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

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CONTENTS

CONTENTS--Continued

ILLUSTRATIONS

ILLUSTRATIONS--Continued

PLATES

[Plate in pocket at end of report]

TABLES

TABLES--Continued

Page

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)

<u>Sea Level</u>: 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.

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

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Preliminary, Subject to Revisions, 04/10/91

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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).

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 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
M4-85	Feb 20, 1985	8.95
	21	8.95
	May 11	7.91
	Jun 09	5.83
	Aug 02	6.12
	29	6.31
	30	6.07
	Sep 21	6.04
	Oct 16	7.10
	Nov 15	8.09
	Dec 13	8.90
	Jan 24, 1986	8.69
	Feb 21	8.58
	Mar 20	8.15
	Apr 23	6.96
	May 14	6.07
	Jun 23	5.40
	Jul 28	5.07
	Sep 22	4.94
	Nov 20	8.55
	Dec 17	8.98
	Jan 21, 1987	9.26
	Feb 17	9.04
	Mar 16	8.92
	Apr 23	8.27
M7-85	Feb 20, 1985	7.40
	21	7.43
	May 11	7.13
	Jun 09	6.09
	Aug 02	6.72
	29	6.79
	30	5.63
	Sep 21	6.09
	Oct 16	6.40
	Nov 15	7.42
	Dec 13	7.66
	Jan 24, 1986	7.14
	Feb 21	7.07
	Mar 20	6.89
	Apr 23	6.83
	May 14	6.13
	Jun 23	6.40
	Jul 28	6.63
	Sep 22	5.84
	Nov 20	7.40
	Dec 17	7.78
	Jan 22, 1987	7.93
	Feb 18	7.75
	Mar 16	7.62
	Apr 23	7.65
	Mar 14, 1989	8.05

Well identifier	Date	Water level
M5-85	Feb 20, 1985	5.39
	21	5.38
	May 10	5.17
	Jun 09	4.69
	Aug 02	5.04
	29	5.13
	30	4.91
	Sep 21	4.89
	Oct 16	4.67
	Nov 15	5.23
	Dec 13	5.39
	Jan 21, 1986	5.05
	Feb 21	4.90
	Mar 20, 1986	4.85
	Apr 23	5.02
	May 14	4.79
	Jun 23	5.02
	Jul 28	5.10
	Sep 22	4.56
	Nov 20	5.30
	Dec 18	5.49
	Jan 22, 1987	5.56
	Feb 18	5.48
	Mar 16	5.32
	Apr 23	5.46
	Mar 13, 1989	5.64
M8-85	Feb 20, 1985	9.47
	21	9.49
	May 11	8.92
	Jun 09	7.92
	Aug 02	8.43
	29	8.50
	30	7.33
	Sep 21	7.93
	Oct 16	8.38
	Nov 15	8.99
	Dec 13	9.29
	Jan 24, 1986	9.17
	Feb 21	9.07
	Mar 20, 1986	8.73
	Apr 23	8.56
	May 14	8.08
	Jun 23	8.04
	Jul 28	8.04
	Sep 22	7.45
	Nov 20	9.07
	Dec 17	9.31
	Jan 22, 1987	9.48
	Feb 18	9.42
	Mar 16	9.22
	Apr 23	9.18
	Mar 14, 1989	9.59

Well identifer	Date	Water level
M6-85	Feb 20, 1985	7.55
	21	7.55
	May 10	7.25
	Jun 09	6.61
	Aug 02	7.14
	29	7.48
	30	6.89
	Sep 21	6.88
	Oct 16	6.66
	Nov 15	7.88
	Dec 13	8.01
	Jan 24, 1986	7.64
	Feb 21	7.36
	Mar 20	7.25
	Apr 23	7.14
	May 14	6.70
	Jun 23	7.16
	Jul 28	7.34
	Sep 22	6.37
	Nov 20	7.72
	Dec 17	8.11
	Jan 22, 1987	8.31
	Feb 18	8.03
	Mar 16	7.87
	Apr 23	7.93
	Mar 13, 1989	8.52
M9-85	Feb 20, 1985	9.81
	21	9.81
	May 11	9.07
	Jun 09	7.88
	Aug 02	8.22
	29	8.32
	30	8.11
	Sep 21	8.02
	Oct 16	8.43
	Nov 15	9.19
	Dec 13	9.50
	Jan 24, 1986	9.65
	Feb 21	9.52
	Mar 20	9.18
	Apr 23	8.63
	May 14	7.96
	Jun 23	7.75
	Jul 28	7.65
	Sep 22	7.20
	Nov 20	9.53
	Dec 17	9.92
	Jan 20, 1987	10.12
	Feb 17	9.98
	Mar 16	9.86
	Apr 22	9.58
	Mar 15, 1989	10.37

PRELIMINARY SUBJECT TO REVISIONS

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

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

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 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

PRELIMINARY SUBJECT TO REVISIONS

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

PRELIMINARY SUBJECT TO REVISIONS

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 dentifier	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	.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

[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

PRELIMINARY SUBJECT TO REVISIONS

Table 5.--*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
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

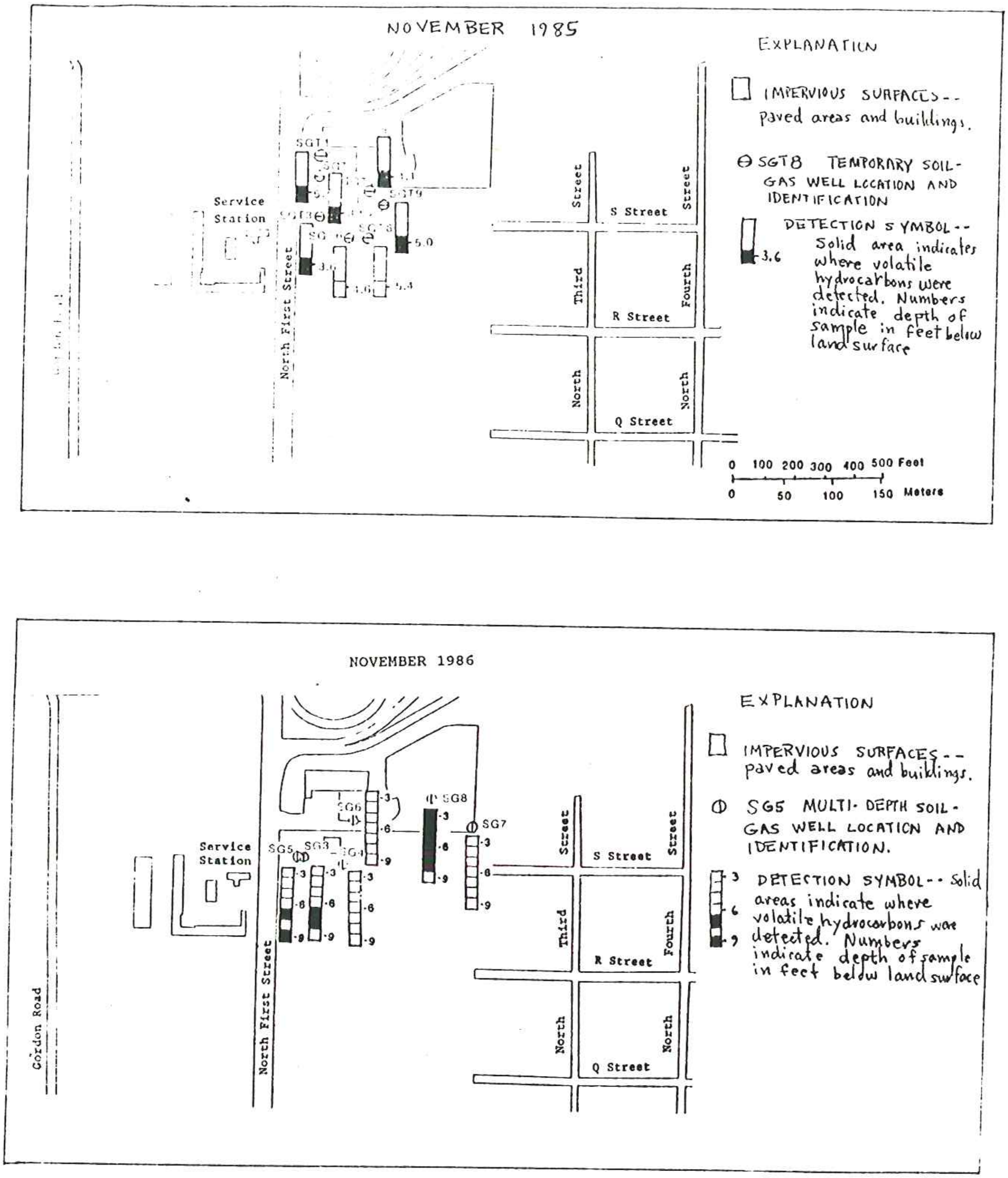


Figure 16.-- Locations of temporary soil-gas samples collected November 1985 and multi-depth soil-gas samples collected November 1986 [Data from the ground-water toxics study].

RELIMINARY SUBJECT TO REVISIONS

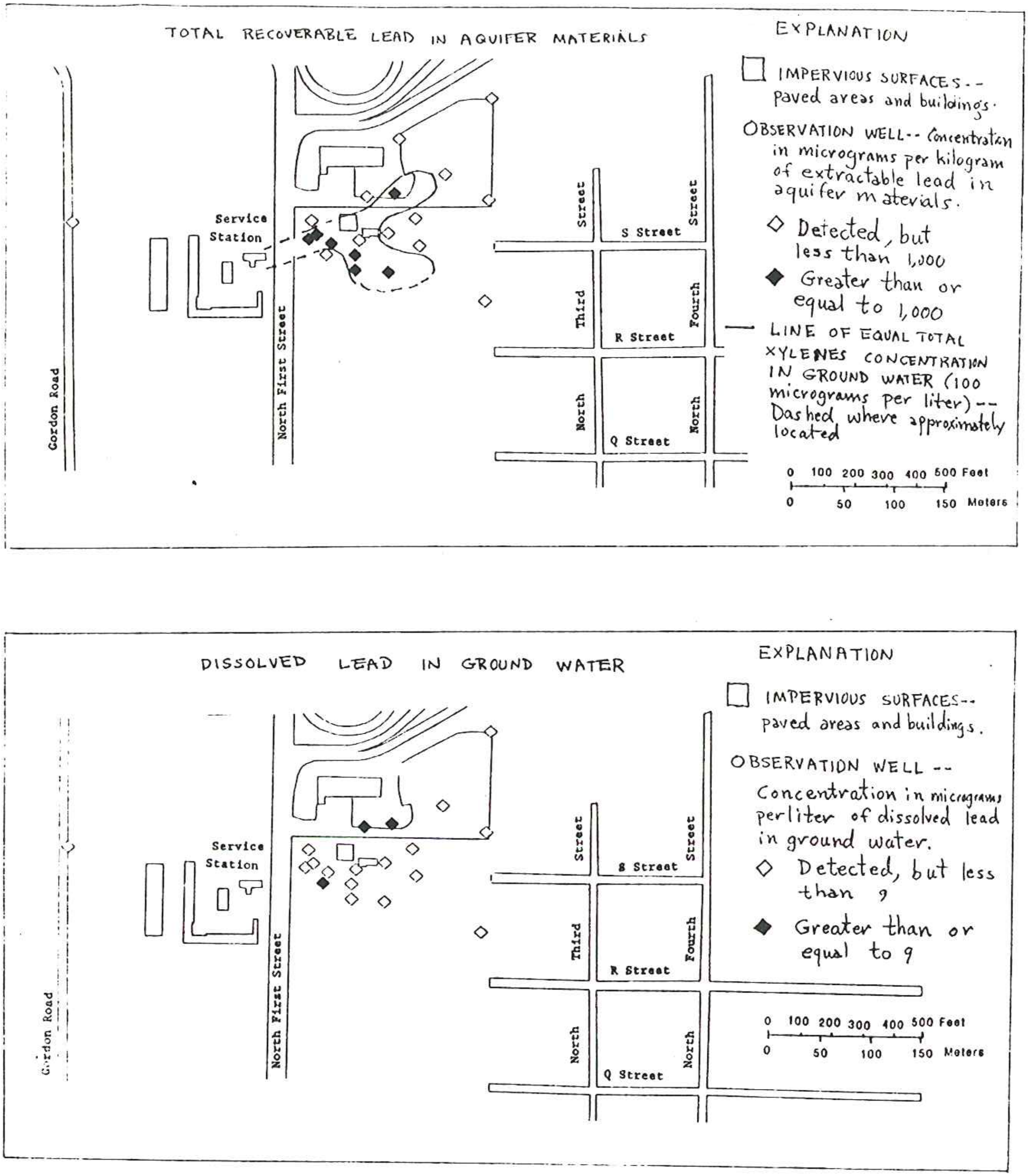


Figure 15.-- Concentrations of total-recoverable lead in aquifer material and dissolved lead in ground water, November 1986 [data from the ground-water toxics study].

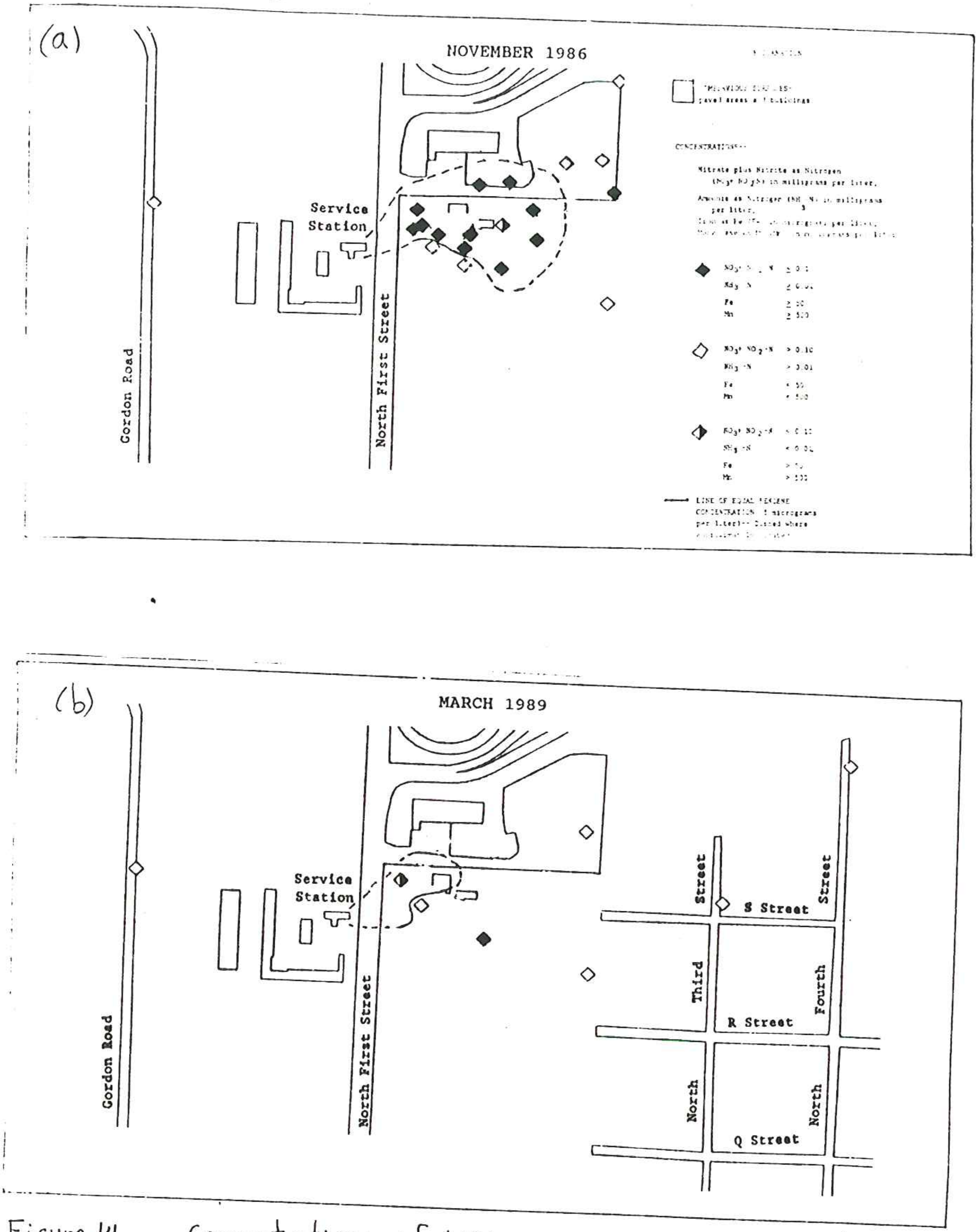
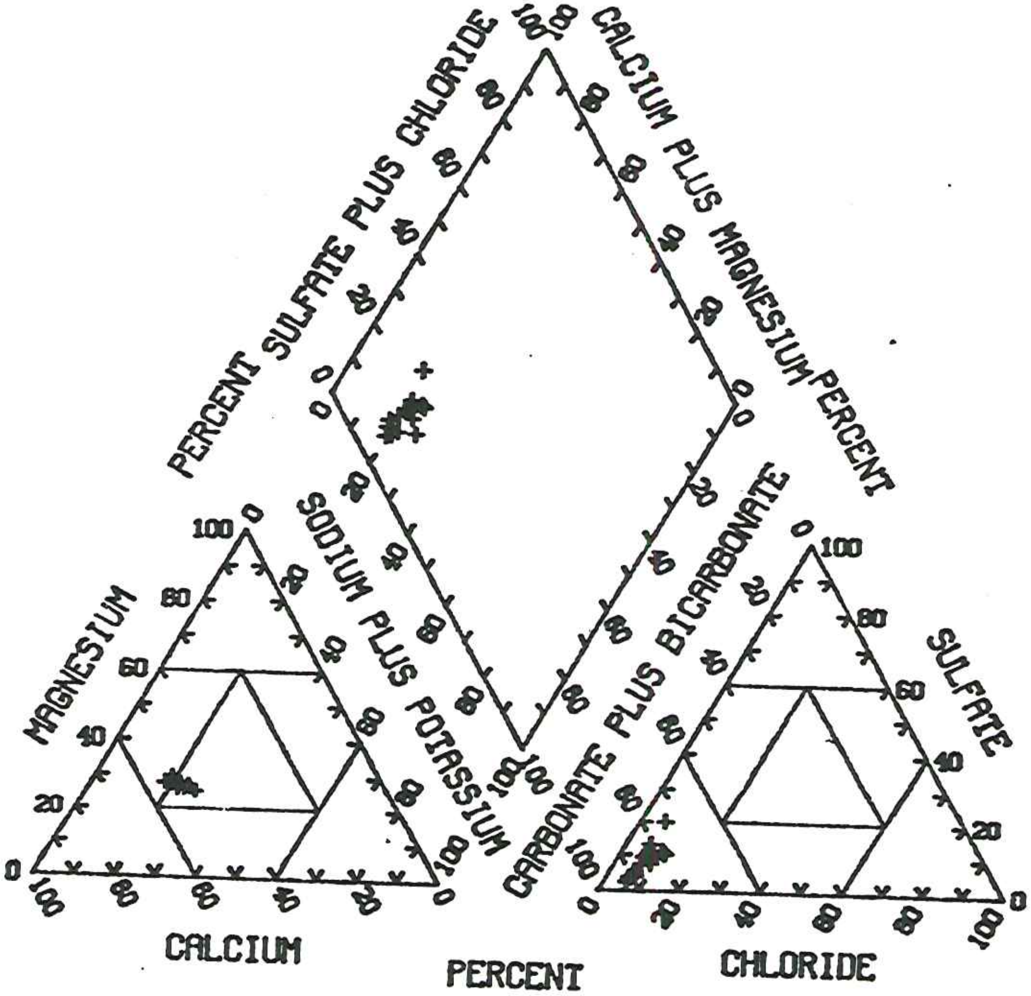


Figure 14.-- Concentrations of iron, manganese, ammonia and nitrate plus nitrite in ground water, November 1986 through March 1989 [data from (a) the ground-water toxics study and (b) 1989 study].

PRELIMINARY SUBJECT TO REVISIONS



PRELIMINARY SUBJECT TO REVISIONS

Figure 13.-- Percentage of major ions in ground water, November, 1986 and March 198[illegible] [data from the ground-water toxics study and 1989 study].

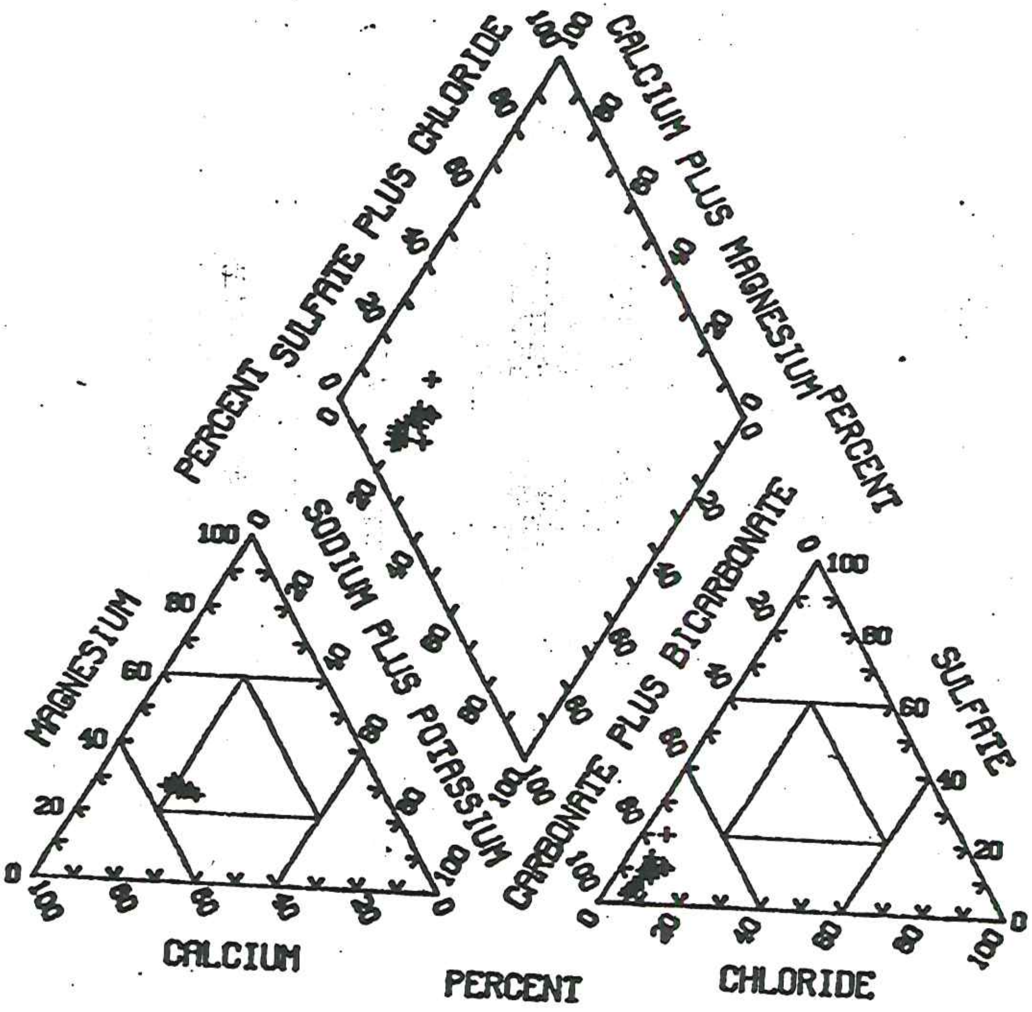


Figure 13. -- Percentage of major ions in ground water, November, 1986 and March 1989 data from the ground-water toxics study d

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

mpc

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

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
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	

PRELIMINARY SUBJECT TO REVISIONS

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	

PRELIMINARY SUBJECT TO REVISIONS

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]

Well identifier	Date	Specific conductance in µs/cm		pH in standard units		Alkalinity in mg/L as $CaCO_3$	
		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	Ethylbenzene	m+p Xylene	o-Xylene	n-Propylbenzene	1,3,5-Trimethylbenzene
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-Trimethylbenzene	Isobutylbenzene	sec-Butylbenzene	n-Butylbenzene	1,2,3,5-Tetramethylbenzene	1,2,3,4-Tetramethylbenzene	Naphthalene
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 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

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	--	--	--	--	--	--	--	--	--

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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

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

Well identifier	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	--	--	--	--

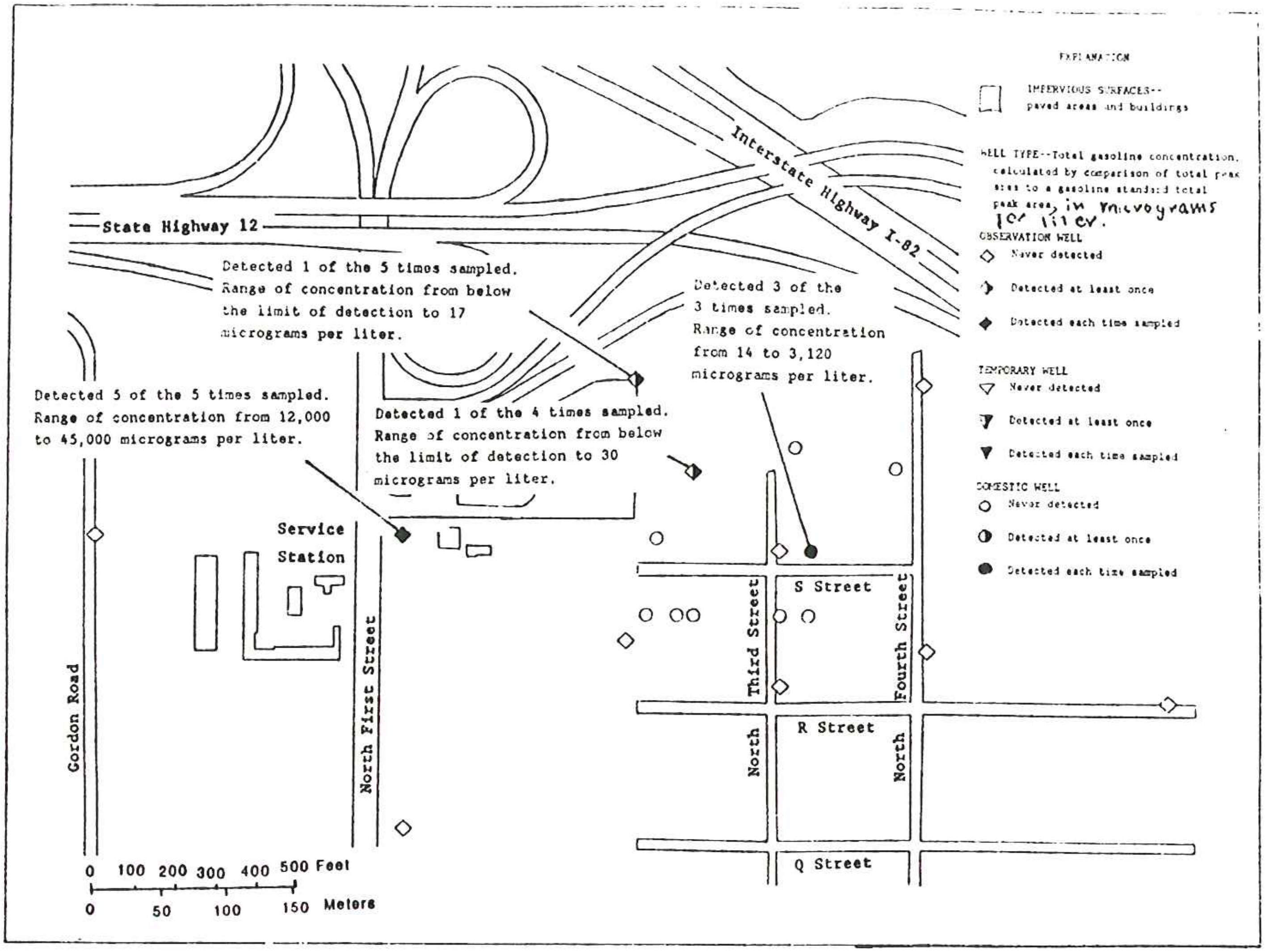
Table 7.--*Concentrations of volatile organic compounds in ground water, August 1985 through November 1986--Continued*

Well identifier	n-Propylbenzene	Isobutylbenzene	sec-Butylbenzene	n-Butylbenzene	Ethylene bromide	t-Butylbenzene	1-Isopropyl-4-methylbenzene	2-Ethyl 1-methylbenzene	1,4-Dimethyl-ethylbenzene	1,4-Dimethyl-2-ethylbenzene	1,3-Dimethyl,4-ethylbenzene
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



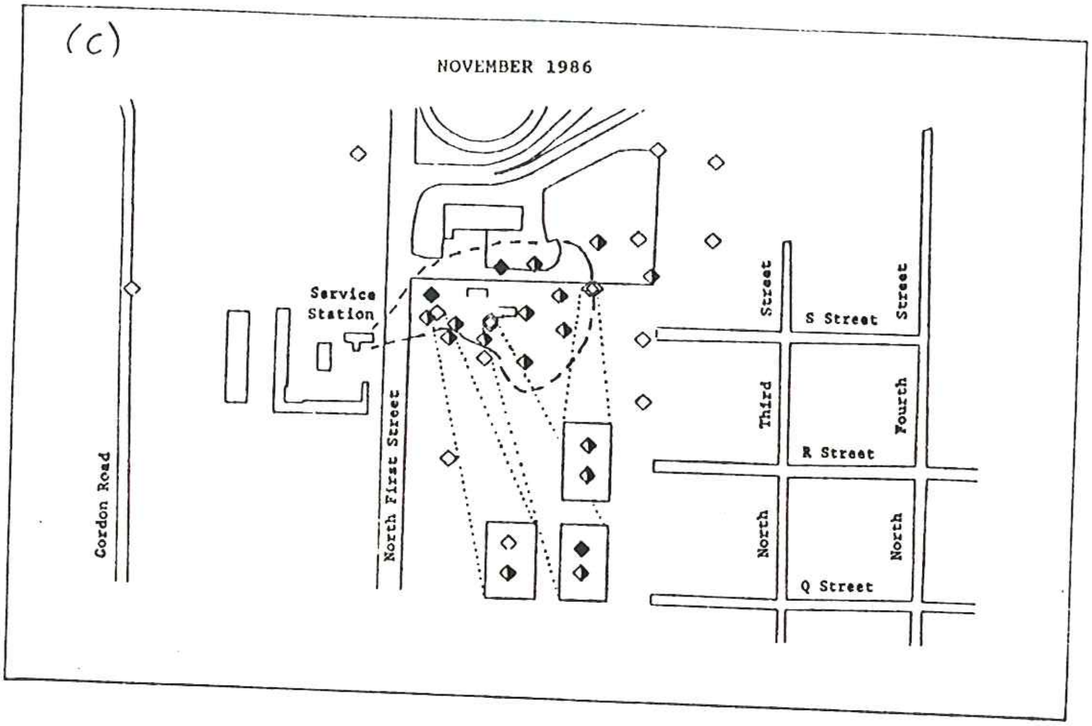
Detected 1 of the 5 times sampled. Range of concentration from below the limit of detection to 17 micrograms per liter.

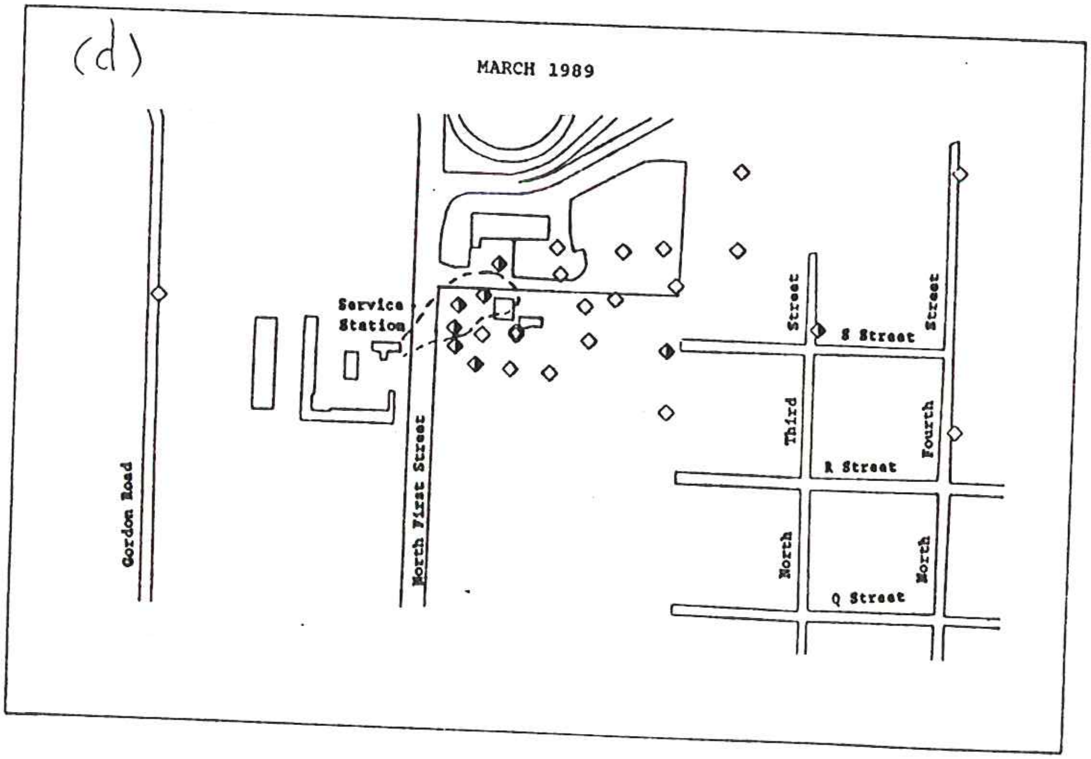
Detected 3 of the 3 times sampled. Range of concentration from 14 to 3,120 micrograms per liter.

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].





PRELIMINARY SUBJECT TO REVISIONS

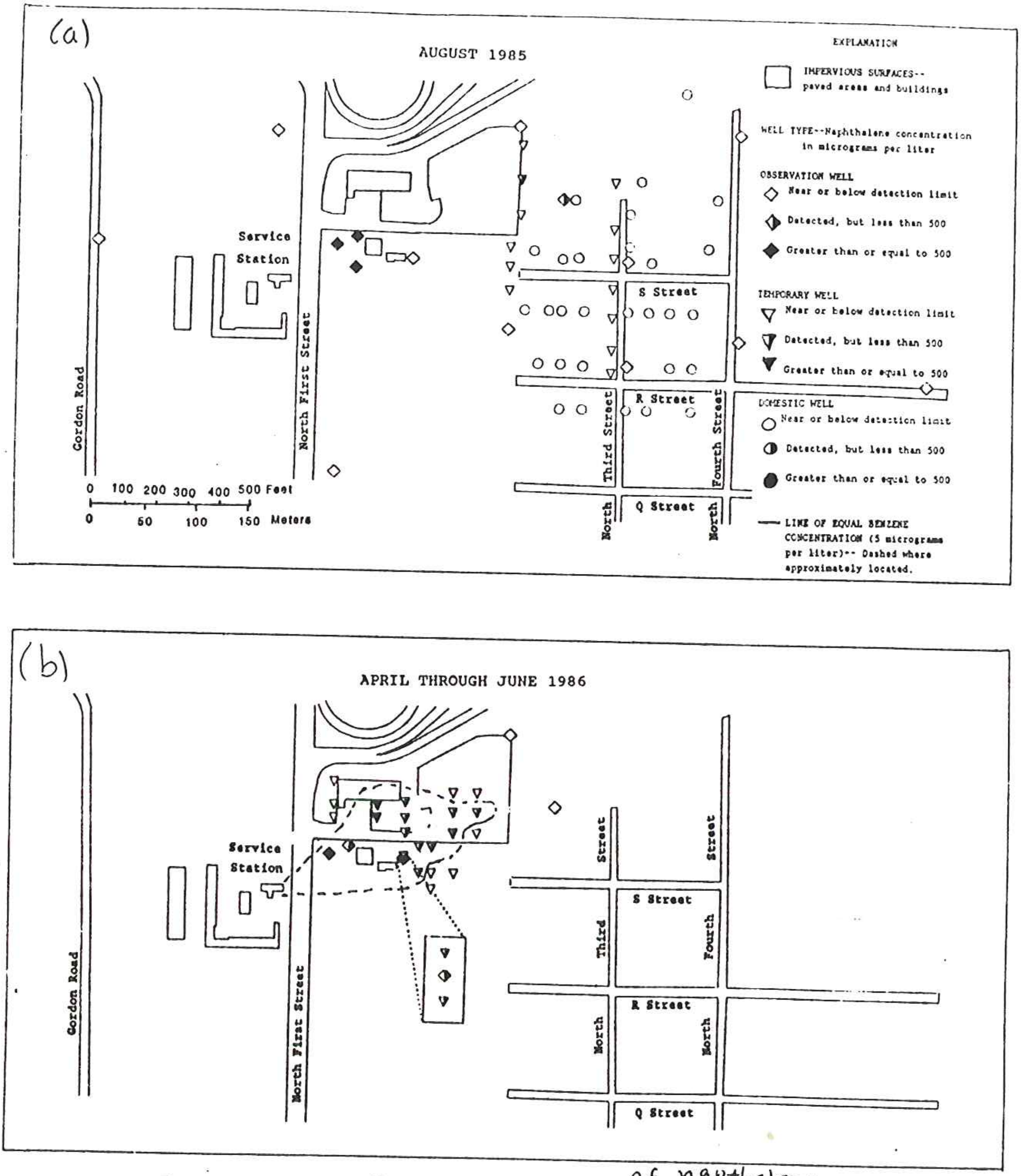
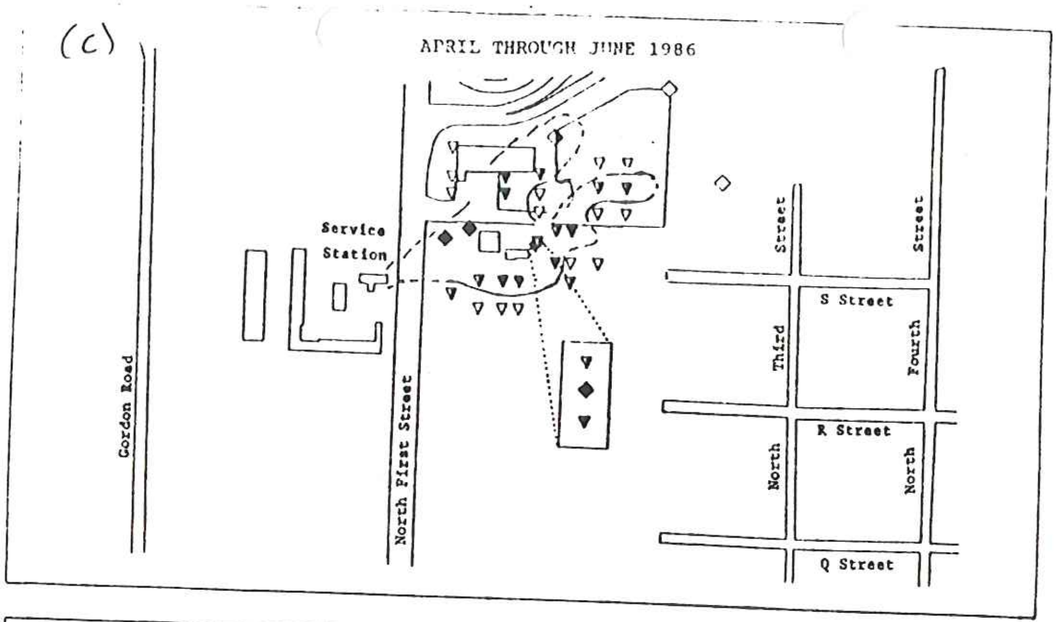
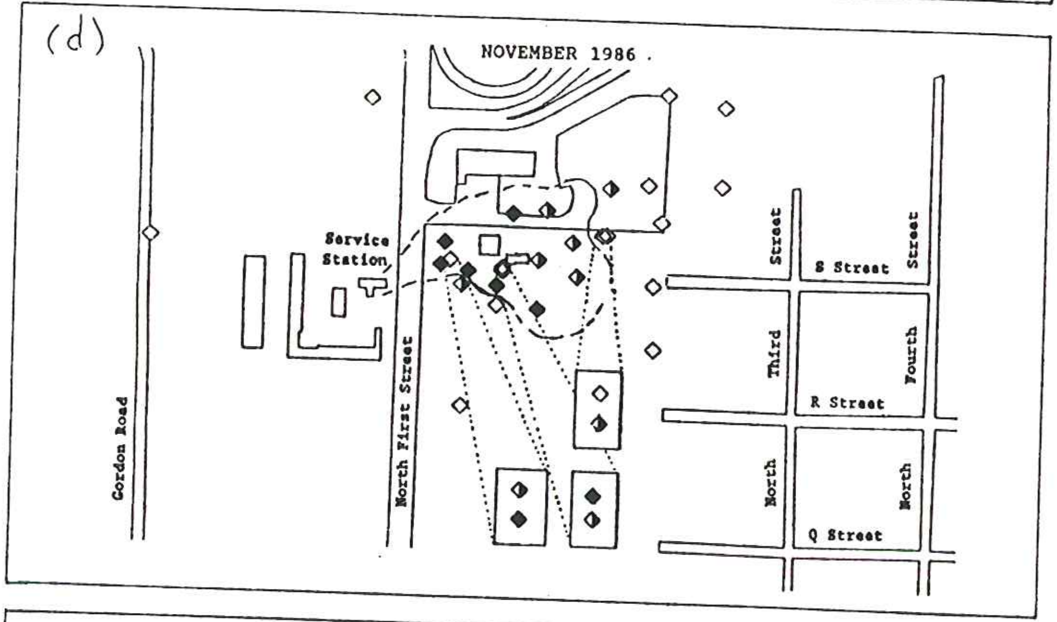
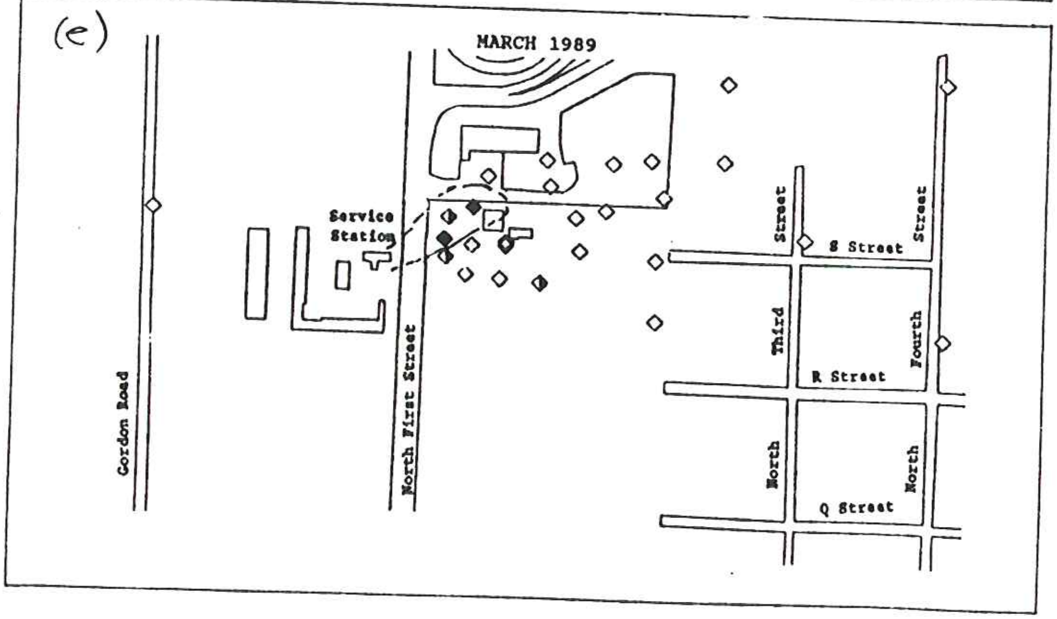


Figure 11.-- ~~Naphthalene~~ Concentrations of napthalene in ground water, August 1985 through March 1989 [data from (a) - (c) the ground-water toxics study, and (d) the 1989 study].

PRELIMINARY SUBJECT TO REVISIONS







PRELIMINARY SUBJECT TO REVISIONS

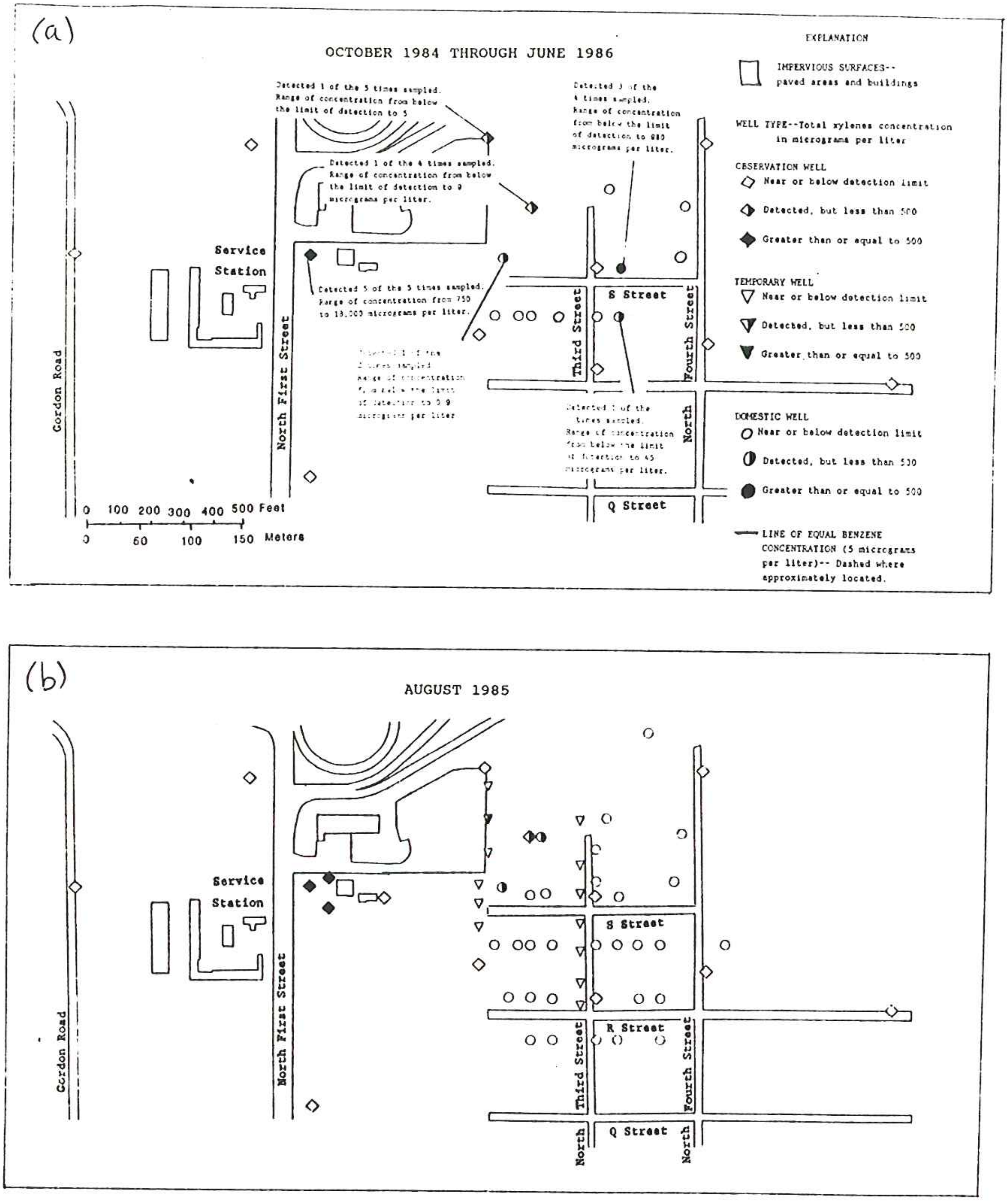
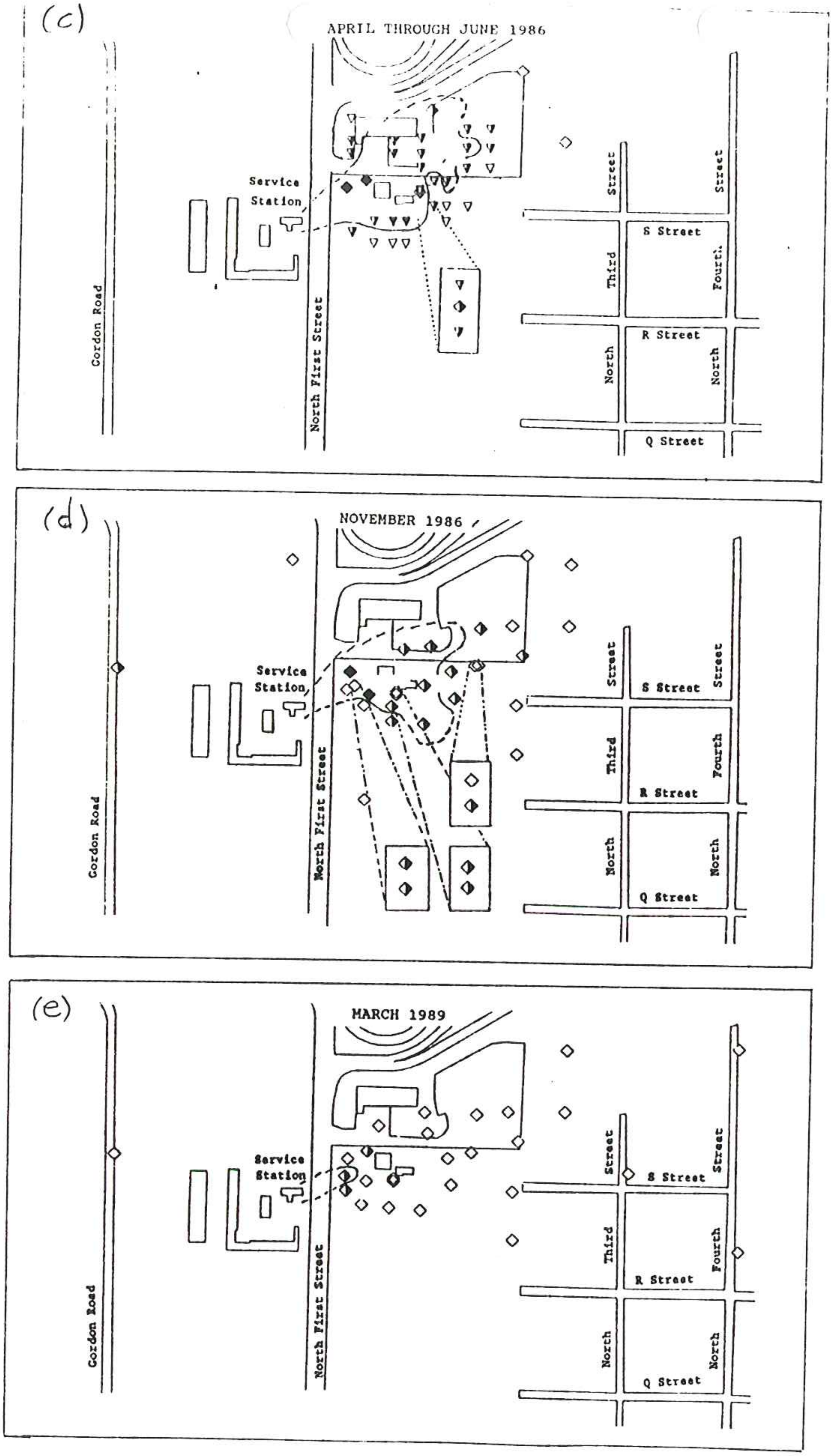


Figure 10.--Concentrations of total xylenes in ground water, October 1984 through March 1989 [data from (a) the insurance company study, (b)-(d) the ground-water toxics study, and (e) the 1989 study].

PRELIMINARY SUBJECT TO REVISIONS



PRELIMINARY SUBJECT TO REVISIONS

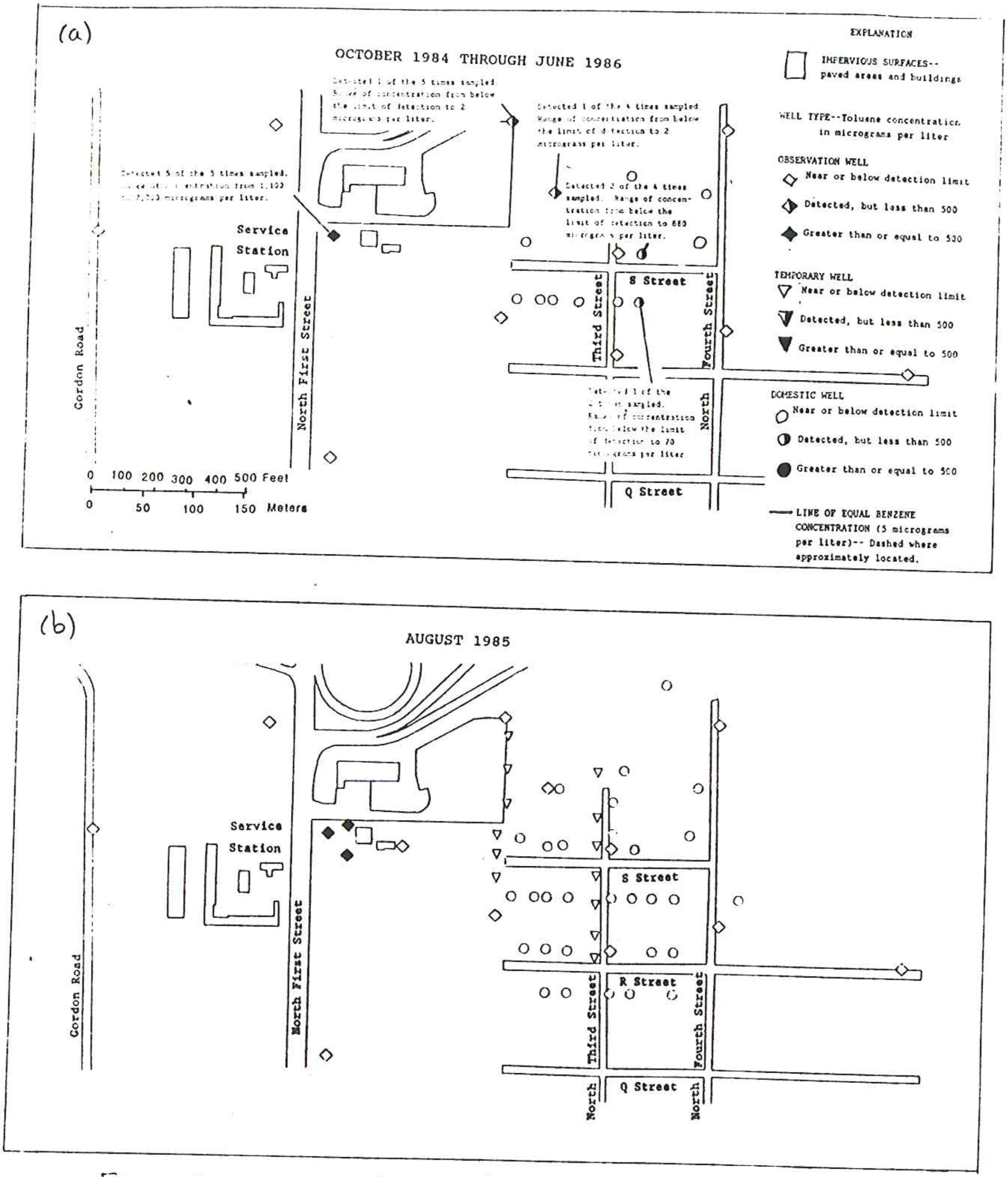
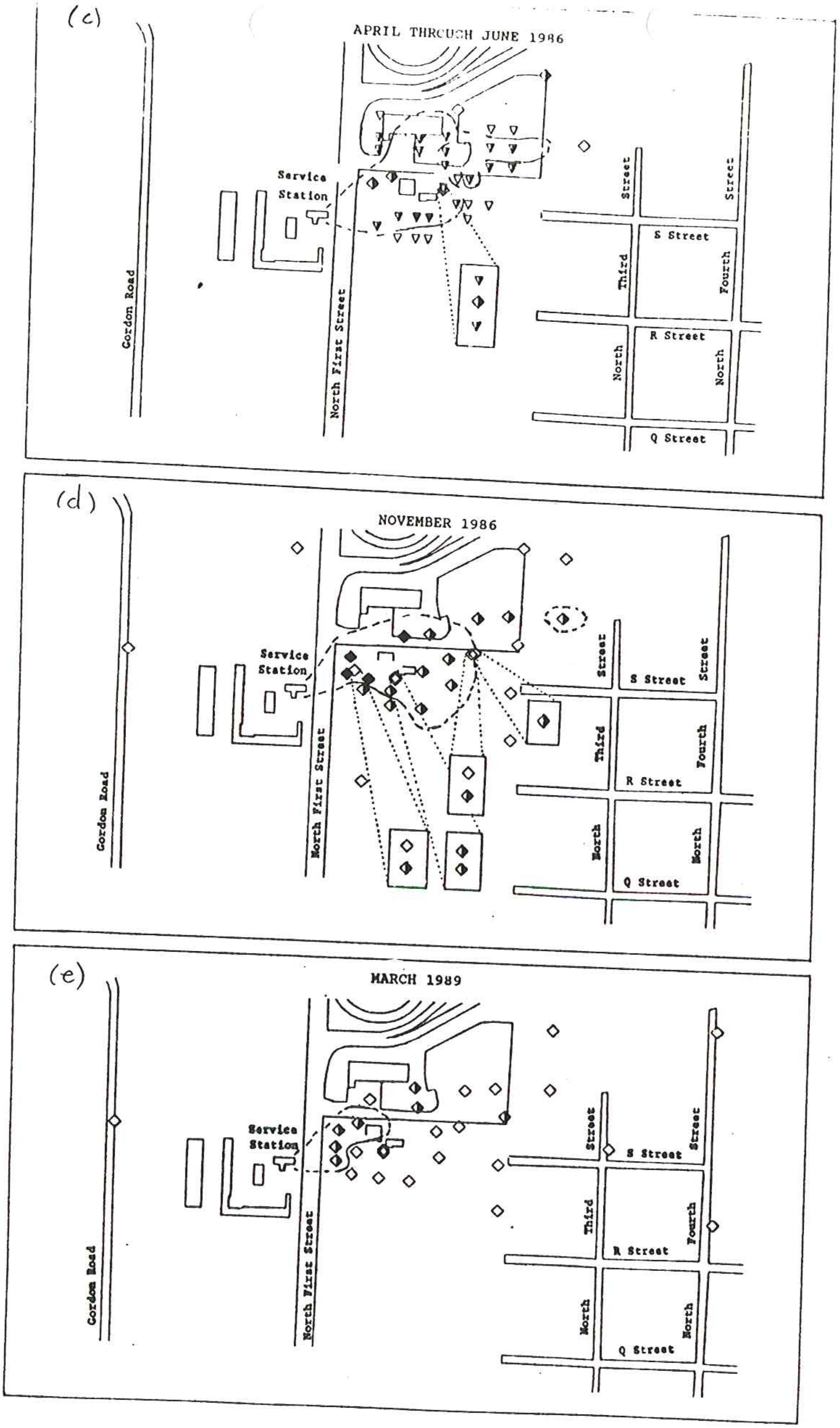
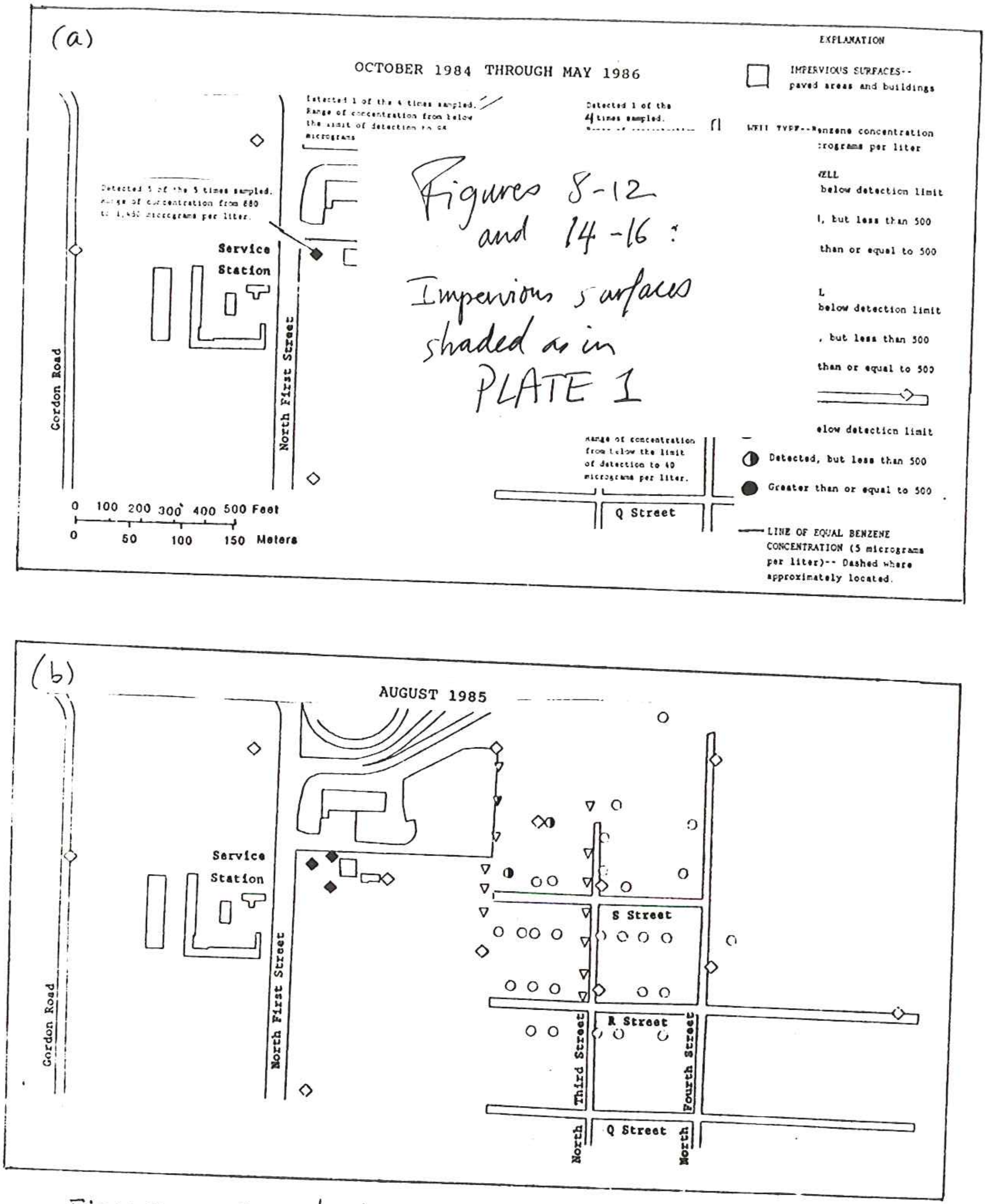


Figure 9.-- Concentrations of toluene in ground water, October 1984 through March 1989 [data from (a) the insurance company study, (b)-(d) ground-water toxics study, and (e) the 1989 study].

PRELIMINARY SUBJECT TO REVISIONS


(c)
APRIL THROUGH JUNE 1986
Service Station
Gordon Road
North First Street
Third Street
North Third
Fourth Street
North Fourth
S Street
R Street
Q Street
(d)
NOVEMBER 1986
Service Station
Gordon Road
North First Street
North Third Street
North Fourth Street
S Street
R Street
Q Street
(e)
MARCH 1989
Service Station
Gordon Road
North First Street
North Third Street
North Fourth Street
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].

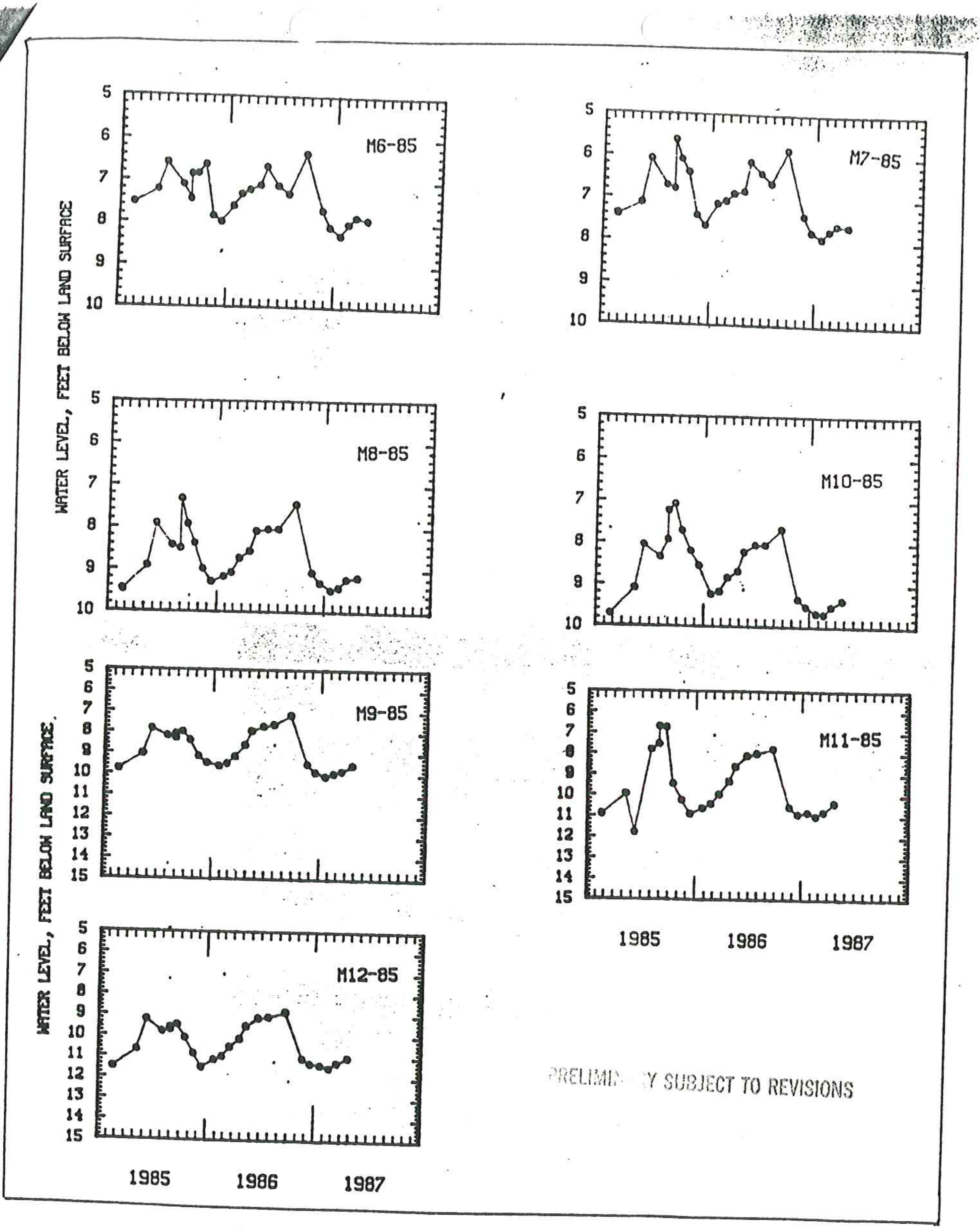
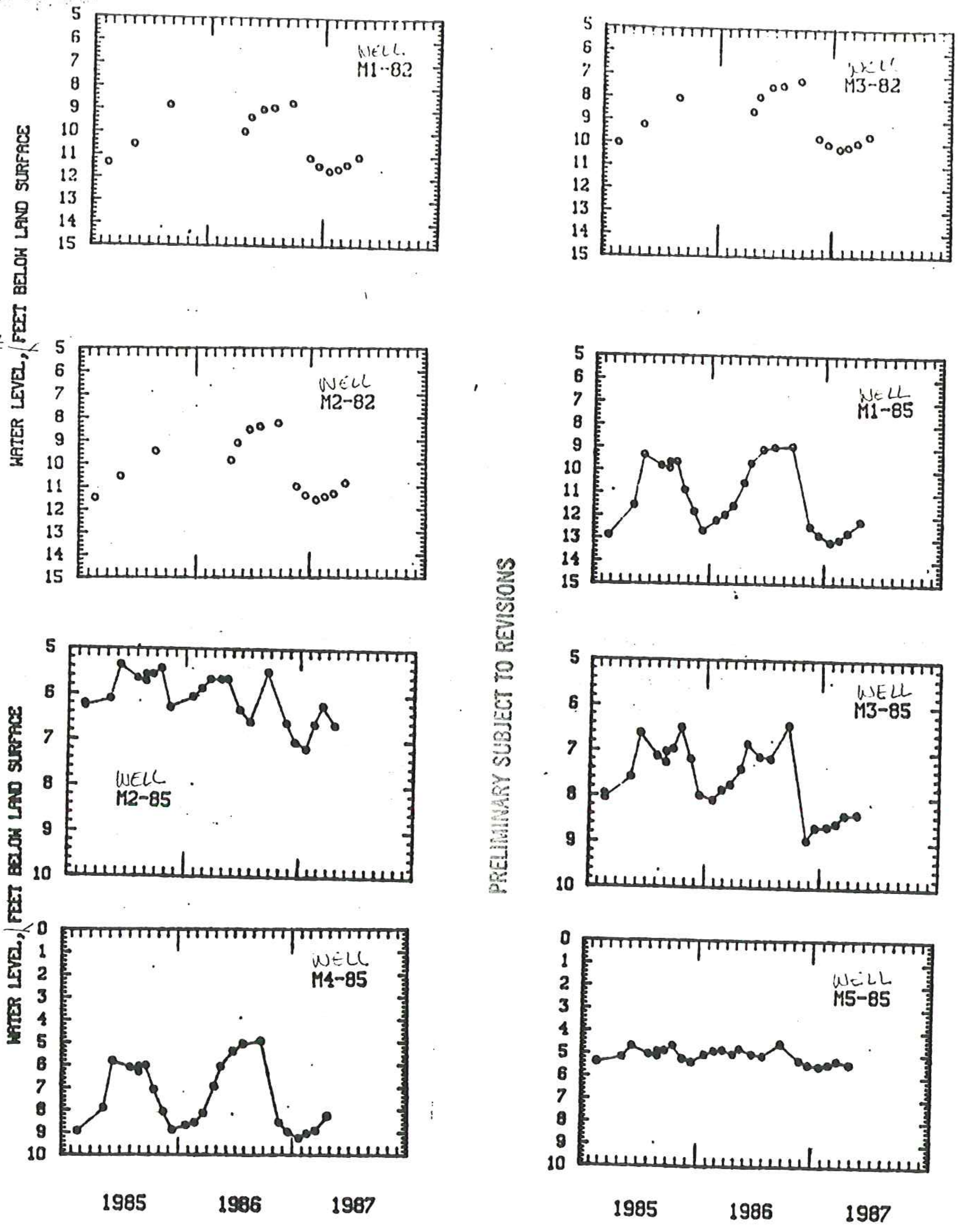


Figure 7. — Continued

see 1st page



PRELIMINARY SUBJECT TO REVISIONS

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.)

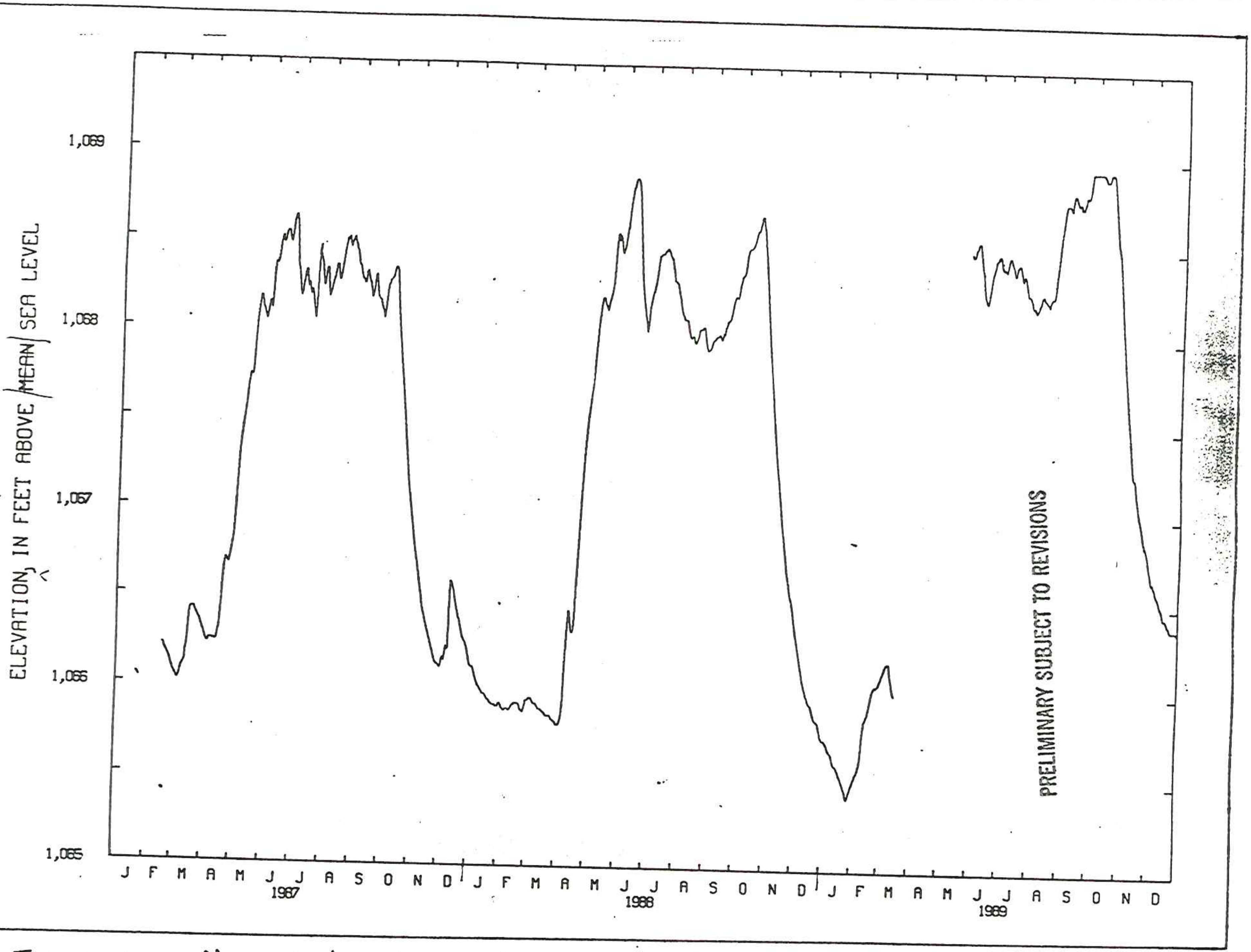
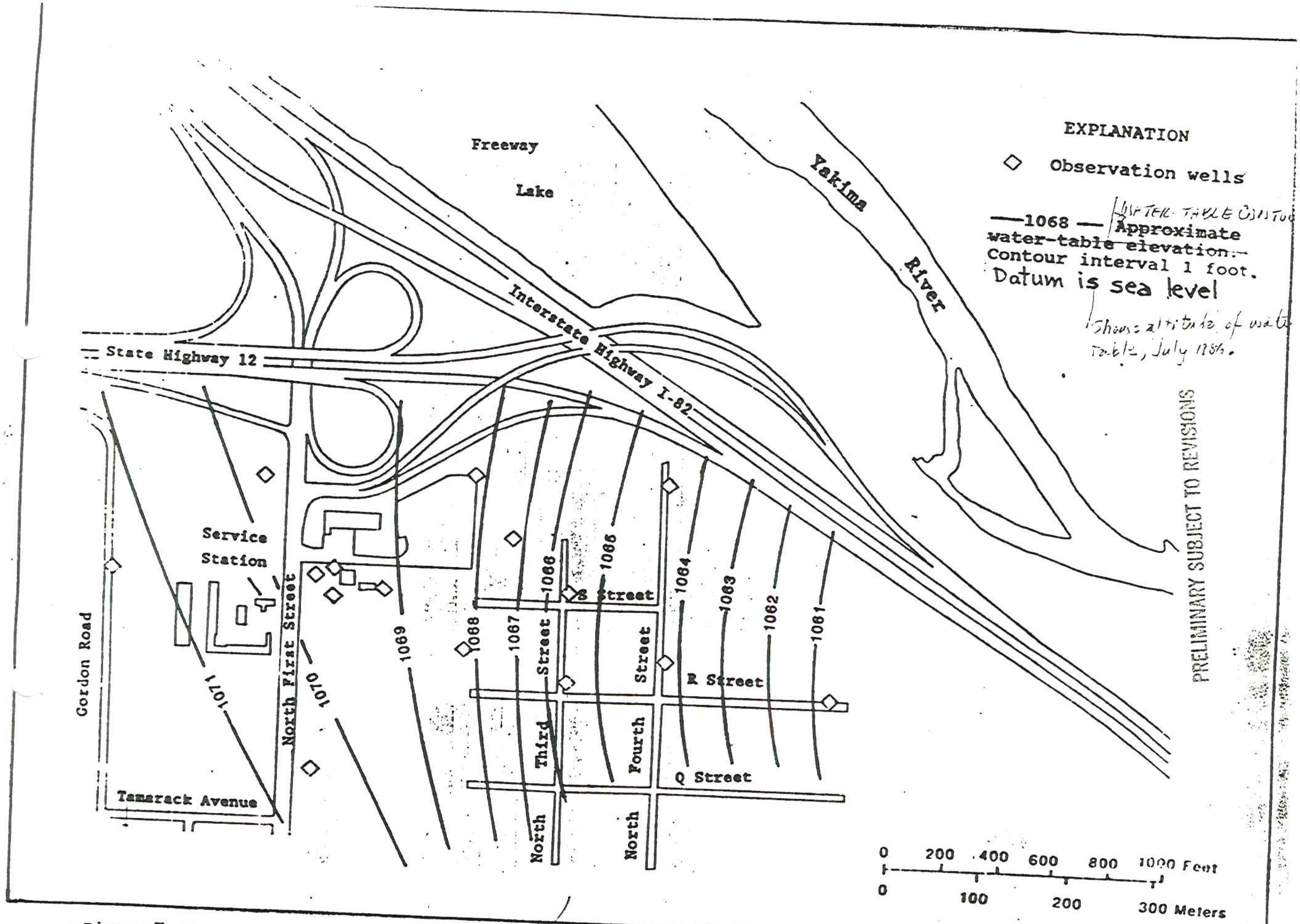
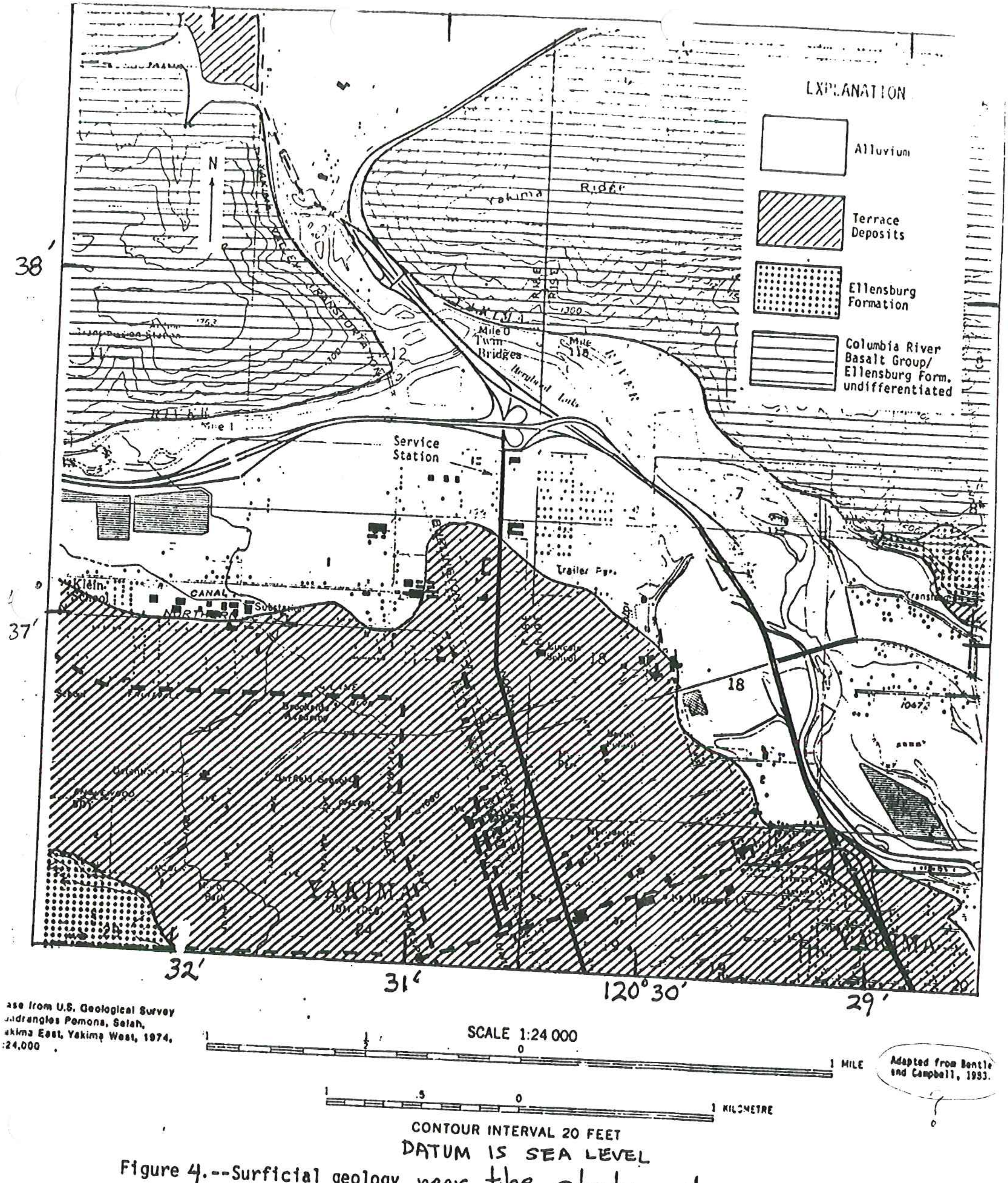


Figure 6.-- Mean daily observed water levels in well M14, 1987 through 1989. Land surface elevation is 1076.14 feet above sea level.



PRELIMINARY SUBJECT TO REVISIONS

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 Bentle
and Campbell, 1983.

CONTOUR INTERVAL 20 FEET
DATUM IS SEA LEVEL

Figure 4.--Surficial geology near the study site

PRELIMINARY SUBJECT TO REVISIONS

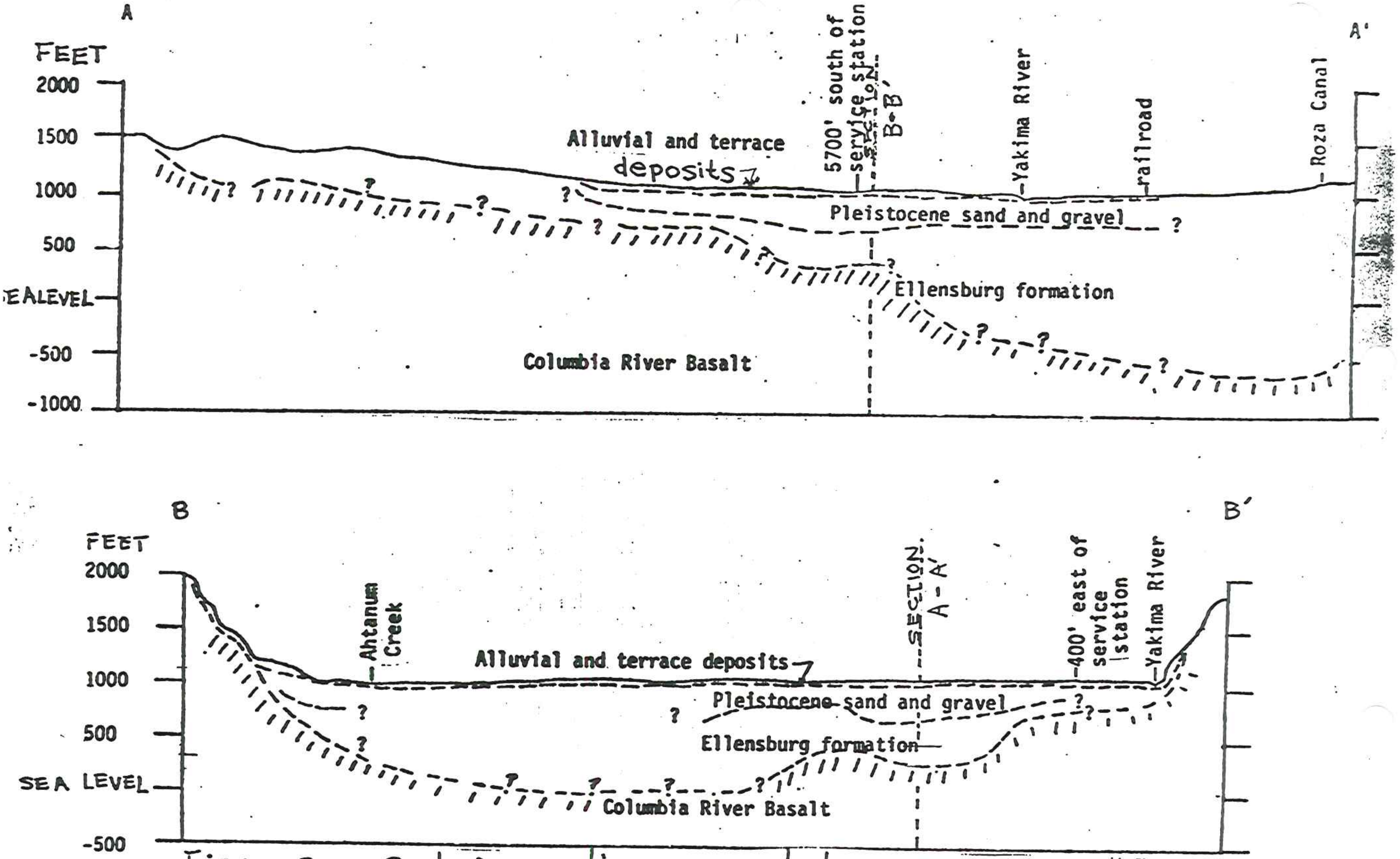
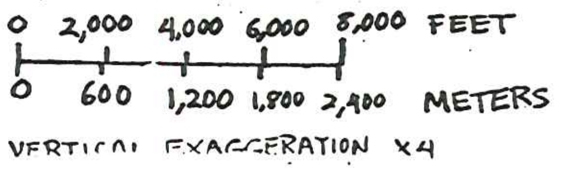


Figure 3.-- Geologic sections near study site. See figure 2 for locations of sections. Geology based on well logs. Pleistocene sand and gravel shown on section only.



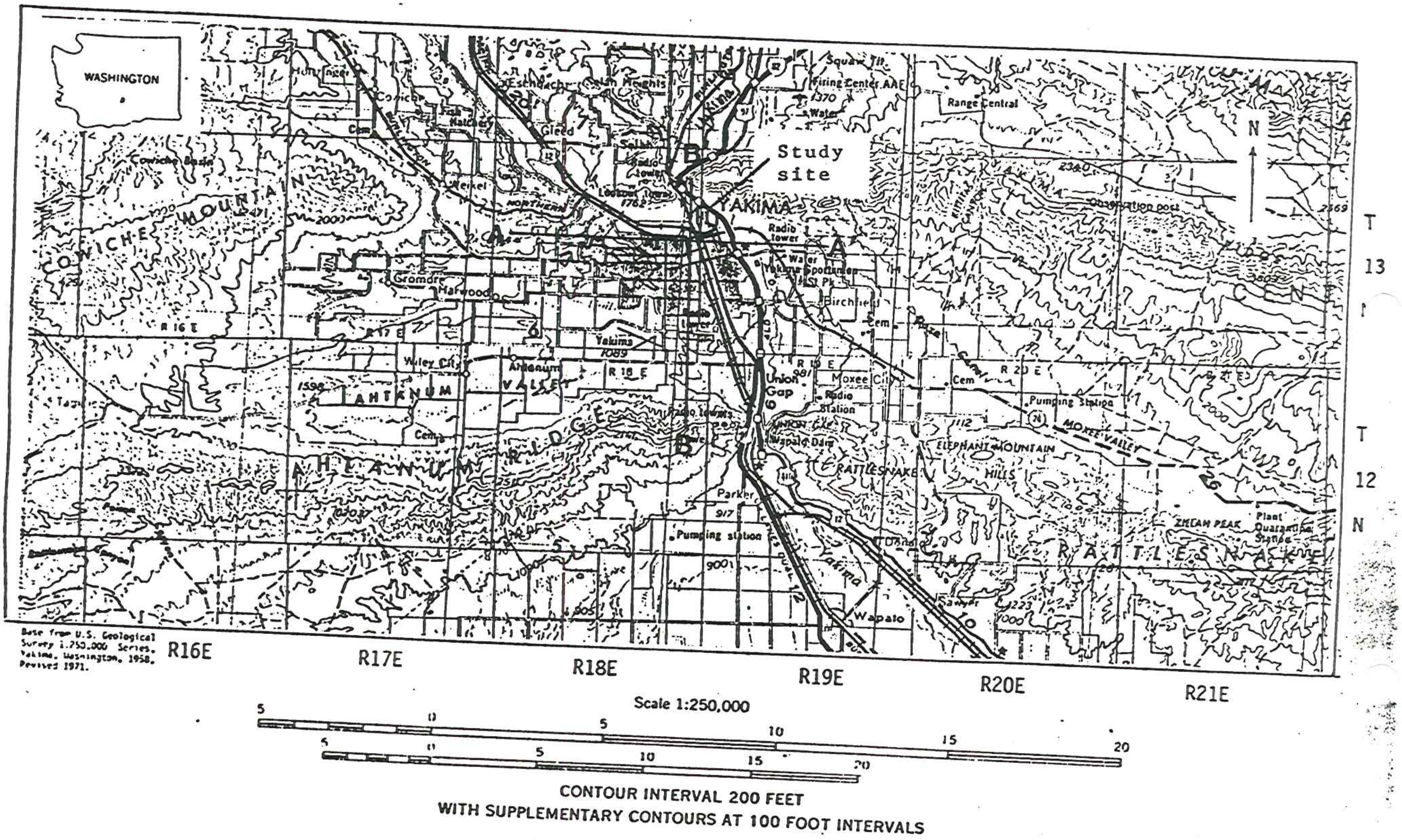
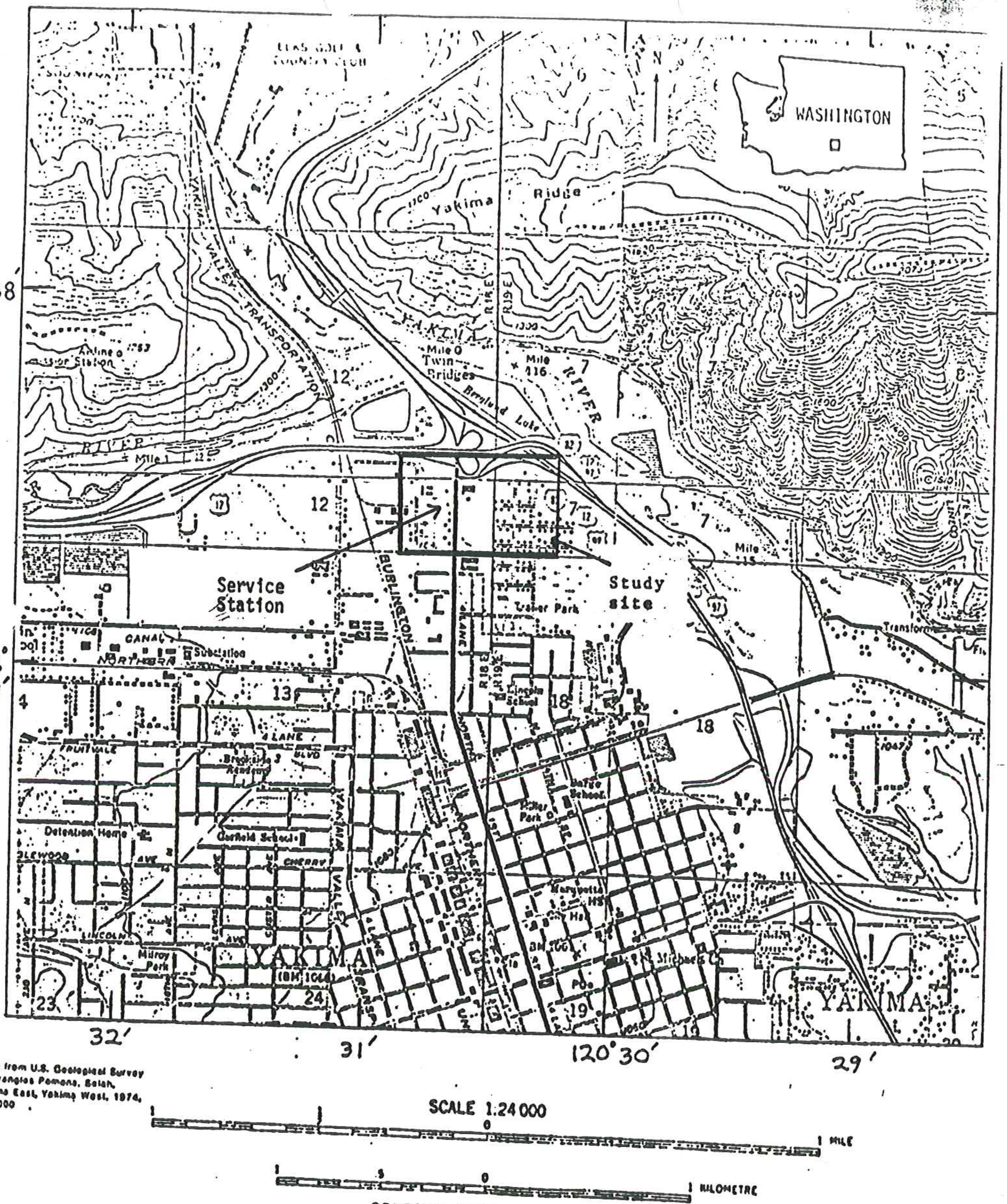


Figure 2.--Subbasin formed by the Ahtanum and Moxee Valleys, Washington. Cross-sections A-A' and B-B' shown on figure 3.

PRELIMINARY SUBJECT TO REVISIONS



Base from U.S. Geological Survey quadrangles Pomona, Selah, Yakima East, Yakima West, 1974, 1:24,000

CONTOUR INTERVAL 20 FEET
DATUM IS SEA LEVEL

PRELIMINARY SUBJECT TO REVISIONS

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 Gather

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 Lane, 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) JBG 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) granites & quartzofeldspathic metamorphic Rxs/ lithic materia were generally distributed in the ranges given below

Color

[Basalt → 60 - 80%
Andesite
Andesite breccia 5-15% (Distinctive dark green clasts)
Sandstone (volcanic?) 2-5%
Claystone (slate) 2-5%
[Granite 3-10%
Quartzo-feldspathic (MRFS).

Mafic to intermediate

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					
This report	WATSTORE	Other reports	Land surface elevation	Depth	Comments
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			

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	

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

CROMWELL AVENUE soil exploration company ST PAUL MN 55114

SE-V-10(84-8)-3

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 @ 8:00

METHOD 6DC 0-19'

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 4-05

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

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	SAND W/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-18(84-B)-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 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

JOB NO 120-12955 VERTICAL SCALE 1" = 3' BORING NO 7-03

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

662 CROMWELL AVENUE soil exploration company ST PAUL MN 55114

SE-V-10(84-B)-3

JOB NO 120-12955 VERTICAL SCALE 1" = 3' BORING NO 0-05

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
	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-Y-10(04-B)-8

JOB NO 120-12955 VERTICAL SCALE 1" = 3' BORING NO 10-85
PROJECT TIGER OIL #3 - YAKIMA, WASHINGTON

DEPTH IN FEET	DESCRIPTION OF MATERIAL SURFACE ELEVATION 1076.3'	GEOLOGIC ORIGIN	N	WL	SAMPLE		COMMENTS
					NO	TYPE	
	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 1 = 3 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

METHOD 6DC 0-20' @ 3:00

CT (Cable Tool) 0-22'

CREW CHIEF Mason

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

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

SE-V-18(04-B)-8 662 CROMWELL AVENUE soil exploration company ST PAUL MN 55114

APPENDIX VI

MONITORING WELL CONSTRUCTION SHEETS

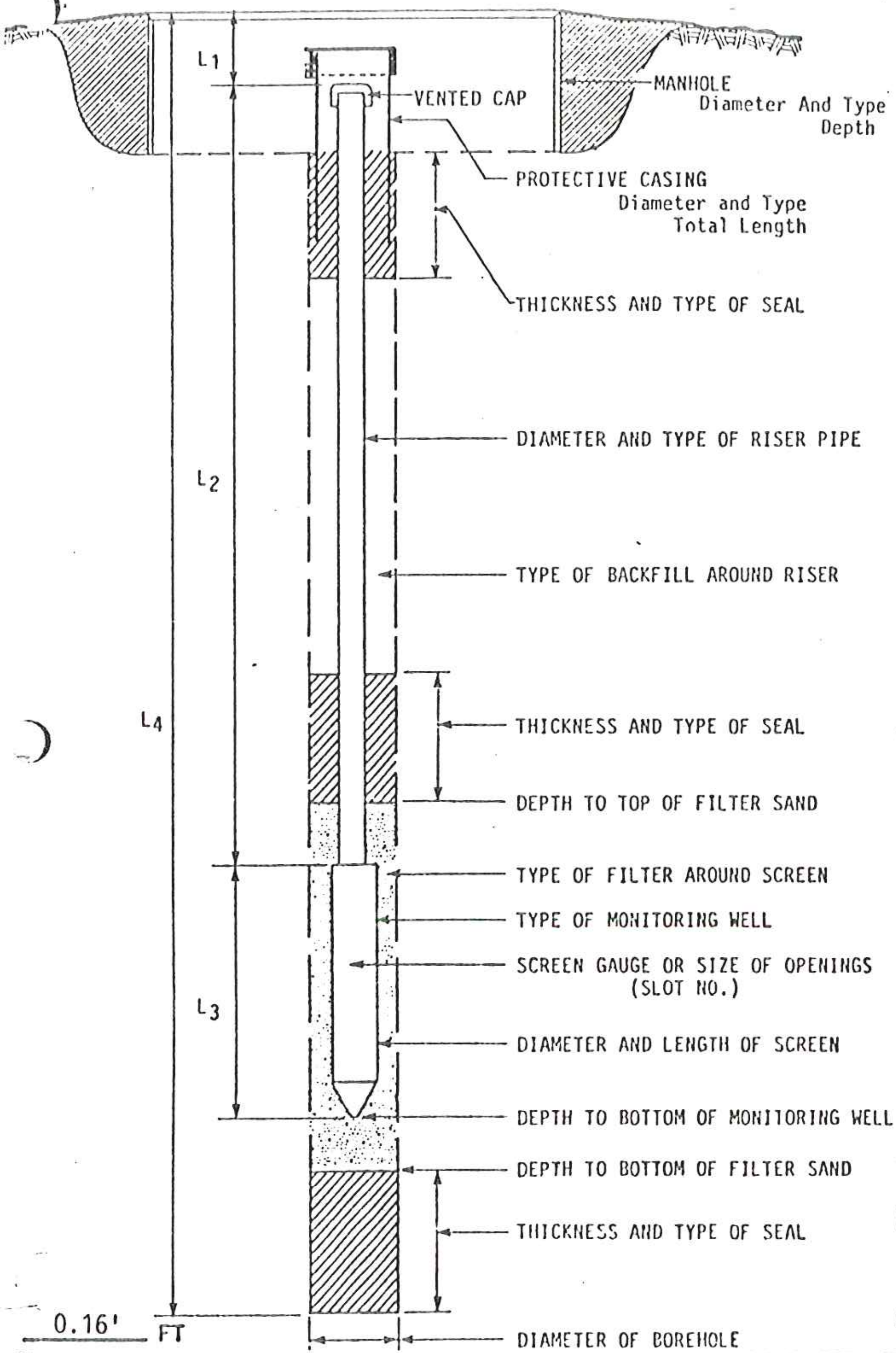
JOB NO. 120-12955

MONITORING WELL NO. 1-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1080.5'

TOP OF RISER ELEVATION 1080.34'
(With Cap Removed)



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

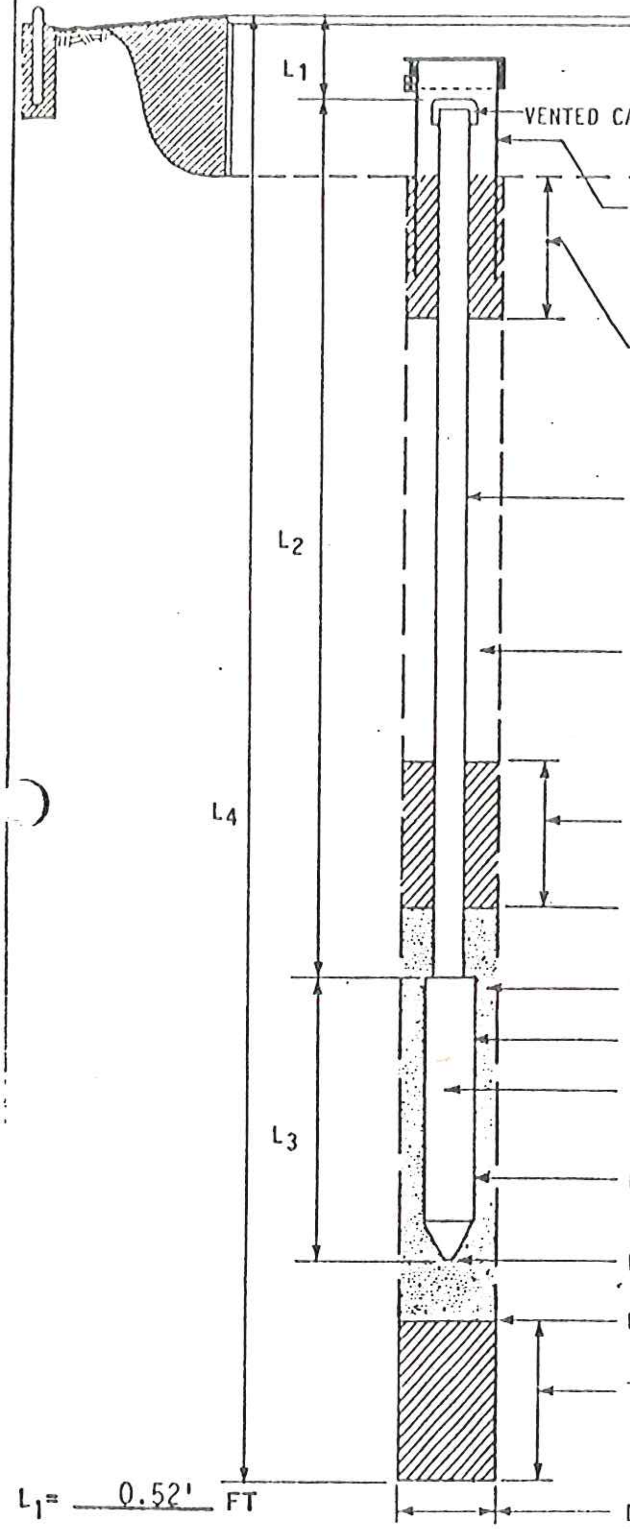
JOB NO. 120-12955

MONITORING WELL NO. 2-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1067.5'

TOP OF RISER ELEVATION 1066.98'
(With Cap Removed)



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 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

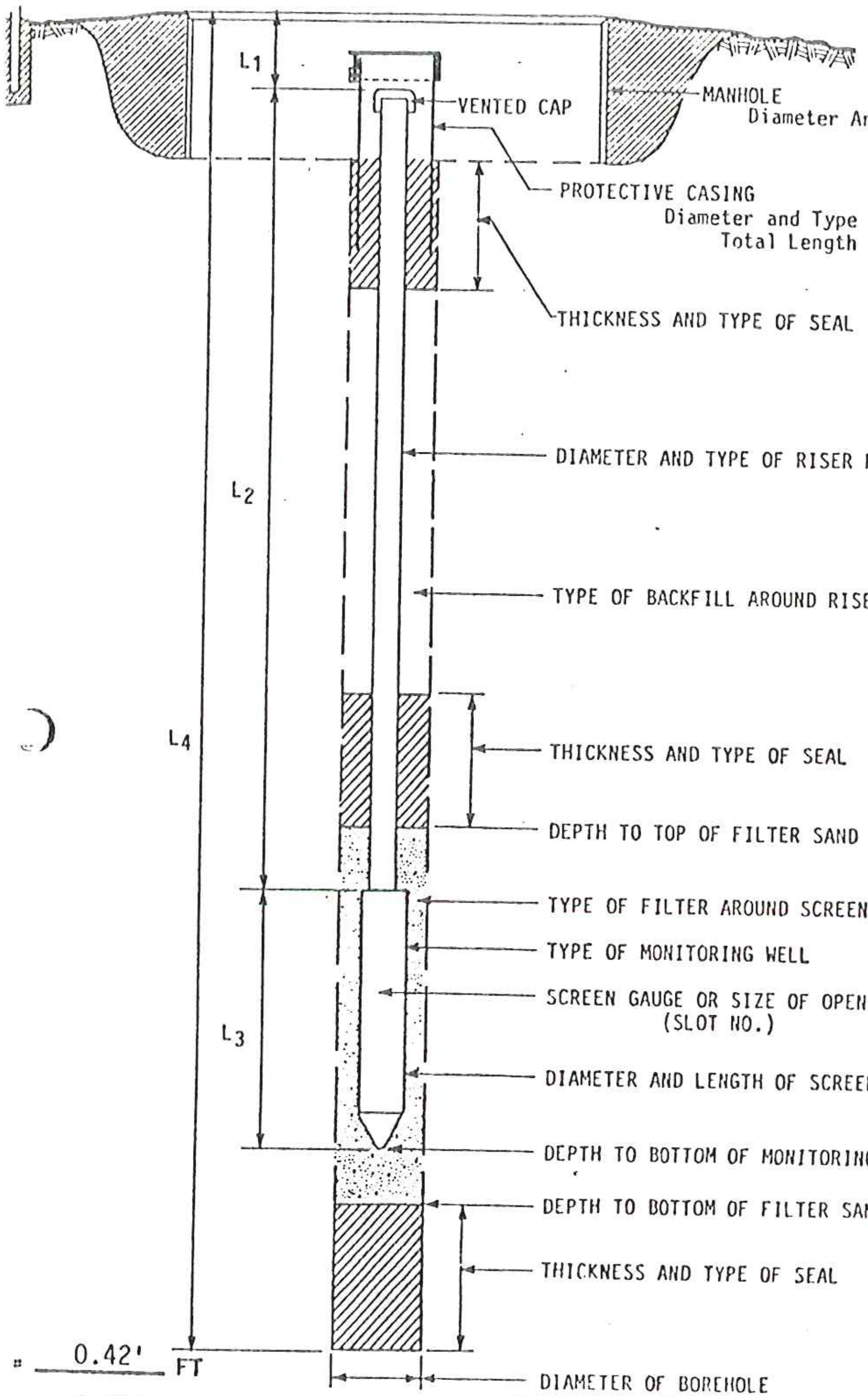
JOB NO. 120-12955

MONITORING WELL NO. 3-85

MARKER HEIGHT 4'

GROUND SURFACE ELEVATION 1072.6'

TOP OF RISER ELEVATION 1072.18'
(With Cap Removed)



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

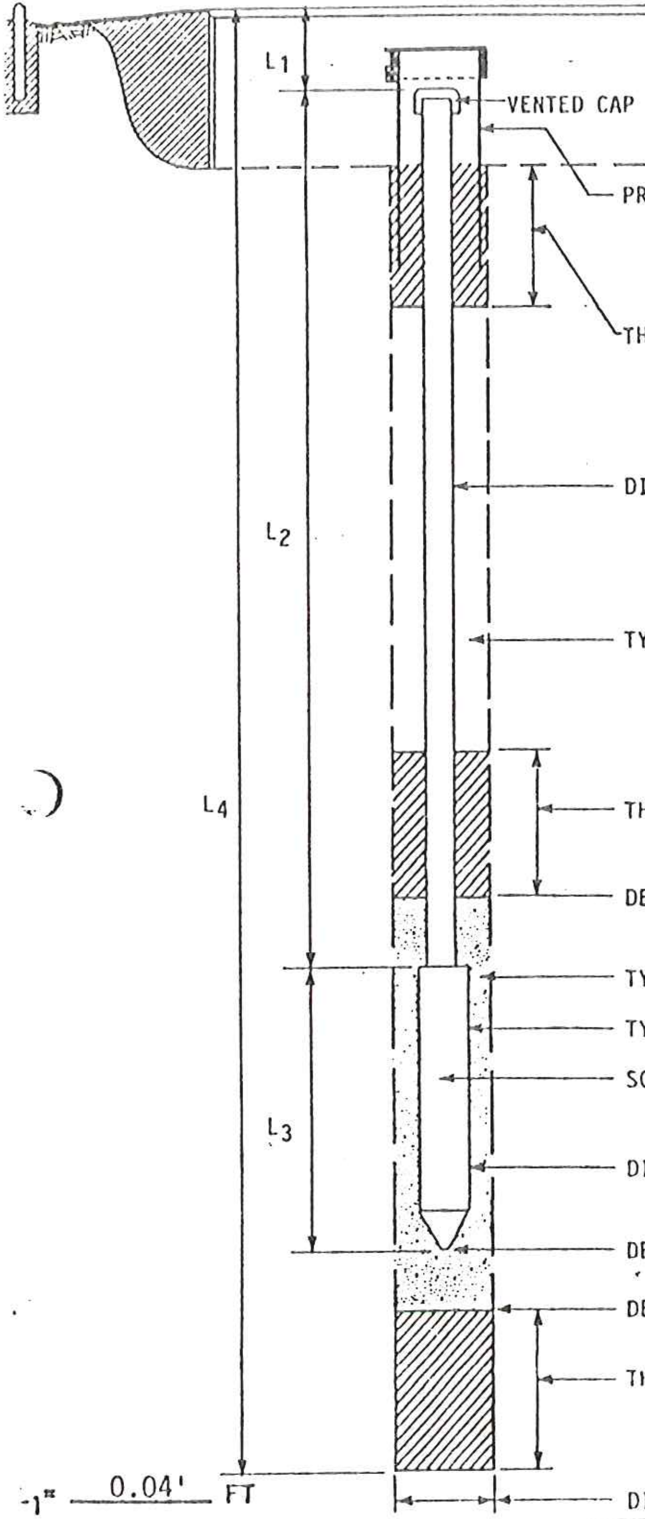
JOB NO. 120-12955

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

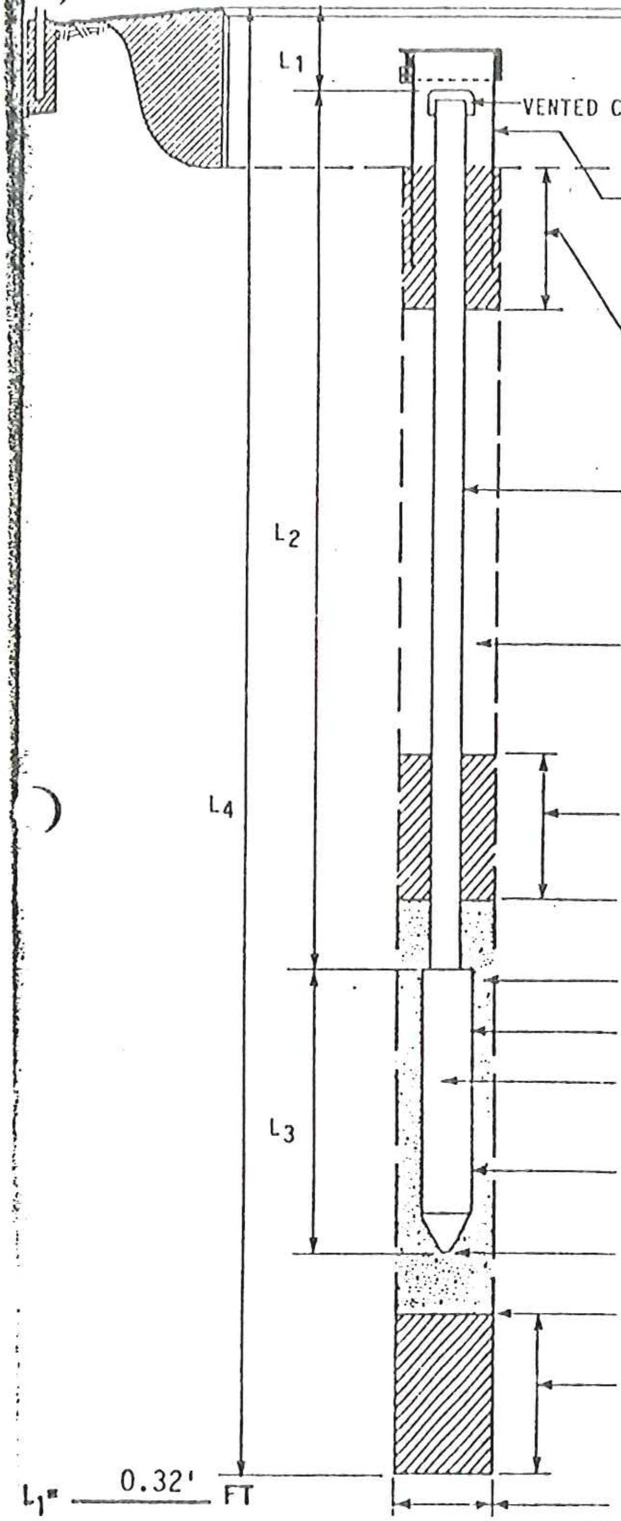
JOB NO. 120-12955

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"

L1= 0.32' FT

L2= 1.5' FT

L3= 15' FT

L4= 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

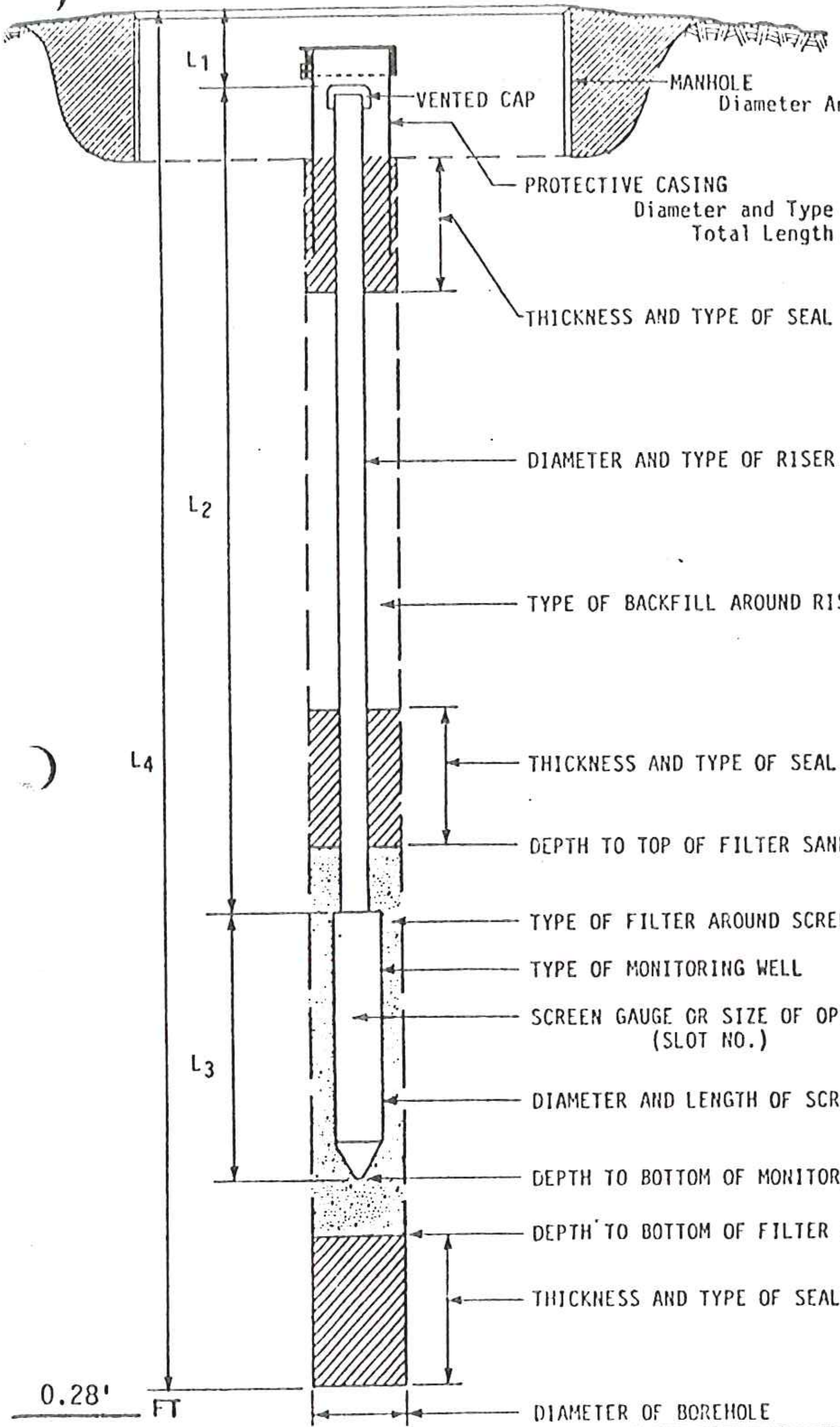
B NO. 120-12955

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

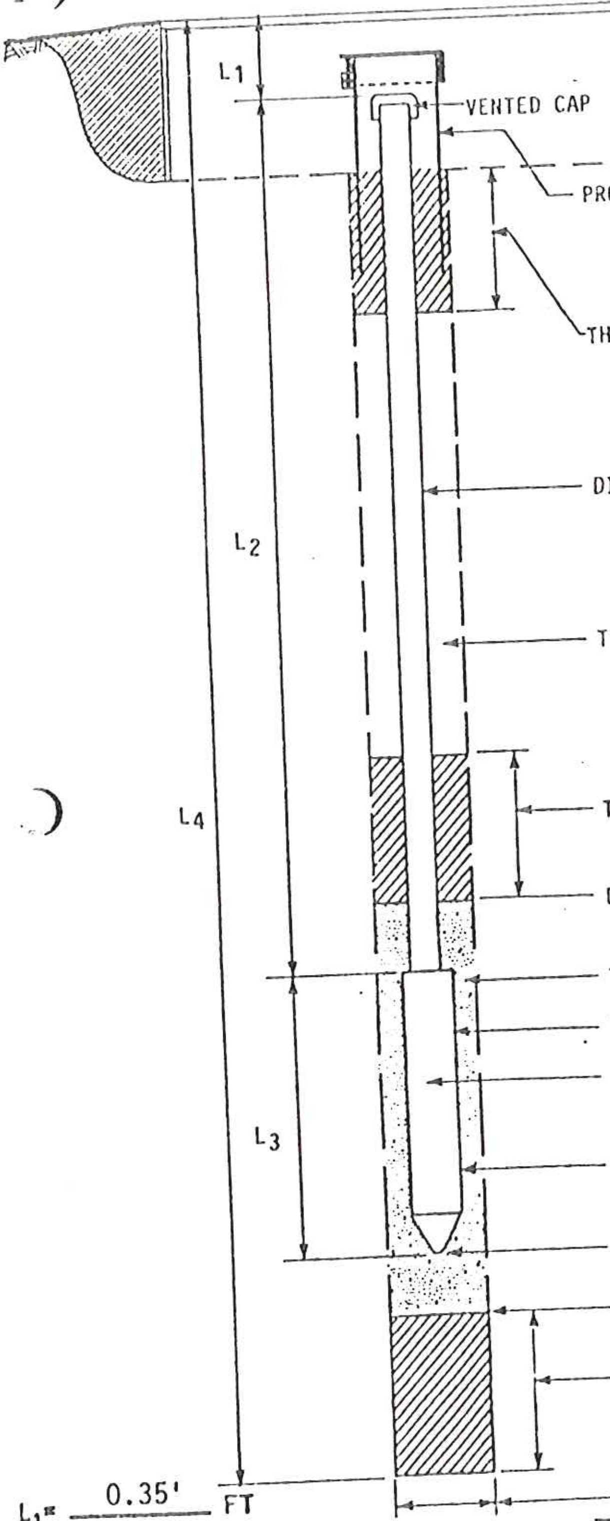
OB NO. 120-12955

MONITORING WELL NO. 7-85

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	11:17 am	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

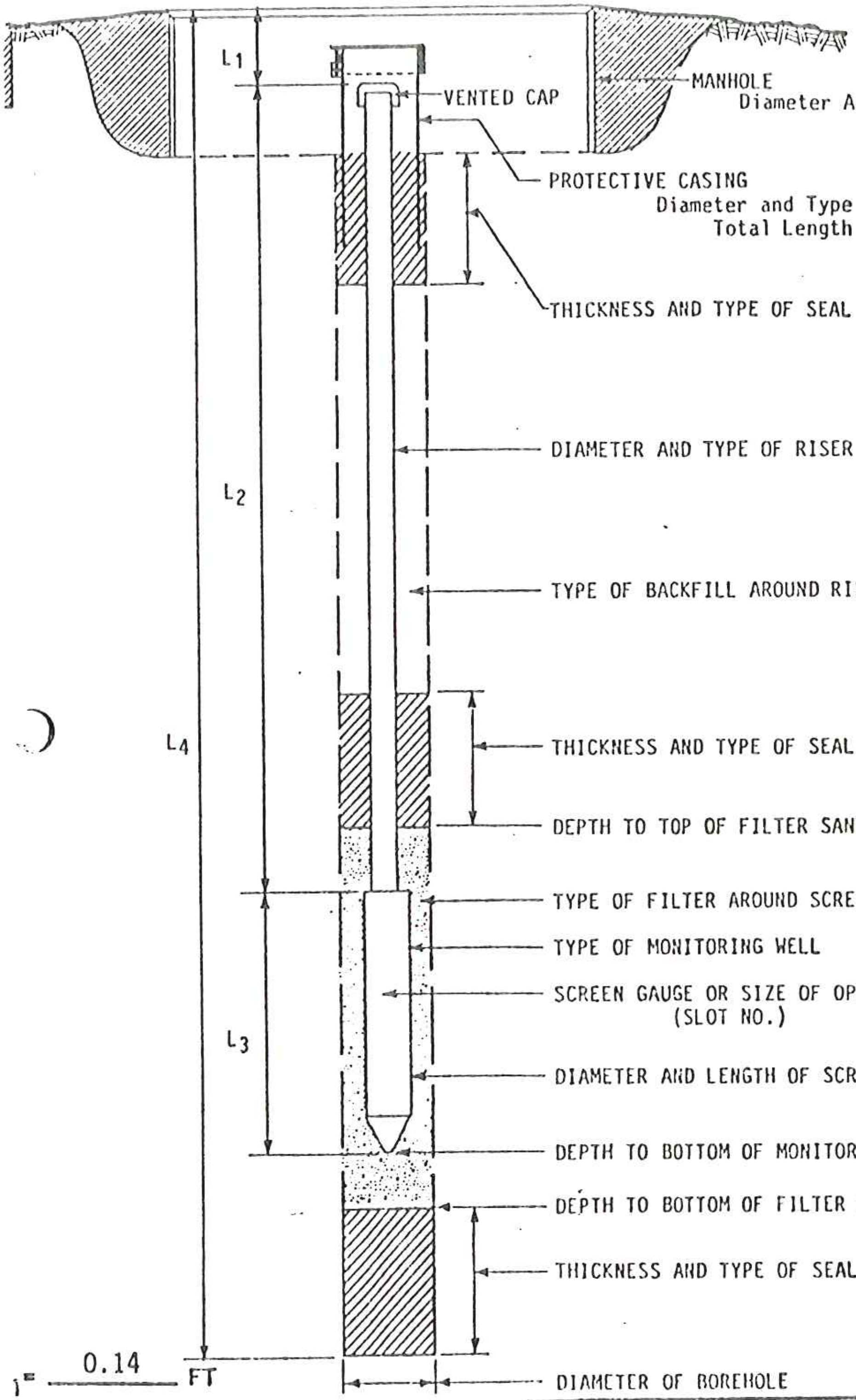
JOB NO. 120-12995

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

3 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:

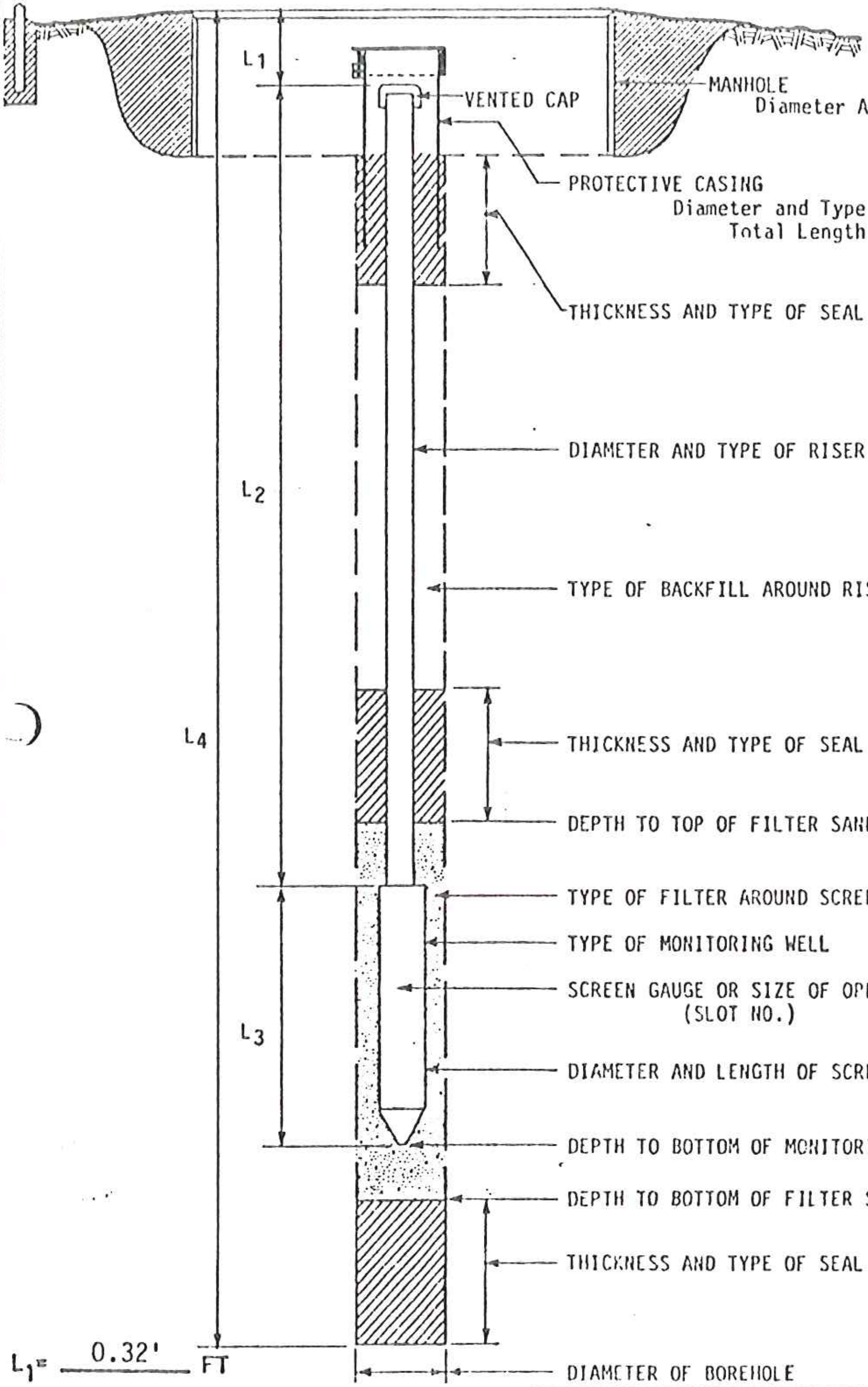
te 2/14/85 Time 3:00 PM

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

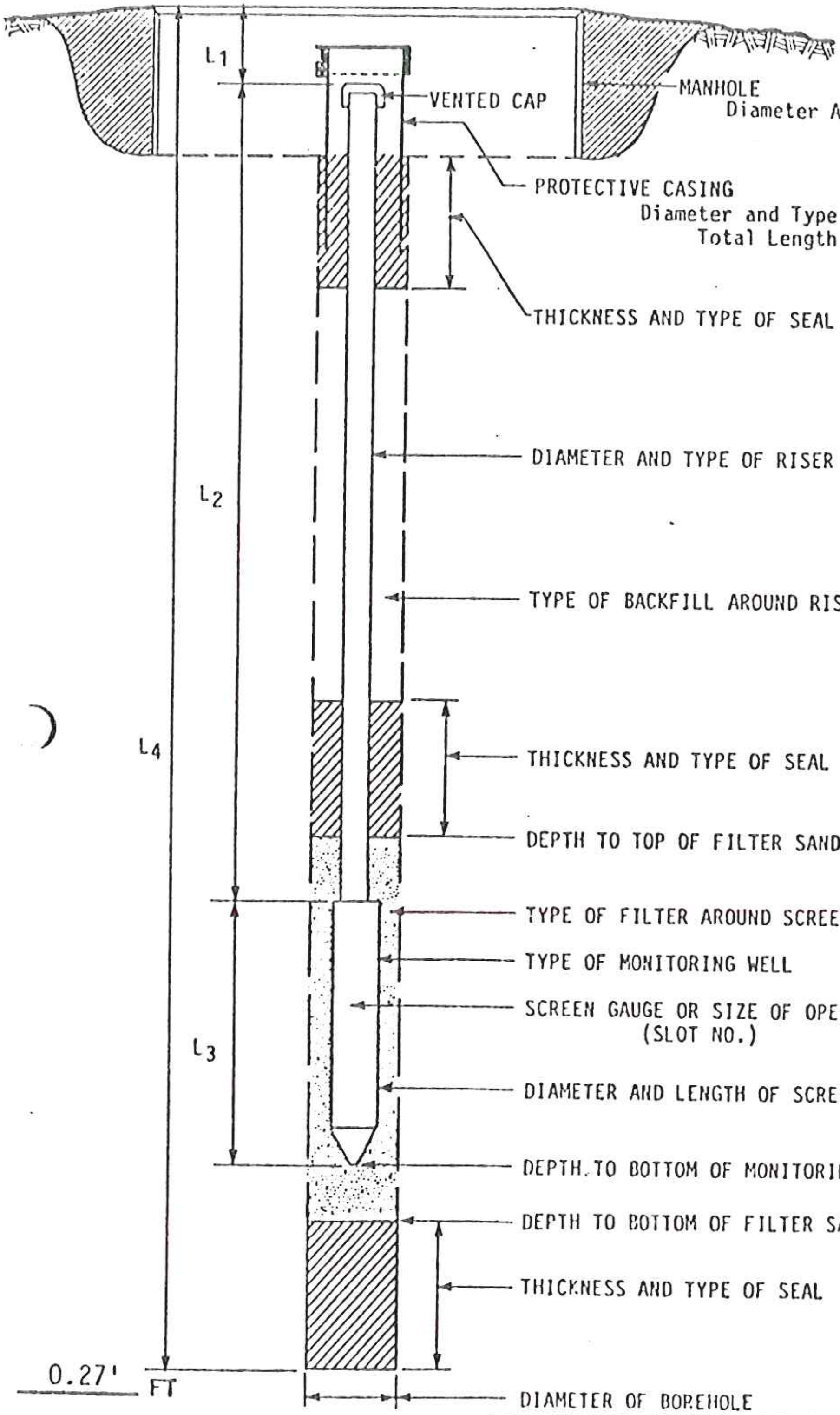
JOB NO. 120-12955

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

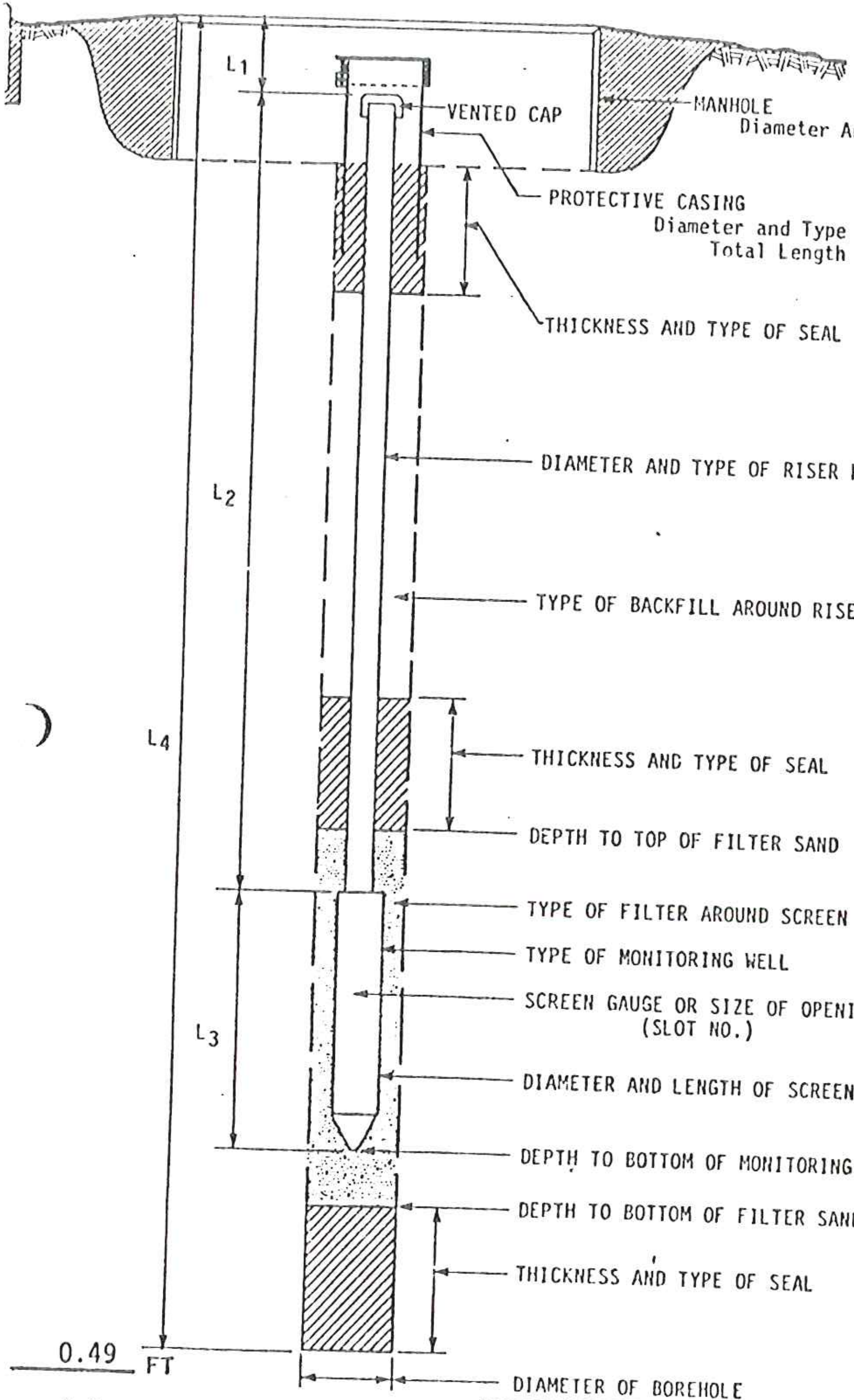
JOB NO. 120-12955

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

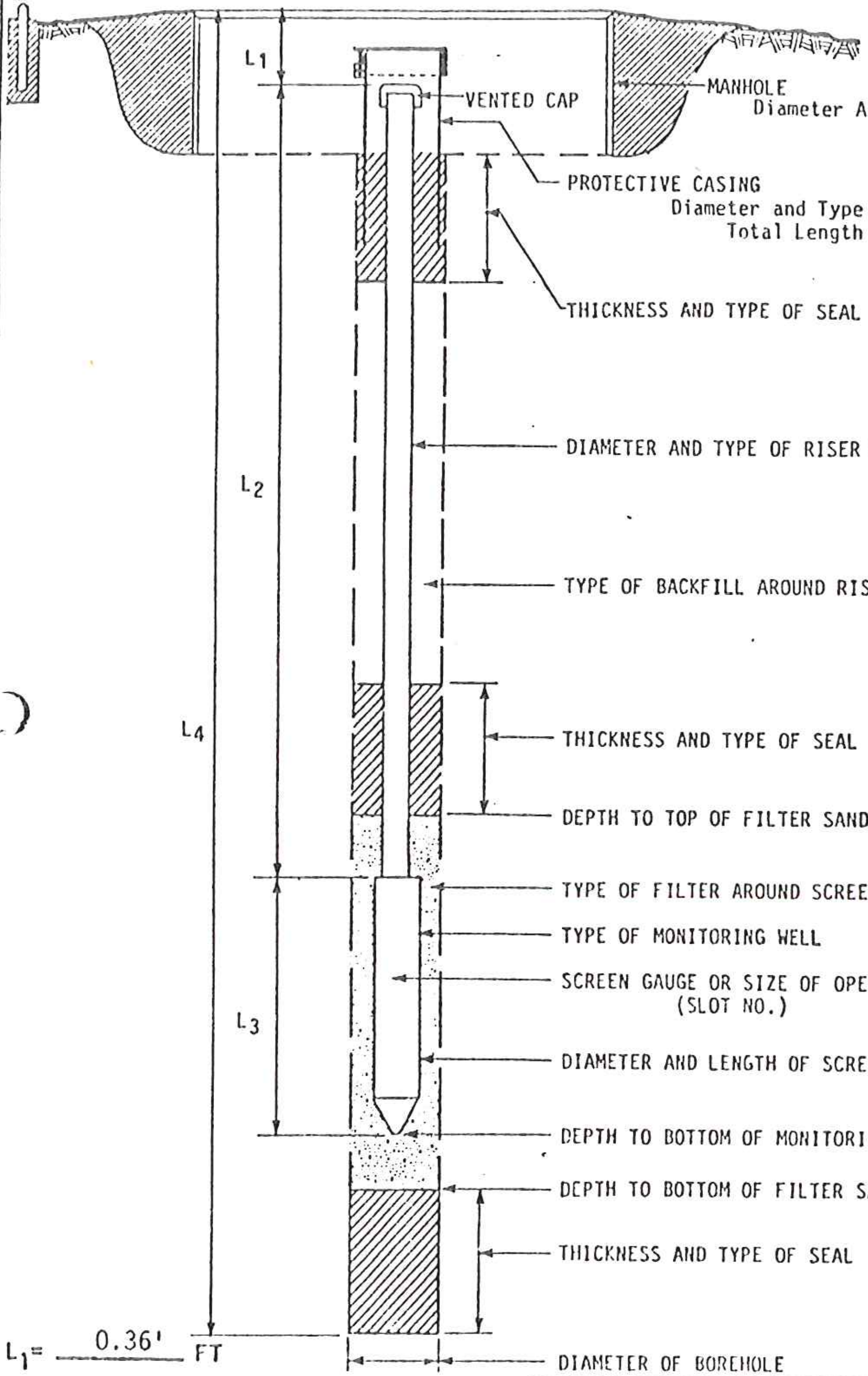
JOB NO. 120-12955

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	

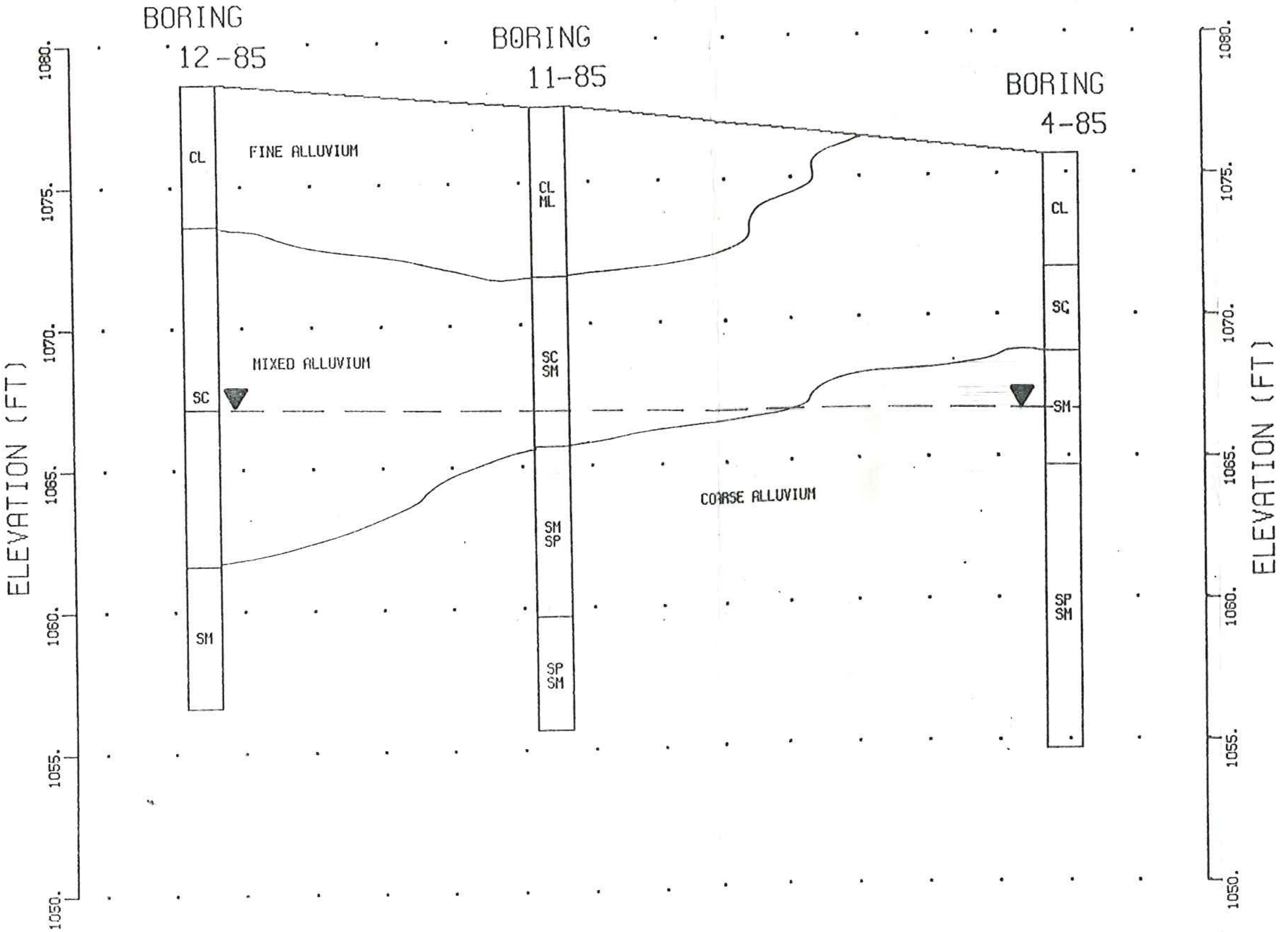
(1) DEPTH BELOW TOP OF RISER PIPE

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

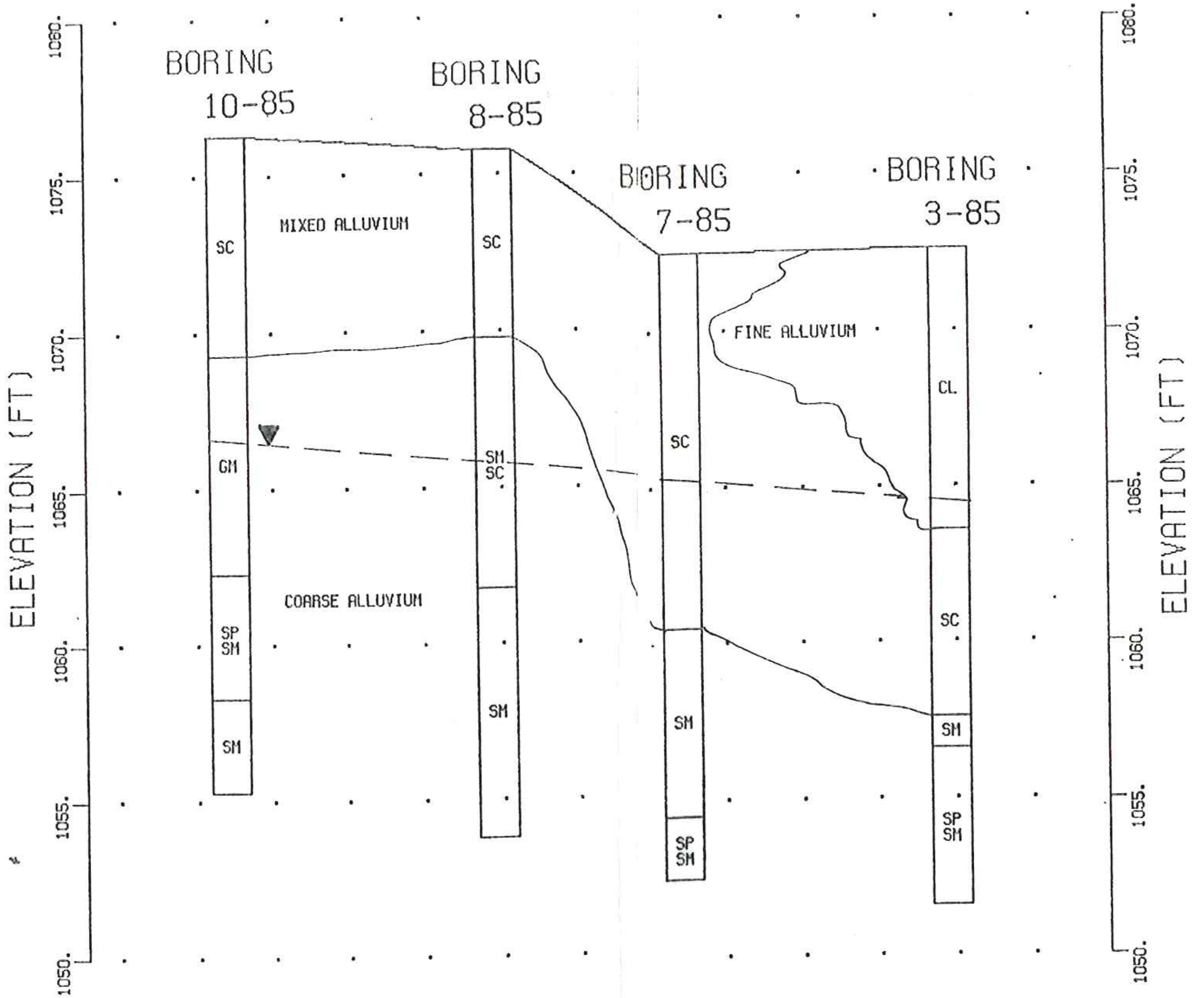
GASOLINE SPILL INVESTIGATION
YAKIMA, WASHINGTON
W.O. 120-12955

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

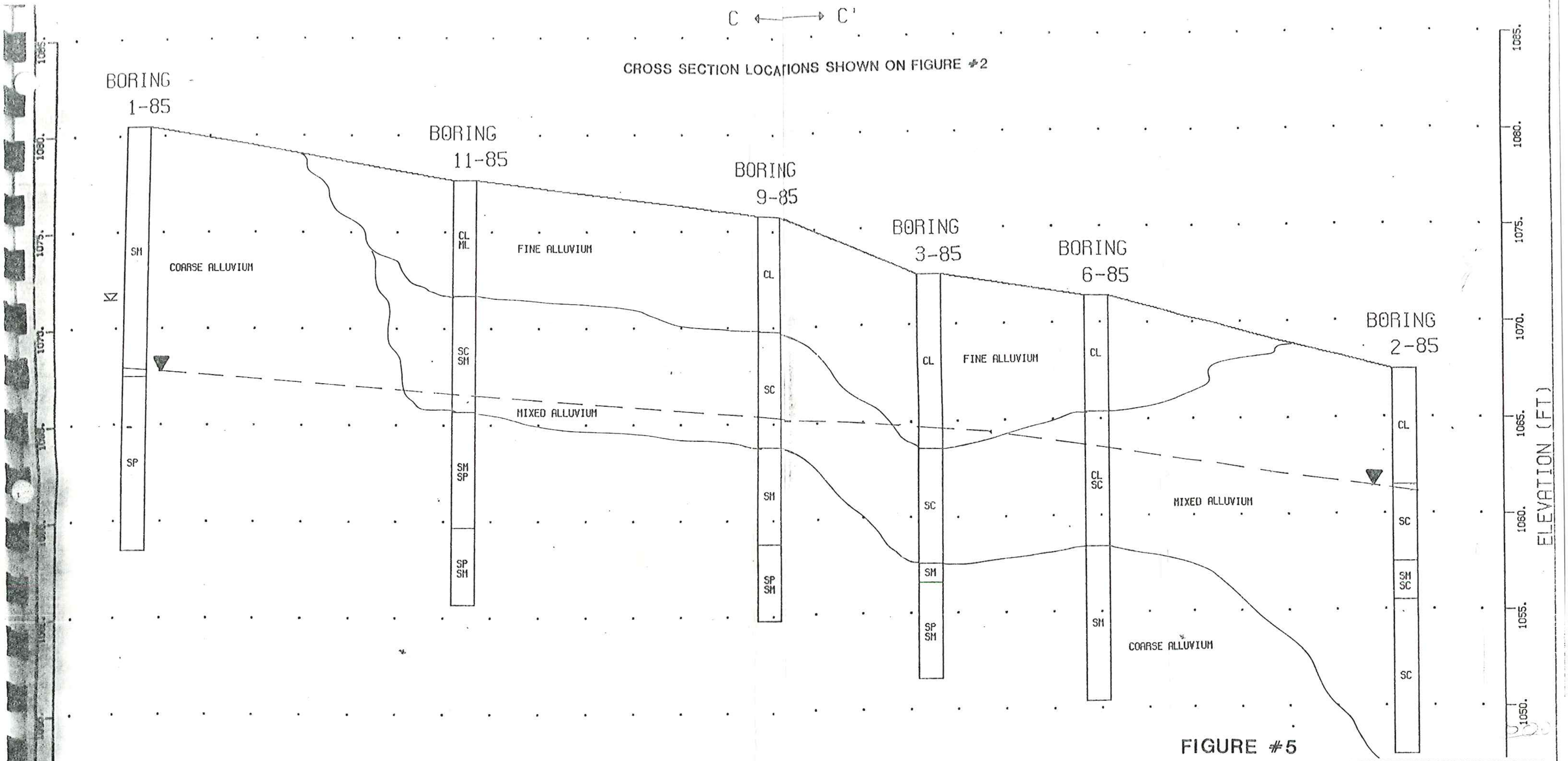


FIGURE #5

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

SOIL PROFILE

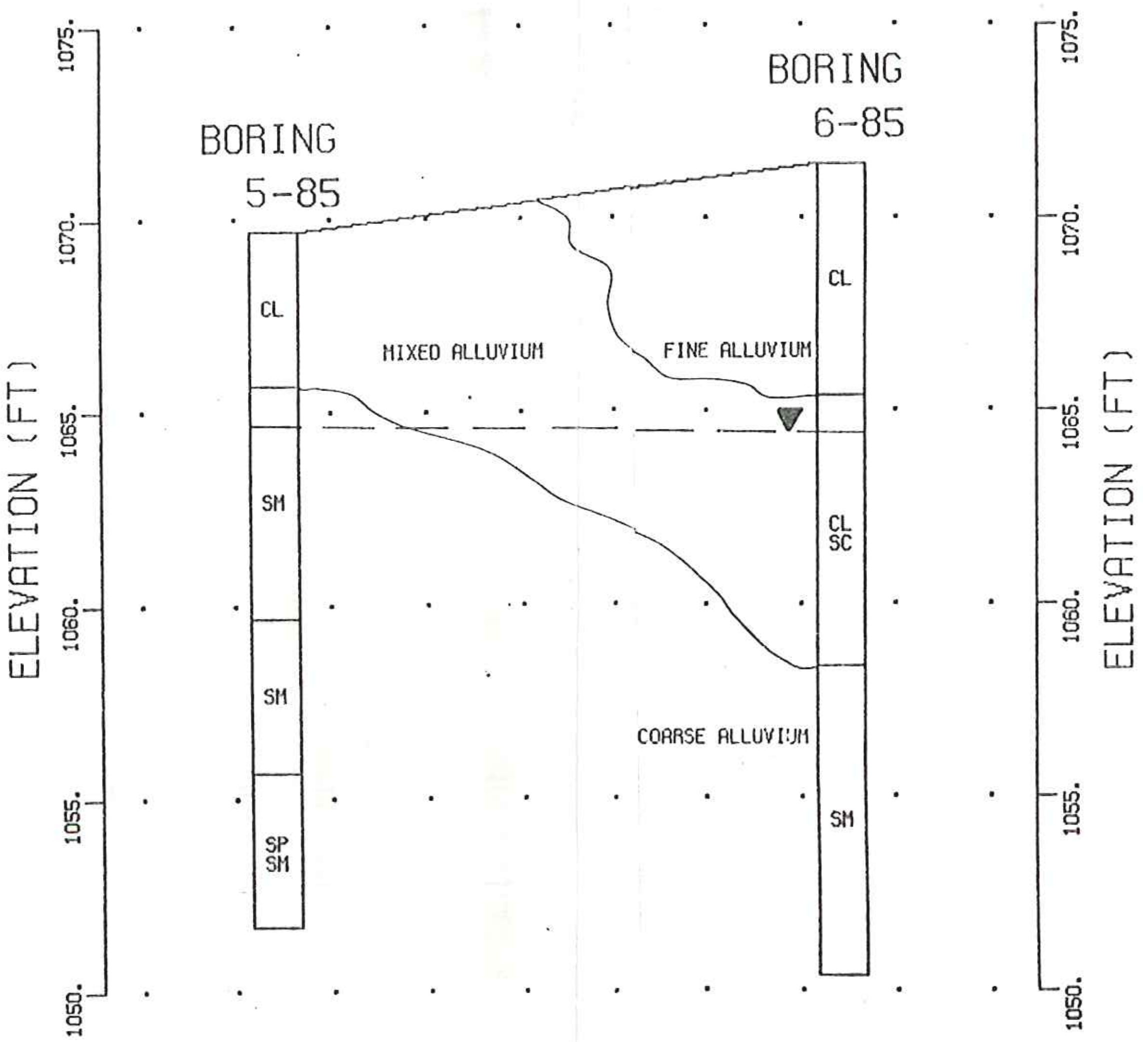
GASOLINE SPILL INVESTIGATION
YAKIMA, WASHINGTON
W.O. 120-12955

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

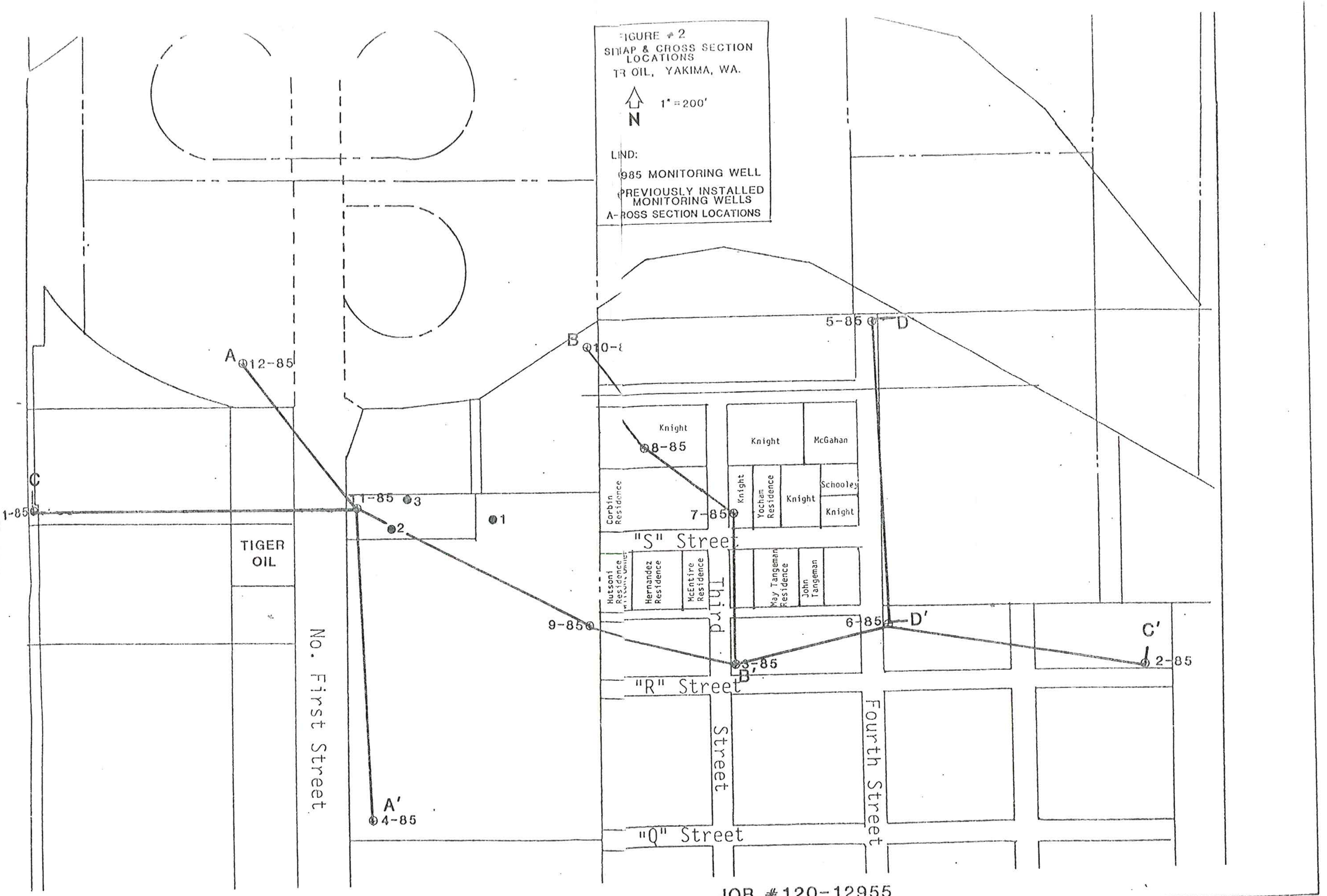


FIGURE # 2
SI MAP & CROSS SECTION LOCATIONS
TR OIL, YAKIMA, WA.

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

☐ ☐ ☐

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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
					See T-7.2 FOR 2" PVC CASING (29' LONG) FINISH	0-20 See Log T-5	
5							
10							
15				14.0'	NATURAL CUTTINGS		
20				20.7	SAND	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	NATUR-AL 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 ¼-3/8", Clay, light brown-grayish.	
35				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

☐ ☐ ☐

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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	-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-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

Rge. ______

Twp. ______

Sec. ______

Lithologic Symbols

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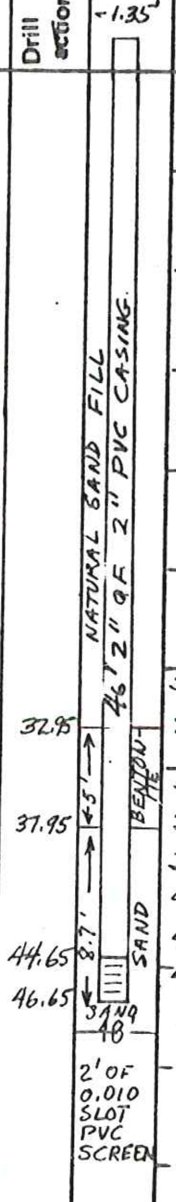
Abbreviations

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



See T-2 for 0-30'

30-32' Gravel, clasts to 3/4"; sand, medium to coarse; clay light brown.

32-34' Sand, fine to coarse; gravel to 1/8"; clay dark brown and gray.

34-36' Sand, fine to coarse, gravel to 1"; clay light brown and gray.

36-38' Sand, medium to coarse, gravel to 1/4"; clay light brown and gray clay

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.

44-46' Sand, fine to coarse, gravel to 1/2", clay gray.

46-48' Sand, fine to coarse, gravel to 1/2", clay gray.

Summary log

Gravel, sand and clay	30-32'
Sand, gravel clay	32-48

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 bottom S Peterson

Lithologic Symbols

Abbreviations

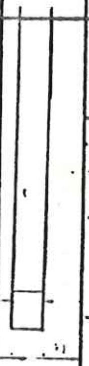
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						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							
						6-7 Gravel (¼") to cobbles (rock chips) 7 Gravel to ¼" with fine sand.	Gravel sandy, cobbly 5-9.2
10			CORE 8.2-9.3			8.2 to 9.2' Cobbly coarse gravel with little clayey fine sand.	
						10-12 Very coarse sand and medium gravel Some silt and fine sand; light brown water (mafic clasts)	Sand and gravel 9.2 - 14 Diesel or sewer smell
15						12-14 Medium sand and gravel, black and gray. Sewer like smell and heavy gas smell.	
20					2' FT 0.010 SLOT SCRFEN PVC	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
						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

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Abbreviations

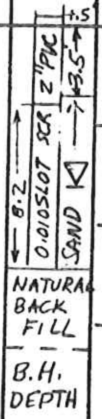
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____

Twsp. ____

Sec. ____

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						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

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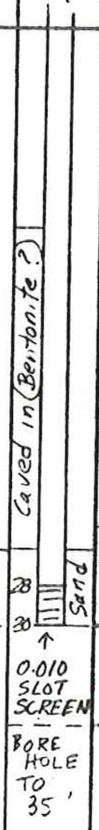
Abbreviations

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'. Clay to medium sand	Clay sandy ? 0-6
5					6-8' gravel	gravel 6-8
					8-10' Sand	sand 8-10
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
				sand Pack	26-28' Clay, fine sand, gravel to 1/4"	
30					28-30' Medium sand, clay, gravel to 1/2"	Sand, clayey, gravelly. 28-30
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

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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		▨				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		▨			2" PVC PIPE	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		25' Silty sand (coarser than above) with very fine gravel	
30		▨			SAND PACK	30' Same as above	
		▨		JOINT MAY LEAK	↑ 2FT 0.010 SLOT PVC SCREEN	32' Same as above but entered medium gravel zone.	Gravel, sandy ? bottom of hole

Sheet ___ of ___

T-1 F[illegible]

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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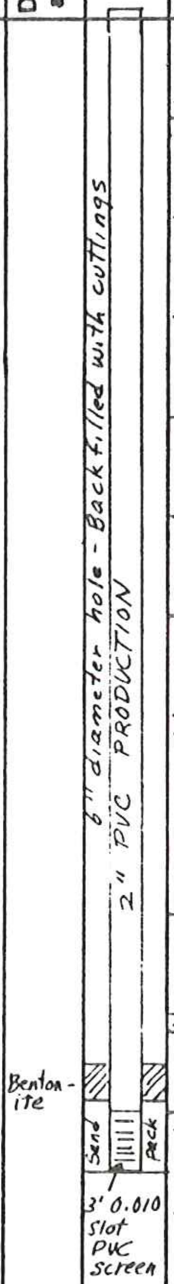
Abbreviations

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. ______

Twp. ______

Sec.



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						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				Bentonite		50' Silt, fine to coarse sand and fine gravel. Gravel clasts mostly mafic. Water very blue.	
55						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

9-280
(Rev. 9-67)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

File No. 2 of 2

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 ±		50		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-[illegible] 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		

U.S. GOVERNMENT PRINTING OFFICE : 1900—O-333-648

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			58.0		58.0		55.0		3.0	54-55		
T-2			32.0		30.0		28.0		2.0	27	JOINT BROKE 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			18.3		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			38 > 36.		32.2		30.5		2.0	Not finish	OGC will finish	
T-14			18.3		12.8		6.8		6.0	4.1		

U.S. GOVERNMENT PRINTING OFFICE : 1980—O-333-648

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

Rge. ______

Twsp. ______

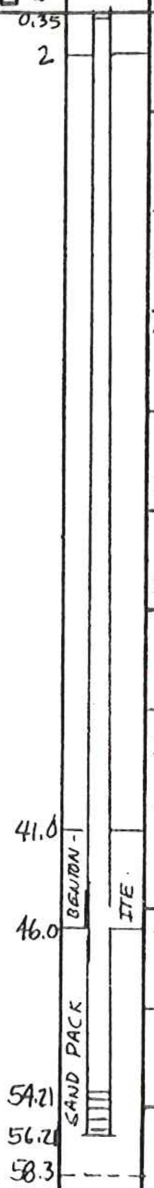
Sec. ______

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' 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.	Sand and gravel 9-36
16-24 Same but with coarser gravel fragments in 3/4 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	
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

H-2 [illegible]

Location ______ Date ______ Local well number ______

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 sand brown 6-8' Gravel, cobbly a little silt and sand.	Gravel, cobbly, silty sandy	4-12
					SAND PACK	8-12' Gravel, hard drilling (cobbles?) gravel at 10-12' may be coarser		
10								
						12-16' Gravel, sand some silt, brown. H_2O 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 ______

Location ______ Date 13-13-86 Local well number M-1 FIELD LOG

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JLE & GLT

Lithologic Symbols

☐ ☐ ☐

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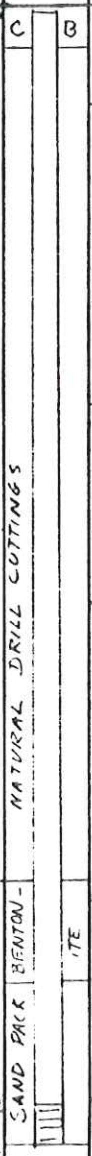
Abbreviations

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. ______

Twp. ______ 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 14-16 Sand and gravel, some silt	sand and gravel, silty 12-20
15						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
						42-44' Sand, black; some gravel, gray silt.	Sand, gravelly 42-44
45				44.0		44-50 Gravel, black some black sand and gray silt. Some larger material also.	Gravel, silty, sandy cobbly 44-52
50				49.0		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

S-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

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
						2-4' Same as above.	
5						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, silty, clayey. 4-18
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.	
						10-12' Fine to coarse, sand and gravel, fragments to ½", grayish brown.	
15						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

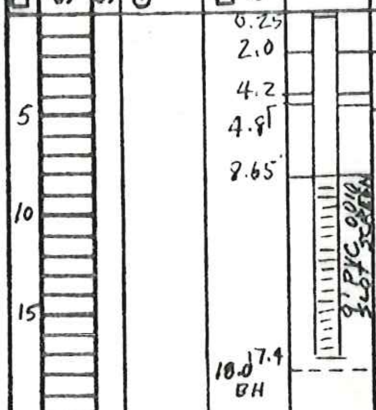
☐ ☐ ☐

☐ ☐ ☐

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

0-1' 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

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	CEM	0-1' Black-top and parking lot fill	Blacktop-fill.	0-1
				2.0	NAT FILL	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	B N B F	5-6' Gravel, gray, fragments to ½" and med to coarse sand.	Gravel, sandy	5-16
				7.8		6-8' Same as above		
10					SAND PACK	8-10' Same		
						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	NAT. FILL		Sand, silty, gravelly	16-18
				18.3 BH		16-18' Silt and fine to coarse sand, dark brown, gravel (≤ ½"), gray-brownish. Saturated.		

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. ____ Twsp. ____ Sec. ____

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description
			Top of CSG	0.15	7.7' PVC CSG CEM	0-1' Black top of parking lot and fill.
				2.0		1-2' Silty clayey fine sand, dark brown
					NAT FILL	2-4' Same but fragments to ½". Cobble gravel at about 3½'
5				5.8	B	4-6' Cobble gravel, fragments to ½", clean.
				7.5 7.7	SAND PACK	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 some fine to medium sand
15				14.0		12-14' Silt and brown fine sand and gravel (<½") gray, saturated. Hydrocarbon odor.
				16.85	NAT F.	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

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

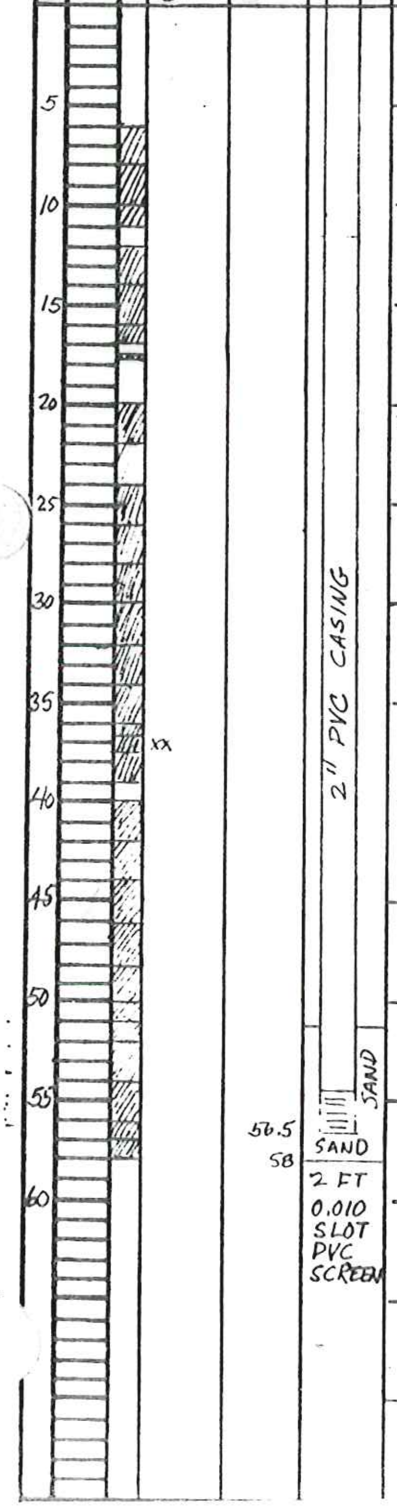
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twp. ______

Sec. ______

Depth | Scale | Sample | Graphic log | Drill action



Lithologic description	Summary log
Asphalt surface	Asphalt surface
0-4' Soil, silty clayey	Soil, silty clayey 0-7'
6-8' Silt and gravel, fine, dark.	
Gravel, coarse, rounded clasts to 15mm.	Gravel 7-8
8-10' Sand, medium to coarse, clayey, brown; with gravel, fine, black	Sand, clayey, gravelly 8-16
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	Gravel, silty sandy. 16-20'
17.5' Water dark brown, very silty coarse sand with very fine to coarse gravel	
20-22' Sand and gravel, silty; water less brown	Sand and gravel silty 20-22'
23'	

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

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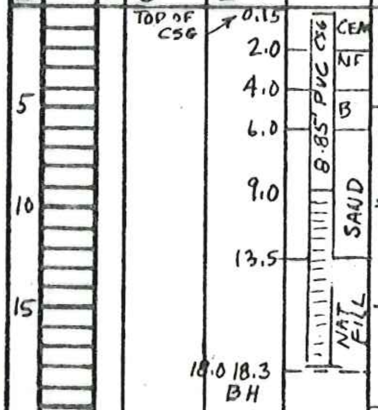
Abbreviations

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

0-2'	Clayey silt, dark brown.
2-4'	Clay, silt some gravel (< ½") dark brown.
4-6'	Cobbles and coarse grave (cobbles at 5') fragments to ½", some silt to coarse sand, gray.
6-8'	Same
8-10'	Fine sand to gravel (≤ ¼"), gray, wet.
10-12	Fine sand to ½" gravel, some fragments > ½", grayish brown, dry.
12-14'	Same as above.
14-16'	Fine sand to ½" gravel, grayish brown. No fragments more sand than above.
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.

Summary log

silt, clayey	0-3
Gravel cobbly	3-6
Sand and gravel	6-17
Sand, fine to coarse, gravelly	17-18

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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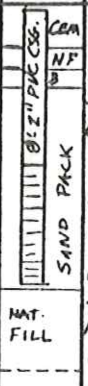
Abbreviations

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. ____

Twp. ____

Sec. ____



Depth	Scale	Sample	Graphic log	Drill action	Lithologic description	Summary log
				T.C. .15	0-1' Blacktop and parking lot fill'.	Blacktop and fill 0-1
				2.0	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	4-6' Fine sand and gravel (to ¼"), dark gray.	Sand and gravel 4-6
					6-8' Gravel (returns = fragments to ½") light gray Drill sounds as if in cobble gravel.	Gravel, cobbly, sandy 6-18.4
				8.0	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	
					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

Lithologic Symbols

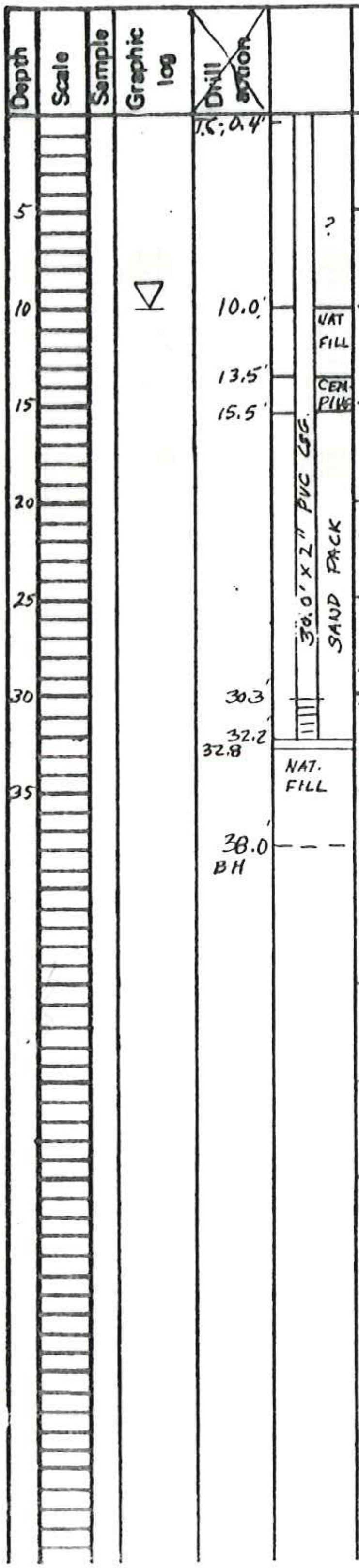
Abbreviations

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.



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 [illegible]

Location YAKIMA, WASH Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron Lane

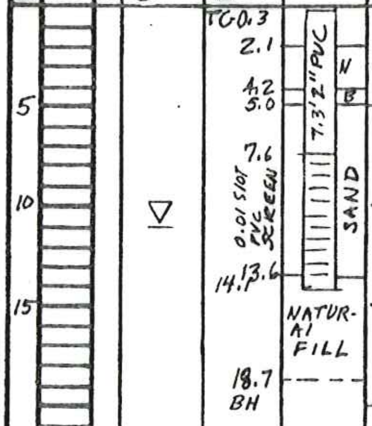
Lithologic Symbols

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. ______

Twp. ______ Sec. ______



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", 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 FELLS

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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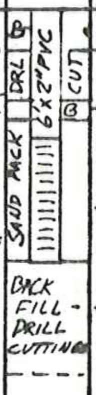
Abbreviations

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**

Depth: 5, 10, 15

TOP OF CSG. 0.3
2.0
4.5
5.5
6.5
6'X2"
0.01
SLOT
PVC
SCREEN
12.5
18.3



Lithologic description

0-2' Light brown very fine sand and silt.

2-4 Light brown fine sand and silt some brown clay.

4-6 Gray fine-coarse sand and gravel, fragments to 1/4". Drill sounds like coarse gravel or cobbles.

6-8' Same except gravel to 1/4"-3/8"; Fragments (few) to 1/2".

8-9' Sand, medium to coarse, some fine, less sand than above, gravel > 1/4" more gravel than above Fe in fragments

9-10' Sand medium to coarse, brown to gray, very little fine gravel to 1/4", No fragments. Clay ?, Silt ?.

10-12 Sand fine to coarse, gray, with clay and. silt; gravel, gray brown, Fragment to 1/2". Drill hitting cobbles and boulders.

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.

Summary log

sand very fine and silt	0-4
Sand and gravel	4-9
Sand, medium to coarse	9-10
Sand and gravel	10-18.4

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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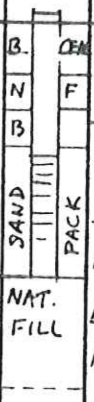
Abbreviations

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	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	
						16-18.3' 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. ______

Twsp. ______

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG -0.43'	Lithologic description	Summary log
				2.5	B. CEM N F B	0-7' Silty clayey fine sand, brown.	Sand, silty, clayey 0-7
5				6.6 6.7			
10					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
				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.	
				18.3		16-18.3' Same but reddish brown	

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

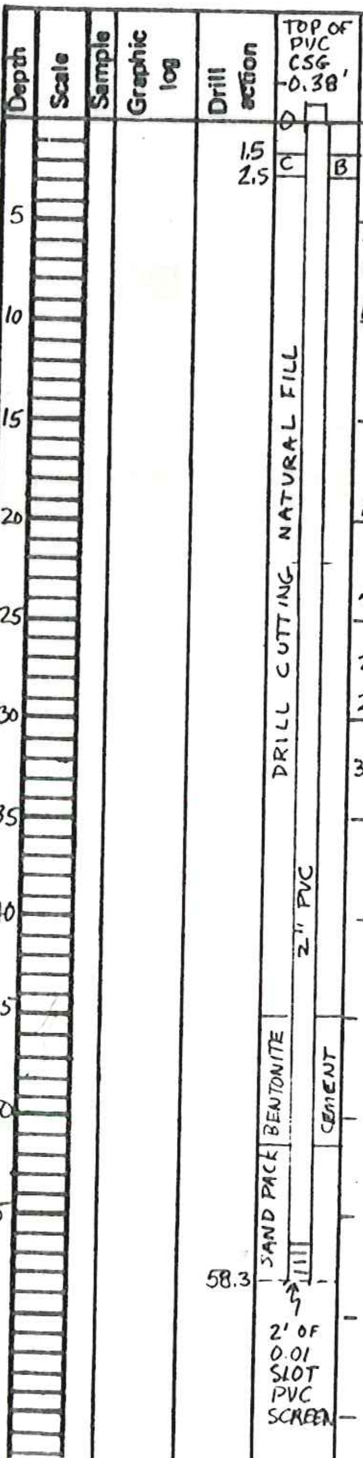
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG -0.38'	Lithologic description	Summary log



0-5' Silty clayey fine sand, brown.

5-6' gravel, cobbly (Drill rig) fragments to 1/2"

6-10' Silty fine to coarse sand, gravel (to 1/2") grayish brown. Cobbly drilling

10-18' Same but brownish gray, saturated between 12 and 14 feet

18-24' Silty fine to coarse sand, gravel (to 1/2") grayish brown. No cobbles

24-26' Silty fine to coarse sand, gravel (to 1/2") 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, silty, clayey	0-5
Gravel, cobbly	5-6
Sand and gravel, silty cobbly	6-18
Sand and gravel (more clay in samples below 32'	18-58

T-20 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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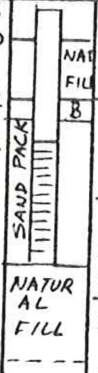
Abbreviations

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	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 ~~½~~"; 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	
15				13.2		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

Twsp. ______ Rge. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG 0.33' BELOW LSD	Lithologic description	Summary log	
				0.33		0-2' Silty clayey fine sand, light brown.	Sand, silty clayey	0-2
				2.0	NAT FILL	2'-4' Fine to coarse sand, gravel (to ½") Drill sound as if in cobble gravel.	Sand and gravel	2-9.5
5				4.7 5.7	B	4-6' fine sand to gravel (to ½") as above Drill sound as if in cobbles		
						6-8' Same as above.		
10				7.8	SAND PACK	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.	9.5-18
						10-12' Same as above		
15				13.8	NAT FILL	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'		
				18.3		16-18' Similar but color is reddish brownish gray		

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

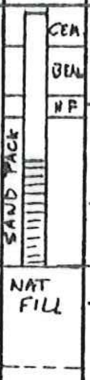
Abbreviations

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 section		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
15				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
				18.3		12-14' Sand, coarse, gravel (to ½") 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-17 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 -0.42	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	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	NAT FILL	12'-14' Same as above. Saturated	
						14'-16' Silty fine to coarse sand and gravel (to ½") brownish 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

Lithologic Symbols

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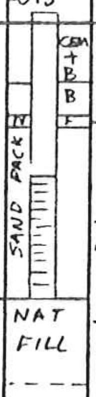
Abbreviations

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'	
				13.9		14'-18' Fine to coarse sand, some silty gravel to ½+ brownish gray.	Sand, silty gravelly 14-18
15							
				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

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, gravel to 1/2", 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 1/4", fine sand, cobbles	Gravel, sandy, cobbly 4.5-9.5
10						9.5-10' Fine sand to gravel (>1/2") dark brownish gray. H_2O at about 10'	
						10-12' Silty fine sand to 1/2" 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 OGC		

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

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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
				1.7	B + CEM	0-2' Clayey silty fine sand, brown	Sand, silty clayey 0-7
					4" PVC CSG B.	2'-4' Same	
5				4.1 5.3	N F	4-6' Same but much more clay (lumps)	
				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 7-18
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-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	Summary log
						0-1' Black top.	Blacktop 0-1
						1-2' Clayey Silty fine sand	Sand, clayey, silty 1-5
						2-4' Clayey silty fine sand, dark brown	
5						4-5' As above fine sand.	
						5-6' Gravel gray (fragments are sandsize to ½" Some clay. Drill sounds cobble gravel.	Gravel, sandy 5-6
						6-8' Fine sand to gravel, fragments to 1". Some Clay and silt, brownish gray. Drill sounds like cobble gravel.	Sand and gravel, clayey, silty. 6-14
10				10.0	NATURAL FILL	8-10' Same as above	
						10-12' Same as above, but brownish gray, strong gas odor	
15			∇			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'	Sand, silty, gravelly 14-36
						16-18' Same as above	
20						18-20' Same as above, but color is reddish brown.	
						20-26' Same as above.	
				23.0	BENTONITE		
25						26-28' Same as above with more silt and fine sand. Color less medium to gray brown	
30				28.0	SAND	28-30' Silt to gravel (to ½") as above, medium brown.	
				30.5		30-32' Same as above	
				32.2	NAT. FILL	32-34' Same as above, color gray brown	
35						34-36' Same as above, grayish brown	
				36.0			

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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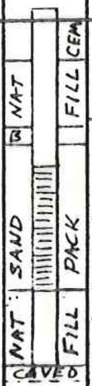
Abbreviations

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 gravel.	Sand and gravel, silty 6-18
10						8-10' Fine to coarse sand and gravel (to 1/2"), 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 B.H.		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

Lithologic Symbols

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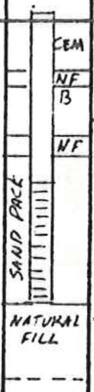
Abbreviations

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 clay fine sand, dark brown	Clay, silty, sandy	0-2
				2.4 3.2	2-4' Silty fine to medium sand tan to light brown.	Sand, fine to medium, silty, gravelly	2-6
5					4-6' Sand as above, tan, with gravel to 1/4" gray.		
				5.6 6.6	6-8' Gravel (to 1/4") gray, some tan sand.	Gravel, sandy	6-8
10				8.2	8-10' Silty fine to coarse sand, tannish gray gravel with fragments to 1/4" gray.	Sand and gravel	8-18
					10-12' Fine to coarse sand and gravel (to 1/4") grayis brown.		
15				14.2	12-14' Fine to coarse sand, gravel (to 1/4") brownish gray.		
				18.3	14-16' Fine to coarse sand and gravel, grayish brown saturated.		
					16-18' Similar to above but more reddish especially H_2O.		

T-10- FLD 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

☐ ☐ ☐

☐ ☐ ☐

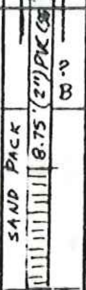
Abbreviations

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. ______

Twsp. ______

Sec.

Depth	Scale	Sample	Graphic log	Drill action	TOP OF CSG. -0.45	Lithologic description	Summary log
				1.6'	 (2") PVC (S) 8.75' ? B	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	SAND PACK	6-8' Same as above	
10						8-10' Same as above.	
						10-13.5' Silty clayey fine to coarse sand, gravel (Fragments to ½") grayish brown.	Sand, clayey, silty, gravelly 10-13.5
				14.3		13.5-18.3' Silt, fine to coarse sand, gravel grayish brown, saturated	
15					UAT FILL		Sand, silty, gravelly 13.5-18
				18.3 BH			

T-9 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

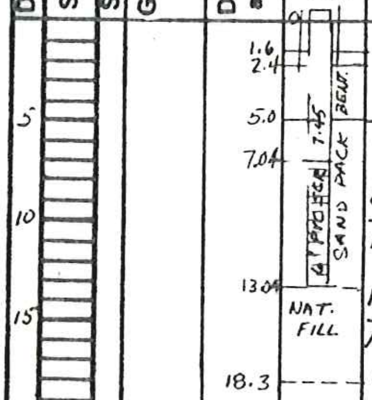
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ________

Twp. ________

Sec. ________

Depth	Scale	Sample	Graphic log	Drill action	Top of CSG -0.41'	Lithologic description	Summary log



Lithologic description

0-2' silty, clayey, fine to medium sand, dark brown.

2-6' silty, clayey fine to medium sand dark brown; gravel fragments to 3/8". Sounds like cobble gravel.

6-8' Silty, clayey fine to coarse sand, gravel fragments to 3/4" (cobble gravel)

8-10' Same as above

10-12' Same as above

12-14 Same as above

14-16 Same as above

16-18 Same as above.

Summary log

Sand, silty, clayey 0-6

Sand, gravelly, silty clayey cobbly 6-18

T-8

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron C. Lane

Rge. ______

Twp. ______ Sec. ______

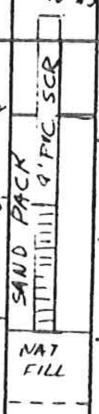
Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

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	TOC -0.65	Lithologic description	Summary log
				0		0-2' Drilling with water. silty clayey fine sand, dark brown.	Sand, silty, clayey 0-3
5				3.8		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			
				18.3			

T-7.2

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist ______

Lithologic Symbols

☐ ☐ ☐

☐ ☐ ☐

Abbreviations

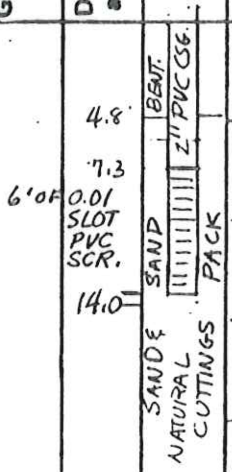
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						SEE LOG T-5 0-20'	



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

☐ ☐ ☐
☐ ☐ ☐

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, 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 log

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
5				
10			}cores	
15				
20			2 SAMPLES	Bentonite

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 (100%) 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%, sandy (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 to be bentonit and is only site that had bentonite or good clay in entire suite 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
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

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 2.5 cm, 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 som. 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

Abbreviations

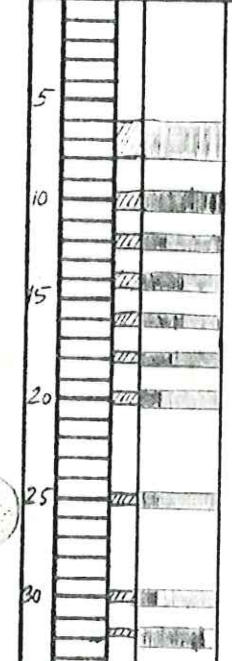
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

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. Gravel, sandy
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.	Sand, gravelly
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.	
18' Sand, coarse (60%) gravelly (40%); brownish black (5YR 2/1, MOIST). Clasts up to 1cm, rounded to angular, 60% basaltic poorly sorted	Gravel, sandy
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%	
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,	

amples only view under binocular Micro: pr 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

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

MRF = Metamorphic rock Fragments

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 vcoss & 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) 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.	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, 25% MRF.	Med sd to fgravel some st. 28 color change 423 it 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 sa 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 80%). dark gray (wet) pebbles to @ 30mm, 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 ts to 2cm, median about 3mm. Clasts 60% basaltic; 10% granitic, 20% MRFs 10% gabbroic	Some st. and f. to co. sand w gravel mostly fine
55		11a cu —			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.
58		12			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% granitic, MRFs 20%	

[illegible]

Location

County

District

Driller

Lithologic Symbols

CLAY SILT SA

GRAVEL

Sec.

On original, there are
coded as follows red yellow
green clay silt sand
gravel brown

Depth	Scale	Sample	Graphic log	Drill action		
		0 · 100%	100%			
5						
		1			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
10		2			② Gravel, granule some pebbles black (wet), angular (clasts appear as if crushed rock, clasts 80% basalt, andesite?, granitic 10%, MRF 5%	
15		3			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.	
20		4			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 (3%).	
25		5			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.	
30		6			⑥ Gravel, sandy; dark brown-to olive, (wet), subround; poorly sorted. Sand fraction 50% quartz, clasts are basalt (50%) granitic (25-30%) MRFs	
35		7			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.	
40		8			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
45		9			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)	Gravel, sandy
50		10			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	
55		11a			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. ⑪b Sand, gravelly slightly silty; dark grey (dry) angular to sub angular, poorly sorted; Clasts 70% basaltic, 20 Mafic granite, 10% MRF.	Sand, gravelly.
58		12			⑫ Sand, gravelly, slightly silty; med grain size about 2mm, dark gray; poorly sorted (max size 2.5cm) Clasts 70% basaltic, 10% gra[illegible], MRFs 20%	

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	Summary log
						34-36' Gravel, 70%) Sandy (30%), greenish black (5G 2/1, WET). Clasts to 5cm, angular (most), basaltic. Gravel, median 2ci, 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%. Grevel 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 80%, 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 Drycolor, 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 J.B. SONTHIER

Lithologic Symbols

Rge. ______

Twsp. ______

Sec. ______

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
						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).	

[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		Lithologic description	Summary log	
						0-2' Mud(85%), sand (15%). olive gray (5GY 4/1, WET). Grity (silt 25%).	Mud, sandy silty	0-6
						2-4' No sample Jar marked but MT.		
5						4-6' Mud (95%) sandy (5%); olive gray (5GY 4/1, WET). Silt (30%).	Gravel, sandy	6-32
						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.		
10						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.		
15						10-12' Gravel as above slightly coaser		
20						12-14' Gravel as above 75% of clasts are angular chips.		
25						14-16' Gravel as above, less silt and clay.		
30						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.	sand and gravel	32-34
35						18-20' Gravel as above except angular chips appear to be fewer	Gravel, sandy	34-52
40						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.		
45						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.		
50						24-26' Gravel as above		
55						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 (40%); olive black (5Y 2/1, WET). Clasts to 1.5cm 60-70% are angular chip 70% basaltic. Gravel median [illegible] mm; sand [illegible] mm.		
						32-34' [illegible]		

2 of 2
H-1 [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	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 (60-70%); lithic (25-30%) 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 . . . 39

Location ______ Date - - -87 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

5
10
15
20
25
30
35
40
45
50
55

Lithologic description

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... sandy). 75% of clasts are angular chips; 80% are mafic.

10-12' Gravel, as above.

12-14 Ditto more mud. 3% 5 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 (N 3, 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, 85% 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 (25%) [illegible] black (5Y 2/1 WET) [illegible] 3cm [illegible]
4[illegible]

Summary log

Mud, silty sandy gravelly	0-6
Gravel, sandy silty	6-16
Sand, gravelly	16-18
Gravel, sandy silty	18-20
Sand, gravelly	20-26
Gravel, sandy	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

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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

Depth: 5, 10, 15

Lithologic description

0-1' No recovery
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

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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	Silt, clayey, sandy 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%), olive 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
5		▨				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 san gravelly 1-4
10		▨				2-4' As above more gravel, strong earthy odor	
15		▨				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, sand. 4-16
						6-8' Gravel (85%). sandy (15%); dark gray (N3, DRY). Clasts to 2.5cm; 75% are angular chips. Gravel median 1cm; sand 1.0mm.	Sand and gravel 16-18
						8-10' Gravel as above slightly more sand.	
						10-12' As above	
						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.	

S-2 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	Summary log
						0-1' No sample - Blactop (ASPHALT).	No sample 0-1'
						1-2'. Silt, clayey (2%), sandy (5%); dusky yellowish brown (10YR 2/2, DRY).	Silt, clayey sandy 1-3'
5						2-4' Silt and gravel; dusky yellowish brown (10YR 2/2, DRY). Clasts to 2cm, 50% broken; MIXED lithic types.	Gravel, sandy 3-18'
10						4-6' Gravel (95%) silty, sandy; medium dark gray (N4, DRY). Clasts to 2.5cm, 80% are angular chips; basaltic. Gravel median 1cm.	
15						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.	

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

Lithologic Symbols

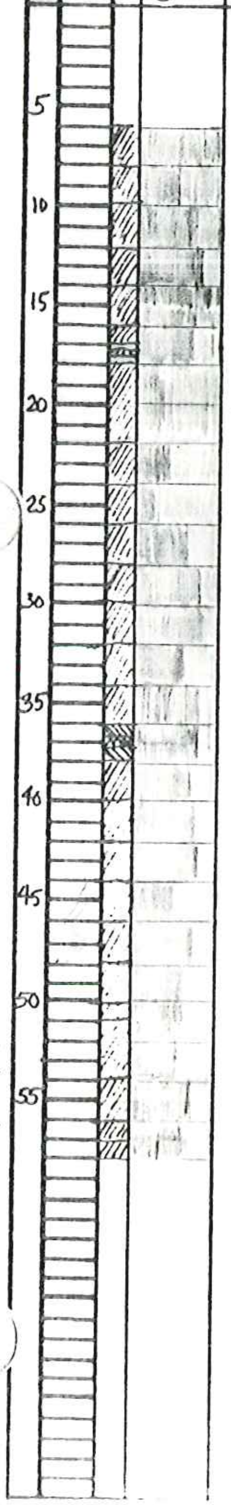
Rge. ______

Twp. ______ Sec.

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

0-6 No sample.

6-8' Gravel, silty; olive gray (5Y 3/2, DAMP), Clasts up to 2.5cm 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 gray. (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 (1mm).

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 1.5cm, mostly rounded To subround, basaltic. Gravel median, 3mm, sand 0.8mm.

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%, MRFs 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] mm.

Summary log

Soil silty clayey

Gravel, silty, sand. 6 - 17.5

Sand, gravelly 17.5 - 26

Gravel, silty, sandy 26 - 37'

sand, gravelly 37 - 38'

Gravel, sand

Sand, gravelly 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

Lithologic Symbols

silt

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

silt
sand gravel

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' Gravel 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% subround 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 5cm, 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

[illegible] Gravel 85% sandy (15%). (5G 3/1, WET). [illegible] 5cm [illegible] angular, [illegible] basaltic [illegible] 1cm Sand [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 ____

H-2 [illegible]

Location ____ Date ____ Local well number ____

County ____ Map ____ Scale ____ Lat. ____ Long. ____

District ____ Project number ____ Altitude ____

Driller ____ Helper ____ Geologist J. B. SOUTHIER

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.	
						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
10						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).	
15						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-5 SAMPLE LOG

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

Depth: 5, 10, 15

Lithologic description

0-2' Silt, clayey (4%), sandy (5%); brownish Black (5YR 2/1, DAMP). Clods 1-2cm and ~~dry~~ silty organic soil.

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.

4-6' Gravel (85%), sandy (15%); medium dark gray (N4, DRY). Clasts ~~angular~~ to 2cm; angular chips 80%+. Gravel median 1.5mm; sand 0.5mm.

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 (5Y4/1, dry

12-14 Gravel 90% silt (4%) sandy (6%); olive gray (5Y4/1, DRY). Clasts to 3cm; 70% angular chips. Gravel median 1cm; sand 0.125mm.

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

17.5 Sand (70%), silty 25% gravelly (5%); olive grey (5Y 4/1, WET). Sand median 0.08mm.

Summary log

Silt, clayey, sandy	0-2
Sand, silty, gravelly	2-4
Gravel, sandy	4-16
Sand, silty, gravelly	16-18

B-4 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	Summary log
						0-1' No sample- BLACK TOP	Blacktop 0-1
						1-2' Silt, clayey(4-5%), sandy (5-10%) gravelly 5%; olive black (5Y 2/1, DAMP). Clods with pebbles	silt, clayey, sandy, gravelly 1-4
5						2-4' Silt, clayey (4%), sandy(8%) gravelly 25%). olive gray (5Y 4/1, DAMP). Clasts are angular chips; Gravel median 7.5mm.	Sand and gravel 4-6
10						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.	Gravel, sandy, (silty) 6-18
15						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 2.5 CM. 75% angular. Gravel median, 3mm; sand 0.5mm mm.	
						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.	

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

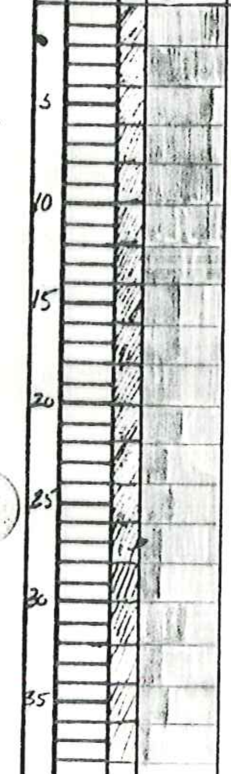
Abbreviations

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 anguler chips basaltic. Gravel median 7.5mm.

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%); alive 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/[illegible] [illegible]). Clasts to 2.5cm, 5[illegible] [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

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

Depth: 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

E-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	
						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	silt, sandy	0-4
5						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.	Sand, gravelly	4-6
						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.	Gravel, sandy	6-12
10						6-8' Gravel (50%), Sandy (50%); olive black (5Y 2/1, MOIST) clasts to 2cm, rounded and angular. basaltic. Gravel median, 5mm, sand 1mm.		
						8-9' Gravel (60%), sandy (40%). olive black (5Y 2/1, MOIST). Clasts to 2.0cm, angular, basaltic. Gravel median, 4mm; sand, 1mm.		
						9-10' Gravel (70%), sandy (30%); olive black (5Y 2/1, WET) Clasts to 1.2cm, angular 50% to rounded 50%, basaltic. Gravel median 5mm, sand 1mm.		
						10-12 Gravel; (75%) sandy 25%; olive black (5Y 2/1, WET. Clasts to 1cm, 25% are angular chips, 75% basaltic. Gravel median 4mm, sand 1.5mm		
15						12-14' Sand (55%), gravelly (45%); olive black (5Y 2/1, MOIST). Clast to 1.5cm, rounded, basaltic. Gravel median, 4mm; sand 1mm.	Sand, gravelly	12-14
						14-16' Gravel (70%), silty (5%) Sandy 25%; olive black (5Y 2/2, WET). Clasts to 1.5cm angular >50%, subround 30 to 40%, Basaltic >70%, gravel median 5mm; sand 0.5mm.	Gravel sandy	14-18'
						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.		

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

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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 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 3/2, 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 05mm.		
		▨	▒			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. ____

Twp. ____

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 0.35 mm.	

Sheet 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 7mm, 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 3cm, rounded to subround; 20% angular chips, [illegible] Sand median [illegible] cm.	

1 . 3

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

Rge. ______

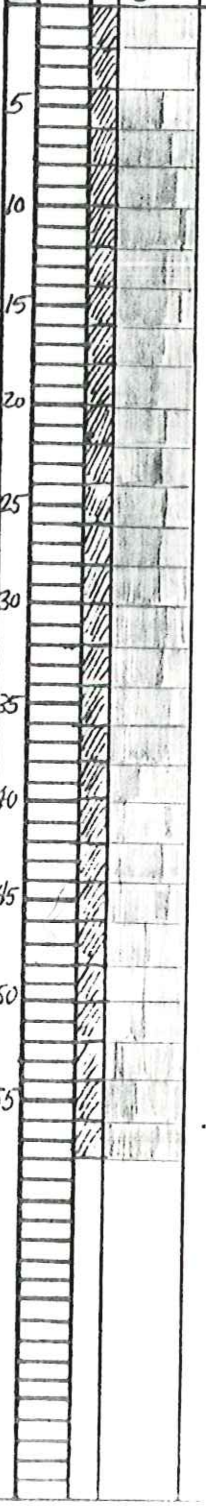
Twsp. ______

Sec.

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' (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%))

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 4/2, 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.

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).

22-24' Gravel (60%) sandy (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.

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; 50% are angular chips, basaltic ([illegible]) Gravel median 4mm, sand [illegible]mm.

28-30' Gravel 55 [illegible] are angular [illegible]

Summary log

Soil, mud, silty sandy	0-4
Gravel, sandy	4-38
Sand, gravelly	38-40
Gravel, sandy	40-52
Sand, gravelly	52-56
Gravel, silty sandy	56-58

T 20 SAMPLE LOG

Location ______ Date -2-87 Local well number ______
County ______ Map ______ Scale ______ Lat. ______ Long. ______
District ______ Project number ______ Altitude ______
Driller ______ Helper ______ Geologist J. B. GONTHIER
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	
						0-2' Silt (80%) sandy (10%) gravelly (10%); dusky yellow (5Y 5/4, DRY). Clasts to 1cm; 50% are angular chips.	silt, sandy, gravelly	0-2
5						2-4' Sand (45%), silty (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.	Sand, silty gravelly	2-4
10 15						4-6' Gravel 70%, silty (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.	Gravel, sandy silty	4-18
						6-8' Gravel (85%), sandy (15%); olive gray (5Y 4/1, DRY), Clasts up to 2cm; 90% are angular chips, 80% 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.		

T-19 FIELD 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

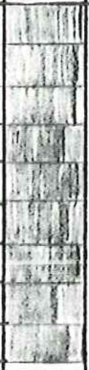
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______ Sec. ______

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log

Depth: 5, 10, 15



Lithologic description

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.

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.

4-6' Gravel(95%); sand (5%); medium dark gray (N4, DRY). Clasts to 1.5cm, 80 to 90% 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; 70% 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

Summary log

silt, sandy gravelly	0-2
Gravel, sandy	2-18

Location ______ Date ______ Local well number T-18 SAMPLE LOG

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist J.B. GONTHIER

Lithologic Symbols

MUD	SAND	
SILT	GRAVEL	

Abbreviations

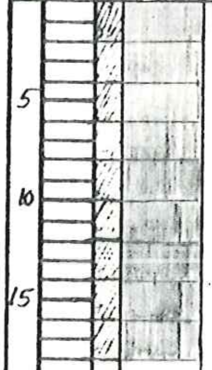
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ______

Twsp. ______

Sec. ______

Depth | Scale | Sample | Graphic log | Drill action



Lithologic description

0-2' Mud, silty. dusky yellowish brown (10YR 2/2, MOIST).

2-4' Silt, clayey, dark yellowish brown (10 YR 3/2, DRY).

4-6' Silt, clayey and sandy; (as above darker color.

6-8' Silt (60%), clayey (5%) sandy (35%); moderate brown (5YR 3/4, MOIST).

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 angularchips, 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.

Summary log

Silt, clayey, sandy.	0 - 10
Gravel, sandy	10 - 18

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

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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' 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.	
						4-6' Gravel, sandy (as above)	
						6-8' Gravel, sandy (as above)	
10						8-10' Grave, sandy (as above).	
						10-12' Gravel(90%), sand (10%) as above; olive black (5Y 2/1, WET); Diesel oil smell.	
15						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

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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 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 4-18'
10				D 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
15				D		6-8' Gravel 85% sandy 15% as above slightly coarser grained (chips 80-90%)	
						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 (10YR 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.	
10						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.	Gravel, sandy 6-18
15						8-10' Gravel (60%); silty (5%) sandy (35%); dark yellowish brown (10YR 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 (10%) sandy 10%, 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.	

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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

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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
						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 [illegible] 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

☐ ☐ ☐
☐ ☐ ☐

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				

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 grey (5Y6 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 angular 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.	26-38

T-12 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

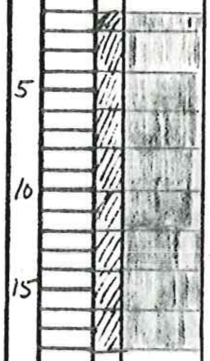
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____

Twsp. ____

Sec. ____

Depth | **Scale** | **Sample** | **Graphic log** | **Drill action**



Lithologic description

0-1' No sample

1-2' Silt, clayey (5%) sandy (5%); dark yellowish brown (10 YR 3/2, MOIST).

2-4' Silt, clodded some gravel, dark yellowish brown (10 YR 3/2, MOIST)

4-6' Gravel (90%), sandy (10%); medium dark gray (N4, DRY). Clasts to 2.5cm. 80 TO 90% are angular basalt chips. Gravel median 5mm; sand 10mm.

6-8' Gravel as above slightly coarser.

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 .5mm.

16-18' Gravel as above, larger clasts, less angular.

Summary log

No Sample (asphalt)	0-1
silt, clayey, sandy	2-4
Gravel, sandy, silty	4-18

STRONG DIESEL ODOR

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

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, silty, organic; brownish black (5YR 2/1, DRY).	Silt, clayey organic 0-5
5						2-4' Silt, clayey (4%) sandy (5%); dark yellowish brown (10 YR 4/2, DRY); some rootlets.	Gravel, clayey, silty, Sandy 5-18'
10						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.	
15						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.	

T 10 [illegible] Log

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist JB GONTHIER

Rge. ______

Twp. ______

Sec. ______

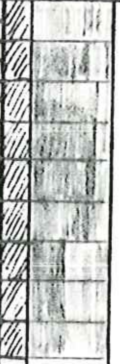
Lithologic Symbols

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

Depth: 5, 10, 15



Lithologic description

0-2' Silt, clayey and sandy. some rootlets. dark yellowish brown (10YR 4/2, DRY).

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.

4-6' Gravel (85%), sandy (15%); medium gray (N3, DRY). Clasts 2.5cm, 70% are angular chips, basaltic. Gravel median 5mm; sand 1.0mm.

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 1.5mm; sand 0.125mm

14-16' Gravel as above, wet, less silt, more sand

16-18' Gravel as above.

Summary log

silt, clayey, sandy	0-2
Gravel, silty, sandy	2-18

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

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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. ______

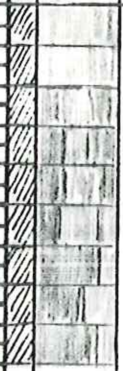
Sec.

Depth | Scale | Sample | Graphic log | Drill action

5

10

15



Lithologic description

0-2' Mud, silty and sandy; dusky yellowish brown (10YR 2/2, MOIST).

2-4' Mud, silty, sandy, gravelly (20%); dusk yellowish brown (10YR 2/2, MOIST).

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.

6-8' Sand (60%); muddy (3%) silty (10%) gravelly (38%); dusky yellowish brown (10YR 2/2 WET). Clasts To 2.5cm, angular. Gravel median, 1cm; sand .5mm.

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.

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.

Summary log

Mud silty sandy gravelly	0-5
Gravel, muddy, silty	5-6
Sand, muddy, silty, gravelly	6-12
Gravel, sandy	12-18'

T-7 SAMPLE LOG

Location ______ Date 1- 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	
						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		
5						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.		
10						24-26' Gravel as above Clasts to 3cm.		
15						26-28' Gravel as above clasts to 1.5cm.		
20						28-30' Gravel (68%), 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.	Sand, gravelly	20-22
25						30-32' Gravel as above except 3% mud. (10YR 2/2)	Gravel, sandy	22-36
30						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.		
35						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.		

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

☐ ☐ ☐

☐ ☐ ☐

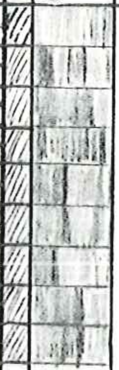
Abbreviations

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	Summary log
						0-2' Mud, silty sandy; some organic rootlets. Dusky yellowish brown; (10YR 3/2, WET)	Mud, silty, sandy, organic 0-3'
5						2-4' Gravel (35% muddy (30%) silty 20% sandy 15%); dusky yellowish brown (10YR 3/2, WET). Clasts to 3cm, angular.	Gravel, sandy, silty 3-12
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.	Sand and gravel, silty 12-14
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.	Gravel, sandy 14-18
						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 frow pebbles. Gravel median, 7.5mm; sand, 0.5mm.	
						16-18' Gravel as above.	

March 3, 1849

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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ECOLOGY

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

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:

District Chief
U.S. Geological Survey
Section
1201 Pacific Avenue - Suite 600
Tacoma, Washington 98402

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Federal Center, Box 25425
Denver, Colorado 80225

CONTENTS

CONTENTS--Continued

ILLUSTRATIONS

ILLUSTRATIONS--Continued

PLATES

[Plate in pocket at end of report]

TABLES

TABLES--Continued

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.

It would be nice to have a
[illegible] profile/cross section through
the site, to aid this discussion - fig 2. isn't enough

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] diesel recovery program may [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

KV

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.

there some way
that the year the well
was drilled? or some
way to differentiate between
the different study periods.
Maybe not in Table 2?

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.

Any idea how these wells were constructed? If the BTEX was at top of water table it may not be detected in wells cased to [illegible]

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 [illegible] determine these 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.

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] first [illegible] MCL in [illegible] B(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 tolune e 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 vs. 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 Month? 1985 and Month? 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.

— any conjecture as to how you would expect to see concentrations relate to season?

— Do you think additional sampling in 1991 would improve results? Or are you saying 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).

TA3

TA4

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.

TA5

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).

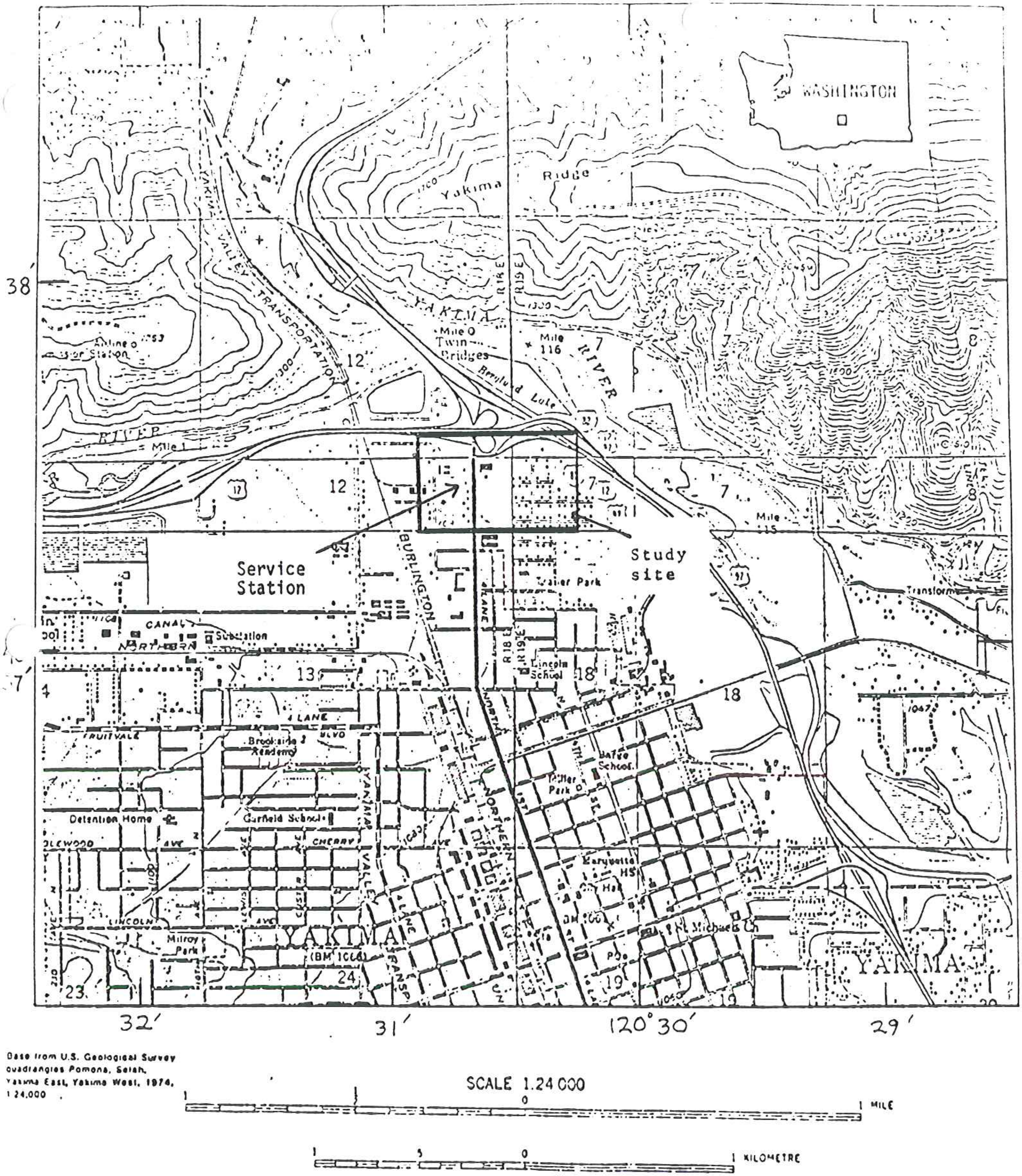
TA6

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

CONTOUR INTERVAL 20 FEET

DATUM IS SEA LEVEL

Figure 1.--Location of the gasoline and diesel-fuel leak site at Yakima, Washington.

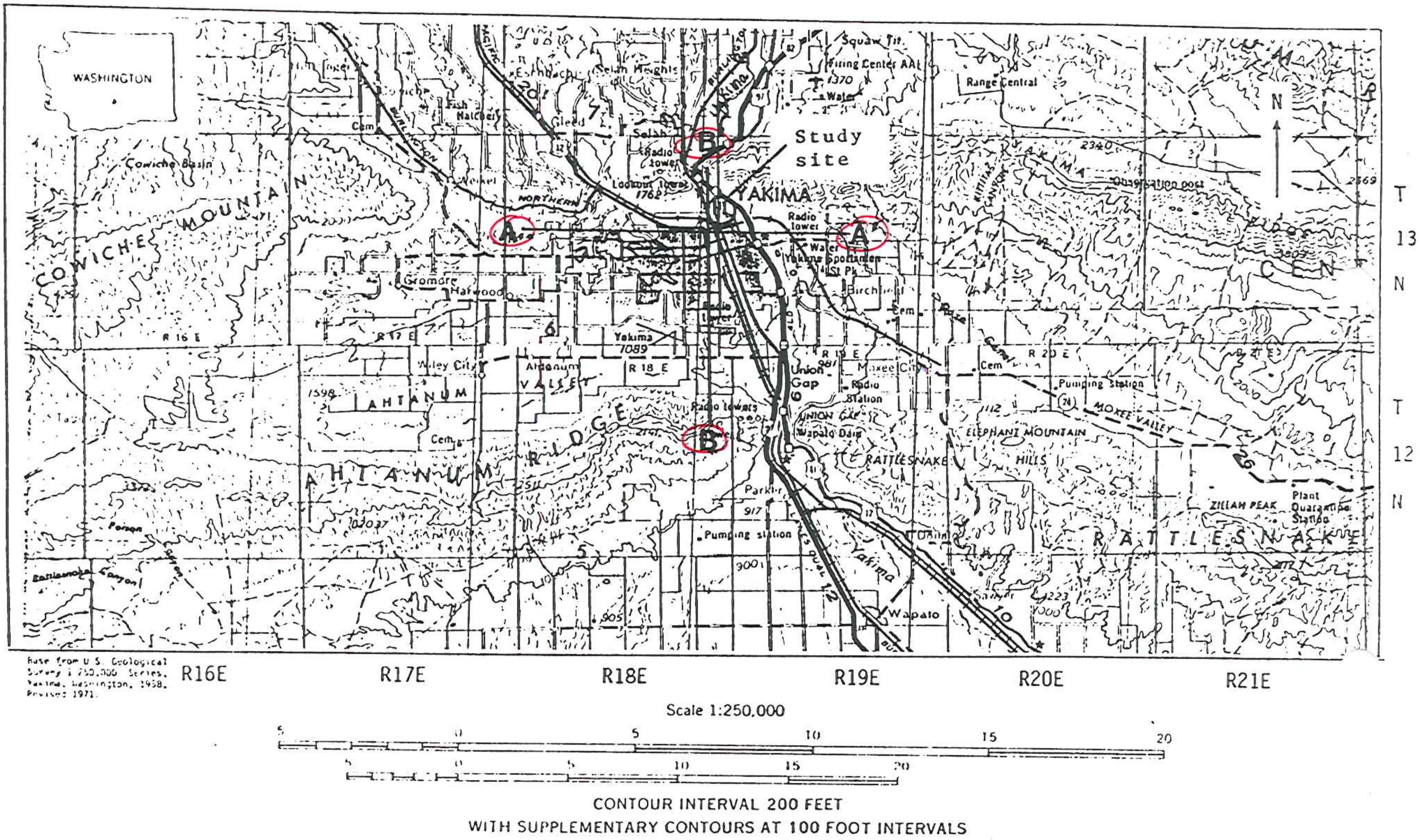


Figure 2.--Subbasin formed by the Ahtanum and Moxee Valleys, Washington. Cross-sections A-A' and B-B' shown on figure 3.

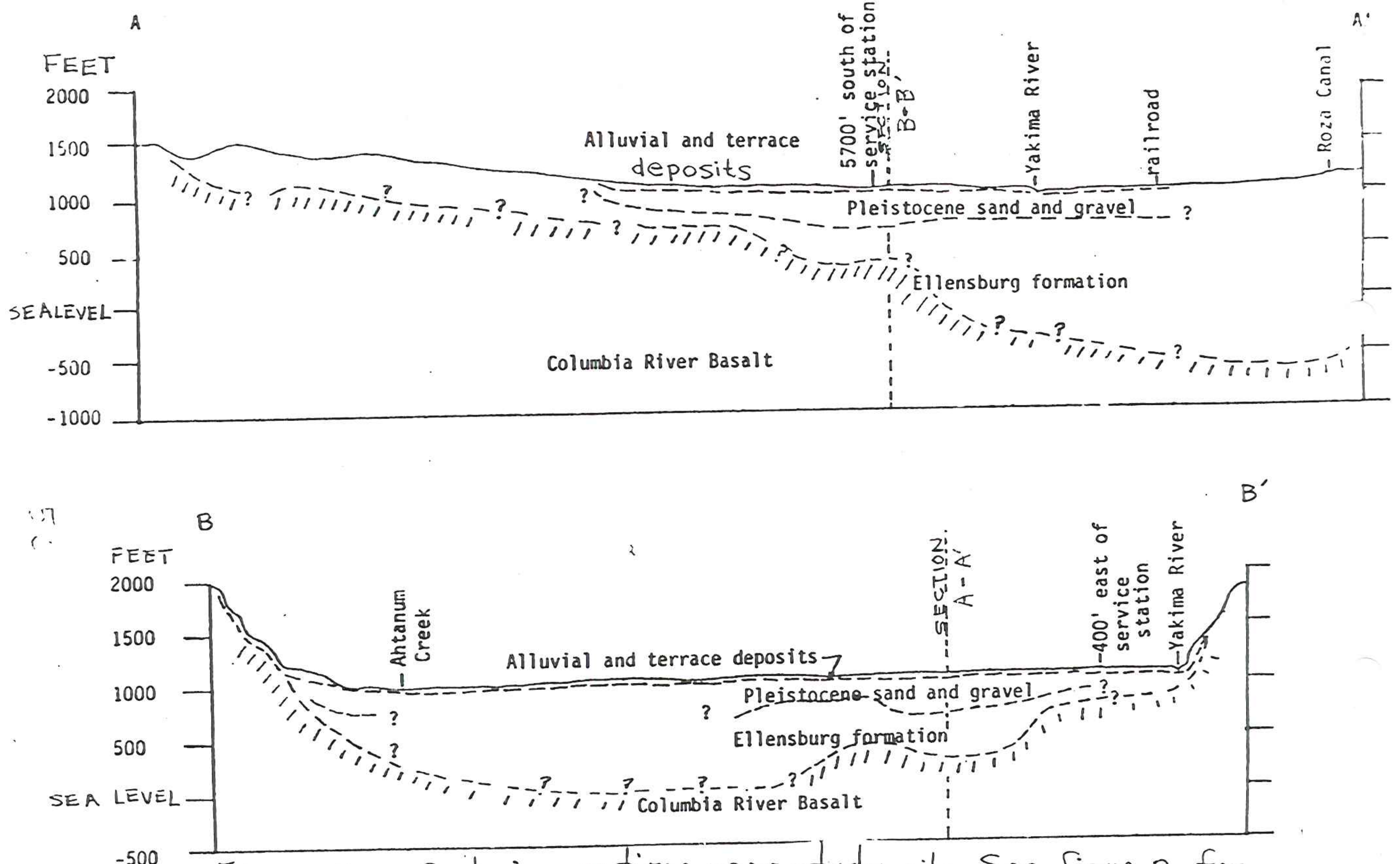
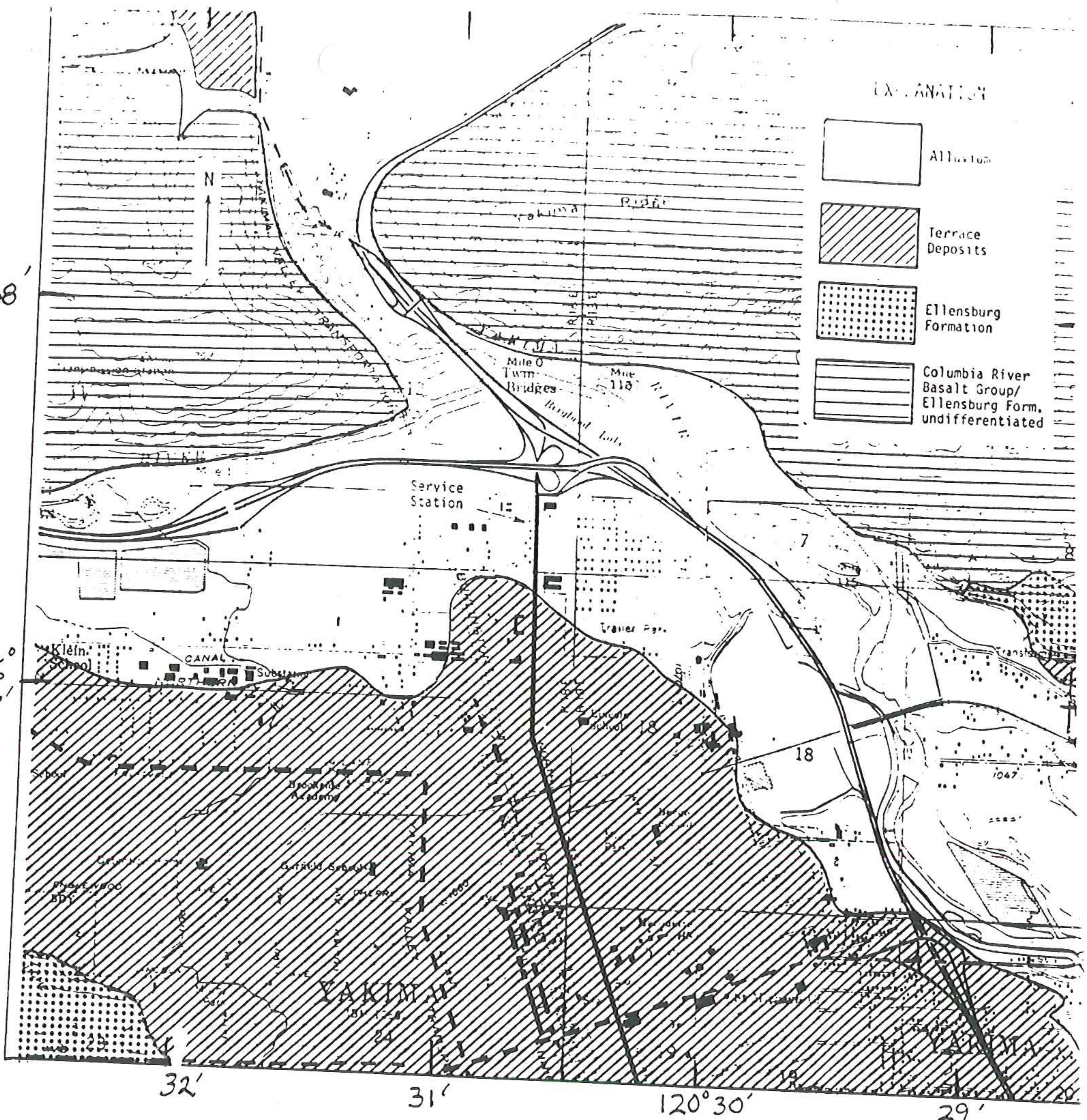


Figure 3.-- Geologic sections near study site. See figure 2 for locations of sections. Geology based on well logs. Pleistocene sand and gravel shown on section only.

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

SCALE 1:24 000

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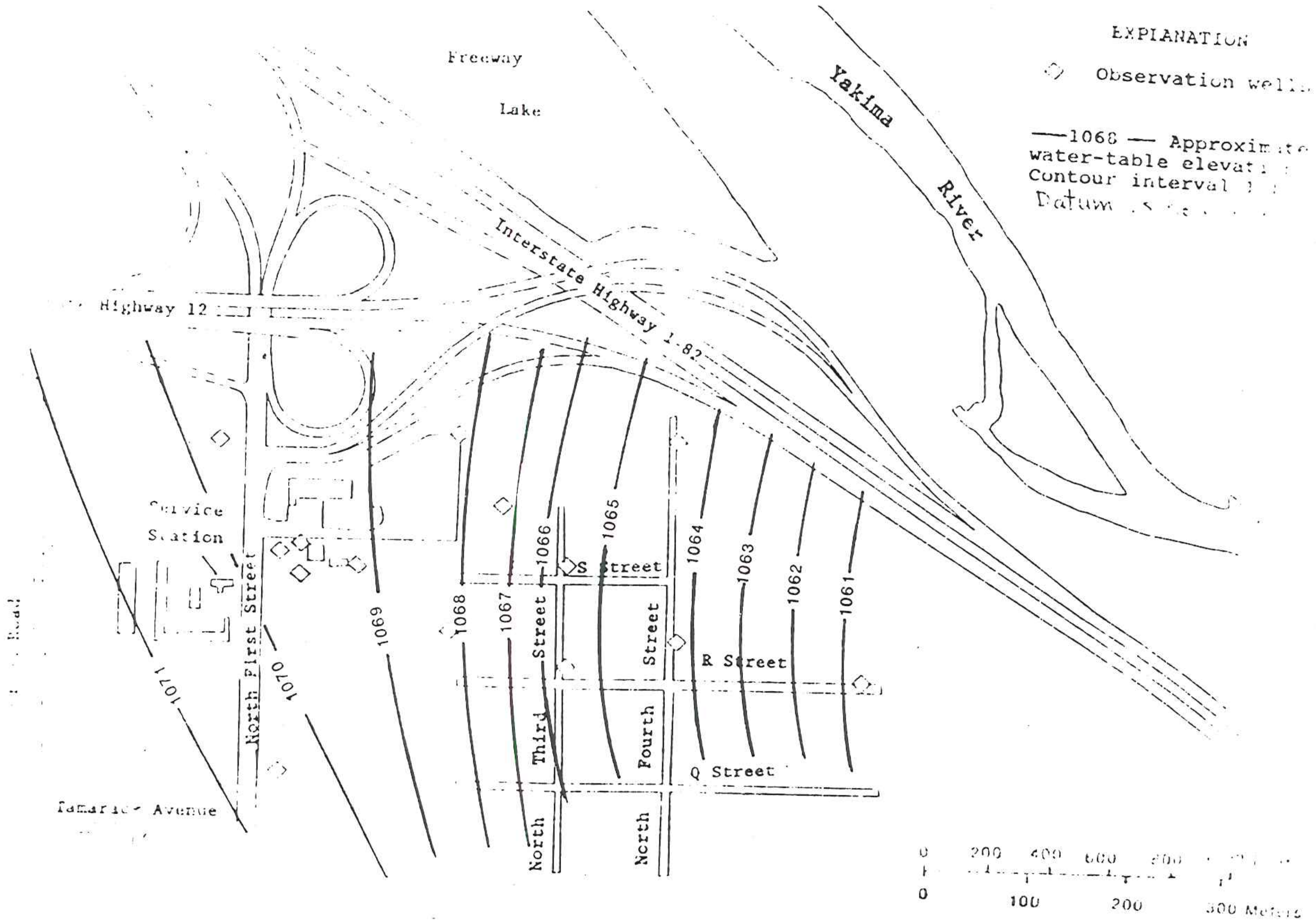
Adapted from Be
and Campbell,

CONTOUR INTERVAL 20 FEET
DATUM IS SEA LEVEL

Figure 4.--Surficial geology near the study site



5.-- [illegible] July, 1986 at the study site

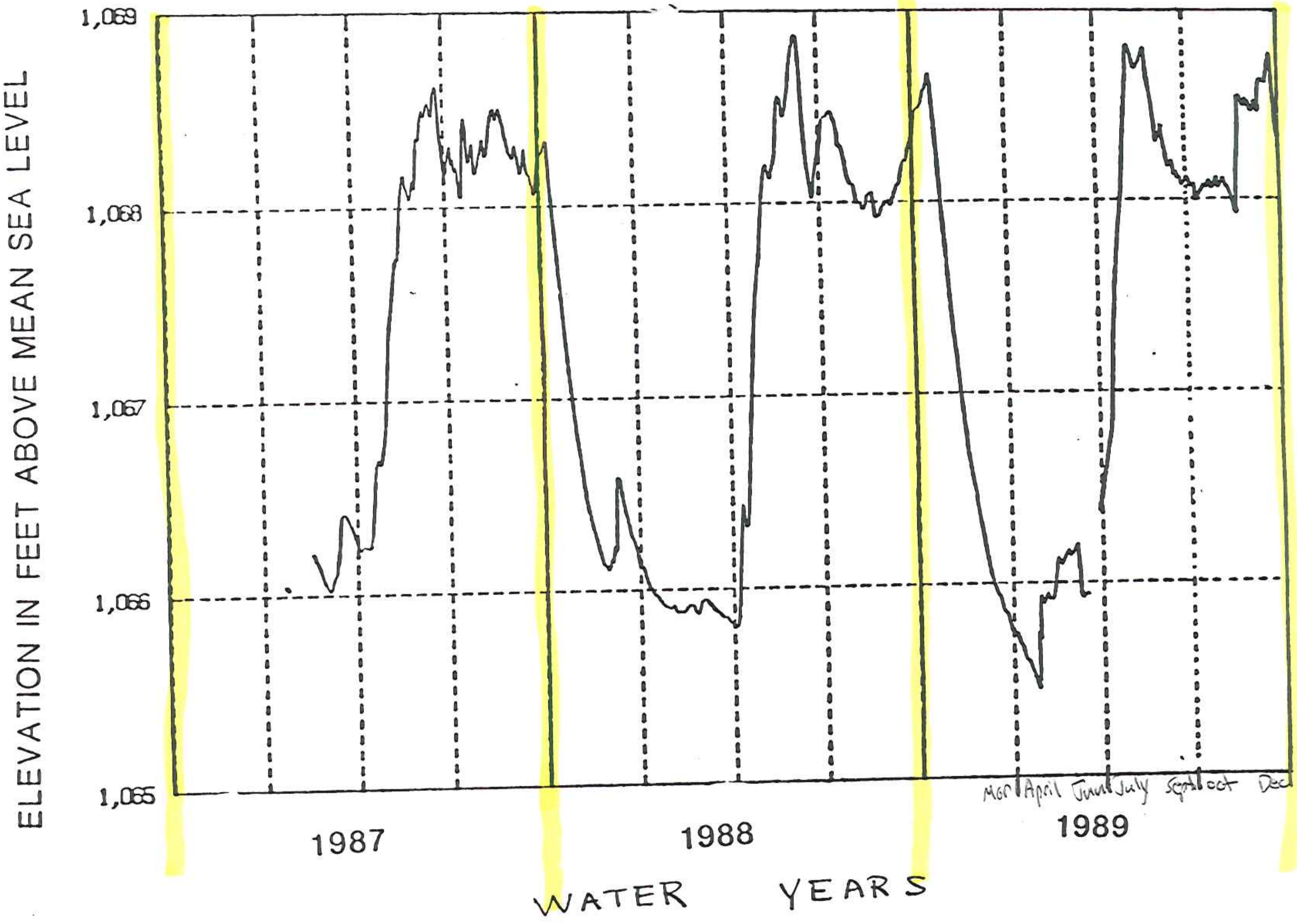


Figure 6.-- Mean daily observed water levels in well M14, water years 1987 through 1989. Water year ending September 30. Land surface elevation is 1076.14 feet above sea level.

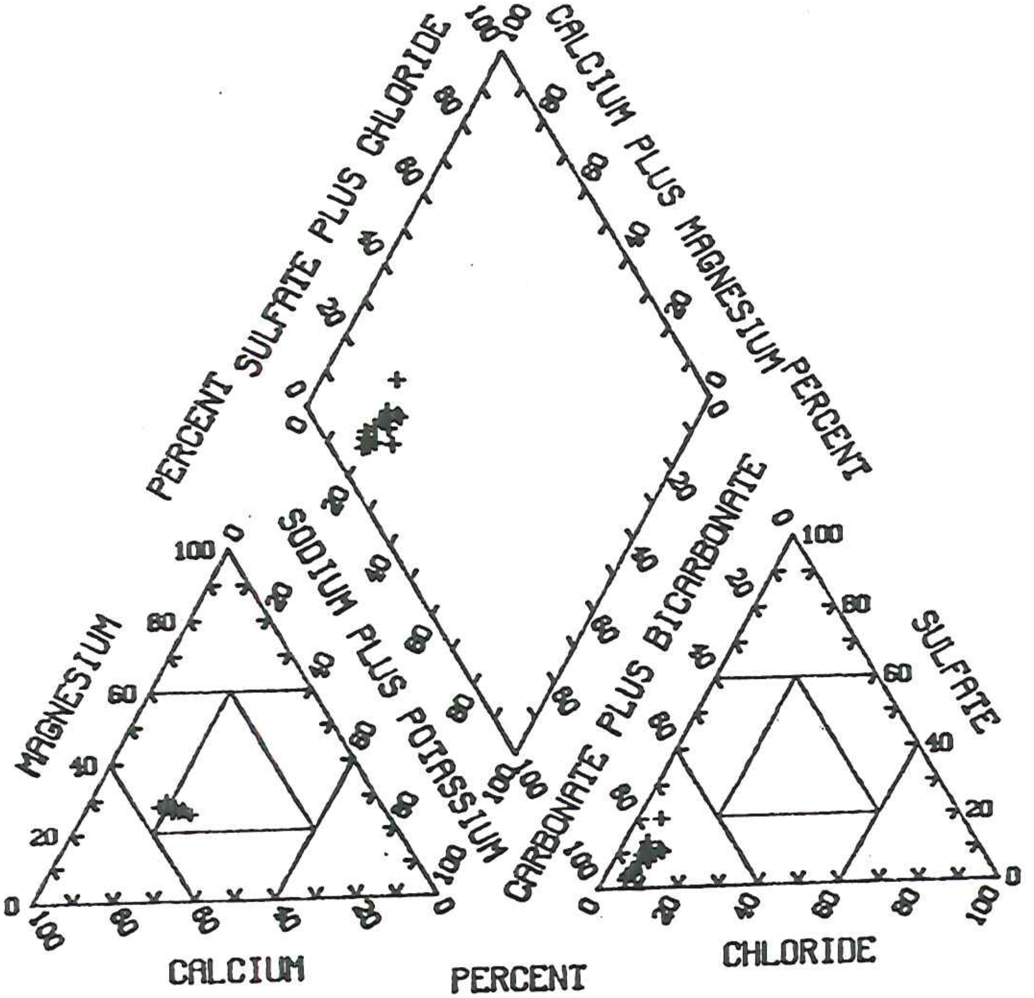
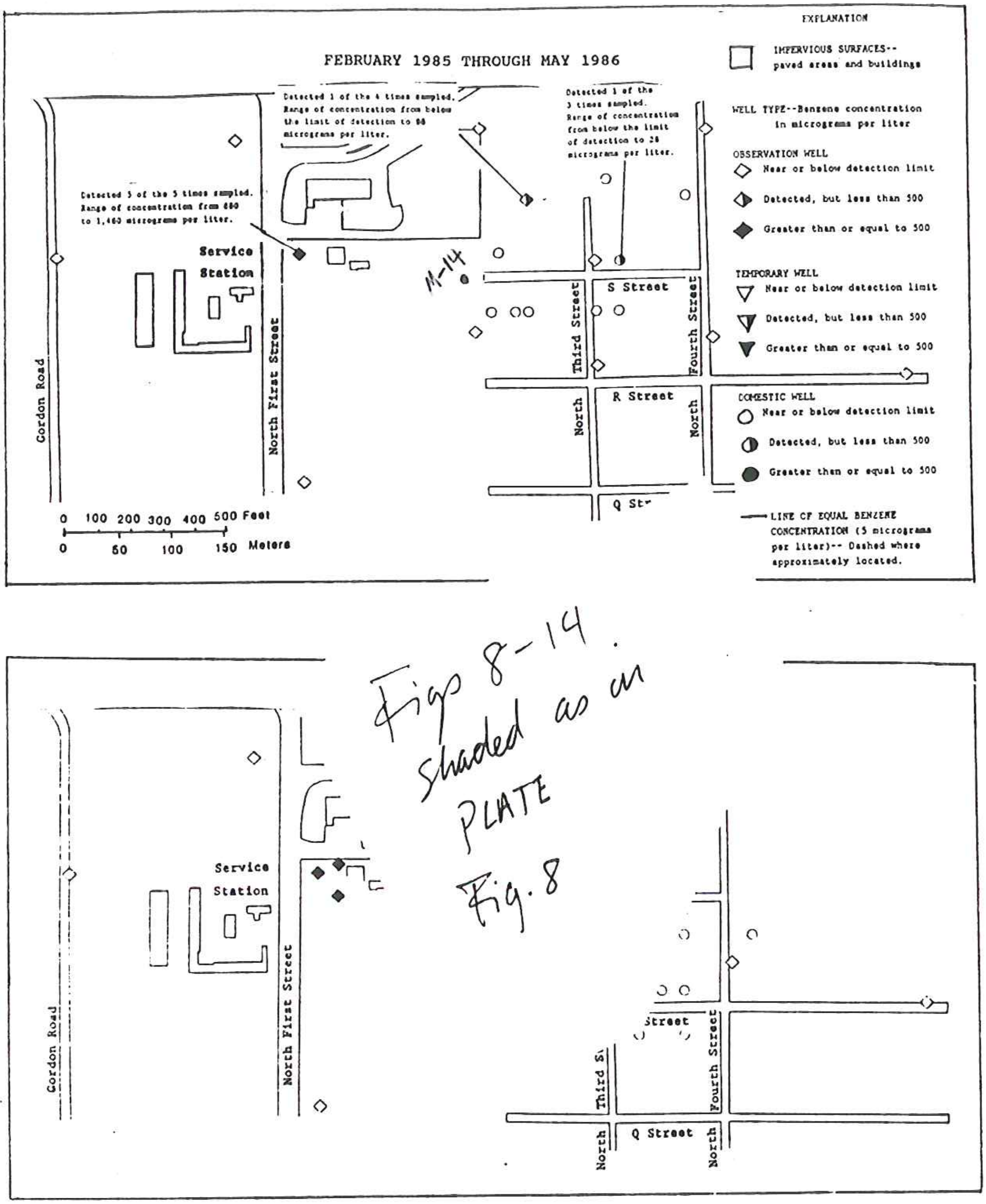


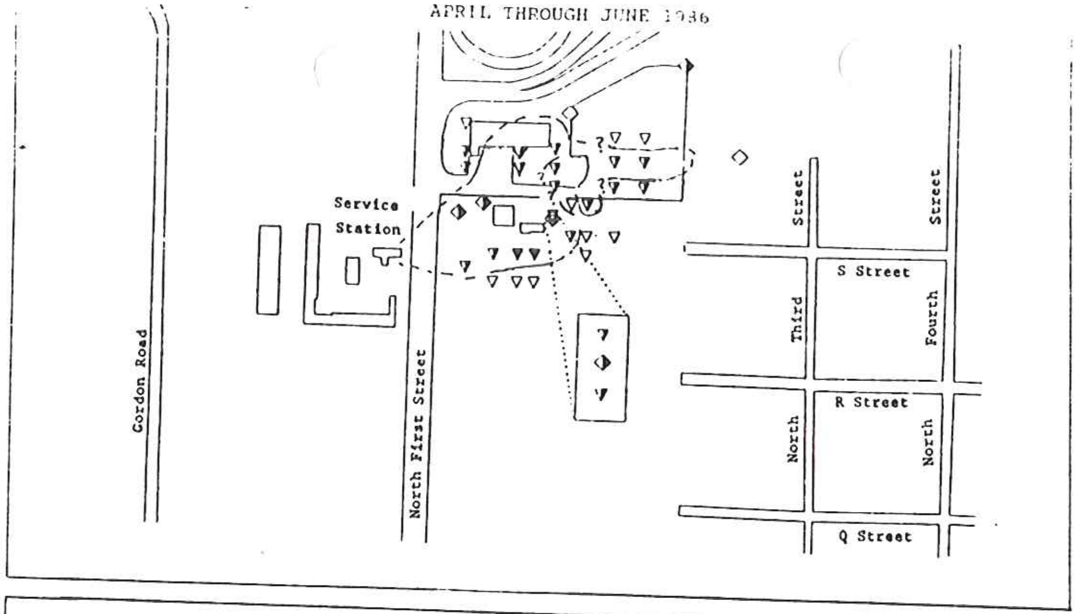
Figure 7.-- Percentage of major ions in ground water,
1986 and March 1989.



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



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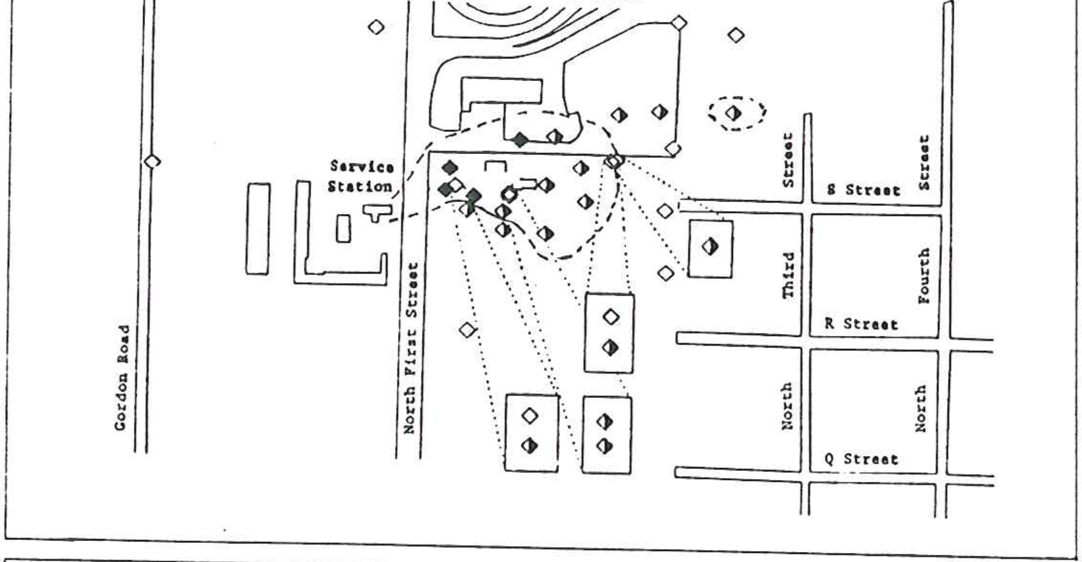
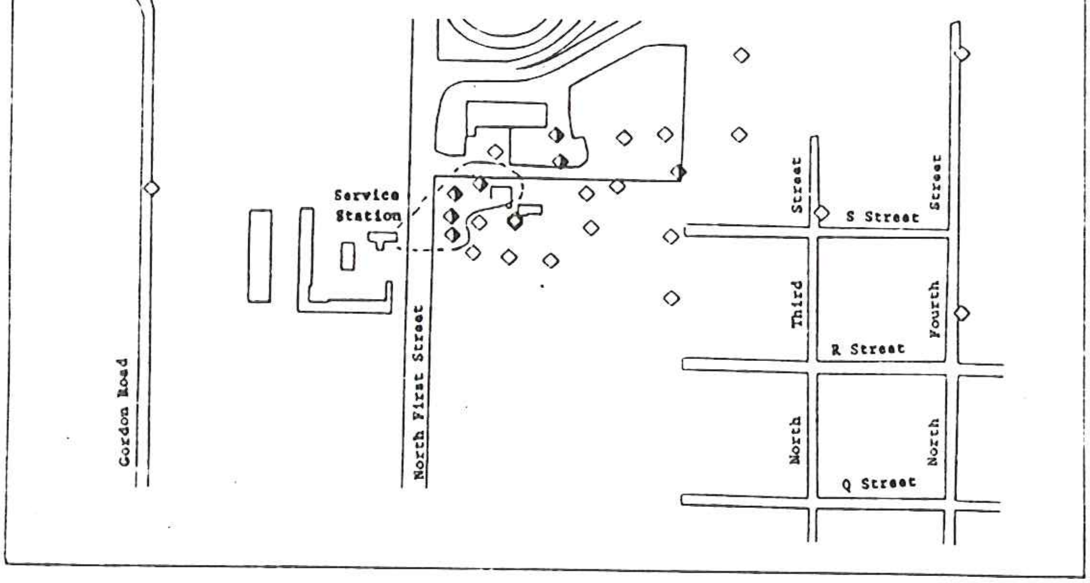


MARCH 1989



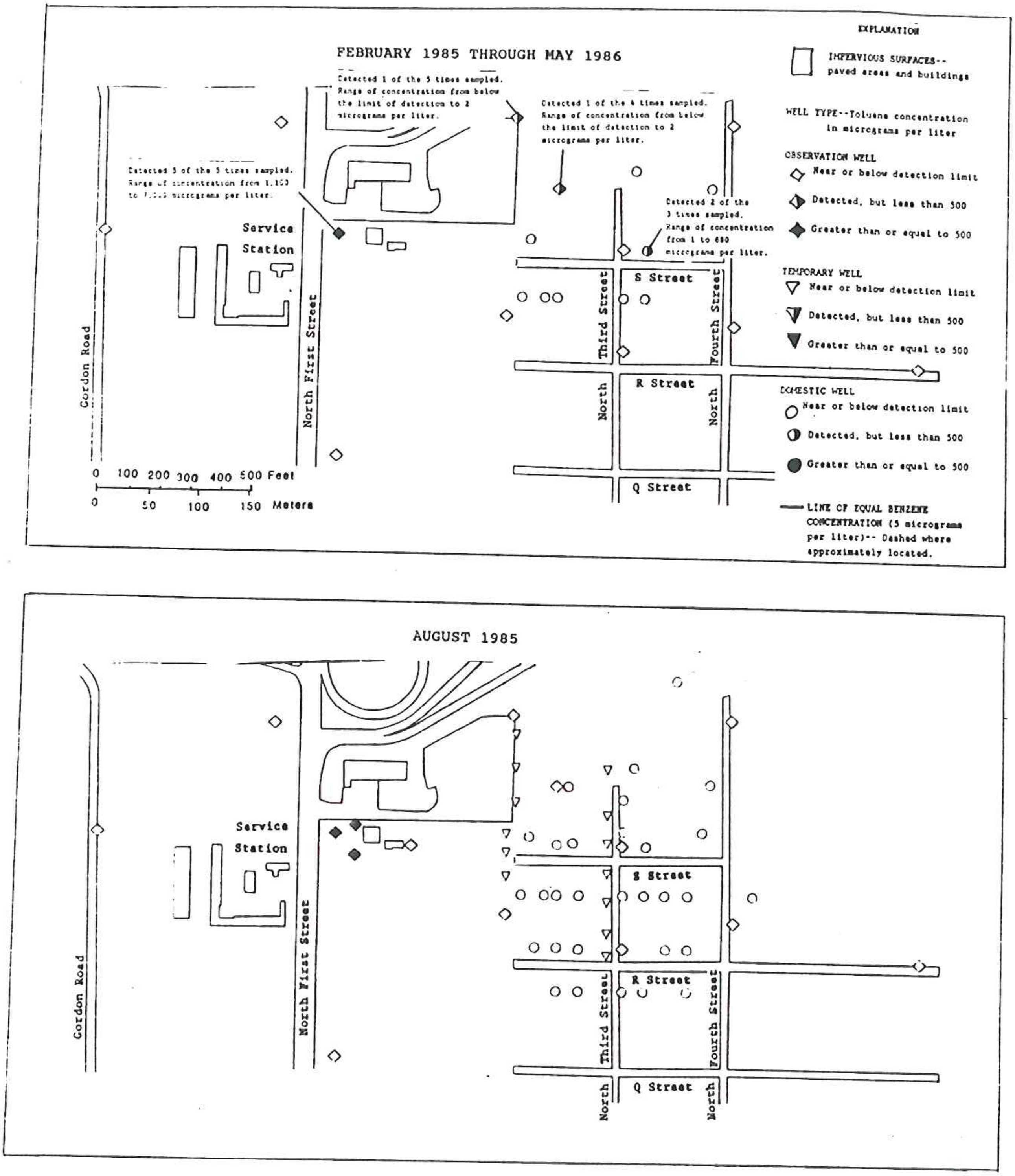
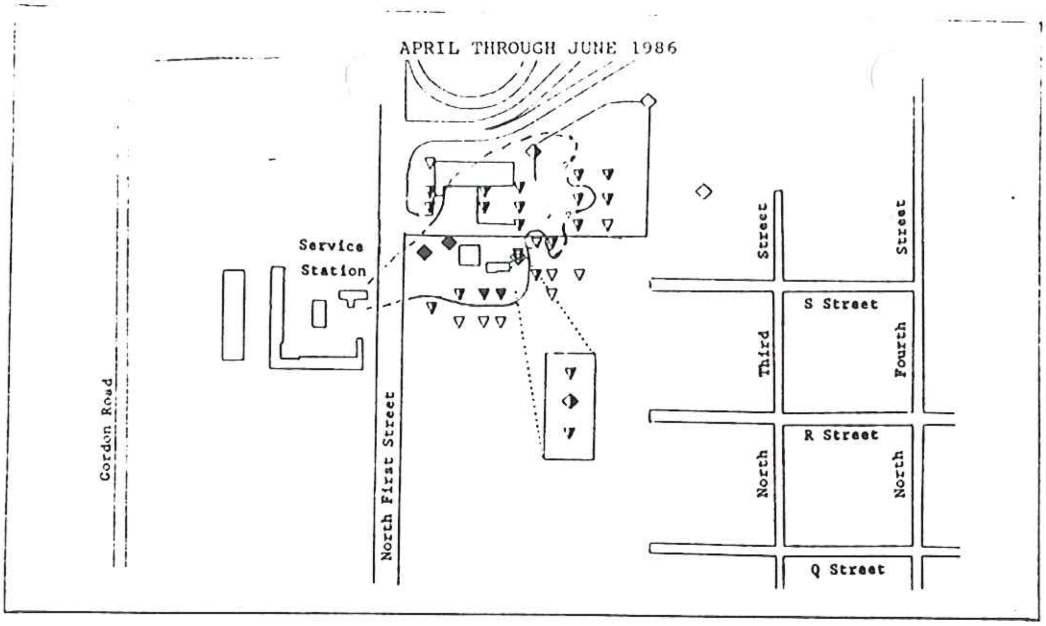


Figure 9.-- Concentrations of toluene in ground water, February 1985 through March 1989.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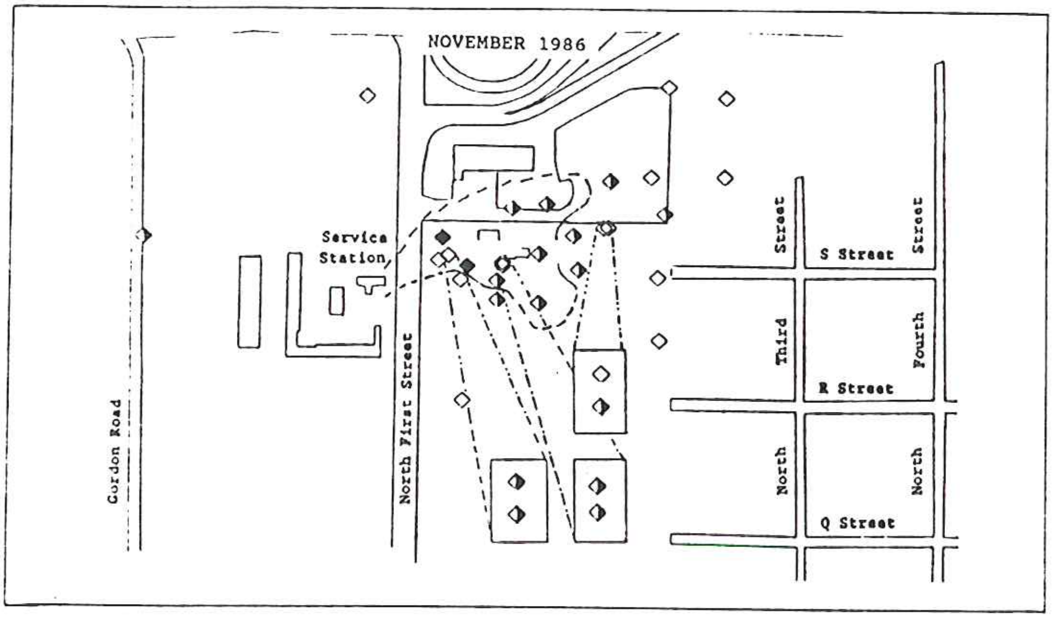
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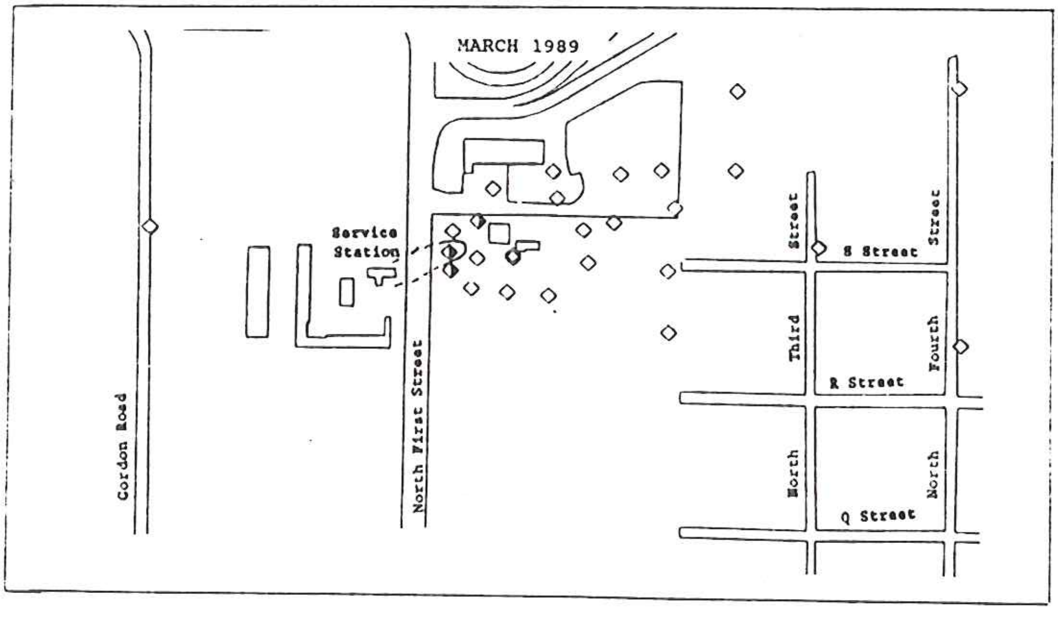
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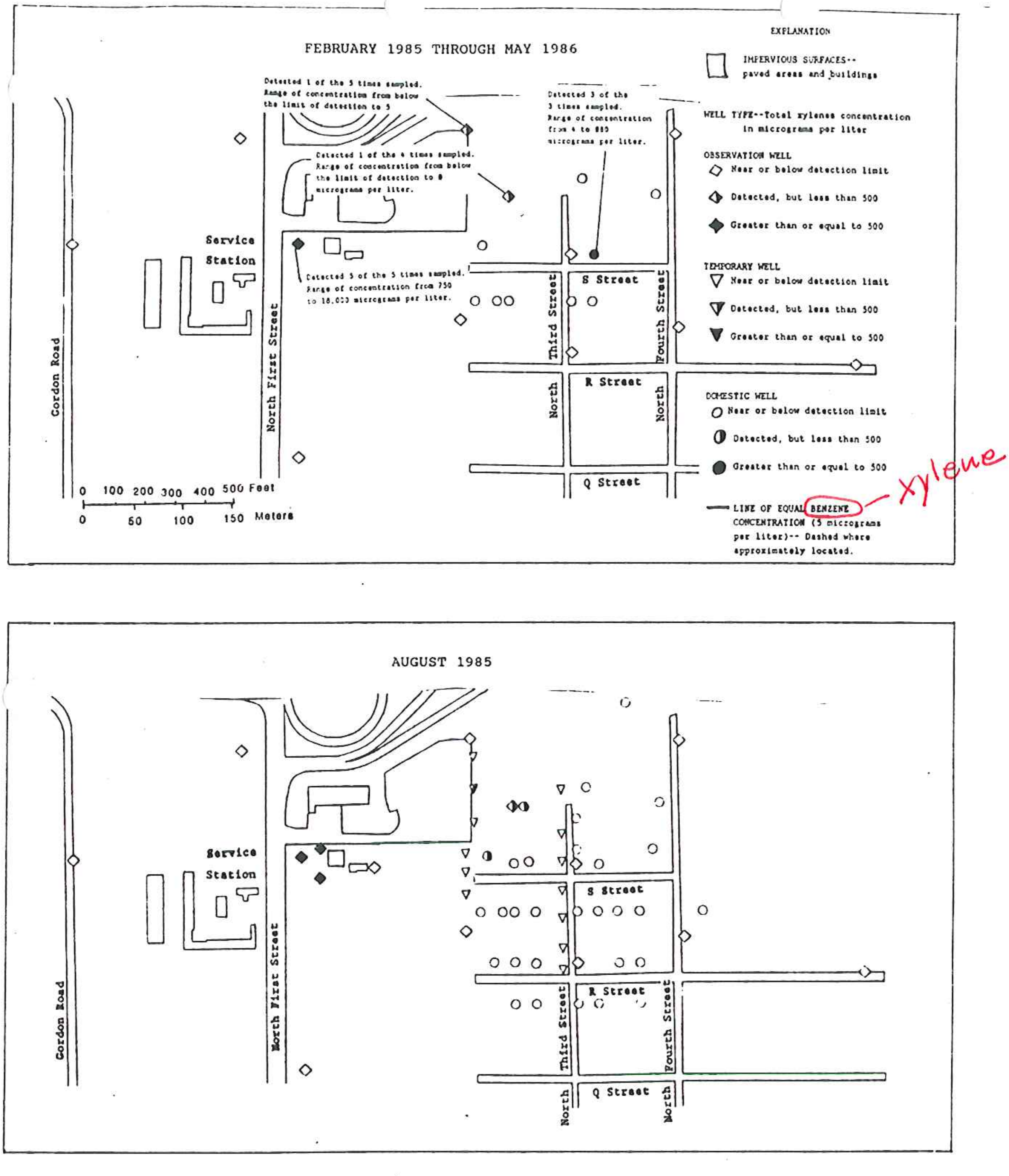
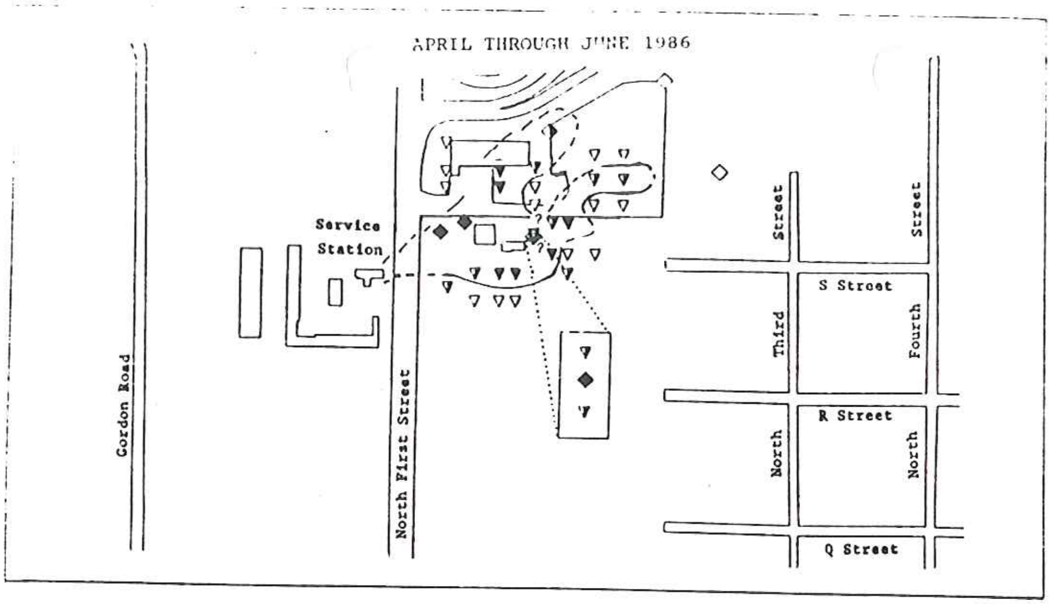


Figure 10.--Concentrations of total xylenes in ground water, February 1985 through March 1989.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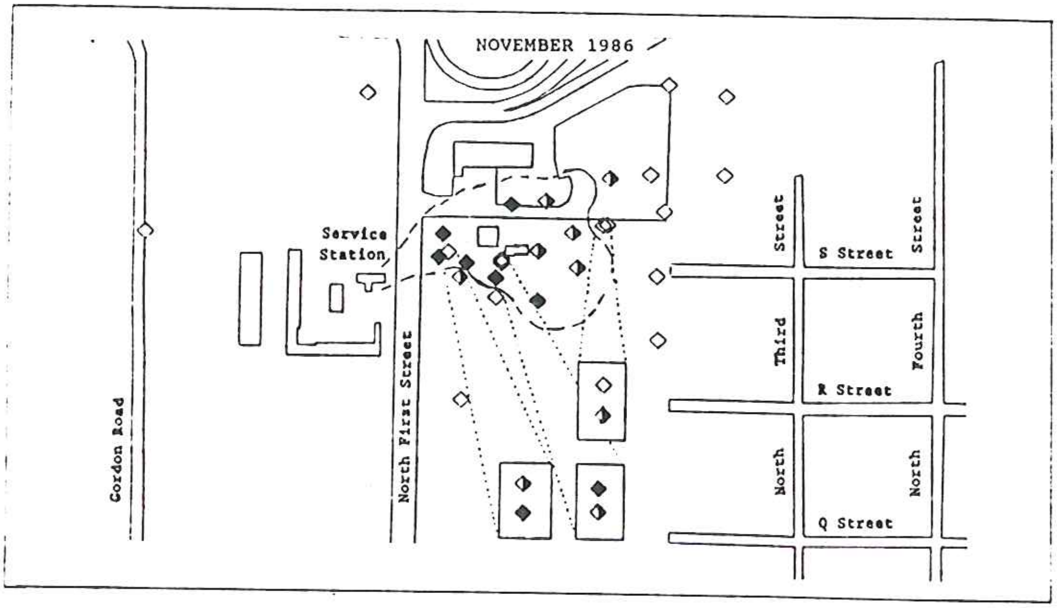
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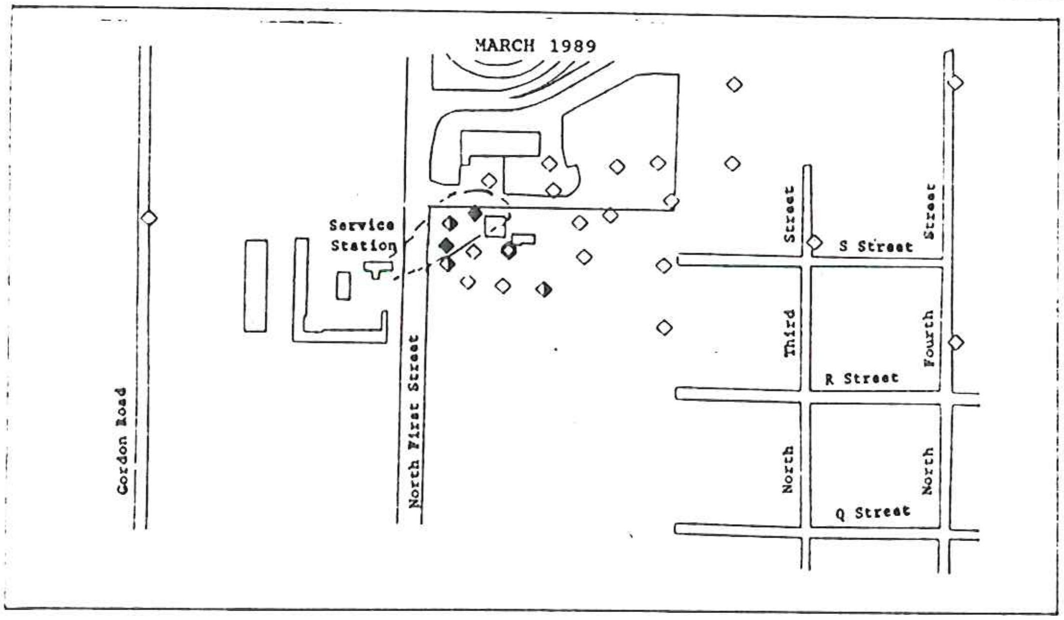
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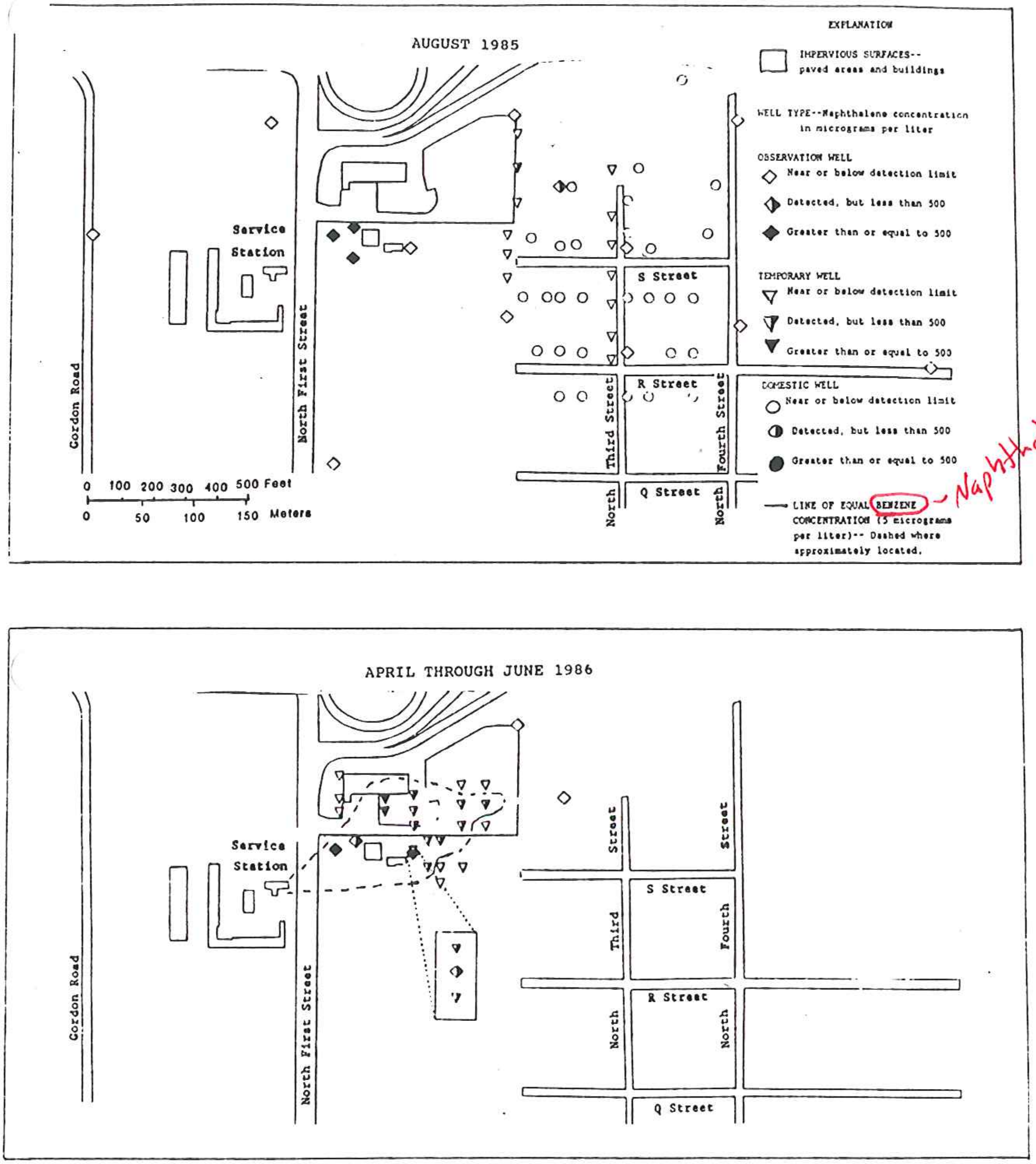
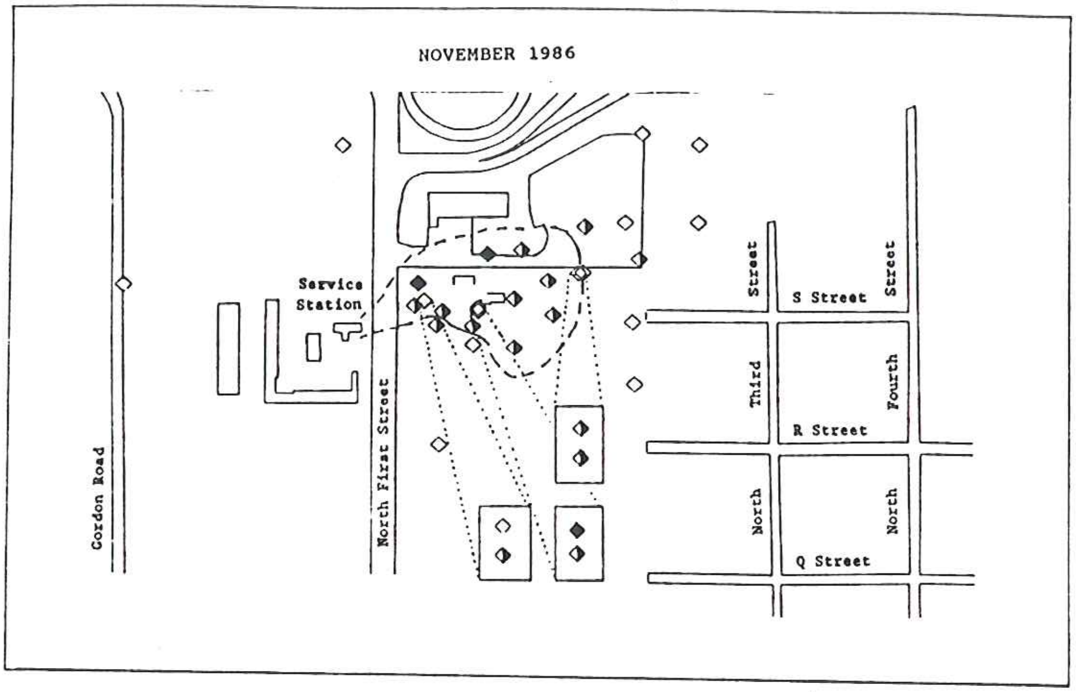


Figure 11.-- Naphthalene concentrations in ground water, August 1985 through March 1989.



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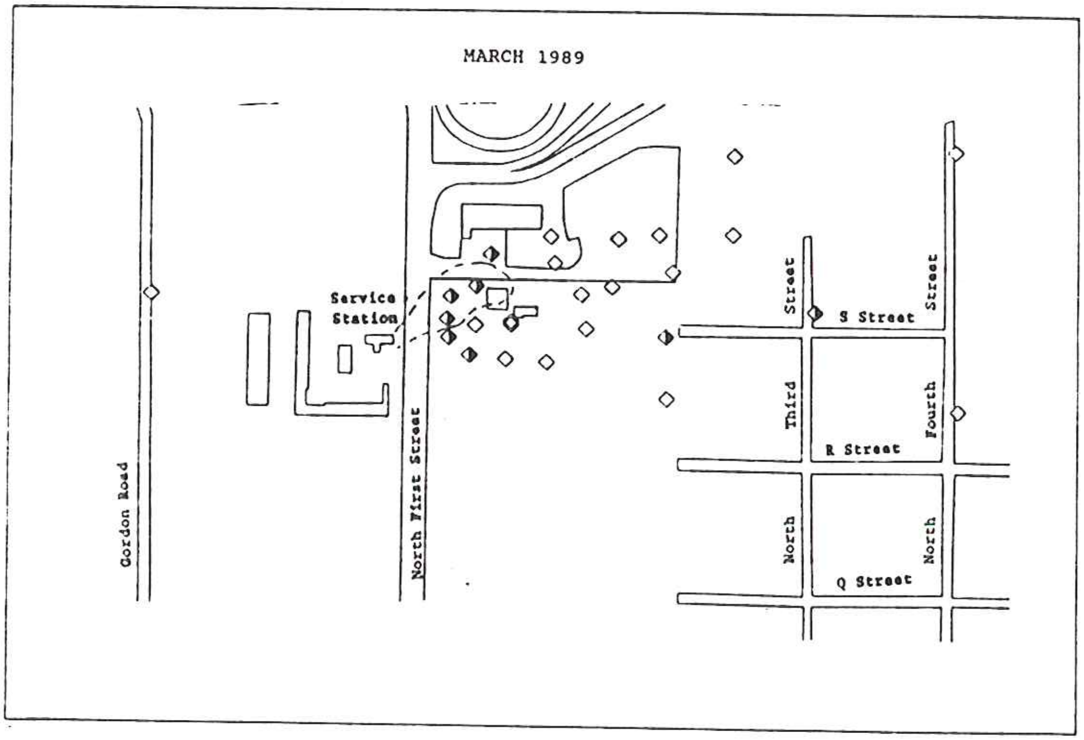

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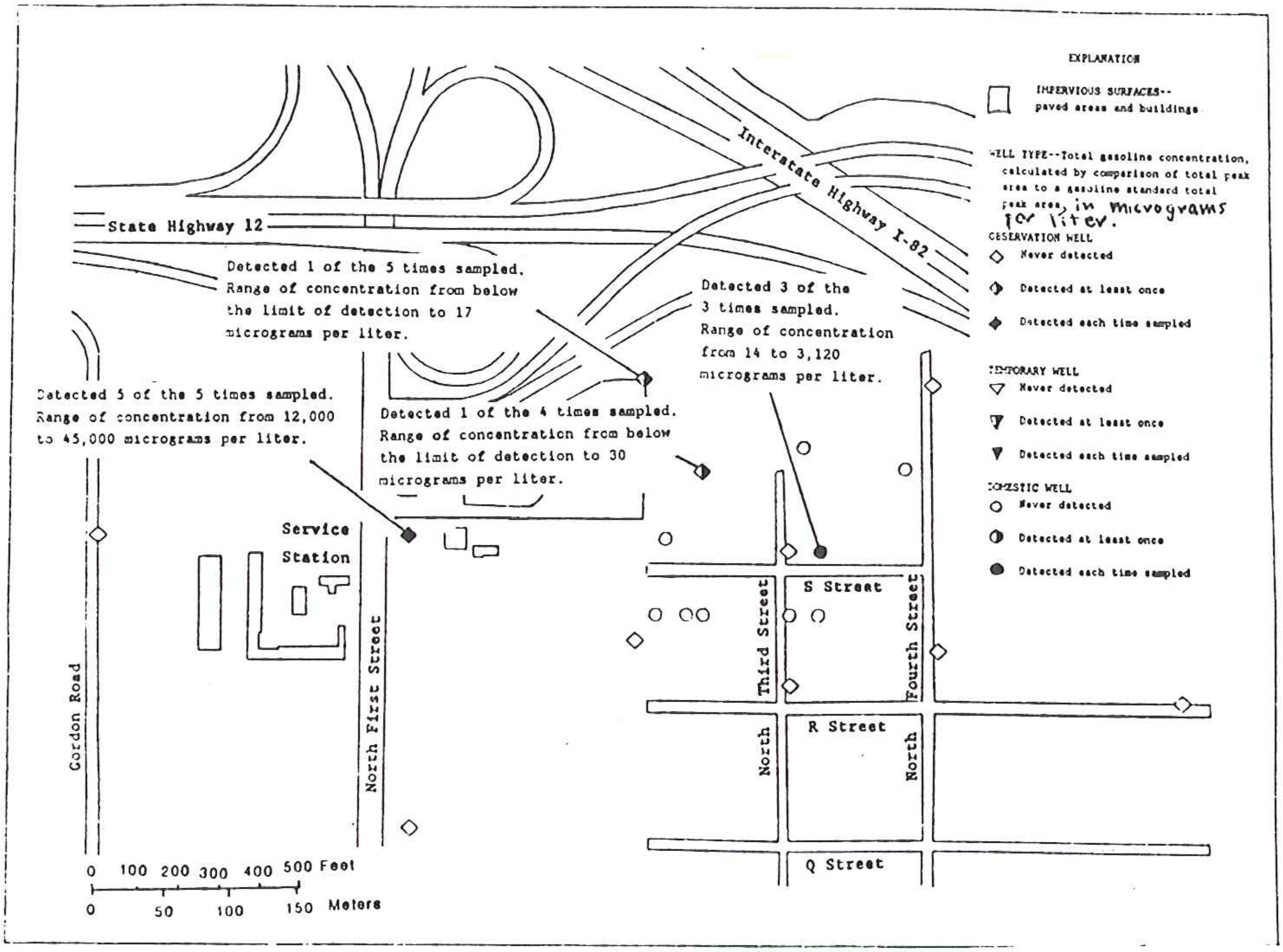


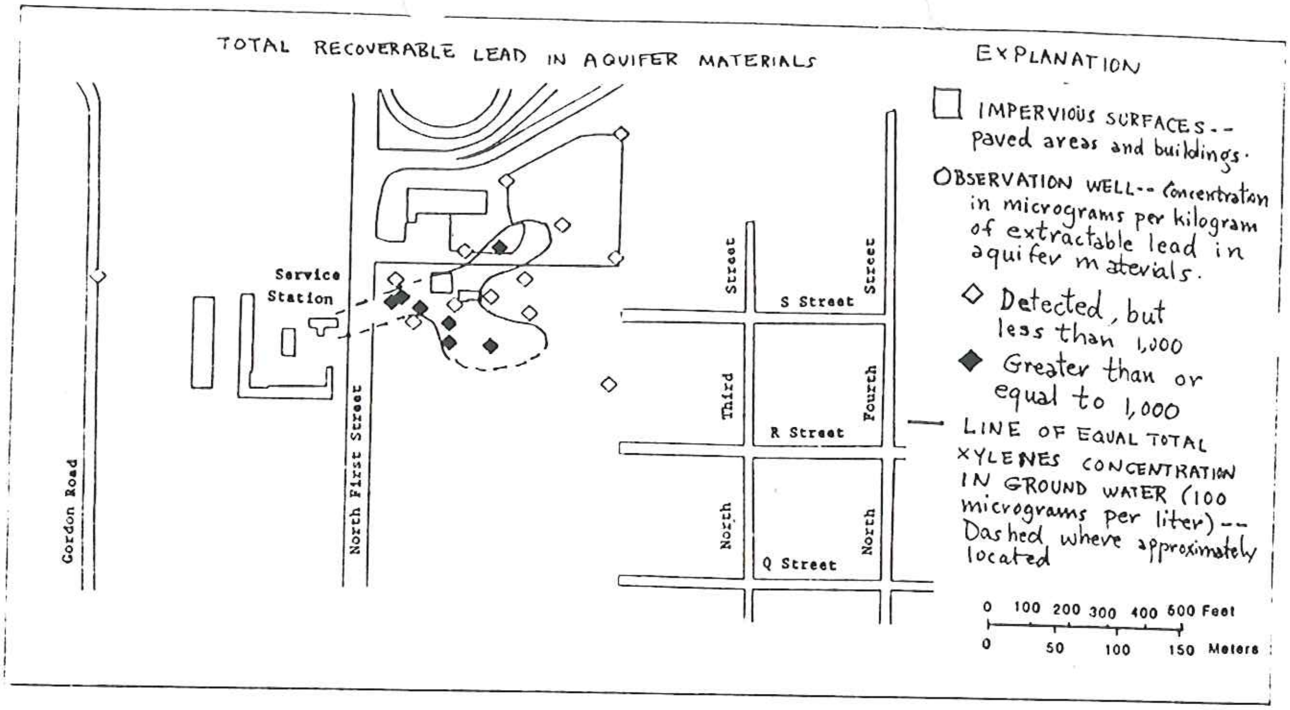
Detected 1 of the 5 times sampled. Range of concentration from below the limit of detection to 17 micrograms per liter.

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.



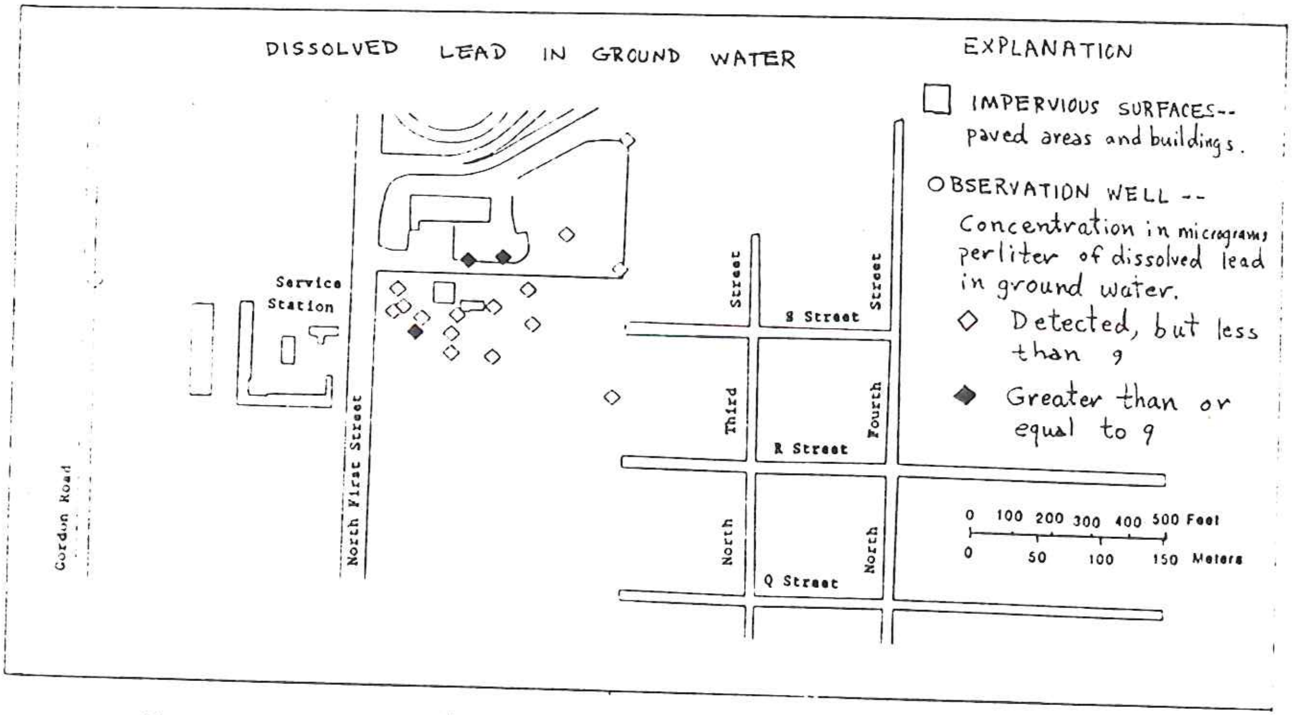


Figure 13.-- Concentrations of total-recoverable, lead in aquifer material and dissolved lead in ground water, November 1986.

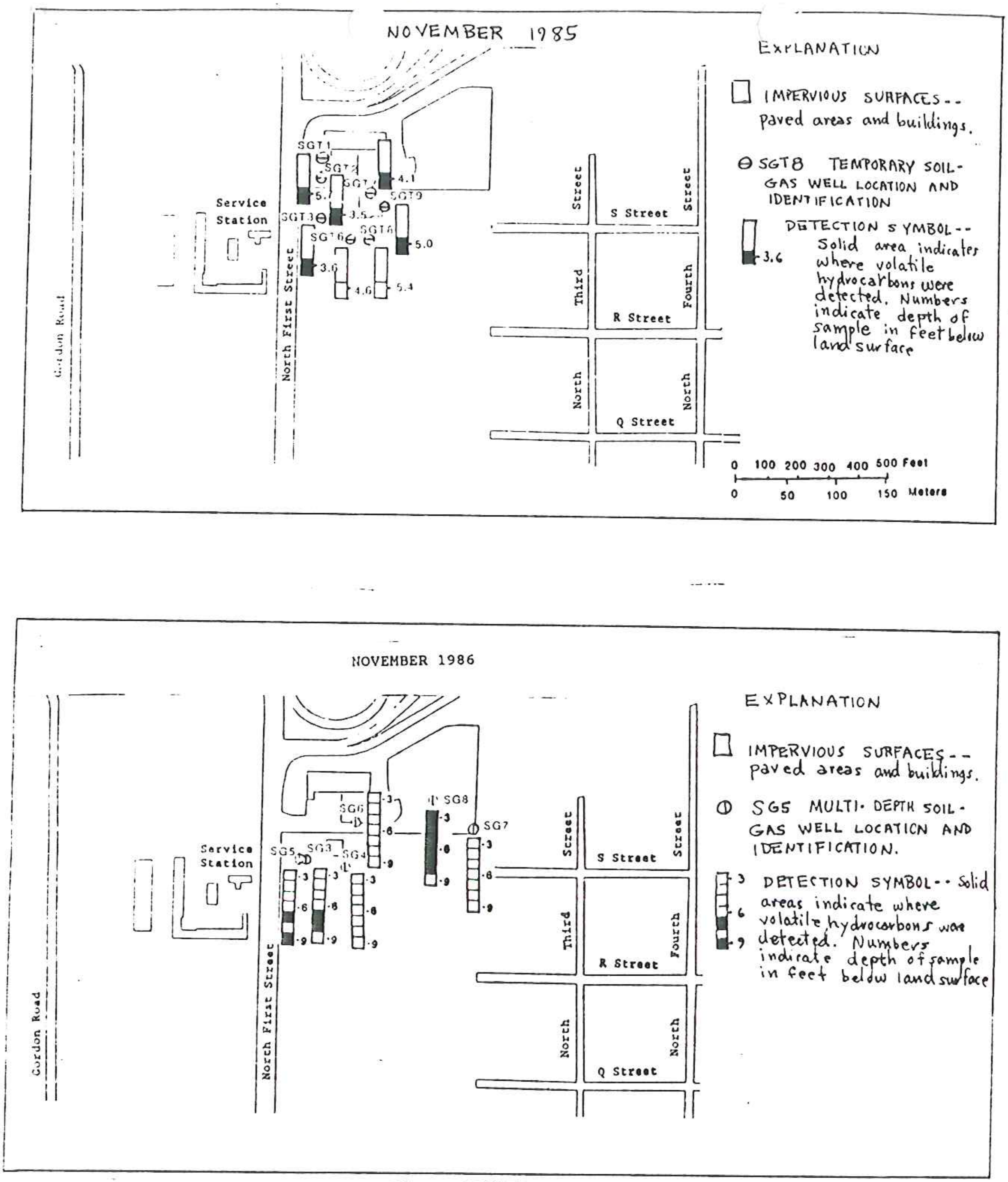


Figure 14.-- Locations of temporary soil-gas samples collected November 1985 and multi-depth soil-gas samples collected November 1986.

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

Tab/ --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[illegible]s and well identifiers used during this this [illegible]ort--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 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.

PRELIMINARY SUBJECT TO REVISIONS

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

PRELIMINARY SUBJECT TO REVISIONS

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

PRELIMINARY SUBJECT TO REVISIONS

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 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	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

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 identi-fier	Manga-nese, dis-solved (µg/L as Mn)	Molyb-denum, dis-solved (µg/L as Mo)	Nickel, dis-solved (µg/L as Ni)	Silver, dis-solved (µg/L as Ag)	Stron-tium, dis-solved (µg/L as Sr)	Vana-dium, dis-solved (µg/L as V)	Zinc, dis-solved (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

PRELIMINARY SUBJECT TO REVISIONS

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

SUBJECT TO REVISIONS

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 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	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 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	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	--	220
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

PRELIMINARY SUBJECT TO REVISION

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

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
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	--	--

PRELIMINARY SUBJECT TO REVISION

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

Well identifier	n-Propylbenzene	Isobutylbenzene	sec-Butylbenzene	n-Butylbenzene	Ethylene bromide	t-Butylbenzene	1-Isopropyl-4-methylbenzene	2-Ethyl 1-methylbenzene	1,4-Dimethylethylbenzene	1,4-Dimethyl-2-ethylbenzene	1,3-Dimethyl,4-ethylbenzene
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	--	--	--	--

PRELIMINARY SUBJECT TO REVISIONS

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

PRELIMINARY SUBJECT TO REVISIONS

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

PRELIMINARY SUBJECT TO REVISIONS

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

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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 identifier	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 M16 is used for SG5; land-surface available from table 2].

Well identifier	Depth	Benzene	Toluene	Ethylbenzene	Total xylenes	Naphthalene	1,3,5-Trimethylbenzene	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 identi-fier	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 identifier	Date	Water level
M1-82	Feb 21, 1985	11.37
	May 11	10.57
	Aug 29	8.84
	Apr 23, 1986	10.00
	May 14	9.36
	Jun 23	9.00
	Jul 28	8.91
	Sep 22	8.69
	Nov 19	11.12
	Dec 17	11.46
	Jan 20, 1987	11.67
	Feb 17	11.58
	Mar 16	11.39
	Apr 22	11.05
M1-85	Feb 21, 1985	12.9
	May 10	11.58
	Jun 09	9.37
	Aug 02	9.84
	29	9.95
	30	9.69
	Sep 21	9.68
	Oct 16	10.91
	Nov 15	11.86
	Dec 13	12.69
	Jan 24, 1986	12.24
	Feb 21	11.99
	Mar 20	11.59
	Apr 23	10.58
	May 14	9.72
	Jun 23	9.11
	Jul 28	9.00
	Sep 22	8.96
	Nov 20	12.48
	Dec 17	12.85
	Jan 21, 1987	13.17
	Feb 18	13.05
	Mar 16	12.75
	Apr 23	12.25
	Mar 13, 1989	13.33
M2-82	Feb 21, 1985	11.48
	May 11	10.55
	Aug 29	9.47
	Apr 23, 1986	9.88
	May 14	9.12
	Jun 23	8.54
	Jul 28	8.40
	Sep 22	8.25
	Nov 19	11.01
	Dec 17	11.40
	Jan 20, 1987	11.60
	Feb 17	11.46
	Mar 16	11.32
	Apr 22	10.86
	Mar 18, 1989	11.65
M2-85	Feb 20, 1985	6.22
	21	6.27
	May 10	6.11
	Jun 09	5.37
	Aug 02	5.66
	29	5.72
	30	5.58
	Sep 21	5.57
	Oct 16	5.44
	Nov 15	6.29
	Jan 24, 1986	6.06
	Feb 21	5.87
	Mar 20	5.67
	Apr 23	5.67
	May 14, 1986	5.67
	Jun 23	6.34
	Jul 28	6.60
	Sep 22	5.51
	Nov 20	6.62
	Dec 18	7.04
	Jan 22, 1987	7.18
	Feb 17	6.64
	Mar 16	6.24
	Apr 23	6.66
	Mar 14, 1989	9.14
M3-82	Feb 21, 1985	10.05
	May 11	9.23
	Aug 29	8.05
	Apr 23, 1986	8.61
	May 14	7.96
	Jun 23	7.51
	Jul 28	7.45
	Sep 22	7.23
	Nov 19	9.76
	Dec 17	10.03
	Jan 22, 1987	10.23
	Feb 17	10.15
	Mar 16	9.96
	Apr 22	9.67
	Mar 18, 1989	10.16
M3-85	Feb 20, 1985	7.98
	21	8.07
	May 11	7.60
	Jun 09	6.64
	Aug 02	7.14
	29	7.28
	30	7.04
	Sep 21	6.98
	Oct 16	6.51
	Nov 15	7.20
	Dec 13	8.00
	Jan 24, 1986	8.10
	Feb 21	7.88
	Mar 20	7.76
	Apr 23	7.40
	May 14	6.86
	Jun 23	7.13
	Jul 28	7.17
	Sep 22	6.44
	Nov 20	8.96
	Dec 17	8.68
	Jan 22, 1987	8.66
	Feb 18	8.59
	Mar 16	8.40
	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 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
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 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 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

PRELIMINARY SUBJECT TO REVISIONS

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

PRELIMINARY SUBJECT TO REVISIONS

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

PRELIMINARY SUBJECT TO REVISIONS

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

PRELIMINARY SUBJECT TO REVISIONS

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 identi-fier	Date	Benzene	Toluene	Ethyl-benzene	Total xylenes	Naph-thalene	1,3,5-Tri-methyl-benzene	2-Ethyl-1-methyl-benzene	1,2,3-Tri-methyl-benzene	1,2,4-Tri-methyl-benzene	1,2,3,5-Tetra-methyl-benzene
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 identi-fier	Date	1,4-Di-methyl-2-ethyl-benzene	1,2,3,4-Tetra-methyl-benzene	p-Iso-propyl-toluene	Iso-propyl-benzene	Di-bromo-methane	Di-chloro-bromo-methane	Carbon-tetra-chlo-ride	sec-Butyl-benzene	1,2,3-Tri-chloro-benzene	1,2,4-Tri-chloro 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

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	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

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	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-Dichloropropene	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]

Well identifier	Date	Specific conductance in µs/cm		pH in standard units		Alkalinity in mg/L as $CaCO_3$	
		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

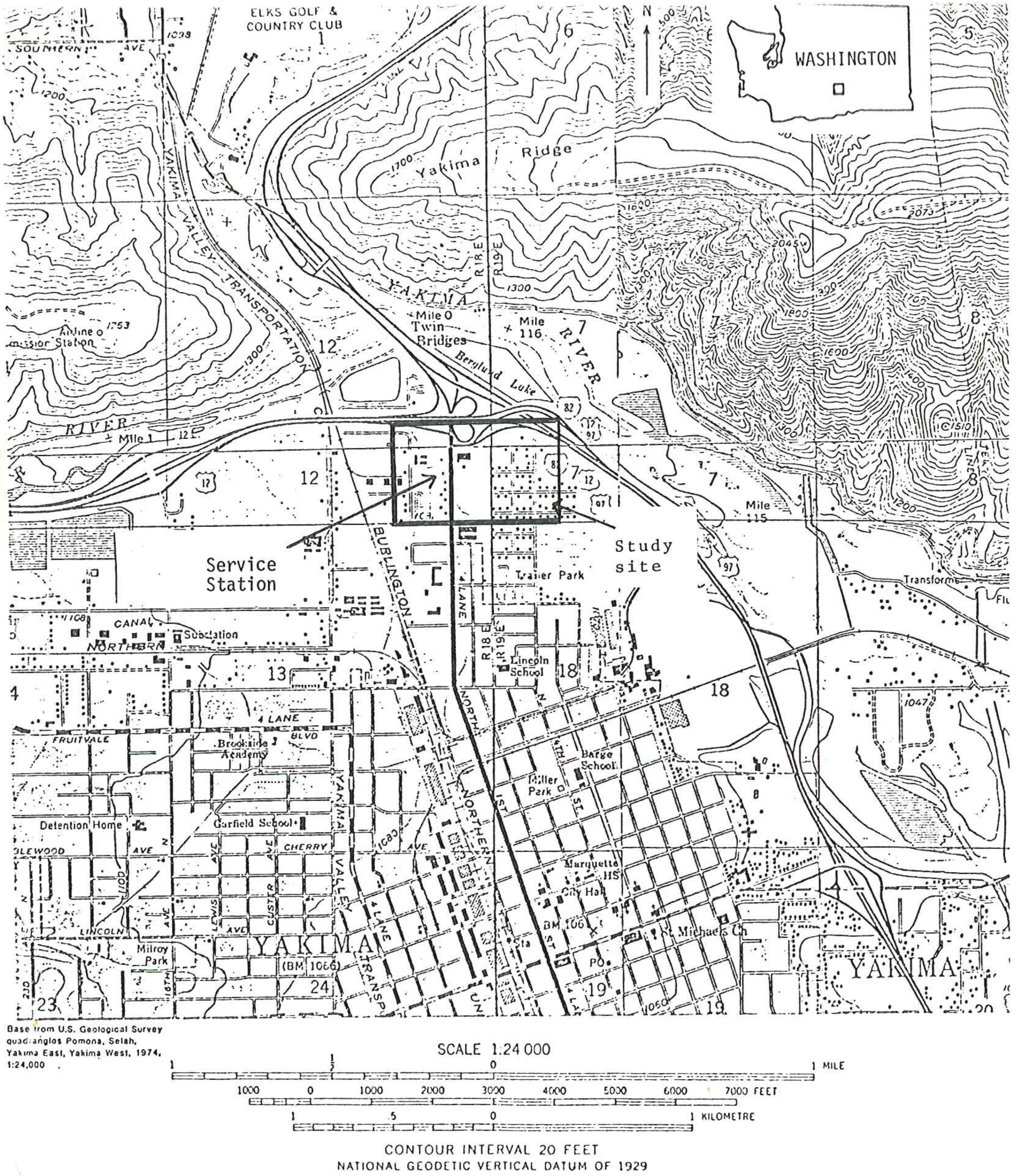
DESCRIPTION OF THE YAKIMA STUDY SITE

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.

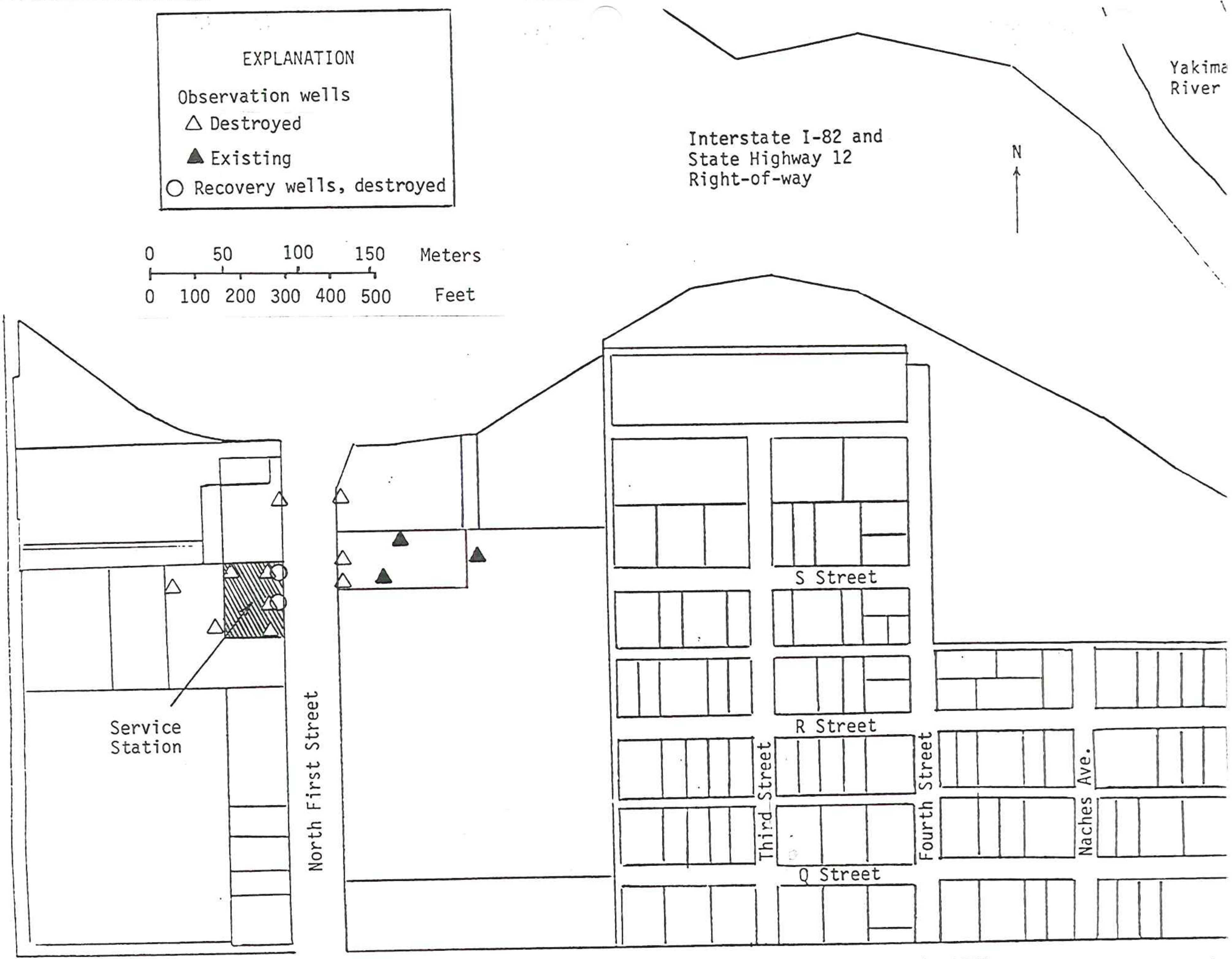


Figure 2.-- Locations of the observation and recovery wells installed in 1982.

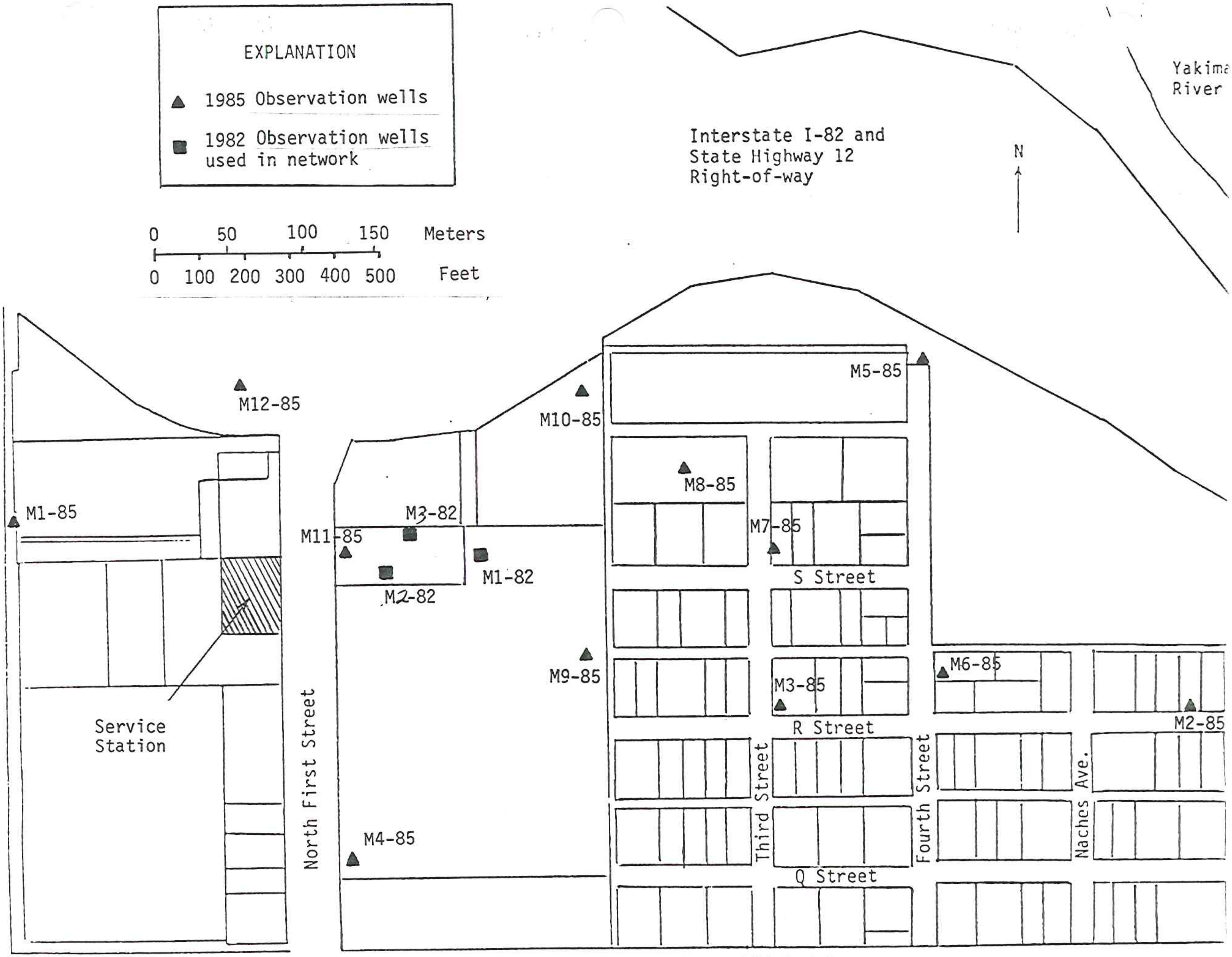


Figure 3.--Observation well network established in 1985.

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

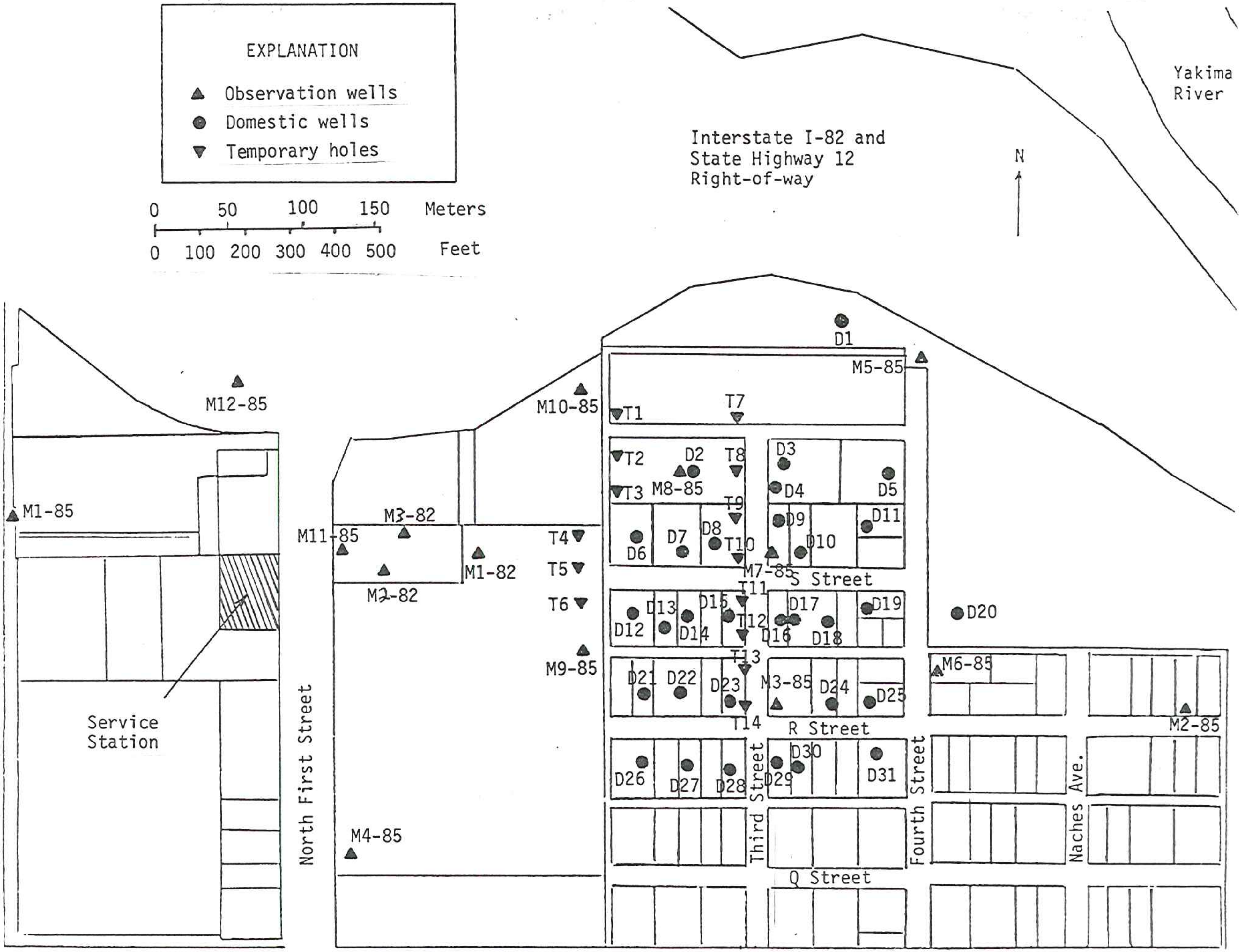


Figure 9.-- Wells sampled by the U. S. Geological Survey and Oregon Graduate Center in August 1985.

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.

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 10

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).

fig 11

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

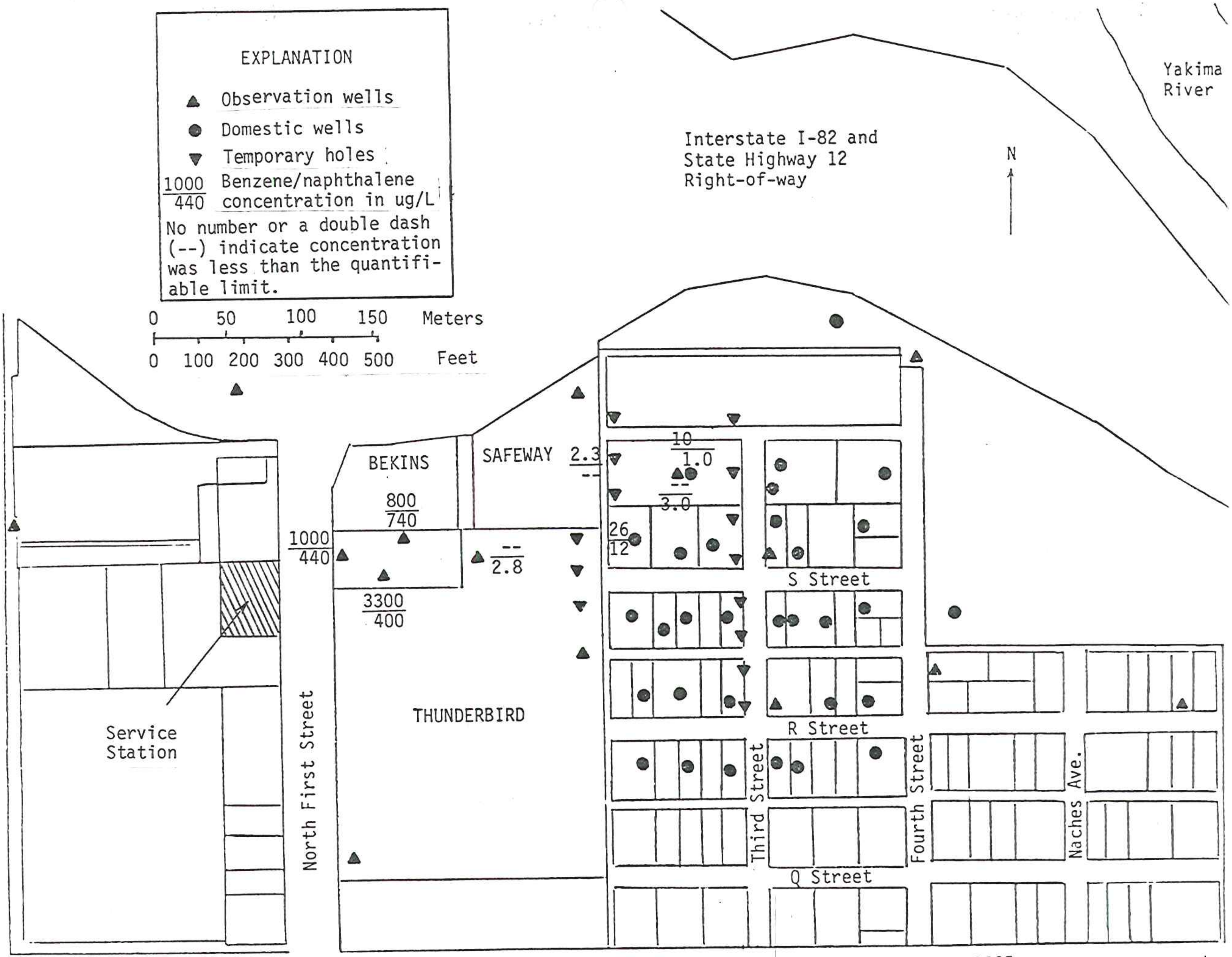


Figure 10.--Concentrations of benzene and naphthalene in groundwater, August 1985.

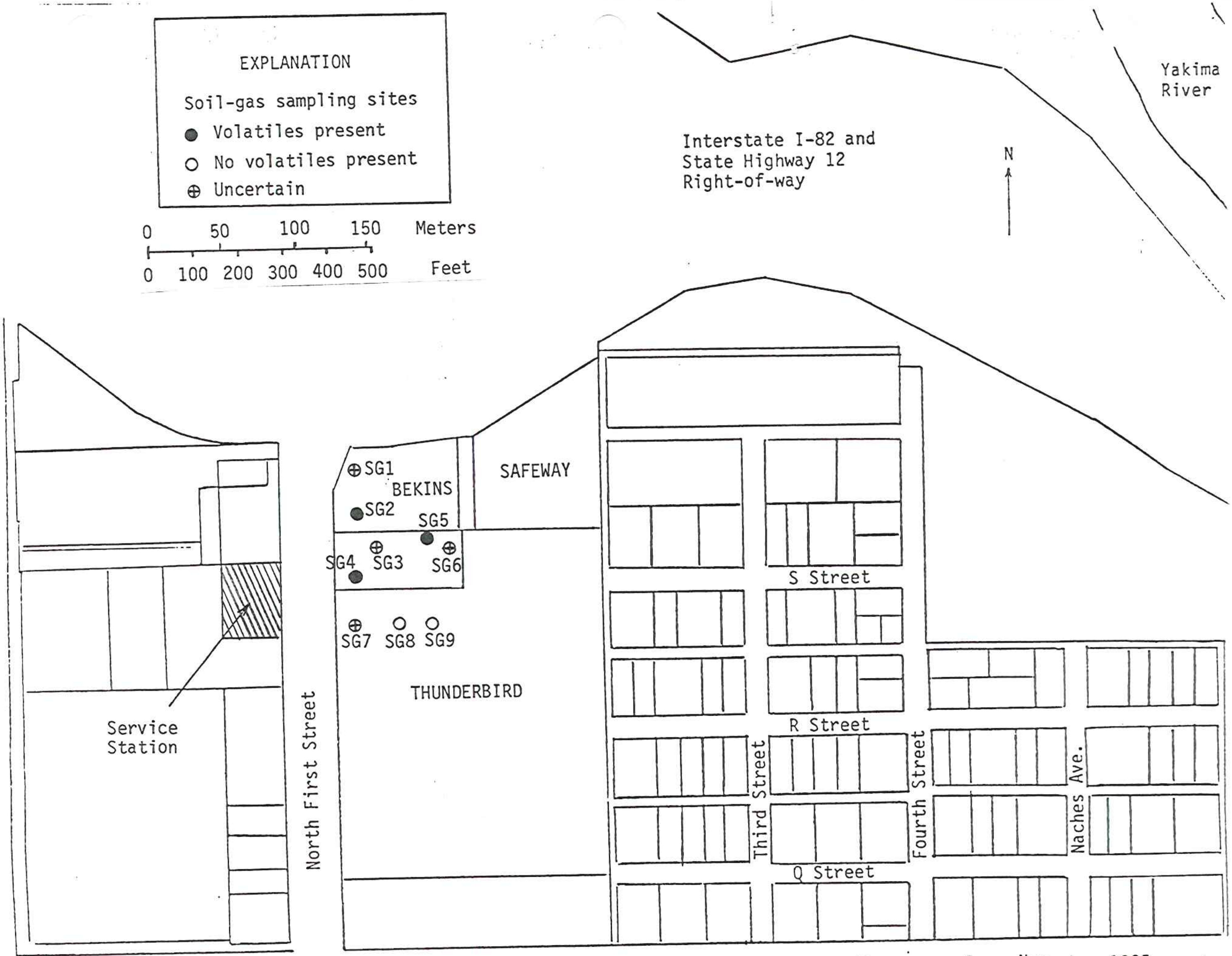


Figure // .--Qualitative results of the testing for volatile organic compounds in soil-gas samples, November 1985.

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

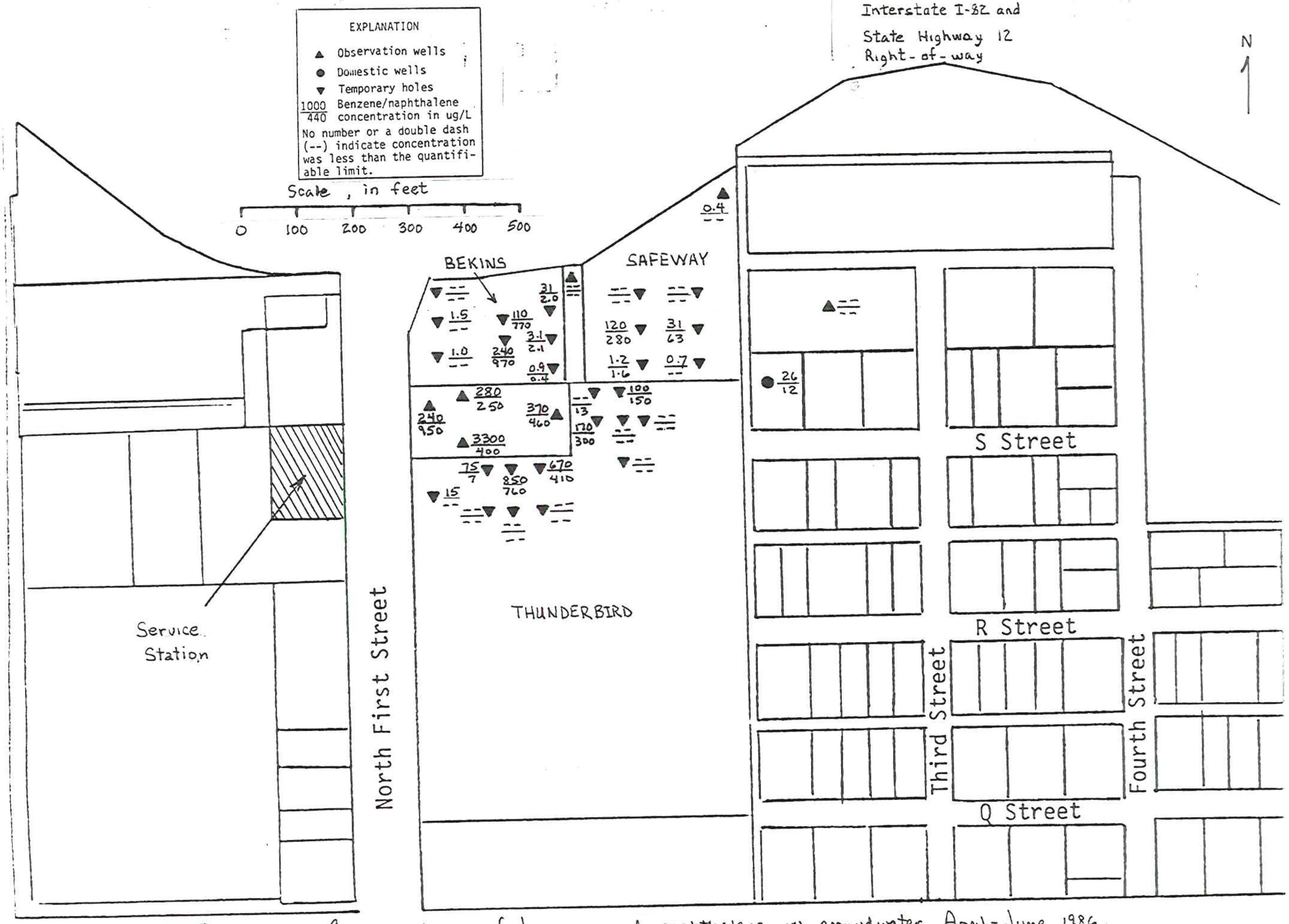


Figure 12. -- Concentrations of benzene and naphthalene in groundwater, April-June 1986.

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

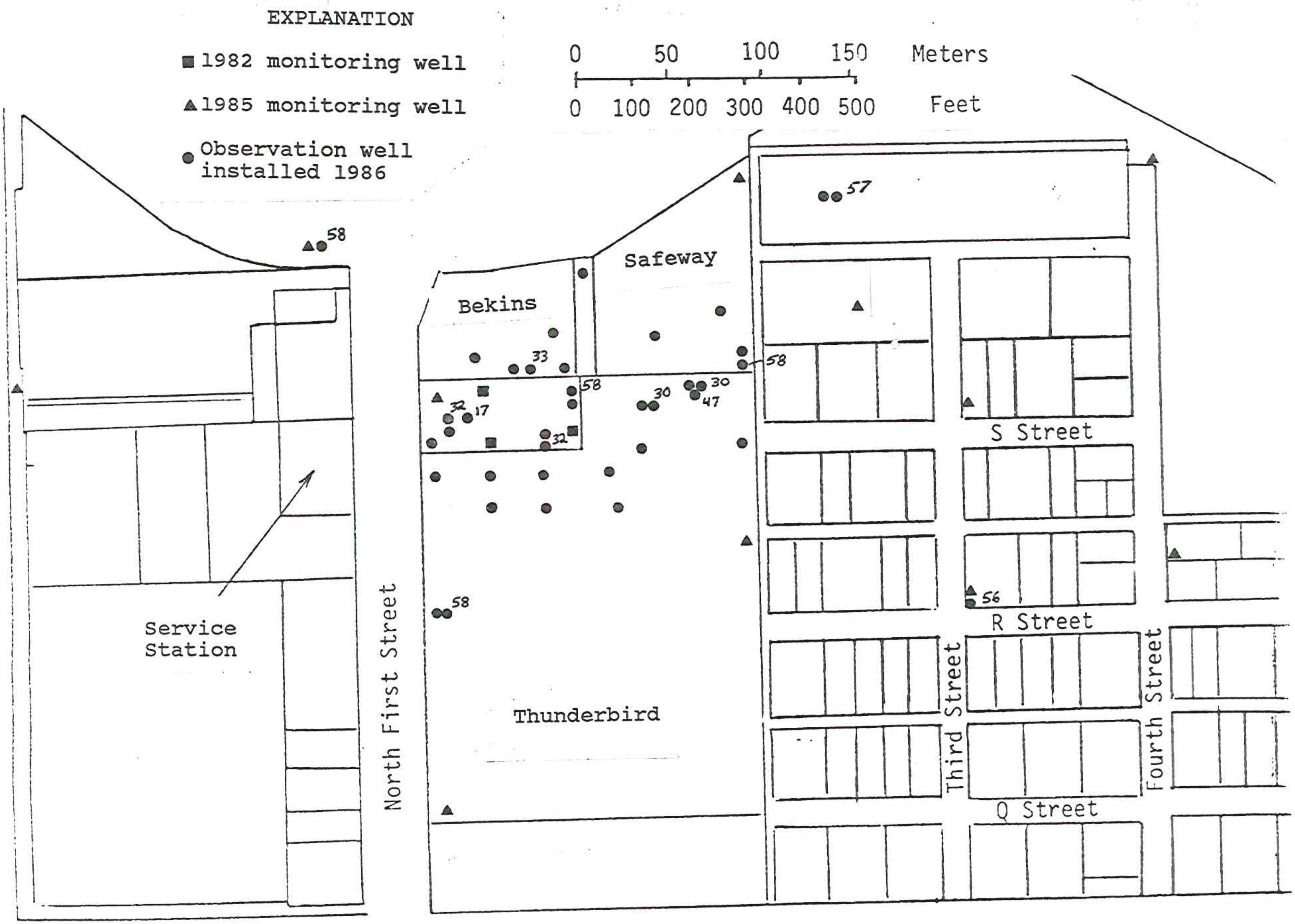


Figure 13.-- Observation-well network as of October 1986. All wells are screened at the water table unless the depth, in feet, is otherwise indicated.

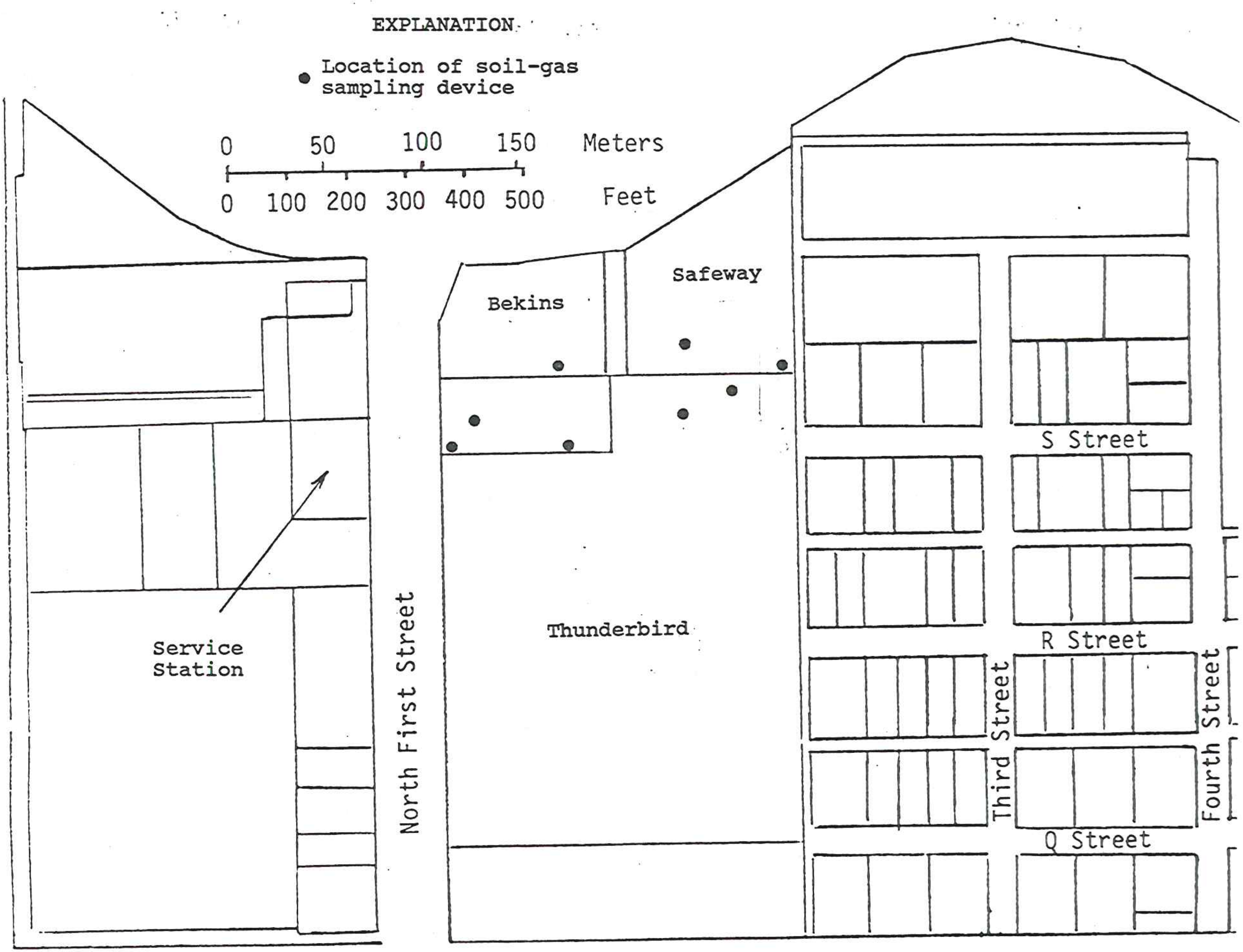


Figure 14.-- Soil-gas sampling devices installed during September 1986.

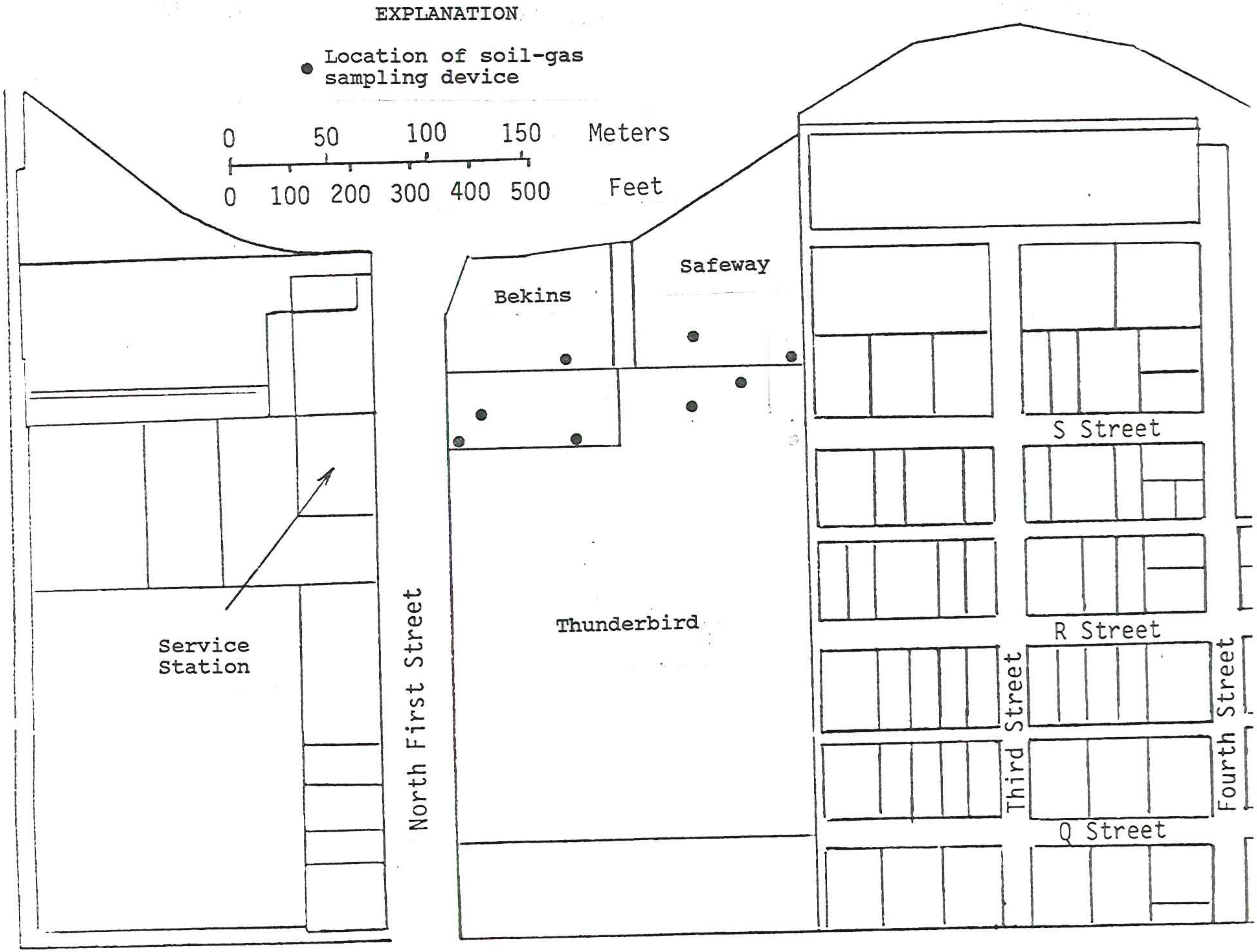


Figure 14.-- Soil-gas sampling devices installed during September 1986.

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

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
			TOP OF CSG	0.15 2.0	CEM 8.85' PVC CSG	0-2' Clayey silt, dark brown.	silt, clayey 0-3
				4.0	NF	2-4' Clay, silt some gravel (< ½") dark brown.	Gravel/cobbly 3-6
5				6.0	B	4-6' Cobbles and coarse grave (cobbles at 5') fragments to ½", some silt to coarse sand, gray.	
					SAND	6-8' Same	Sand and gravel 6-17
10				9.0		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.	

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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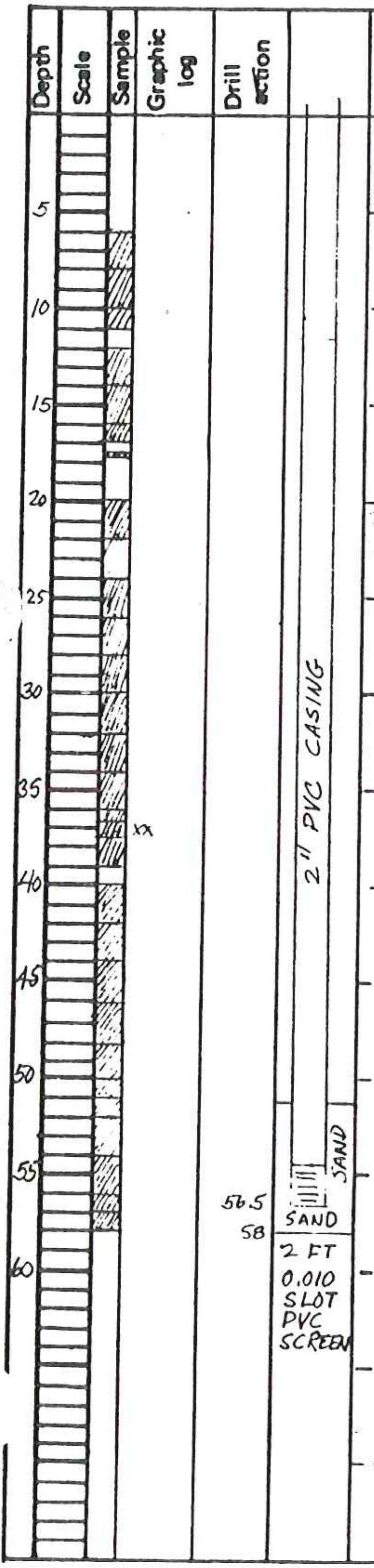
Abbreviations

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. ______

Twsp. ______

Sec. ______



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

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 [illegible] MAY LEAK	
T-3			33.0		30.0		28.0		2.0	26	OGC SAMPLERS [illegible] 8 FT - CAVED ??	
T-4			16.0		12.0		3.7		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			48.0		46.65		44.65		2.0	32.95 37.95		
T-6.2			(37.95)	← 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		

9-230
(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 well 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 SHALE →	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±		50		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		<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			[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		

U.S. GOVERNMENT PRINTING OFFICE : 1980—O-333-648

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

Lithologic Symbols

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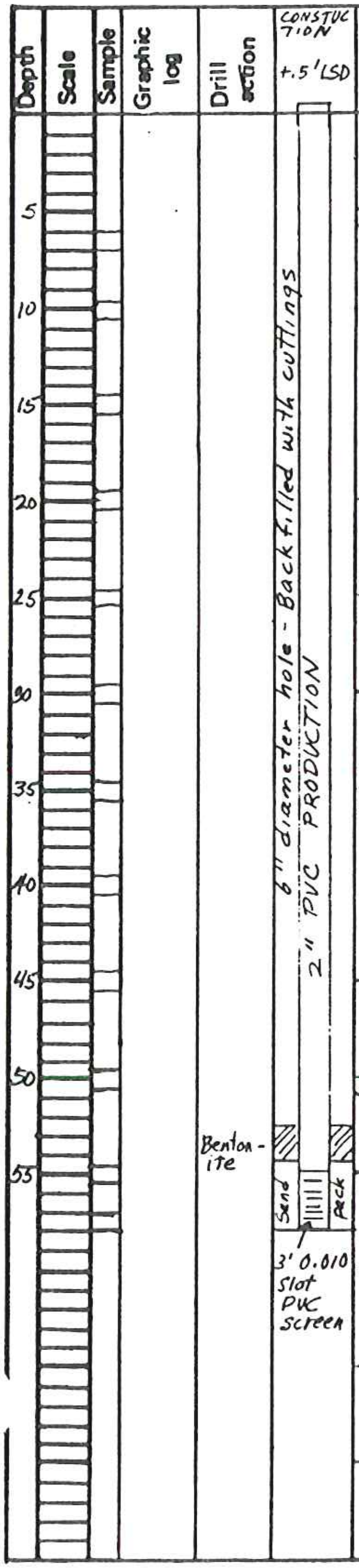
Abbreviations

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
0-3'. Soil, very silty and clayey No samples 3-6'. Increasing pebbles No samples	Silt, clayey
6-7'. Cobbles with very coarse sand and fine gravel	Gravel, cobbly and sandy
10'. Change, much silt and fine sand with medium gravel, also cobbles, still present. (brown silt, darker sands).	Silt, sandy gravelly and cobbly.
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' Silt, fine to very coarse sand, very fine gravel some cobbles, clay?	Silt, sandy gravelly
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' Silt, some fine to very coarse sand and fine gravel. gravel contains quartz, mafics feldspar. variable dark colors. 34' Water turns muddy brown again.	Silt, sandy, gravelly
35' Silty medium sand, some clay and fine gravel.	Sand, silty, gravelly
40' Silty fine to coarse sand, some cobbles, some clay(?) (brown and black). Water turning bluish (Gas slick?)	
45' Silt, some fine to medium sand and pebble gravel (gravel clasts black and green).	Silt, sandy, gravelly
50' Silt, fine to coarse sand and fine gravel. Gravel clasts mostly mafic. Water very blue.	
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

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. 12' Medium to coarse sand, some silt, and fine gravel, black	sand, silty, gravelly
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. 20' Same as 18'.	Clay and silt, Sandy Sand, silty, gravelly.
25		▨		BENTONITE SEAL	SAND PACK	25' Silty sand (coarser than above) with very fine gravel	
30		▨ ▨		QUESTIONABLE MAY HAVE BRIDGED JOINT MAY LEAK	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-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

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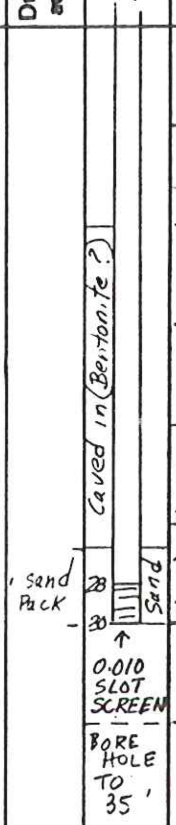
Abbreviations

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'. 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 14-16' Sand and gravel (clasts > than 1") (hard drilling; large chips) 16-18' Sand and gravel, rounded pebbles up to 1" at 17". 18-22 Fine sand to gravel	Sand and gravel
15							
20						22-24' Coase sand and gravel, some chips.	
25						24-26' Clay, fine to coarse sand	Clay, sandy. [illegible]
				Sand Pack		26-28' Clay, fine sand, gravel to ¼" 28-30' Medium sand, clay, gravel to ½"	Sand, clayey, gravelly. 28-30
30							
35							



T-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
					CEM + B	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	B	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	N F		
					SAND PACK	6-12' Same as above	
10						12' 14' Same as above, saturated. Sample 12.5'	
				13.9	NAT FILL	14'-18' Fine to coarse sand, some silty gravel to ½"+ brownish gray.	Sand, silty gravelly 14-18
15							
				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

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 0.42	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	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	NAT FILL	12'-14' Same as above. Saturated	
						14'-16' Silty fine to coarse sand and gravel (To ½") brownish 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

☐ ☐ ☐

☐ ☐ ☐

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 2.0	CEM	0-2 Silty clayey fine sand, brown.	Sand, silty clayey 0-8
					BEN	2'-4' Same as above (clayey lumps)	
5				4.7 5.7	NF	4-6 Same as above lots of clay could be silty sandy clay.	
				7.1	SAND PACK	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
15				13.1	NAT FILL	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
				18.3		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

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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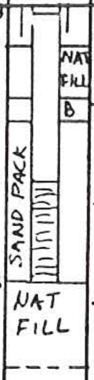
Abbreviations

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. ______



Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG 0.33' BELOW LSD	Lithologic description	Summary log	
				0.33		0-2' Silty clayey fine sand, light brown.	Sand, silty clayey	0-2
				2.0		2'-4' Fine to coarse sand, gravel (To ½") Drill sound as if in cobble gravel.	Sand and gravel	2-9.5
5				4.7 5.7		4-6' fine sand to gravel (to ½") as above Drill sound as if in cobbles		
						6-8' Same as above.		
				7.8		8-9.5' Same as above		
10						9.5-10' Similar but contains brown clayey silt. Drill still sounds cobbly.	Sand and gravel clayey and silty	9.5-18
						10-12' Same as above		
15				13.8		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'		
				18.3		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** ______

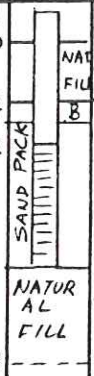
Driller ______ **Helper** ______ **Geologist** Ron C. Lane

Rge. ______ **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 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 [illegible]
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.	Sand and gravel, silty 11.5 [illegible]
						10-11.5' Same as above	
				13.2		11.5-12' Silty sandy gravel (To ½") grayish brown.	
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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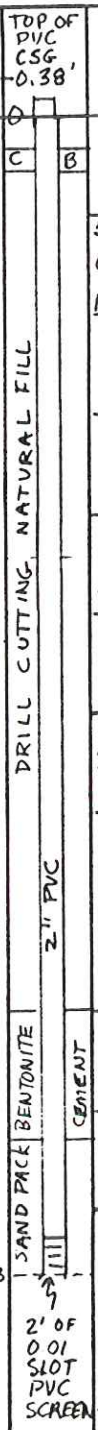
Abbreviations

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
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. ______

Twsp. ______

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
				2.5	B. N B CEM F	0-7' Silty clayey fine sand, brown.	Sand, silty, clayey 0-7
5				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				18.3		14-16' Same as above but grayish brown color 16-18.3' Same but reddish 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

Lithologic Symbols

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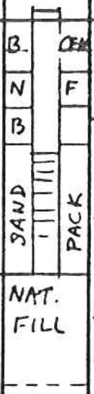
Abbreviations

clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Twp. ______ Rge. ______

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. 14-16' Same as above but grayish brown color. 16 -183' Same but reddish brown	
15				18.3			

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. ________

Twp. ________ Sec. ________

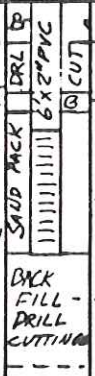
Depth 5 10 15

Scale

Sample

Graphic log TOP OF CSG.

Drill action
0.3
2.0
4.5
5.5
6.5
6'X2"
0.01
SLOT
PVC
SCREEN
12.5
18.3



Lithologic description

0-2' Light brown very fine sand and silt.

2-4 Light brown fine sand and silt some brown clay.

4-6 Gray fine-coarse sand and gravel, fragments to 1/4". Drill sounds like coarse gravel or cobbles.

6-8' Same except gravel to 1/4"-3/8"; Fragments (few) to 1/2"+

8-9' Sand, medium to coarse, some fine, less sand than above, gravel > 1/4" more gravel than above Fe in fragments

9-10' Sand medium to coarse, brown to gray, very little fine gravel to 1/4", No fragments. Clay ?, Silt ?.

10-12' Sand fine to coarse, gray, with clay and. silt; gravel, gray brown, Fragment to 1/2". Drill hitting cobbles and boulders.

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

Summary log

sand very fine and silt	0-4
Sand and gravel	4-9
Sand, medium to coarse	9-1
Sand and gravel	10-18

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

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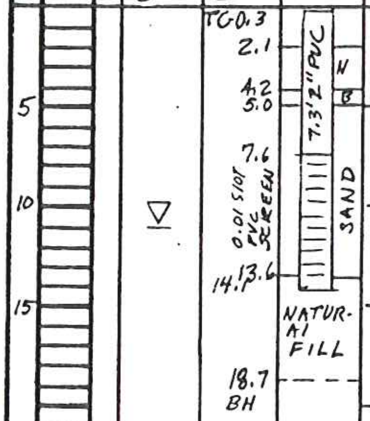
Abbreviations

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

0-2' 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", 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

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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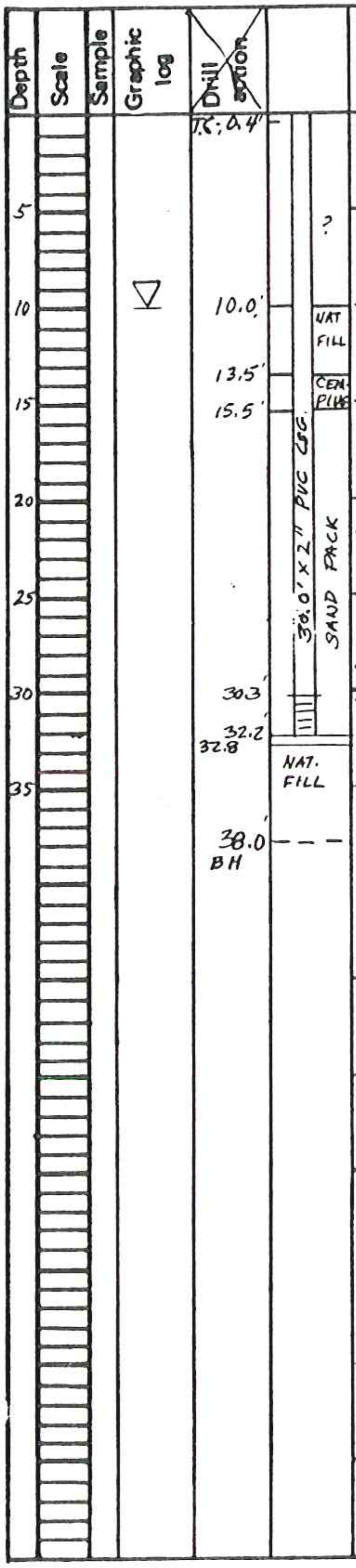
Abbreviations

clay	c	cobbles	cob	sandy	sdy		
silt	st	boulders	b	fine	f		
sand	s	clayey	cly	medium	m		
gravel	g	silty	sty	coarse	co		



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' Sanne 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

Rge. ______ Twsp. ______ Sec. ______

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
				T.C. .15	Ø: 2" PVC CSG. CEM	0-1' Blacktop and parking lot fil'.	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
				8.0	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						8-10' 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

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 ⅛", dark brown Drill sound like cobble gravel. 2-4.5' Same as above	Sand, fine, silty clayey 0-4.5
5						4.5'-9.5' Gravel, fragments to ¼", fine sand, cobbles	Gravel, sandy, cobbly 4.5-9.5
						9.5-10' Fine sand to gravel (>½") dark brownish gray. H_2O at about 10'	
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. 16-18' Same as above but some fragments in 3/4 to 1" size.	
				18.0			
					To be completed by OGC		

S-2 - [illegible] 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	Summary log
			Top of CSG	0.15	CEM	0-1' Blacktop of parking lot and fill.	Blacktop and fill 0-1
				2.0	7.7' PVC CSG	1-2' Silty clayey fine sand, dark brown	Sand, fine, silty and clayey 1-3½
					NAT FILL	2-4' Same but fragments to ½". Cobble gravel at about 3½'	Gravel, cobbly, sandy 3½-7
5				5.8		4-6' Cobble gravel, fragments to ½", clean.	
				7.5 7.1	B	6-8' Upper as above gray. lower, fine to coarse sand, grayish brown.	Sand and gravel 7 - 18
10			∇		SAND PACK	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	
15				14.0		12-14' Silt and brown fine sand and gravel (<½") gray, saturated. Hydrocarbon odor.	
				16.85	NAT F.	14-16' Same as above	
				18.3		16-18' Same as above	

S-3 [illegible]

Location ______ Date ______ Local well number ______

County ______ Map ______ Scale ______ Lat. ______ Long. ______

District ______ Project number ______ Altitude ______

Driller ______ Helper ______ Geologist Ron Lane

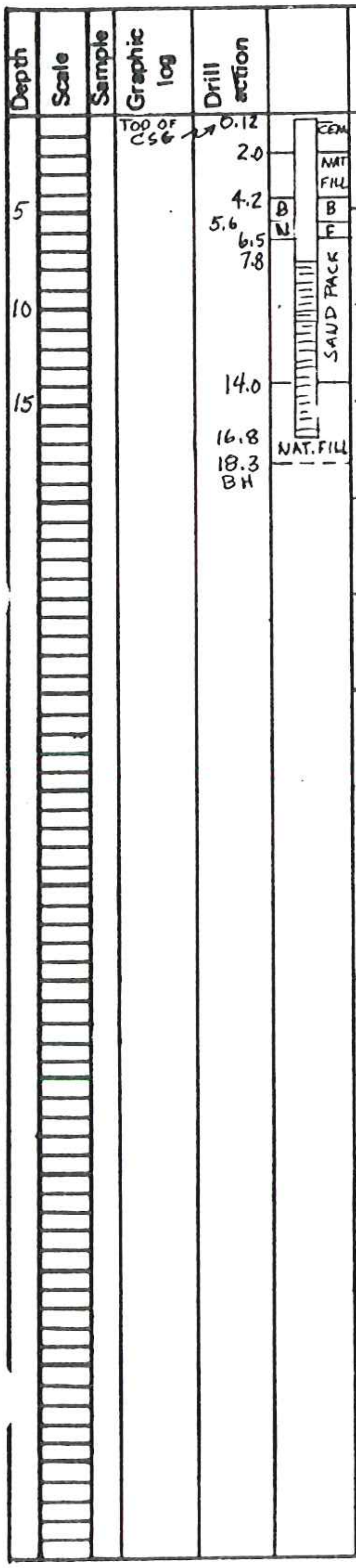
Rge. ______

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



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-4 [illegible]

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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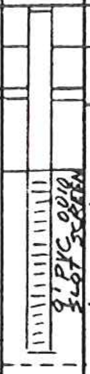
Abbreviations

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
				0.25		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 ~~3/4~~ 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						12-14' Silty fine to coarse sand and gravel to 1/2", dark grayish brown. Saturated, diesel fuel odor.	
				17.4 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

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
						0-1' Black top and fill	Blacktop and fill 0-1
						1-2' Silty clayey fine to coarse sand, dark brown.	Sand fine to coarse, silty, clayey 1-4
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, silty, clayey. 4-18
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 3-3-86 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. ______

Twp. ______

Sec.

Depth	Scale	Sample	Graphic log	Drill action	TOP OF PVC CSG 0.45	Lithologic description	Summary log
				0.45 2.0	C B	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					NATURAL DRILL CUTTINGS	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
						42-44' Sand, black; some gravel, gray silt.	Sand, gravelly 42-44
45				44.0	BENTONITE	44-50 Gravel, black some black sand and gray silt. Some larger material also.	Gravel, silty, sandy cobbly 44-5
50				49.0	SAND PACK	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

☐ ☐ ☐

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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 sand brown 6-8' Gravel, cobbly a little silt and sand.	Gravel, cobbly, silty sandy	4-12
					SAND PACK	8-12' Gravel, hard drilling (cobbles?) gravel at 10-12' may be coarser		
10								
						12-16' Gravel, sand some silt, brown. H_2O 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

☐ ☐ ☐
☐ ☐ ☐

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
5				0.35 2	0-2' Clayey silty fine sand, brown. 2-4' Clayey silty fine to med. sand and some gravel (To 1/4") brown. 4-9' Clayey silty fine to medium sand, brown.	Sand, fine, clayey, silty 0-9
10 15					9'-10' Fine to coarse sand, gravel to 1/2", grayish brown. 10'-16' fine to coarse sand, gravel to 1/2" grayish brown, some clay and silt.	Sand and gravel 9-36
20					16-24 Same but with coarser gravel fragments in 3/4 to 1" range. Drilling as if coarse gravel to cobbly gravel.	
25					24-28' Same but more sand less gravel and gravel to 1/2"	
30					28'-36 clayey Silty fine to coarse sand, gravel to 3/4", brownish gray. Drills as if Coarse gravel and cobbles	
35 40				41.0	36-44' Clayey silty fine to coarse sand, very little gravel (To 1/2") brownish gray H_2O temperature is 15°C, Drilling and driving is easier.	Sand, fine to coarse, clayey silty. 36-44
45 50 55				46.0 54.21 56.21 58.3	44'-58.3' As above but drilling is harder coarse gravel and cobbles.	Sand and gravel cobbly 44-56.3

T-11 FELD LOG

Location ______ Date 10-6-86 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 -0.45'	Lithologic description	Summary log	
					CEM	0-2' Silty clay fine sand, dark brown	clay silty sandy	0-2
				2.4 3.2	NF	2-4' Silty fine to medium sand tan to light brown.	sand, fine to medium, silty, gravelly	2-6
5				5.6	B	4-6' Sand as above, tan, with gravel to 1/4" gray;		
				6.6	NF	6-8' Gravel (to 1/4") gray, some tan sand.	Gravel, sandy	6-8
10				8.2	SAND PACK	8-10' Silty fine to coarse sand, tannish gray gravel with fragments to 1/4" gray.	Sand and gravel	8-18
						10-12' Fine to coarse sand and gravel (to 1/4") grayis brown.		
15				14.2		12-14' Fine to coarse sand, gravel (to 1/4") brownish gray.		
					NATURAL FILL	14-16' Fine to coarse sand and gravel, grayish brown saturated.		
				18.3		16-18' Similar to above but more reddish especially H_2O.		

T-12 FIELD LOG

Location ______________ Date ______________ Local well number ______________

County ______________ Map ______________ Scale ______________ Lat. ______________ Long. ______________

District ______________ Project number ______________ Altitude ______________

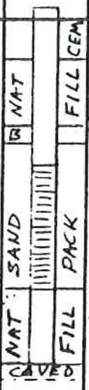
Driller ______________ Helper ______________ Geologist ______________

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	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 ⅛"). Some silt, brownish gray. Drill sounds like cobble gravel.	
				13.4		10-12' Fine to coarse sand, (Fragments to ¼"), grayish brown. Drill sounds indicate cobbles. Strong gasoline odor.	Gasoline odor reported
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

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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 BELOW LSD	Lithologic description	Summary log
						0-1' Black top.	Blacktop 0-1
						1-2' Clayey silty fine sand	Sand, clayey, silty 1-5
						2-4' Clayey silty fine sand, dark brown	
5						4-5' As above fine sand.	
						5-6' Gravel gray (fragments are sandsize to ½" Some clay Drill sounds cobble gravel.	Gravel, sandy 5-6
						6-8' Fine sand to gravel, fragments to 1". Some clay and silt, brownish gray. Drill sounds like cobble gravel.	Sand and gravel, clayey, silty. 6-14
10				10.0		8-10' Same as above	
						10-12' Same as above, but brownish gray, strong gas odor	
15			∇		NATURAL FILL	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'	Sand, silty, gravelly 14-30
						16-18' Same as above	
20						18-20' Same as above, but color is reddish brown.	
				23.0		20-26' Same as above.	
25					BENTONITE	26-28' Same as above with more silt and fine sand. Color less medium to gray brown	
30				28.0	SAND	28-30' Silt to gravel (to ½") as above, medium brown.	
				30.5		30-32' Same as above	
				32.2	NAT. FILL	32-34' Same as above, color gray brown	
35				36.0		34-36' Same as above, grayish brown	

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

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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
				1.7	B CEM	0-2' Clayey silty fine sand, brown	Sand, silty clayey 0-7
					4" PVC CSG B.	2'-4' Same	
5				4.1 5.3	N F	4-6' Same but much more clay (lumps)	
				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					SAND PACK 6" (4" PVC SCREEN)	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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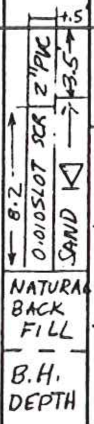
Abbreviations

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							
				12'			
				16'			
						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 0-8' 8' to [illegible]

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' Clay & silt with some gravel to ¼".	[illegible] 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 [illegible] cobbly 5-9.2
10		▨	CORE 8.2-9.3			8.2 to 9.2' Cobbly coarse gravel with little clayey fine sand.	Sand [illegible] 9.2 - 14
		▨				10-12 Very coarse sand and medium gravel some silt and fine sand; light brown water (mafic clasts)	[illegible] sewer smell
15		▨				12-14 Medium sand and gravel, black and gray. Sewer like smell and heavy gas smell.	Silt clayey, gravelly 14 - 16 (gas smell)
		▨			2'FT 0.010 SLOT SCREEN PVC	14' Clayey silt, grey with much medium gravel, black. Gas smell.	Gravel [illegible] sandy 16 - 18 [illegible] 17-18' much water
20						16-18' Gravel, very to coarse, cemented silt to sand, medium, matrix. Gas smell	
						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

Lithologic Symbols

☐ ☐ ☐

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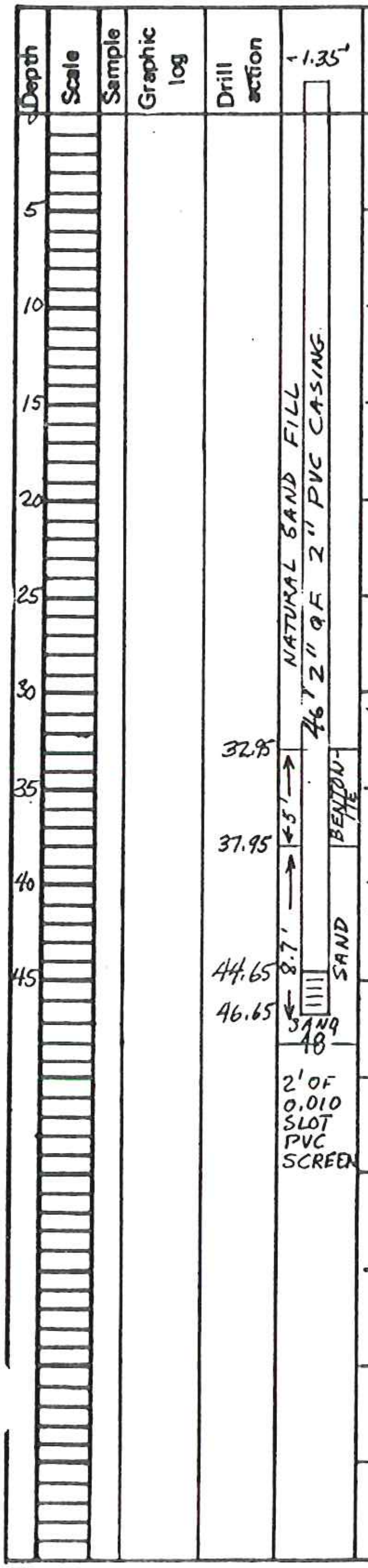
Abbreviations

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

See T-2 for 0-30'

30-32' Gravel, clasts to 3/4"; sand, medium to coarse; clay light brown.

32-34' Sand, fine to coarse; gravel to 1/8"; clay dark brown and gray.

34-36' Sand, fine to coarse, gravel to 1"; clay light brown and gray.

36-38' Sand, medium to coarse, gravel to 1/4"; clay light brown and gray clay

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.

44-46' Sand, fine to coarse, gravel to 1/2", clay gray.

46-48' Sand, fine to coarse, gravel to 1/2", clay gray.

Summary log

Gravel, sand and clay	30-32
Sand; gravel clay	32-48

T-6.2

Location ____________ 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	-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 - [illegible] LOG

Location YAKIMA WASHINGTON Date 9-29-86 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		Lithologic description	Summary log
					See T-7.2 FOR 2" PVC CASING (29' LONG) FINISH	0-20 See Log T-5	
5							
10							
				14.0'	NATURAL CUTTINGS		
15							
20				20.7	SAND	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	
						32-34' Sand, fine to very coarse, gravel to ¼-⅜"; clay, light brown-grayish.	
35				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	

T-7.2

Location ____________ Date ____________ Local well number ____________

County ____________ Map ____________ Scale ____________ Lat. ____________ Long. ____________

District ____________ Project number ____________ Altitude ____________

Driller ____________ Helper ____________ Geologist ____________

Lithologic Symbols

Abbreviations

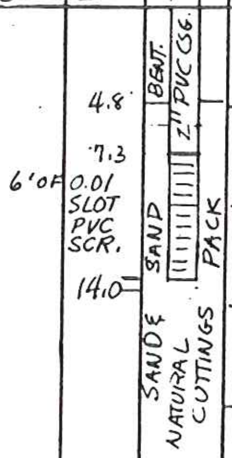
clay	c	cobbles	cob	sandy	sdy
silt	st	boulders	b	fine	f
sand	s	clayey	cly	medium	m
gravel	g	silty	sty	coarse	co

Rge. ____

Twp. ____

Sec. ____

Depth	Scale	Sample	Graphic log	Drill action		Lithologic description	Summary log
						SEE LOG T-5 0-20'	



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. ______

Twp. ______

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 40 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			

T-9 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	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.	
				7.0	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	
				13.0	NAT. FILL	12-14 Same as above	
15						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 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	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 2-10
5				5.3'		4-6' Same as above but brownish gray. Very little silt or other fines	
				8.3		6-8' Same as above	
10						8-10' Same as above.	
						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' Silty fine to coarse sand, gravel grayish brown, saturated.	Sand, silty gravelly 13.5-19
				18.3 BH