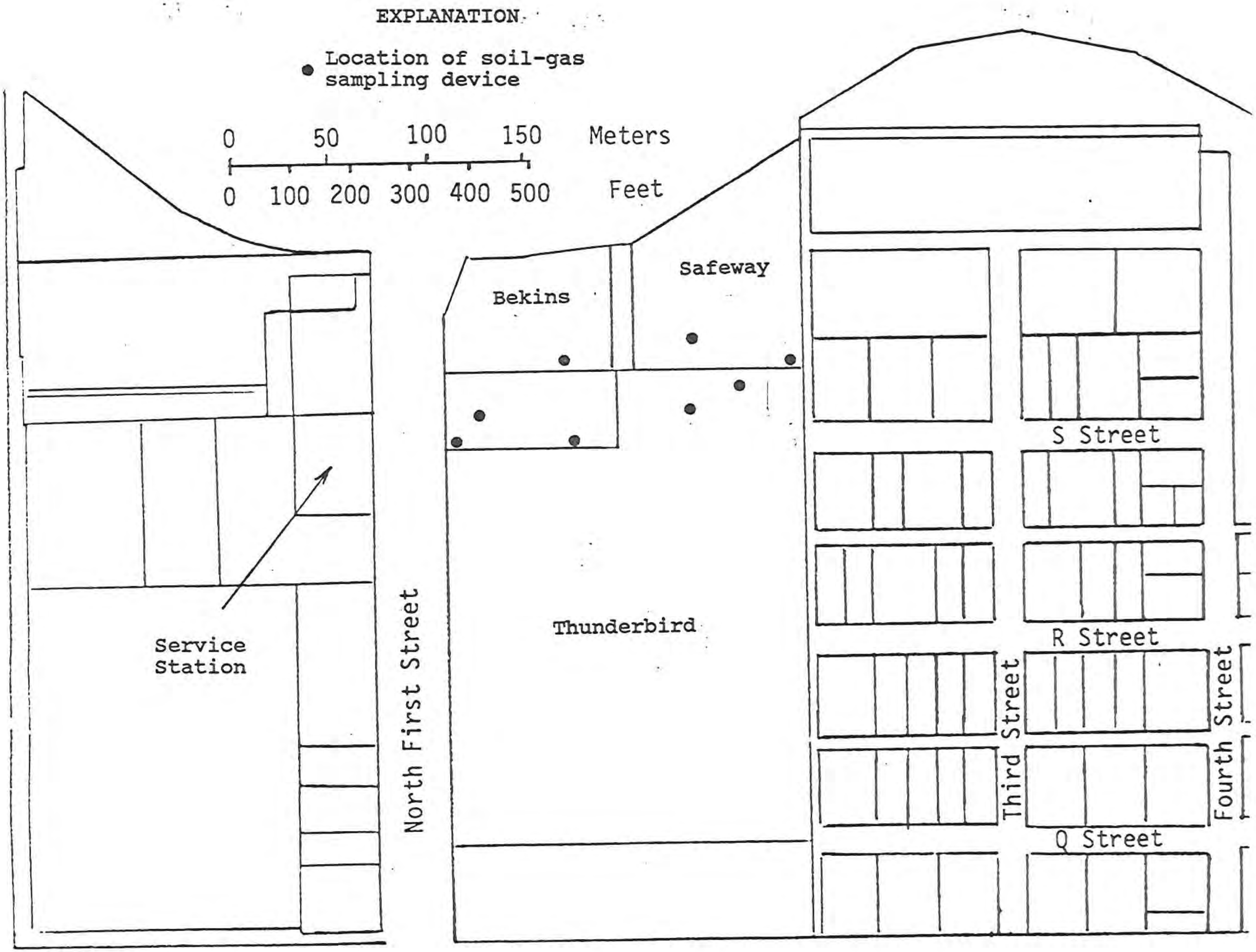


Figure 14.-- Soil-gas sampling devices installed during September 1986.

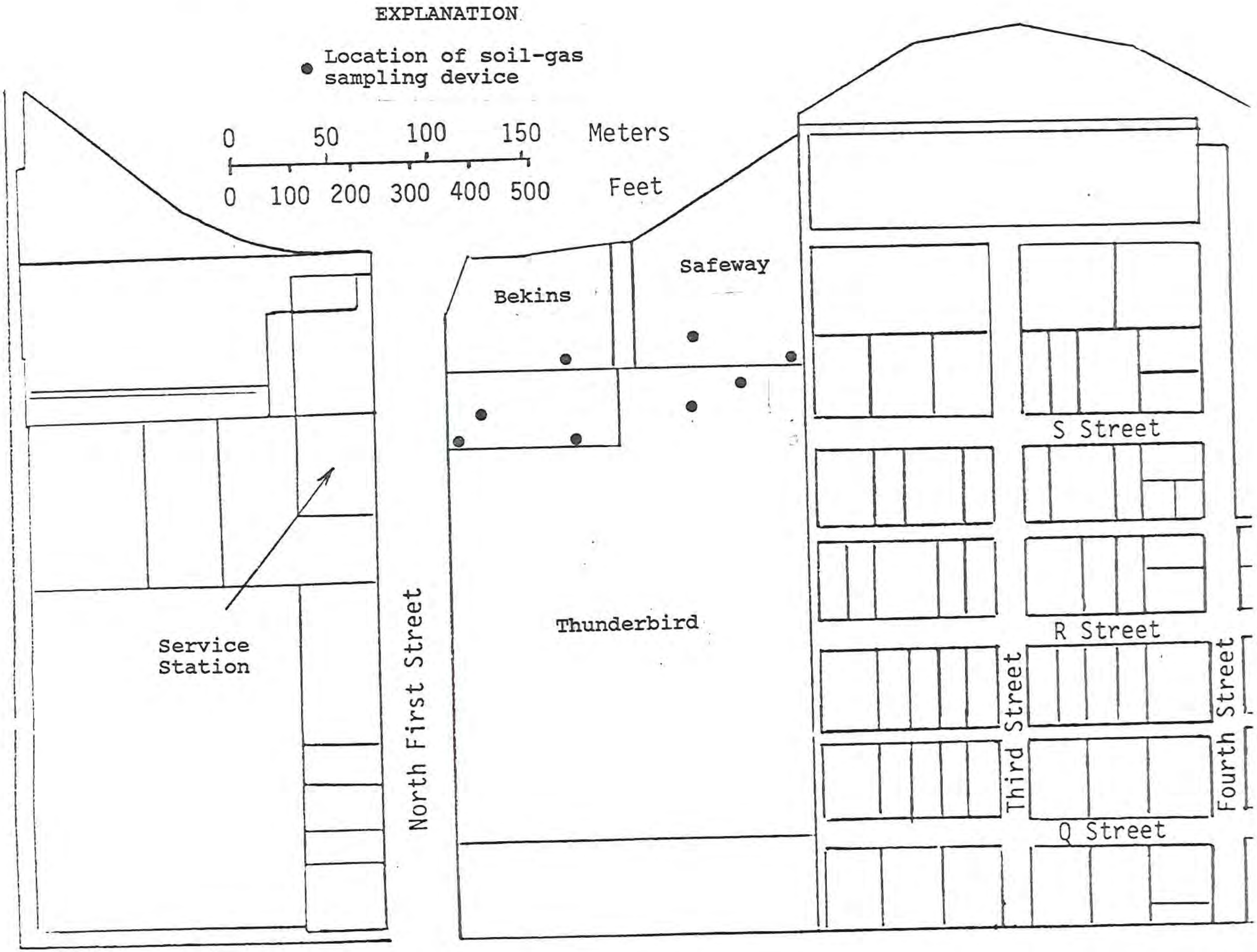


Figure 14.-- Soil-gas sampling devices installed during September 1986.

8-5- FIELD LOG

Location ______ Date 10-1-86 ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron Lane

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
			TOP OF CSG	0.15	8.85' PVC CSG CEM	0-2' Clayey silt, dark brown.	silt, clayey 0-3
				2.0	NF	2-4' Clay, silt some gravel (< ½") dark brown.	Gravel cobbly 3-6
5				4.0	B	4-6' Cobbles and coarse grave [cobbles at 5'] fragments to ½", some silt to coarse sand, gray.	
				6.0		6-8' Same	Sand and gravel 6-17
10				9.0	SAND	8-10' Fine sand to gravel (≤ 1/4"), gray, wet.	
				13.5		10-12 Fine sand to ½" gravel, some fragments > ½", grayish brown, dry.	
15					NAT FILL	12-14' Same as above.	
				18.0 18.3 BH		14-16' Fine sand to ½" gravel, grayish brown. No fragments more sand than above	Sand, fine to coarse, gravelly 17-18
						16-18' Same as above, but more moist, plus brown fine to coarse sand at 17+ and beyond	
						18' to BH Fine to coarse sand, some fine gravel, saturated.	

S 1 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist DS. Peterson

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

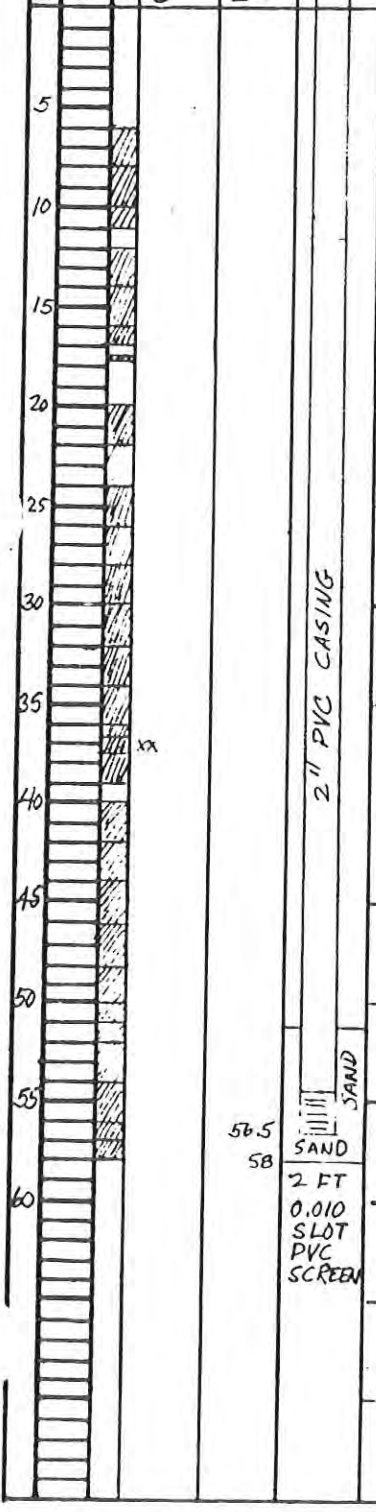
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log



Lithologic description

Asphalt surface
0-4' Soil, silty clayey

6-8' Silt and gravel, fine, dark.
Gravel, coarse, rounded clasts to 15mm.
8-10' Sand, medium to coarse, clayey, brown; with gravel, fine, black
11' Same as above
12-14' Same as above but wet. Water Sample
14-16' Silty (brown water) sand, medium to coarse, dark with gravel, fine, black.
16-17' Gravel coarse with silt fine gravel; dark green to black
17.5' Water dark brown, very silty coarse sand with very fine to coarse gravel
20-22' Sand and gravel, silty; water less brown
23'

Summary log

Asphalt surface
Soil, silty clayey 0-7'
Gravel 7-8
Sand, clayey, gravelly 8-10
Gravel, silty sand 16-20'
Sand and gravel silty 20-22'

9-230
(Rev. 9-67)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

File No. 1 of 2

YAKIMA OIL&GAS SPILL

Well Number	Altitude of LSD (NGVD)	Altitude of MP NGVD	DEPTH OF HOLE AT TIME OF DRILLING (FT)		DEPTH TO BOTTOM OF SCREEN	ALTITUDE OF BOTTOM OF SCREEN	DEPTH TO TOP OF SCREEN	ALTITUDE OF TOP OF SCREEN	LENGTH OF SCREEN	BOTTOM OF BENTONITE SEAL		
1-85	1080.48	1080.349	21.0		18.52		5.84		15.0	NONE —		
2-85			20.0		20		3.0		15.0	—		
3-85			21.0		19.12		3.7		15.0	—		
4-85			21.0		19.94		4.9		15.0	—		
5-85			18.0		16.82		1.5		15.0	—		
6-85			21.0		19.28		4.0		15.0	—		
7-85			20.0		19.25		3.9		15.0	—		
8-85			22.0		20.04		4.9		15.0	—		
9-85			21.0		19.82		4.5		15.0	—		
10-85			21.0		19.27		4.0		15.0	—		
11-85			22.0		20.49		5.0		15.0	—		
12-85			22.0		21.36		6.0		15.0	—		
1-82										—		
2-82										—		
3-82										—		
T-1			56.0		58.0		55.0		3.0	54-55		
T-2			32.0		30.0		28.0		2.0	27	JOINT [illegible] AT DEPTH OF 8' [illegible] MAY LEAK	
T-3			33.0		30.0		28.0		2.0	26	OGC SAMPLERS UNTIL 8 FT - CAVED ?	
T-4			16.0		12.0		3.2		8.2	3.5	WELL TOO CLOSE TO TB [illegible] COMMUNICATE	
T-5			17 20.0		15.5		13.5		2.0	12.5		
T-6.1			41.0		46.65		44.65		2.0	32.95 37.95		
T-6.2			(35.95)	← No PLUG →	13.65		7.65		6.0	—		
T-7.1			36.3		37.3		35.3		2.0	25.0		
T-7.2			[illegible] 14.		13.3		7.3		6.0	—		
T-8			18.3		14.35		8.35		6.0	—		
T-9			18.3		13.04		7.04		6.0	5.0		
T-10			12.3		14.3		8.3		6.0	5.3		
T-11			18.3		14.2		8.2		6.0	5.6		
T-12			18.3		13.4		7.4		6.0	6.2		
T-13			33 > 36.		32.2		30.5		2.0	Not Finished	OGC will finish	
T-14			18.3		12.8		6.8		6.0	4.1		

9-230
(Rev. 9-67)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

File No. [illegible]

YAKIMA OIL & GAS SPILL

WELL NUMBER	ALTITUDE OF LSD NGVD	ALTITUDE OF MP NGVD	DEPTH OF HOLE AT TIME OF DRILLING	ALTITUDE OF BOTTOM AT TIME OF DRILL.	DEPTH TO BOTTOM OF SCREEN	ALTITUDE OF BOTTOM OF SCREEN	DEPTH TO TOP OF SCREEN	ALTITUDE OF TOP OF SCREEN	LENGTH OF SCREEN IN FEET	BOTTOM OF BENTONITE SEAL		
T-15			18.3								Soil gas well Not installed	
T-16			18.3		13.9		7.9		6.0	4.8		
T-17			18.3		13.7		77		6.0	4.9		
T-18			18.3		13.1		71		6.0	4.7		
T-19			18.3		13.8		7.8		6.0	5.7		
T-20			18.3		13.2		7.2		6.0	6.2?		
T-21			58.3		58.3		56.3		2.0	51.3		
T-22			18.3		12.7		6.7		6.0	6.6		
B-1			18.3	← No [illegible] →	12.5		6.5		6.0	5.5		
B-2			18.7	DITTO	13.6		7.6		6.0	5.0		
B-3			38.0		32.3		30.3		2.0	15.5		
B-4			18.4		14.0		8.0		6.0	4.0		
B-5			18.3		12.0		9.0		9.0	6.0		
S-1			52.0		57±		55		2.5			
S-2			18.3		16.85		7.7		9.0	7.5?		
S-3			16.3		16.8		7.8		9.0	5.6		
S-4			17.4		17.4		8.65		9.0	4.8		
S-5			18.3		<10.0						Soil Gas Well Not completed	
H-1			58.		57.02		55.02		2	49.0		
H-2			18.3		14.60		8.60		6.0	5.5		
GS-1			15.0		14.?		~7.0		7.0	~6.0		
GS-2			re-used 17		13		6.0		7.0	~3+		
3/R			58.5		56.21		54.21		2.0	46.0		
MESA												
WS 1			58.		57.98		55.98		2.0	50.0		

T-1 [illegible]

Location Yakima Arch Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist D.S. Peterson

Rge. ______ Twsp. ______ Sec. ______

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action	CONSTUCTION +.5' LSD	Lithologic description	Summary log
						0-3'. Soil, very silty and clayey No samples	Silt, clayey
5						3-6'. Increasing pebbles No samples	
						6-7'. Cobbles with very coarse sand and fine gravel	Gravel, cobbly and sandy
10					6" diameter hole - Back filled with cuttings	10'. Change, much silt and fine sand with medium gravel, also cobbles still present. (brown silt, darker sands).	Silt, sandy gravelly and cobbly.
15						15' Sand, fine to very coarse, clay, silt, fine. gravel, some cobbles	Sand, clayey, silty and gravelly
						17' Change to much more silt and fine sand.	Sand, silty
20						20' Silt, fine to very coarse sand, very fine gravel some cobbles, clay?	Silt, sandy gravelly
25						25' Medium sand to fine gravel, some silt. (brown to dark gray)	Sand and gravel, silty
						28' Water changed in color from light muddy brown to reddish brown.	
30					2" PVC PRODUCTION	30' Silt, some fine to very coarse sand and fine gravel. gravel contains quartz, mafics feldspar variable dark colors.	Silt, sandy, gravelly
						34' Water turns muddy brown again.	
35						35' Silty medium sand, some clay and fine gravel.	Sand silty, gravelly
40						40' Silty fine to coarse sand, some cobbles some clay(?) (brown and black). Water turning bluish (Gas slick?)	
45						45' Silt, some fine to medium sand and pebble gravel (gravel clasts black and green).	Silt sandy, gravelly
50				Bentonite		50' Silt, fine to coarse sand and fine gravel Gravel clasts mostly mafic. Water very blue.	
55					Sand Pack	55' Silty medium sand, dark gray to black, and fine gravel, black.	Sand, silty, gravelly
					3' 0.010 Slot PVC screen	58' Same as above, bottom of hole	Bottom of hole

T-2

Location YAKIMA WASH Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist D.S Peterson

Lithologic Symbols

☐ ☐ ☐

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec.

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
			TOP 8' BEING USED FOR DGC MULTILEVEL SAMPLES			0-6' Soil, clayey some silt.	Soil, clayey silty
5		▨					
						7-8' Cobbles (drilling much harder) fragmented gravel.	gravel, cobbly
10		▨			2" PVC PIPE	10' Silty fine to very coarse sand with very fine to fine gravel. Sand grains generally quartz, gravel clasts are basaltic.	sand, silty; gravelly
		▨				12' Medium to coarse sand, some silt, and fine gravel, black	
15		▨				14' Silty sand with fine to coarse gravel. darker than above.	
		▨				16' Same as above	
		▨				18' Clay and silt with some sand brown and black.	clay and silt, sandy
20		▨				20' Same as 18'.	Sand, silty gravelly.
25		▨		BENTONITE SEAL QUESTIONABLE MAY HAVE BRIDGED JOINT MAY LEAK	SAND PACK	25' Silty sand (coarser than above) with very fine gravel	
30		▨				30' Same as above	
		▨			↑ 2FT 0.010 SLOT PVC SCREEN	32' Same as above but entered medium gravel zone.	Gravel, sandy ? bottom of hole

T-3 - ELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist D. B Sapik ?

Lithologic Symbols

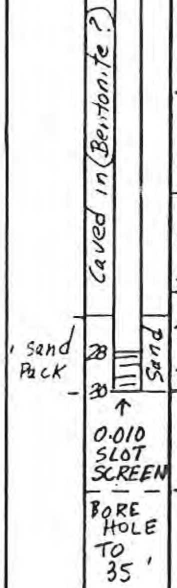
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______



Depth	Scale	Sample	Graphic log	Drill action	?	Lithologic description	Summary log
						0-6'. Clay to medium sand	Clay sandy 0-6
5						6-8' gravel	Gravel 6-8
						8-10' Sand	Sand [illegible]
10						10-12' Sand and gravel 12-14' Sand and gravel - hard drilling	Sand and gravel
15						14-16' Sand and gravel (clasts > than 1") (hard drilling; large chips) 16-18' Sand and gravel, rounded pebbles up to 1" at 17".	
20						18-22 Fine sand to gravel	
						22-24' Coase sand and gravel, some chips.	
25						24-26' Clay, fine to coarse sand	Clay, sandy. 24-26
30						26-28' Clay, fine sand, gravel to 1/4" 28-30' Medium sand, clay, gravel to 1/2"	Sand, clayey, gravelly. 28-30
35							

7 - 16 [illegible]

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Lithologic Symbols

☐ ☐ ☐

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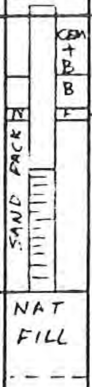
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______ Sec. ______



Depth	Scale	Sample	Graphic log	Drill action	Top OF csg, -0.5'	Lithologic description	Summary log
						0-2' Silty clayey fine to medium sand, brown gravel fragments to ½", gray. Drill sounds cobbly gravel	Sand, silty clayey gravelly, cobbly 0 - 14
				3.1		2-6' Silty clayey sand as above. Fine sand to ½" gravel. Drill cobble gravel. 4 to 6' Brownish gray.	
5				4.8 5.3		6-12' Same as above	
10						12' 14' Same as above, saturated. Sample 12.5'	
15				13.9		14'-18' Fine to coarse sand, some silty gravel to ½"+ brownish gray.	Sand, silty gravelly 14 - 18
				18.3			

T-17 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Rge. ______

Twsp. ______ Sec. ______

Lithologic Symbols

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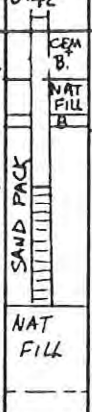
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG 0.42	Lithologic description	Summary log
				0 2.5		0-2' Clayey silty fine sand, gravel to 1" Drill sounds like cobble gravel	Sand, clayey, silty, gravelly, cobbly 0-4
						2-4' Same as above.	
5				4.2 4.9		4-6 Fine to coarse sand, gravel (to ½") grayish brown. Drill sound like cobble gravel.	Sand and gravel 4-18
				7.7		6-10' Same as above.	
10						10'-12' Med to coarse sand (less than above) gravel with frags ½ (more than above) Drill still sound like cobble gravel.	
15				13.7		12'-14' Same as above. Saturated	
						14'-16' Silty fine to coarse sand and gravel (To ½") brawnish gray.	
				18.3		16-18 Same as above but gravel to 1"+.	



T-18 FIELD LOG

Location ________ Date ________ Local well number ________

County ________ Map ________ Scale ________ Lat. ________ Long. ________

District ________ Project number ________ Altitude ________

Driller ________ Helper ________ Geologist Ron C Lane

Lithologic Symbols

☐ ☐ ☐

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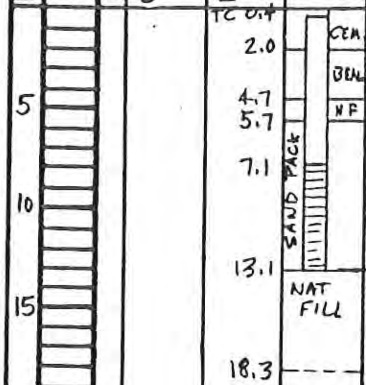
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____ Twsp. ____ Sec. ____

Depth | Scale | Sample | Graphic log | Drill action



Lithologic description	Summary log
0-2' Silty clayey fine sand, brown.	Sand, silty clayey 0-8
2'-4' Same as above (clayey lumps)	
4-6' Same as above lots of clay could be silty sandy clay.	
6-8' Same as above.	
8'-10' Same as above but drill sounds like in cobble gravel. Grayish brown.	Sand silty clayey and cobble gravel 8-10
10-12' Silty clayey fine sand to gravel (fragments to 1/2") Drill sound like in cobble gravel. Grayish brown.	Sand and gravel 10-18
12-14' Sand, coarse, gravel (to 1/2") some fine to medium sand, brownish gray. Wet at 14'	
14'-18 Silty clayey fine sand to gravel brownish gray, as above but more fines and larger fragments. At 18'+ water color became reddish brown	

T-19 [illegible]

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Don C Lane

Lithologic Symbols

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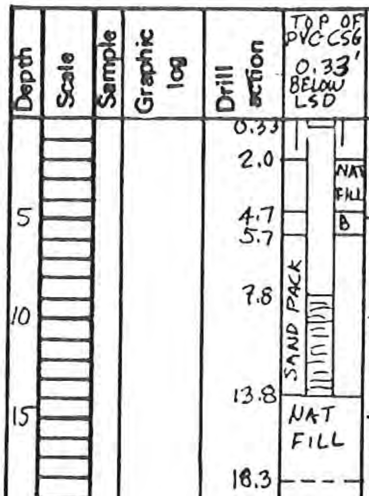
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______ Sec. ______



Lithologic description	Summary log	
0-2' Silty clayey fine sand, light brown.	Sand, silty clayey	0-2
2'-4' Fine to coarse sand, gravel (To ½") Drill sound as if in cobble gravel	Sand and gravel	2-9.5
4-6' fine sand to gravel (to ½") as above Drill sound as if in cobbles		
6-8' Same as above.		
8-9.5' Same as above		
9.5-10' Similar but contains brown clayey silt. Drill still sounds cobbly.	Sand and gravel clayey and silty	9.5-.3
10-12' Same as above		
12-14' Silty sandy gravel (to ½") gravel to 1¼ moist, brownish gray.		
14-16' Silty fine to coarse sand gravel (to ¾") brownish. Saturated at 14'		
16-18' Similar but color is reddish brownish gray		

T-20 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Rge. ______

Twp. ______ Sec. ______

Lithologic Symbols

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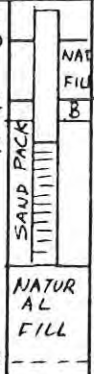
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG. 0.3 BELOW LSD	Lithologic description	Summary log
				0.3		0-2' Silty clayey fine sand, brown.	Sand, fine, silty, clayey, 0-2
				2.0		2'-4' Silty, clayey, fine to coarse sand and gravel (fragments to ½") Could be Cobbles	Sand and gravel silty clayey cobbly 2-11.5
5				5.2 ?		4-6' Same as above but gravel to ⅛", Cobbles still present.	
				7.2		6-8' Same as above. Drill still sounds as if in Cobbles.	
10						8-10' Silty fine to coarse sand, gray brown and gravel (To ½") gray black, Cobbles. Frags are basaltic.	
						10-11.5' Same as above	
				13.2		11.5-12' Silty sandy gravel (To ½") grayish brown.	Sand and gravel, silty 11.5-18
15						12-14' Sand, fine to coarse, gravel (to ½") grayish brown, saturated at about 13 feet.	
				18.3		14-18' Same as above	

T-21

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C Lane

Rge. ______

Twsp. ______ Sec. ______

Lithologic Symbols

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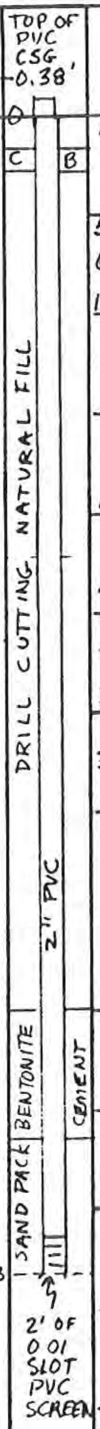
Abbreviations

clay	c	cobbles	cob	sandy	sdy		
silt	st	boulders	b	fine	f		
sand	s	clayey	cly	medium	m		
gravel	g	silty	sty	coarse	co		



Depth	Scale	Sample	Graphic log	Drill action	Lithologic description	Summary log	
				1.5 2.5	0-5' Silty clayey fine sand, brown.	Sand, silty, clayey	0-5
5					5-6' gravel, cobbly (Drill rig) Fragments to ½"	Gravel, cobbly	5-6
					6-10' Silty fine to coarse sand, gravel (to ½") grayish brown. Cobbly drilling	Sand and gravel, silty cobbly	6-18
10					10-18' Same but brownish gray, saturated between 12 and 14 feet		
15							
20					18-24' Silty fine to coarse sand, gravel (to ½") grayish brown. No cobbles	Sand and gravel (more clay in samples below 32')	18-58.3
25					24-26' Silty fine to coarse sand, gravel (to ½") brownish gray		
					26-28 Same except grayish brown		
30					28-32' Same except brownish gray		
					32-58.3' Same, except more clay, color dull gray to blackish gray/brownish gray		
35							
40							
45							
50							
55							
				58.3			

T-22 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Rge. ______

Twp. ______

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG -0.43'	Lithologic description	Summary log
					B CEM	0-7' Silty clayey fine sand, brown.	Sand, silty, clayey 0-7
				2.5	N F		
5					B		
				6.6 6.7	SAND PACK	7-12' Silty clayey fine sand to gravel (to ½") brownish gray. Drill is hitting cobbles	Sand and gravel, silty 7-18.3
10						12-14' Silty fine sand to gravel; brownish gray. Drill is in fine gravel.	
				12.7	NAT. FILL	14-16' Same as above but grayish brown color.	
15						16-183' Same but reddish brown	
				18.3			

T-22 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Rge. ______

Twp. ______

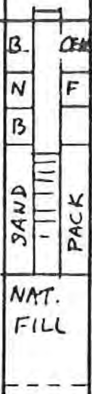
Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co



Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG -0.43'	Lithologic description	Summary log
				2.5		0-7' Silty clayey fine sand, brown.	Sand, silty, clayey 0-7
5							
				6.6 6.7		7-12' Silty clayey fine sand to gravel (to ½") brownish gray. Drill is hitting cobbles	Sand and gravel, silty 7-18.3
10							
				12.7		12-14' Silty fine sand to gravel, brownish gray. Drill is in fine gravel.	
15						14-16' Same as above but grayish brown color	
				18.3		16-18.3' Same but reddish brown	

B1 FELWS

Location YAKIMA, WASHINGTON Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist ______

Lithologic Symbols

☐ ☐ ☐

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______ Twsp. ______ Sec.

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
			TOP OF CSG.	0.3	B	0-2' Light brown very fine sand and silt.	sand very fine and silt 0-4
				2.0	DRL, 6'x2" PVC, CUT	2-4 Light brown fine sand and silt some brown clay.	
5				4.5 5.5	B	4-6 Gray fine-coarse sand and gravel, fragments to 1/4". Drill sounds like coarse gravel or cobbles.	Sand and gravel 4-9
				6.5 6'x2" 0.01 SLOT PVC SCREEN	SAND PACK	6-8' Same except gravel to 1/4"-3/8"; Fragments (few) to 1/2"+	
10						8-9' Sand, medium to coarse, some fine, less sand than above, gravel > 1/4" more gravel than above Fe in fragments	
				12.5		9-10' Sand medium to coarse, brown to gray, very little fine gravel to 1/4", No fragments. Clay ?, Silt ?.	Sand, medium to coarse 9-10
15					BACK FILL - DRILL CUTTINGS	10-12' Sand fine to coarse, gray, with clay and silt; gravel, gray brown, Fragment to 1/2". Drill hitting cobbles and boulders.	Sand and gravel 10-18
				18.3		12-14' Sand, fine to coarse, very little gravel, clay, gray brown.	
						14-16 Sand, fine to coarse and gravel to 1/2", some fragments, clay/silt gray	
						16-18.4 Sand, fine, silt and gravel to 1/4", brownish gray to grayish brown	

B-2 FIELD

Location YAKIMA, WASH Date Local well number

County Map Scale Lat. Long.

District Project number Altitude

Driller Helper Geologist Ron Lane

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge.

Twsp.

Sec.

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
				TG0.3		0-2' Dark brown clayey silt.	Silt, clayey 0-2
				2.1	7.3' 2" PVC N	2-4' Same as above but gravel to 1¼", fragments to ¼". Cobble and coarse gravel drill action. (possible parking lot fill?)	Gravel, cobbly coarse, silty 2-8
5				4.2 5.0	B	4-6' Sand, fine to coarse, mostly fragments to ¼" - Drill still hitting cobbles. Some fines (clay and silt) being blown away	
				7.6		6-8' Sand, fine to coarse, fragments to ½" Drill still in cobbles. Silt and clay still being blown away	
10			▽	0.01 slot PVC SCREEN	SAND	8-10' Sand, fine to coarse, dark gray and gravel to ¼". No clay in exhaust returns	Sand and gravel, silty 8-18.7
				13.6 14.1		10-12' Silt, sand, fine to coarse, gravel with fragments to ¼", dark gray, saturated	
15					NATURAL FILL	12-14' Same as above but few fines more gravel fragments.	
				18.7 BH		14-16' Same as above, but much more fines and less gravel fragments	
						16-17.5' Silt, coarse sand, gravel with fragments to ½", dark gray.	
						17.5-18.7' Similar to above, but lacks fines, dark brown. Much evidence of gasoline	

B-3 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron Lane

Rge. ______ Twsp. ______ Sec. ______

Lithologic Symbols

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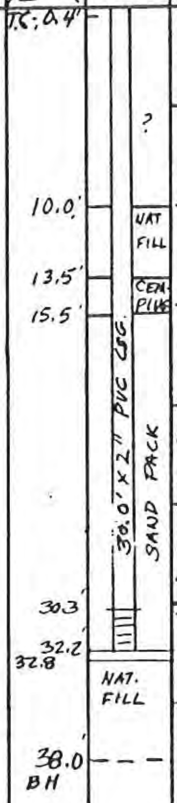
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth | Scale | Sample | Graphic log | Drill action



Depth: 5, 10, 15, 20, 25, 30, 35

▽ (10)

Lithologic description

0-2' Sand, clayey silt, dark brown

2-4' Silty, fine to coarse, sand, fragments to ½" Drill sound, cobble gravel.

4-6 gravel, fragments to ½", most < ¼", Some medium to coarse sand, some rock dust? gray. Drill sound as if in cobble gravel

6-8' Same as above

8-10' Silty fine to coarse sand to gravel, Fragments to ½" Strong gas or diesal odor. H_2O at 10'.

10-12' Silty fine to coarse sand, some fine gravels Strong gas odor.

12-14' Silty coarse sand to gravel, fragments to ¼. Dark gray. Gas odor decreasing?

14-16' Silty fine sand to fine gravel (< ¼"), dark gray.

16-18' Same as above gravel to ¼", dark brown

18-20' Silty fine to coarse sand, gravel (Fragments to ½"), dark brown.

20-22' Silty fine to coarse sand and gravel, (clasts to ½") dark brown, Less odor,

22-24' Same as above, more sand, less gravel and silt.

24-26' Same as above.

26-28' Silty fine to coarse sand and fine gravel (< ¼"), dark brown. Strong diesel fuel odor.

28-30' Same as above but at 30' distinct change to light brown color. Foam on water and strong odor of organic decay

30-32' Silty fine sand to coarse sand gravel (¼ to ½" range), dull grayish brown

32-34' Same as above

34-36' Same as above

36-38' Fine to coarse sand, mostly medium to coarse sand, no gravel, dark gray.

Summary log

Sand, silty, clayey	0-3'
Gravel, cobbly	3-8
Sand and gravel	8 - 36
Sand, fine to coarse	36 -38

B-4 FIELD LOG

Location ____ Date ____ Local well number ____
County ____ Map ____ Scale ____ Lat. ____ Long. ____
District ____ Project number ____ Altitude ____
Driller ____ Helper ____ Geologist Ron Lane

Lithologic Symbols

☐ ☐ ☐
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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____
Twsp. ____
Sec. ____

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
				T.C.-15	Ø 2" PVC CSG. CEM	0-1' Blacktop and parking lot fill.	Blacktop and fill 0-1
				2.0	NF	1-4' Silty clay, fine to medium sand and gravel (to ½"), dark gray	Clay, silty, sandy gravelly 1-4
5				3.2 4.0	B	4-6' Fine sand and gravel (to ¼"), dark gray.	Sand and gravel 4-6
					SAND PACK	6-8' Gravel (returns = fragments to ½") light gray Drill sounds as if in cobble gravel.	Gravel, cobbly, sandy 6-18.4
10				8.0		8-10' Same as above but finer. Medium sand to ¾" fragments.	
						10-12' Same as above	
						12-14' Same as above	
15						14-15.7' Similar, but fine in fine to coarse sand range. Saturated. Dark brown	
					NAT. FILL	15.7-16 No samples, no changes. No odor.	
				18.4 BH.		16-18' Same as above.	

T-15 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Silty clayey fine sand, gravel to ½", dark brown Drill sound like cobble gravel.	Sand, fine, silty clayey 0-4.5
						2-4.5' Same as above	
5						4.5'-9.5' Gravel, fragments to ¼", fine sand, cobbles	Gravel, sandy, cobbly 4.5-9.5
10						9.5-10' Fine sand to gravel (>½") dark brownish gray. H_2O at about 10'	
						10-12' Silty fine sand to ½" gravel, brownish gray, saturated. More fines than above. Some cobbles.	Sand and gravel 9.5-18
15						12-16 Same as above.	
				18.0		16-18' Same as above but some fragments in 3/4 to 1" size.	
					To be completed by OSC		

5-2 - [illegible] LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron Lane

Rge. ______

Twp. ______

Sec. ______

Lithologic Symbols

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Abbreviations

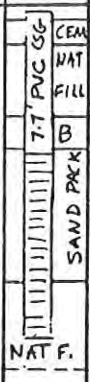
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth | **Scale** | **Sample** | **Graphic log** | **Drill action** | | **Lithologic description** | **Summary log**

Depth: 5, 10, 15

Graphic log: Top of CSG; ∇ (at about 10)

Drill action: 0.15', 2.0, 5.8, 7.5 7.7, 14.0, 16.85, 18.3



0-1' Blacktop of parking lot and fill.

1-2' Silty clayey fine sand, dark brown

2-4' Same but fragments to ½". Cobble gravel at about 3½'

4-6' Cobble gravel, fragments to ½", clean.

6-8' Upper as above gray. lower fine to coarse sand, grayish brown.

8-10' Coarse sand gravel to ¼" with fragments, light dull gray.

10-12' Same as above, but wet, dark gray Some fine to medium sand

12-14' Silt and brown fine sand and gravel (<½") gray, saturated. Hydrocarbon odor.

14-16' Same as above

16-18' Same as above

Summary log

Blacktop and fill	0-1
Sand, fine, silty and clayey	1-3½
Gravel, cobbly, sandy	3½-7
Sand and gravel	7-18

S-3 [illegible]

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron Lane

Rge. ______

Twsp. ______ Sec. ______

Lithologic Symbols

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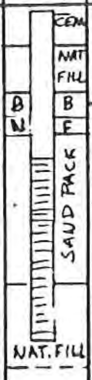
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co



Depth	Scale	Sample	Graphic log	Drill action	Lithologic description	Summary log	
			TOP OF CSG →	0.12	0-1' Black-top and parking lot fill	Blacktop-fill.	0-1
				2.0	1-2' Silty, clayey fine sand, gravel to ¼", dark brown	Sand, fine, silty, clayey	1-5
				4.2	2-5' Same as above		
5				5.6 6.5	5-6' Gravel, gray, fragments to ½" and med to coarse sand.	Gravel, sandy	5-16
				7.8	6-8' Same as above		
					8-10' Same		
10					10-12 gravel (< ½") grayish, silt to fine and medium sand, grayish brown		
				14.0	12-14' Same as above but saturated at about 14'		
15					14-16' Gravel (≤ ½") grayish and silt with fine to coarse sand, brown. Saturated		
				16.8 18.3 BH	16-18' Silt and fine to coarse sand, dark brown, gravel (≤ ½"), gray-brownish. Saturated.	Sand, silty, gravelly	16-18

S-4 [illegible]

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C Lane

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
				0.25		0-1' Blacktop and fill.	Asphalt and fill
				2.0		1-2' Silty clayey fine sand to gravel (≤ 1/4"), dark brownish gray.	Sand fine clayey silty 1-4
				4.2		2-4' Same as above.	
5				4.8		4-6' Medium to coarse sand and gravel to 3/8" (Cobble Fragments), some silt and clay (blows away in wind).	Sand and gravel (cobbly) 4-18
				8.65		6-8' Same as above.	
10						8-10' Same as above	
						10-12' Same as above except color has changed to reddish brown and gray.	
15				17.4		12-14' Silty fine to coarse sand and gravel to 1/2", dark grayish brown. Saturated, diesel fuel odor.	
				18.0 BH		14-16' Same as above.	
						16-18 Same as above.	

5-5 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Rge. ______

Twp. ______ Sec. ______

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-1' Black top and fill	Blacktop and fill 0-1
						1-2' Silty clayey fine to coarse sand, dark brown.	Sand fine to coarse, silty, 1-4 clayey
5						2-4' Same as above.	
						4-6' Medium to coarse sand and gravel (Fragments to ½") gray. Drill sounds as if in cobble gravel. Strong diesel odor.	Sand and gravel, cobbly, 4-18 silty, clayey.
10						6-8' Same as above. Some silt or clay (rock powder blowing from hole)	
						8-10' Same as above, Color changing to brownish gray.	
15						10-12' Fine to coarse, sand and gravel, fragments to ½", grayish brown.	
						12-14' Same as above.	
				18.3 B.H.		14-16' Silty fine to coarse sand and gravel to ½", grayish brown; saturated about 15 feet	
						16-18' Same as above	
						Lost hole trying to set casing - redrilled. OGC personnell finished.	

H-2 FIELD LOG

Location ______ Date 6-3-86 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JLE & GLT

Rge. ______

Twsp. ______ Sec. ______

Lithologic Symbols

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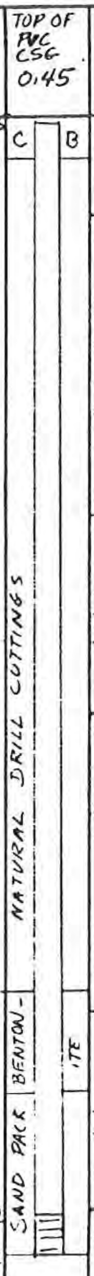
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co



Depth	Scale	Sample	Graphic log	Drill action	Lithologic description	Summary log
				0.45 2.0	0-6' Silt with some sand	Silt, sandy 0-6
5					6-8' Gravel, some sand silt and cobbles	Gravel cobbly sandy 6-12
					8-10' Cobble gravel some sand.	
10					10-12 Cobbly gravel with sand and silt.	
					12-14' Gravel, sand some silt	Sand and gravel, silty 12-20
15					14-16 Sand and gravel, some silt	
					16-18' Sand some gravel and silt	
					18-20' Gravel, sand some silt	
20					20-24' Sand, some gravel and silt. less sand than 16-18'	Sand, silty, gravelly 20-30
25					24-26 Sand, some small gravel and silt.	
					26-30 Sand, some gravel and silt. Color change silt changed from brown to gray.	
30					30-36' Gravel and sand, black, some silt (maybe clay)	Gravel and sand, silty, 30-36
35					36-40' Gravel, black, some sand, gray silt.	Gravel, sandy silty 36-40
40					40-42' Sand and gravel (50/50) black some gray silt.	Sand and gravel, silty. 40-42
				44.0	42-44' Sand, black; some gravel, gray silt.	Sand, gravelly 42-44
45				49.0	44-50 Gravel, black some black sand and gray silt. Some larger material also.	Gravel, silty, sandy cobbly 44-52
50					50-52 Gravel, black, some black sand, gray silt.	
					52-56' Sand, black some gravel, silt	Sand, gravelly, silty 52-56
55				55.02 59.02	56-58' Sand, black gravel (large broken material) a bit of silt.	Sand and gravel, silty cobbly 56-58

Location ______ Date ______ Local well number H-2

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist GLT&JCE

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG 0.5' BELOW LSD.	Lithologic description	Summary log
				0.5		0-4' Soil, brown silt some sand	Soil, silt sandy 0-4
					NF		
5				4.6 5.5	B	4-6' Gravel, some silt and sand brown	Gravel, cobbly, silty sandy 4-12
						6-8' Gravel, cobbly a little silt and sand.	
10					SAND PACK	8-12' Gravel, hard drilling (cobbles ?) gravel at 10-12' may be coarser	
						12-16' Gravel, sand some silt, brown. H₂O in cuttings between 12-14'	Sand and gravel 12-18
15				14.6	NAT. FILL	16-18' Sand and gravel, some silt. More sand than in previous (12-16') samples (50/50)	
				18'			

3-R FIELD LOG

Location ______ Date 10-10-86 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron Lane

Lithologic Symbols

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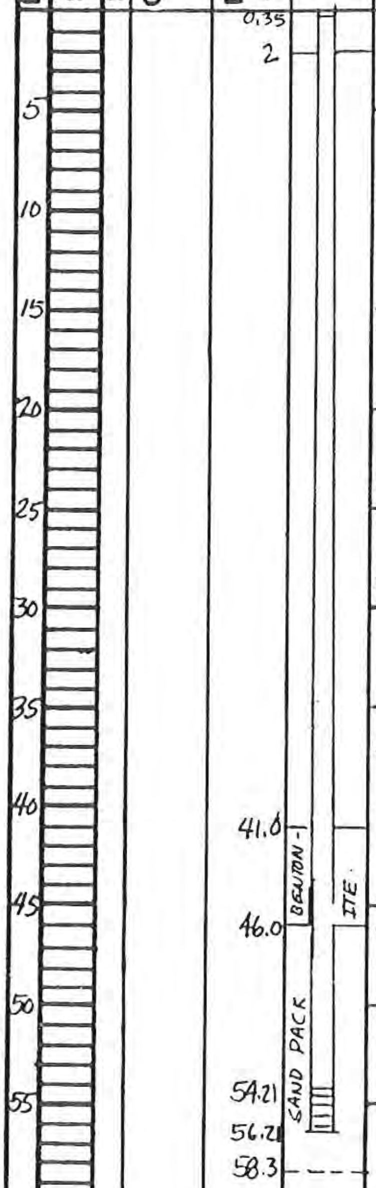
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______ Sec. ______

Depth | Scale | Sample | Graphic log | Drill action



Lithologic description	Summary log
0-2' Clayey silty fine sand, brown. 2-4' Clayey silty fine to med. sand and some gravel (To ¼") brown. 4-9' Clayey silty fine to medium sand, brown.	Sand, fine, clayey, silty 0-9
9'-10' Fine to coarse sand, gravel to ½", grayish brown. 10'-16' fine to coarse sand, gravel to ½" grayish brown, some clay and silt. 16-24 Same but with coarser gravel fragments in ¾ to 1" range. Drilling as if coarse gravel to cobbly gravel. 24-28' Same but more sand less gravel and gravel to ½" 28'-36 clayey Silty fine to coarse sand, gravel to 3/4", brownish gray. Drills as if Coarse gravel and cobbles	Sand and gravel 9-36
36-44' Clayey silty fine to coarse sand, very little gravel (To ½") brownish gray H_2O temperature is 15°C, Drilling and driving is easier.	Sand, fine to coarse clayey silty. 36-44
44'-58.3' As above but drilling is harder coarse gravel and cobbles.	Sand and gravel cobbly 44-56.3

Location ______ Date 10-6-86 Local well number T-11 FIELD LOG

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C Lane

Rge. ______ Twsp. ______ Sec. ______

Lithologic Symbols

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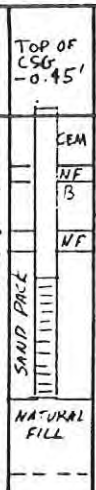
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth | **Scale** | **Sample** | **Graphic log** | **Drill action**

Depth: 5, 10, 15

Drill action: 2.4, 3.2, 5.6, 6.6, 8.2, 14.2, 18.3



Lithologic description

0-2' Silty clay fine sand, dark brown

2-4' Silty fine to medium sand tan to light brown.

4-6' Sand as above, tan, with gravel to ¼" gray.

6-8' Gravel (to ¼") gray, some tan sand.

8-10' Silty fine to coarse sand, tannish gray gravel with fragments to ¼" gray.

10-12' Fine to coarse sand and gravel (to ¼") grayis brown.

12-14' Fine to coarse sand, gravel (to ¼") brownish gray.

14-16' Fine to coarse sand and gravel, grayish brown saturated.

16-18' Similar to above but more reddish especially H_2O.

Summary log

Clay silty sandy	0-2
Sand, fine to medium, silty, gravelly	2-6
Gravel, sandy	6-8
Sand and gravel	8-18

T-12 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist ______

Lithologic Symbols

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Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	TOP OF CSG -0.45'	Lithologic description	Summary log
						0-1' Blacktop and fill.	Blacktop and fill 0-1
				2.0		1-2' Silty clayey fine sand, medium dark brown.	Sand, fine, silty, clayey 1-6
						2-4' Same as above.	
5				5.3 6.2		4-6' Same as above	
				7.4		6-8' Coarse sand to gravel (To 1/4") dull gray well sorted. Drill sounds like cobble	Sand and gravel, silty 6-18
10						8-10' fine gravel to coarse sand and gravel (to 1/8") Some silt, brownish gray. Drill sounds like cobble gravel.	gasoline odor reported
				13.4		10-12' Fine to coarse sand, (Fragments to 1/4"), grayish brown. Drill sounds indicate cobbles. Strong gasoline odor.	
15				17.4 18.3 BH.		12-14' Silty, fine to coarse sand, gravel to 3/8", dark grayish brown. Saturated and strong gasoline smell.	
						14-16' Similar to above but dark grayish brown and black, saturated	
						16-18' Medium to coarse sand and some fine sand and silt, gravel to 1", reddish brown.	

T-13 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

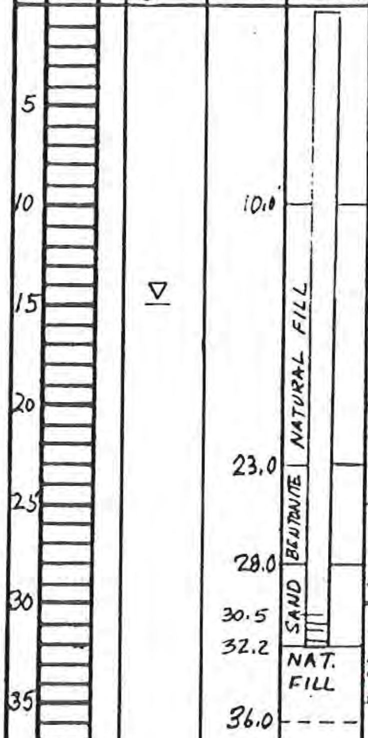
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______

Sec.

Depth	Scale	Sample	Graphic log	Drill action	TOP OF CSG 0.95 BELOW LSD



Lithologic description

0-1' Black top.
1-2' Clayey silty fine sand
2-4' Clayey silty fine sand, dark brown
4-5' As above fine sand.
5-6' Gravel gray (fragments are sandsize to ½" Some clay Drill sounds cobble gravel.
6-8' Fine sand to gravel, fragments to 1". Some Clay and silt, brownish gray. Drill sounds Like cobble gravel.
8-10' Same as above
10-12' Same as above, but brownish gray, strong gas odor
12-14' Same as above but more silt and clay
No H2O yet
14-16' Silty fine to coarse sand, gravel fragments to ½", grayish dark brown. H2O at 15'
16-18' Same as above
18-20' Same as above, but color is reddish brown.
20-26' Same as above.
26-28' Same as above with more silt and fine sand. Color less medium to gray brown
28-30' Silt to gravel (to ½") as above, medium brown.
30-32' Same as above
32-34' Same as above, color gray brown
34-36' Same as above, grayish brown

Summary log

Blacktop	0-1
Sand, clayey, silty	1-5
Gravel, sandy	5-6
Sand and gravel, clayey, silty.	6-14
Sand, silty, gravelly	14-30

T-14 FIELD LOG

Location ______ Date 12-23-86 Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
				1.7	8 CEM	0-2' Clayey silty fine sand, brown	Sand, silty clayey 0-7
					4" PVC CSG B.	2'-4' Same	
5				4.1		4-6' Same but much more clay (lumps)	
				5.3	N F		
				6.8	SAND PACK 6" (4" PVC SCREEN)	6-8' Clayey silty fine sand as above, medium to coarse sand, gravel (with fragments to ½") gray. Drill sounds like cobble gravel	Sand and gravel 7-1[illegible]
10						8-10' Fine to coarse sand and gravel (Fragments to ½"+) gray.	
				12.8	NATURAL FILL	10-12' fine sand to gravel (½"), grayish brown	Gasoline sheen on water
15						12-14' Same as above. Saturated gasoline. sheen on H_2O.	
				18.3		14-18' Same as above.	

T-4 [illegible]

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist DB. Sapik

Rge. ______

Twsp. ______ Sec. ______

Lithologic Symbols

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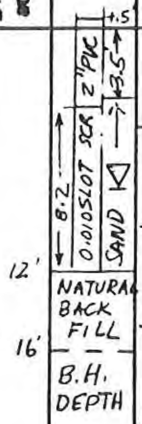
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						Same as T-3	
5							
10							
						WELL LOCATED 2' FROM T-3, (TOO CLOSE) DURING DRILLING AIR PRESS RELEASED THROUGH T-3 BORE HOLE.	

T-5 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist D S Sapik & S Peterson (0-9' Peterson)

Rge. ______ Twsp. ______ Sec. ______

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy		
silt	st	boulders	b	fine	f		
sand	s	clayey	cly	medium	m		
gravel	g	silty	sty	coarse	co		

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						0-2' Clay & silt with some gravel to ¼".	Clays & silt, gravelly 0-2
						2-5 Fine sand to gravel (max ½")	Sand and gravel 2-5'
5						6-7 Gravel (¼") to cobbles (rock chips) 7 Gravel to ¼" with fine sand.	Gravel sand cobbly 5-9.2
			CORE 8.2-9.3			8.2 to 9.2' Cobbly coarse gravel with little clayey fine sand.	
10						10-12 Very coarse sand and medium gravel some silt and fine sand; light brown water (mafic clasts)	[illegible] 9.2-14
						12-14 Medium sand and gravel, black and gray. Sewer like smell and heavy gas smell.	Gravel, [illegible] sewer smell
15						14-' Clayey silt, grey with much medium gravel, black. Gas smell.	Silt clayey, gravelly 14-16 (gas smell)
					2'FT 0.010 SLOT SCREEN PVC	16-18' Gravel, very to coarse, cemented silt to sand, medium, matrix. Gas smell	Gravel [illegible] sandy 16-18 [illegible] 17-18 much water
20						18-20 Same as above; 17-18' much water	

LOG INDICATES BOREHOLE DEPTH 18'
DIAGRAM IN FIELD BOOK SAYS 17'

TOP OF SCREEN LISTED AS 13.5 FT
PLUS 2 FT OF SCREEN SUGGESTS
DEPTH OF CASING ONLY 15.5 FT. TO
BOTTOM

T-6.1
REWRITTEN BY JBG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist D.B. Sapik

Rge. ______

Twp. ______

Sec. ______

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action	-1.35'	Lithologic description	Summary log
0						See T-2 for 0-30'	
5							
10							
15					NATURAL SAND FILL 46' 2" OF 2" PVC CASING		
20							
25							
30						30-32' Gravel, clasts to 3/4"; sand, medium to coarse; clay light brown.	Gravel, sand and clay 30-32
				32.95	↑ 5' ↓	32-34' Sand, fine to coarse; gravel to 1/8"; clay dark brown and gray.	Sand; gravel/clay 32-48
35					BENTONITE	34-36' Sand, fine to coarse, gravel to 1"; clay light brown and gray.	
				37.95		36-38' Sand, medium to coarse, gravel to 1/4"; clay light brown and gray clay	
					↑ 8.7' ↓	38-40 Sand, fine to very coarse, gravel to 1/2"; clay, gray	
40					SAND	40-42' Sand, medium to coarse, gravel to 1/4", clay gray.	
						42-44' Sand, medium to coarse, gravel to 1/2", clay light brown to gray.	
45				44.65		44-46' Sand, fine to coarse, gravel to 1/2", clay gray.	
				46.65	SAND 48	46-48' Sand, fine to coarse, gravel to 1/2", clay gray.	
					2' OF 0.010 SLOT PVC SCREEN		

T-6.2

Location ______ Date ______ Local well number T-6.2

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist D.S. Peterson

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

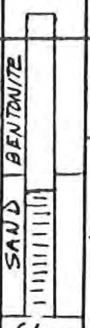
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	-2.2'	Lithologic description	Summary log
						See T-2 FOR LOG	
5				7.0 7.65			
10				13.65	6' OF 0.01 SLOT PVC SCREEN NATURAL FILL 13.65 TO 32.95	PIEZOMETERS T-6.1 T-6.2 ARE IN SAME 6" ? HOLE.	
						(NOTE: BECAUSE THERE IS NO BENTONITE IN INTERVAL BETWEEN 32.95 FT AND 7.0 IT IS POSSIBLE THAT HEAD FOR INTERVAL IS COMPOSITE FOR INTERVAL.)	

T-7-1 - WELL LOG

Location YAKIMA WASHINGTON Date 9-29-86 Local well number

County Map Scale Lat. Long.

District Project number Altitude

Driller Helper Geologist

Rge.

Twp.

Sec.

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
					See T-7.2 FOR FINISH	0-20 See Log T-5	
5							
10							
15				14.0'	NATURAL SAND 2" PVC CASING (29' LONG) CUTTINGS		
20				20.7		20-22' Sand, fine to medium coarse, gravel to ½"; Clay, gray. 22-24' Sand, fine to coarse, gravel to ⅜"; some clay, gray.	Sand and gravel 20 - 36
25				27.8		24-26' Sand, fine to coarse, gravel to ¼, clay gray/brown. 26-28' Sand, fine to very coarse, gravel to ¼" (but less than above), clay, brown.	
30				29.8	NATURAL SAND.	28-30' Sand, fine to very coarse, gravel to ½"; clay, dark brown. 30-32' Same 32-34' Sand, fine to very coarse, gravel to ¼-⅜"; clay, light brown-grayish.	
35				36.3	2'FT 0.01 SLOT PVC SCREEN	34-36' Sand, fine to very coarse, clay, grayish; gravel to ¼". Fragments of cobbles and pebbles up to ½". 36' Sand, fine to very coarse, mostly medium to coarse; gravel to ¼" few fragments; clay, light brown to grayish.	

T-7.2

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist ______

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

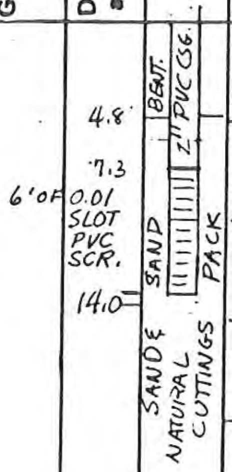
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						SEE LOG T-5 0-20'	



Location ______ Date ______ Local well number T-8

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

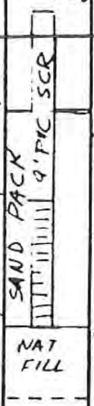
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______



Depth	Scale	Sample	Graphic log	Drill action	TOC -0.65	Lithologic description	Summary log
				0		0-2' Drilling with water. silty clayey fine sand, dark brown.	Sand, silty, clayey 0-3
				3.8		2-4' Sity clayex fine, to coarse sand dark brown, gravel with fragments to 1/4", cobbles or coarse gravel	Sand and gravel, clayey, silty cobbly 3-18.3
5						4-6' Same as above but fragments ≤ 3/4"	
				8.35		6-8' Same as above, but color grayish brown.	
10						8-10' Same as above. 10-18.3' Same as above.	
15				14.35			
				18.3			

T-9 FIELD LOG

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Rge. ______

Twsp. ______

Sec. ______

Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Depth	Scale	Sample	Graphic log	Drill action	TOP OF CSG -0.41'	Lithologic description	Summary log
				1.6 2.4		0-2' silty, clayey, fine to medium sand, dark brown.	Sand, silty, clayey 0-6
5				5.0	BENT.	2-6' silty, clayey fine to medium sand, dark brown; gravel fragments to 3/8". Sounds like cobble gravel.	
				7.04	4" PVC SCR. 7.45 SAND PACK	6-8' Silty, clayey fine to coarse sand, gravel fragments to 3/4" (cobble gravel)	Sand, gravelly, silty, clayey, 6-18 cobbly
10						8-10' Same as above	
						10-12' Same as above	
15				13.04	NAT. FILL	12-14 Same as above	
						14-16 Same as above	
				18.3		16-18 Same as above.	

T-10 - [illegible]

Location ____ Date 0-3-86 Local well number ____

County ____ Map ____ Scale ____ Lat. ____ Long. ____

District ____ Project number ____ Altitude ____

Driller ____ Helper ____ Geologist RC [illegible]

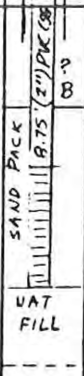
Lithologic Symbols

Abbreviations

clay	c	cobbles	cob	sandy	sdy		
silt	st	boulders	b	fine	f		
sand	s	clayey	cly	medium	m		
gravel	g	silty	sty	coarse	co		

Rge. ____

Twp. ____ Sec. ____



Depth	Scale	Sample	Graphic log	Drill action	TOP OF CSG -0.45	Lithologic description	Summary log
				1.6'		0-2' Silty, clayey, fine sand, dark brown.	Sand, fine, silty, clayey 0-2
						2-4' Silty, clayey fine to coarse sand and gravel fragments to ½". Drill sounds like cobble gravel.	Sand and gravel, silty clayey 2-16
5				5.3'		4-6' Same as above but brownish gray. Very little silt or other fines	
				8.3		6-8' Same as above	
						8-10' Same as above.	
10						10-13.5' Silty clayey fine to coarse sand, gravel (Fragments to ½") grayish brown.	Sand, clayey, silty, gravelly 10-13.5
15				14.3		13.5-18.3' Silts fine to coarse sand, gravel grayish brown, saturated	Sand, silty gravelly 13.5-19
				18.3 BH			

APPENDIX D

UST Decommissioning and Site Assessment, March 17, 2005

UST site ID#, 9904
FS# 477

TETRA TECH FW, INC.

March 17, 2005
TTEC-SL-2005GEO009

DEPT. OF ECOLOGY
Received
MAR 24 2005
CENTRAL REGION OFFICE

Mr. Chuck Conley
Tiger Oil Corporation
2850 Fletcher
Boise, ID 83702

Subject: UST Decommissioning and Site Assessment at Tiger Oil Corporation Facility, 1808 First Avenue, Yakima, Washington.

Dear Mr. Conley:

Tetra Tech FW, Inc. (TtFWI) is pleased to provide Tiger Oil Corporation (Tiger) with this report documenting the results of underground storage tank (UST) removals and site assessment (Figure 1) at the former gas station located at 1808 First Avenue, Yakima, Washington. Tiger retained TtFWI to provide decommissioning, site assessment and documentation services during the UST removal. The site contained four steel USTs located in a single excavation consisting of three unleaded gasoline tanks and one diesel tank. The unleaded gasoline tanks were 20,000 gallon, 10,000 gallon and 8,000 gallon capacity. The diesel tank was 6,000 gallon capacity.

The UST decommissioning and site assessment were performed by a Licensed Washington State UST Decommissioner and Site Assessor from TtFWI. Tri-Valley Construction, Inc. (Tri-Valley) of Yakima, under separate contract with Tiger, provided the UST removal, tank cleaning/disposal and backfilling services

UST DECOMMISSIONING AND SITE ASSESSMENT ACTIVITIES

All four USTs were removed from the site on January 20th. The excavation backfilling was completed on January 21th. Prior to removal, the tanks were checked for the presence of fluids. Residual fuel in each tank was less than 1 inch. Tri-Valley removed the concrete and shallow backfill material overlying the tanks in preparation for removal. Once exposed, each tank was inerted with dry ice. Approximately one hundred pounds of dry ice was used to inert the 20,000 gallon tank and approximately 50 pounds were used for the smaller tanks. Oxygen measurements were collected prior to removal to verify that the oxygen levels had decreased to a point that combustion could not occur. The four USTs were removed from the excavation by Tri-Valley using a trackhoe and set aside for cleaning and cutting. The final excavation dimensions were approximately 40' by 40' by 14' foot deep. Groundwater was not encountered during the removal of the USTs.

UST removal and decommissioning activities were observed and documented by a Licensed UST Decommissioner and Site Assessor from TtFWI. Copies of UST decommissioning documents are provided in Appendix A. Upon removal, the tanks were examined by TtFWI, Tri-Valley, and the Washington State Department of Ecology (Ecology). The tanks had minor surface rust and were in good condition with no visual evidence of leaks or holes in the tank bodies. However, some visual evidence of staining was observed on the UST near the fill pipe and turbine unit as well as in soil near the 20,000 gallon unleaded gasoline tank. No evidence of fill piping or turbine unit spillage were noted on the other three tanks. The four tanks were then cut and cleaned on-site and transported offsite for disposal/recycling on January 21 by Tri-Valley. The residual fuel and

12100 Northeast 195th Street, Suite 200, Bothell, WA 98011
Tel 425.482.7600 Fax 425.482.7652
www.ttfwi.com

9. A total of eleven soil samples were collected from beneath USTs and from the excavation sidewalls for chemical analysis. Samples were not collected from the stockpiled soil or backfill material.
10. Laboratory results indicate that samples from the UST excavation contain gasoline range hydrocarbon concentrations (TPH-G) ranging from ND (<3) to 870 mg/kg. The highest TPH-G concentration was reported in the sample collected along the west sidewall adjacent to the 20,000 gallon gasoline UST.
11. Laboratory results indicate that samples from the UST excavation contain benzene concentrations ranging from ND (<0.03) to 0.04 mg/kg, toluene concentrations ranging from ND (<0.05) to 0.4 mg/kg, ethybenzene concentrations ranging from ND (<0.05) to 2.0 mg/kg, and xylene concentrations ranging from ND (<0.2) to 3.9 mg/kg.
12. Laboratory results indicate that samples from the UST excavation contain diesel range hydrocarbon concentrations ranging from ND (<25) to 300 mg/kg.
13. Laboratory results indicate that samples from the UST excavation contain heavier than diesel range hydrocarbon concentrations ranging from ND (<50) to 51 mg/kg.
14. Laboratory results indicate that samples from the UST excavation contain total lead concentrations ranging from ND (<2.7) to 32 mg/kg.
15. MTBE was not detected in the sample collected from this UST excavation.
16. Based on laboratory chromatographs, hydrocarbons are heavily weathered gasoline and diesel range hydrocarbons.
17. The dispenser islands and associated piping were not removed during this UST decommissioning. The piping, however, was drained and capped using quick setting cement.
18. The residual fuel/sludge removed from the USTs were placed in 55 gallon drums for disposal by Tri-Valley.
19. Based on field observations, it appears that spillage associated with the fill pipe and turbine unit of the 20,000-gallon gasoline tank may have occurred periodically over time. Based on laboratory results of the collected soil samples it appears that the extent of petroleum hydrocarbons in soil is limited to the immediate area near the former location of the 20,000-gallon tank. The petroleum hydrocarbon concentrations were noted as "highly weathered" by the laboratory indicating historic spillage.

TtFWI appreciates the opportunity to be of service to you on this project. If you have any questions regarding these results please do not hesitate to contact the undersigned at (509) 255-9969 or (425) 482-7726.

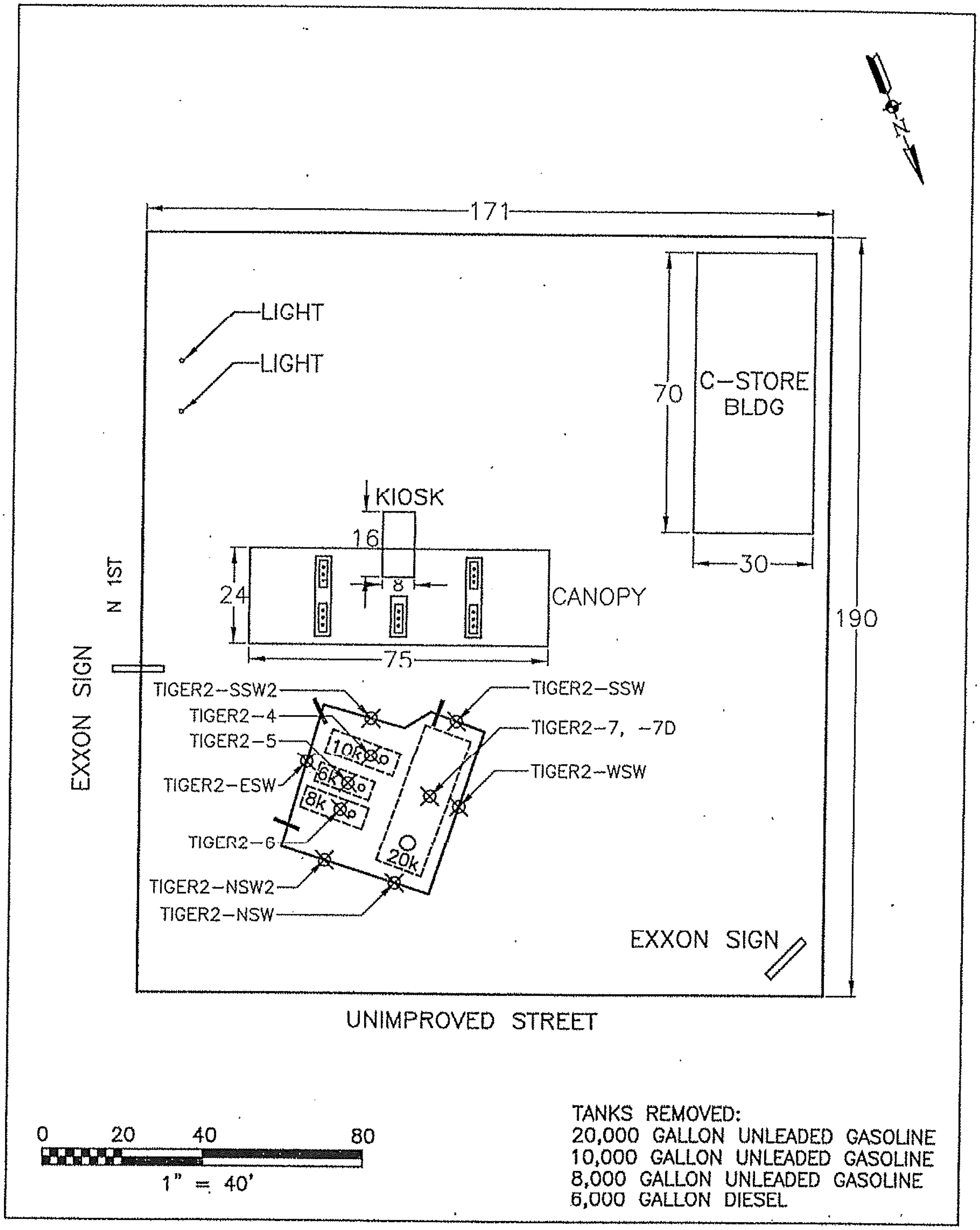
Richard Weingarz, LG
TtFWI

Senior Geologist
Licensed WA Decommissioner # 5037163 U2
Licensed WA Site Assessor # 5037163 U7

Chris Generous, LG
TtFWI

Consulting Engineer
Senior Project Manager

Cc: Tom Mackey, Department of Ecology



TANKS REMOVED:
20,000 GALLON UNLEADED GASOLINE
10,000 GALLON UNLEADED GASOLINE
8,000 GALLON UNLEADED GASOLINE
6,000 GALLON DIESEL

1808 NORTH 1ST AVENUE FACILITY

NOTES:
1) DIMENSIONS IN FEET

LEGEND:
— EXTENT OF EXCAVATION
☒ SAMPLE LOCATION
\ CAPPED PIPING TERMINATED AT EXCAVATION

TETRATECH FW,INC.
12100 NE 195th Street
Suite 200
Bothell, Wa. 98011
TEL: (425) 482-7600 FAX: (425) 482-7652

FIGURE 1
UST DECOMMISSIONING
TIGER OIL CORPORATION
1808 FIRST AVENUE
YAKIMA, WASHINGTON

C:\Projects\Drawings for Rick W\1808.dwg
PLOT/UPDATE: Mar 14, 2005

APPENDIX A

UST REMOVAL/DISPOSAL DOCUMENTS

WASHINGTON STATE DEPARTMENT OF ECOLOGY

UNDERGROUND STORAGE TANK
Site Check/Site Assessment Checklist

FOR OFFICE USE ONLY
Site #: ____________
Owner #: ____________

INSTRUCTIONS

When a release has not been confirmed and reported, this Site Check/Site Assessment Checklist must be completed and signed by a person certified by IFCI or a Washington registered professional engineer who is competent, by means of examination, experience, or education, to perform site assessments. **The results of the site check or site assessment must be included with this checklist.** This form must be submitted to Ecology at the address shown below within 30 days after completion of the site check/site assessment.

SITE INFORMATION: Include the Ecology site ID number if the tanks are registered with Ecology. This number may be found on the tank owner's invoice or tank permit.

TANK INFORMATION: Please list all tanks for which the site check or site assessment is being conducted. Use the owner's tank ID numbers if available, and indicate tank capacity and substance stored.

REASON FOR CONDUCTING SITE CHECK/SITE ASSESSMENT: Please check the appropriate item.

CHECKLIST: Please initial each item in the appropriate box.

SITE ASSESSOR INFORMATION: This information must be signed by the registered site assessor who is responsible for conducting the site check/site assessment.

Underground Storage Tank Section
Department of Ecology
PO Box 47655
Olympia WA 98504-7655

SITE INFORMATION

Site ID Number (Available from Ecology if the tanks are registered): 00904

Site/Business Name: Tiger Mart

Site Address: 1808 1st. (Street) Telephone: ( )

City: Yakima State: WA Zip Code: 98901

TANK INFORMATION

Tank ID No.	Tank Capacity	Substance Stored
1 and 2	20,000 and 10,000	gasoline
3	8,000	gasoline
4	6,000	Diesel

REASON FOR CONDUCTING SITE CHECK/SITE ASSESSMENT

Check one:

_____ Investigate suspected release due to on-site environmental contamination.
_____ Investigate suspected release due to off-site environmental contamination.
_____ Extend temporary closure of UST system for more than 12 months.
_____ UST system undergoing change-in-service.
__X__ UST system permanently closed with tank removed.
_____ Abandoned tank containing product.
_____ Required by Ecology or delegated agency for UST system closed before 12/22/88.
_____ Other (describe): ____________

INTERNATIONAL CODE COUNCIL

RICK A WEINGARZ

The International Code Council attests that the individual named on this certificate has satisfactorily demonstrated knowledge as required by the International Code Council by successfully completing the prescribed written examination based on codes and standards then in effect, and is hereby issued this certification as:

WASHINGTON STATE SITE ASSESSMENT

given this day of August 28, 2003

Paul E. Myers

Paul E Myers
President, ICC Board of Directors

James L. Witt

James L. Witt
ICC Chief Executive Officer

5037163-U7
Certificate Number

ICC
INTERNATIONAL
CODE COUNCIL®

APPENDIX B

LABORATORY REPORTS

CCI
ANALYTICAL
LABORATORIES, INC.

CERTIFICATE OF ANALYSIS

CLIENT: TETRA TECH FW INC.
12100 NE 195TH ST., SUITE 200
BOTHELL, WA 98011

DATE: 2/10/05
CCIL JOB #: 501075
CCIL SAMPLE #: 10
DATE RECEIVED: 1/21/05
WDOE ACCREDITATION #: C142

CLIENT CONTACT: CHRIS GENEROUS

CLIENT PROJECT ID: TIGER OIL
CLIENT SAMPLE ID: TIGER2-5 1/20/05 1430

DATA RESULTS

ANALYTE	METHOD	RESULTS*	UNITS**	ANALYSIS DATE	ANALYSIS BY
TPH-VOLATILE RANGE	NWTPH-GX	270	MG/KG	1/21/05	LAP
BENZENE	EPA-8021	ND(<0.06)	MG/KG	1/21/05	LAP
TOLUENE	EPA-8021	ND(<0.1)	MG/KG	1/21/05	LAP
ETHYLBENZENE	EPA-8021	ND(<0.1)	MG/KG	1/21/05	LAP
XYLENES	EPA-8021	ND(<0.4)	MG/KG	1/21/05	LAP
TPH-DIESEL RANGE	NWTPH-DX	300	MG/KG	1/21/05	EBS
TPH-LUBE OIL RANGE	NWTPH-DX	ND	MG/KG	1/21/05	EBS
LEAD	EPA-6010	ND(<3.0)	MG/KG	1/31/05	RAB
METHYL T-BUTYL ETHER (MTBE)	EPA-8260	ND(<10)	UG/KG	2/8/05	CCN
1,2-DICHLOROETHANE (EDC)	EPA-8260	ND(<10)	UG/KG	2/8/05	CCN
1,2-DIBROMOETHANE (EDB)	EPA-8260	ND(<5)	UG/KG	2/8/05	CCN

NOTES: CHROMATOGRAM INDICATES SAMPLE CONTAINS PRODUCTS WHICH ARE LIKELY
HIGHLY WEATHERED GASOLINE AND WEATHERED DIESEL FUEL
VOLATILE RESULT BIASED HIGH DUE TO SEMIVOLATILE RANGE OVERLAP
EPA-8260 ANALYSIS PERFORMED OUTSIDE OF HOLD TIME

* "ND" INDICATES ANALYTE ANALYZED FOR BUT NOT DETECTED AT LEVEL ABOVE REPORTING LIMIT. REPORTING LIMIT IS GIVEN IN PARENTHESES OR AS FOLLOWS:
GASOLINE(VOLATILE RANGE) REPORTING LIMIT IS 6 MG/KG
DIESEL RANGE REPORTING LIMIT IS 25 MG/KG
LUBE OIL RANGE REPORTING LIMIT IS 50 MG/KG

** UNITS FOR ALL NON LIQUID SAMPLES ARE REPORTED ON A DRY WEIGHT BASIS

APPROVED BY:

CCI
ANALYTICAL
LABORATORIES, INC.

CERTIFICATE OF ANALYSIS

CLIENT:	TETRA TECH FW INC. 12100 NE 195TH ST., SUITE 200 BOTHELL, WA 98011	DATE:	2/1/05
		CCIL JOB #:	501075
		CCIL SAMPLE #:	12
		DATE RECEIVED:	1/21/05
		WDOE ACCREDITATION #:	C142

CLIENT CONTACT: CHRIS GENEROUS

CLIENT PROJECT ID: TIGER OIL
CLIENT SAMPLE ID: TIGER2-7 1/20/05 1500

DATA RESULTS

ANALYTE	METHOD	RESULTS*	UNITS**	ANALYSIS DATE	ANALYSIS BY
TPH-VOLATILE RANGE	NWTPH-GX	ND	MG/KG	1/21/05	LAP
BENZENE	EPA-8021	ND(<0.03)	MG/KG	1/21/05	LAP
TOLUENE	EPA-8021	ND(<0.05)	MG/KG	1/21/05	LAP
ETHYLBENZENE	EPA-8021	ND(<0.05)	MG/KG	1/21/05	LAP
XYLENES	EPA-8021	ND(<0.2)	MG/KG	1/21/05	LAP
LEAD	EPA-6010	4.4	MG/KG	1/31/05	RAB

NOTE: VOLATILE RANGE REPORTING LIMIT RAISED DUE TO LIKELY PRESENCE OF SEMIVOLATILE RANGE PRODUCT

* "ND" INDICATES ANALYTE ANALYZED FOR BUT NOT DETECTED AT LEVEL ABOVE REPORTING LIMIT. REPORTING LIMIT IS GIVEN IN PARENTHESES OR AS FOLLOWS:
GASOLINE(VOLATILE RANGE) REPORTING LIMIT IS 4 MG/KG

** UNITS FOR ALL NON LIQUID SAMPLES ARE REPORTED ON A DRY WEIGHT BASIS

APPROVED BY:

CCI
ANALYTICAL
LABORATORIES, INC.

CERTIFICATE OF ANALYSIS

CLIENT: TETRA TECH FW INC.
12100 NE 195TH ST., SUITE 200
BOTHELL, WA 98011

DATE: 2/1/05
CCIL JOB #: 501075
CCIL SAMPLE #: 14
DATE RECEIVED: 1/21/05
WDOE ACCREDITATION #: C142

CLIENT CONTACT: CHRIS GENEROUS

CLIENT PROJECT ID: TIGER OIL
CLIENT SAMPLE ID: TIGER2-NSW 1/20/05 1505

DATA RESULTS

ANALYTE	METHOD	RESULTS*	UNITS**	ANALYSIS DATE	ANALYSIS BY
TPH-VOLATILE RANGE	NWTPH-GX	ND	MG/KG	1/21/05	LAP
BENZENE	EPA-8021	ND(<0.03)	MG/KG	1/21/05	LAP
TOLUENE	EPA-8021	ND(<0.05)	MG/KG	1/21/05	LAP
ETHYLBENZENE	EPA-8021	ND(<0.05)	MG/KG	1/21/05	LAP
XYLENES	EPA-8021	ND(<0.2)	MG/KG	1/21/05	LAP
TPH-DIESEL RANGE	NWTPH-DX	ND	MG/KG	1/21/05	EBS
TPH-LUBE OIL RANGE	NWTPH-DX	51	MG/KG	1/21/05	EBS
LEAD	EPA-6010	7.3	MG/KG	1/31/05	RAB

NOTE: CHROMATOGRAM INDICATES SAMPLE CONTAINS PRODUCT WHICH IS LIKELY LUBE OIL

* "ND" INDICATES ANALYTE ANALYZED FOR BUT NOT DETECTED AT LEVEL ABOVE REPORTING LIMIT. REPORTING LIMIT IS GIVEN IN PARENTHESES OR AS FOLLOWS:
GASOLINE(VOLATILE RANGE) REPORTING LIMIT IS 3 MG/KG
DIESEL RANGE REPORTING LIMIT IS 25 MG/KG
LUBE OIL RANGE REPORTING LIMIT IS 50 MG/KG

** UNITS FOR ALL NON LIQUID SAMPLES ARE REPORTED ON A DRY WEIGHT BASIS

APPROVED BY:

CCI
ANALYTICAL
LABORATORIES, INC.

CERTIFICATE OF ANALYSIS

CLIENT: TETRA TECH FW INC.
12100 NE 195TH ST., SUITE 200
BOTHELL, WA 98011

DATE: 2/1/05
CCIL JOB #: 501075
CCIL SAMPLE #: 16
DATE RECEIVED: 1/21/05
WDOE ACCREDITATION #: C142

CLIENT CONTACT: CHRIS GENEROUS

CLIENT PROJECT ID: TIGER OIL
CLIENT SAMPLE ID: TIGER2-ESW 1/20/05 1410

DATA RESULTS

ANALYTE	METHOD	RESULTS*	UNITS**	ANALYSIS DATE	ANALYSIS BY
TPH-VOLATILE RANGE	NWTPH-GX	ND	MG/KG	1/21/05	LAP
BENZENE	EPA-8021	ND(<0.03)	MG/KG	1/21/05	LAP
TOLUENE	EPA-8021	ND(<0.05)	MG/KG	1/21/05	LAP
ETHYLBENZENE	EPA-8021	ND(<0.05)	MG/KG	1/21/05	LAP
XYLENES	EPA-8021	ND(<0.2)	MG/KG	1/21/05	LAP
TPH-DIESEL RANGE	NWTPH-DX	ND	MG/KG	1/21/05	EBS
TPH-LUBE OIL RANGE	NWTPH-DX	ND	MG/KG	1/21/05	EBS
LEAD	EPA-6010	ND(<3.6)	MG/KG	1/31/05	RAB

* "ND" INDICATES ANALYTE ANALYZED FOR BUT NOT DETECTED AT LEVEL ABOVE REPORTING LIMIT. REPORTING LIMIT IS GIVEN IN PARENTHESES OR AS FOLLOWS:
GASOLINE(VOLATILE RANGE) REPORTING LIMIT IS 3 MG/KG
DIESEL RANGE REPORTING LIMIT IS 25 MG/KG
LUBE OIL RANGE REPORTING LIMIT IS 50 MG/KG

** UNITS FOR ALL NON LIQUID SAMPLES ARE REPORTED ON A DRY WEIGHT BASIS

APPROVED BY:

CCI
ANALYTICAL
LABORATORIES, INC.

CERTIFICATE OF ANALYSIS

CLIENT: TETRA TECH FW INC.
12100 NE 195TH ST., SUITE 200
BOTHELL, WA 98011

DATE: 2/1/05
CCIL JOB #: 501075
CCIL SAMPLE #: 18
DATE RECEIVED: 1/21/05
WDOE ACCREDITATION #: C142

CLIENT CONTACT: CHRIS GENEROUS

CLIENT PROJECT ID: TIGER OIL
CLIENT SAMPLE ID: TIGER2-SSW2 1/20/05 1440

DATA RESULTS

ANALYTE	METHOD	RESULTS*	UNITS**	ANALYSIS DATE	ANALYSIS BY
TPH-VOLATILE RANGE	NWTPH-GX	15	MG/KG	1/24/05	LAP
BENZENE	EPA-8021	ND(<0.03)	MG/KG	1/24/05	LAP
TOLUENE	EPA-8021	ND(<0.05)	MG/KG	1/24/05	LAP
ETHYLBENZENE	EPA-8021	ND(<0.05)	MG/KG	1/24/05	LAP
XYLENES	EPA-8021	ND(<0.2)	MG/KG	1/24/05	LAP
TPH-DIESEL RANGE	NWTPH-DX	ND	MG/KG	1/21/05	EBS
TPH-LUBE OIL RANGE	NWTPH-DX	ND	MG/KG	1/21/05	EBS
LEAD	EPA-6010	19	MG/KG	1/31/05	RAB

NOTE: CHROMATOGRAM INDICATES SAMPLE CONTAINS PRODUCT WHICH IS LIKELY HIGHLY WEATHERED GASOLINE

* "ND" INDICATES ANALYTE ANALYZED FOR BUT NOT DETECTED AT LEVEL ABOVE REPORTING LIMIT. REPORTING LIMIT IS GIVEN IN PARENTHESES OR AS FOLLOWS:
GASOLINE(VOLATILE RANGE) REPORTING LIMIT IS 3 MG/KG
DIESEL RANGE REPORTING LIMIT IS 25 MG/KG
LUBE OIL RANGE REPORTING LIMIT IS 50 MG/KG

** UNITS FOR ALL NON LIQUID SAMPLES ARE REPORTED ON A DRY WEIGHT BASIS

APPROVED BY:

CCI
ANALYTICAL
LABORATORIES, INC.

CERTIFICATE OF ANALYSIS

CLIENT: TETRA TECH FW INC.
12100 NE 195TH ST., SUITE 200
BOTHELL, WA 98011

DATE: 2/10/05
CCIL JOB #: 501075

DATE RECEIVED: 1/21/05
WDOE ACCREDITATION #: C142

CLIENT CONTACT: CHRIS GENEROUS

CLIENT PROJECT ID: TIGER OIL

QUALITY CONTROL RESULTS

SURROGATE RECOVERY

CCIL SAMPLE ID	ANALYTE	SUR ID	% RECV
501075-01	NWTPH-GX	TFT	*
501075-01	EPA-8021	TFT	*
501075-02	NWTPH-GX	TFT	*
501075-02	EPA-8021	TFT	*
501075-03	NWTPH-GX	TFT	*
501075-03	EPA-8021	TFT	*
501075-03	EPA-8260	1,2-DCE-d4	127
501075-04	NWTPH-GX	TFT	93
501075-04	EPA-8021	TFT	84
501075-05	NWTPH-GX	TFT	72
501075-05	EPA-8021	TFT	68
501075-06	NWTPH-GX	TFT	66
501075-06	EPA-8021	TFT	62
501075-07	NWTPH-GX	TFT	56
501075-07	EPA-8021	TFT	55
501075-08	NWTPH-GX	TFT	*
501075-08	EPA-8021	TFT	*
501075-09	NWTPH-GX	TFT	59
501075-09	EPA-8021	TFT	56
501075-10	NWTPH-GX	TFT	87
501075-10	EPA-8021	TFT	99
501075-10	NWTPH-DX	C25	89
501075-10	EPA-8260	1,2-DCE-d4	97

CCI
ANALYTICAL
LABORATORIES, INC.

CERTIFICATE OF ANALYSIS

CLIENT: TETRA TECH FW INC.
12100 NE 195TH ST., SUITE 200
BOTHELL, WA 98011

DATE: 2/10/05
CCIL JOB #: 501075

DATE RECEIVED: 1/21/05
WDOE ACCREDITATION #: C142

CLIENT CONTACT: CHRIS GENEROUS

CLIENT PROJECT ID: TIGER OIL

QUALITY CONTROL RESULTS

BLANK AND DUPLICATE RESULTS

METHOD	BLK RESULT	ASSOC SMPLS
NWTPH-GX (GAS)	ND(<3)	501075-01 TO 19
EPA-8021(BENZENE)	ND(<0.03)	501075-01 TO 19
EPA-8021(TOLUENE)	ND(<0.05)	501075-01 TO 19
EPA-8021(ETHYLBENZ)	ND(<0.05)	501075-01 TO 19
EPA-8021(XYLENE)	ND(<0.2)	501075-01 TO 19
NWTPH-DX (DSL)	ND(<25)	501075-10, 14 TO 19
NWTPH-DX (OIL)	ND(<50)	501075-10, 14 TO 19
EPA-6010 (PB)	ND(<0.72)	501075-01 TO 19
EPA-8260 (MTBE)	ND(<10)	501075-03, 10
EPA-8260 (EDC)	ND(<10)	501075-03, 10
EPA-8260 (EDB)	ND(<5)	501075-03, 10

SPIKE/ SPIKE DUPLICATE RESULTS

METHOD	SPIKE ID	ASSOCIATED SAMPLES	% SPIKE RECOVERY	% SPIKE DUP RECOVERY	REL % DIFF
NWTPH-GX	GASOLINE	501075-01 TO 19	76	71	7
EPA-8021	BENZENE	501075-01 TO 19	92	106	14
EPA-8021	TOLUENE	501075-01 TO 19	93	108	15
EPA-8021	ETHYLBENZENE	501075-01 TO 19	92	105	13
EPA-8021	XYLENE	501075-01 TO 19	94	108	14
NWTPH-DX	DIESEL	501075-10, 14 TO 19	94	95	1
EPA-6010 (PB)	LEAD	501075-01 TO 19	89	90	1
EPA-8260	TRICHLOROETHENE	501075-03, 10	110	107	3

* SURROGATE DILUTED OUT OF CALIBRATION RANGE

APPROVED BY:

CCI Analytical Laboratories, Inc.
8620 Holly Drive
Everett, WA 98208
Phone (425) 356-2600
(206) 292-9059 Seattle
(425) 356-2626 Fax
http://www.ccilabs.com

Chai)f Custody/ Laboratory Analysis Request

CCI Job# (L ory Use Only)

Date 1-2005 Page 1 Of 2

PROJECT ID: Tiger Oil
REPORT TO COMPANY: TTFW
PROJECT MANAGER: Chris Generous
ADDRESS: 12100 N.E. 195th Sue 200
Bothell WA 98011
PHONE: 425-452-7726 FAX:
P.O. NUMBER: E-MAIL:
INVOICE TO COMPANY: TTFW
ATTENTION: Sue Tarvo
ADDRESS:

	SAMPLE I.D.	DATE	TIME	TYPE	LAB#	NWTPH-HCID	NWTPH-DX	NWTPH-GX	BTEX by EPA-8021	MTBE by EPA-8021 ☐ EPA-8260 ☐ Hold	Halogenated Volatiles by EPA 8260	Volatile Organic Compounds by EPA 8260	Ethylene dibromide (EDB) by EPA-8260 ☐ EPA-504.1 ☐ Hold	1,2 Dichloroethene (EDC) by EPA-8260 Hold	Semivolatile Organic Compounds by EPA 8270	Polycyclic Aromatic Hydrocarbons (PAH) by EPA-8270 SIM ☐	PCB ☐ Pesticides ☐ by EPA 8081/8082	Metals-MTCA-5 ☐ RCRA-8 ☐ Pri Pol ☐ TAL ☐	Metals Other (Specify)	TCLP-Metals ☐ VOA ☐ Semi-Vol ☐ Pest ☐ Herbs ☐	OTHER (Specify) Pd - Total							NUMBER OF CONTAINERS	RECEIVED IN GOO NDITION?
1	1. Tiger1-1	1-20-05	1310	Soil	1			X	X	X			X	X							X								
2	2. Tiger1-2		0950		2			X	X	X			X	X							X								
3	3. Tiger1-3		1000		3			X	X	X			X	X							X								
4	4. Tiger1-ESW		1325		4			X	X	X			X	X							X								
5	5. Tiger1-WSW		1025		5			X	X	X			X	X							X								
6	6. Tiger1-NSW		1015		6			X	X	X			X	X							X								
7	7. Tiger1-SSW		1320		7			X	X	X			X	X							X								
8	8. Tiger1-3D		1000		8			X	X	X			X	X							X								
9	9. Tiger2-4		1435		9			X	X	X			X	X							X								
10	10. Tiger2-KS2		1430		10		X	X	X	X			X	X							X								

SPECIAL INSTRUCTIONS Fax Copies To Chris Generous + (Rich Weingarz 509-255-9969)

CCI Analytical Laboratories, Inc accepts and processes this request on the terms and conditions set forth on the reverse side. By its signature hereon, Customer accepts these terms and conditions.

SIGNATURES (Name, Company, Date, Time):

1. Relinquished By: TTFW 1-20-05 1545
   Received By: Fed Ex
2. Relinquished By:
   Received By: Dorola C. 1/21/05 0025 pc

TURNAROUND REQUESTED in Business Days*

Organic, Metals & Inorganic Analysis

☐ 10 Standard ☐ 5 ☐ 3 ☐ 2 ☐ 1 ☐ SAME DAY

Fuels & Hydrocarbon Analysis

☐ 5 Standard ☐ 3 ☐ 1 ☐ SAME DAY

OTHER:
Specify: Pr(5935 Cnc Caps

REPORT COPY

APPENDIX E

Re: Tiger Oil Corporation (Tiger) – 1808 North First Street (North First) and 1606 East Nob Hill Blvd. (East Nob), Yakima, WA, August 9, 2005

McCreedy
Law Office, P.C.

3184 Elder Street
Boise, ID 83705
Telephone: (208) 383-6521
Facsimile: (208) 383-6688

John C. McCreedy Licensed in Idaho and Washington

August 9, 2005

VIA FACSIMILE & U.S.MAIL

Alex Smith
Assistant Attorney General
Ecology Division
P.O. Box 40117
Olympia, WA 98504-0117

VIA FACSIMILE & U.S.MAIL

Thomas L. Mackie, P.G.
Hydrogeologist, Site Manager
Toxics Cleanup Program
Department of Ecology
15 West Yakima Avenue "B", Suite 200
Yakima, WA 98902-3452

DEPT. OF ECOLOGY
Received
AUG 15 2005
CENTRAL REGION OFFICE

Re: ***Tiger Oil Corporation (Tiger) – 1808 North First Street (North First) and 1606 East Nob Hill Blvd. (East Nob), Yakima, Washington***

Dear Alex and Tom:

This letter follows our telephone conference calls on June 7 and 17, 2005. The technical input in this letter was provided by Chris Generous, LG, Tetra Tech EC, Inc. This letter also supplements Tiger's prior correspondence regarding completion of the investigation and remediation at the North First and East Nob sites. Tiger will respond by separate letter to Ecology's PLP Notice regarding 5511 W. Summitview.

Tiger's position is that, with the exception of completing the site assessment for the underground piping and dispenser islands, no further investigation or remediation is warranted at North First and East Nob. The evidence establishes that the remaining contamination is the result of historical releases prior to Tiger's ownership. Ecology cleaned up those sites under prior authority, allowed the remediation and monitoring systems previously installed to be removed, and expressly consented to leaving residual contamination in place. Tiger has not contributed to contamination at these sites and should not be required to investigate or cleanup contamination that Ecology has already thoroughly investigated and allowed to remain in place. Ecology's decision to not require the prior owner's to remediate the old, residual contamination is an acknowledgement that the remaining contamination does not present any threat to human health or the environment.

Tiger submits the following analysis in support of its position.

1808 NORTH FIRST

Prior Investigation and Remediation Activities

In 1982, leaks were discovered in the delivery lines at North First. Between 1982 and 1992, Ecology and others thoroughly investigated the extent of contamination and concluded that no further action was required. Ecology's files contain the following history.

On May 9, 1985, Soil Exploration Company (SEC) submitted an Hydrogeologic Evaluation to Ecology. The Hydrogeologic Evaluation summarized previous investigation and remediation efforts, noting that seventeen (17) monitoring wells and two (2) recovery wells were previously installed. Between November 1984 and February 1985, SEC advanced twelve (12) additional soil borings and finished those borings as monitoring wells. Based on the data obtained, SEC concluded that a "pocket" of free gasoline does not exist, that groundwater depression for product recovery is not recommended, and that a monitoring program be implemented to document groundwater flow and quality over a period of one year.

On August 21, 1986, Twin City Testing Corporation (formerly, SEC) submitted a quarterly monitoring report to Ecology. The report stated that downgradient hydrocarbon contamination had decreased in all but one of the monitoring wells sampled. Twin City Testing (TCT) informed Ecology that USGS intended to install additional site monitoring wells. On behalf of Tiger Oil Company (not Tiger Oil Corporation), TCT requested permission from Ecology to discontinue site monitoring.

On May 11, 1987, USGS submitted a letter and documentation to Ecology. USGS noted that the initial recovery operation performed in 1982 and 1983 was discontinued after two (2) months because only forty (40) gallons of free product were recovered at a reported cost of $100,000. USGS noted that most homes having affected wells were connected to Yakima City water supplies at a cost to the City of about $175,000. USGS stated:

> **"Because of the cost of the unsuccessful clean up effort, and because uncontaminated drinking water supplies were secured, no further remedial action is anticipated."**

Figure 2 submitted by USGS to Ecology on May 11, 1987, establishes that two (2) recovery wells and four (4) monitoring wells had previously been installed on the service station property. In the letter received by Ecology on May 11, 1987, USGS advised Ecology that it was no longer funded to work at the site, and therefore the observation wells must be removed. USGS asked Ecology if it would like any of the wells left in place.

On May 15, 1987, Ecology thanked USGS for the submission of the additional data, and advised USGS that Ecology had no real legitimate use for the wells, either from a water rights management "or pollution control management standpoint[.]" Ecology told USGS that the monitoring wells could therefore be abandoned.

On October 1, 1987, Tiger purchased the assets of Tiger Oil Company. MTCA was not enacted until March, 1989.

Monitoring did, in fact, continue at North First under the direction of Federated Service Insurance Company. The investigation and monitoring activities performed at North First were summarized by the USGS in a report entitled Areal Extent of Petroleum-Related Compounds From a Gasoline Diesel-Fuel Leak in Groundwater at a Site in Yakima, WA, 1984-89 (USGS Report). The USGS Report reviewed three (3) separate investigations performed at the property and noted that at least thirty-four (34) observation wells and two (2) recovery wells were installed on or down gradient from the station property. After analyzing the data available for the site, the USGS reached the following primary conclusion:

> By March 1989, concentrations of volatile hydrocarbons had decreased and the areal extent over which they were present in shallow ground water was smaller. Only concentrations of total xylenes exceeded 500 μg/L, at two wells near the source of the leak. Concentrations of volatile hydrocarbons generally were less than 500 μg/L near the source of the leak and generally were less than 5 μg/L at distances more than 400 feet from the source of the leak. In contrast, during the sample periods of November 1986 and earlier, volatile hydrocarbon concentrations exceeded 5 μg/L at distances of as much as 1,200 feet from the source of the leak. The decrease in volatile dissolved hydrocarbons in the shallow ground water between 1984-86 and 1989 could be due to natural dispersal, volatilization, or

> biodegradation.

USGS Report, p.70.

Clar Pratt was a Supervisor of Environmental Quality for Ecology in the 1980's. At his deposition taken on March 22, 2004, Mr. Pratt testified that when Ecology gave USGS permission to abandon the wells at North First, Ecology was satisfied with the recovery and clean up efforts because there was no longer a threat. Mr. Pratt testified:

> Q. By the time you authorized the USGS to abandon the wells at that site, were recovery efforts complete?
>
> A. For all practical purposes, yes, they were complete, because we didn't have, to my memory, the best of my memory, anyway, we did not have a groundwater pollution situation there anymore and the petroleum product in the soil had degraded to, had degraded greatly to the point that it really wasn't much of a threat anymore.
>
> So on the other hand, under that program, at the federal and the state level, there is no such thing, really, as a clean site, so I can't say the site was cleaned up, because under those laws, in a way, that's not possible.
>
> Q. But when you turned over the recovery wells, or gave USGS permission to abandon them--
>
> A. Right.
>
> Q. --Ecology was satisfied with the recovery and cleanup efforts at that point?
>
> A. Yes, that it was no longer a threat.

Pratt Deposition, p. 68, l. 11-p. 69, l. 6.

There is only one reasonable conclusion to reach regarding the releases that occurred in the early 1980's – those releases were cleaned up to Ecology's satisfaction and any residual contamination left in place presents no threat to human health and the environment.

Recent Tank Removal Activities

The recent tank removal activities confirm that Tiger has not contributed to the residual contamination at North First. The UST Decommissioning and Site Assessment Report submitted by TTEC establishes the following:

1. Four tanks were removed in January 2005 (20,000 gal., 10,000 gal., and 8,000 gal. unleaded and 6,000 gal. diesel).

2. The tanks did not contain evidence of holes upon removal. Only a minor amount of product had been spilled due to historic spillage during filling of the tanks prior to Tiger Oil Corporation's purchase of the property. Tiger Oil Corporation installed spill containment and overfill protection equipment which had not been previously installed by Tiger Oil Company. In addition, Tiger Oil Corporation's inventory control records were audited by Ecology and showed no evidence of releases.

3. Only two of ten soil samples collected and analyzed during the UST removal were determined to be above cleanup levels (Sample TIGER2-WSW and TIGER2-5).

4. Sample TIGER2-WSW collected at a depth of 8 feet from the west sidewall adjacent to the 20,000 gallon UST contained TPH-G concentrations of 870 ppm.

5. Sample TIGER2-5W collected at a depth of 13 feet from beneath the diesel UST contained TPH-G concentrations of 270 ppm.

6. The gasoline is weathered (no benzene) indicating old product, a lower potential for leaching and migration to groundwater, and lower toxicity.

7. The backfill material at this site is pea gravel.

8. 220 yards of clean soil was imported to backfill the hole.

The recent tank removal activities do not alter the prior conclusion that there is no threat presented by the residual, historical contamination at North First. Two potential exposure pathways were identified by Ecology in our June 7 telephone call: (1) exposure through consumption of drinking water; and (2) direct contact with soil. Groundwater beneath the site is present at a depth of over 20 feet. Groundwater is not used for drinking water in the immediate area of the site because resident's use water supplied by City of Yakima from the Naches River Water Treatment Plant or from deep groundwater wells. Therefore, no exposure is possible through the drinking water pathway. It should also be noted that the MTCA 173-340-900 residual saturation screening level for weathered gasoline in soil is 1,000 ppm for coarse sand and gravelly soils, further supporting the low potential for leaching and migration to groundwater.

With respect to direct contact, the site is currently paved and at least a 5 foot layer of soil and gravel was placed over the top of the soil containing TPH concentrations above cleanup levels. Therefore, no direct contact exposure is possible if site conditions remain the same. However, even if cleanup were to occur, soil along the sidewall at the location of Sample TIGER2-WSW would be excavated approximately 2 feet by 20 feet by 10 feet (5 feet to 15 feet in depth), totaling approximately 15 cubic yards. It is also estimated that an area of 5 feet by 15 feet by 2 feet deep (7 cubic yards) would be excavated from beneath the diesel UST. This totals approximately 22 cubic yards which is a small volume considering that 220 yards of clean soil were imported during backfilling (ratio of 10-1). The benefits of removing this small amount of soil contaminated by previous owners does not justify the costs of implementing such activities at this site.

1606 EAST NOB HILL BOULEVARD

Prior Investigation and Remediation Activities

The site history for East Nob is similar to North First. In addition, Ecology's records establish that an earlier release occurred at the site in 1962 when the station was known as "Signal" and operated by Exxon. In response, private, replacement drinking water wells were installed, including one well installed through the impermeable clay layer. It does not appear that Ecology required any other monitoring or remediation in response to the Signal oil spill.

Releases of petroleum products from the delivery lines apparently occurred at East Nob in 1980, when the site was under the ownership of Tiger Oil Company. Ecology took the lead in responding to those releases, instructing Tiger Oil Company to take recovery measures, and even directing Tiger Oil Company to retain Crowley Environmental. On September 3, 1980, Ecology wrote Tiger Oil Company suggesting that it install a recovery well to recover the contamination. Tiger Oil Company complied and an internal Ecology memorandum dated September 23, 1980, shows that more than half the 10,000 gallons released had been recovered by that time. In October, 1980, Tiger Oil Company estimated that the total fuel loss was 11,335 gallons. On November 14, 1980, Ecology wrote to Tiger Oil Company, thanking it for the recovery efforts and approving Tiger Oil Company's proposal to remove all but two (2) of the recovery wells based on the fact that the additional wells were dry and of no present value in recovery. A letter from Tiger Oil Company to Ecology, received November 25, 1980, summarizes the recovery efforts dictated by Ecology, and establishes that nearly 10,000 gallons of the estimated 11,335 gallons had been recovered and donated to the Yakima Fire Department.

In 1981, Ecology engaged in an aggressive effort to ensure that impacted drinking water wells were replaced with deeper wells drilled through the impermeable clay layer into the deeper aquifer. On September 9, 1981, Ecology wrote to Tiger Oil Company explaining that, based on Ecology's observations and sampling of the recovery and monitoring wells east of the station, "there does not appear to be any additional recoverable product." Ecology stated that "[t]he recovery well may be removed so that the roadway may be restored."

On April 19, 1985, Tiger Oil Company wrote Ecology to advise of an additional, small release that occurred in the loading rack area. Tiger Oil Company stated that the release was confined to a five (5) foot area with no seepage into the ground.

In September, 1990, Ecology prepared a list of Central Regional Office UST sites. The East Nob site was listed with the comment that "NFA will be taken."

Ecology proceeded regarding East Nob in the same manner it proceeded with North First. Ecology required remediation and monitoring efforts until it was satisfied that no further action was necessary to protect human health and the environment.

Recent Tank Removal Activities

The recent UST decommissioning and site assessment activities confirm that Tiger has not contributed to the residual contamination at East Nob. The UST decommissioning and Site Reassessment Report submitted by TTEC establishes the following:

1. Twelve 20,000 gallon tanks were removed in January 2005 (six gasoline, five diesel, and one Stoddard solvent).

2. The tanks did not contain evidence of holes upon removal. Only a minor amount of product had been spilled due to historic spillage during filling of the tanks prior to Tiger's purchase of the property. Again, Tiger Oil Corporation installed spill containment and overfill protection equipment, and its inventory control records were audited by Ecology and did not show evidence of releases.

3. Only three of twenty-five soil samples collected and analyzed during the UST removal were determined to be above cleanup levels (Samples TIGER4-D, TIGER4-E, and TIGER4-F).

4. These three soil samples were collected at depths of 14 feet from under gasoline USTs located in the southwest corner of the loading rack excavation and contained TPH-D concentrations

ranging from 4,100 to 8,200 ppm.

5. The contaminant is diesel with low potential for leaching and migration to groundwater and is lower in toxicity than gasoline.

6. The backfill material at this site is pea gravel.

7. Approximately 800 yards of clean soil was imported to backfill the hole.

Again, there is no threat presented by the residual, historical contamination at East Nob. Groundwater beneath the site is present at a depth of 20 feet. Groundwater is not used for drinking water in the immediate area of the site because resident's use water supplied by City of Yakima. Therefore, no exposure is possible through the drinking water pathway. In addition, residual saturation levels based on Ecology's 1997 Interim Interpretative and Policy Statement – Cleanup of Total Petroleum Hydrocarbons (Publication No. ECY97-600) for diesel in silty soils would be expected to be approximately 15,000 ppm.

The site is currently paved and at least a five (5) foot layer of soil and gravel was placed over the top of the soil containing TPH concentrations above cleanup levels. Therefore, no direct contact exposure is possible if site conditions remain the same. However, even if cleanup were to occur, soil in the southwest corner of the former loading rack would be excavated approximately 35 feet by 45 feet by 2 feet (13 feet to 15 feet in depth). This totals approximately 100 cubic yards which is a small volume of soil considering that 800 yards of clean soil were imported during backfilling (ratio of 8-1). The benefits of removing this small amount of soil contaminated by previous owners does not justify the costs of implementing such activities at this site.

CONCLUSION

Tiger recognizes that in the Settlement Agreement effective June 21, 2004, New Tiger stated its intent to propose actions at North First and East Nob under Ecology's Voluntary Cleanup Program (VCP), if necessary. The evidence in Ecology's files, as well as the data obtained during the recent UST decommissioning and site assessment activities, demonstrates that Tiger has not contributed to the residual contamination left in place at those sites. Ecology previously concluded that the residual contamination does not present a threat to human health or the environment. Given these facts, it does not seem warranted for Tiger to submit VCP applications for sites that do not pose a threat. Ecology can simply now issue in writing what it previously concluded – that "No Further Action" is necessary at North First and East Nob. If this request cannot be fulfilled by Ecology, Tiger hereby requests, pursuant to Section 8 of the Settlement Agreement, that formal mediation with retired Judge Robert A. Duran be scheduled at the parties' earliest convenience.

Please be advised that Tiger is not admitting in any manner that it is responsible or liable for any of the remaining contamination at North First and East Nob. Tiger simply wants to bring closure to the environmental activities at those sites.

Please contact me if you would like us to provide any of the documents or information discussed in this letter, or if we can provide any other information in support of this request. Thank you.

Sincerely,

John C. McCreedy

JCM:smh
cc: Charles D. Conley
Chris Generous

APPENDIX F

Site Boring Logs DP-9 through DP-19 and MW-6 through MW-8

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS MORE THAN 50% RETAINED ON NO. 200 SIEVE	GRAVEL AND GRAVELLY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	○	GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES
			○	GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)	▥	GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
			▨	GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	░	SW	WELL-GRADED SANDS, GRAVELLY SANDS
			░	SP	POORLY-GRADED SANDS, GRAVELLY SAND
		SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)	▥	SM	SILTY SANDS, SAND - SILT MIXTURES
			▨	SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50	▥	ML	INORGANIC SILTS, ROCK FLOUR, CLAYEY SILTS WITH SLIGHT PLASTICITY
			▨	CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			▦	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50	▥	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS SILTY SOILS
			▨	CH	INORGANIC CLAYS OF HIGH PLASTICITY
			▦	OH	ORGANIC CLAYS AND SILTS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS			☰	PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

NOTE: Multiple symbols are used to indicate borderline or dual soil classifications

ADDITIONAL MATERIAL SYMBOLS

SYMBOLS		TYPICAL DESCRIPTIONS
GRAPH	LETTER	
■	AC	Asphalt Concrete
▨	CC	Cement Concrete
▚	CR	Crushed Rock/ Quarry Spalls
░	TS	Topsoil/ Forest Duff/Sod

Groundwater Contact

▼	**Measured groundwater level in exploration, well, or piezometer**
▼	**Measured free product in well or piezometer**

Graphic Log Contact

—	**Distinct contact between soil strata**
/	**Approximate contact between soil strata**

Material Description Contact

—	**Contact between geologic units**
– – – –	**Contact between soil of the same geologic unit**

Sampler Symbol Descriptions

▯	**2.4-inch I.D. split barrel**
◨	**Standard Penetration Test (SPT)**
■	**Shelby tube**
☰	**Piston**
◧	**Direct-Push**
☒	**Bulk or grab**
▥	**Continuous Coring**

Blowcount is recorded for driven samplers as the number of blows required to advance sampler 12 inches (or distance noted). See exploration log for hammer weight and drop.

A "P" indicates sampler pushed using the weight of the drill rig.

A "WOH" indicates sampler pushed using the weight of the hammer.

Laboratory / Field Tests

%F	**Percent fines**
%G	**Percent gravel**
AL	**Atterberg limits**
CA	**Chemical analysis**
CP	**Laboratory compaction test**
CS	**Consolidation test**
DS	**Direct shear**
HA	**Hydrometer analysis**
MC	**Moisture content**
MD	**Moisture content and dry density**
OC	**Organic content**
PM	**Permeability or hydraulic conductivity**
PI	**Plasticity index**
PP	**Pocket penetrometer**
PPM	**Parts per million**
SA	**Sieve analysis**
TX	**Triaxial compression**
UC	**Unconfined compression**
VS	**Vane shear**

Sheen Classification

NS	**No Visible Sheen**
SS	**Slight Sheen**
MS	**Moderate Sheen**
HS	**Heavy Sheen**
NT	**Not Tested**

NOTE: The reader must refer to the discussion in the report text and the logs of explorations for a proper understanding of subsurface conditions. Descriptions on the logs apply only at the specific exploration locations and at the time the explorations were made; they are not warranted to be representative of subsurface conditions at other locations or times.

KEY TO EXPLORATION LOGS

GeoEngineers

FIGURE A-1

Drilled	Start 8/3/2016	End 8/3/2016	Total Depth (ft) 20	Logged By CMD Checked By JRS	Driller Cascade Drilling, Inc.
Drilling Method	Direct-Push				
Surface Elevation (ft)	1079	Vertical Datum	NAVD88	Hammer Data	
Drilling Equipment	Geoprobe 6600 Truck-mount				
Easting (X)		Northing (Y)		System South Zone	Datum NAD83/91
Groundwater	Date Measured	Depth to Water (ft)	Elevation (ft)	See Remarks	
Notes:					

FIELD DATA

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		60						AC	Approximately 8 inches asphalt concrete pavement			
									CC	Approximately 2 feet concrete (possibly angular fill)	NS	<1	
									ML	Brown silt with sand and occasional gravel (stiff, moist)			
1075											NS	<1	
	5		60						CC	Concrete			
									ML	Brown silt with sand and gravel (stiff, moist)	NS	<1	
									GP	Gray fine to coarse gravel with sand and trace silt (dense, moist)	NS	<1	
1070												<1	
	10												
1065													Groundwater observed at approximately 13.5 feet below ground surface during drilling
	15		60			N1DP-9 (14.5-15) CA				Grades to wet	NS	<1	
													Cobbles encountered
1060											NS	<1	
	20												

Note: See Figure A-1 for explanation of symbols.

Log of Boring NIDP-9

GEOENGINEERS

Project: Tiger Oil - North 1st Street

Project Location: Yakima, Washington

Project Number: 0504-101-03

Figure A-2

Sheet 1 of 1

Drilled	Start 8/3/2016	End 8/3/2016	Total Depth (ft) 20	Logged By CMD Checked By JRS	Driller Cascade Drilling, Inc.
Drilling Method	Direct-Push				
Surface Elevation (ft)	1079	Hammer Data		Drilling Equipment	Geoprobe 6600 Truck-mount
Vertical Datum	NAVD88				
Easting (X)		System	South Zone	Groundwater	
Northing (Y)		Datum	NAD83/91	Date Measured / Depth to Water (ft) / Elevation (ft)	See Remarks
Notes:					

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		60						AC	Approximately 8 inches asphalt concrete pavement			
									CC	Concrete	NS	<1	
									GP	Brown fine to coarse gravel with silt, sand and concrete pieces (dense, moist)	NS	<1	
1075									ML	Brown silt with sand and occasional gravel (stiff, moist)			
	5		60						CC	Concrete	NS	<1	
									GP	Gray fine to coarse gravel with sand and trace silt (dense, moist)			
1070													
	10		60								NS	<1	
											NS	<1	
1065										Grades to wet			Groundwater observed at approximately 13.5 feet below ground surface during drilling
	15		60			N1DP-10 (14.5-15) CA					NS	2.4	Petroleum like odor
											NS	<1	
											NS	64.1	Petroleum like odor
1060											NS	<1	Petroleum like odor
	20												

Note: See Figure A-1 for explanation of symbols.

Log of Boring NIDP-10

GEOENGINEERS

Project: Tiger Oil - North 1st Street
Project Location: Yakima, Washington
Project Number: 0504-101-03

Figure A-3
Sheet 1 of 1

Drilled Start 8/3/2016 End 8/3/2016	Total Depth (ft) 20	Logged By CMD Checked By JRS	Driller Cascade Drilling, Inc.	Drilling Method Direct-Push

Surface Elevation (ft) 1079 Vertical Datum NAVD88	Hammer Data	Drilling Equipment Geoprobe 6600 Truck-mount
Easting (X) Northing (Y)	System South Zone Datum NAD83/91	Groundwater Date Measured / Depth to Water (ft) / Elevation (ft) See Remarks
Notes:		

Elevation (feet)	Depth (feet)	FIELD DATA Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		60						AC	Approximately 8 inches asphalt concrete pavement			
									CC	Approximately 18 inches concrete	NS	<1	
									GP	Brown fine to coarse gravel with sand and trace silt (dense, moist)	NS	<1	
1075									ML	Brown silt with trace sand (stiff, moist)			
	5		60										
									GP	Brown gravel with silt and sand (dense, moist)			
									GP	Gray fine to coarse gravel with sand and trace silt (dense, moist)	NS	<1	
1070													
	10		60										
											NS	<1	
1065													Groundwater observed at approximately 14 feet below ground surface during drilling
	15		16			N1DP-11 (14.5-15) CA				Grades to wet			
											NS	<1	
											NS	<1	
1060													
	20												

Note: See Figure A-1 for explanation of symbols.

Log of Boring NIDP-11

GEOENGINEERS

Project: Tiger Oil - North 1st Street
Project Location: Yakima, Washington
Project Number: 0504-101-03

Figure A-4
Sheet 1 of 1

Drilled	Start 8/4/2016	End 8/4/2016	Total Depth (ft)	20
Logged By	CMD	Checked By	JRS	
Driller	Cascade Drilling, Inc.	Drilling Method	Direct-Push	
Surface Elevation (ft) Vertical Datum	1089 NAVD88	Hammer Data		
Drilling Equipment	Geoprobe 6600 Truck-mount			
Easting (X) Northing (Y)		System Datum	South Zone NAD83/91	
Notes:				

Groundwater Date Measured	Depth to Water (ft)	Elevation (ft)
	See Remarks	

Elevation (feet)	Depth (feet)	FIELD DATA Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		45						AC	Approximately 5 inches asphalt concrete pavement			
									GP	Gray fine to coarse gravel (dense, moist) (fill)	NS	<1	
									ML	Brown silt with sand and occasional gravel (stiff, moist)			
1085													
									GP	Gray fine to coarse gravel with sand and trace silt (dense, moist)	NS	<1	
	5		60										
1080													
	10		60								NS	1.4	
1075										Grades to wet	NS	51.4	Petroleum like odor
	15		60			N1DP-12 (14.5-15) CA					NS	10.4	Petroleum like odor Groundwater observed at approximately 15.5 feet below ground surface during drilling
1070													
	20												

Note: See Figure A-1 for explanation of symbols.

Log of Boring NIDP-12

GEOENGINEERS

Project:	Tiger Oil - North 1st Street
Project Location:	Yakima, Washington
Project Number:	0504-101-03

Figure A-5
Sheet 1 of 1

Drilled	Start 8/4/2016	End 8/4/2016	Total Depth (ft) 20	Logged By CMD Checked By JRS	Driller Cascade Drilling, Inc.
Drilling Method	Direct-Push				
Surface Elevation (ft) 1101 Vertical Datum NAVD88		Hammer Data		Drilling Equipment	Geoprobe 6600 Truck-mount
Easting (X) Northing (Y)		System South Zone Datum NAD83/91		Groundwater	Date Measured / Depth to Water (ft) / Elevation (ft) See Remarks
Notes:					

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		15						GP	Gray fine to coarse gravel with sand and cobbles (dense, moist) (fill)			
1100											NS	<1	
									GP	Brown fine to coarse gravel with sand and trace silt (dense, moist) (fill)	NS	<1	
1095	5		35										
											NS	3.2	
1090	10		40										
											NS	50.2	
									SM	Brown silty fine to coarse sand with occasional gravel (dense, moist)			Groundwater observed at approximately 13 feet below ground surface during drilling
						N1DP-13 (14.5-15) CA					NS	106.4	Petroleum like odor
1085	15		35						GP	Gray fine to coarse gravel with silt and sand (dense, wet)			
											NS	12.7	Petroleum like odor
	20												

Note: See Figure A-1 for explanation of symbols.

Spokane: Date:11/17/16 Path:P:\0\0504101\GINT\050410103.GPJ DBTemplate/LibTemplate:GEOENGINEERS_DF_STD_US.GDT/GEI8_ENVIRONMENTAL_STANDARD

Log of Boring NIDP-13

GEOENGINEERS

Project: Tiger Oil - North 1st Street
Project Location: Yakima, Washington
Project Number: 0504-101-03

Figure A-6
Sheet 1 of 1

Drilled	Start 8/4/2016	End 8/4/2016	Total Depth (ft) 20	Logged By CMD Checked By JRS	Driller Cascade Drilling, Inc.
Drilling Method	Direct-Push				

Surface Elevation (ft) Undetermined
Vertical Datum NAVD88

Hammer Data

Drilling Equipment Geoprobe 6600 Truck-mount

Easting (X)
Northing (Y)

System South Zone
Datum NAD83/91

Groundwater

Date Measured	Depth to Water (ft)	Elevation (ft)
	See Remarks	

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		60					■	AC	Approximately 8 inches of asphalt concrete pavement			
									GP	Gray fine to coarse gravel (fill)			
											NS	<1	
									ML	Brown sandy silt with occasional gravel (stiff, moist)			
	5		60						GP	Gray fine to coarse gravel with sand and trace silt (dense, moist)	NS	<1	
											NS	<1	
	10		60										
													Groundwater observed at approximately 13 feet below ground surface during drilling
										Grades to wet			
	15		60			N1DP-14 (14.5-15) CA					NS	22	Petroleum like odor
											NS	2.3	Petroleum like odor
	20												

Note: See Figure A-1 for explanation of symbols.

Log of Boring NIDP-14

GEOENGINEERS

Project: Tiger Oil - North 1st Street
Project Location: Yakima, Washington
Project Number: 0504-101-03

Figure A-7
Sheet 1 of 1

Drilled	Start 8/4/2016	End 8/4/2016	Total Depth (ft) 20	Logged By CMD Checked By JRS	Driller Cascade Drilling, Inc.	Drilling Method Direct-Push

Surface Elevation (ft) 1072 Vertical Datum NAVD88	Hammer Data	Drilling Equipment	Geoprobe 6600 Truck-mount
Easting (X) Northing (Y)	System South Zone Datum NAD83/91	Groundwater Date Measured	Depth to Water (ft) See Remarks Elevation (ft)

Notes:

Elevation (feet)	Depth (feet)	FIELD DATA Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		60						AC	Approximately 5 inches asphalt concrete pavement			
									SM	Brown silty fine sand (dense, moist)	NS	<1	
1070													
											NS	<1	
	5		60										
1065													
									GP	Gray fine to coarse gravel with sand and trace silt (dense, moist)	NS	<1	
	10		60										
1060													
	15		60			N1DP-15 (14.5-15) CA				Grades to wet	NS	<1	Groundwater observed at approximately 15 feet below ground surface during drilling
1055													
	20												

Note: See Figure A-1 for explanation of symbols.

Log of Boring NIDP-15

GEOENGINEERS

Project: Tiger Oil - North 1st Street
Project Location: Yakima, Washington
Project Number: 0504-101-03

Figure A-8
Sheet 1 of 1

Drilled	Start 8/4/2016	End 8/4/2016	Total Depth (ft) 20	Logged By CMD Checked By JRS	Driller Cascade Drilling, Inc.	Drilling Method Direct-Push

Surface Elevation (ft) 1073 Vertical Datum NAVD88	Hammer Data	Drilling Equipment Geoprobe 6600 Truck-mount
Easting (X) Northing (Y)	System South Zone Datum NAD83/91	Groundwater Date Measured / Depth to Water (ft) / Elevation (ft) See Remarks
Notes:		

Elevation (feet)	Depth (feet)	FIELD DATA Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		60						AC	Approximately 5 inches asphalt concrete pavement			
									ML	Brown silt with sand and gravel (stiff, moist)			
											NS	<1	
										With decreasing gravel			
1070													
											NS	<1	
	5		60										
									GP	Gray fine to coarse gravel with silt and sand (dense, moist)			
1065													
											NS	<1	
	10		60										
1060													
										Grades to wet	NS	<1	Groundwater observed at approximately 14 feet below ground surface during drilling
	15		60			N1DP-16 (14.5-15) CA							
											NS	<1	
1055													
	20												

Note: See Figure A-1 for explanation of symbols.

Spokane: Date:11/17/16 Path:P:\0\0504101\GINT\050410103.GPJ DBTemplate/LibTemplate:GEOENGINEERS_DF_STD_US.GDT/GEI8_ENVIRONMENTAL_STANDARD

Log of Boring NIDP-16

GEOENGINEERS

Project: Tiger Oil - North 1st Street
Project Location: Yakima, Washington
Project Number: 0504-101-03

Figure A-9
Sheet 1 of 1

Drilled Start 8/3/2016 End 8/3/2016	Total Depth (ft) 20	Logged By CMD Checked By JRS	Driller Cascade Drilling, Inc.	Drilling Method Direct-Push
Surface Elevation (ft) 1116 Vertical Datum NAVD88		Hammer Data		Drilling Equipment Geoprobe 6600 Truck-mount
Easting (X) Northing (Y)		System South Zone Datum NAD83/91		Groundwater Date Measured / Depth to Water (ft) / Elevation (ft) See Remarks
Notes:				

Elevation (feet)	Depth (feet)	FIELD DATA: Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		60						ML	Brown sandy silt with occasional gravel (stiff, moist)	NS	<1	
1115											NS	<1	
	5		60								NS	<1	
1110									GP	Gray fine to coarse gravel with silt and sand (dense, moist)	NS	<1	
	10		60						ML	Brown silt with sand and occasional gravel (stiff, moist)	NS	<1	
1105									GP	Gray fine to coarse gravel with silt and sand (dense, moist)	NS	<1	
										Grades to wet			Groundwater observed at approximately 13 feet below ground surface during drilling
	15		60			N1DP-17 (14.5-15) CA							
1100											NS	<1	
	20												

Note: See Figure A-1 for explanation of symbols.

Log of Boring NIDP-17

GeoEngineers

Project: Tiger Oil - North 1st Street
Project Location: Yakima, Washington
Project Number: 0504-101-03

Figure A-10
Sheet 1 of 1

Spokane: Date:11/17/16 Path:P:\0\0504101\GINT\050410103.GPJ DBTemplate/LibTemplate:GEOENGINEERS_DF_STD_US.GDT/GEI8_ENVIRONMENTAL_STANDARD

Drilled	Start 8/3/2016	End 8/3/2016	Total Depth (ft) 20	Logged By CMD Checked By JRS	Driller Cascade Drilling, Inc.
Drilling Method	Direct-Push				
Surface Elevation (ft)	1090	Hammer Data		Drilling Equipment	Geoprobe 6600 Truck-mount
Vertical Datum	NAVD88				
Easting (X)		System	South Zone	Groundwater	
Northing (Y)		Datum	NAD83/91	Date Measured / Depth to Water (ft) / Elevation (ft)	See Remarks
Notes:					

Elevation (feet)	Depth (feet)	FIELD DATA Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		60						ML	Brown sandy silt with occasional gravel (stiff, moist)	NS	<1	
									GP	Gray fine to coarse gravel with silt and sand (dense, moist)	NS	<1	
1085	5		60										
									ML	Brown sandy silt with occasional gravel (stiff, moist)	NS	<1	
									GP	Gray fine to coarse gravel with silt and sand (dense, moist)	NS	<1	
1080	10		60										
										Grades to wet	NS	<1	Groundwater observed at approximately 13.5 feet below ground surface during drilling
1075	15		60			N1DP-18 (14.5-15) CA							
1070	20												

Note: See Figure A-1 for explanation of symbols.

Log of Boring NIDP-18

GEOENGINEERS

Project: Tiger Oil - North 1st Street

Project Location: Yakima, Washington

Project Number: 0504-101-03

Figure A-11
Sheet 1 of 1

Drilled	Start 8/3/2016	End 8/3/2016	Total Depth (ft) 20	Logged By CMD Checked By JRS	Driller Cascade Drilling, Inc.
Drilling Method	Direct-Push				
Surface Elevation (ft) 1075 Vertical Datum NAVD88		Hammer Data		Drilling Equipment	Geoprobe 6600 Truck-mount
Easting (X) Northing (Y)		System South Zone Datum NAD83/91		Groundwater	
Notes:				Date Measured / Depth to Water (ft) / Elevation (ft)	See Remarks

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)	REMARKS
	0		60						ML	Brown sandy silt with gravel (stiff, moist)	NS	<1	
											NS	<1	
1070	5		60										
									SP-SM	Brown sand with silt (dense, moist)	NS	<1	
1065	10		60										
									ML	Brown sandy silt with gravel (stiff, moist)			
									GP	Gray fine to coarse gravel with silt and sand (dense, moist)			
													Groundwater observed at approximately 13.5 feet below ground surface during drilling
1060	15		60			N1DP-19 (14.5-15) CA					NS	<1	
										Grades to wet			
									SP-SM	Gray fine to medium sand with silt (dense, wet)			
									GP	Gray fine to coarse gravel with silt and sand (dense, wet)			
1055	20												

Note: See Figure A-1 for explanation of symbols.

Log of Boring NIDP-19

GeoEngineers

Project: Tiger Oil - North 1st Street
Project Location: Yakima, Washington
Project Number: 0504-101-03

Figure A-12
Sheet 1 of 1

Drilled	Start 10/17/2016	End 10/17/2016	Total Depth (ft) 20.5	Logged By JML Checked By JRS	Driller Cascade Drilling, Inc.
Drilling Method	Hollow-Stem Auger				

Hammer Data	Autohammer 300 (lbs) / 40 (in) Drop	Drilling Equipment	CME-75	DOE Well I.D.: BJY 287 A 2 (in) well was installed on 10/17/2016 to a depth of 20.5 (ft).
Surface Elevation (ft) Vertical Datum	1083.96 NAVD88	Top of Casing Elevation (ft)	1083.54	
Easting (X) Northing (Y)	1637363.5 470639	Horizontal Datum	South Zone NAD83/91	

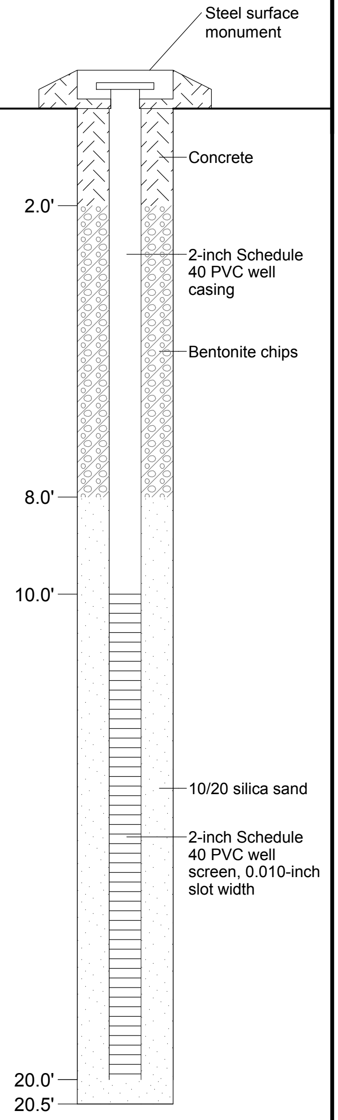
Groundwater

Date Measured	Depth to Water (ft)	Elevation (ft)
10/17/2016	13.5	1070.0

Notes:

		FIELD DATA										
Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)
	0								AC	Approximately 4 inches asphalt concrete pavement		
									CL	Light brown clay with gravel and trace sand (stiff, moist)		
1080												
	5		15	13							NS	<1
									GP	Brown fine to coarse gravel with fine to coarse sand (very dense, moist)		
1075												
	10		6	50/6"							NS	<1
			12	50/6"		N1MW-6 (12.5-13): 101716 CA	▼			Grades to gray gravel with sand and occasional cobbles (very dense, moist) (fill)	MS	1435
1070												
									SP	Gray fine to coarse sand with occasional gravel and trace silt (very dense, moist) (fill)		
	15											
			6	50/6"							MS	506
1065												
			14	32							NS	2.8
	20								GP-GC	Gray fine to coarse gravel with clay (dense, wet) (fill)		

WELL LOG



Note: See Figure A-1 for explanation of symbols.

Log of Monitoring Well N1MW-6

GEOENGINEERS

Project:	Tiger Oil - North 1st Street
Project Location:	Yakima, Washington
Project Number:	0504-101-03

Figure A-13
Sheet 1 of 1

Spokane: Date:11/17/16 Path:P:\05\0504101\GINT\050410103.GPJ DBTemplate/LibTemplate:GEOENGINEERS_DF_STD_US.GDT/GEI8_ENVIRONMENTAL_WELL

Drilled	Start	End	Total Depth (ft)	Logged By	Checked By	Driller	Drilling Method
	10/18/2016	10/18/2016	19	JML	JRS	Cascade Drilling, Inc.	Hollow-Stem Auger

Hammer Data: Autohammer 300 (lbs) / 40 (in) Drop
Drilling Equipment: CME-75
Surface Elevation (ft): 1085.18
Vertical Datum: NAVD88
Top of Casing Elevation (ft): 1084.84
Easting (X): 1637370.7
Northing (Y): 470586.4
Horizontal Datum: South Zone NAD83/91

DOE Well I.D.: BJY 288
A 2 (in) well was installed on 10/18/2016 to a depth of 19 (ft).

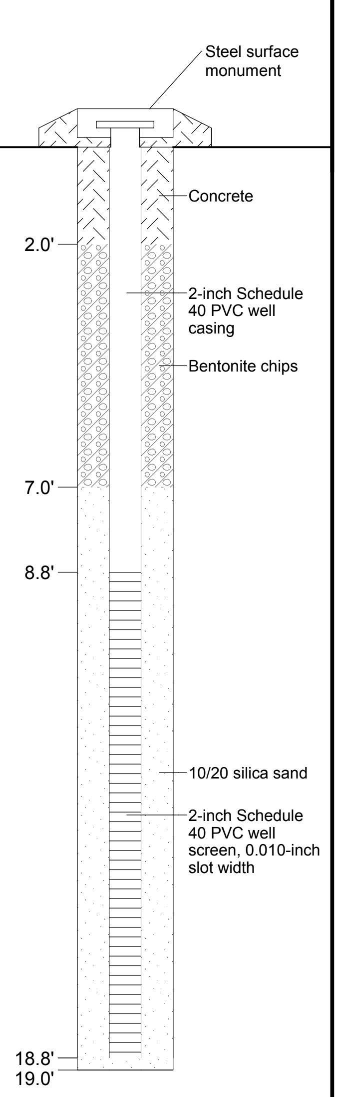
Groundwater

Date Measured	Depth to Water (ft)	Elevation (ft)
10/18/2016	14.0	1070.8

Notes:

Elevation (feet)	Depth (feet)	Interval	Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Graphic Log	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)
1085	0								ML	Brown silt with sand, occasional gravel and organic matter (grass, roots) (very stiff, moist) (fill)		
1080	5		14	25							NS	<1
									GP	Brown gravel with trace sand, trace silt and and occasional cobbles (medium dense, moist) (fill)		
1075	10		8	50/6"						Debris (brick); grades to very dense	NS	<1
			12	50/6"							NS	33.7
									GP	Brown gravel with sand, trace silt and occasional cobbles (very dense, wet) (fill)		
							▼					
1070	15		6	50/6"		N1MW-7 (15-15.5): 101816 CA			GP	Gray gravel with trace sand, trace silt and cobbles (very dense, wet)		NS	161.2

WELL LOG



Note: See Figure A-1 for explanation of symbols.

Log of Monitoring Well N1MW-7

GEOENGINEERS

Project: Tiger Oil - North 1st Street
Project Location: Yakima, Washington
Project Number: 0504-101-03

Figure A-14
Sheet 1 of 1

Drilled	Start 10/17/2016	End 10/17/2016	Total Depth (ft) 21	Logged By JML Checked By JRS	Driller Cascade Drilling, Inc.
Drilling Method	Hollow-Stem Auger				
Hammer Data	Autohammer 300 (lbs) / 40 (in) Drop	Drilling Equipment	CME-75		
Surface Elevation (ft) Vertical Datum	1084.98 NAVD88	Top of Casing Elevation (ft)	1084.51		
Easting (X) Northing (Y)	1637328.3 470623.5	Horizontal Datum	South Zone NAD83/91		

DOE Well I.D.: BJY 286
A 2 (in) well was installed on 10/17/2016 to a depth of 21 (ft).

Groundwater

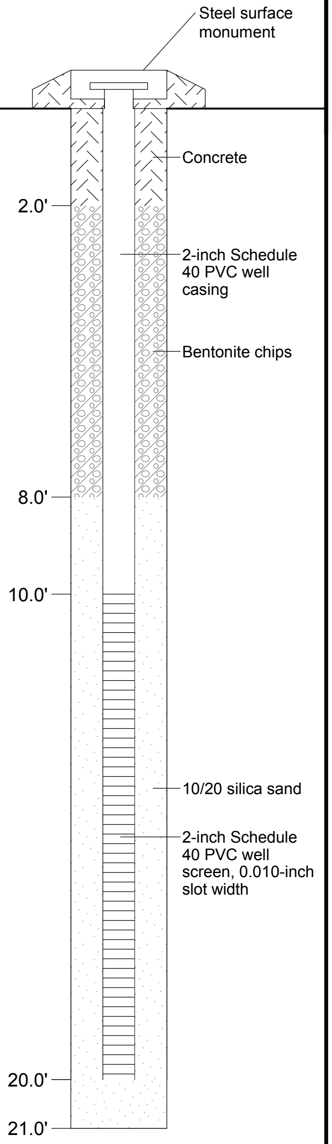
Date Measured	Depth to Water (ft)	Elevation (ft)
11/17/2016	12.0	1072.5

Notes:

FIELD DATA

Elevation (feet)	Depth (feet)	Interval Recovered (in)	Blows/foot	Collected Sample	Sample Name Testing	Water Level	Group Classification	MATERIAL DESCRIPTION	Sheen	Headspace Vapor (ppm)
	0						SP	Brown fine to medium sand with occasional angular gravel and trace silt (medium dense, moist) (fill)		
1080	5	8	10						NS	<1
1075	10	15	12				SP	Brown fine to medium sand with occasional gravel and debris (wood chips) (medium dense, moist)	NS	<1
		14	40		N1MW-8 (12-12.5): 101716	▼			HS	380
							GP	Gray fine to coarse gravel with trace sand, broken basalt cobble (dense, wet) (fill)		
1070	15	12	50/6"		N1MW-8 (15-15.5): 101716 CA		SP	Gray fine to coarse sand with gravel and occasional cobbles (very dense, wet)	HS	664
							GP	Gray fine to coarse angular gravel with fine to coarse sand (very dense, wet)		
1065	20	15	50/6"						SS	81.8

WELL LOG



Note: See Figure A-1 for explanation of symbols.

Log of Monitoring Well N1MW-8

GEOENGINEERS

Project:	Tiger Oil - North 1st Street
Project Location:	Yakima, Washington
Project Number:	0504-101-03

Figure A-15
Sheet 1 of 1

APPENDIX G

Data Validation Reports and Analytical Data, August 2016 and October 2016 Sampling Events

GeoEngineers

523 East Second Avenue, Spokane, Washington 99202, Telephone: 509.363.3125
www.geoengineers.com

Data Validation Report

Project: Tiger Oil – North 1st Street
August 2016 Direct Push and October 2016 Samples

GEI File No: 00504-101-03

Date: November 13, 2016

This report documents the results of a United States Environmental Protection Agency (EPA)-defined Stage 2A data validation (EPA Document 540-R-08-005; EPA, 2009) of analytical data from the analyses of soil and water samples collected as part of the August 2016 and October 2016 sampling events, and the associated laboratory and field quality control (QC) samples. The samples were obtained from the Tiger Oil, North 1st Street Site located at 1808 North 1st Street in Yakima, Washington.

Objective and Quality Control Elements

GeoEngineers, Inc. (GeoEngineers) completed the data validation consistent with the EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review (EPA 2008) and Inorganic Superfund Data Review (EPA 2010) (National Functional Guidelines) to determine if the laboratory analytical results meet the project objectives and are usable for their intended purpose. Data usability was assessed by determining if:

- The samples were analyzed using well-defined and acceptable methods that provide reporting limits below applicable regulatory criteria;
- The precision and accuracy of the data are well-defined and sufficient to provide defensible data; and
- The quality assurance/quality control (QA/QC) procedures utilized by the laboratory meet acceptable industry practices and standards.

In accordance with Quality Assurance Project Plan (Appendix A of the Sampling and Analysis Plan, Soil and Groundwater Assessment; GeoEngineers 2016), the data validation included review of the following QC elements:

- Data Package Completeness
- Chain-of-Custody Documentation
- Holding Times and Sample Preservation
- Surrogate Recoveries
- Method Blanks
- Matrix Spikes/Matrix Spike Duplicates
- Laboratory Control Samples/Laboratory Control Sample Duplicates
- Laboratory Duplicates
- Miscellaneous

Validated Sample Delivery Groups

This data validation included review of the sample delivery groups (SDGs) listed below in Table 1.

TABLE 1: SUMMARY OF VALIDATED SAMPLE DELIVERY GROUPS

Laboratory SDG	Samples Validated
590-4145-1	NIDP-9:080316, NIDP-10:080316, NIDP-11:080316, NIDP-12:080416, NIDP-13:080416, NIDP-14:080416, NIDP-15:080416, NIDP-16:080416, NIDP-17:080316, NIDP-18:080316, NIDP-19:080316
590-4147-1	NIDP-9(14.5-15), NIDP-10(14.5-15), NIDP-11(14.5-15), NIDP-12(14.5-15), NIDP-13(14.5-15), NIDP-14(14.5-15), NIDP-15(14.5-15), NIDP-16(14.5-15), NIDP-17(14.5-15), NIDP-18(14.5-15), NIDP-19(14.5-15)
590-4761-1	N1MW-6 (12.5-13):101716, N1MW-7 (15-15.5):101816, N1MW-8 (12-12.5):101716, N1MW-8 (15-15.5):101716

Chemical Analysis Performed

TestAmerica Laboratories, Inc. (TestAmerica), located in Spokane, Washington, performed laboratory analyses on the soil and water samples using one or more of the following methods*:*

- Hydrocarbon Identification (NWTPH-HCID) by Method NWTPH-HCID;
- Petroleum Hydrocarbons (NWTPH-Dx) by Method NWTPH-Dx;
- Gasoline-Range Hydrocarbons (NWTPH-Gx) by Method NWTPH-Gx;
- Volatile Organic Compounds (VOCs) by Method SW8260C;
- Polycyclic Aromatic Hydrocarbons (PAHs) by Method SW8270D-SIM; and
- Total Metals by Method EPA6010C

Data Validation Summary

The results for each of the QC elements are summarized below.

Data Package Completeness

TestAmerica provided the required deliverables for the data validation according to the National Functional Guidelines. The laboratory followed adequate corrective action processes and the identified anomalies were discussed in the relevant laboratory case narrative.

Chain-of-Custody Documentation

Chain-of-custody (COC) forms were provided with the laboratory analytical report. The COCs were accurate and complete when submitted to the laboratory, with the following exception:

SDG 590-4147-1: The laboratory noted that a trip blank sample was received; however, it was not written on the COC. The trip blank sample was logged and placed "on hold".

Holding Times and Sample Preservation

The sample holding time is defined as the time that elapses between sample collection and sample analysis. Maximum holding time criteria exist for each analysis to help ensure that the analyte concentrations found at the time of analysis reflect the concentration present at the time of sample collection. Established holding times were met for each analysis. The sample coolers arrived at the laboratory within the appropriate temperatures of between two and six degrees Celsius.

Surrogate Recoveries

A surrogate compound is a compound that is chemically similar to the organic analytes of interest, but unlikely to be found in an environmental sample. Surrogates are used for organic analyses and are added to the samples, standards, and blanks to serve as an accuracy and specificity check of each analysis. The surrogates are added to the samples at a known concentration and percent recoveries are calculated following analysis. The surrogate percent recoveries for field samples were within the laboratory control limits, with the following exception:

SDG 590-4147-1: (VOCs) The percent recovery for surrogate 4-Bromofluorobenzene was greater than the control limits in Samples NIDP-12(14.5-15) and NIDP-13(14.5-15); however, the samples were spiked with three additional surrogates and in each case the percent recoveries were within their respective control limits. No action was required for these outliers.

Method Blanks

Method blanks are analyzed to ensure that laboratory procedures and reagents do not introduce measurable concentrations of the analytes of interest. A method blank was analyzed with each batch of samples, at a frequency of 1 per 20 samples. For each sample batch, method blanks for the applicable methods were analyzed at the required frequency. None of the analytes of interest were detected above the reporting limits in the method blanks.

Matrix Spikes/Matrix Spike Duplicates

Since the actual analyte concentration in an environmental sample is not known, the accuracy of a particular analysis is usually inferred by performing a matrix spike (MS) analysis on one sample from the associated batch, known as the parent sample. One aliquot of the sample is analyzed in the normal manner and then a second aliquot of the sample is spiked with a known amount of analyte concentration and analyzed. From these analyses, a percent recovery is calculated. Matrix spike duplicate (MSD) analyses are generally performed for organic analyses as a precision check and analyzed in the same sequence as a matrix spike. Using the result values from the MS and MSD, the relative percent difference (RPD) is calculated. The percent recovery control limits for MS and MSD analyses are specified in the laboratory documents, as are the RPD control limits for MS/MSD sample sets.

One MS/MSD analysis should be performed for every analytical batch or every 20 field samples, whichever is more frequent. The frequency requirements were met for each analysis and the percent recovery and RPD values were within the proper control limits.

Laboratory Control Samples/Laboratory Control Sample Duplicates

A laboratory control sample (LCS) is a blank sample that is spiked with a known amount of analyte and then analyzed. An LCS is similar to an MS, but without the possibility of matrix interference. Given that matrix interference is not an issue, the LCS/LCSD control limits for accuracy and precision are usually more rigorous than for MS/MSD analyses. Additionally, data qualification based on LCS/LCSD analyses would apply to all samples in the associated batch, instead of just the parent sample. The percent recovery control limits for LCS and LCSD analyses are specified in the laboratory documents, as are the RPD control limits for LCS/LCSD sample sets.

One LCS/LCSD analysis should be performed for every analytical batch or every 20 field samples, whichever is more frequent. The frequency requirements were met for all analyses and the percent recovery and RPD values were within the proper control limits.

Laboratory Duplicates

Internal laboratory duplicate analyses are performed to monitor the precision of the analyses. Two separate aliquots of a sample are analyzed as distinct samples in the laboratory and the RPD between the two results is calculated. Duplicate analyses should be performed once per analytical batch. If one or more of the samples used has a concentration less than five times the reporting limit for that sample, the absolute difference is used instead of the RPD. The RPD control limits are specified in the laboratory documents. Laboratory duplicates were analyzed at the proper frequency and the specified acceptance criteria were met.

Miscellaneous

SDG 590-4145-1: (NWTPH-HCID) The positive result for diesel-range hydrocarbons in Samples NIDP-10:080316, NIDP-12:080416, NIDP-13:080416, and NIDP-14:080416 may be influenced by the relative concentration of gasoline-range hydrocarbons in the samples. For this reason, the positive results for diesel-range hydrocarbons were qualified as estimated (J) in these samples, in order to signify a potential high bias.

SDG 590-4147-1: (NWTPH-Dx) The positive result for diesel-range hydrocarbons in Sample NIDP-9(14.5-15) may be influenced by the relative concentration of lube oil-range hydrocarbons in the sample. For this reason, the positive result for diesel-range hydrocarbons was qualified as estimated (J) in this sample, in order to signify a potential high bias.

The positive result for diesel-range hydrocarbons in Samples NIDP-11(14.5-15), NIDP-12(14.5-15), and NIDP-13(14.5-15) may be influenced by the relative concentration of gasoline-range hydrocarbons in the samples. For this reason, the positive results for diesel-range hydrocarbons were qualified as estimated (J) in these samples, in order to signify a potential high bias.

Overall Assessment

As was determined by this data validation, the laboratory followed the specified analytical methods. Accuracy was acceptable, as demonstrated by the surrogate, LCS/LCSD, and MS/MSD percent recovery values. Precision was acceptable, as demonstrated by the LCS/LCSD, MS/MSD and laboratory duplicate RPD values.

The data are acceptable for the intended use, with the following qualifications listed below in Table 2.

TABLE 2: SUMMARY OF QUALIFIED SAMPLES

Sample ID	Analyte	Qualifier	Reason
NIDP-9(14.5-15)	Diesel-range hydrocarbons (Dx)	J	See Miscellaneous
NIDP-10:080316	Diesel-range hydrocarbons (HCID)	J	See Miscellaneous
NIDP-11(14.5-15)	Diesel-range hydrocarbons (Dx)	J	See Miscellaneous
NIDP-12(14.5-15)	Diesel-range hydrocarbons (Dx)	J	See Miscellaneous
NIDP-12:080416	Diesel-range hydrocarbons (HCID)	J	See Miscellaneous

Sample ID	Analyte	Qualifier	Reason
NIDP-13(14.5-15)	Diesel-range hydrocarbons (Dx)	J	See Miscellaneous
NIDP-13:080416	Diesel-range hydrocarbons (HCID)	J	See Miscellaneous
NIDP-14:080416	Diesel-range hydrocarbons (HCID)	J	See Miscellaneous

References

U.S. Environmental Protection Agency (EPA). “Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review,” EPA-540-R-08-01. June 2008.

U.S. Environmental Protection Agency (EPA). “Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use,” EPA-540-R-08-005. January 2009.

U.S. Environmental Protection Agency (EPA). “Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review,” EPA-540-R-10-011. January 2010.

GeoEngineers, Inc., “Sampling and Analysis Plan, Soil and Groundwater Assessment”, prepared for Washington State Department of Ecology. August 1, 2016.

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Spokane
11922 East 1st Ave
Spokane, WA 99206
Tel: (509)924-9200

TestAmerica Job ID: 590-4147-1
Client Project/Site: Tiger Oil - North 1st/0504-101-03

For:
GeoEngineers Inc
523 East Second Ave
Spokane, Washington 99202

Attn: JR Sugalski

Randee Arrington

Authorized for release by:
8/17/2016 4:35:50 PM

Randee Arrington, Project Manager II
(509)924-9200
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This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Case Narrative

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st/0504-101-03

TestAmerica Job ID: 590-4147-1

Job ID: 590-4147-1

Laboratory: TestAmerica Spokane

Narrative

Receipt
The samples were received on 8/5/2016 12:07 PM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 3.6º C.

Receipt Exceptions

A trip blank was submitted for analysis with these samples; however, it was not listed on the Chain of Custody (COC). The trip blank has been logged in 'on hold'.

GC/MS VOA
Method 8260C: Surrogate 4-Bromofluorobenzene recovery for the following samples was outside control limits: NIDP-13(14.5-15) (590-4147-14). Evidence of matrix interference is present; therefore, re-extraction and re-analysis was not performed.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

GC/MS Semi VOA
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

GC Semi VOA
Method NWTPH-Dx: Detected hydrocarbons in the diesel range appear to be due to oil overlap in the following sample: NIDP-9(14.5-15) (590-4147-3).

Method NWTPH-Dx: Detected hydrocarbons in the diesel range appear to be due to gasoline overlap in the following samples: NIDP-11(14.5-15) (590-4147-11) and NIDP-12(14.5-15) (590-4147-13).

Method NWTPH-Dx: Detected hydrocarbons in the diesel range appear to be due to diesel as well as gasoline overlap in the following sample: NIDP-13(14.5-15) (590-4147-14).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Metals
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

General Chemistry
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Organic Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

VOA Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Sample Summary

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st/0504-101-03

TestAmerica Job ID: 590-4147-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
590-4147-3	NIDP-9(14.5-15)	Solid	08/03/16 14:50	08/05/16 12:07
590-4147-7	NIDP-10(14.5-15)	Solid	08/03/16 13:10	08/05/16 12:07
590-4147-11	NIDP-11(14.5-15)	Solid	08/03/16 11:30	08/05/16 12:07
590-4147-13	NIDP-12(14.5-15)	Solid	08/04/16 10:20	08/05/16 12:07
590-4147-14	NIDP-13(14.5-15)	Solid	08/04/16 09:30	08/05/16 12:07
590-4147-15	NIDP-14(14.5-15)	Solid	08/04/16 08:25	08/05/16 12:07
590-4147-17	NIDP-15(14.5-15)	Solid	08/04/16 07:15	08/05/16 12:07
590-4147-18	NIDP-16(14.5-15)	Solid	08/04/16 11:45	08/05/16 12:07
590-4147-21	NIDP-17(14.5-15)	Solid	08/03/16 17:25	08/05/16 12:07
590-4147-25	NIDP-18(14.5-15)	Solid	08/03/16 16:25	08/05/16 12:07
590-4147-29	NIDP-19(14.5-15)	Solid	08/03/16 18:15	08/05/16 12:07

Definitions/Glossary

Qualifiers

GC/MS VOA

Qualifier	Qualifier Description
X	Surrogate is outside control limits

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Client Sample Results

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st/0504-101-03

TestAmerica Job ID: 590-4147-1

Client Sample ID: NIDP-9(14.5-15)

Date Collected: 08/03/16 14:50
Date Received: 08/05/16 12:07

Lab Sample ID: 590-4147-3
Matrix: Solid
Percent Solids: 96.3

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.022		mg/Kg	☼	08/08/16 12:22	08/08/16 14:05	1
Ethylbenzene	ND		0.11		mg/Kg	☼	08/08/16 12:22	08/08/16 14:05	1
m,p-Xylene	ND		0.43		mg/Kg	☼	08/08/16 12:22	08/08/16 14:05	1
o-Xylene	ND		0.22		mg/Kg	☼	08/08/16 12:22	08/08/16 14:05	1
Toluene	ND		0.11		mg/Kg	☼	08/08/16 12:22	08/08/16 14:05	1
Xylenes, Total	ND		0.65		mg/Kg	☼	08/08/16 12:22	08/08/16 14:05	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*97*		*75 - 120*	*08/08/16 12:22*	*08/08/16 14:05*	*1*
4-Bromofluorobenzene (Surr)	*95*		*76 - 122*	*08/08/16 12:22*	*08/08/16 14:05*	*1*
Dibromofluoromethane (Surr)	*100*		*80 - 120*	*08/08/16 12:22*	*08/08/16 14:05*	*1*
Toluene-d8 (Surr)	*105*		*80 - 120*	*08/08/16 12:22*	*08/08/16 14:05*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	ND		5.4		mg/Kg	☼	08/08/16 12:22	08/08/16 14:05	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*95*		*41.5 - 162*	*08/08/16 12:22*	*08/08/16 14:05*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
2-Methylnaphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
1-Methylnaphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Acenaphthylene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Acenaphthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Fluorene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Phenanthrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Benzo[a]anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Chrysene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Benzo[b]fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Benzo[k]fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Benzo[a]pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Indeno[1,2,3-cd]pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Dibenz(a,h)anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1
Benzo[g,h,i]perylene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:35	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*79*		*23 - 120*	*08/09/16 11:39*	*08/09/16 15:35*	*1*
2-Fluorobiphenyl (Surr)	*72*		*38 - 123*	*08/09/16 11:39*	*08/09/16 15:35*	*1*
p-Terphenyl-d14	*104*		*68 - 136*	*08/09/16 11:39*	*08/09/16 15:35*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	**16**		10		mg/Kg	☼	08/10/16 13:01	08/10/16 16:24	1

Client Sample Results

Client: GeoEngineers Inc
TestAmerica Job ID: 590-4147-1
Project/Site: Tiger Oil - North 1st/0504-101-03

Client Sample ID: NIDP-9(14.5-15)
Lab Sample ID: 590-4147-3

Date Collected: 08/03/16 14:50
Matrix: Solid
Date Received: 08/05/16 12:07
Percent Solids: 96.3

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Residual Range Organics (RRO) (C25-C36)	**180**		26		mg/Kg	☼	08/10/16 13:01	08/10/16 16:24	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*102*		*50 - 150*	*08/10/16 13:01*	*08/10/16 16:24*	*1*
n-Triacontane-d62	*100*		*50 - 150*	*08/10/16 13:01*	*08/10/16 16:24*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		5.0		mg/Kg	☼	08/16/16 08:55	08/17/16 10:14	5

Client Sample ID: NIDP-10(14.5-15)
Lab Sample ID: 590-4147-7

Date Collected: 08/03/16 13:10
Matrix: Solid
Date Received: 08/05/16 12:07
Percent Solids: 93.8

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.020		mg/Kg	☼	08/08/16 12:22	08/08/16 14:26	1
Ethylbenzene	ND		0.10		mg/Kg	☼	08/08/16 12:22	08/08/16 14:26	1
m,p-Xylene	ND		0.40		mg/Kg	☼	08/08/16 12:22	08/08/16 14:26	1
o-Xylene	ND		0.20		mg/Kg	☼	08/08/16 12:22	08/08/16 14:26	1
Toluene	ND		0.10		mg/Kg	☼	08/08/16 12:22	08/08/16 14:26	1
Xylenes, Total	ND		0.60		mg/Kg	☼	08/08/16 12:22	08/08/16 14:26	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*94*		*75 - 120*	*08/08/16 12:22*	*08/08/16 14:26*	*1*
4-Bromofluorobenzene (Surr)	*94*		*76 - 122*	*08/08/16 12:22*	*08/08/16 14:26*	*1*
Dibromofluoromethane (Surr)	*101*		*80 - 120*	*08/08/16 12:22*	*08/08/16 14:26*	*1*
Toluene-d8 (Surr)	*103*		*80 - 120*	*08/08/16 12:22*	*08/08/16 14:26*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	**90**		5.0		mg/Kg	☼	08/08/16 12:22	08/08/16 14:26	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*94*		*41.5 - 162*	*08/08/16 12:22*	*08/08/16 14:26*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
2-Methylnaphthalene	**44**		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
1-Methylnaphthalene	**25**		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Acenaphthylene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Acenaphthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Fluorene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Phenanthrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Benzo[a]anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Chrysene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1

Client Sample Results

Client: GeoEngineers Inc TestAmerica Job ID: 590-4147-1
Project/Site: Tiger Oil - North 1st/0504-101-03

Client Sample ID: NIDP-10(14.5-15) Lab Sample ID: 590-4147-7

Date Collected: 08/03/16 13:10 **Matrix: Solid**
Date Received: 08/05/16 12:07 **Percent Solids: 93.8**

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzo[b]fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Benzo[k]fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Benzo[a]pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Indeno[1,2,3-cd]pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Dibenz(a,h)anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1
Benzo[g,h,i]perylene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 15:58	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*95*		*23 - 120*	*08/09/16 11:39*	*08/09/16 15:58*	*1*
2-Fluorobiphenyl (Surr)	*71*		*38 - 123*	*08/09/16 11:39*	*08/09/16 15:58*	*1*
p-Terphenyl-d14	*113*		*68 - 136*	*08/09/16 11:39*	*08/09/16 15:58*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	ND		10		mg/Kg	☼	08/10/16 13:01	08/10/16 16:42	1
Residual Range Organics (RRO) (C25-C36)	ND		26		mg/Kg	☼	08/10/16 13:01	08/10/16 16:42	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*99*		*50 - 150*	*08/10/16 13:01*	*08/10/16 16:42*	*1*
n-Triacontane-d62	*105*		*50 - 150*	*08/10/16 13:01*	*08/10/16 16:42*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		4.6		mg/Kg	☼	08/16/16 08:55	08/17/16 10:34	5

Client Sample ID: NIDP-11(14.5-15) Lab Sample ID: 590-4147-11

Date Collected: 08/03/16 11:30 **Matrix: Solid**
Date Received: 08/05/16 12:07 **Percent Solids: 92.8**

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.022		mg/Kg	☼	08/08/16 12:22	08/08/16 14:48	1
Ethylbenzene	**1.0**		0.11		mg/Kg	☼	08/08/16 12:22	08/08/16 14:48	1
m,p-Xylene	**4.9**		0.45		mg/Kg	☼	08/08/16 12:22	08/08/16 14:48	1
o-Xylene	**1.1**		0.22		mg/Kg	☼	08/08/16 12:22	08/08/16 14:48	1
Toluene	ND		0.11		mg/Kg	☼	08/08/16 12:22	08/08/16 14:48	1
Xylenes, Total	**6.0**		0.67		mg/Kg	☼	08/08/16 12:22	08/08/16 14:48	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*98*		*75 - 120*	*08/08/16 12:22*	*08/08/16 14:48*	*1*
4-Bromofluorobenzene (Surr)	*97*		*76 - 122*	*08/08/16 12:22*	*08/08/16 14:48*	*1*
Dibromofluoromethane (Surr)	*97*		*80 - 120*	*08/08/16 12:22*	*08/08/16 14:48*	*1*
Toluene-d8 (Surr)	*102*		*80 - 120*	*08/08/16 12:22*	*08/08/16 14:48*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	**150**		5.6		mg/Kg	☼	08/08/16 12:22	08/08/16 14:48	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*97*		*41.5 - 162*	*08/08/16 12:22*	*08/08/16 14:48*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	**80**		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
2-Methylnaphthalene	**370**		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
1-Methylnaphthalene	**200**		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Acenaphthylene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Acenaphthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Fluorene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Phenanthrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Benzo[a]anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Chrysene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Benzo[b]fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Benzo[k]fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Benzo[a]pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Indeno[1,2,3-cd]pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Dibenz(a,h)anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1
Benzo[g,h,i]perylene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 16:20	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*81*		*23 - 120*	*08/09/16 11:39*	*08/09/16 16:20*	*1*
2-Fluorobiphenyl (Surr)	*65*		*38 - 123*	*08/09/16 11:39*	*08/09/16 16:20*	*1*
p-Terphenyl-d14	*108*		*68 - 136*	*08/09/16 11:39*	*08/09/16 16:20*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	**16**		11		mg/Kg	☼	08/10/16 13:01	08/10/16 17:00	1
Residual Range Organics (RRO) (C25-C36)	ND		27		mg/Kg	☼	08/10/16 13:01	08/10/16 17:00	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*96*		*50 - 150*	*08/10/16 13:01*	*08/10/16 17:00*	*1*
n-Triacontane-d62	*103*		*50 - 150*	*08/10/16 13:01*	*08/10/16 17:00*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		4.4		mg/Kg	☼	08/16/16 08:55	08/17/16 10:38	5

Client Sample ID: NIDP-12(14.5-15)

Lab Sample ID: 590-4147-13

Date Collected: 08/04/16 10:20
Date Received: 08/05/16 12:07

Matrix: Solid
Percent Solids: 94.3

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.026		mg/Kg	☼	08/08/16 12:22	08/08/16 15:10	1
Ethylbenzene	ND		0.13		mg/Kg	☼	08/08/16 12:22	08/08/16 15:10	1
m,p-Xylene	**0.55**		0.52		mg/Kg	☼	08/08/16 12:22	08/08/16 15:10	1
o-Xylene	ND		0.26		mg/Kg	☼	08/08/16 12:22	08/08/16 15:10	1
Toluene	ND		0.13		mg/Kg	☼	08/08/16 12:22	08/08/16 15:10	1
Xylenes, Total	ND		0.78		mg/Kg	☼	08/08/16 12:22	08/08/16 15:10	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*102*		*75 - 120*	*08/08/16 12:22*	*08/08/16 15:10*	*1*
4-Bromofluorobenzene (Surr)	*135*	*X*	*76 - 122*	*08/08/16 12:22*	*08/08/16 15:10*	*1*

Client Sample Results

Client Sample ID: NIDP-12(14.5-15)

Lab Sample ID: 590-4147-13

Date Collected: 08/04/16 10:20
Date Received: 08/05/16 12:07

Matrix: Solid
Percent Solids: 94.3

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Dibromofluoromethane (Surr)	*101*		*80 - 120*	*08/08/16 12:22*	*08/08/16 15:10*	*1*
Toluene-d8 (Surr)	*110*		*80 - 120*	*08/08/16 12:22*	*08/08/16 15:10*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	**2900**		65		mg/Kg	☼	08/08/16 12:22	08/09/16 12:29	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*103*		*41.5 - 162*	*08/08/16 12:22*	*08/09/16 12:29*	*10*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	**510**		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
2-Methylnaphthalene	**5700**		100		ug/Kg	☼	08/09/16 11:39	08/10/16 10:45	10
1-Methylnaphthalene	**2400**		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Acenaphthylene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Acenaphthene	**12**		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Fluorene	**15**		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Phenanthrene	**38**		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Benzo[a]anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Chrysene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Benzo[b]fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Benzo[k]fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Benzo[a]pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Indeno[1,2,3-cd]pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Dibenz(a,h)anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1
Benzo[g,h,i]perylene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 16:43	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*75*		*23 - 120*	*08/09/16 11:39*	*08/09/16 16:43*	*1*
Nitrobenzene-d5	*76*		*23 - 120*	*08/09/16 11:39*	*08/10/16 10:45*	*10*
2-Fluorobiphenyl (Surr)	*70*		*38 - 123*	*08/09/16 11:39*	*08/09/16 16:43*	*1*
p-Terphenyl-d14	*109*		*68 - 136*	*08/09/16 11:39*	*08/09/16 16:43*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	**160**		10		mg/Kg	☼	08/10/16 13:01	08/10/16 17:17	1
Residual Range Organics (RRO) (C25-C36)	ND		26		mg/Kg	☼	08/10/16 13:01	08/10/16 17:17	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*106*		*50 - 150*	*08/10/16 13:01*	*08/10/16 17:17*	*1*
n-Triacontane-d62	*102*		*50 - 150*	*08/10/16 13:01*	*08/10/16 17:17*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		4.3		mg/Kg	☼	08/16/16 08:55	08/17/16 10:42	5

Client Sample Results

Client Sample ID: NIDP-13(14.5-15)

Lab Sample ID: 590-4147-14

Date Collected: 08/04/16 09:30
Matrix: Solid
Date Received: 08/05/16 12:07
Percent Solids: 86.6

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.23		mg/Kg	☼	08/08/16 12:22	08/08/16 15:31	10
Ethylbenzene	**48**		1.1		mg/Kg	☼	08/08/16 12:22	08/08/16 15:31	10
m,p-Xylene	**170**		45		mg/Kg	☼	08/08/16 12:22	08/08/16 18:23	100
o-Xylene	**44**		23		mg/Kg	☼	08/08/16 12:22	08/08/16 18:23	100
Toluene	ND		1.1		mg/Kg	☼	08/08/16 12:22	08/08/16 15:31	10
Xylenes, Total	**210**		68		mg/Kg	☼	08/08/16 12:22	08/08/16 18:23	100

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*101*		*75 - 120*	*08/08/16 12:22*	*08/08/16 15:31*	*10*
1,2-Dichloroethane-d4 (Surr)	*101*		*75 - 120*	*08/08/16 12:22*	*08/08/16 18:23*	*100*
4-Bromofluorobenzene (Surr)	*132*	*X*	*76 - 122*	*08/08/16 12:22*	*08/08/16 15:31*	*10*
4-Bromofluorobenzene (Surr)	*92*		*76 - 122*	*08/08/16 12:22*	*08/08/16 18:23*	*100*
Dibromofluoromethane (Surr)	*102*		*80 - 120*	*08/08/16 12:22*	*08/08/16 15:31*	*10*
Dibromofluoromethane (Surr)	*102*		*80 - 120*	*08/08/16 12:22*	*08/08/16 18:23*	*100*
Toluene-d8 (Surr)	*107*		*80 - 120*	*08/08/16 12:22*	*08/08/16 15:31*	*10*
Toluene-d8 (Surr)	*101*		*80 - 120*	*08/08/16 12:22*	*08/08/16 18:23*	*100*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	**3800**		560		mg/Kg	☼	08/08/16 12:22	08/08/16 18:23	100

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*92*		*41.5 - 162*	*08/08/16 12:22*	*08/08/16 18:23*	*100*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	**19000**		440		ug/Kg	☼	08/09/16 11:39	08/10/16 11:07	40
2-Methylnaphthalene	**42000**		440		ug/Kg	☼	08/09/16 11:39	08/10/16 11:07	40
1-Methylnaphthalene	**22000**		440		ug/Kg	☼	08/09/16 11:39	08/10/16 11:07	40
Acenaphthylene	**57**		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Acenaphthene	**110**		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Fluorene	**200**		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Phenanthrene	**350**		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Anthracene	**20**		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Fluoranthene	**18**		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Pyrene	**17**		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Benzo[a]anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Chrysene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Benzo[b]fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Benzo[k]fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Benzo[a]pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Indeno[1,2,3-cd]pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Dibenz(a,h)anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1
Benzo[g,h,i]perylene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 17:05	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*107*		*23 - 120*	*08/09/16 11:39*	*08/10/16 11:07*	*40*
2-Fluorobiphenyl (Surr)	*88*		*38 - 123*	*08/09/16 11:39*	*08/09/16 17:05*	*1*
p-Terphenyl-d14	*110*		*68 - 136*	*08/09/16 11:39*	*08/09/16 17:05*	*1*

Client Sample ID: NIDP-13(14.5-15)

Lab Sample ID: 590-4147-14

Date Collected: 08/04/16 09:30

Matrix: Solid

Date Received: 08/05/16 12:07

Percent Solids: 86.6

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	**700**		11		mg/Kg	☼	08/10/16 13:01	08/10/16 17:35	1
Residual Range Organics (RRO) (C25-C36)	ND		29		mg/Kg	☼	08/10/16 13:01	08/10/16 17:35	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*135*		*50 - 150*	*08/10/16 13:01*	*08/10/16 17:35*	*1*
n-Triacontane-d62	*98*		*50 - 150*	*08/10/16 13:01*	*08/10/16 17:35*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	**7.8**		5.2		mg/Kg	☼	08/16/16 08:55	08/17/16 10:54	5

Client Sample ID: NIDP-14(14.5-15)

Lab Sample ID: 590-4147-15

Date Collected: 08/04/16 08:25

Matrix: Solid

Date Received: 08/05/16 12:07

Percent Solids: 95.4

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.026		mg/Kg	☼	08/08/16 12:22	08/09/16 12:50	1
Ethylbenzene	ND		0.13		mg/Kg	☼	08/08/16 12:22	08/09/16 12:50	1
m,p-Xylene	ND		0.52		mg/Kg	☼	08/08/16 12:22	08/09/16 12:50	1
o-Xylene	ND		0.26		mg/Kg	☼	08/08/16 12:22	08/09/16 12:50	1
Toluene	ND		0.13		mg/Kg	☼	08/08/16 12:22	08/09/16 12:50	1
Xylenes, Total	ND		0.78		mg/Kg	☼	08/08/16 12:22	08/09/16 12:50	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*100*		*75 - 120*	*08/08/16 12:22*	*08/09/16 12:50*	*1*
4-Bromofluorobenzene (Surr)	*94*		*76 - 122*	*08/08/16 12:22*	*08/09/16 12:50*	*1*
Dibromofluoromethane (Surr)	*105*		*80 - 120*	*08/08/16 12:22*	*08/09/16 12:50*	*1*
Toluene-d8 (Surr)	*105*		*80 - 120*	*08/08/16 12:22*	*08/09/16 12:50*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	**23**		6.5		mg/Kg	☼	08/08/16 12:22	08/09/16 12:50	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*94*		*41.5 - 162*	*08/08/16 12:22*	*08/09/16 12:50*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
2-Methylnaphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
1-Methylnaphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Acenaphthylene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Acenaphthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Fluorene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Phenanthrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Benzo[a]anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1

Client Sample ID: NIDP-14(14.5-15)

Lab Sample ID: 590-4147-15

Date Collected: 08/04/16 08:25

Matrix: Solid

Date Received: 08/05/16 12:07

Percent Solids: 95.4

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chrysene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Benzo[b]fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Benzo[k]fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Benzo[a]pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Indeno[1,2,3-cd]pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Dibenz(a,h)anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1
Benzo[g,h,i]perylene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:28	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*75*		*23 - 120*	*08/09/16 11:39*	*08/09/16 17:28*	*1*
2-Fluorobiphenyl (Surr)	*68*		*38 - 123*	*08/09/16 11:39*	*08/09/16 17:28*	*1*
p-Terphenyl-d14	*105*		*68 - 136*	*08/09/16 11:39*	*08/09/16 17:28*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	**12**		10		mg/Kg	☼	08/10/16 13:01	08/10/16 17:53	1
Residual Range Organics (RRO) (C25-C36)	ND		26		mg/Kg	☼	08/10/16 13:01	08/10/16 17:53	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*103*		*50 - 150*	*08/10/16 13:01*	*08/10/16 17:53*	*1*
n-Triacontane-d62	*106*		*50 - 150*	*08/10/16 13:01*	*08/10/16 17:53*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		7.6		mg/Kg	☼	08/16/16 08:55	08/17/16 11:19	10

Client Sample ID: NIDP-15(14.5-15)

Lab Sample ID: 590-4147-17

Date Collected: 08/04/16 07:15

Matrix: Solid

Date Received: 08/05/16 12:07

Percent Solids: 94.3

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.024		mg/Kg	☼	08/08/16 12:22	08/08/16 16:15	1
Ethylbenzene	ND		0.12		mg/Kg	☼	08/08/16 12:22	08/08/16 16:15	1
m,p-Xylene	ND		0.48		mg/Kg	☼	08/08/16 12:22	08/08/16 16:15	1
o-Xylene	ND		0.24		mg/Kg	☼	08/08/16 12:22	08/08/16 16:15	1
Toluene	ND		0.12		mg/Kg	☼	08/08/16 12:22	08/08/16 16:15	1
Xylenes, Total	ND		0.72		mg/Kg	☼	08/08/16 12:22	08/08/16 16:15	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*99*		*75 - 120*	*08/08/16 12:22*	*08/08/16 16:15*	*1*
4-Bromofluorobenzene (Surr)	*97*		*76 - 122*	*08/08/16 12:22*	*08/08/16 16:15*	*1*
Dibromofluoromethane (Surr)	*102*		*80 - 120*	*08/08/16 12:22*	*08/08/16 16:15*	*1*
Toluene-d8 (Surr)	*105*		*80 - 120*	*08/08/16 12:22*	*08/08/16 16:15*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	ND		6.0		mg/Kg	☼	08/08/16 12:22	08/08/16 16:15	1

Client Sample Results

Client Sample ID: NIDP-15(14.5-15)

Lab Sample ID: 590-4147-17

Date Collected: 08/04/16 07:15

Matrix: Solid

Date Received: 08/05/16 12:07

Percent Solids: 94.3

Surrogate	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
4-Bromofluorobenzene (Surr)	*97*		*41.5 - 162*	*08/08/16 12:22*	*08/08/16 16:15*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
2-Methylnaphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
1-Methylnaphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Acenaphthylene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Acenaphthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Fluorene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Phenanthrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Benzo[a]anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Chrysene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Benzo[b]fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Benzo[k]fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Benzo[a]pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Indeno[1,2,3-cd]pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Dibenz(a,h)anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1
Benzo[g,h,i]perylene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 17:50	1

Surrogate	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
Nitrobenzene-d5	*81*		*23 - 120*	*08/09/16 11:39*	*08/09/16 17:50*	*1*
2-Fluorobiphenyl (Surr)	*72*		*38 - 123*	*08/09/16 11:39*	*08/09/16 17:50*	*1*
p-Terphenyl-d14	*116*		*68 - 136*	*08/09/16 11:39*	*08/09/16 17:50*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	ND		10		mg/Kg	☼	08/10/16 13:01	08/10/16 18:11	1
Residual Range Organics (RRO) (C25-C36)	ND		26		mg/Kg	☼	08/10/16 13:01	08/10/16 18:11	1

Surrogate	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
o-Terphenyl	*97*		*50 - 150*	*08/10/16 13:01*	*08/10/16 18:11*	*1*
n-Triacontane-d62	*103*		*50 - 150*	*08/10/16 13:01*	*08/10/16 18:11*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		4.9		mg/Kg	☼	08/16/16 08:55	08/17/16 11:01	5

Client Sample ID: NIDP-16(14.5-15)

Lab Sample ID: 590-4147-18

Date Collected: 08/04/16 11:45

Matrix: Solid

Date Received: 08/05/16 12:07

Percent Solids: 92.5

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.027		mg/Kg	☼	08/08/16 12:22	08/08/16 16:58	1
Ethylbenzene	ND		0.13		mg/Kg	☼	08/08/16 12:22	08/08/16 16:58	1
m,p-Xylene	ND		0.54		mg/Kg	☼	08/08/16 12:22	08/08/16 16:58	1

Client Sample Results

Client Sample ID: NIDP-16(14.5-15)
Date Collected: 08/04/16 11:45
Date Received: 08/05/16 12:07

Lab Sample ID: 590-4147-18
Matrix: Solid
Percent Solids: 92.5

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
o-Xylene	ND		0.27		mg/Kg	☼	08/08/16 12:22	08/08/16 16:58	1
Toluene	ND		0.13		mg/Kg	☼	08/08/16 12:22	08/08/16 16:58	1
Xylenes, Total	ND		0.81		mg/Kg	☼	08/08/16 12:22	08/08/16 16:58	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*97*		*75 - 120*	*08/08/16 12:22*	*08/08/16 16:58*	*1*
4-Bromofluorobenzene (Surr)	*94*		*76 - 122*	*08/08/16 12:22*	*08/08/16 16:58*	*1*
Dibromofluoromethane (Surr)	*101*		*80 - 120*	*08/08/16 12:22*	*08/08/16 16:58*	*1*
Toluene-d8 (Surr)	*103*		*80 - 120*	*08/08/16 12:22*	*08/08/16 16:58*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	ND		6.7		mg/Kg	☼	08/08/16 12:22	08/08/16 16:58	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*94*		*41.5 - 162*	*08/08/16 12:22*	*08/08/16 16:58*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
2-Methylnaphthalene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
1-Methylnaphthalene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Acenaphthylene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Acenaphthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Fluorene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Phenanthrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Benzo[a]anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Chrysene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Benzo[b]fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Benzo[k]fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Benzo[a]pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Indeno[1,2,3-cd]pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Dibenz(a,h)anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1
Benzo[g,h,i]perylene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:12	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*81*		*23 - 120*	*08/09/16 11:39*	*08/09/16 18:12*	*1*
2-Fluorobiphenyl (Surr)	*71*		*38 - 123*	*08/09/16 11:39*	*08/09/16 18:12*	*1*
p-Terphenyl-d14	*120*		*68 - 136*	*08/09/16 11:39*	*08/09/16 18:12*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	ND		11		mg/Kg	☼	08/10/16 13:01	08/10/16 15:28	1
Residual Range Organics (RRO) (C25-C36)	ND		26		mg/Kg	☼	08/10/16 13:01	08/10/16 15:28	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*94*		*50 - 150*	*08/10/16 13:01*	*08/10/16 15:28*	*1*

Client Sample ID: NIDP-16(14.5-15)

Lab Sample ID: 590-4147-18

Date Collected: 08/04/16 11:45

Matrix: Solid

Date Received: 08/05/16 12:07

Percent Solids: 92.5

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC) (Continued)

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
n-Triacontane-d62	*96*		*50 - 150*	*08/10/16 13:01*	*08/10/16 15:28*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		5.2		mg/Kg	☼	08/16/16 08:55	08/17/16 11:04	5

Client Sample ID: NIDP-17(14.5-15)

Lab Sample ID: 590-4147-21

Date Collected: 08/03/16 17:25

Matrix: Solid

Date Received: 08/05/16 12:07

Percent Solids: 92.7

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.025		mg/Kg	☼	08/08/16 12:22	08/08/16 17:19	1
Ethylbenzene	ND		0.12		mg/Kg	☼	08/08/16 12:22	08/08/16 17:19	1
m,p-Xylene	ND		0.49		mg/Kg	☼	08/08/16 12:22	08/08/16 17:19	1
o-Xylene	ND		0.25		mg/Kg	☼	08/08/16 12:22	08/08/16 17:19	1
Toluene	ND		0.12		mg/Kg	☼	08/08/16 12:22	08/08/16 17:19	1
Xylenes, Total	ND		0.74		mg/Kg	☼	08/08/16 12:22	08/08/16 17:19	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*99*		*75 - 120*	*08/08/16 12:22*	*08/08/16 17:19*	*1*
4-Bromofluorobenzene (Surr)	*93*		*76 - 122*	*08/08/16 12:22*	*08/08/16 17:19*	*1*
Dibromofluoromethane (Surr)	*98*		*80 - 120*	*08/08/16 12:22*	*08/08/16 17:19*	*1*
Toluene-d8 (Surr)	*102*		*80 - 120*	*08/08/16 12:22*	*08/08/16 17:19*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	ND		6.2		mg/Kg	☼	08/08/16 12:22	08/08/16 17:19	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*93*		*41.5 - 162*	*08/08/16 12:22*	*08/08/16 17:19*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
2-Methylnaphthalene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
1-Methylnaphthalene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Acenaphthylene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Acenaphthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Fluorene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Phenanthrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Benzo[a]anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Chrysene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Benzo[b]fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Benzo[k]fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Benzo[a]pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Indeno[1,2,3-cd]pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1

1 2 3 4 5 6 7 8 9 10 11 12

Client Sample ID: NIDP-17(14.5-15)

Lab Sample ID: 590-4147-21

Date Collected: 08/03/16 17:25
Matrix: Solid
Date Received: 08/05/16 12:07
Percent Solids: 92.7

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Dibenz(a,h)anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1
Benzo[g,h,i]perylene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 18:35	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*96*		*23 - 120*	*08/09/16 11:39*	*08/09/16 18:35*	*1*
2-Fluorobiphenyl (Surr)	*77*		*38 - 123*	*08/09/16 11:39*	*08/09/16 18:35*	*1*
p-Terphenyl-d14	*104*		*68 - 136*	*08/09/16 11:39*	*08/09/16 18:35*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	ND		11		mg/Kg	☼	08/10/16 13:01	08/10/16 15:47	1
Residual Range Organics (RRO) (C25-C36)	ND		26		mg/Kg	☼	08/10/16 13:01	08/10/16 15:47	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*100*		*50 - 150*	*08/10/16 13:01*	*08/10/16 15:47*	*1*
n-Triacontane-d62	*102*		*50 - 150*	*08/10/16 13:01*	*08/10/16 15:47*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		4.3		mg/Kg	☼	08/16/16 08:55	08/17/16 11:07	5

Client Sample ID: NIDP-18(14.5-15)

Lab Sample ID: 590-4147-25

Date Collected: 08/03/16 16:25
Matrix: Solid
Date Received: 08/05/16 12:07
Percent Solids: 92.7

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.023		mg/Kg	☼	08/08/16 12:22	08/08/16 17:40	1
Ethylbenzene	ND		0.12		mg/Kg	☼	08/08/16 12:22	08/08/16 17:40	1
m,p-Xylene	ND		0.46		mg/Kg	☼	08/08/16 12:22	08/08/16 17:40	1
o-Xylene	ND		0.23		mg/Kg	☼	08/08/16 12:22	08/08/16 17:40	1
Toluene	ND		0.12		mg/Kg	☼	08/08/16 12:22	08/08/16 17:40	1
Xylenes, Total	ND		0.69		mg/Kg	☼	08/08/16 12:22	08/08/16 17:40	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*96*		*75 - 120*	*08/08/16 12:22*	*08/08/16 17:40*	*1*
4-Bromofluorobenzene (Surr)	*97*		*76 - 122*	*08/08/16 12:22*	*08/08/16 17:40*	*1*
Dibromofluoromethane (Surr)	*99*		*80 - 120*	*08/08/16 12:22*	*08/08/16 17:40*	*1*
Toluene-d8 (Surr)	*104*		*80 - 120*	*08/08/16 12:22*	*08/08/16 17:40*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	ND		5.8		mg/Kg	☼	08/08/16 12:22	08/08/16 17:40	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*97*		*41.5 - 162*	*08/08/16 12:22*	*08/08/16 17:40*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1

1 2 3 4 5 6 7 8 9 10 11 12

Client Sample ID: NIDP-18(14.5-15) Lab Sample ID: 590-4147-25

Date Collected: 08/03/16 16:25 **Matrix: Solid**
Date Received: 08/05/16 12:07 **Percent Solids: 92.7**

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
2-Methylnaphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
1-Methylnaphthalene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Acenaphthylene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Acenaphthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Fluorene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Phenanthrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Benzo[a]anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Chrysene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Benzo[b]fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Benzo[k]fluoranthene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Benzo[a]pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Indeno[1,2,3-cd]pyrene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Dibenz(a,h)anthracene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1
Benzo[g,h,i]perylene	ND		10		ug/Kg	☼	08/09/16 11:39	08/09/16 18:57	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*79*		*23 - 120*	*08/09/16 11:39*	*08/09/16 18:57*	*1*
2-Fluorobiphenyl (Surr)	*71*		*38 - 123*	*08/09/16 11:39*	*08/09/16 18:57*	*1*
p-Terphenyl-d14	*96*		*68 - 136*	*08/09/16 11:39*	*08/09/16 18:57*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	ND		11		mg/Kg	☼	08/10/16 13:01	08/10/16 16:05	1
Residual Range Organics (RRO) (C25-C36)	ND		26		mg/Kg	☼	08/10/16 13:01	08/10/16 16:05	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*97*		*50 - 150*	*08/10/16 13:01*	*08/10/16 16:05*	*1*
n-Triacontane-d62	*91*		*50 - 150*	*08/10/16 13:01*	*08/10/16 16:05*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		4.9		mg/Kg	☼	08/16/16 08:55	08/17/16 11:11	5

Client Sample ID: NIDP-19(14.5-15) Lab Sample ID: 590-4147-29

Date Collected: 08/03/16 18:15 **Matrix: Solid**
Date Received: 08/05/16 12:07 **Percent Solids: 92.9**

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.018		mg/Kg	☼	08/08/16 12:22	08/08/16 18:02	1
Ethylbenzene	ND		0.091		mg/Kg	☼	08/08/16 12:22	08/08/16 18:02	1
m,p-Xylene	ND		0.36		mg/Kg	☼	08/08/16 12:22	08/08/16 18:02	1
o-Xylene	ND		0.18		mg/Kg	☼	08/08/16 12:22	08/08/16 18:02	1
Toluene	ND		0.091		mg/Kg	☼	08/08/16 12:22	08/08/16 18:02	1
Xylenes, Total	ND		0.55		mg/Kg	☼	08/08/16 12:22	08/08/16 18:02	1

Client Sample Results

Client Sample ID: NIDP-19(14.5-15)
Date Collected: 08/03/16 18:15
Date Received: 08/05/16 12:07

Lab Sample ID: 590-4147-29
Matrix: Solid
Percent Solids: 92.9

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*99*		*75 - 120*	*08/08/16 12:22*	*08/08/16 18:02*	*1*
4-Bromofluorobenzene (Surr)	*97*		*76 - 122*	*08/08/16 12:22*	*08/08/16 18:02*	*1*
Dibromofluoromethane (Surr)	*103*		*80 - 120*	*08/08/16 12:22*	*08/08/16 18:02*	*1*
Toluene-d8 (Surr)	*106*		*80 - 120*	*08/08/16 12:22*	*08/08/16 18:02*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	ND		4.6		mg/Kg	☼	08/08/16 12:22	08/08/16 18:02	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*97*		*41.5 - 162*	*08/08/16 12:22*	*08/08/16 18:02*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
2-Methylnaphthalene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
1-Methylnaphthalene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Acenaphthylene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Acenaphthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Fluorene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Phenanthrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Benzo[a]anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Chrysene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Benzo[b]fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Benzo[k]fluoranthene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Benzo[a]pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Indeno[1,2,3-cd]pyrene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Dibenz(a,h)anthracene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1
Benzo[g,h,i]perylene	ND		11		ug/Kg	☼	08/09/16 11:39	08/09/16 19:20	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*84*		*23 - 120*	*08/09/16 11:39*	*08/09/16 19:20*	*1*
2-Fluorobiphenyl (Surr)	*70*		*38 - 123*	*08/09/16 11:39*	*08/09/16 19:20*	*1*
p-Terphenyl-d14	*101*		*68 - 136*	*08/09/16 11:39*	*08/09/16 19:20*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	ND		11		mg/Kg	☼	08/10/16 13:01	08/10/16 16:24	1
Residual Range Organics (RRO) (C25-C36)	ND		27		mg/Kg	☼	08/10/16 13:01	08/10/16 16:24	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*97*		*50 - 150*	*08/10/16 13:01*	*08/10/16 16:24*	*1*
n-Triacontane-d62	*98*		*50 - 150*	*08/10/16 13:01*	*08/10/16 16:24*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		5.4		mg/Kg	☼	08/16/16 08:55	08/17/16 11:15	5

QC Sample Results

Method: 8260C - Volatile Organic Compounds by GC/MS

Lab Sample ID: MB 590-7958/1-A
Matrix: Solid
Analysis Batch: 7959

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 7958

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.020		mg/Kg		08/08/16 12:22	08/08/16 13:01	1
Ethylbenzene	ND		0.10		mg/Kg		08/08/16 12:22	08/08/16 13:01	1
m,p-Xylene	ND		0.40		mg/Kg		08/08/16 12:22	08/08/16 13:01	1
o-Xylene	ND		0.20		mg/Kg		08/08/16 12:22	08/08/16 13:01	1
Toluene	ND		0.10		mg/Kg		08/08/16 12:22	08/08/16 13:01	1
Xylenes, Total	ND		0.60		mg/Kg		08/08/16 12:22	08/08/16 13:01	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*97*		*75 - 120*	*08/08/16 12:22*	*08/08/16 13:01*	*1*
4-Bromofluorobenzene (Surr)	*96*		*76 - 122*	*08/08/16 12:22*	*08/08/16 13:01*	*1*
Dibromofluoromethane (Surr)	*104*		*80 - 120*	*08/08/16 12:22*	*08/08/16 13:01*	*1*
Toluene-d8 (Surr)	*106*		*80 - 120*	*08/08/16 12:22*	*08/08/16 13:01*	*1*

Lab Sample ID: LCS 590-7958/2-A
Matrix: Solid
Analysis Batch: 7959

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 7958

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Benzene	0.500	0.514		mg/Kg		103	76 - 123
Ethylbenzene	0.500	0.497		mg/Kg		99	77 - 121
m,p-Xylene	0.500	0.507		mg/Kg		101	78 - 124
o-Xylene	0.500	0.481		mg/Kg		96	77 - 129
Toluene	0.500	0.548		mg/Kg		110	77 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*94*		*75 - 120*
4-Bromofluorobenzene (Surr)	*97*		*76 - 122*
Dibromofluoromethane (Surr)	*98*		*80 - 120*
Toluene-d8 (Surr)	*106*		*80 - 120*

Lab Sample ID: LCS 590-7959/1003
Matrix: Solid
Analysis Batch: 7959

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Benzene	0.0100	0.0106		mg/Kg		106	76 - 123
Benzene	0.0100	0.0109		mg/Kg		109	76 - 123
Ethylbenzene	0.0100	0.0106		mg/Kg		106	77 - 121
Ethylbenzene	0.0100	0.0105		mg/Kg		105	77 - 121
m,p-Xylene	0.0100	0.0110		mg/Kg		110	78 - 124
m,p-Xylene	0.0100	0.0104		mg/Kg		104	78 - 124
o-Xylene	0.0100	0.0107		mg/Kg		107	77 - 129
o-Xylene	0.0100	0.0105		mg/Kg		105	77 - 129
Toluene	0.0100	0.0106		mg/Kg		106	77 - 125
Toluene	0.0100	0.0113		mg/Kg		113	77 - 125

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Lab Sample ID: LCS 590-7959/1003
Matrix: Solid
Analysis Batch: 7959

Client Sample ID: Lab Control Sample
Prep Type: Total/NA

Surrogate	LCS %Recovery	LCS Qualifier	Limits
1,2-Dichloroethane-d4 (Surr)	97		75 - 120
1,2-Dichloroethane-d4 (Surr)	99		75 - 120
4-Bromofluorobenzene (Surr)	96		76 - 122
4-Bromofluorobenzene (Surr)	95		76 - 122
Dibromofluoromethane (Surr)	99		80 - 120
Dibromofluoromethane (Surr)	98		80 - 120
Toluene-d8 (Surr)	100		80 - 120
Toluene-d8 (Surr)	102		80 - 120

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Lab Sample ID: MB 590-7958/1-A
Matrix: Solid
Analysis Batch: 7960

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 7958

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	ND		5.0		mg/Kg		08/08/16 12:22	08/08/16 13:01	1

Surrogate	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
4-Bromofluorobenzene (Surr)	96		41.5 - 162	08/08/16 12:22	08/08/16 13:01	1

Lab Sample ID: LCS 590-7958/3-A
Matrix: Solid
Analysis Batch: 7960

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 7958

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Gasoline	49.9	51.3		mg/Kg		103	74.4 - 124

Surrogate	LCS %Recovery	LCS Qualifier	Limits
4-Bromofluorobenzene (Surr)	94		41.5 - 162

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Lab Sample ID: MB 590-7978/1-A
Matrix: Solid
Analysis Batch: 7983

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 7978

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
2-Methylnaphthalene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
1-Methylnaphthalene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Acenaphthylene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Acenaphthene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Fluorene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Phenanthrene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Anthracene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Fluoranthene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM) (Continued)

Lab Sample ID: MB 590-7978/1-A
Matrix: Solid
Analysis Batch: 7983

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 7978

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Pyrene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Benzo[a]anthracene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Chrysene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Benzo[b]fluoranthene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Benzo[k]fluoranthene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Benzo[a]pyrene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Indeno[1,2,3-cd]pyrene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Dibenz(a,h)anthracene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1
Benzo[g,h,i]perylene	ND		10		ug/Kg		08/09/16 11:39	08/09/16 13:43	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*99*		*23 - 120*	*08/09/16 11:39*	*08/09/16 13:43*	*1*
2-Fluorobiphenyl (Surr)	*91*		*38 - 123*	*08/09/16 11:39*	*08/09/16 13:43*	*1*
p-Terphenyl-d14	*116*		*68 - 136*	*08/09/16 11:39*	*08/09/16 13:43*	*1*

Lab Sample ID: LCS 590-7978/2-A
Matrix: Solid
Analysis Batch: 7983

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 7978

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Naphthalene	267	224		ug/Kg		84	41 - 121
2-Methylnaphthalene	267	262		ug/Kg		98	39 - 132
1-Methylnaphthalene	267	246		ug/Kg		92	46 - 131
Acenaphthylene	267	210		ug/Kg		79	56 - 123
Acenaphthene	267	156		ug/Kg		59	43 - 140
Fluorene	267	152		ug/Kg		57	54 - 131
Phenanthrene	267	272		ug/Kg		102	55 - 141
Anthracene	267	264		ug/Kg		99	60 - 129
Fluoranthene	267	283		ug/Kg		106	63 - 141
Pyrene	267	283		ug/Kg		106	62 - 139
Benzo[a]anthracene	267	261		ug/Kg		98	61 - 136
Chrysene	267	280		ug/Kg		105	57 - 144
Benzo[b]fluoranthene	267	284		ug/Kg		106	66 - 141
Benzo[k]fluoranthene	267	250		ug/Kg		94	63 - 150
Benzo[a]pyrene	267	257		ug/Kg		96	60 - 133
Indeno[1,2,3-cd]pyrene	267	272		ug/Kg		102	55 - 142
Dibenz(a,h)anthracene	267	280		ug/Kg		105	60 - 150
Benzo[g,h,i]perylene	267	269		ug/Kg		101	58 - 147

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Nitrobenzene-d5	*107*		*23 - 120*
2-Fluorobiphenyl (Surr)	*74*		*38 - 123*
p-Terphenyl-d14	*119*		*68 - 136*

QC Sample Results

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM) (Continued)

Lab Sample ID: LCSD 590-7978/3-A
Matrix: Solid
Analysis Batch: 7983

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 7978

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Naphthalene			267	200		ug/Kg		75	41 - 121	11	35
2-Methylnaphthalene			267	227		ug/Kg		85	39 - 132	14	35
1-Methylnaphthalene			267	213		ug/Kg		80	46 - 131	14	35
Acenaphthylene			267	220		ug/Kg		83	56 - 123	5	35
Acenaphthene			267	164		ug/Kg		62	43 - 140	5	35
Fluorene			267	162		ug/Kg		61	54 - 131	6	35
Phenanthrene			267	265		ug/Kg		99	55 - 141	2	35
Anthracene			267	248		ug/Kg		93	60 - 129	6	35
Fluoranthene			267	273		ug/Kg		102	63 - 141	4	35
Pyrene			267	287		ug/Kg		108	62 - 139	1	35
Benzo[a]anthracene			267	278		ug/Kg		104	61 - 136	6	35
Chrysene			267	279		ug/Kg		105	57 - 144	0	35
Benzo[b]fluoranthene			267	268		ug/Kg		101	66 - 141	6	35
Benzo[k]fluoranthene			267	244		ug/Kg		91	63 - 150	2	35
Benzo[a]pyrene			267	235		ug/Kg		88	60 - 133	9	35
Indeno[1,2,3-cd]pyrene			267	255		ug/Kg		96	55 - 142	6	35
Dibenz(a,h)anthracene			267	257		ug/Kg		97	60 - 150	8	35
Benzo[g,h,i]perylene			267	250		ug/Kg		94	58 - 147	7	35

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
Nitrobenzene-d5	*98*		*23 - 120*
2-Fluorobiphenyl (Surr)	*81*		*38 - 123*
p-Terphenyl-d14	*116*		*68 - 136*

Lab Sample ID: 590-4147-3 MS
Matrix: Solid
Analysis Batch: 7983

Client Sample ID: NIDP-9(14.5-15)
Prep Type: Total/NA
Prep Batch: 7978

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Naphthalene	ND		273	216		ug/Kg	☼	79	41 - 121
2-Methylnaphthalene	ND		273	238		ug/Kg	☼	86	39 - 132
1-Methylnaphthalene	ND		273	229		ug/Kg	☼	84	46 - 131
Acenaphthylene	ND		273	213		ug/Kg	☼	78	56 - 123
Acenaphthene	ND		273	143		ug/Kg	☼	52	43 - 140
Fluorene	ND		273	148		ug/Kg	☼	54	54 - 131
Phenanthrene	ND		273	251		ug/Kg	☼	91	55 - 141
Anthracene	ND		273	280		ug/Kg	☼	103	60 - 129
Fluoranthene	ND		273	270		ug/Kg	☼	99	63 - 141
Pyrene	ND		273	280		ug/Kg	☼	101	62 - 139
Benzo[a]anthracene	ND		273	277		ug/Kg	☼	101	61 - 136
Chrysene	ND		273	259		ug/Kg	☼	95	57 - 144
Benzo[b]fluoranthene	ND		273	304		ug/Kg	☼	110	66 - 141
Benzo[k]fluoranthene	ND		273	261		ug/Kg	☼	96	63 - 150
Benzo[a]pyrene	ND		273	288		ug/Kg	☼	104	60 - 133
Indeno[1,2,3-cd]pyrene	ND		273	263		ug/Kg	☼	95	55 - 142
Dibenz(a,h)anthracene	ND		273	269		ug/Kg	☼	99	60 - 150
Benzo[g,h,i]perylene	ND		273	263		ug/Kg	☼	94	58 - 147

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM) (Continued)

Lab Sample ID: 590-4147-3 MS
Matrix: Solid
Analysis Batch: 7983

Client Sample ID: NIDP-9(14.5-15)
Prep Type: Total/NA
Prep Batch: 7978

Surrogate	*MS %Recovery*	*MS Qualifier*	*Limits*
Nitrobenzene-d5	*90*		*23 - 120*
2-Fluorobiphenyl (Surr)	*72*		*38 - 123*
p-Terphenyl-d14	*106*		*68 - 136*

Lab Sample ID: 590-4147-3 MSD
Matrix: Solid
Analysis Batch: 7983

Client Sample ID: NIDP-9(14.5-15)
Prep Type: Total/NA
Prep Batch: 7978

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Naphthalene	ND		275	225		ug/Kg	☼	82	41 - 121	4	35
2-Methylnaphthalene	ND		275	263		ug/Kg	☼	95	39 - 132	10	35
1-Methylnaphthalene	ND		275	240		ug/Kg	☼	87	46 - 131	5	35
Acenaphthylene	ND		275	230		ug/Kg	☼	84	56 - 123	8	35
Acenaphthene	ND		275	163		ug/Kg	☼	59	43 - 140	13	35
Fluorene	ND		275	172		ug/Kg	☼	63	54 - 131	15	35
Phenanthrene	ND		275	265		ug/Kg	☼	96	55 - 141	6	35
Anthracene	ND		275	280		ug/Kg	☼	102	60 - 129	0	35
Fluoranthene	ND		275	284		ug/Kg	☼	104	63 - 141	5	35
Pyrene	ND		275	276		ug/Kg	☼	99	62 - 139	1	35
Benzo[a]anthracene	ND		275	286		ug/Kg	☼	104	61 - 136	3	35
Chrysene	ND		275	265		ug/Kg	☼	97	57 - 144	3	35
Benzo[b]fluoranthene	ND		275	321		ug/Kg	☼	116	66 - 141	5	35
Benzo[k]fluoranthene	ND		275	287		ug/Kg	☼	105	63 - 150	9	35
Benzo[a]pyrene	ND		275	295		ug/Kg	☼	106	60 - 133	2	35
Indeno[1,2,3-cd]pyrene	ND		275	259		ug/Kg	☼	94	55 - 142	1	35
Dibenz(a,h)anthracene	ND		275	268		ug/Kg	☼	98	60 - 150	0	35
Benzo[g,h,i]perylene	ND		275	254		ug/Kg	☼	91	58 - 147	3	35

Surrogate	*MSD %Recovery*	*MSD Qualifier*	*Limits*
Nitrobenzene-d5	*93*		*23 - 120*
2-Fluorobiphenyl (Surr)	*82*		*38 - 123*
p-Terphenyl-d14	*114*		*68 - 136*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Lab Sample ID: MB 590-8022/1-A
Matrix: Solid
Analysis Batch: 8010

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 8022

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	ND		10		mg/Kg		08/10/16 13:01	08/10/16 15:28	1
Residual Range Organics (RRO) (C25-C36)	ND		25		mg/Kg		08/10/16 13:01	08/10/16 15:28	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*105*		*50 - 150*	*08/10/16 13:01*	*08/10/16 15:28*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC) (Continued)

Lab Sample ID: MB 590-8022/1-A
Matrix: Solid
Analysis Batch: 8010

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 8022

Surrogate	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
n-Triacontane-d62	108		50 - 150	08/10/16 13:01	08/10/16 15:28	1

Lab Sample ID: LCS 590-8022/2-A
Matrix: Solid
Analysis Batch: 8010

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 8022

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Diesel Range Organics (DRO) (C10-C25)	67.1	57.4		mg/Kg		86	50 - 150
Residual Range Organics (RRO) (C25-C36)	66.8	64.6		mg/Kg		97	50 - 150

Surrogate	LCS %Recovery	LCS Qualifier	Limits
o-Terphenyl	96		50 - 150
n-Triacontane-d62	101		50 - 150

Lab Sample ID: LCSD 590-8022/3-A
Matrix: Solid
Analysis Batch: 8010

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 8022

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Diesel Range Organics (DRO) (C10-C25)	67.1	61.8		mg/Kg		92	50 - 150	7	25
Residual Range Organics (RRO) (C25-C36)	66.8	69.0		mg/Kg		103	50 - 150	7	25

Surrogate	LCSD %Recovery	LCSD Qualifier	Limits
o-Terphenyl	100		50 - 150
n-Triacontane-d62	106		50 - 150

Method: 6010C - Metals (ICP)

Lab Sample ID: MB 590-8078/2-A
Matrix: Solid
Analysis Batch: 8126

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 8078

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		1.3		mg/Kg		08/16/16 08:55	08/17/16 10:11	1

Lab Sample ID: LCS 590-8078/1-A
Matrix: Solid
Analysis Batch: 8126

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 8078

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Lead	50.0	51.4		mg/Kg		103	80 - 120

QC Sample Results

Method: 6010C - Metals (ICP) (Continued)

Lab Sample ID: 590-4147-3 MS
Client Sample ID: NIDP-9(14.5-15)
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 8126
Prep Batch: 8078

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec. Limits
Lead	ND		35.3	34.6		mg/Kg	☼	89	75 - 125

Lab Sample ID: 590-4147-3 MSD
Client Sample ID: NIDP-9(14.5-15)
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 8126
Prep Batch: 8078

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Lead	ND		41.9	42.5		mg/Kg	☼	94	75 - 125	20	20

Lab Sample ID: 590-4147-3 DU
Client Sample ID: NIDP-9(14.5-15)
Matrix: Solid
Prep Type: Total/NA
Analysis Batch: 8126
Prep Batch: 8078

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Lead	ND		ND		mg/Kg	☼	NC	20

Lab Chronicle

Client Sample ID: NIDP-9(14.5-15)

Lab Sample ID: 590-4147-3

Date Collected: 08/03/16 14:50
Matrix: Solid
Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			7975	08/09/16 10:57	EAF	TAL SPK

Client Sample ID: NIDP-9(14.5-15)

Lab Sample ID: 590-4147-3

Date Collected: 08/03/16 14:50
Matrix: Solid
Date Received: 08/05/16 12:07
Percent Solids: 96.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			4.988 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	7959	08/08/16 14:05	MRS	TAL SPK
Total/NA	Prep	5035			4.988 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		1	0.86 mL	43 mL	7960	08/08/16 14:05	MRS	TAL SPK
Total/NA	Prep	3550C			15.32 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			7983	08/09/16 15:35	NMI	TAL SPK
Total/NA	Prep	3550C			15.10 g	5 mL	8022	08/10/16 13:01	EAF	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			8010	08/10/16 16:24	NMI	TAL SPK
Total/NA	Prep	3050B			1.29 g	50 mL	8078	08/16/16 08:55	JSP	TAL SPK
Total/NA	Analysis	6010C		5			8126	08/17/16 10:14	JSP	TAL SPK

Client Sample ID: NIDP-10(14.5-15)

Lab Sample ID: 590-4147-7

Date Collected: 08/03/16 13:10
Matrix: Solid
Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			7975	08/09/16 10:57	EAF	TAL SPK

Client Sample ID: NIDP-10(14.5-15)

Lab Sample ID: 590-4147-7

Date Collected: 08/03/16 13:10
Matrix: Solid
Date Received: 08/05/16 12:07
Percent Solids: 93.8

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			5.669 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	7959	08/08/16 14:26	MRS	TAL SPK
Total/NA	Prep	5035			5.669 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		1	0.86 mL	43 mL	7960	08/08/16 14:26	MRS	TAL SPK
Total/NA	Prep	3550C			15.36 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			7983	08/09/16 15:58	NMI	TAL SPK
Total/NA	Prep	3550C			15.31 g	5 mL	8022	08/10/16 13:01	EAF	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			8010	08/10/16 16:42	NMI	TAL SPK
Total/NA	Prep	3050B			1.44 g	50 mL	8078	08/16/16 08:55	JSP	TAL SPK
Total/NA	Analysis	6010C		5			8126	08/17/16 10:34	JSP	TAL SPK

Lab Chronicle

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st/0504-101-03

TestAmerica Job ID: 590-4147-1

Client Sample ID: NIDP-11(14.5-15)

Lab Sample ID: 590-4147-11

Date Collected: 08/03/16 11:30
Date Received: 08/05/16 12:07

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			7975	08/09/16 10:57	EAF	TAL SPK

Client Sample ID: NIDP-11(14.5-15)

Lab Sample ID: 590-4147-11

Date Collected: 08/03/16 11:30
Date Received: 08/05/16 12:07

Matrix: Solid
Percent Solids: 92.8

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			5.173 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	7959	08/08/16 14:48	MRS	TAL SPK
Total/NA	Prep	5035			5.173 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		1	0.86 mL	43 mL	7960	08/08/16 14:48	MRS	TAL SPK
Total/NA	Prep	3550C			15.39 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			7983	08/09/16 16:20	NMI	TAL SPK
Total/NA	Prep	3550C			15.21 g	5 mL	8022	08/10/16 13:01	EAF	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			8010	08/10/16 17:00	NMI	TAL SPK
Total/NA	Prep	3050B			1.52 g	50 mL	8078	08/16/16 08:55	JSP	TAL SPK
Total/NA	Analysis	6010C		5			8126	08/17/16 10:38	JSP	TAL SPK

Client Sample ID: NIDP-12(14.5-15)

Lab Sample ID: 590-4147-13

Date Collected: 08/04/16 10:20
Date Received: 08/05/16 12:07

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			7975	08/09/16 10:57	EAF	TAL SPK

Client Sample ID: NIDP-12(14.5-15)

Lab Sample ID: 590-4147-13

Date Collected: 08/04/16 10:20
Date Received: 08/05/16 12:07

Matrix: Solid
Percent Solids: 94.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			4.298 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	7959	08/08/16 15:10	MRS	TAL SPK
Total/NA	Prep	5035			4.298 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		10	0.86 mL	43 mL	7977	08/09/16 12:29	MRS	TAL SPK
Total/NA	Prep	3550C			15.40 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			7983	08/09/16 16:43	NMI	TAL SPK
Total/NA	Prep	3550C			15.40 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		10			8003	08/10/16 10:45	NMI	TAL SPK
Total/NA	Prep	3550C			15.51 g	5 mL	8022	08/10/16 13:01	EAF	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			8010	08/10/16 17:17	NMI	TAL SPK
Total/NA	Prep	3050B			1.55 g	50 mL	8078	08/16/16 08:55	JSP	TAL SPK
Total/NA	Analysis	6010C		5			8126	08/17/16 10:42	JSP	TAL SPK

Lab Chronicle

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st/0504-101-03

TestAmerica Job ID: 590-4147-1

Client Sample ID: NIDP-13(14.5-15)

Lab Sample ID: 590-4147-14

Date Collected: 08/04/16 09:30
Date Received: 08/05/16 12:07

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			7975	08/09/16 10:57	EAF	TAL SPK

Client Sample ID: NIDP-13(14.5-15)

Lab Sample ID: 590-4147-14

Date Collected: 08/04/16 09:30
Date Received: 08/05/16 12:07

Matrix: Solid
Percent Solids: 86.6

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			5.933 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	8260C		10	0.86 mL	43 mL	7959	08/08/16 15:31	MRS	TAL SPK
Total/NA	Prep	5035			5.933 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	8260C		100	0.86 mL	43 mL	7959	08/08/16 18:23	MRS	TAL SPK
Total/NA	Prep	5035			5.933 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		100	0.86 mL	43 mL	7960	08/08/16 18:23	MRS	TAL SPK
Total/NA	Prep	3550C			15.62 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			7983	08/09/16 17:05	NMI	TAL SPK
Total/NA	Prep	3550C			15.62 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		40			8003	08/10/16 11:07	NMI	TAL SPK
Total/NA	Prep	3550C			15.11 g	5 mL	8022	08/10/16 13:01	EAF	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			8010	08/10/16 17:35	NMI	TAL SPK
Total/NA	Prep	3050B			1.38 g	50 mL	8078	08/16/16 08:55	JSP	TAL SPK
Total/NA	Analysis	6010C		5			8126	08/17/16 10:54	JSP	TAL SPK

Client Sample ID: NIDP-14(14.5-15)

Lab Sample ID: 590-4147-15

Date Collected: 08/04/16 08:25
Date Received: 08/05/16 12:07

Matrix: Solid

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			7975	08/09/16 10:57	EAF	TAL SPK

Client Sample ID: NIDP-14(14.5-15)

Lab Sample ID: 590-4147-15

Date Collected: 08/04/16 08:25
Date Received: 08/05/16 12:07

Matrix: Solid
Percent Solids: 95.4

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			4.156 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	7976	08/09/16 12:50	MRS	TAL SPK
Total/NA	Prep	5035			4.156 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		1	0.86 mL	43 mL	7977	08/09/16 12:50	MRS	TAL SPK
Total/NA	Prep	3550C			15.15 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			7983	08/09/16 17:28	NMI	TAL SPK
Total/NA	Prep	3550C			15.23 g	5 mL	8022	08/10/16 13:01	EAF	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			8010	08/10/16 17:53	NMI	TAL SPK
Total/NA	Prep	3050B			1.72 g	50 mL	8078	08/16/16 08:55	JSP	TAL SPK

Lab Chronicle

Client Sample ID: NIDP-14(14.5-15)

Lab Sample ID: 590-4147-15

Date Collected: 08/04/16 08:25
Matrix: Solid
Date Received: 08/05/16 12:07
Percent Solids: 95.4

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	6010C		10			8126	08/17/16 11:19	JSP	TAL SPK

Client Sample ID: NIDP-15(14.5-15)

Lab Sample ID: 590-4147-17

Date Collected: 08/04/16 07:15
Matrix: Solid
Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			7975	08/09/16 10:57	EAF	TAL SPK

Client Sample ID: NIDP-15(14.5-15)

Lab Sample ID: 590-4147-17

Date Collected: 08/04/16 07:15
Matrix: Solid
Date Received: 08/05/16 12:07
Percent Solids: 94.3

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			4.681 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	7959	08/08/16 16:15	MRS	TAL SPK
Total/NA	Prep	5035			4.681 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		1	0.86 mL	43 mL	7960	08/08/16 16:15	MRS	TAL SPK
Total/NA	Prep	3550C			15.24 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			7983	08/09/16 17:50	NMI	TAL SPK
Total/NA	Prep	3550C			15.16 g	5 mL	8022	08/10/16 13:01	EAF	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			8010	08/10/16 18:11	NMI	TAL SPK
Total/NA	Prep	3050B			1.35 g	50 mL	8078	08/16/16 08:55	JSP	TAL SPK
Total/NA	Analysis	6010C		5			8126	08/17/16 11:01	JSP	TAL SPK

Client Sample ID: NIDP-16(14.5-15)

Lab Sample ID: 590-4147-18

Date Collected: 08/04/16 11:45
Matrix: Solid
Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			7975	08/09/16 10:57	EAF	TAL SPK

Client Sample ID: NIDP-16(14.5-15)

Lab Sample ID: 590-4147-18

Date Collected: 08/04/16 11:45
Matrix: Solid
Date Received: 08/05/16 12:07
Percent Solids: 92.5

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			4.275 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	7959	08/08/16 16:58	MRS	TAL SPK
Total/NA	Prep	5035			4.275 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		1	0.86 mL	43 mL	7960	08/08/16 16:58	MRS	TAL SPK
Total/NA	Prep	3550C			15.25 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			7983	08/09/16 18:12	NMI	TAL SPK

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3550C			15.37 g	5 mL	8022	08/10/16 13:01	EAF	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			8011	08/10/16 15:28	NMI	TAL SPK
Total/NA	Prep	3050B			1.29 g	50 mL	8078	08/16/16 08:55	JSP	TAL SPK
Total/NA	Analysis	6010C		5			8126	08/17/16 11:04	JSP	TAL SPK

Client Sample ID: NIDP-17(14.5-15)

Lab Sample ID: 590-4147-21

Date Collected: 08/03/16 17:25

Matrix: Solid

Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			7975	08/09/16 10:57	EAF	TAL SPK

Client Sample ID: NIDP-17(14.5-15)

Lab Sample ID: 590-4147-21

Date Collected: 08/03/16 17:25

Matrix: Solid

Date Received: 08/05/16 12:07

Percent Solids: 92.7

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			4.668 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	7959	08/08/16 17:19	MRS	TAL SPK
Total/NA	Prep	5035			4.668 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		1	0.86 mL	43 mL	7960	08/08/16 17:19	MRS	TAL SPK
Total/NA	Prep	3550C			15.12 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			7983	08/09/16 18:35	NMI	TAL SPK
Total/NA	Prep	3550C			15.40 g	5 mL	8022	08/10/16 13:01	EAF	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			8011	08/10/16 15:47	NMI	TAL SPK
Total/NA	Prep	3050B			1.57 g	50 mL	8078	08/16/16 08:55	JSP	TAL SPK
Total/NA	Analysis	6010C		5			8126	08/17/16 11:07	JSP	TAL SPK

Client Sample ID: NIDP-18(14.5-15)

Lab Sample ID: 590-4147-25

Date Collected: 08/03/16 16:25

Matrix: Solid

Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			7975	08/09/16 10:57	EAF	TAL SPK

Client Sample ID: NIDP-18(14.5-15)

Lab Sample ID: 590-4147-25

Date Collected: 08/03/16 16:25

Matrix: Solid

Date Received: 08/05/16 12:07

Percent Solids: 92.7

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			5.007 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	7959	08/08/16 17:40	MRS	TAL SPK
Total/NA	Prep	5035			5.007 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		1	0.86 mL	43 mL	7960	08/08/16 17:40	MRS	TAL SPK
Total/NA	Prep	3550C			15.77 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			7983	08/09/16 18:57	NMI	TAL SPK
Total/NA	Prep	3550C			15.28 g	5 mL	8022	08/10/16 13:01	EAF	TAL SPK

Lab Chronicle

Client Sample ID: NIDP-18(14.5-15)

Lab Sample ID: 590-4147-25

Date Collected: 08/03/16 16:25

Matrix: Solid

Date Received: 08/05/16 12:07

Percent Solids: 92.7

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	NWTPH-Dx		1			8011	08/10/16 16:05	NMI	TAL SPK
Total/NA	Prep	3050B			1.38 g	50 mL	8078	08/16/16 08:55	JSP	TAL SPK
Total/NA	Analysis	6010C		5			8126	08/17/16 11:11	JSP	TAL SPK

Client Sample ID: NIDP-19(14.5-15)

Lab Sample ID: 590-4147-29

Date Collected: 08/03/16 18:15

Matrix: Solid

Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			7975	08/09/16 10:57	EAF	TAL SPK

Client Sample ID: NIDP-19(14.5-15)

Lab Sample ID: 590-4147-29

Date Collected: 08/03/16 18:15

Matrix: Solid

Date Received: 08/05/16 12:07

Percent Solids: 92.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			6.441 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	7959	08/08/16 18:02	MRS	TAL SPK
Total/NA	Prep	5035			6.441 g	5 mL	7958	08/08/16 12:22	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		1	0.86 mL	43 mL	7960	08/08/16 18:02	MRS	TAL SPK
Total/NA	Prep	3550C			15.05 g	2 mL	7978	08/09/16 11:39	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			7983	08/09/16 19:20	NMI	TAL SPK
Total/NA	Prep	3550C			15.18 g	5 mL	8022	08/10/16 13:01	EAF	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			8011	08/10/16 16:24	NMI	TAL SPK
Total/NA	Prep	3050B			1.24 g	50 mL	8078	08/16/16 08:55	JSP	TAL SPK
Total/NA	Analysis	6010C		5			8126	08/17/16 11:15	JSP	TAL SPK

Laboratory References:

TAL SPK = TestAmerica Spokane, 11922 East 1st Ave, Spokane, WA 99206, TEL (509)924-9200

Certification Summary

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st/0504-101-03

TestAmerica Job ID: 590-4147-1

Laboratory: TestAmerica Spokane

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Alaska (UST)	State Program	10	UST-071	10-31-16
Washington	State Program	10	C569	01-06-17

Method Summary

Method	Method Description	Protocol	Laboratory
8260C	Volatile Organic Compounds by GC/MS	SW846	TAL SPK
NWTPH-Gx	Northwest - Volatile Petroleum Products (GC/MS)	NWTPH	TAL SPK
8270D SIM	Semivolatile Organic Compounds (GC/MS SIM)	SW846	TAL SPK
NWTPH-Dx	Northwest - Semi-Volatile Petroleum Products (GC)	NWTPH	TAL SPK
6010C	Metals (ICP)	SW846	TAL SPK
Moisture	Percent Moisture	EPA	TAL SPK

Protocol References:

EPA = US Environmental Protection Agency

NWTPH = Northwest Total Petroleum Hydrocarbon

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL SPK = TestAmerica Spokane, 11922 East 1st Ave, Spokane, WA 99206, TEL (509)924-9200

TestAmerica Spokane
11922 East 1st Ave
Spokane, WA 99206
Phone (509) 924-9200 Fax (509) 924-9290

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information

Client Contact: JR Sugalski
Company: GeoEngineers Inc
Address: 523 East Second Ave
City: Spokane
State, Zip: WA, 99202
Phone: 509-209-2830(Tel)
Email: jsugalski@geoengineers.com
Project Name: Tiger Oil - North 1st
Site: Washington

Sampler:
Phone:
Due Date Requested:
TAT Requested (days):
PO #: Purchase Order not required
WO #:
Project #: 59000516
SSOW#:

Lab PM: Arrington, Randee E
E-Mail: randee.arrington@testamericainc.com
Carrier Tracking No(s):
COC No: 590-1666-603.3
Page: Page 3 of 4
Job #:

590-4147 Chain of Custody

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - ph 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	NWTPH-Gx	NWTPH-Dx	BTEX	PAH-8270D-Sim	Lead-6010C	Total Number of containers	Special Instructions/Note:
			Preservation Code:										
NIDP-9 (4.5-5)	8/3/16	1410		S									hold
NIDP-9 (9.5-10)	8/3/16	1420		S									hold
NIDP-9 (14.5-15)	8/3/16	1450		S			X	X	X	X	X		
NIDP-9 (19.5-20)	8/3/16	1520		S									hold
NIDP-10 (4.5-5)	8/3/16	1250		S									hold
NIDP-10 (9.5-10)	8/3/16	1305		S									hold
NIDP-10 (14.5-15)	8/3/16	1310		S			X	X	X	X	X		
NIDP-10 (17-17.5)	8/3/16	1320		S									hold
NIDP-11 (4-5)	8/3/16	1100		S									hold
NIDP-11 (7-7.5)	8/3/16	1120		S									hold
NIDP-11 (14.5-15)	8/3/16	1130		S			X	X	X	X	X		

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:
Date:
Time:
Method of Shipment:

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
	3/5/16 1210	GEI	Sheila [illegible]	8/5/16 1207	TA dpk

Custody Seals Intact:
Δ Yes Δ No
Custody Seal No.:
Cooler Temperature(s) °C and Other Remarks: 3.6 °C IR003

TestAmerica Spokane
11922 East 1st Ave
Spokane, WA 99206
Phone (509) 924-9200 Fax (509) 924-9290

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information
Client Contact: JR Sugalski
Company: GeoEngineers Inc
Address: 523 East Second Ave
City: Spokane
State, Zip: WA, 99202
Phone: 509-209-2830(Tel)
Email: jsugalski@geoengineers.com
Project Name: Tiger Oil - North 1st
Site: Washington

Sampler:
Phone:
Due Date Requested:
TAT Requested (days):
PO #: Purchase Order not required
WO #:
Project #: 59000516
SSOW#:

Lab PM: Arrington, Randee E
E-Mail: randee.arrington@testamericainc.com
Carrier Tracking No(s):

COC No: 590-1666-603.4
Page: Page 4 of 4
Job #:

Analysis Requested

Preservation Codes:

A - HCL
B - NaOH
C - Zn Acetate
D - Nitric Acid
E - NaHSO4
F - MeOH
G - Amchlor
H - Ascorbic Acid
I - Ice
J - DI Water
K - EDTA
L - EDA

M - Hexane
N - None
O - AsNaO2
P - Na2O4S
Q - Na2SO3
R - Na2S2O3
S - H2SO4
T - TSP Dodecahydrate
U - Acetone
V - MCAA
W - ph 4-5
Z - other (specify)

Other:

Sample Identification	Sample Date	Sample Time	Sample Type (C=comp, G=grab)	Matrix (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	Field Filtered Sample (Yes or No)	Perform MS/MSD (Yes or No)	NWTPH-Gx	NWTPH-Dx	BTEX	PAH-8270D-Sim	Lead-6010C									Total Number of containers	Special Instructions/Note:
			Preservation Code:		☒	☒														☒	
NIDP-11(19.5-20)	8/3/16	1140		S																	hold
NIDP-12(14.5-15)	8/4/16	1020		S			X	X	X	X	X										
NIDP-13(14.5-15)	8/4/16	0930		S			X	X	X	X	X										
NIDP-14(14.5-15)	8/4/16	0825		S			X	X	X	X	X										
NIDP-14(16-16.5)	8/4/16	0835		S																	hold
NIDP-15(14.5-15)	8/4/16	0715		S			X	X	X	X	X										
NIDP-16(14.5-15)	8/4/16	1145		S			X	X	X	X	X										
NIDP-17(4.5-5)	8/3/16	1705		S																	hold
NIDP-17(9.5-10)	8/3/16	1715		S																	hold
NIDP-17(14.5-15)	8/3/16	1725		S			X	X	X	X	X										
NIDP-17(19.5-20)	8/3/16	1735		S																	hold

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For ________ Months*

Deliverable Requested: I, II, III, IV, Other (specify)

Special Instructions/QC Requirements:

Empty Kit Relinquished by:
Date:
Time:
Method of Shipment:

Relinquished by	Date/Time	Company	Received by	Date/Time	Company
	8/5/16 1210	GEI	Sheila Knad	8/5/16 1207	TA Spok

Custody Seals Intact: Δ Yes Δ No
Custody Seal No.:
Cooler Temperature(s) °C and Other Remarks: 3.6 C IR003

TestAmerica Spokane
11922 East 1st Ave
Spokane, WA 99206
Phone (509) 924-9200 Fax (509) 924-9290

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Client Information
Sampler:
Lab PM: Arrington, Randee E
Carrier Tracking No(s):
COC No: 590-1666-603.1

Client Contact: JR Sugalski
Phone:
E-Mail: randee.arrington@testamericainc.com
Page: Page 1 of 4

Company: GeoEngineers Inc
Job #:

Address: 523 East Second Ave
Due Date Requested:

City: Spokane
TAT Requested (days):

State, Zip: WA, 99202

Phone: 509-209-2830(Tel)
PO #: Purchase Order not required

Email: jsugalski@geoengineers.com
WO #:

Project Name: Tiger Oil - North 1st
Project #: 59000516

Site: Washington
SSOW#:

Analysis Requested

Preservation Codes:

A - HCL	M - Hexane
B - NaOH	N - None
C - Zn Acetate	O - AsNaO2
D - Nitric Acid	P - Na2O4S
E - NaHSO4	Q - Na2SO3
F - MeOH	R - Na2S2O3
G - Amchlor	S - H2SO4
H - Ascorbic Acid	T - TSP Dodecahydrate
I - Ice	U - Acetone
J - DI Water	V - MCAA
K - EDTA	W - ph 4-5
L - EDA	Z - other (specify)

Other:

Sample Identification	**Sample Date**	**Sample Time**	**Sample Type** (C=comp, G=grab)	**Matrix** (W=water, S=solid, O=waste/oil, BT=Tissue, A=Air)	**Field Filtered Sample (Yes or No)**	**Perform MS/MSD (Yes or No)**	NWTPH-Gx	NWTPH-Dx	BTEX	PAH-8270D-SIM	Lead-6010C	**Total Number of containers**	**Special Instructions/Note:**
			Preservation Code:		☒	☒						☒	
NIDP-18 (4.5-5)	8/3/16	1615		S									hold
NIDP-18 (9.5-10)	8/3/16	1620		S									hold
NIDP-18 (14.5-15)	8/3/16	1625		S			X	X	X	X	X		
NIDP-18 (19.5-20)	8/3/16	1630		S									hold
NIDP-19 (4.5-5)	8/3/16	1800		S									hold
NIDP-19 (9.5-10)	8/3/16	1810		S									
NIDP-19 (14.5-15)	8/3/16	1815		S			X	X	X	X	X		
NIDP-19 (19.5-20)	8/3/16	1825		S									hold
													hold
													hold
													hold hold

Possible Hazard Identification
☐ *Non-Hazard* ☐ *Flammable* ☐ *Skin Irritant* ☐ *Poison B* ☐ *Unknown* ☐ *Radiological*

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)
☐ *Return To Client* ☐ *Disposal By Lab* ☐ *Archive For* ______ *Months*

Deliverable Requested: I, II, III, IV, Other (specify)
Special Instructions/QC Requirements:

Empty Kit Relinquished by:
Date:
Time:
Method of Shipment:

Relinquished by:	Date/Time:	Company	Received by:	Date/Time:	Company
	3/5/16 1210		Sheila Kraut	8/5/16 1207	TA Spok

Custody Seals Intact:
Δ Yes Δ No
Custody Seal No.:
Cooler Temperature(s) °C and Other Remarks: 3.6 ° IR003

Login Sample Receipt Checklist

Client: GeoEngineers Inc

Job Number: 590-4147-1

Login Number: 4147

List Source: TestAmerica Spokane

List Number: 1

Creator: Arrington, Randee E

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	False	Not listed on CoC
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Spokane
11922 East 1st Ave
Spokane, WA 99206
Tel: (509)924-9200

TestAmerica Job ID: 590-4145-1
Client Project/Site: Tiger Oil - North 1st/0504-101-03

For:
GeoEngineers Inc
523 East Second Ave
Spokane, Washington 99202

Attn: JR Sugalski

Randee Arrington

Authorized for release by:
8/10/2016 12:35:25 PM

Randee Arrington, Project Manager II
(509)924-9200
randee.arrington@testamericainc.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

Table of Contents

Case Narrative

Job ID: 590-4145-1

Laboratory: TestAmerica Spokane

Narrative

Receipt

The samples were received on 8/5/2016 12:07 PM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 3.6º C.

GC Semi VOA

Method NWTPH-HCID: Detected hydrocarbons in the diesel range appear to be due to gasoline overlap in the following samples: NIDP-10:080316 (590-4145-2), NIDP-12:080416 (590-4145-4), NIDP-13:080416 (590-4145-5) and NIDP-14:080416 (590-4145-6).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

Organic Prep

No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Sample Summary

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st/0504-101-03

TestAmerica Job ID: 590-4145-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
590-4145-1	NIDP-9:080316	Water	08/03/16 15:53	08/05/16 12:07
590-4145-2	NIDP-10:080316	Water	08/03/16 13:50	08/05/16 12:07
590-4145-3	NIDP-11:080316	Water	08/03/16 12:25	08/05/16 12:07
590-4145-4	NIDP-12:080416	Water	08/04/16 11:05	08/05/16 12:07
590-4145-5	NIDP-13:080416	Water	08/04/16 10:05	08/05/16 12:07
590-4145-6	NIDP-14:080416	Water	08/04/16 09:00	08/05/16 12:07
590-4145-7	NIDP-15:080416	Water	08/04/16 07:55	08/05/16 12:07
590-4145-8	NIDP-16:080416	Water	08/04/16 12:20	08/05/16 12:07
590-4145-9	NIDP-17:080316	Water	08/03/16 17:55	08/05/16 12:07
590-4145-10	NIDP-18:080316	Water	08/03/16 17:00	08/05/16 12:07
590-4145-11	NIDP-19:080316	Water	08/03/16 18:40	08/05/16 12:07

Definitions/Glossary

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Client Sample ID: NIDP-9:080316

Lab Sample ID: 590-4145-1

Date Collected: 08/03/16 15:53
Matrix: Water
Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline Range Organics [C6 - C10]	ND		0.13		mg/L		08/09/16 14:39	08/09/16 18:35	1
Diesel Range Organics (DRO) (C10-C25)	ND		0.34		mg/L		08/09/16 14:39	08/09/16 18:35	1
Residual Range Organics (RRO) (C25-C36)	ND		0.34		mg/L		08/09/16 14:39	08/09/16 18:35	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*80*		*50 - 150*	*08/09/16 14:39*	*08/09/16 18:35*	*1*
n-Triacontane-d62	*83*		*50 - 150*	*08/09/16 14:39*	*08/09/16 18:35*	*1*

Client Sample ID: NIDP-10:080316

Lab Sample ID: 590-4145-2

Date Collected: 08/03/16 13:50
Matrix: Water
Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline Range Organics [C6 - C10]	**0.80**		0.13		mg/L		08/09/16 14:39	08/09/16 18:52	1
Diesel Range Organics (DRO) (C10-C25)	**0.88**		0.32		mg/L		08/09/16 14:39	08/09/16 18:52	1
Residual Range Organics (RRO) (C25-C36)	ND		0.32		mg/L		08/09/16 14:39	08/09/16 18:52	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*84*		*50 - 150*	*08/09/16 14:39*	*08/09/16 18:52*	*1*
n-Triacontane-d62	*90*		*50 - 150*	*08/09/16 14:39*	*08/09/16 18:52*	*1*

Client Sample ID: NIDP-11:080316

Lab Sample ID: 590-4145-3

Date Collected: 08/03/16 12:25
Matrix: Water
Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline Range Organics [C6 - C10]	**0.19**		0.13		mg/L		08/09/16 14:39	08/09/16 19:10	1
Diesel Range Organics (DRO) (C10-C25)	ND		0.33		mg/L		08/09/16 14:39	08/09/16 19:10	1
Residual Range Organics (RRO) (C25-C36)	ND		0.33		mg/L		08/09/16 14:39	08/09/16 19:10	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*88*		*50 - 150*	*08/09/16 14:39*	*08/09/16 19:10*	*1*
n-Triacontane-d62	*93*		*50 - 150*	*08/09/16 14:39*	*08/09/16 19:10*	*1*

Client Sample ID: NIDP-12:080416

Lab Sample ID: 590-4145-4

Date Collected: 08/04/16 11:05
Matrix: Water
Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline Range Organics [C6 - C10]	**1.5**		0.13		mg/L		08/09/16 14:39	08/09/16 19:27	1

1 2 3 4 5 6 7 8 9 10 11 12

Client Sample ID: NIDP-12:080416 Lab Sample ID: 590-4145-4

Date Collected: 08/04/16 11:05 **Matrix: Water**
Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC) (Continued)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	**1.2**		0.33		mg/L		08/09/16 14:39	08/09/16 19:27	1
Residual Range Organics (RRO) (C25-C36)	**0.37**		0.33		mg/L		08/09/16 14:39	08/09/16 19:27	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*82*		*50 - 150*	*08/09/16 14:39*	*08/09/16 19:27*	*1*
n-Triacontane-d62	*86*		*50 - 150*	*08/09/16 14:39*	*08/09/16 19:27*	*1*

Client Sample ID: NIDP-13:080416 Lab Sample ID: 590-4145-5

Date Collected: 08/04/16 10:05 **Matrix: Water**
Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline Range Organics [C6 - C10]	**0.66**		0.13		mg/L		08/09/16 14:39	08/09/16 19:45	1
Diesel Range Organics (DRO) (C10-C25)	**0.40**		0.34		mg/L		08/09/16 14:39	08/09/16 19:45	1
Residual Range Organics (RRO) (C25-C36)	ND		0.34		mg/L		08/09/16 14:39	08/09/16 19:45	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*80*		*50 - 150*	*08/09/16 14:39*	*08/09/16 19:45*	*1*
n-Triacontane-d62	*86*		*50 - 150*	*08/09/16 14:39*	*08/09/16 19:45*	*1*

Client Sample ID: NIDP-14:080416 Lab Sample ID: 590-4145-6

Date Collected: 08/04/16 09:00 **Matrix: Water**
Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline Range Organics [C6 - C10]	**0.65**		0.13		mg/L		08/09/16 14:39	08/09/16 20:02	1
Diesel Range Organics (DRO) (C10-C25)	**0.95**		0.32		mg/L		08/09/16 14:39	08/09/16 20:02	1
Residual Range Organics (RRO) (C25-C36)	ND		0.32		mg/L		08/09/16 14:39	08/09/16 20:02	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*82*		*50 - 150*	*08/09/16 14:39*	*08/09/16 20:02*	*1*
n-Triacontane-d62	*87*		*50 - 150*	*08/09/16 14:39*	*08/09/16 20:02*	*1*

Client Sample ID: NIDP-15:080416 Lab Sample ID: 590-4145-7

Date Collected: 08/04/16 07:55 **Matrix: Water**
Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline Range Organics [C6 - C10]	ND		0.14		mg/L		08/09/16 14:39	08/09/16 20:19	1
Diesel Range Organics (DRO) (C10-C25)	ND		0.35		mg/L		08/09/16 14:39	08/09/16 20:19	1

Client Sample ID: NIDP-15:080416

Lab Sample ID: 590-4145-7

Date Collected: 08/04/16 07:55

Matrix: Water

Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC) (Continued)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Residual Range Organics (RRO) (C25-C36)	ND		0.35		mg/L		08/09/16 14:39	08/09/16 20:19	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*75*		*50 - 150*	*08/09/16 14:39*	*08/09/16 20:19*	*1*
n-Triacontane-d62	*81*		*50 - 150*	*08/09/16 14:39*	*08/09/16 20:19*	*1*

Client Sample ID: NIDP-16:080416

Lab Sample ID: 590-4145-8

Date Collected: 08/04/16 12:20

Matrix: Water

Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline Range Organics [C6 - C10]	ND		0.13		mg/L		08/09/16 14:39	08/09/16 20:37	1
Diesel Range Organics (DRO) (C10-C25)	ND		0.32		mg/L		08/09/16 14:39	08/09/16 20:37	1
Residual Range Organics (RRO) (C25-C36)	**1.8**		0.32		mg/L		08/09/16 14:39	08/09/16 20:37	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*78*		*50 - 150*	*08/09/16 14:39*	*08/09/16 20:37*	*1*
n-Triacontane-d62	*98*		*50 - 150*	*08/09/16 14:39*	*08/09/16 20:37*	*1*

Client Sample ID: NIDP-17:080316

Lab Sample ID: 590-4145-9

Date Collected: 08/03/16 17:55

Matrix: Water

Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline Range Organics [C6 - C10]	ND		0.13		mg/L		08/09/16 14:39	08/09/16 20:54	1
Diesel Range Organics (DRO) (C10-C25)	ND		0.33		mg/L		08/09/16 14:39	08/09/16 20:54	1
Residual Range Organics (RRO) (C25-C36)	ND		0.33		mg/L		08/09/16 14:39	08/09/16 20:54	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*77*		*50 - 150*	*08/09/16 14:39*	*08/09/16 20:54*	*1*
n-Triacontane-d62	*82*		*50 - 150*	*08/09/16 14:39*	*08/09/16 20:54*	*1*

Client Sample ID: NIDP-18:080316

Lab Sample ID: 590-4145-10

Date Collected: 08/03/16 17:00

Matrix: Water

Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline Range Organics [C6 - C10]	ND		0.13		mg/L		08/09/16 14:39	08/09/16 21:11	1
Diesel Range Organics (DRO) (C10-C25)	ND		0.33		mg/L		08/09/16 14:39	08/09/16 21:11	1
Residual Range Organics (RRO) (C25-C36)	ND		0.33		mg/L		08/09/16 14:39	08/09/16 21:11	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*71*		*50 - 150*	*08/09/16 14:39*	*08/09/16 21:11*	*1*

Client Sample Results

Client Sample ID: NIDP-18:080316

Lab Sample ID: 590-4145-10

Date Collected: 08/03/16 17:00

Matrix: Water

Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC) (Continued)

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
n-Triacontane-d62	*77*		*50 - 150*	*08/09/16 14:39*	*08/09/16 21:11*	*1*

Client Sample ID: NIDP-19:080316

Lab Sample ID: 590-4145-11

Date Collected: 08/03/16 18:40

Matrix: Water

Date Received: 08/05/16 12:07

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC)

Analyte	Result	Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline Range Organics [C6 - C10]	ND		0.13		mg/L		08/09/16 14:39	08/09/16 21:29	1
Diesel Range Organics (DRO) (C10-C25)	ND		0.34		mg/L		08/09/16 14:39	08/09/16 21:29	1
Residual Range Organics (RRO) (C25-C36)	ND		0.34		mg/L		08/09/16 14:39	08/09/16 21:29	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*78*		*50 - 150*	*08/09/16 14:39*	*08/09/16 21:29*	*1*
n-Triacontane-d62	*83*		*50 - 150*	*08/09/16 14:39*	*08/09/16 21:29*	*1*

QC Sample Results

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st/0504-101-03

TestAmerica Job ID: 590-4145-1

Method: NWTPH-HCID - Northwest - Hydrocarbon Identification (GC)

Lab Sample ID: MB 590-7987/1-A
Matrix: Water
Analysis Batch: 7988

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 7987

Analyte	MB Result	MB Qualifier	RL	RL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline Range Organics [C6 - C10]	ND		0.13		mg/L		08/09/16 14:39	08/09/16 18:18	1
Diesel Range Organics (DRO) (C10-C25)	ND		0.32		mg/L		08/09/16 14:39	08/09/16 18:18	1
Residual Range Organics (RRO) (C25-C36)	ND		0.32		mg/L		08/09/16 14:39	08/09/16 18:18	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*81*		*50 - 150*	*08/09/16 14:39*	*08/09/16 18:18*	*1*
n-Triacontane-d62	*78*		*50 - 150*	*08/09/16 14:39*	*08/09/16 18:18*	*1*

Lab Chronicle

Client Sample ID: NIDP-9:080316 **Lab Sample ID: 590-4145-1**
Date Collected: 08/03/16 15:53 **Matrix: Water**
Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			234.7 mL	2 mL	7987	08/09/16 14:39	EAF	TAL SPK
Total/NA	Analysis	NWTPH-HCID		1			7988	08/09/16 18:35	NMI	TAL SPK

Client Sample ID: NIDP-10:080316 **Lab Sample ID: 590-4145-2**
Date Collected: 08/03/16 13:50 **Matrix: Water**
Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			243.4 mL	2 mL	7987	08/09/16 14:39	EAF	TAL SPK
Total/NA	Analysis	NWTPH-HCID		1			7988	08/09/16 18:52	NMI	TAL SPK

Client Sample ID: NIDP-11:080316 **Lab Sample ID: 590-4145-3**
Date Collected: 08/03/16 12:25 **Matrix: Water**
Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			241.7 mL	2 mL	7987	08/09/16 14:39	EAF	TAL SPK
Total/NA	Analysis	NWTPH-HCID		1			7988	08/09/16 19:10	NMI	TAL SPK

Client Sample ID: NIDP-12:080416 **Lab Sample ID: 590-4145-4**
Date Collected: 08/04/16 11:05 **Matrix: Water**
Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			240.5 mL	2 mL	7987	08/09/16 14:39	EAF	TAL SPK
Total/NA	Analysis	NWTPH-HCID		1			7988	08/09/16 19:27	NMI	TAL SPK

Client Sample ID: NIDP-13:080416 **Lab Sample ID: 590-4145-5**
Date Collected: 08/04/16 10:05 **Matrix: Water**
Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			233 mL	2 mL	7987	08/09/16 14:39	EAF	TAL SPK
Total/NA	Analysis	NWTPH-HCID		1			7988	08/09/16 19:45	NMI	TAL SPK

Client Sample ID: NIDP-14:080416 **Lab Sample ID: 590-4145-6**
Date Collected: 08/04/16 09:00 **Matrix: Water**
Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			245.5 mL	2 mL	7987	08/09/16 14:39	EAF	TAL SPK
Total/NA	Analysis	NWTPH-HCID		1			7988	08/09/16 20:02	NMI	TAL SPK

Lab Chronicle

1 2 3 4 5 6 7 8 9 10 11 12

Client Sample ID: NIDP-15:080416

Lab Sample ID: 590-4145-7

Date Collected: 08/04/16 07:55

Matrix: Water

Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			227 mL	2 mL	7987	08/09/16 14:39	EAF	TAL SPK
Total/NA	Analysis	NWTPH-HCID		1			7988	08/09/16 20:19	NMI	TAL SPK

Client Sample ID: NIDP-16:080416

Lab Sample ID: 590-4145-8

Date Collected: 08/04/16 12:20

Matrix: Water

Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			243.9 mL	2 mL	7987	08/09/16 14:39	EAF	TAL SPK
Total/NA	Analysis	NWTPH-HCID		1			7988	08/09/16 20:37	NMI	TAL SPK

Client Sample ID: NIDP-17:080316

Lab Sample ID: 590-4145-9

Date Collected: 08/03/16 17:55

Matrix: Water

Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			237.7 mL	2 mL	7987	08/09/16 14:39	EAF	TAL SPK
Total/NA	Analysis	NWTPH-HCID		1			7988	08/09/16 20:54	NMI	TAL SPK

Client Sample ID: NIDP-18:080316

Lab Sample ID: 590-4145-10

Date Collected: 08/03/16 17:00

Matrix: Water

Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			238 mL	2 mL	7987	08/09/16 14:39	EAF	TAL SPK
Total/NA	Analysis	NWTPH-HCID		1			7988	08/09/16 21:11	NMI	TAL SPK

Client Sample ID: NIDP-19:080316

Lab Sample ID: 590-4145-11

Date Collected: 08/03/16 18:40

Matrix: Water

Date Received: 08/05/16 12:07

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			233.8 mL	2 mL	7987	08/09/16 14:39	EAF	TAL SPK
Total/NA	Analysis	NWTPH-HCID		1			7988	08/09/16 21:29	NMI	TAL SPK

Laboratory References:

TAL SPK = TestAmerica Spokane, 11922 East 1st Ave, Spokane, WA 99206, TEL (509)924-9200

Certification Summary

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st/0504-101-03

TestAmerica Job ID: 590-4145-1

Laboratory: TestAmerica Spokane

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Alaska (UST)	State Program	10	UST-071	10-31-16
Washington	State Program	10	C569	01-06-17

Method Summary

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st/0504-101-03

TestAmerica Job ID: 590-4145-1

Method	Method Description	Protocol	Laboratory
NWTPH-HCID	Northwest - Hydrocarbon Identification (GC)	NWTPH	TAL SPK

Protocol References:

NWTPH = Northwest Total Petroleum Hydrocarbon

Laboratory References:

TAL SPK = TestAmerica Spokane, 11922 East 1st Ave, Spokane, WA 99206, TEL (509)924-9200

CHAIN OF CUSTODY RECORD

GeoEngineers
523 EAST SECOND AVE.
SPOKANE, WASHINGTON 99202
(509) 363-3125

DATE 8/5/16
PAGE 1 OF 2
LAB
LAB NO.

PROJECT NAME/LOCATION 0504-101-03
PROJECT NUMBER Tiger Oil
PROJECT MANAGER JR Sugalski
SAMPLED BY Callen Driscoll

ANALYSIS REQUIRED

NOTES/COMMENTS (Preserved, filtered, etc.)

SAMPLE IDENTIFICATION		SAMPLE COLLECTION			# OF	NWTPH-HCID
LAB	GEOENGINEERS	DATE	TIME	MATRIX	JARS	
	~~[illegible]:080316~~					X
	NIDP-9:080316	8/3/16	1553	W	1	X
	NIDP-10:080316	8/3/16	1350		1	X
	NIDP-11:080316	8/3/16	1225		1	X
	NIDP-12:080416	8/4/16	1105		1	X
	NIDP-13:080416	8/4/16	1005		1	X
	NIDP-14:080416	8/4/16	0900		1	X
	NIDP-15:080416	8/4/16	0755		1	X
	NIDP-16:080416	8/4/16	1220		1	X
	NIDP-17:080316	8/3/16	1755		1	X
	NIDP-18:080316	8/3/16	1700		1	X

590-4145 Chain of Custody

RELINQUISHED BY FIRM
SIGNATURE Callen D
PRINTED NAME Callen Driscoll
DATE 8/5/16 TIME 1210

RECEIVED BY FIRM TA-SPOK
SIGNATURE Sheila Kratz
PRINTED NAME Sheila Kratz
DATE 8/5/16 TIME 1204

RELINQUISHED BY FIRM
SIGNATURE
PRINTED NAME
DATE TIME

RECEIVED BY FIRM
SIGNATURE
PRINTED NAME
DATE TIME

RELINQUISHED BY FIRM
SIGNATURE
PRINTED NAME
DATE TIME

RECEIVED BY FIRM
SIGNATURE
PRINTED NAME
DATE TIME

ADDITIONAL COMMENTS: 3.6^{c} IR003

CHAIN OF CUSTODY RECORD

GeoEngineers
523 EAST SECOND AVE.
SPOKANE, WASHINGTON 99202
(509) 363-3125

DATE
PAGE 2 OF 2
LAB
LAB NO.

PROJECT NAME/LOCATION Tiger Oil
PROJECT NUMBER 0504-101-03
PROJECT MANAGER JR Sugalski
SAMPLED BY Callen Driscoll

SAMPLE IDENTIFICATION		SAMPLE COLLECTION			# OF JARS	ANALYSIS REQUIRED												NOTES/COMMENTS (Preserved, filtered, etc.)
LAB	GEOENGINEERS	DATE	TIME	MATRIX		NWTPH-HCID												
	NIDP-19:080316	8/3/16	1840	W	1	X												

RELINQUISHED BY FIRM
SIGNATURE
PRINTED NAME Callen Driscoll
DATE 8/5/16 TIME 1210

RECEIVED BY FIRM TA Spok
SIGNATURE Sheila Kratz
PRINTED NAME Sheila Kratz
DATE 8/5/16 TIME 1207

RELINQUISHED BY FIRM
SIGNATURE
PRINTED NAME
DATE TIME

RECEIVED BY FIRM
SIGNATURE
PRINTED NAME
DATE TIME

RELINQUISHED BY FIRM
SIGNATURE
PRINTED NAME
DATE TIME

RECEIVED BY FIRM
SIGNATURE
PRINTED NAME
DATE TIME

ADDITIONAL COMMENTS: 3.6 ^{c}IR003

Login Sample Receipt Checklist

Client: GeoEngineers Inc
Job Number: 590-4145-1

Login Number: 4145
List Source: TestAmerica Spokane
List Number: 1
Creator: Arrington, Randee E

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

ANALYTICAL REPORT

TestAmerica Laboratories, Inc.
TestAmerica Spokane
11922 East 1st Ave
Spokane, WA 99206
Tel: (509)924-9200

TestAmerica Job ID: 590-4761-1
Client Project/Site: Tiger Oil - North 1st

For:
GeoEngineers Inc
523 East Second Ave
Spokane, Washington 99202

Attn: JR Sugalski

Randee Arrington

Authorized for release by:
10/28/2016 4:18:00 PM

Randee Arrington, Project Manager II
(509)924-9200
randee.arrington@testamericainc.com

This report has been electronically signed and authorized by the signatory. Electronic signature is intended to be the legally binding equivalent of a traditionally handwritten signature.

Results relate only to the items tested and the sample(s) as received by the laboratory.

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Table of Contents

Case Narrative

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st

TestAmerica Job ID: 590-4761-1

Job ID: 590-4761-1

Laboratory: TestAmerica Spokane

Narrative

Receipt
The samples were received on 10/19/2016 9:20 AM; the samples arrived in good condition, properly preserved and, where required, on ice. The temperature of the cooler at receipt was 4.4º C.

GC/MS VOA
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

GC/MS Semi VOA
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

GC Semi VOA
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Metals
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

General Chemistry
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Organic Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

VOA Prep
No analytical or quality issues were noted, other than those described in the Definitions/Glossary page.

Sample Summary

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st

TestAmerica Job ID: 590-4761-1

Lab Sample ID	Client Sample ID	Matrix	Collected	Received
590-4761-1	N1MW-8 (12-12.5):101716	Solid	10/17/16 11:15	10/19/16 09:20
590-4761-2	N1MW-8 (15-15.5):101716	Solid	10/17/16 11:12	10/19/16 09:20
590-4761-3	N1MW-6 (12.5-13):101716	Solid	10/17/16 14:30	10/19/16 09:20
590-4761-4	N1MW-7 (15-15.5):101816	Solid	10/18/16 09:05	10/19/16 09:20

Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
¤	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CNF	Contains no Free Liquid
DER	Duplicate error ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision level concentration
MDA	Minimum detectable activity
EDL	Estimated Detection Limit
MDC	Minimum detectable concentration
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
NC	Not Calculated
ND	Not detected at the reporting limit (or MDL or EDL if shown)
PQL	Practical Quantitation Limit
QC	Quality Control
RER	Relative error ratio
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)

Client Sample Results

Client Sample ID: N1MW-8 (12-12.5):101716

Date Collected: 10/17/16 11:15
Date Received: 10/19/16 09:20

Lab Sample ID: 590-4761-1

Matrix: Solid
Percent Solids: 92.1

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.017		mg/Kg	☼	10/19/16 12:48	10/20/16 01:10	1
Ethylbenzene	**0.24**		0.084		mg/Kg	☼	10/19/16 12:48	10/20/16 01:10	1
m,p-Xylene	**1.4**		0.34		mg/Kg	☼	10/19/16 12:48	10/20/16 01:10	1
o-Xylene	**0.53**		0.17		mg/Kg	☼	10/19/16 12:48	10/20/16 01:10	1
Toluene	ND		0.084		mg/Kg	☼	10/19/16 12:48	10/20/16 01:10	1
Xylenes, Total	**1.9**		0.51		mg/Kg	☼	10/19/16 12:48	10/20/16 01:10	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*103*		*75 - 120*	*10/19/16 12:48*	*10/20/16 01:10*	*1*
4-Bromofluorobenzene (Surr)	*96*		*76 - 122*	*10/19/16 12:48*	*10/20/16 01:10*	*1*
Dibromofluoromethane (Surr)	*114*		*80 - 120*	*10/19/16 12:48*	*10/20/16 01:10*	*1*
Toluene-d8 (Surr)	*98*		*80 - 120*	*10/19/16 12:48*	*10/20/16 01:10*	*1*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	**170**		4.2		mg/Kg	☼	10/19/16 12:48	10/20/16 01:10	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*96*		*41.5 - 162*	*10/19/16 12:48*	*10/20/16 01:10*	*1*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	**54**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
2-Methylnaphthalene	**670**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
1-Methylnaphthalene	**390**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Acenaphthylene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Acenaphthene	**12**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Fluorene	**17**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Phenanthrene	**23**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Anthracene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Fluoranthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Pyrene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Benzo[a]anthracene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Chrysene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Benzo[b]fluoranthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Benzo[k]fluoranthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Benzo[a]pyrene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Indeno[1,2,3-cd]pyrene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Dibenz(a,h)anthracene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1
Benzo[g,h,i]perylene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 15:45	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*57*		*23 - 120*	*10/21/16 09:45*	*10/21/16 15:45*	*1*
2-Fluorobiphenyl (Surr)	*77*		*38 - 123*	*10/21/16 09:45*	*10/21/16 15:45*	*1*
p-Terphenyl-d14	*99*		*68 - 136*	*10/21/16 09:45*	*10/21/16 15:45*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	**150**		11		mg/Kg	☼	10/25/16 08:02	10/25/16 11:27	1

1 2 3 4 5 6 7 8 9 10 11 12

Client Sample ID: N1MW-8 (12-12.5):101716 Lab Sample ID: 590-4761-1

Date Collected: 10/17/16 11:15 **Matrix: Solid**
Date Received: 10/19/16 09:20 **Percent Solids: 92.1**

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Residual Range Organics (RRO) (C25-C36)	ND		26		mg/Kg	☼	10/25/16 08:02	10/25/16 11:27	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*116*		*50 - 150*	*10/25/16 08:02*	*10/25/16 11:27*	*1*
n-Triacontane-d62	*103*		*50 - 150*	*10/25/16 08:02*	*10/25/16 11:27*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		6.2		mg/Kg	☼	10/19/16 13:35	10/27/16 16:52	5

Client Sample ID: N1MW-8 (15-15.5):101716 Lab Sample ID: 590-4761-2

Date Collected: 10/17/16 11:12 **Matrix: Solid**
Date Received: 10/19/16 09:20 **Percent Solids: 90.1**

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	**0.025**		0.022		mg/Kg	☼	10/19/16 12:48	10/20/16 01:32	1
Ethylbenzene	**11**		2.2		mg/Kg	☼	10/19/16 12:48	10/20/16 14:13	20
m,p-Xylene	**58**		8.6		mg/Kg	☼	10/19/16 12:48	10/20/16 14:13	20
o-Xylene	**21**		4.3		mg/Kg	☼	10/19/16 12:48	10/20/16 14:13	20
Toluene	**1.3**		0.11		mg/Kg	☼	10/19/16 12:48	10/20/16 01:32	1
Xylenes, Total	**80**		13		mg/Kg	☼	10/19/16 12:48	10/20/16 14:13	20

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*98*		*75 - 120*	*10/19/16 12:48*	*10/20/16 01:32*	*1*
1,2-Dichloroethane-d4 (Surr)	*100*		*75 - 120*	*10/19/16 12:48*	*10/20/16 14:13*	*20*
4-Bromofluorobenzene (Surr)	*105*		*76 - 122*	*10/19/16 12:48*	*10/20/16 01:32*	*1*
4-Bromofluorobenzene (Surr)	*100*		*76 - 122*	*10/19/16 12:48*	*10/20/16 14:13*	*20*
Dibromofluoromethane (Surr)	*93*		*80 - 120*	*10/19/16 12:48*	*10/20/16 01:32*	*1*
Dibromofluoromethane (Surr)	*102*		*80 - 120*	*10/19/16 12:48*	*10/20/16 14:13*	*20*
Toluene-d8 (Surr)	*97*		*80 - 120*	*10/19/16 12:48*	*10/20/16 01:32*	*1*
Toluene-d8 (Surr)	*102*		*80 - 120*	*10/19/16 12:48*	*10/20/16 14:13*	*20*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	**1200**		110		mg/Kg	☼	10/19/16 12:48	10/20/16 14:13	20

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*100*		*41.5 - 162*	*10/19/16 12:48*	*10/20/16 14:13*	*20*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	**880**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
2-Methylnaphthalene	**5600**		110		ug/Kg	☼	10/21/16 09:45	10/25/16 15:12	10
1-Methylnaphthalene	**2800**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Acenaphthylene	**17**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Acenaphthene	**72**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Fluorene	**83**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Phenanthrene	**150**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Anthracene	**36**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1

Client Sample ID: N1MW-8 (15-15.5):101716

Lab Sample ID: 590-4761-2

Date Collected: 10/17/16 11:12
Matrix: Solid
Date Received: 10/19/16 09:20
Percent Solids: 90.1

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Fluoranthene	**11**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Pyrene	**13**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Benzo[a]anthracene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Chrysene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Benzo[b]fluoranthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Benzo[k]fluoranthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Benzo[a]pyrene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Indeno[1,2,3-cd]pyrene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Dibenz(a,h)anthracene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1
Benzo[g,h,i]perylene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:11	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*62*		*23 - 120*	*10/21/16 09:45*	*10/21/16 16:11*	*1*
Nitrobenzene-d5	*62*		*23 - 120*	*10/21/16 09:45*	*10/25/16 15:12*	*10*
2-Fluorobiphenyl (Surr)	*85*		*38 - 123*	*10/21/16 09:45*	*10/21/16 16:11*	*1*
2-Fluorobiphenyl (Surr)	*91*		*38 - 123*	*10/21/16 09:45*	*10/25/16 15:12*	*10*
p-Terphenyl-d14	*110*		*68 - 136*	*10/21/16 09:45*	*10/21/16 16:11*	*1*
p-Terphenyl-d14	*97*		*68 - 136*	*10/21/16 09:45*	*10/25/16 15:12*	*10*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	**210**		11		mg/Kg	☼	10/25/16 08:02	10/25/16 11:46	1
Residual Range Organics (RRO) (C25-C36)	ND		28		mg/Kg	☼	10/25/16 08:02	10/25/16 11:46	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*118*		*50 - 150*	*10/25/16 08:02*	*10/25/16 11:46*	*1*
n-Triacontane-d62	*104*		*50 - 150*	*10/25/16 08:02*	*10/25/16 11:46*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		6.8		mg/Kg	☼	10/19/16 13:35	10/27/16 16:56	5

Client Sample ID: N1MW-6 (12.5-13):101716

Lab Sample ID: 590-4761-3

Date Collected: 10/17/16 14:30
Matrix: Solid
Date Received: 10/19/16 09:20
Percent Solids: 91.9

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.019		mg/Kg	☼	10/19/16 12:48	10/20/16 01:54	1
Ethylbenzene	**4.7**		0.096		mg/Kg	☼	10/19/16 12:48	10/20/16 01:54	1
m,p-Xylene	**25**		3.8		mg/Kg	☼	10/19/16 12:48	10/20/16 14:35	10
o-Xylene	ND		1.9		mg/Kg	☼	10/19/16 12:48	10/20/16 14:35	10
Toluene	ND		0.096		mg/Kg	☼	10/19/16 12:48	10/20/16 01:54	1
Xylenes, Total	**25**		5.7		mg/Kg	☼	10/19/16 12:48	10/20/16 14:35	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*89*		*75 - 120*	*10/19/16 12:48*	*10/20/16 01:54*	*1*
1,2-Dichloroethane-d4 (Surr)	*100*		*75 - 120*	*10/19/16 12:48*	*10/20/16 14:35*	*10*
4-Bromofluorobenzene (Surr)	*102*		*76 - 122*	*10/19/16 12:48*	*10/20/16 01:54*	*1*

Client Sample Results

Client Sample ID: N1MW-6 (12.5-13):101716

Date Collected: 10/17/16 14:30
Date Received: 10/19/16 09:20

Lab Sample ID: 590-4761-3

Matrix: Solid
Percent Solids: 91.9

Method: 8260C - Volatile Organic Compounds by GC/MS (Continued)

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*102*		*76 - 122*	*10/19/16 12:48*	*10/20/16 14:35*	*10*
Dibromofluoromethane (Surr)	*90*		*80 - 120*	*10/19/16 12:48*	*10/20/16 01:54*	*1*
Dibromofluoromethane (Surr)	*99*		*80 - 120*	*10/19/16 12:48*	*10/20/16 14:35*	*10*
Toluene-d8 (Surr)	*98*		*80 - 120*	*10/19/16 12:48*	*10/20/16 01:54*	*1*
Toluene-d8 (Surr)	*100*		*80 - 120*	*10/19/16 12:48*	*10/20/16 14:35*	*10*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	**940**		48		mg/Kg	☼	10/19/16 12:48	10/20/16 14:35	10

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*102*		*41.5 - 162*	*10/19/16 12:48*	*10/20/16 14:35*	*10*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	**350**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
2-Methylnaphthalene	**2100**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
1-Methylnaphthalene	**1100**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Acenaphthylene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Acenaphthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Fluorene	**11**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Phenanthrene	**18**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Anthracene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Fluoranthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Pyrene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Benzo[a]anthracene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Chrysene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Benzo[b]fluoranthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Benzo[k]fluoranthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Benzo[a]pyrene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Indeno[1,2,3-cd]pyrene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Dibenz(a,h)anthracene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1
Benzo[g,h,i]perylene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 16:38	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*62*		*23 - 120*	*10/21/16 09:45*	*10/21/16 16:38*	*1*
2-Fluorobiphenyl (Surr)	*82*		*38 - 123*	*10/21/16 09:45*	*10/21/16 16:38*	*1*
p-Terphenyl-d14	*102*		*68 - 136*	*10/21/16 09:45*	*10/21/16 16:38*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	**25**		11		mg/Kg	☼	10/25/16 08:02	10/25/16 12:17	1
Residual Range Organics (RRO) (C25-C36)	ND		27		mg/Kg	☼	10/25/16 08:02	10/25/16 12:17	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*101*		*50 - 150*	*10/25/16 08:02*	*10/25/16 12:17*	*1*
n-Triacontane-d62	*101*		*50 - 150*	*10/25/16 08:02*	*10/25/16 12:17*	*1*

Client Sample Results

Client Sample ID: N1MW-6 (12.5-13):101716

Lab Sample ID: 590-4761-3

Date Collected: 10/17/16 14:30
Matrix: Solid
Date Received: 10/19/16 09:20
Percent Solids: 91.9

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		6.6		mg/Kg	☼	10/19/16 13:35	10/27/16 16:59	5

Client Sample ID: N1MW-7 (15-15.5):101816

Lab Sample ID: 590-4761-4

Date Collected: 10/18/16 09:05
Matrix: Solid
Date Received: 10/19/16 09:20
Percent Solids: 86.5

Method: 8260C - Volatile Organic Compounds by GC/MS

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.019		mg/Kg	☼	10/19/16 12:48	10/20/16 02:16	1
Ethylbenzene	**25**		4.8		mg/Kg	☼	10/19/16 12:48	10/20/16 14:56	50
m,p-Xylene	**100**		19		mg/Kg	☼	10/19/16 12:48	10/20/16 14:56	50
o-Xylene	**31**		9.5		mg/Kg	☼	10/19/16 12:48	10/20/16 14:56	50
Toluene	**3.5**		0.095		mg/Kg	☼	10/19/16 12:48	10/20/16 02:16	1
Xylenes, Total	**130**		29		mg/Kg	☼	10/19/16 12:48	10/20/16 14:56	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*88*		*75 - 120*	*10/19/16 12:48*	*10/20/16 02:16*	*1*
1,2-Dichloroethane-d4 (Surr)	*102*		*75 - 120*	*10/19/16 12:48*	*10/20/16 14:56*	*50*
4-Bromofluorobenzene (Surr)	*96*		*76 - 122*	*10/19/16 12:48*	*10/20/16 02:16*	*1*
4-Bromofluorobenzene (Surr)	*98*		*76 - 122*	*10/19/16 12:48*	*10/20/16 14:56*	*50*
Dibromofluoromethane (Surr)	*82*		*80 - 120*	*10/19/16 12:48*	*10/20/16 02:16*	*1*
Dibromofluoromethane (Surr)	*100*		*80 - 120*	*10/19/16 12:48*	*10/20/16 14:56*	*50*
Toluene-d8 (Surr)	*90*		*80 - 120*	*10/19/16 12:48*	*10/20/16 02:16*	*1*
Toluene-d8 (Surr)	*99*		*80 - 120*	*10/19/16 12:48*	*10/20/16 14:56*	*50*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	**1900**		240		mg/Kg	☼	10/19/16 12:48	10/20/16 14:56	50

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*98*		*41.5 - 162*	*10/19/16 12:48*	*10/20/16 14:56*	*50*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	**12**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
2-Methylnaphthalene	**52**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
1-Methylnaphthalene	**28**		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Acenaphthylene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Acenaphthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Fluorene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Phenanthrene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Anthracene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Fluoranthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Pyrene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Benzo[a]anthracene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Chrysene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Benzo[b]fluoranthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Benzo[k]fluoranthene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Benzo[a]pyrene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Indeno[1,2,3-cd]pyrene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1
Dibenz(a,h)anthracene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1

Client Sample ID: N1MW-7 (15-15.5):101816

Lab Sample ID: 590-4761-4

Date Collected: 10/18/16 09:05

Matrix: Solid

Date Received: 10/19/16 09:20

Percent Solids: 86.5

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM) (Continued)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzo[g,h,i]perylene	ND		11		ug/Kg	☼	10/21/16 09:45	10/21/16 17:04	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*52*		*23 - 120*	*10/21/16 09:45*	*10/21/16 17:04*	*1*
2-Fluorobiphenyl (Surr)	*74*		*38 - 123*	*10/21/16 09:45*	*10/21/16 17:04*	*1*
p-Terphenyl-d14	*103*		*68 - 136*	*10/21/16 09:45*	*10/21/16 17:04*	*1*

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	ND		11		mg/Kg	☼	10/25/16 08:02	10/25/16 12:35	1
Residual Range Organics (RRO) (C25-C36)	ND		27		mg/Kg	☼	10/25/16 08:02	10/25/16 12:35	1

Surrogate	*%Recovery*	*Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*94*		*50 - 150*	*10/25/16 08:02*	*10/25/16 12:35*	*1*
n-Triacontane-d62	*102*		*50 - 150*	*10/25/16 08:02*	*10/25/16 12:35*	*1*

Method: 6010C - Metals (ICP)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		6.6		mg/Kg	☼	10/19/16 13:35	10/27/16 17:02	5

QC Sample Results

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st

TestAmerica Job ID: 590-4761-1

Method: 8260C - Volatile Organic Compounds by GC/MS

Lab Sample ID: MB 590-9178/1-A
Matrix: Solid
Analysis Batch: 9182

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 9178

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Benzene	ND		0.020		mg/Kg		10/19/16 12:48	10/19/16 20:45	1
Ethylbenzene	ND		0.10		mg/Kg		10/19/16 12:48	10/19/16 20:45	1
m,p-Xylene	ND		0.40		mg/Kg		10/19/16 12:48	10/19/16 20:45	1
o-Xylene	ND		0.20		mg/Kg		10/19/16 12:48	10/19/16 20:45	1
Toluene	ND		0.10		mg/Kg		10/19/16 12:48	10/19/16 20:45	1
Xylenes, Total	ND		0.60		mg/Kg		10/19/16 12:48	10/19/16 20:45	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
1,2-Dichloroethane-d4 (Surr)	*108*		*75 - 120*	*10/19/16 12:48*	*10/19/16 20:45*	*1*
4-Bromofluorobenzene (Surr)	*107*		*76 - 122*	*10/19/16 12:48*	*10/19/16 20:45*	*1*
Dibromofluoromethane (Surr)	*115*		*80 - 120*	*10/19/16 12:48*	*10/19/16 20:45*	*1*
Toluene-d8 (Surr)	*98*		*80 - 120*	*10/19/16 12:48*	*10/19/16 20:45*	*1*

Lab Sample ID: LCS 590-9178/2-A
Matrix: Solid
Analysis Batch: 9182

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 9178

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Benzene	0.500	0.441		mg/Kg		88	76 - 123
Ethylbenzene	0.500	0.519		mg/Kg		104	77 - 121
m,p-Xylene	0.500	0.499		mg/Kg		100	78 - 124
o-Xylene	0.500	0.500		mg/Kg		100	77 - 129
Toluene	0.500	0.507		mg/Kg		101	77 - 125

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
1,2-Dichloroethane-d4 (Surr)	*99*		*75 - 120*
4-Bromofluorobenzene (Surr)	*94*		*76 - 122*
Dibromofluoromethane (Surr)	*101*		*80 - 120*
Toluene-d8 (Surr)	*102*		*80 - 120*

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS)

Lab Sample ID: MB 590-9178/1-A
Matrix: Solid
Analysis Batch: 9183

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 9178

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Gasoline	ND		5.0		mg/Kg		10/19/16 12:48	10/19/16 20:45	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
4-Bromofluorobenzene (Surr)	*107*		*41.5 - 162*	*10/19/16 12:48*	*10/19/16 20:45*	*1*

QC Sample Results

Method: NWTPH-Gx - Northwest - Volatile Petroleum Products (GC/MS) (Continued)

Lab Sample ID: LCS 590-9178/3-A
Matrix: Solid
Analysis Batch: 9183

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 9178

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Gasoline	50.0	57.9		mg/Kg		116	74.4 - 124

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
4-Bromofluorobenzene (Surr)	*105*		*41.5 - 162*

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM)

Lab Sample ID: MB 590-9216/1-A
Matrix: Solid
Analysis Batch: 9214

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 9216

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Naphthalene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
2-Methylnaphthalene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
1-Methylnaphthalene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Acenaphthylene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Acenaphthene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Fluorene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Phenanthrene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Anthracene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Fluoranthene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Pyrene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Benzo[a]anthracene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Chrysene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Benzo[b]fluoranthene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Benzo[k]fluoranthene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Benzo[a]pyrene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Indeno[1,2,3-cd]pyrene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Dibenz(a,h)anthracene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1
Benzo[g,h,i]perylene	ND		10		ug/Kg		10/21/16 09:45	10/21/16 11:13	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
Nitrobenzene-d5	*67*		*23 - 120*	*10/21/16 09:45*	*10/21/16 11:13*	*1*
2-Fluorobiphenyl (Surr)	*88*		*38 - 123*	*10/21/16 09:45*	*10/21/16 11:13*	*1*
p-Terphenyl-d14	*122*		*68 - 136*	*10/21/16 09:45*	*10/21/16 11:13*	*1*

Lab Sample ID: LCS 590-9216/2-A
Matrix: Solid
Analysis Batch: 9214

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 9216

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Naphthalene	267	194		ug/Kg		73	41 - 121
2-Methylnaphthalene	267	225		ug/Kg		84	39 - 132
1-Methylnaphthalene	267	209		ug/Kg		79	46 - 131
Acenaphthylene	267	210		ug/Kg		79	56 - 123
Acenaphthene	267	219		ug/Kg		82	43 - 140
Fluorene	267	234		ug/Kg		88	54 - 131

Method: 8270D SIM - Semivolatile Organic Compounds (GC/MS SIM) (Continued)

Lab Sample ID: LCS 590-9216/2-A
Matrix: Solid
Analysis Batch: 9214

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 9216

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Phenanthrene	267	244		ug/Kg		92	55 - 141
Anthracene	267	248		ug/Kg		93	60 - 129
Fluoranthene	267	240		ug/Kg		90	63 - 141
Pyrene	267	226		ug/Kg		85	62 - 139
Benzo[a]anthracene	267	254		ug/Kg		95	61 - 136
Chrysene	267	245		ug/Kg		92	57 - 144
Benzo[b]fluoranthene	267	256		ug/Kg		96	66 - 141
Benzo[k]fluoranthene	267	245		ug/Kg		92	63 - 150
Benzo[a]pyrene	267	243		ug/Kg		91	60 - 133
Indeno[1,2,3-cd]pyrene	267	250		ug/Kg		94	55 - 142
Dibenz(a,h)anthracene	267	246		ug/Kg		92	60 - 150
Benzo[g,h,i]perylene	267	243		ug/Kg		91	58 - 147

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
Nitrobenzene-d5	*64*		*23 - 120*
2-Fluorobiphenyl (Surr)	*88*		*38 - 123*
p-Terphenyl-d14	*103*		*68 - 136*

Lab Sample ID: LCSD 590-9216/3-A
Matrix: Solid
Analysis Batch: 9214

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 9216

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Naphthalene	267	179		ug/Kg		67	41 - 121	8	35
2-Methylnaphthalene	267	219		ug/Kg		82	39 - 132	3	35
1-Methylnaphthalene	267	200		ug/Kg		75	46 - 131	5	35
Acenaphthylene	267	202		ug/Kg		76	56 - 123	4	35
Acenaphthene	267	208		ug/Kg		78	43 - 140	5	35
Fluorene	267	227		ug/Kg		85	54 - 131	3	35
Phenanthrene	267	236		ug/Kg		89	55 - 141	4	35
Anthracene	267	238		ug/Kg		89	60 - 129	4	35
Fluoranthene	267	233		ug/Kg		87	63 - 141	3	35
Pyrene	267	220		ug/Kg		82	62 - 139	3	35
Benzo[a]anthracene	267	245		ug/Kg		92	61 - 136	4	35
Chrysene	267	244		ug/Kg		92	57 - 144	0	35
Benzo[b]fluoranthene	267	242		ug/Kg		91	66 - 141	6	35
Benzo[k]fluoranthene	267	223		ug/Kg		84	63 - 150	9	35
Benzo[a]pyrene	267	231		ug/Kg		87	60 - 133	5	35
Indeno[1,2,3-cd]pyrene	267	241		ug/Kg		90	55 - 142	4	35
Dibenz(a,h)anthracene	267	238		ug/Kg		89	60 - 150	3	35
Benzo[g,h,i]perylene	267	234		ug/Kg		88	58 - 147	4	35

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
Nitrobenzene-d5	*60*		*23 - 120*
2-Fluorobiphenyl (Surr)	*83*		*38 - 123*
p-Terphenyl-d14	*101*		*68 - 136*

QC Sample Results

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st

TestAmerica Job ID: 590-4761-1

Method: NWTPH-Dx - Northwest - Semi-Volatile Petroleum Products (GC)

Lab Sample ID: MB 590-9259/1-A
Matrix: Solid
Analysis Batch: 9262

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 9259

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Diesel Range Organics (DRO) (C10-C25)	ND		10		mg/Kg		10/25/16 08:02	10/25/16 09:42	1
Residual Range Organics (RRO) (C25-C36)	ND		25		mg/Kg		10/25/16 08:02	10/25/16 09:42	1

Surrogate	*MB %Recovery*	*MB Qualifier*	*Limits*	*Prepared*	*Analyzed*	*Dil Fac*
o-Terphenyl	*93*		*50 - 150*	*10/25/16 08:02*	*10/25/16 09:42*	*1*
n-Triacontane-d62	*98*		*50 - 150*	*10/25/16 08:02*	*10/25/16 09:42*	*1*

Lab Sample ID: LCS 590-9259/2-A
Matrix: Solid
Analysis Batch: 9262

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 9259

Analyte			Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits		
Diesel Range Organics (DRO) (C10-C25)			67.1	62.6		mg/Kg		93	50 - 150		
Residual Range Organics (RRO) (C25-C36)			66.8	61.8		mg/Kg		92	50 - 150		

Surrogate	*LCS %Recovery*	*LCS Qualifier*	*Limits*
o-Terphenyl	*95*		*50 - 150*
n-Triacontane-d62	*97*		*50 - 150*

Lab Sample ID: LCSD 590-9259/3-A
Matrix: Solid
Analysis Batch: 9262

Client Sample ID: Lab Control Sample Dup
Prep Type: Total/NA
Prep Batch: 9259

Analyte			Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec. Limits	RPD	RPD Limit
Diesel Range Organics (DRO) (C10-C25)			67.1	61.3		mg/Kg		91	50 - 150	2	25
Residual Range Organics (RRO) (C25-C36)			66.8	62.8		mg/Kg		94	50 - 150	2	25

Surrogate	*LCSD %Recovery*	*LCSD Qualifier*	*Limits*
o-Terphenyl	*95*		*50 - 150*
n-Triacontane-d62	*98*		*50 - 150*

Method: 6010C - Metals (ICP)

Lab Sample ID: MB 590-9179/2-A
Matrix: Solid
Analysis Batch: 9243

Client Sample ID: Method Blank
Prep Type: Total/NA
Prep Batch: 9179

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Lead	ND		1.3		mg/Kg		10/19/16 13:35	10/21/16 17:13	1

Method: 6010C - Metals (ICP) (Continued)

Lab Sample ID: LCS 590-9179/1-A
Matrix: Solid
Analysis Batch: 9243

Client Sample ID: Lab Control Sample
Prep Type: Total/NA
Prep Batch: 9179

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec. Limits
Lead	50.0	51.1		mg/Kg		102	80 - 120

Lab Chronicle

Client Sample ID: N1MW-8 (12-12.5):101716

Lab Sample ID: 590-4761-1

Date Collected: 10/17/16 11:15

Matrix: Solid

Date Received: 10/19/16 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			9186	10/19/16 14:13	EAF	TAL SPK

Client Sample ID: N1MW-8 (12-12.5):101716

Lab Sample ID: 590-4761-1

Date Collected: 10/17/16 11:15

Matrix: Solid

Date Received: 10/19/16 09:20

Percent Solids: 92.1

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			7.154 g	5 mL	9178	10/19/16 12:48	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	9182	10/20/16 01:10	MRS	TAL SPK
Total/NA	Prep	5035			7.154 g	5 mL	9178	10/19/16 12:48	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		1	0.86 mL	43 mL	9183	10/20/16 01:10	MRS	TAL SPK
Total/NA	Prep	3550C			15.30 g	2 mL	9216	10/21/16 09:45	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			9214	10/21/16 15:45	NMI	TAL SPK
Total/NA	Prep	3550C			15.48 g	5 mL	9259	10/25/16 08:02	NMI	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			9262	10/25/16 11:27	NMI	TAL SPK
Total/NA	Prep	3050B			1.10 g	50 mL	9179	10/19/16 13:35	JSP	TAL SPK
Total/NA	Analysis	6010C		5			9327	10/27/16 16:52	JSP	TAL SPK

Client Sample ID: N1MW-8 (15-15.5):101716

Lab Sample ID: 590-4761-2

Date Collected: 10/17/16 11:12

Matrix: Solid

Date Received: 10/19/16 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			9186	10/19/16 14:13	EAF	TAL SPK

Client Sample ID: N1MW-8 (15-15.5):101716

Lab Sample ID: 590-4761-2

Date Collected: 10/17/16 11:12

Matrix: Solid

Date Received: 10/19/16 09:20

Percent Solids: 90.1

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			5.723 g	5 mL	9178	10/19/16 12:48	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	9182	10/20/16 01:32	MRS	TAL SPK
Total/NA	Prep	5035			5.723 g	5 mL	9178	10/19/16 12:48	MRS	TAL SPK
Total/NA	Analysis	8260C		20	0.86 mL	43 mL	9198	10/20/16 14:13	MRS	TAL SPK
Total/NA	Prep	5035			5.723 g	5 mL	9178	10/19/16 12:48	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		20	0.86 mL	43 mL	9199	10/20/16 14:13	CBW	TAL SPK
Total/NA	Prep	3550C			15.08 g	2 mL	9216	10/21/16 09:45	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			9214	10/21/16 16:11	NMI	TAL SPK
Total/NA	Prep	3550C			15.08 g	2 mL	9216	10/21/16 09:45	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		10			9260	10/25/16 15:12	NMI	TAL SPK
Total/NA	Prep	3550C			15.08 g	5 mL	9259	10/25/16 08:02	NMI	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			9262	10/25/16 11:46	NMI	TAL SPK
Total/NA	Prep	3050B			1.02 g	50 mL	9179	10/19/16 13:35	JSP	TAL SPK

Lab Chronicle

Client Sample ID: N1MW-8 (15-15.5):101716

Lab Sample ID: 590-4761-2
Date Collected: 10/17/16 11:12
Matrix: Solid
Date Received: 10/19/16 09:20
Percent Solids: 90.1

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	6010C		5			9327	10/27/16 16:56	JSP	TAL SPK

Client Sample ID: N1MW-6 (12.5-13):101716

Lab Sample ID: 590-4761-3
Date Collected: 10/17/16 14:30
Matrix: Solid
Date Received: 10/19/16 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			9186	10/19/16 14:13	EAF	TAL SPK

Client Sample ID: N1MW-6 (12.5-13):101716

Lab Sample ID: 590-4761-3
Date Collected: 10/17/16 14:30
Matrix: Solid
Date Received: 10/19/16 09:20
Percent Solids: 91.9

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			6.271 g	5 mL	9178	10/19/16 12:48	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	9182	10/20/16 01:54	MRS	TAL SPK
Total/NA	Prep	5035			6.271 g	5 mL	9178	10/19/16 12:48	MRS	TAL SPK
Total/NA	Analysis	8260C		10	0.86 mL	43 mL	9198	10/20/16 14:35	MRS	TAL SPK
Total/NA	Prep	5035			6.271 g	5 mL	9178	10/19/16 12:48	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		10	0.86 mL	43 mL	9199	10/20/16 14:35	CBW	TAL SPK
Total/NA	Prep	3550C			15.44 g	2 mL	9216	10/21/16 09:45	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			9214	10/21/16 16:38	NMI	TAL SPK
Total/NA	Prep	3550C			15.12 g	5 mL	9259	10/25/16 08:02	NMI	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			9262	10/25/16 12:17	NMI	TAL SPK
Total/NA	Prep	3050B			1.03 g	50 mL	9179	10/19/16 13:35	JSP	TAL SPK
Total/NA	Analysis	6010C		5			9327	10/27/16 16:59	JSP	TAL SPK

Client Sample ID: N1MW-7 (15-15.5):101816

Lab Sample ID: 590-4761-4
Date Collected: 10/18/16 09:05
Matrix: Solid
Date Received: 10/19/16 09:20

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Analysis	Moisture		1			9186	10/19/16 14:13	EAF	TAL SPK

Client Sample ID: N1MW-7 (15-15.5):101816

Lab Sample ID: 590-4761-4
Date Collected: 10/18/16 09:05
Matrix: Solid
Date Received: 10/19/16 09:20
Percent Solids: 86.5

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			7.277 g	5 mL	9178	10/19/16 12:48	MRS	TAL SPK
Total/NA	Analysis	8260C		1	0.86 mL	43 mL	9182	10/20/16 02:16	MRS	TAL SPK
Total/NA	Prep	5035			7.277 g	5 mL	9178	10/19/16 12:48	MRS	TAL SPK
Total/NA	Analysis	8260C		50	0.86 mL	43 mL	9198	10/20/16 14:56	MRS	TAL SPK

Lab Chronicle

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	5035			7.277 g	5 mL	9178	10/19/16 12:48	MRS	TAL SPK
Total/NA	Analysis	NWTPH-Gx		50	0.86 mL	43 mL	9199	10/20/16 14:56	CBW	TAL SPK
Total/NA	Prep	3550C			15.58 g	2 mL	9216	10/21/16 09:45	EAF	TAL SPK
Total/NA	Analysis	8270D SIM		1			9214	10/21/16 17:04	NMI	TAL SPK
Total/NA	Prep	3550C			15.99 g	5 mL	9259	10/25/16 08:02	NMI	TAL SPK
Total/NA	Analysis	NWTPH-Dx		1			9262	10/25/16 12:35	NMI	TAL SPK
Total/NA	Prep	3050B			1.09 g	50 mL	9179	10/19/16 13:35	JSP	TAL SPK
Total/NA	Analysis	6010C		5			9327	10/27/16 17:02	JSP	TAL SPK

Laboratory References:

TAL SPK = TestAmerica Spokane, 11922 East 1st Ave, Spokane, WA 99206, TEL (509)924-9200

Certification Summary

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st

TestAmerica Job ID: 590-4761-1

Laboratory: TestAmerica Spokane

All certifications held by this laboratory are listed. Not all certifications are applicable to this report.

Authority	Program	EPA Region	Certification ID	Expiration Date
Alaska (UST)	State Program	10	UST-071	10-31-16
Washington	State Program	10	C569	01-06-17

Method Summary

Client: GeoEngineers Inc
Project/Site: Tiger Oil - North 1st

TestAmerica Job ID: 590-4761-1

Method	Method Description	Protocol	Laboratory
8260C	Volatile Organic Compounds by GC/MS	SW846	TAL SPK
NWTPH-Gx	Northwest - Volatile Petroleum Products (GC/MS)	NWTPH	TAL SPK
8270D SIM	Semivolatile Organic Compounds (GC/MS SIM)	SW846	TAL SPK
NWTPH-Dx	Northwest - Semi-Volatile Petroleum Products (GC)	NWTPH	TAL SPK
6010C	Metals (ICP)	SW846	TAL SPK
Moisture	Percent Moisture	EPA	TAL SPK

Protocol References:

EPA = US Environmental Protection Agency
NWTPH = Northwest Total Petroleum Hydrocarbon
SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

Laboratory References:

TAL SPK = TestAmerica Spokane, 11922 East 1st Ave, Spokane, WA 99206, TEL (509)924-9200

CHAIN OF CUSTODY RECORD

GeoEngineers
523 EAST SECOND AVE.
SPOKANE, WASHINGTON 99202
(509) 363-3125

DATE 10/18/2016
PAGE 1 OF 1
LAB TestAmerica
LAB NO. Spokane Valley, WA

PROJECT NAME/LOCATION Tiger Oil - North 1st
PROJECT NUMBER 0504-101-03
PROJECT MANAGER JR Sugatski
SAMPLED BY JML

SAMPLE IDENTIFICATION		SAMPLE COLLECTION			# OF JARS	ANALYSIS REQUIRED												NOTES/COMMENTS (Preserved, filtered, etc.)
LAB	GEOENGINEERS	DATE	TIME	MATRIX		NWTPH-Gx	BTEX	NWTPH-Dx	PAHs	Total Lead								
	N1MW-8(12-12.5):101716	10/17/16	1115	Soil	3													
	N1MW-8(15-15.5):101716	10/17/16	1120	Soil	3	X	X	X	X	X								
	N1MW-6(12.5-13):101716	10/17/16	1430	Soil	3	X	X	X	X	X								
	N1MW-7(15-15.5):101816	10/18/16	0905	Soil	3	X	X	X	X	X								

RELINQUISHED BY FIRM GEI
SIGNATURE
PRINTED NAME Josh Lee
DATE 10-19-2016 TIME 0920

RECEIVED BY FIRM TASpok
SIGNATURE
PRINTED NAME Sheila Kietz
DATE 10/19/16 TIME 920

RELINQUISHED BY FIRM
SIGNATURE
PRINTED NAME
DATE TIME

RECEIVED BY FIRM
SIGNATURE
PRINTED NAME
DATE TIME

RELINQUISHED BY FIRM
SIGNATURE
PRINTED NAME
DATE TIME

RECEIVED BY FIRM
SIGNATURE
PRINTED NAME
DATE TIME

ADDITIONAL COMMENTS: 4,4°C IR003

590-4761 Chain of Custody

Login Sample Receipt Checklist

Client: GeoEngineers Inc

Job Number: 590-4761-1

Login Number: 4761

List Source: TestAmerica Spokane

List Number: 1

Creator: Kratz, Sheila J

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	N/A	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	N/A	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

APPENDIX H
Terrestrial Ecological Evaluation Form

DEPARTMENT OF
ECOLOGY
State of Washington

Voluntary Cleanup Program

Washington State Department of Ecology
Toxics Cleanup Program

TERRESTRIAL ECOLOGICAL EVALUATION FORM

Under the Model Toxics Control Act (MTCA), a terrestrial ecological evaluation is necessary if hazardous substances are released into the soils at a Site. In the event of such a release, you must take one of the following three actions as part of your investigation and cleanup of the Site:

1. Document an exclusion from further evaluation using the criteria in WAC 173-340-7491.
2. Conduct a simplified evaluation as set forth in WAC 173-340-7492.
3. Conduct a site-specific evaluation as set forth in WAC 173-340-7493.

When requesting a written opinion under the Voluntary Cleanup Program (VCP), you must complete this form and submit it to the Department of Ecology (Ecology). The form documents the type and results of your evaluation.

Completion of this form is not sufficient to document your evaluation. You still need to document your analysis and the basis for your conclusion in your cleanup plan or report.

If you have questions about how to conduct a terrestrial ecological evaluation, please contact the Ecology site manager assigned to your Site. For additional guidance, please refer to www.ecy.wa.gov/programs/tcp/policies/terrestrial/TEEHome.htm.

Step 1: IDENTIFY HAZARDOUS WASTE SITE

Please identify below the hazardous waste site for which you are documenting an evaluation.

Facility/Site Name: Tiger Oil - North 1st Street

Facility/Site Address: 1808 North 1st Street, Yakima, WA

Facility/Site No: 477

VCP Project No.: 4922

Step 2: IDENTIFY EVALUATOR

Please identify below the person who conducted the evaluation and their contact information.

Name: JR Sugalski

Title: Environmental Engineer

Organization: GeoEngineers

Mailing address: 523 East Second Avenue

City: Spokane

State: WA

Zip code: 99202

Phone: 509-363-3125

Fax:

E-mail: jsugalski@geoengineers.com

Step 3: DOCUMENT EVALUATION TYPE AND RESULTS

A. Exclusion from further evaluation.

1. Does the Site qualify for an exclusion from further evaluation?

☑ Yes *If you answered **"YES,"** then answer **Question 2**.*

☐ No or Unknown *If you answered **"NO" or "UKNOWN,"** then skip to **Step 3B** of this form.*

2. What is the basis for the exclusion? *Check all that apply. Then skip to **Step 4** of this form.*

Point of Compliance: WAC 173-340-7491(1)(a)

☐ All soil contamination is, or will be,* at least 15 feet below the surface.

☐ All soil contamination is, or will be,* at least 6 feet below the surface (or alternative depth if approved by Ecology), and institutional controls are used to manage remaining contamination.

Barriers to Exposure: WAC 173-340-7491(1)(b)

☐ All contaminated soil, is or will be,* covered by physical barriers (such as buildings or paved roads) that prevent exposure to plants and wildlife, and institutional controls are used to manage remaining contamination.

Undeveloped Land: WAC 173-340-7491(1)(c)

☐ There is less than 0.25 acres of contiguous[#] undeveloped[±] land on or within 500 feet of any area of the Site and any of the following chemicals is present: chlorinated dioxins or furans, PCB mixtures, DDT, DDE, DDD, aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, heptachlor epoxide, benzene hexachloride, toxaphene, hexachlorobenzene, pentachlorophenol, or pentachlorobenzene.

☒ For sites not containing any of the chemicals mentioned above, there is less than 1.5 acres of contiguous[#] undeveloped[±] land on or within 500 feet of any area of the Site.

Background Concentrations: WAC 173-340-7491(1)(d)

☐ Concentrations of hazardous substances in soil do not exceed natural background levels as described in WAC 173-340-200 and 173-340-709.

* An exclusion based on future land use must have a completion date for future development that is acceptable to Ecology.

[±] "Undeveloped land" is land that is not covered by building, roads, paved areas, or other barriers that would prevent wildlife from feeding on plants, earthworms, insects, or other food in or on the soil.

[#] "Contiguous" undeveloped land is an area of undeveloped land that is not divided into smaller areas of highways, extensive paving, or similar structures that are likely to reduce the potential use of the overall area by wildlife.

B. Simplified evaluation.

1. Does the Site qualify for a simplified evaluation?

☒ Yes *If you answered **"YES,"** then answer **Question 2** below.*

☐ No or Unknown *If you answered **"NO"** or **"UNKNOWN,"** then skip to **Step 3C** of this form.*

2. Did you conduct a simplified evaluation?

☒ Yes *If you answered **"YES,"** then answer **Question 3** below.*

☐ No *If you answered **"NO,"** then skip to **Step 3C** of this form.*

3. Was further evaluation necessary?

☐ Yes *If you answered **"YES,"** then answer **Question 4** below.*

☒ No *If you answered **"NO,"** then answer **Question 5** below.*

4. If further evaluation was necessary, what did you do?

☐ Used the concentrations listed in Table 749-2 as cleanup levels. *If so, then skip to **Step 4** of this form.*

☐ Conducted a site-specific evaluation. *If so, then skip to **Step 3C** of this form.*

5. If no further evaluation was necessary, what was the reason? *Check all that apply. Then skip to **Step 4** of this form.*

Exposure Analysis: WAC 173-340-7492(2)(a)

☐ Area of soil contamination at the Site is not more than 350 square feet.

☒ Current or planned land use makes wildlife exposure unlikely. Used Table 749-1.

Pathway Analysis: WAC 173-340-7492(2)(b)

☐ No potential exposure pathways from soil contamination to ecological receptors.

Contaminant Analysis: WAC 173-340-7492(2)(c)

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 15 feet at concentrations that exceed the values listed in Table 749-2.

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 6 feet (or alternative depth if approved by Ecology) at concentrations that exceed the values listed in Table 749-2, and institutional controls are used to manage remaining contamination.

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 15 feet at concentrations likely to be toxic or have the potential to bioaccumulate as determined using Ecology-approved bioassays.

☐ No contaminant listed in Table 749-2 is, or will be, present in the upper 6 feet (or alternative depth if approved by Ecology) at concentrations likely to be toxic or have the potential to bioaccumulate as determined using Ecology-approved bioassays, and institutional controls are used to manage remaining contamination.

C. Site-specific evaluation. A site-specific evaluation process consists of two parts: (1) formulating the problem, and (2) selecting the methods for addressing the identified problem. Both steps require consultation with and approval by Ecology. *See* WAC 173-340-7493(1)(c).

1. Was there a problem? *See* WAC 173-340-7493(2).

☐ Yes *If you answered* ***"YES,"*** *then answer* ***Question 2*** *below.*

☐ No *If you answered* ***"NO,"*** *then identify the reason here and then skip to* ***Question 5*** *below:*

- ☐ No issues were identified during the problem formulation step.
- ☐ While issues were identified, those issues were addressed by the cleanup actions for protecting human health.

2. What did you do to resolve the problem? *See* WAC 173-340-7493(3).

☐ Used the concentrations listed in Table 749-3 as cleanup levels. *If so, then skip to* ***Question 5*** *below.*

☐ Used one or more of the methods listed in WAC 173-340-7493(3) to evaluate and address the identified problem. *If so, then answer* ***Questions 3 and 4*** *below.*

3. If you conducted further site-specific evaluations, what methods did you use? *Check all that apply. See* WAC 173-340-7493(3).

☐ Literature surveys.

☐ Soil bioassays.

☐ Wildlife exposure model.

☐ Biomarkers.

☐ Site-specific field studies.

☐ Weight of evidence.

☐ Other methods approved by Ecology. If so, please specify:

4. What was the result of those evaluations?

☐ Confirmed there was no problem.

☐ Confirmed there was a problem and established site-specific cleanup levels.

5. Have you already obtained Ecology's approval of both your problem formulation and problem resolution steps?

☐ Yes If so, please identify the Ecology staff who approved those steps:

☐ No

Step 4: SUBMITTAL

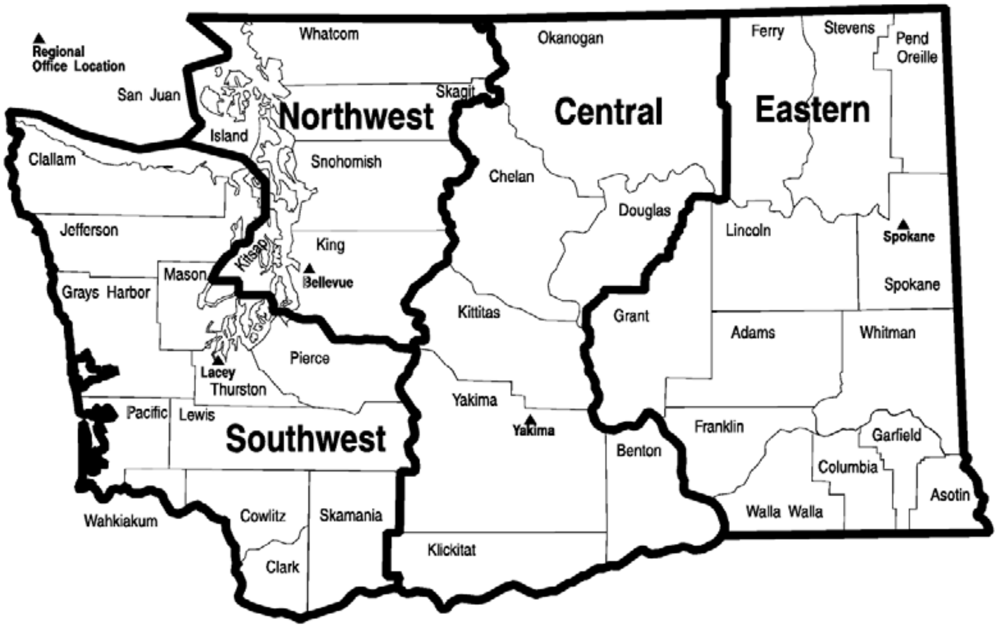
Please mail your completed form to the Ecology site manager assigned to your Site. If a site manager has not yet been assigned, please mail your completed form to the Ecology regional office for the County in which your Site is located.

Northwest Region:
Attn: VCP Coordinator
3190 160th Ave. SE
Bellevue, WA 98008-5452

Central Region:
Attn: VCP Coordinator
1250 West Alder St.
Union Gap, WA 98903-0009

Southwest Region:
Attn: VCP Coordinator
P.O. Box 47775
Olympia, WA 98504-7775

Eastern Region:
Attn: VCP Coordinator
N. 4601 Monroe
Spokane WA 99205-1295



Washington State Department of Ecology
Toxics Cleanup Program

Table 749-1

Simplified Terrestrial Ecological Evaluation-Exposure Analysis Procedure

<table>
<tr><td colspan="2">Estimate the area of contiguous (connected) undeveloped land on the site or within 500 feet of any area of the site to the nearest 1/2 acre (1/4 acre if the area is less than 0.5 acre).</td></tr>
<tr><td>1) From the table below, find the number of points corresponding to the area and enter this number in the field to the right.</td><td></td></tr>
<tr><td><table>
<tr><th>Area (acres)</th><th>Points</th></tr>
<tr><td>0.25 or less</td><td>4</td></tr>
<tr><td>0.5</td><td>5</td></tr>
<tr><td>1.0</td><td>6</td></tr>
<tr><td>1.5</td><td>7</td></tr>
<tr><td>2.0</td><td>8</td></tr>
<tr><td>2.5</td><td>9</td></tr>
<tr><td>3.0</td><td>10</td></tr>
<tr><td>3.5</td><td>11</td></tr>
<tr><td>4.0 or more</td><td>12</td></tr>
</table></td><td></td></tr>
<tr><td>2) Is this an industrial or commercial property? If yes, enter a score of 3. If no, enter a score of 1</td><td>3</td></tr>
<tr><td>3)[a] Enter a score in the box to the right for the habitat quality of the site, using the following rating system[b]. High=1, Intermediate=2, Low=3</td><td>3</td></tr>
<tr><td>4) Is the undeveloped land likely to attract wildlife? If yes, enter a score of 1 in the box to the right. If no, enter a score of 2.[c]</td><td>2</td></tr>
<tr><td>5) Are there any of the following soil contaminants present: Chlorinated dioxins/furans, PCB mixtures, DDT, DDE, DDD, aldrin, chlordane, dieldrin, endosulfan, endrin, heptachlor, benzene hexachloride, toxaphene, hexachlorobenzene, pentachlorophenol, pentachlorobenzene? If yes, enter a score of 1 in the box to the right. If no, enter a score of 4.</td><td>4</td></tr>
<tr><td>6) Add the numbers in the boxes on lines 2-5 and enter this number in the box to the right. If this number is larger than the number in the box on line 1, the simplified evaluation may be ended.</td><td>12</td></tr>
</table>

Notes for Table 749-1

[a] It is expected that this habitat evaluation will be undertaken by an experienced field biologist. If this is not the case, enter a conservative score of (1) for questions 3 and 4.

[b] **Habitat rating system.** Rate the quality of the habitat as high, intermediate or low based on your professional judgment as a field biologist. The following are suggested factors to consider in making this evaluation:

> **Low:** Early successional vegetative stands; vegetation predominantly noxious, nonnative, exotic plant species or weeds. Areas severely disturbed by human activity, including intensively cultivated croplands. Areas isolated from other habitat used by wildlife.

High: Area is ecologically significant for one or more of the following reasons: Late-successional native plant communities present; relatively high species diversity; used by an uncommon or rare species; priority habitat (as defined by the Washington Department of fish and Wildlife); part of a larger area of habitat where size or fragmentation may be important for the retention of some species.

Intermediate: Area does not rate as either high or low.

[c] Indicate "yes" if the area attracts wildlife or is likely to do so. Examples: Birds frequently visit the area to feed; evidence of high use b mammals (tracks, scat, etc.); habitat "island" in an industrial area; unusual features of an area that make it important for feeding animals; heavy use during seasonal migrations.

[Area Calculation Aid] [Aerial Photo with Area Designations] [TEE Table 749-1] [Index of Tables]

[Exclusions Main] [TEE Definitions] [Simplified or Site-Specific?] [Simplified Ecological Evaluation] [Site-Specific Ecological Evaluation] [WAC 173-340-7493]

[TEE Home]

Tiger Oil North 1st

500 foot radius around the site

Have we delivered World Class Client Service?

Please let us know by visiting **www.geoengineers.com/feedback**.

GEOENGINEERS