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REPORTS

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1991

DANIEL B. STEPHENS & ASSOCIATES, INC.
ENVIRONMENTAL SCIENTISTS AND ENGINEERS

GROUND-WATER ASSESSMENT REPORT

FOR

COMPRESSOR STATION NO. 5

THOREAU, NEW MEXICO

VOLUME I: REPORT TEXT, TABLES, AND FIGURES

PREPARED FOR:

TRANSWESTERN PIPELINE CO.
HOUSTON, TEXAS

JULY 26, 1991

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DANIEL B. STEPHENS & ASSOCIATES, INC.
ENVIRONMENTAL SCIENTISTS AND ENGINEERS

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July 26, 1991

Transwestern Pipeline Co.
1400 Smith Street
Houston, TX 77002

ATTENTION: Mr. Jim Alexander, Manager of Projects, Environmental Affairs

SUBJECT: Thoreau Ground-Water Assessment Report

Gentlemen:

Enclosed herein are copies of our Ground-Water Assessment Report at the Thoreau Compressor Station. Please call if you have questions regarding any aspect of this report.

Sincerely,

DANIEL B. STEPHENS & ASSOCIATES, INC.

Larry M. Crone for/DBS

Daniel B. Stephens, Ph.D., C.P.H.
President

Enclosure

SOIL AND GROUND-WATER INVESTIGATIONS • REMEDIAL ACTION • LITIGATION SUPPORT • VADOSE ZONE HYDROLOGY
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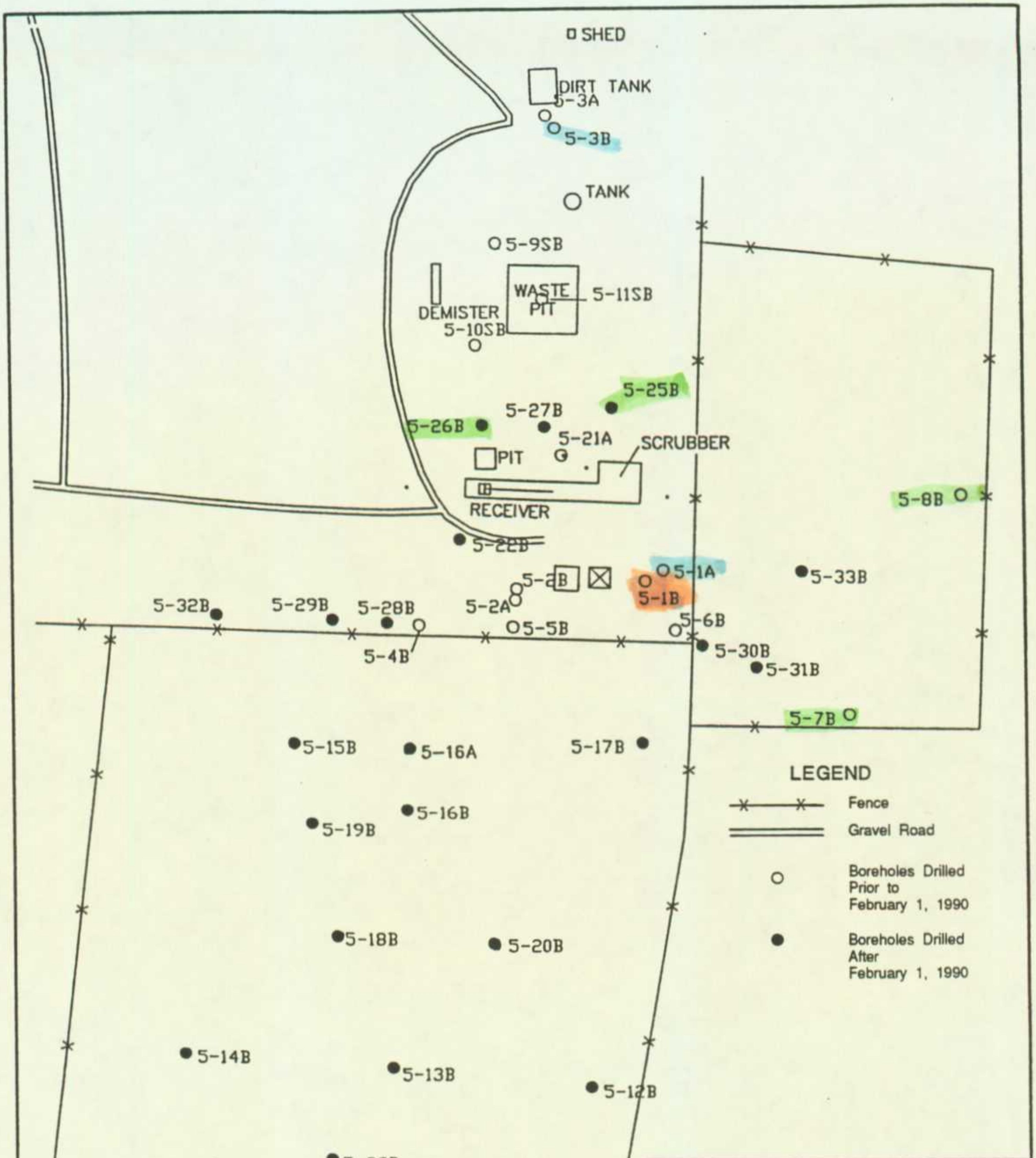

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ALBUQUERQUE, NEW MEXICO

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LOCATION OF WELLS AND BOREHOLES
TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO

DATE	PROJECT NO.	DESIGNED BY	DRAWN BY	CHECKED BY
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1.0 EXECUTIVE SUMMARY

Daniel B. Stephens & Associates, Inc. has prepared a Ground-Water Assessment Report which satisfies the requirements for hydrogeologic information at Compressor Station No. 5 set forth in the Consent Decree between Transwestern Pipeline Company, and the U.S. Environmental Protection Agency.

Since March 1989 the scope of our entire investigation, both on and off the property, led to the completion of 26 monitor and test wells, 11 exploratory borings, field and laboratory tests for hydrologic properties characterization, two geophysical surveys, and several special investigations pertaining to ground-water flow and transport.

The perched alluvial aquifer is the most shallow water-bearing unit beneath the compressor station. The alluvium is comprised mostly of silty, fine sand having moderate permeability. The shallow alluvial aquifer is perched upon the low-permeable Chinle Formation shales. Owing to erosion by paleodrainages, the geologic contact between the alluvium and Chinle Formation is very irregular. Consequently, the perched aquifer is absent over parts of the compressor station where the Chinle Formation lies above the perched water table. Where present, the perched aquifer is approximately 15 feet thick, but it may be as much as 30 feet thick in the paleochannels. The depth to the perched water table is about 45 feet, and this increases to about 55 feet or more off site to the south. The average velocity of ground-water flow is about 26 feet per year to the south, based on analysis of hydraulic properties. The regional water table lies about 400 feet beneath the station, within the upper part of the Chinle Formation where natural water quality is very poor. There is very low potential for significant downward ground-water movement through the upper Chinle Formation, because of the very low matrix permeability of the shale. Within about 1 mile of the compressor station there are no known users of water in the perched aquifer, although the water is potable under natural conditions.

Polychlorinated biphenyl (PCB) compounds were detected only in on-site monitor wells in the perched aquifer at the southeastern part of the property. Recent sampling has not detected any PCB in the on-site monitor wells. Field and laboratory tests suggest that the PCB is highly sorbed to soils at the site. The PCB in the monitor wells was probably introduced during drilling, and subsequent sampling eventually purged the PCB held to suspended sediment in the monitor wells. PCB has never been detected in off-site monitor wells.

Benzene, toluene, ethylbenzene, and xylene (BTEX) have been detected in on-site and off-site monitor wells. The impacted area extends downgradient at least 500 feet south of the compressor station property boundary and is about 250 feet wide. The highest concentrations of benzene and toluene measured on site were 2500 and 4700 µg/l, respectively. At the southernmost monitor wells, benzene concentrations are approximately 100 to 200 µg/l and appear to be slowly increasing. The probable source of the BTEX is seepage from the former waste pit that already has been excavated during remediation of PCB in soil.

2.0 INTRODUCTION

2.1 Purpose

Daniel B. Stephens & Associates (DBS&A) was retained by Transwestern Pipeline Company (Transwestern) in March 1989 to characterize the hydrogeology at four compressor stations located along Transwestern's natural gas transmission line in central and western New Mexico. Compressor Station No. 5 in Thoreau, New Mexico is the subject of this report. The remaining three compressor stations are situated near Laguna, Mountainair, and Corona, New Mexico. The initial purpose of these investigations was to assess the potential for polychlorinated biphenyl compounds (PCBs) to impact the uppermost aquifer as required by the Consent Decree with EPA Region VI. The soil at the stations had become contaminated when liquid organic wastes containing PCBs and petroleum hydrocarbon condensate cleaned from the pipeline were discharged into unlined pits and on soils at the sites. The results of DBS&A's initial hydrogeological investigations conducted from March 1989 through January 1990 were reported in February 1990 (DBS&A, 1990).

Herein is a Ground-Water Assessment Report (GAR) describing all ground water related investigations conducted at Compressor Station No. 5 subsequent to January 1990 in accordance with the Consent Decree. According to the Consent Decree (p. 36), "The Groundwater Assessment Report shall characterize the rate, concentration, and extent of horizontal and vertical migration of contaminants, and describe the probable on-site source of the contamination." This report will also present petroleum hydrocarbon (benzene, toluene, ethylbenzene, and xylene; referred to as BTEX) data that were collected from the perched aquifer concurrently with PCB data. Transwestern has indicated to DBS&A that the presentation of BTEX data is not formally required to be reported under the Consent Decree between Transwestern and the EPA. However, Transwestern has requested that BTEX data be included in this report to keep EPA apprised of the progress made to characterize and remediate BTEX in ground water.

2.2 Summary of Previous Investigations

The results of initial investigations at Thoreau through January 1990 (DBS&A, 1990) indicated that two of the seven shallow monitor wells located downgradient of the PCB waste pit and near the southern property boundary of the site contained concentrations of PCBs that exceeded New Mexico Water Quality Control Commission (NMWQCC) ground-water standards of 1 µg/l. All ground-water standards referred to in this report are NMWQCC values unless otherwise stated. In addition, three of the seven downgradient wells were found to contain concentrations of benzene that exceeded ground-water standards (10 µg/l), and one of the seven wells contained concentrations of toluene above standards (750 µg/l). The shallow upgradient well (background well) contained neither detectable levels of PCBs nor petroleum hydrocarbon compounds. No other volatile organics (EPA Method 624), semi-volatile organics (EPA Method 625), or organo-chlorine pesticides (EPA Method 608) were detected in either upgradient or downgradient alluvial wells. The only exceptions were bis(2-ethlyhexyl) phthalate (a semi-volatile compound) and methylene chloride (a volatile compound), which were found in low concentrations in separate shallow wells. Both of these compounds are common laboratory contaminants and were considered in the initial report as artifacts resulting from the chemical analysis process.

The initial report also demonstrated that the three deep test wells, which were completed in underlying bedrock aquifers of the upper Chinle Formation and the Sonsela Sandstone beds within the Chinle Formation, were free of PCB contamination. Two of the three deep test wells were also free of volatile, semi-volatile, and organo-chlorine compounds as measured by EPA analytical methods. However, the remaining deep test well contained benzene concentrations above ground-water standards and toluene and ethylbenzene at detectable levels. Subsequent field tests (described in Appendix A) suggested that leakage was occurring via some undefined pathway (around the well casing or the adjacent formation) from the perched water to the deeper previously uncontaminated bedrock aquifer. To eliminate this problem, this deep monitor well was plugged and abandoned as described in Appendix A. Finally, it should be noted that all three of these deep test wells also showed the presence of minor amounts of bis(ethylhexyl) phthalate. As described above, this compound was considered to be a result of laboratory contamination.

The preliminary investigations also determined that the alluvial aquifer was perched on the upper eroded bedrock surface of the Chinle Formation. The dry nature of the Chinle Formation bedrock beneath the alluvium-bedrock contact suggested that very little leakage occurs from the perched aquifer to the underlying shale. Available data at the time of the February 1990 report indicated that the depth to this shallow aquifer ranged from less than about 50 to more than 70 feet from the ground surface, with a saturated thickness varying from 0 to more than 25 feet. Based on preliminary hydrologic field data, the authors of DBS&A's initial report (February 1990) concluded that it was likely that off-site migration of PCBs, benzene, and toluene had occurred, or would occur in the near future. Consequently, additional drilling and sampling was initiated to further characterize the extent of these chemicals in the perched aquifer.

2.3 Scope of Work

The principal ground-water investigation tasks covered in this report include the following:

- Drilling, completion, sampling and analysis of eleven additional shallow monitor wells downgradient of the southern site boundary, and five additional shallow monitor wells within the site boundary;
- Drilling, core sampling and analysis of eight soil borings near the potential sources of BTEX and PCB;
- Drilling, water sampling and analysis of six exploratory borings near the southern site boundary;
- Periodic water sampling and analysis of all on- and off-site monitor wells for PCBs and BTEX;
- Perched aquifer pumping and recovery tests to characterize aquifer hydraulic parameters;
- Laboratory testing of representative soil cores to define hydraulic parameters required to model flow and transport in the vadose zone;

- Surface geophysics to help characterize the bedrock topography and perched aquifer geometry; and

- Special laboratory and field studies to help explain the transport mechanism for PCBs and temporal variability in water quality data in some wells.

3.0 SITE DESCRIPTION

3.1 Location and Setting

The Transwestern Compressor Station No. 5 is located approximately 1.5 miles north-northwest of Thoreau, New Mexico in McKinley County. The station lies within Township 14 North, Range 13 West, Section 20. The town of Thoreau is approximately 30 miles west of Grants along U.S. Interstate Route 40 (Figure 3.1). The location of monitor wells, waste pits, compressors, and residences are shown on Figure 3.2. The area of concentrated hydrogeologic work is in the south central part of this map. The field area investigated also includes a 500- by 500-foot area of Navajo Tribal and Bureau of Land Management lands that are just south and east of the compressor station property, respectively.

At the station the land surface slopes gently to the south and is sparsely vegetated with native grasses, juniper, and pinon pine. The land surface elevation is about 7300 feet above mean sea level (ft., msl). The station is located on the north side of a broad east-west trending valley just east of the continental divide. The Zuni Mountains rise to about 9100 feet to the south, and the prominent cliffs of the Owl Rock escarpment define the northern edge of the valley.

There are no well-defined surface water drainages crossing the station. The principal drainage, Mitchell Draw, is an ephemeral tributary of the Rio San Jose located south of the station.

3.2 Geology

The station is situated on the southern end of the San Juan Structural Basin within the Colorado Plateau physiographic province. The area is within the Zuni uplift element of the basin, a northwest-southeast trending, forested upland where Precambrian rocks are exposed and the Permian and younger strata dip to the north away from the uplift (Figure 3.3). The formations in the vicinity of the station are not influenced by structural deformation, except for the three- to five-degree north-dipping monocline. The rock-stratigraphic units of importance in this investigation are the Glorieta Sandstone, the San Andres Limestone of Permian age and the Triassic Chinle Formations. Figure 3.4 shows a "layercake" stratigraphic section of the regional geologic units. These regional sedimentary units are described in detail within the DBS&A, February 1990 report.

The Glorieta Formation is a massive sandstone varying from 120 to 220 feet in thickness. The Glorieta Formation is overlain conformably by the San Andres Formation, comprised of a lower massive limestone, a middle sandstone, and an upper massive, fossiliferous limestone. The San Andres Formation varies from 90 to 140 feet within the region (Smith, 1954).

The Chinle Formation is the principal bedrock underlying the station, as well as much of the Rio San Jose valley north of Interstate 40. The Chinle Formation is comprised mostly of red claystones and mudstones roughly 1000 to 1300 feet thick. In addition, there is a middle Chinle Formation member called the Sonsela sandstone that is approximately 90 to 130 feet thick. The upper part of the Chinle Formation has been eroded so that its surface generally slopes southward and nearly opposite to the dip of the formation. The Chinle Formation is overlain by 30 to 80 feet or more of alluvium. The alluvium thickness is variable, primarily as a consequence of the north-south aligned paleochannels eroded into the Chinle Formation surface.

The alluvium consists of reddish brown, silty sand which is fine- to very fine-grained, moderately to well sorted, with thin (less than 1" thick) silty interbeds. Within the alluvium there are localized zones of caliche and gravels. The alluvium becomes saturated at approximately 45 feet below land surface. Approximately 1 to 5 feet of weathered, sandy clay mark the transition between the surface alluvium and underlying Chinle Formation. This clayey zone is generally damp to wet near the Chinle Formation contact. Appendix A contains individual lithologic descriptions for boreholes drilled through the alluvium.

4.0 SHALLOW BOREHOLE INVESTIGATIONS

The following sections describe the rationale for drilling shallow boreholes subsequent to DBS&A's initial report (DBS&A, 1990). This section also contains a summary of the chemical concentrations in geologic core samples collected from these borings as well as chemical data in initial ground-water samples obtained from the borings. The locations of these shallow boreholes are shown in Figure 4.1. Also shown in this figure are the locations of boreholes completed prior to this phase of work, including both shallow monitor wells (5-1B through 5-8B) and deeper bedrock aquifer test wells (5-1A through 5-3A). Drilling logs for all boreholes and well completion logs for all monitor wells constructed by DBS&A are in Appendix A. Also included in Appendix A is a description of abandonment procedures for selected boreholes.

The borehole investigations described in the following have been divided into three subinvestigations on the basis of their primary objectives. These include off-site monitor wells for the purpose of BTEX plume definition in the downgradient direction, on-site boreholes to further define the source of BTEX, and exploratory boreholes to define the lateral extent of the BTEX plume and subsurface bedrock topography in the vicinity of the southern site boundary.

4.1 Shallow Off-Site Monitor Wells for BTEX Plume Delineation

As mentioned above, ground-water quality data presented in DBS&A's initial report covering site characterization work prior to February 1990 indicated the potential for PCB and BTEX in the perched aquifer to spread downgradient to the south and off Transwestern's property. Permission from the Navajo Nation to install additional monitor wells downgradient within a 500- by 500-foot area directly south of the southeastern corner of Transwestern's property was obtained in June 1990. Subsequently, nine additional monitor wells (5-12B through 5-20B) were installed in June and July 1990 within this downgradient area (see Figure 4.1). Problems with flowing sands prevented the completion of the monitor well originally designated as 5-16B. This well was abandoned, renamed as 5-16A, and replaced with a new monitor well labeled 5-16B (see Figure 4.1). This phase of downgradient well construction ended in September 1990 with the drilling and installation of two additional monitor wells (5-23B and 5-24B) near the southern boundary of the 500- by 500-foot area.

4.1.1 Description of Drilling, Sampling, Completion, Development, and Monitoring Methods

These monitor wells were drilled using a hollow-stem auger method through the alluvium overburden and several feet into the underlying Chinle Formation. Cuttings samples were collected at five-foot intervals directly from the auger flights primarily for lithologic description and chemical analyses in some borings. Split-spoon samples (either drive-core or wire-line push methods) were collected at selected depths either for the purpose of laboratory chemical analyses or laboratory hydraulic parameter measurements. In addition, a split-spoon sample was collected from the bottom of nearly every borehole to confirm that the Chinle Formation had been encountered. Split-spoon sample depth intervals, type of split-spoon sample, and related data are summarized in Table 4.1 for the subject monitor wells and all other boreholes completed since February 1990. The results of chemical analyses on geologic samples will be briefly described in the following paragraphs. Data from hydraulic parameter tests on selected geologic core samples will be discussed in Section 6.0.

The subject monitor wells were cased and developed following EPA protocol (EPA, 1986) and Exhibit F in the Consent Decree. Monitor well completion logs are given in Appendix A. All wells were constructed with new Schedule 40, threaded PVC casing. The slot size in the screened interval was 0.010 inch. In all wells the entire saturated thickness of the alluvial aquifer was screened with at least 2 feet of screen above the static water level. In each monitor well, a 10-20 silica sand was placed by hand through the hollow stem auger to a point 1 to 2 feet above the top of the screen. The top of the sand pack was measured with a clean tag line after each 0.5-cubic foot of sand was placed. The No. 10-20 silica sand was followed by 1 to 3 feet of No. 16-40 (finer) silica sand, which was also measured during placement. In Monitor Wells 5-18B, 5-19B, and 5-20B, due to flowing sand problems, the sand pack material was washed into place. (Water was obtained from the municipal water system of Milan, NM.) One cubic foot of 0.25-inch diameter bentonite pellets was placed above the No. 16-40 silica sand. The pellets were hydrated with distilled water. Bentonite slurry (American Colloid Inc. Pure Gold) rather than a cement grout was used to fill the annulus between the bentonite pellet plug on the top of the sand pack and the surface casing, to prevent invasion of cement into the gravel pack and well screen. All wells were completed flush with grade with surface completions consisting of a steel locking cap in a 12- by 12-inch vault and both in a 3-foot square, 0.75-inch, 3000-lb cement pad. The pads sloped away from the vaults to minimize precipitation ponding on the vault.

A great deal of effort was spent developing these wells to ensure that ground-water samples collected for chemical analysis would be representative of the aquifer. A 3-horsepower submersible pump (Grundfoss Pumps, Inc., Clovis, California) (2- to 3-gpm capacity) placed near the bottom of the well screen was used to purge a minimum of 20 and a maximum of 220 gallons from these wells (Table 4.2). These large purge volumes were required to reduce the amount of suspended sediment entering the wells from the silty fine sands in the alluvial aquifer and the unavoidable "cake" of auger cuttings on the borehole wall. In most cases the purge water never became totally free of sediment while employing the 2- to 3-gpm purge pump. Lower flow rate bladder pumps (0.5 gpm) were successful in producing samples that were free of sediment.

Ground-water samples for chemical analysis were collected from each well using dedicated bladder pumps. These pumps were placed at the midpoint of the saturated interval in the perched aquifer (Table 4.2). EPA guidance was also followed by DBS&A when conducting ground-water sampling tasks (EPA, 1986). The reader is referred to DBS&A's Standard Operating Procedure (SOP) for ground-water sampling, which incorporates EPA guidance, for details concerning ground-water sampling procedures (Appendix D).

4.1.2. Results of Chemical Analyses on Geologic Core Samples

Geologic samples collected during drilling at approximately the five-foot depth and near the bottom of Monitor Wells 5-12B, 5-13B, and 5-15B (Table 4.1) were analyzed for the presence of PCBs. In all cases the concentration of PCBs found in these samples (see Table E.4 in Appendix E) was far below the action limit of 25 mg/kg established in the Consent Decree for on-site restricted access areas. The highest concentration of PCBs in these samples was approximately 1 mg/kg.

Split-spoon samples from saturated alluvium near the bottom of Monitor Wells 5-16A and 5-16B through 5-20B were analyzed for volatile organic compounds by EPA Methods 8010 and 8020. The results of the volatile organic analyses are presented in Tables E.5 and E.6 in Appendix E.

Concentrations of volatile organic compounds were below detection limits in all soil samples. The results from Monitor Well 5-20B are somewhat surprising, because organic vapors were encountered near the bottom of the borehole during drilling that gave a photoionization detector (HNu Meter, Model PI-101, HNu Systems Inc., Newton, Massachusetts) reading of approximately 90 ppm near the top of the auger flights. These organic vapors dispersed readily, and HNu readings decreased to background levels within one foot of the auger flights. In addition, HNu organic vapor readings of 110 ppm were measured during the drilling of both 5-16A and 5-16B near the bottom of the borehole in saturated alluvium. These vapors appeared to have a strong mercaptan-like odor. The above-mentioned organic vapors may result from low concentrations of organic compounds present in the aquifer that are not detectable by soil analyses. Initial ground-water sample analyses from these holes (discussed below) indicate that low levels of dissolved organic compounds are present.

Geologic split-spoon samples were collected for chemical analysis near the ground surface, at five feet, and near the water table in Monitor Wells 5-23B and 5-24B (Table 4.1). The purpose of sampling in the vicinity of the water table was to determine if there was a separate low-density hydrocarbon phase present. Wire-line push-core samples were also collected near the bottom of these wells both for chemical analysis and to confirm the presence of bedrock. Both PCB and BTEX chemical analyses were conducted on all but a few of these samples. Concentrations of these chemicals were below detection limits in all samples (Tables E.11 and E.12 in Appendix E). BTEX was not analyzed in samples from Monitor Wells 5-12B through 5-15B, and PCBs were not analyzed in Monitor Wells 5-16B through 5-20B.

In summary, PCB and BTEX in soil were below detection limits in all geologic core samples analyzed.

4.1.3 Summary of PCB and BTEX Plume Data from Initial Ground-Water Samples

PCBs were not detected in ground-water samples collected from Monitor Wells 5-12B through 5-20B in August 1990. However, benzene was present at concentrations above NMWQCC ground-water standards in five of these nine wells (5-13B, 5-16B, 5-18B, 5-19B, and 5-20B). Based on this information, two additional shallow wells (5-23B and 5-24B) located further downgradient were installed and sampled to attempt to identify the leading edge of the BTEX plume. Initial ground-water samples collected from these wells did not contain levels of BTEX (or PCBs) above ground-water standards; however, subsequent sampling indicated levels of benzene in both wells above the standard, as will be discussed in Section 7 (Table 7.1).

In summary, PCBs were not found in soil or ground-water samples from any of the downgradient monitor wells installed south of the compressor station boundary. However, BTEX (primarily benzene) was present in ground-water samples from a number of these wells at concentrations exceeding ground-water standards. A map of the approximate area (plume) where some BTEX constituents (primarily benzene) were above standards in November 1990 is presented in Figure 4.2 Data from these 11 off site, downgradient wells appeared to roughly define the eastern and western boundaries of the BTEX plume; however, there was still some uncertainty, primarily about the lateral boundary for PCBs to the east of Monitor Well 5-6B and the lateral boundary for BTEX to the west of Monitor Well 5-4B. Additional borings completed in this area will be described in Section 4.3. The southern downgradient boundary of the plume has also not yet been clearly defined. Efforts are currently under way to obtain permission from the Navajo Nation to drill additional monitor wells downgradient (to the south) of Monitor Well 5-24B to define the leading edge of the BTEX plume.

4.2 Shallow On-Site Boreholes for Source Characterization

Investigations by DBS&A prior to February 1990 did not focus on defining the source of PCB and BTEX in the perched ground water. At the request of Transwestern, DBS&A undertook a multi-stage investigation in 1990 to better define the source of both PCB and BTEX in ground water. These activities are briefly described in the following paragraphs. All boreholes were drilled using hollow stem auger methods. The types of geologic samples, sample depths, and the tests conducted on these samples are summarized in Table 4.1. EPA protocol and the Consent Decree were followed in cases where monitor wells were constructed in the boreholes.

4.2.1 Soil Borings in the Vicinity of the Waste Pit

In June of 1990 DBS&A drilled and sampled three soil borings (5-9SB, 5-10SB, and 5-11SB) to more fully characterize the occurrence of PCB and BTEX in the vadose zone near the waste pit (Figure 4.1). Boring 5-9SB was drilled to the water table at approximately 46 feet just northwest of the pit. Boring 5-10SB, located just to the south and west of the pit, did not encounter water, but it penetrated Chinle Formation bedrock at approximately 45 feet and terminated at approximately 55 feet below ground surface. Boring 5-11SB, located near the center of the waste pit, was terminated at approximately 25 feet in the alluvium when high concentrations of organic vapors broke through the air-purifying respirators of DBS&A and drilling personnel. Higher levels of personal protective equipment were not available to field personnel during this stage of drilling; therefore, it was not possible to obtain additional data from this soil boring.

The results of BTEX and PCB soil analyses on core samples collected from these soil borings are summarized in Tables E.1, E.2, and E.3 in Appendix E. The soil sample from the 25-foot depth in Monitor Well 5-11SB contained elevated levels of PCBs and some BTEX constituents; it should be noted that the contaminated soils in the region of the waste pit have been subsequently removed as part of the PCB remediation. However, PCBs were not detected in soil core samples from Monitor Well 5-10SB and were detected in only the surface sample from 5-9SB. BTEX was not detected in these latter two borings except for minor amounts of toluene (< 100 μg/kg) at the 10- and 45-foot depths in Monitor Well 5-9SB and at ground surface in 5-10SB.

4.2.2 Monitor Wells in the Vicinity of the Pig Receiver

In October 1990 Monitor Wells 5-21A and 5-22B were installed near the pig receiver (see Figure 4.1) to more fully describe the distribution of PCB and BTEX on site. DBS&A's initial investigations (DBS&A, 1990) indicated significant BTEX in Monitor Well 5-2B, located just south of the pig receiver. In Monitor Well 5-22B, however, PCBs and BTEX were not detected in soil samples collected at five-foot intervals to a depth of 55 feet (Table E.10 in Appendix E), and none were detected in ground-water samples collected after the completion and development of the well. Soil samples collected at 5-foot intervals to 20 feet in Monitor Well 5-21A were also free of

PCBs and BTEX (Table E.9 in Appendix E). However, the 26-foot depth soil sample in this well contained detectable levels of toluene, ethylbenzene, and xylene, as well as higher molecular weight semi-volatile organics (naphthalene, and 2-methylnaphthalene) (Tables E.7 and E.8 in Appendix E). The organic vapors from approximately the 26-foot depth in this monitor well were present in sufficient concentrations to break through the air-purifying respirators (GMC-H Type Filters) of DBS&A and drilling personnel. Again, since higher levels of personal protection equipment were not available to these personnel, Monitor Well 5-21A was terminated at 26 feet.

4.2.3 Monitor Wells Between the Waste Pit and Pig Receiver

Monitor Wells 5-25B, 5-26B, and 5-27B were installed in November and December 1990 between the pig receiver and waste pit to better characterize the source of and pathways followed by on-site PCB and BTEX. None of these three wells encountered shallow perched ground water, but all encountered Chinle Formation bedrock at a relatively shallow depth ranging from 34 to 37 feet (see Appendix A). PCBs were not detected in soil samples collected from these boreholes at 5-foot intervals to 20 feet and at 2-foot intervals to total depth (Table E.13 in Appendix E).

4.2.4 Summary of Borehole Source Characterization Data

In summary, data from the borings described above showed no evidence of an additional source of PCBs other than the previously defined waste pit. These borings were also unsuccessful in delineating a source of BTEX other than the waste pit. Floating petroleum products or petroleum-saturated soils in the vadose zone were not encountered in these or any other boreholes drilled on or in the vicinity of the site.

4.3 Exploratory Boreholes for Water Quality and Geology Characterization

Exploratory Boreholes 5-28B through 5-33B (see Figure 4.1 for location) were drilled to define the lateral boundaries of PCBs and BTEX in the vicinity of the southern site boundary, and to improve the definition of the subsurface bedrock topography. The latter controls aquifer width and thickness, and therefore is an important influence on the design of future ground-water remediation for BTEX. As described in Section 4.1, there was some uncertainty concerning the extent of PCBs in the perched aquifer in the vicinity of easternmost Monitor Well 5-6B and the extent of benzene in the vicinity of the westerly Monitor Well 5-4B. In addition, surface geophysical data (see EM-34 data discussed in Section 5.0) suggested the presence of a bedrock low (valley) to the west of Monitor Well 5-4B and a bedrock high (hill) to the east of 5-6B. Each of the exploratory boreholes was positioned (see Figure 4.1) to attempt to define the lateral extent of the plumes and to verify the depth to bedrock. Results concerning the extent of PCB and BTEX plumes will be discussed in the following paragraphs and in more detail in Section 7. Data concerning bedrock topography will be presented in Section 6.0.

4.3.1 Description of Drilling and Sampling Methods

The exploratory boreholes were designed, drilled, completed, developed, and sampled to obtain one-time-only measurements of PCB and BTEX concentrations in the perched aquifer. These boreholes were not completed (see Appendix A for well completion logs) according to EPA guidance for monitor wells. Instead, they were completed to the extent necessary to permit development and the collection of ground-water samples. This minimal completion consisted of installing PVC screen and casing in the borehole and allowing the formation to collapse on the screen. The casing was new 2-inch, Schedule 40, threaded PVC. The screen had 0.010-inch slots and extended a minimum of 2 feet above the perched water level. As these wells were temporary installations, the annulus was left open from the top of the natural backfill to the surface. A 4-foot square plywood board was placed over the annulus to prevent contamination. The wells and plywood cover were then sealed in plastic sheeting, and a berm was placed around the well head. The plugging and abandonment of these boreholes is described in Appendix A.

These boreholes were drilled by hollow-stem auger methods as quickly as possible through the alluvium overburden and several feet into the dry Chinle Formation bedrock to minimize problems with flowing sands that were encountered previously in a number of boreholes at this site. For this same reason, drive-core or wire-line push-tube core samples were not collected for chemical analysis in the alluvium overburden. However, one split-spoon sample was collected at the alluvium-bedrock contact to confirm that Chinle Formation bedrock had been reached. Finally, every effort was made to develop (purge) the exploratory borehole as completely as possible within several days after completion. Boreholes were developed by bailing a minimum of three casing volumes.

4.3.2 Results From Exploratory Borehole Drilling and Ground-Water Sampling

PCB concentrations in ground-water samples collected from Exploratory Boreholes 5-29B through 5-33B (Table 4.4) were below the detection level (1 µg/l) in all cases. The absence of PCBs in Exploratory Boreholes 5-30B, 5-31B, and 5-33B provides strong evidence that the lateral extent of PCB in the easterly direction is bounded by Monitor Well 5-6B. Moreover, this information, combined with previously described data that indicates that PCBs have not migrated downgradient from Monitor Well 5-6B (Section 4.1.3), suggests that the apparent original extent of PCBs in ground water is confined on site to a relatively small area in the immediate vicinity of Monitor Wells 5-6B and 5-1B. (See Section 7.0 for additional discussion concerning the presence of PCBs in ground water in these wells.)

Inasmuch as BTEX constituents are below ground-water standards in these same easterly exploratory boreholes (Table 4.4), the easterly extent of the BTEX plume appears to be bounded by Monitor Well 5-6B or at least by the nearby Exploratory Borehole 5-30B. Exploratory boreholes to the west of Exploratory Boreholes 5-4B (5-28B, 5-29B, and 5-32B) were not successful in defining the westerly extent of the BTEX plume. Each exploratory borehole drilled to the west of 5-4B encountered organic vapors in the unsaturated alluvium (see drill logs in Appendix A). In addition, BTEX was detected in ground-water samples from Exploratory Boreholes 5-29B and 5-32B. Benzene, toluene, and xylene concentrations in ground-water samples from 5-29B were above standards, and benzene and toluene concentrations were above standards in 5-32B (Table 4.4). A ground-water sample for chemical analysis could not be obtained from Exploratory Borehole 5-28B because the well screen broke while attempting to install a sandpack, and flowing sands filled the well screen to the level of the water table.

In summary, chemical data collected at the completion of drilling exploratory boreholes indicate that, on site, the westerly extent of the BTEX plume is not yet established. Additional wells could not be drilled further to the west of Exploratory Borehole 5-32B at the time (May 1990) this exploratory borehole investigation was being carried out due to the presence of large stacks of pipe lying on the ground surface in this region of the site. Plans are now under way to make this portion of the site accessible and to drill an additional borehole(s) to the west of Exploratory Borehole 5-32B to more fully define the lateral extent of BTEX along the southern site boundary.

5.0 SURFACE GEOPHYSICAL SURVEYS

In the period from January to March 1991, two types of surface geophysical surveys were conducted at Compressor Station #5. These surveys were a seismic refraction survey conducted by Charles B. Reynolds and Associates (CBR&A) and an electromagnetic conductivity survey (EM-conductivity survey) conducted by DBS&A. The purpose of this work was to generate structure contour maps of the erosional surface (paleotopography) of the top of the Chinle Formation underlying the compressor station property. This map would then serve as a basis to identify paleochannels that may serve as preferred flow paths and bedrock highs that may impede or divert ground water.

5.1 Electromagnetic Conductivity Survey

DBS&A designed and implemented an EM-conductivity survey of the compressor station area using portable survey equipment (EM34-3XL, Geonics, Ontario, Canada). The major advantage of this type of instrument and method is the relative ease of collecting many measurements over a large area.

The EM-34 instrument consists of separate hand-held transmitter and receiver coils and power sources. During the operation of the instrument, the transmitter coil is energized by a low-frequency alternating current that radiates an electromagnetic field into the earth. This primary field induces eddy currents in the ground. The receiver coil detects both the primary field and the secondary magnetic field resulting from the eddy currents. The ratio between the primary field and the out-of-phase component of the secondary field is converted by a linear relationship to conductivity, which is displayed by the instrument. This reading is a bulk measurement of conductivity comprised of the cumulative responses of the subsurface conditions extending from the surface to the effective depth of penetration for the instrument. A more detailed discussion of the interpretation of the EM-34 data is given in Section 5.1.2.

The penetration depths of the primary and secondary fields are dependent on the separation distances of the hand-held coils and their orientations; the greater the coil separation, the greater the depth of penetration. For a given coil spacing, coils oriented in the vertical plane (horizontal dipole) result in a shallower field penetration than coils oriented in the horizontal plane (vertical dipole).

The area of interest was between N+1800 to S+900 and W+1500 to E+1000 (Figure 5.1). A total of 21 survey lines were completed, consisting of over 23,500 linear feet of line and approximately 1200 individual measurement stations. The distance between stations on each line was 20 feet, in order to provide detailed depth to bedrock data to facilitate delineating paleochannels that may be less that 50 feet wide.

5.1.1 Methods

The EM-conductivity survey was conducted in two phases, one in January 1991 and the other in March 1991. The intent of the first phase was to cover a large area and to generate a general picture of bedrock topography. The purpose of the second phase was to verify the preliminary effort, as well as to fill in any areas from the first survey that required more detail.

A calibration test was conducted to determine the appropriate coil spacing and dipole orientations for the top of the Chinle Formation bedrock target. Several lines (Lines 10, 7, 1, 14) were run in multiple coil separation and orientation configurations. This was done to ascertain the optimal configuration for determining the top of the Chinle Formation bedrock surface, which ranges from 40 to 70 feet below ground across the site. Samples of the data plots from the various coil separation and orientation configurations are shown in Figures 5.2 and 5.3. The 20-meter coil spacing in the horizontal dipole mode provided the most consistent relationship between depth to bedrock and EM-conductivity and the greatest sensitivity to lateral variations in the bedrock surface in all cases.

To minimize the effect of cultural interferences on data collection, the station cathodic protection beds were shut down when the survey was being conducted in the area, and buried pipes, electrical lines, and fences were located on site plans and avoided when possible.

Bedrock was correlated graphically with EM-conductivity at locations where both measured depth and EM-conductivity readings were available. Separate correlations were generated for the January and March 1991 phases of work. Measurements made near 16 monitor wells with known depths to bedrock were used as control points for the correlation plot for the January 1991 data. Six wells were used for the correlation plot for the March 1991 data. A best fit linear regression of the control data was employed for the final conversion of EM-conductivity data to bedrock depths. The correlation plots are shown in Figures 5.4 and 5.5.

Surface elevations along each line were determined from a surface contour map produced by Condor Geotechnical Services, Inc. (Figure 9 in DBS&A, 1990). The calculated depth to bedrock was subtracted from the surface elevations to give the conductivity data as elevation of the top of the Chinle Formation (bedrock). Tables containing station numbers, EM-conductivity values, depth to bedrock, and top of Chinle Formation elevations are shown in Appendix F. The elevation data for the top of the bedrock were plotted and contoured as described below.

The elevation for the top of the Chinle Formation was tabulated and plotted as distance along a survey transect vs. elevation (ft., msl) of the top of the Chinle Formation. The transects were also plotted on the Condor surface contour map. In an attempt to smooth the data, only every fifth data point was plotted and contoured. When a significant trend was detected between the fifth points, the maximum or minimum of the trend was also plotted. See Figure 5.6 for an example of how the smoothing was applied. When the data from the March 1991 survey were merged with those of the January 1991 survey, it was found that an exact match was not possible in all cases where the survey lines overlapped. This difference is probably the result of using different EM-34 units (same model number, different serial number). In these cases, the data from every fifth point from the March 1991 survey was used until the difference between the two surveys became greater than 7 feet. At that point, a straight line of elevation was used to bridge from the previous fifth point on the truncated March 1991 line to the start of the January 1991 line.

5.1.2 Interpretation

Data interpretation is dependent upon understanding the geologic and cultural features which may affect the measurements. Conversion of EM-conductivity values to depth to bedrock assumes that the siltstones and shales of the Chinle Formation contain saline pore fluids and solid matrix material, which are significantly more conductive than the overlying alluvium. Furthermore, we assume that the lateral variations in conductivity for the two units is small. Lateral variation in conductivity can be attributed to changes in water content within the alluvial cover, residual salts, cultural interferences, etc. As the alluvium thickens, the conductivity values measured by EM-34 decreased, because the top of the Chinle Formation is further from the instrument. Conversely, when the Chinle Formation was close to the surface, the conductivity measured by the instrument increased.

The bedrock elevation contour map derived from the EM-34 data (Figure 5.7) indicates that at least two distinct paleochannels may exist in the eastern part of the compressor station, with possibly a third paleochannel on the western side of the station. A prominent bedrock high splits the two systems near the waste pit. This ridge or hill may have resulted from resistance to erosional forces due to tighter cementation of the Chinle Formation matrix. Three soil borings in this area (5-25B, -26B, and -27B) verify that there is a bedrock high ridge of Chinle Formation. Placement of paleochannels on the bedrock map is interpretive, and other equally valid interpretations exist. For example, one paleochannel could feasibly bifurcate around the ridge and rejoin near Line 7. The bedrock contours also suggest that the channels broaden toward the south and join together south and west of coordinates 0+00, 0+00.

5.2 Seismic Refraction

In January 1991, CBR&A performed a seismic refraction survey at the Compressor Station #5. The purpose of the survey was to generate a refined structure-contour map of the top surface of the Chinle Formation, identify major paleochannels, and locate perched water in the alluvium. It is much more time consuming and costly to survey large areas by seismic methods than by

EM-34 methods. Therefore, the area of the seismic survey was considerably smaller and focused on the southeastern portion of the site. The area surveyed was approximately between N+1000 to S+700 and W+700 to E+500.

CBR&A's report summarizing the findings from this survey is included in Appendix F. Included in the report are detailed descriptions of the methods used, results, interpretations, conclusions, and recommendations resulting from the survey. Also included in this report are plates showing the seismic line locations, depth sections, and structure contours of the Chinle Formation.

The results of the seismic refraction survey are summarized as a structure-contour map of the top of the Chinle Formation in Figure 5.8. This map shows the Chinle Formation and alluvium contact generally sloping to the south with several south-draining paleochannels. Seismic data in the pit area reveal a bedrock high that causes the paleochannels to bifurcate. The seismic refraction data also suggest that the perched water may thicken, from five feet or less to ten feet or more, immediately south of the buried hill.

5.3 Comparison of Geophysical Surveys

The structure contour maps of the top of the Chinle Formation from each of the two geophysical survey methods are shown in Figures 5.7 and 5.8. While the two structure contour maps are not identical, they are very similar. Both show that the waste pit area is underlain by a round-shaped structural high in the Chinle Formation and that paleochannels bifurcate around the hill and drain to the south. The exact location of the main or trunk channel is slightly different, due probably in part to the difference in the extent of the areas surveyed. The larger EM-conductivity data base also shows a large, east-west trending, buried ridge about 1000 feet north of the pit area, a north-south trending ridge about 500 feet east of the pit, and a second paleodrainage 1000 feet west of the pit.

The combined results of the two geophysical surveys above indicate the following: 1) the surface of the Chinle Formation slopes to the south more steeply than the ground surface, 2) there is a buried hill under the pit area that may act to spread chemicals in ground water to the east and west of the pit, 3) there are paleochannels in the pit area that may act as preferential flow paths for ground water and BTEX, 4) there are buried hills to the north of the pit area that may influence subsurface flow to the waste pit area, and 5) a buried hill to the east may prevent the spread of BTEX to the east. A more detailed discussion of bedrock topography is given in Section 6.0, where cross-sections developed from boreholes are discussed.

The results of the two surveys were partially verified by a drilling program conducted in May 1991. This program concentrated on the east and west ends of Line 7 (see Figure 5.1) of the EM-conductivity survey. In general, the high and low trends in the bedrock topography determined from the EM-34 survey correlated well with high and low bedrock elevations determined by drilling. However, the actual depth to bedrock detected by drilling was as much as 10 to 20 feet greater than predicted by the EM-34 data at some locations. See Section 4.3 for a more detailed description of this drilling program.

6.0 SITE HYDROGEOLOGY

In descending stratigraphic position the principal water-bearing zones at the site are the perched alluvium, the Upper Chinle Formation mudstone and claystone, the Sonsela Sandstone within the Chinle Formation, and the San Andres Limestone-Glorieta Sandstone. The alluvium forms an unconfined perched aquifer ranging from approximately 10 to 25 feet thick across the station. The perched aquifer contains sodium-calcium-bicarbonate type water of good to moderate quality. The regional water table lies approximately 400 feet below land surface within mudstones and claystones of the Upper Chinle Formation. Test Wells 5-2A and 5-3A are completed in the Upper Chinle Formation and contain saline water of poor quality. The Sonsela Sandstone member of the Chinle Formation forms a confined, fresh, sodium-bicarbonate type aquifer that lies beneath about 650 feet of low-permeable Upper Chinle. Test Well 5-1A is completed within the Sonsela member of the Chinle Formation. The base of the Sonsela is separated from the deeper San Andres Limestone-Glorieta Sandstone aquifer by approximately 400 feet of the lower Chinle Formation. The San Andres-Glorieta aquifer is about 1240 feet beneath the station. These hydrostratigraphic units are described in detail within the DBS&A February 1990 report.

Hydrogeologic investigations initiated since the February 1990 report have focused on the alluvial ground-water system perched upon the Chinle Formation bedrock. The following sections concentrate on the findings of this additional work.

6.1 Thickness and Extent of the Perched Aquifer

Ground water within the alluvium is perched upon the underlying Chinle Formation. The aquifer thickness and lateral extent are controlled by the irregular erosional features cut into the Chinle. Drilling investigations indicate that the saturated thickness varies from 0 to more than 30 feet, and is generally 10 to 25 feet thick across the study area. The perched aquifer is thinnest below an erosional high of Chinle Formation bedrock located just south of the waste pit, and is thickest within paleochannel lows and at the southern end of the 500- by 500-foot annex area.

Several hydrogeologic cross sections were constructed in order to determine the subsurface geometry (refer to Figure 6.1 for cross section locations). Cross sections illustrate that the contact between the Chinle Formation and alluvium generally dips toward the southwest within the original property boundaries (Figures 6.2 through 6.8). The A-A' and B-B' west to east transects within the original property boundary exhibit a highly irregular bedrock surface (Figures 6.2 and 6.3). Bedrock contact elevations within the annex area are comparably flat on west to east transects and dip to the south at a relatively constant angle (Figures 6.4 through 6.8). The exception to the constant southerly dip is the noticeable increase in dip to the south between Monitor Wells 5-20B and 5-24B toward the southern end of the study area (Figure 6.7). This increased dip may be the result of increased erosional rates due to coalescing paleodrainages.

An isolated prominence of Chinle Formation was encountered above the perched water table during the drilling of Borings 5-25B, 5-26B, 5-27B, and 5-10SB near the waste pit. This prominence appears to act as a dividing point within the ground-water flow field by diverting flow around it to the east and west sides of the high. With the exception of the above dry borings, all other borings encountered water within the alluvium. This implies that the alluvial aquifer is continuous beneath the site, but varies greatly in thickness depending on the location of erosional lows and highs within the Chinle Formation.

In general, borings were drilled until auger refusal, and this depth usually coincided with competent Chinle Formation bedrock. The competent Chinle Formation is dry but overlain by a damp to wet, clayey, weathered Chinle Formation profile ranging from 1 to 5 feet in thickness. Monitor Wells 5-4B, 5-7B, and 5-8B, which were drilled in the earlier field program, may have been terminated above the Chinle Formation, based on split-spoon blow counts, lithologic description of cuttings, and recent drilling. However, the EM-34 geophysical survey does suggest that the Chinle surface rises east of the study area.

6.2 Ground-Water Flow Directions

Ground water occurs in deep bedrock as well as in the alluvium. The two ground-water systems are distinctly different and are hydrologically disconnected. The following two sections describe the flow regime for the bedrock aquifer and the perched alluvial aquifer.

6.2.1 Sonsela Sandstone and Upper Chinle Formation Shale

Recharge to the bedrock aquifers occurs primarily in outcrop areas on the north slope of the Zuni Mountains and along Mitchell Draw. Regional ground-water flow is north toward the center of the San Juan Basin and also eastward in the subcrop areas along the Mitchell Draw valley.

Depth to water measurements in on-site monitor wells exhibit fluctuations of up to 71 feet in the Sonsela and 18 feet in the Upper Chinle Formation since January 1991 (see Table 6.1). Water-level fluctuations within the deep wells were originally observed during the 1989 field study (Appendix D, DBS&A, 1990). Depths to water in Test Well 5-1A declined during the summer of 1989, which corresponded to increased pumping from station supply wells completed in the Sonsela. Water level elevations increased in Test Wells 5-2A and 5-3A (Appendix D, DBS&A, 1990) during the summer and fall of 1989, which represents recovery from drilling and sampling or seasonal recharge of the Upper Chinle Formation. The hydraulic heads in the Upper Chinle Formation, Sonsela, and San Andres-Glorieta aquifers increase with depth, suggesting that there is potential for upward flow within the deep multiple aquifer system below the station. However, the low vertical hydraulic conductivity of the Lower and Upper Chinle Formations would cause the rates of upward flow to be quite small. Ground-water gradients and directions of flow from on-site deep bedrock wells are difficult to determine, but regionally, ground-water flow is toward the north in each of these hydrostratigraphic units (DBS&A, 1990).

6.2.2 Perched Aquifer

Recharge to the perched aquifer occurs as infiltration of rainfall, runoff, and snowmelt on the Transwestern property. Some recharge may also occur where there may be underflow from bedrock formations which outcrop to the north of the property.

Depth to water in the perched aquifer ranges from 43 to 56 feet below the land surface (Table 6.2). Water elevations measured in the monitor wells indicate a southerly flow direction. The depth to water is shallowest within the original property boundaries and increases southward. Water table contours were constructed from May 1991 water level data and top of casing (TOC) elevations provided by Condor Geotechnical Services, Inc. (Figure 6.9). The mean hydraulic gradient is about 0.03 ft/ft across the area of investigation. In general, the ground-water gradient appears to mirror the surface topography across the site. However, local variability in the gradient is explained by spatial heterogeneity in permeability and aquifer thickness. The gradient decreases near Monitor Wells 5-4B and 5-6B and increases to about 0.06 foot per foot between Monitor Wells 5-20B and 5-13B (Figure 6.9). Streamlines shown in Figure 6.9 suggest that the paleochannels identified by the geophysical surveys (Section 5.0) appear to influence the ground-water flow directions locally.

Hydrographs for all monitor wells completed in the perched aquifer are given in Appendix B. The duration of the record is brief because most of the site monitor wells were installed during the summer and fall of 1990. Depth to water measurements were made in each well prior to water quality sampling events. During the period of November 1990 through January 1991, several of the water depths in monitor wells increased slightly and/or stabilized, but the overall declining trend continued through the spring of 1991. Hydrographs for the period of August 1990 to May 1991 indicate water-level declines ranging from 0.06 to 0.85 feet (Appendix B). In general, water-level hydrographs show minimal seasonal fluctuations, suggesting that the flow system may be near dynamic equilibrium.

6.3 Aquifer Hydraulic Testing

Aquifer parameters are determined by applying a known stress to the aquifer system and measuring the system's response. We used three field methods to determine the in situ hydraulic properties of the alluvial aquifer. Field methods included constant-rate pumping, constant-rate bailing, and slug displacement tests. Hydraulic conductivity values were calculated by dividing the calculated transmissivity by the total saturated thickness of alluvium prior to the time of testing. Values calculated for hydraulic conductivity are within an order of magnitude for the different tests. Due to the relatively large distances between existing monitor wells and the low transmissivity of the alluvium, aquifer interference testing using observation wells proved to be unsuccessful. In all field tests cases, no measurable drawdown occurred in the nearest observation well. The nearest potential observation well was 45 feet from the test location. Test methodologies, observations, and results are presented in the following sections. Aquifer test data and graphs can be found in Appendix B.

6.3.1 Constant-Rate Pumping Tests

Constant-rate pumping tests were conducted in Monitor Wells 5-4B, 5-5B, and 5-6B. The primary advantage of conducting this type of test is the comparably large volume of aquifer that is stressed. The tests were of relatively short duration due to the limited saturated thickness and low yields of the alluvial material. Measurements of water-level decline and recovery were limited to the pumped well.

Drawdown and recovery data were collected at predetermined time intervals to assure adequate coverage on semi-logarithmic graph paper. Water levels were measured with pressure transducers and verified by electrical sounders capable of measuring to within 0.01 foot. Discharged water was routed to stock tanks for storage through teflon-lined tubing. An electrical submersible pump capable of maintaining constant low discharge rates was used. Electrical power for operating the pump was provided by a gasoline-powered generator. Discharge rates from the pumping well were maintained with in-line calibrated "Dole valves" (a circular orifice weir) and periodically checked by timing the filling rate of a calibrated container. Tabulated values of measured discharge versus time are given in Appendix B for each pumping test.

During pumping tests at Monitor Wells 5-5B and 5-6B, discharge water was sampled for PCBs and BTEX at regular time intervals. The analytical results and corresponding discharge volumes for these special sampling events are discussed in Section 7.1.4. In addition, temperature, pH, and specific electrical conductance of the pumped water were measured at regular time intervals. Short-term, step drawdown tests were conducted at each well to select the optimal pumping rate and test duration. Pumped wells were allowed to fully recover before starting the constant-rate tests.

In general, time versus drawdown and recovery plots depart from the Theis logarithmic type curve but do exhibit straight line segments on semi-log plots (Figures B.1 through B.9 in Appendix B). These plots suggest that the aquifer does not meet all the assumptions inherent in using the Theis or modified Theis solution (Cooper and Jacob, 1946). The alluvial aquifer underlying the station is unconfined, is of limited saturated thickness, and is bounded by bedrock highs in the Chinle Formation. To avoid the adverse effects of well loss, variable discharge rates, and other inner boundary effects, aquifer transmissivity was determined from the recovery data using the Cooper-Jacob approximation. However, specific yield cannot be determined from such data. Table 6.3 summarizes the results from the three tests.

Middle to late time data were used to avoid over- or under-estimating transmissivity. For tests of short duration, far-field boundary conditions are less important than perturbations near the pumped well. The radius of influence generated during these tests is on the order of 2 to 5 feet from the pumped well. Therefore, the likelihood of intersecting barrier boundaries or other hydraulic discontinuities is small.

Due to aquifer dewatering, this analysis is constrained by the decreasing transmissivity during pumping and changing storage properties of the perched aquifer. Semi-log drawdown plots for Monitor Wells 5-5B and 5-6B (Appendix B, Figures B.2 and B.6) both exhibit sudden increases in the drawdown rate at 50 and 160 minutes respectively. This may be the result of decreasing aquifer thickness during pumping and dewatering of more permeable zones. The semi-log recovery plot for the test at Monitor Well 5-4B (Appendix B, Figure B.1) shows an initial rapid water level recovery indicating that the well suffers from well loss or skin effects. Tests at Monitor Wells 5-5B and 5-6B did not demonstrate similar well loss or skin effects. The apparent geometric mean hydraulic conductivity for the three wells tested is 0.22 feet per day (Table 6.3).

6.3.2 Constant-Rate Bailing Tests

Constant-rate bailing tests were conducted in ten monitor wells. We bailed the wells for approximately 30 minutes, or until the well was nearly dry, and measured the water-level recovery to the original static level with an electrical sounder. The main advantage of this method was the relative ease of setting up and testing the wells rapidly while still stressing a relatively large volume of aquifer. Total time and volume bailed were noted to determine an average discharge rate. This method allows easy comparison of the permeability of many locations. With the exception of Monitor Well 5-17B, all wells experienced nearly 100% recovery within 45 to 60 minutes after bailing stopped.

A summary of wells tested and the respective calculated parameters is given in Table 6.4. Residual drawdown data obtained during recovery were analyzed using the Cooper-Jacob approximation. The same assumptions and limitations apply as described above for the constant rate pumping test (Section 6.3.1). Appendix B contains the semi-log recovery plots and field data. Several of the recovery curves (Figures B.10 through B.16 in Appendix B) intersect the point of zero residual drawdown to the right of the origin (t/t' = 1). This indicates a decrease in specific yield during the recovery period (Hargis, 1979). Jacob (1963) attributed the difference in storage coefficient for unconfined systems to hysteresis of the capillary fringe and entrapment of air bubbles by the rising water table. The larger the curvature in the recovery plots, the greater is the change in storage properties.

The apparent geometric mean hydraulic conductivity for seven of the ten tests is 0.12 feet per day. This is in close agreement with the constant rate pumping tests results, suggesting that there are no isolated inactive zones within the flow field, except for possibly at Monitor Well 5-17B. Monitor Wells 5-3B, 5-5B, and 5-16B are capable of producing more water than the other wells tested, as seen by the inability to depress the static levels by more than 1.5 feet after ½ hour of bailing at 0.5 to 0.6 gpm. A "rough" two-point calculation of drawdown using the Cooper-Jacob approximation for these three higher producing wells yielded an average hydraulic conductivity (1.7 feet per day) that is approximately one order of magnitude larger than the other seven wells tested. Of the three wells that were tested by pumping, Monitor Well 5-5B was able to sustain a larger discharge rate than 5-4B or 5-6B.

6.3.3 Slug Displacement Tests

Slug displacement tests are conducted by instantaneously adding a predetermined volume of water to the well and monitoring the water level decline as it flows from the wellbore into the surrounding formation. Detailed information on analytical solutions can be found in Lohman (1979).

Three slug displacement tests were discussed in the original February 1990 report by DBS&A. The original monitor wells tested were 5-1B, 5-2B, and 5-3B. The mean hydraulic conductivity calculated for Monitor Wells 5-2B and 5-3B was 1.2 feet per day, and the storage coefficient estimates ranged from 0.1 to 0.0001. The data from the Monitor Well 5-1B slug test was not amenable to such an analysis.

In September 1990 an attempt was made to test the hydraulic properties of Wells 5-12B, 5-13B, and 5-16B. The procedure involved submerging a sealed bailer of known dimensions below the water table, allowing the water levels in the well to equilibrate, and then quickly removing the bailer from the well, thus effectively creating a slug withdrawal. The apparent geometric mean hydraulic conductivity calculated from these tests was 1.1 feet per day. A summary of the slug displacement tests is given in Table 6.5.

The results from the two slug testing events appear to be in close agreement. Hydraulic conductivity values calculated by slug displacement versus constant-rate bail tests vary by as much as one order of magnitude, but in some cases similar results were achieved. Refer to Tables 6.5 and 6.4 for a comparison of relative values for Monitor Wells 5-3B and 5-16B by the two methods.

Slug test results appear to be internally reproducible but there are several disadvantages to this method in unconfined systems. First, the volume of the slug was too small to adequately stress the system. Slug displacement volumes were only 1 to 3 gallons at most; an accounting of the displaced water is therefore essential to the accuracy of the resulting calculations. Second, in an unconfined system the slug may actually be saturating previously unsaturated materials above the capillary fringe. Third, the wells are sand packed above the water table; therefore, it is possible that a portion of the slug propagated into the permeable gravel pack. Because a larger volume of aquifer is tested using the pump- and bail-recovery methods, more weight should be assigned to results from those tests. None of the methods are suitable for accurately determining specific yield, which is best determined from interference testing or laboratory analysis.

6.4 Laboratory Analysis of Soil Hydraulic Parameters

In October 1990, drive-core samples (see Section 4.1.1) were collected near and below the water table during the installation of Monitor Wells 5-15B, 5-16B, 5-18B, and 5-19B for laboratory analysis of hydraulic parameters. Measured soil parameters included initial moisture content, dry bulk density, porosity, moisture retention characteristics, saturated hydraulic conductivity, and particle size distributions. Laboratory results and procedures are presented in Appendix C.

In general, the perched aquifer materials are fine grained, densely compacted, and of moderate permeability (see Appendix C); the 5-16B sample collected above the water table is the only sample deviating from this general description. This sample was coarser, loosely compacted, and of higher porosity and hydraulic conductivity. The loose compaction of this sample suggests that it was disturbed during sampling; therefore, measurements are likely not representative of formation properties. The mean porosity is 27%, moisture content at 15 bars is 14.9%, and saturated hydraulic conductivity is 0.03 feet per day for the six samples. The mean particle diameter (d_{50}) is 0.35 mm.

The aquifer specific yield can be estimated by subtracting the moisture content at 15 bars from the porosity of the aquifer. The calculated value for specific yield is 0.12.

6.5 Summary of Hydraulic Conductivity and Storage Properties

Three types of in situ and several laboratory testing methods have been used in order to estimate the hydraulic properties of the aquifer. Table 6.6 summarizes the number of wells tested by each method, the parameters calculated, and the geometric mean for each type of test.

The in situ and laboratory testing discussed above have served to bracket the range of possible parameter values from all test methods for the alluvial materials at the site. Hydraulic conductivity values from all test methods range from 0.03 to 1.80 feet per day with a geometric average of 0.28 feet per day. Spatial variability of hydraulic conductivity is estimated to be about one order of magnitude. Spatially, hydraulic conductivity estimates inversely correspond to hydraulic gradients across the site (Figure 6.9). Greater variation in hydraulic conductivity estimates is apparent between testing methodologies.

Laboratory values for hydraulic conductivity are approximately an order of magnitude lower than in situ tests. This may be due to a number of factors, including excessive compaction during initial sampling via drive-core methods. Drive-cores are not considered to be truly undisturbed samples, and compaction to beyond-formation densities is possible, especially with samples containing a significant amount of fine materials. Also, a very small sample of the aquifer material is tested. However, in general, lab results confirm that the permeability of the alluvial material is low.

The best estimates of specific yield and porosity are from the direct laboratory measurements, since single well pumping, slug displacement,and bail-recovery tests allow no direct method for determining these parameters. Specific yields of 0.12 are reasonable for this type of aquifer material (Davis and Deweist, 1966).

6.6 Water Budget Calculations and Conceptual Model of Flow Pathways

An approximate water budget was prepared for a one-year period to assess whether the source of the perched aquifer was attributable to infiltration of precipitation through the soil or other sources. In this simple analysis we envision that the perched aquifer is truncated on the north, and discharge occurs by lateral ground-water flow to the south. The only source of recharge considered was infiltration over the compressor station. For the water balance calculation, the hydrologic divides, or no-flow boundaries, and surface area were estimated from the station map (Figure 3.2). The following paragraphs outline the procedure used.

Mean annual precipitation is approximately 11 inches and is assumed to be uniform across the area of interest. There are no well-defined drainage channels at the station; therefore, overland flow is conservatively estimated at 3 to 5% of total yearly precipitation.

The southern boundary of the system corresponds to the station's southern boundary fence, and the lateral boundaries are assumed to be the western station boundary and the eastern Chinle bedrock high (Figure 6.10). Figure 6.10 is a general hydrogeologic map of ground-water flow within the perched system based on surface geophysical surveys, drilling data, and projected water table contours from the monitor well network. Shaded areas are considered dry or of limited saturated thickness (Figure 6.10).

Under steady state conditions ground-water recharge is equal to ground-water discharge; therefore, estimating the ground-water discharge across the site is necessary. Approximate ground-water discharge can be determined from the equation:

$$Q = K\,i\,A$$

Where Q is the ground-water discharge rate, K is the hydraulic conductivity, i is the hydraulic gradient, and A is the cross-sectional area through which ground-water flow occurs. Ground-water discharge was estimated using the geometric mean hydraulic conductivity of 0.28 feet per day, a gradient of 0.03, a saturated thickness of 15 feet, and a aquifer width of 1635 feet. The calculated discharge rate is 7.5×10^4 cubic feet per year.

The ground-water recharge rate over the 1.8×10^6-square-foot station, necessary to produce a ground water flow of 7.5×10^4 cubic feet per year would be 0.04 feet per year. This recharge comprises approximately 5% of the mean annual precipitation over the station, which is reasonable for typical southwestern areas. If overland flow and recharge each comprise 5% of precipitation, then evapotranspiration represents about 90% of mean annual precipitation. These water budget components are reasonably representative of semi-arid climates (Evans, 1981).

Based on the water budget analysis and hydrogeologic data from the preceding sections, a reasonable conceptual model for recharge and flow pathways is as follows. Water is recharged to the alluvial ground-water system by infiltration of rainfall, runoff, and snowmelt, and it is perched on top of the low-permeable Chinle mudstone and claystone. Paleochannels incised into the Chinle Formation have a significant influence on flow within the alluvial aquifer, especially near the waste pit and within the original property boundaries. Within the annex area downgradient, the bedrock surface has less control on flow direction and hydraulic properties.

6.7 Rate of Ground-Water Movement

Ground-water travel times can be calculated by approaching the problem in two ways. First, the downgradient extent of the benzene plume divided by the time since first use of the waste pits gives a rough estimate of average flow velocities. For example, if waste disposal began 30 years ago and presently the leading edge of detectable BTEX concentrations is near Monitor Wells 5-23B and 5-24B (approximately 700 feet downgradient from the dumping areas), the average flow velocity would be 23 feet per year through the alluvial aquifer (neglecting any retardation or biodegradation effects).

Average flow velocities can also be determined from the equation:

$$v = Ki/n_e$$

Where **v** is the average pore velocity, **K** is the hydraulic conductivity, **i** is the hydraulic gradient, and $\mathbf{n_e}$ is the effective porosity. Using an effective porosity of 0.12 determined from lab data, a gradient of 0.03, and a hydraulic conductivity of 0.28 feet per day, the travel time velocities are approximately 26 feet per year. This would be considered a site average. This velocity is in close agreement with the estimate given above. However, hydraulic testing indicates regions of higher permeability on the order of 1 to 2 feet per day. Using the higher estimate of 2 feet per day and holding the other parameters in the velocity equation constant, flow velocities could be as high as 182 feet per year. These high estimates probably correspond to average velocities within coarser materials of the paleodrainages. If this is the case, ground water would travel from the waste pit to the southern part of the annexed area in only about 4 years, and in 30 years conservative constituents would be about 5400 feet from the site. Our estimate of ground-water velocity and travel time will improve when additional site investigations are completed on Navajo Tribal land to the south of our existing monitor well network.

7.0 GROUND-WATER CHEMISTRY

In Section 4.0 findings concerning the boundaries of PCB and BTEX plumes were briefly discussed, primarily to explain the rationale for the different phases of borehole and monitor well drilling. In most cases, Section 4.0 presented only the results of the initial ground-water sampling events. The following sections will summarize the results of subsequent ground-water sampling events and their effect on characterizing the extent and movement of the PCB and BTEX in the perched ground water. In addition, a number of laboratory and field studies are described whose purpose is primarily to better understand the transport of PCB and BTEX in the perched aquifer.

7.1 Summary of PCB in Ground Water

The results of initial ground-water sampling after the installation of boreholes described in Section 4.0 indicated that PCBs in ground water were confined on site to the immediate vicinity of Monitor Wells 5-1B and 5-6B. The results of additional periodic ground-water sampling of these and other wells will be discussed below. In addition, special studies will be described which were designed to characterize the adsorption properties of PCBs on aquifer materials and to understand the PCB transport mechanism in shallow ground water beneath the site.

7.1.1 PCB Concentrations in Ground-Water Samples Collected Over Time

Transwestern requested DBS&A to begin routine monthly ground-water sampling of all monitor and test wells at all four of the New Mexico sites in September 1990. With the exception of October and December 1990, DBS&A maintained this monthly sampling schedule at Thoreau. Prior to that time, ground-water sampling had been limited to samples collected after monitor well installation and development (initial samples), except for the deep Test Well 5-2A (see Appendix A). The PCB and BTEX results from all sampling events are summarized in Table 7.1. Copies of actual sample laboratory data sheets; QA/QC blank, split, and replicate data sheets; chains of custody; and other supporting information are available upon request.

Early sampling events included PCB and BTEX analyses, along with other organo-chlorine (EPA Method 608) and volatile organic (EPA Method 624) compounds and semivolatiles (EPA Method 625). The complete results of these larger schedules of analyses have been presented in an earlier report (DBS&A, 1990); these results demonstrated that no organic constituents (except PCBs and BTEX) were detected in soil and ground water. Chemical analyses of routine monthly samples have since been limited to PCBs (EPA Method 8080) and BTEX (EPA Method 8020).

Table 7.1 indicates that PCBs were consistently detected in monthly samples from Monitor Wells 5-1B and 5-6B from September 1990 through January 1991, although concentrations varied by as much as nearly two orders of magnitude between monthly sampling events. However, from February 1991 through May 1991 (last sampling event included herein) PCBs have not been detected in these wells. Monitor Well 5-5B was the only other well where PCBs were detected. PCB compounds were initially absent from this well, appeared in samples collected in September and November of 1990, and were absent in subsequent samples. To attempt to account for such variability of PCBs in these monitor wells, several special investigations were undertaken by DBS&A. These investigations will be described in the following sections.

7.1.2 PCB Adsorption/Migration Special Study

In the initial hydrogeologic report (DBS&A, 1990), data from a number of sources in the technical literature were cited which demonstrated that PCBs are very strongly adsorbed to geologic materials and therefore could be expected to move very slowly in ground water. To quantify the degree to which PCBs or other substances are adsorbed to solid materials (e.g., aquifer materials) a parameter termed "distribution coefficient" can be measured in the laboratory. DBS&A has conducted laboratory tests to measure distribution coefficients for site specific geologic materials and PCB compounds. These tests are described in detail in Appendix G, and the results as well as their application to determining flow rates and travel times in ground water are described below.

DBS&A's experiments were conducted by equilibrating PCB-contaminated soil obtained from the site with clean ground water obtained from Monitor Well 5-3B located upgradient of all PCB-impacted areas. After equilibration, the amount of PCBs remaining on the soil (μg PCB/g soil) was divided by the amount of PCBs which had dissolved into solution (µg PCB/ml solution) to yield the distribution coefficient (ml/g). The average distribution coefficient obtained from these experiments was calculated to be 88 ml/g, which DBS&A considers a lower boundary of the actual distribution coefficient (see Appendix G for additional details). This distribution coefficient compares favorably with a distribution coefficient of 65 ml/g calculated (using hydrophobic theory) from a measured organic matter content of soils at Thoreau (245mg/kg) and the measured octanol water partition coefficient (log Kow=5.63) for Aroclor 1242. Aroclor 1242 is one of the major PCB compounds detected at Thoreau.

A retardation factor of 624 is calculated from the measured distribution coefficient (88 ml/g) by multiplying by the average dry bulk density (1.91 g/ml) and dividing by the average porosity (0.27). Both the average density and porosity were calculated from laboratory measurements made on soil cores (Appendix C). Since DBS&A considers the distribution coefficient a lower boundary or minimum value, the retardation factor is also considered a minimum value. This retardation factor indicates that PCBs in the dissolved phase should move at least 509 times more slowly than the ground water, or about 0.03 feet per year.

This retardation factor can be used to calculate the travel time for PCBs to move from the presumed source (waste pit) to the area where they have been detected (Monitor Wells 5-1B, 5-5B, and 5-6B) if the travel time for ground water is known. The ground-water travel time, the distance between the source and the nearest impacted wells (approximately 200 feet) divided by the average shallow aquifer flow velocity (26 feet per year), is 7.7 years. Thus, the time it should take for PCB compounds to reach Monitor Wells 5-1B and 5-6B is computed by multiplying the ground-water travel time (7.7 years) by the retardation factor (624), which equals approximately 4800 years. Because PCBs have reached these wells within approximately 30 years, either the retardation factor is much too large, or the ground-water velocity is too small, or movement of PCBs is due to a mechanism other than dissolved transport.

Several alternative explanations are possible. First, the source of PCBs may be much closer to these monitor wells than the condensate pit. For example, the source may have been PCB-contaminated soils on or near the ground surface at these well sites.

Another possible explanation for the anomalous rapid transport of PCBs may be colloidal transport via iron hydroxyoxide particles. It is possible that anoxic conditions caused by high concentrations of organic matter in the waste condensate pit created conditions that were favorable for the formation of colloidal iron hydroxyoxide particles. The anoxic zone near the pit would allow for the reduction and dissolution of iron oxides, and as dissolved ferrous iron moves into the oxygenated zone away from the center of the pit, it will oxidize and precipitate to form colloidal iron hydroxyoxides. These high-surface-area colloidal particles will serve as ideal sites for adsorption of PCBs. Their subsequent advection through the aquifer could serve as a transport mechanism. The movement of these colloidal particles will be inhibited to some degree by coagulation and by the filtering effect of aquifer materials. When the monitor wells are purged, some of the colloidal particles containing PCBs could be pulled into the well. Eventually the region around the well screen may be "purged" of these iron hydroxyoxide-PCB colloids, and ground-water samples would be free of PCBs as detected in the subject monitor wells.

A third explanation for the rapid disappearance of PCBs from the subject on-site monitor wells is the possibility that mobile colloidal PCBs have moved downgradient from the subject wells. The main argument against this scenario is that in order for PCBs to be at relatively high concentrations in Monitor Wells 5-1B and 5-6B in January 1991 and to completely disappear one month later, they must be moving very rapidly in a "piston-like" manner with a very sharp concentration front. This implies that very little or no mixing and retardation is occurring, which is highly unlikely for either dissolved or colloidal material. Further, if colloidal PCBs were moving this rapidly, it is likely that they would already have appeared in downgradient wells such as 5-17B. It should be noted that the rationale for drilling exploratory Monitor Wells 5-30B and 5-31B downgradient and crossgradient from the sites where we previously encountered PCB (see Section 4.3) was in part to disprove this rapid piston-like movement hypothesis. No PCB has been detected south of the southern property boundary. Consequently, transport of PCB south from the vicinity of Monitor Wells 5-1B and 5-6B is unlikely.

Finally, the drilling process or related activities potentially could have carried PCBs down to the region of the well screen. The drilling process could also have helped, via physical agitation, to suspend the PCBs into a colloidal phase in the ground water. Evidence for PCBs being in a colloidal phase will be discussed below in Section 7.1.3. The finite amount of colloidal PCBs introduced into the borehole during drilling should eventually be removed from the area of the well screen by repeated purging and sampling. This proposed removal process may explain the disappearance of PCBs from Monitor Wells 5-1B and 5-6B in February 1991.

7.1.3 Colloidal Transport Test

The source material of the PCB concentrations at the Thoreau compressor station is Aroclor 1242, according to Transwestern representatives and DBS&A chemical analyses. The solubility values of Aroclor 1242 from various sources are as follows: 0.24 mg/l, 0.34 mg/l and 0.24 mg/l at 25°C; 0.100 mg/l at 24°C; and 0.2 mg/l at 20°C (Montgomery and Welkom, 1990). Linear regression of these data gives an extrapolated solubility of 0.110 mg/l or 110 µg/l at 15°C, which is approximately the average temperature of the perched aquifer. This is the maximum concentration which can be expected in ground water at Thoreau when this ground water is in equilibrium with free-phase PCBs. Adsorption to solid aquifer materials and dilution and mixing with ground water act to decrease the PCB concentration in ground water as it moves away from free-phase PCBs.

The solubility concentration limit of 110 µg/l was exceeded in Monitor Well 5-6B on one occasion and was nearly matched in 5-6B and 5-1B during several other sampling events (Table 7.1). Since there was no evidence of free-phase PCBs in the drill cuttings or in the purge or sample water collected from these wells, the high concentrations of PCBs in ground-water samples suggested that these compounds were primarily in a colloidal state rather than a dissolved state.

To test this hypothesis, DBS&A conducted the following series of tests. On August 16, 1990 a special sample was collected from Monitor Well 5-6B and submitted for PCB analyses by EPA Method 8080. This sample was analyzed twice, once before centrifugation and once after centrifugation. The concentration of PCBs (Aroclor 1242) before centrifugation was 5.6 µg/l and the concentration after centrifugation was below detection limits. This result suggests that centrifugation had removed suspended colloidal PCBs.

To further test the colloidal hypothesis, another experiment was conducted in which samples were collected from Monitor Well 5-6B as a function of pumping rate. It was hypothesized that iron hydroxyoxide-PCB colloids or clay-PCB colloids in the vicinity of the well screen would be brought into suspension by the hydrodynamic action of well pumping. Further, the higher the pumping rate, the greater the amount of colloids that would be suspended.

Results of this experiment are shown in Table 7.2. Split samples were collected as a function of pumping rate to measure PCBs in both filtered (0.45 μm) and unfiltered samples. The results indicate that an increase in flow rate does increase the concentration of PCBs in both filtered and unfiltered samples. Note that at the highest flow rate both the filtered and unfiltered samples are well in excess of the solubility limit of 110 μg/l for PCBs. This suggests that the PCBs measured in these samples are largely adsorbed onto colloidal particles maintained in suspension rather than in the dissolved form. The fact that filtering through a 0.45 μm filter did not eliminate PCBs from the samples suggests that a significant proportion of the colloidal material is very fine in nature and difficult to separate by filtering or centrifugation.

In conclusion, the low mobility of PCBs in ground water is well documented. Therefore, the appearance of PCBs in monitor wells more than 200 feet from the apparent source is a paradox. The high concentrations of PCBs measured in these wells, the wide variation in concentrations over time, the effects of centrifugation and filtration on PCB concentrations, plus the effect of pumping rate on PCB concentrations all support the hypothesis that PCBs are adsorbed onto suspended colloidal particles. It is not clear, however, whether the PCBs in these wells originated from the condensate disposal pit or from surface soils introduced during drilling.

7.1.4 The Effect of Pumping Duration on PCBs (and BTEX) in Ground Water

In March of 1991 DBS&A conducted constant discharge pumping tests in Monitor Wells 5-5B and 5-6B as described in Section 6.3.1 Discharge rates were 1.0 gpm and 0.25 gpm, and the durations of the tests were approximately 3 hours and 7 hours in Wells 5-5B and 5-6B respectively. These tests were conducted approximately one month after PCBs were not detected in Well 5-6B and 4 months after these compounds were not detected in Well 5-5B. It was of interest to determine if removing relatively large volumes of water and drawing water levels down to near the bedrock contact would cause PCBs (and BTEX) to be pulled into these wells in increasing concentrations. Ground-water samples were collected as a function of volume of water pumped and analyzed for both PCBs and BTEX. The results of these chemical analyses are summarized in Tables 7.3 and 7.4, and show that constant discharge pumping does not cause detectable levels of PCBs to move to the wells and does not noticeably affect the concentrations of BTEX in the samples.

The fact that PCBs were not pulled into these wells during the pumping tests, which were designed to stress the alluvial aquifer, has important significance concerning the issue whether PCB will be detected in the future in these wells. Several possible mechanisms have been proposed in Section 7.1.2 to account for the rapid disappearance of PCBs from these wells between February and January 1991. With the exception of invoking the unlikely mechanism that PCBs are moving rapidly downgradient in a "piston-like" manner (see Section 7.1.2 for an explanation of why this hypothesis is considered unreasonable), it is difficult to argue without additional supporting field data that PCBs will reappear in monitor wells. The results of these pumping tests provide the necessary field data needed to support the contention that it is unlikely that they will reappear in these wells. These pumping tests essentially forced PCBs (either colloidal or dissolved) in the vicinity of the wells to move towards the well screen. Since these chemicals did not appear at the well during the pumping test and have not appeared after two additional monthly sampling events, available test results indicate it is unlikely that they will appear again in these wells unless the alluvial aquifer is perturbed in a manner (e.g., reducing conditions develop again) to remobilize PCBs.

7.2 Summary of BTEX in Ground Water

The results of initial ground-water sampling after the installation of monitor wells described in Section 4.0 indicated that BTEX (mainly benzene) was present at concentrations above standards in a number of monitor wells located off site, downgradient of the original site boundary. Data from these off-site, downgradient wells appeared to roughly define the east-west lateral boundaries of the downgradient plume (Figure 4.2), but insufficient land was accessible to define the southern downgradient leading edge of the BTEX plume. Further, exploratory boreholes in the vicinity of the southern boundary of the property do not delineate the western edge of the

BTEX plume. This present section presents and discusses BTEX results from additional periodic sampling conducted subsequent to the initial sampling. In addition, special field tests will be described whose objectives were to explain the monthly variability in BTEX concentrations in some monitor wells.

7.2.1 Time Series of BTEX Concentrations

The purpose of collecting monthly ground-water monitoring data is to both increase the level of confidence in initial measurements (i.e., identify false positives or false negatives) and to discern important trends in the data (e.g., plume expansion). BTEX and PCB analyses from both initial ground-water samples and routine monthly sampling are summarized in Table 7.1. EPA methods of analyses employed and associated QA/QC information have been described earlier in connection with PCBs (Section 7.1).

Examination of Table 7.1 indicates that in general, monitor wells which initially contained BTEX concentrations above standards have continued to exhibit elevated levels of BTEX. These include Monitor Wells 5-2B, 5-4B, 5-13B, 5-16B, 5-18B, 5-19B, and 5-20B (see Table 7.1). BTEX was not detected in initial sampling of Monitor Well 5-24B (furthest downgradient well); however, subsequent sampling events have detected benzene levels above standards. This fact, combined with the trend of generally increasing BTEX concentrations in other downgradient wells (e.g., 5-4B, 5-13B, 5-19B, and 5-23B) (Figures 7.1 and 7.2), suggests that the BTEX plume is moving in the downgradient direction. Monitor Wells 5-12B, 5-14B, 5-15B, and 5-17B located on the lateral margins of the plume have remained free of BTEX, indicating that the lateral downgradient boundaries of the plume have not expanded (Table 7.1 and Figure 7.3).

BTEX concentrations in a number of monitor wells exhibit significant temporal variability. This is especially noticeable in monitor wells with relatively high benzene concentrations (5-2B, 5-16B, 5-18B, and 5-24B) (Figure 7.4). Temporal variability in water quality data is also found in wells where benzene concentrations are much closer to ground-water standards (e.g., 5-5B, 5-6B, and 5-22B) (Figure 7.4). In order to attempt to understand the reason(s) for this large degree of variability in data, a special study was designed to examine the effects of sampling methodology on resulting BTEX concentration data. This study will be described in the following section.

Close examination of the data in Table 7.1 indicated that the March 1991 concentrations were probably the most amenable of all monthly data sets for developing a concentration contour map for benzene. Figure 7.3 illustrates the March 1991 benzene plume. It should be emphasized that this map includes data only from monitor wells. It does not include data from exploratory boreholes (Section 4.3) where one-time-only ground-water samples indicated that the western boundary of the benzene plume extends beyond Borehole 5-32B.

7.2.2 Field Investigation of the Influence of Sampling Methodology on Variability in BTEX Ground-Water Sample Concentrations

As part of the May 1991 monthly sampling program, DBS&A personnel carried out a number of field tests that were designed to determine if differences in sampling technique and/or sampling depth within a monitor well could account for the variation in BTEX data described in the preceding section. It was hypothesized that different field personnel could employ slightly different techniques when sampling the same well, which would result in significantly different concentrations of volatile organics in samples. EPA sampling protocol, as incorporated in DBS&A's sampling SOP (Appendix D) is sufficiently general in some areas, such as sample pumping rates and sample bottle filling, that differences in technique could influence sample concentration.

We also wanted to consider that sample concentration may vary with depth below the water table because of the relatively low density of BTEX compounds and aquifer stratification. Floating BTEX free product was never observed at the site either during drilling, development, or sampling. However, chemical stratification in aquifers is common, even for highly soluble chemicals in low concentrations.

All tests were conducted in Monitor Well 5-2B, which was previously identified as one of the most variable wells in terms of monthly BTEX concentrations. We varied the rate at which the sample was pumped to the surface via a dedicated bladder pump, and varied the method by which the 40-ml VOC sample vials were filled. Field personnel noted that the higher the flow rate of the bladder pump, the greater the amount of gas bubbles generated. These gas bubbles, which potentially contain vapor phase BTEX, consequently escaped before the 40-ml sample vial was capped. To attempt to quantify the effect of different sampling techniques, samples were collected using the following three approaches. The first sample was collected using a low flow rate in the bladder pump to minimize the formation of gas bubbles, and any gas bubbles that were transferred to the sample vials were removed as quickly as possible (by tapping the vial) prior to capping. The second sample was collected using a much faster bladder pump flow rate to purposely generate gas bubbles in the sample. Further, these gas bubbles were removed slowly (by excessive tapping of the vial) prior to capping. The third sample was collected by using a special sample cell (AMS Liquid Sampler, Norton Mfg., American Falls, Idaho) that eliminated the exposure of the sample to the atmosphere. A slow bladder flow rate was also used for this third sample to minimize gas bubble production.

To determine if sample depth affected BTEX concentrations, the samples were collected from this same well (5-2B) several days later. The first sample was collected from 0 to 6 inches below the water table surface using a disposable bailer. The second sample was collected at approximately the midpoint of the water column (3.5 feet from the surface of the water) using a special variable depth sampling bailer. The bailer was lowered and withdrawn very slowly to and from the specified depth to minimize mixing in the water column. Finally, the third sample was taken from the bottom of the well screen (approximately 7 feet from the water table surface) using the same technique as described for the midpoint sample. The well was allowed to stabilize after each collected sample to avoid mixing within the well bore.

The data in Table 7.5 suggest that sample technique has a measurable, but relatively small effect on BTEX concentrations. Differences in sampling technique alone do not appear to explain the variability in BTEX concentrations described previously. Attempts to maximize bubble formation and degassing did not result in noticeably lower concentrations of most BTEX constituents compared to the other more conservative sampling techniques. The largest portion of gas bubbles was most likely carbon dioxide.

The results from the depth stratified sampling tests are presented in Table 7.6. BTEX concentrations increased with depth, rather than decreased, as might be expected if floating product was present. Benzene concentration ranged from 250 µg/l at the water table to 1100 µg/l at the base of the aquifer. Recall from Table 7.1 that benzene in the composite sample collected from Monitor Well 5-2B by the bladder pump was 830 µg/l, which falls well within the range of concentrations sampled at the three depths. DBS&A believes that biological degradation of the petroleum hydrocarbon may be responsible for the variability of BTEX concentrations with depth. Biological activity is probably most active near the water table and would be expected to decrease with depth below the water table. As a monitor well is pumped for water sampling and the water table near the monitor well declines, an increasing proportion of the flow may be derived from the lower part of the well where concentrations are higher.

We conclude that significant variability could occur from one sampling event to another due to variation in purge volume. However, it is also likely that variability in water quality data could be attributed to water table fluctuations, or to variability in the chemical mass loading rate into the perched aquifer, or other factors.

7.2.3 Source of Shallow Perched Ground Water

The source of recharge to the perched ground water is highly relevant to the design of a remedial action program. Potential sources could include infiltration from precipitation and runoff, and leakage from piping or other cultural features. For example, in late 1990 site workers discovered that the water supply line from on-site well TPL-2 was leaking in the vicinity of the pump shed. This well is located several hundred feet upgradient of the waste pit. The three on-site water supply wells are believed to produce water from the Sonsela Sandstone and San Andres-Glorieta aquifers located approximately 600 to 1150 feet, respectively, beneath the base of the perched aquifer. We believed that the geochemistry of ground water in the deep bedrock aquifers would be significantly different than the perched ground water. DBS&A analyzed the inorganic geochemical signatures of all three water supply wells, including TPL-2, and five selected downgradient monitor wells to determine if the source of perched ground water could be due to seepage from the on-site water system (Figure 3.2). The approach and results of this study are described below.

Water samples were collected for major cation and anion analyses from the three supply wells and five monitor wells at Thoreau in February 1991. Results of these inorganic analyses are presented in Tables H.1 through H.8 in Appendix H. Stiff diagrams were constructed to evaluate the geochemical signature for each well. Figure 7.5 illustrates results displayed on a Stiff diagram for the supply wells, and Figure 7.6 shows results for the monitor wells. The geochemical characteristics of all the perched zone wells are very similar except for Monitor Well 5-2B, which contains significant BTEX concentration, as we will discuss later. The deep water supply wells have lower total dissolved solids (smaller area within pattern), but otherwise are generally similar in composition to the perched ground water.

The available geochemical data suggest that leakage from the on-site water supply system and other cultural features probably contributes relatively little recharge to the perched aquifer. There appears to be little evidence of mixing between the low salinity deep ground water and the more saline perched aquifer.

Monitor Well 5-2B is anomalous relative to the other monitor wells. It has a geochemical signature that is very similar to other monitor wells, except it has additional calcium and bicarbonate. This may be the result of the influence of the anoxic conditions associated with the waste pit. These waste pit conditions may cause ferric iron oxides to be reduced to ferrous iron. As ferrous iron moves away from the pit and towards Monitor Well 5-2B it encounters more oxic conditions, which oxidizes the ferrous iron to ferric iron, which subsequently precipitates as hydroxyoxides in the vicinity of this well. This process releases acid that could act to dissolve calcite in the soil and alter the original ground-water signature to that observed in Well 5-2B.

8.0 SUMMARY AND CONCLUSIONS

8.1 Description of Important Aquifer Characteristics and Properties

- Extensive drilling and surface geophysics investigations have shown that the uppermost aquifer is a shallow alluvial system that is perched on the underlying Chinle Formation. The thickness of the perched system in general ranges from 10 to 25 feet and thickens to the south.

- Paleochannels incised into the upper Chinle Formation bedrock surface, together with bedrock highs that extend above the water table, are probably the most important geologic features that control flow within the perched aquifer.

- Laboratory tests indicate that the perched aquifer materials are densely packed, moderately permeable, silty, fine-grained sands.

- The average hydraulic conductivity is about 0.28 feet per day with an upper limit of about 2 feet per day, based upon field tests in monitor wells.

- The average ground-water flow velocity is about 26 feet per year in a southerly direction. Higher permeability pathways may exist where the ground-water velocity could be as high as 180 feet per year, or more.

8.2 PCB in Ground Water

- PCBs in ground water have been detected in only 3 of 17 shallow alluvial monitor wells. These wells are located on site near the southeast property boundary. PCBs have not been detected in any of the three deeper bedrock test wells.

- There is no evidence that PCBs have migrated off site. PCB was not detected in six exploratory boreholes drilled down- and cross-gradient from the three impacted on-site shallow monitor wells.

- PCBs have not been detected in the three previously impacted on-site monitor wells since January 1991.

- Due to the highly sorbing characteristics of PCB that were measured in the laboratory, it is not likely that PCB previously found in on-site monitor wells is due to dissolved phase ground-water transport from the waste disposal pit.

- Laboratory filtering and centrifuge tests, as well as field sampling tests, indicate that PCBs in the perched ground water are primarily in a colloidal state rather than a dissolved state.

- Based on available data, PCBs previously detected in on-site monitor wells are most likely a result of drilling activity and sampling of PCB attached to colloidal particles in the monitor wells.

8.3 BTEX in Ground Water

- BTEX (mainly benzene) has been detected at least 500 feet downgradient and south of the compressor station property boundary.

- The concentration of benzene has exceeded 2000 μg/l on site and is as much as approximately 200 μg/l at one of the southernmost monitor wells.

- The downgradient lateral boundaries of the BTEX plume have been well defined off site. However, the downgradient leading edge, as well as the western boundary of the plume in the vicinity of the southern property boundary, has not as yet been delineated.

- Monthly ground-water monitoring data indicate that concentrations of BTEX are increasing in some downgradient monitor wells, which suggests that the plume is advancing southward.

- The results of a field test indicate that BTEX concentrations may increase with depth below the water table in at least some locations, probably due to microbial degradation.

- The stratification of BTEX concentrations in the shallow aquifer may be partly responsible for the wide variations in BTEX concentrations between monthly sampling events for certain wells.

- The primary source of BTEX appears to be the waste disposal pit, which was recently excavated during remediation of PCB.

9.0 REFERENCES

Cooper, H.H, JR. and C.E. Jacob, 1946. A generalized graphical method for evaluating formation constants and summarizing well field history. *Trans. Am. Geophysical Union, Vol. 27,* pp.526-534.

Daniel B. Stephens & Associates, Inc., February 1990. *Hydrogeology at the Transwestern Pipeline Compressor Station No. 5, Thoreau, New Mexico.* Prepared for Transwestern Pipeline Company, Houston, Texas.

Davis, S.N., and R.J.M. Deweist, 1966. *Hydrogeology.* John Wiley & Sons, New York, 463 pp.

EPA, 1986. RCRA Groundwater Montoring Technical Enforcement Guidance Document. OSWER-9950.1

Evans, D.D., and J.L. Thames, 1981. *Water in Desert Ecosystems,* US/IBP Synthesis Series. Dowden, Hutchingson, & Ross, Inc.

Hargis, D.R., 1979. *Analysis of Factors affecting Water Level Recovery Data.* PHD Dissertation, Department of Hydrology, University of Arizona.

Jacob, C.E., 1963. Recovery method for determining the coefficient of transmissivity. U.S. Geological Survey Water Supply Paper 1536-I.

Lohman, S., 1979. Ground Water Hydraulics. U.S. Geol. Surv. Prof. Paper 708, 70 pp.

Montgomery, J.H. and L.M. Welkom, 1990. *Groundwater Chemicals Desk Reference.* Lewis Publishers, Inc., Chelsea, Michigan.

Smith, C.T., 1954. Geology of the Thoreau Quadrangle, McKinley and Valencia Counties, New Mexico. New Mexico Bureau of Mines and Mineral Resources, Bulletin 31, pp. 5-33.

TABLES

TABLE 4.1 SUMMARY OF INFORMATION CONCERNING GEOLOGIC SAMPLE COLLECTION AND TESTING

Date	Borehole No.	Sample Depth (Ft. Below Ground)	Sample Type			Geochemical Analyses Conducted[3]				Hydraulic Properties
			Grab	Split Spoon[1]	Wire Line[2]	EPA 8010	EPA 8020	EPA 8080	EPA 8240	
6/21/90	5-9 SB	0		X			X	X		
		5		X			X	X		
		10		X			X	X		
		15		X			X	X		
		20		X			X	X		
		25		X			X	X		
		30		X			X	X		
		35		X			X	X		
		40		X			X	X		
		45		X			X	X		
6/21/90	5-10 SB	0		X			X	X		
		5		X			X	X		
		10		X			X	X		
		15		X						
		20		X			X	X		
		25		X			X	X		
		30		X			X	X		
		35		X			X	X		
		40		X			X	X		
		45		X						
		50		X						
		55		X						
7/6/90	5-11 SB	0		X				X	X	
		5		X				X	X	
		10		X				X	X	
		15		X				X	X	
		20		X				X	X	
		25		X				X	X	
6/28/90	5-12 B	5	X					P		
		60			X			P		
		65			X			P		
6/28/90	5-13 B	5	X					X		
		69			X			X		
6/27/90	5-14 B	5	X							
		72			X					

TABLE 4.1 SUMMARY OF INFORMATION CONCERNING GEOLOGIC SAMPLE COLLECTION AND TESTING (CONTINUED)
Page 2 of 5

Date	Borehole No.	Sample Depth (Ft. Below Ground)	Sample Type			Geochemical Analyses Conducted[3]				Hydraulic Properties
			Grab	Split Spoon[1]	Wire Line[2]	EPA 8010	EPA 8020	EPA 8080	EPA 8240	
6/29/90	5-15 B	5	X					P		
		47			X					X[4]
		63			X			P		
7/2/90	5-16 A	5	X							
		40		X						X
		42		X						X
		63.5			X	X	X			
7/5/90	5-16 B	5	X							
		64			X	X	X			
7/3/90	5-17 B	5	X							
		58			X	X	X			
7/9/90	5-18 B	5	X							
		60		X		X	X			X
		65		X						
		70		X						
7/10/90	5-19 B	5	X							
		50		X		X	X			
		55		X						X
		60		X						
		65		X						
7/11/90	5-20 B	0	X							
		5	X							
		60		X		X	X			
		65			X					
9/19/90	5-21 A	5		X			B	P		
		10		X			B	P		
		15		X			B	P		
		20		X			B	P		
		25		X					X[5]	

TABLE 4.1 SUMMARY OF INFORMATION CONCERNING GEOLOGIC SAMPLE COLLECTION AND TESTING (CONTINUED)
Page 3 of 5

Date	Borehole No.	Sample Depth (Ft. Below Ground)	Sample Type			Geochemical Analyses Conducted[3]				Hydraulic Properties
			Grab	Split Spoon[1]	Wire Line[2]	EPA 8010	EPA 8020	EPA 8080	EPA 8240	
9/13/90	5-22 B	5		X			B	P		
		10		X						
		15		X			B	P		
		20		X			B	P		
		25		X			B	P		
		30		X			B	P		
		35		X			B	P		
		40		X			B	P		
		45		X			B	P		
		50		X			B	P		
		55		X			B	P		
		55.5		X			B	P		
9/20/90	5-23 B	5		X			B	P		
		40		X			B	P		
		45		X						
		50		X			B	P		
		55.5		X			B	P		
		77			X		B	P		
		79			X		B	P		
9/24/90	5-24 B	5		X			B	P		
		35		X						
		40		X			B	P		
		45		X			B	P		
		50		X			B	P		
		55		X			B	P		
		75.5			X		B	P		
12/6/90	5-25 B	5		X				P		
		10		X				P		
		15		X				P		
		20		X				P		
		22		X				P		
		24		X				P		
		26		X				P		
		28		X				P		
		30		X				P		
		32		X				P		
		34		X				P		
		36		X				P		

TABLE 4.1 SUMMARY OF INFORMATION CONCERNING GEOLOGIC SAMPLE COLLECTION AND TESTING (CONTINUED)

Date	Borehole No.	Sample Depth (Ft. Below Ground)	Sample Type			Geochemical Analyses Conducted[3]				Hydraulic Properties
			Grab	Split Spoon[1]	Wire Line[2]	EPA 8010	EPA 8020	EPA 8080	EPA 8240	
12/5/90	5-26 B	5		X				P		
		10		X				P		
		15		X				P		
		20		X				P		
		22		X				P		
		24		X				P		
		26		X				P		
		28		X				P		
		30		X				P		
		32		X				P		
		34		X				P		
		36		X				P		
		38		X				P		
12/7/90	5-27 B	5		X				P		
		10		X				P		
		15		X				P		
		20		X				P		
		22		X				P		
		24		X				P		
		26		X				P		
		28	No Recovery							
		30		X				P		
		32	No Recovery							
		34	No Recovery							
		36		X				P		
		38		X				P		
		40		X				P		
		42		X				P		
		44		X				P		
		46		X				P		
		48		X				P		
		50		X				P		
		52		X				P		
		54		X				P		
5/8/91	5-28 B	81.5			X	Not analyzed - Chinle Fm. confirmation only				

TABLE 4.1 SUMMARY OF INFORMATION CONCERNING GEOLOGIC SAMPLE COLLECTION AND TESTING (CONTINUED)
Page 5 of 5

Date	Borehole No.	Sample Depth (Ft. Below Ground)	Sample Type			Geochemical Analyses Conducted[3]				Hydraulic Properties
			Grab	Split Spoon[1]	Wire Line[2]	EPA 8010	EPA 8020	EPA 8080	EPA 8240	
5/9/91	5-29 B	75.5			X	Not analyzed - Chinle Fm. confirmation only				
5/13/91	5-30 B	56			X	Not analyzed - Chinle Fm. confirmation only				
5/14/91	5-31 B	51.5			X	Not analyzed - Chinle Fm. confirmation only				
5/14/91	5-32 B	83			X	Not analyzed - Chinle Fm. confirmation only				
5/15/91	5-33 B	59			X	Not analyzed - Chinle Fm. confirmation only				

[1] 2½ I.D x 18" = stainless steel liners use for geochemical sampling.

[2] 3" I.D. x 60" = unlined, for Chinle Formation verification only. 12" to 14" runs only.

[3] P = PCBs only, B = B, T, E, X only.

[4] Two samples analyzed from this depth (5-15B — 46.5 ft. and 5-15B — 46.5 ft.).

[5] Also analyzed for EPA 8270.

TABLE 4.2 SUMMARY OF WELL DEVELOPMENT AND DEDICATED SAMPLE PUMP INFORMATION FOR SHALLOW DOWNGRADIENT MONITOR WELLS

WELL ID	TOTAL DEPTH (FEET)[1]	INITIAL WATER DEPTH (FEET)[2]	BLADDER PUMP INTAKE (FEET)[3]	BOREHOLE VOLUME (GALLONS)	TOTAL DEVELOPMENT VOLUME (GALLONS)
5-12B	65.4	48.85	57.1	47.1	117
5-13B	69.1	52.48	60.7	47.9	220
5-14B	71.9	55.14	63.5	47.9	75
5-15B	65.8	49.86	57.9	45.6	140
5-16B	64.7	47.21	55.9	50.1	110
5-17B	65.1	40.79	55.0	69.6	165
5-18B	69.8	51.67	60.8	52.4	165
5-19B	65.0	49.44	57.2	44.9	165
5-20B	65.7	48.86	57.3	47.9	125
5-22B	55.8	48.08	52.6	22.4	20
5-23B	79.8	55.70	67.8	68.8	130
5-24B	75.5	53.64	64.5	62.8	180

1 Measured from top of present casing.

2 Water levels for 5-22B, -23B, and -24B were measured between October 9 and 12, 1990. All other wells were measured on April 14 and 18, 1990. All water levels are referenced to present top of casing.

3 Measured from top of present casing.

TABLE 4.3 SUMMARY OF INITIAL ANALYTICAL RESULTS FROM DOWNGRADIENT MONITOR WELLS

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb)				
		PCB	Benzene	Toluene	Ethyl-benzene	Xylene
T 5-12B	09/90	*	*	*	*	*
T 5-13B	09/90	*	63.0	12.0	1.3	350.0
T 5-14B	09/90	*	*	*	*	*
T 5-15B	09/90	*	*	*	*	*
T-5-16B	09/90	*	19.0	25.0	50.0	320.0
T 5-17B	09/90	*	*	*	*	*
T 5-18B	08/90	*	1100.0	14.0	*	220.0
T 5-19B	09/90	*	190.0	3.5	5.8	44.0
T 5-20B	09/90	*	58.0	8.0	*	51.0
T 5-22B	09/90	*	*	*	*	*
T 5-23B	09/90	*	*	*	*	*
T 5-24B	09/90	*	*	*	*	*

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) enforceable standards:

PCB = 1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

* = Indicates the well was sampled but the concentrations were below the reporting limits.

NYR = Analysis not yet received

NS = Not sampled in Nov/Dec/Jan rounds

[a]Reporting Limit = 50.0
[b]Reporting Limit = 100.0
[c]Reporting Limit = 0.5
[d]Reporting Limit = 5.0
[e]Reporting Limit = 10.0
[f]Reporting Limit = 0.3
[g]Reporting Limit = 0.6
[h]Reporting Limit = 25.0
[i]Reporting Limit = 1.0
[j]Reporting Limit = 2.0
[k]Reporting Limit = 20.0
[l]Reporting Limit = 2.5
[m]Reporting Limit = 120.0
[n]Reporting Limit = 250.0
[o]Reporting Limit = 12.0

Table 4.4
Summary of Results of Ground-Wâter Chemical Analyses from
Exploratory Boreholes 5-29B, 5-30B, 5-31B, 5-32B, 5-33B

Date: May 13-16, 1991
Laboratory: ENSECO Houston
Lab ID: See below

Parameter	Concentration (ug/l)				
	5-29B	5-30B	5-31B	5-32B	5-33B
PCB	ND	ND	ND	ND	ND
Benzene	2100	7.9	ND	350	ND
Toulene	4200	1.4	ND	1400	ND
Ethylbenzene	380	16	ND	120	ND
Xylene	3100	63	ND	1100	ND

ND = Not Detected

5-29B Lab ID: 001207
5-30B Lab ID: 001211
5-31B Lab ID: 0012121
5-32B Lab ID: 001214
5-33B Lab ID: 001219

TABLE 6.1 DEPTH TO WATER IN TEST WELLS

DATE	**5-1A** *Top of Casing (TOC)* *Elevation: 7289.72'* *Total Well Depth: 667.1'* DEPTH TO WATER (Feet below TOC)	**5-3A** *Top of Casing (TOC)* *Elevation: 7301.84'* *Total Well Depth: 443.8'* DEPTH TO WATER (Feet below TOC)
01/08/91	397.00	406.00
02/05/91	331.70	424.50
03/05/91	326.40	425.10
04/11/91	328.30	421.30

TABLE 6.2 DEPTH TO WATER IN SHALLOW MONITOR WELLS
(Page 1 of 3)

	DEPTH TO WATER (Feet Below Top of Casing [TOC])					
DATE	5-1B *TOC Elevation: 7286.08'*	5-2B *TOC Elevation: 7288.47'*	5-3B *TOC Elevation: 7300.15'*	5-4B *TOC Elevation: 7288.79'*	5-5B *TOC Elevation: 7287.23'*	5-6B *TOC Elevation: 7285.71'*
08/29/90	44.69	47.60	43.77	48.35	47.50	43.47
11/08/90	44.70	47.72		48.42	47.25	43.24
01/07/91			44.10			
01/08/91	44.82					43.42
01/10/91					47.14	
01/11/91		47.88		48.42		
01/31/91				48.94		
02/05/91	44.86				47.20	
02/12/91		47.90	44.12			43.50
03/04/91				48.68		
03/05/91	44.91	47.93	44.24		47.20	43.50
04/10/91	44.94		44.31			
04/11/91		47.92				
04/12/91				48.79		
04/18/91					47.34	43.61
05/20/91		48.14				
05/21/91	45.08		44.53	48.90	47.44	43.66

TABLE 6.2 DEPTH TO WATER IN SHALLOW MONITOR WELLS
(Page 2 of 3)

	DEPTH TO WATER (Feet Below Top of Casing [TOC])											
DATE	5-12B TOC Elevation: 7275.96'	5-13B TOC Elevation: 7277.06'	5-14B TOC Elevation: 7280.52'	5-15B TOC Elevation: 7289.43'	5-16B TOC Elevation: 7284.53'	5-17B TOC Elevation: 7278.82'	5-18B TOC Elevation: 7282.93'	5-19B TOC Elevation: 7287.16'	5-20B TOC Elevation: 7281.11'	5-22B TOC Elevation: 7289.52'	5-23B TOC Elevation: 7279.19'	5-24B TOC Elevation: 7275.60'
08/14/90	48.85	52.43	55.14	49.86	47.21	40.79	51.67	49.44				
08/24/90									48.86			
10/25/90										48.08	55.78	53.64
11/15/90	48.92	52.76	55.02	49.98	47.46	40.83	51.60	49.76		48.08	55.75	53.72
01/03/91											55.90	
01/04/91							51.66					
01/09/91	48.96	52.82	55.12						48.70			53.78
01/10/91				51.10	47.60	40.96		49.86		48.33		
02/04/91										48.38		
02/06/91					47.62							
02/07/91		52.89	55.19	50.16				49.90	48.79		56.20	53.87
02/08/91						40.99						
02/13/91	49.00						51.76					
03/06/91				50.17	47.63	41.01	51.79	49.92		48.42		
03/07/91	49.00	52.92	55.21						48.80		56.02	53.86
04/09/91					47.73			50.02				
04/10/91				50.25								
04/11/91						41.06				48.49		

TABLE 6.2 DEPTH TO WATER IN SHALLOW MONITOR WELLS
(Page 3 of 3)

	DEPTH TO WATER (Feet Below Top of Casing [TOC])											
DATE	5-12B *TOC Elevation: 7275.96'*	5-13B *TOC Elevation: 7277.06'*	5-14B *TOC Elevation: 7280.52'*	5-15B *TOC Elevation: 7289.43'*	5-16B *TOC Elevation: 7284.53'*	5-17B *TOC Elevation: 7278.82'*	5-18B *TOC Elevation: 7282.93'*	5-19B *TOC Elevation: 7287.16'*	5-20B *TOC Elevation: 7281.11'*	5-22B *TOC Elevation: 7289.52'*	5-23B *TOC Elevation: 7279.19'*	5-24B *TOC Elevation: 7275.60'*
04/12/91	49.05	53.00	55.64									
04/16/91							51.09		48.88		56.08	53.94
05/20/91									48.92			
05/21/91										48.65		
05/22/91	49.12	53.06	55.36			41.14					56.14	54.00
05/23/91				50.45	47.87			50.92				

TABLE 6.3 SUMMARY OF CONSTANT-RATE PUMPING TESTS

Date	Monitor Well	Flow Rate (GPM)	Duration (minutes)	T (ft^2/d)	b (ft)	K (ft/d)	Comments
3/26/91	5-4B	0.12	36	2.1	10.0	0.21	Poor well efficiency. Recovery data used for calculation.
4/5/91	5-5B	1.0	166	8.30	12.2	0.68	Recovery data used for calculation.
3/27/91	5-6B	0.25	428	0.97	13.8	0.07	Recovery data used for calculation.

Geometric Mean K = 0.22 ft/d

TABLE 6.4 SUMMARY OF CONSTANT-RATE BAILING TESTS

Date	Monitor Well	Flow Rate* (GPM)	Gallons Bailed	T (ft^2/d)	B (ft)	K (ft/d)	Comments
4/2/91	5-1B	0.16	4.1	0.9	7.7	0.12	None
4/2/91	5-3B	0.57	17.0	15.8	11.0	1.40	Rough estimate, bailed for 30 minutes, lowering water level by 1.47 ft
4/3/91	5-5B	0.52	12.0	38.2	12.2	3.10	Rough estimate, bailed for 23 minutes, lowering water level by 0.48 ft
4/3/91	5-12B	0.51	11.4	1.5	15.6	0.71	None
4/3/91	5-13B	0.5	8.3	4.2 1.3	13.9	0.30 0.09	Slope 1 Slope 2 Avg. K = 0.20 ft/d
3/26/91	5-15B	0.46	13.8	3.4	15.4	0.22	None
4/9/91	5-16B	0.60	18.0	21.2	16.3	1.30	Rough estimate, bailed for 30 minutes, lowering water table by 1.2 ft
4/2/91	5-17B	0.55	13.8	0.1	15.4	0.01	None
4/3/91	5-19B	0.44	14.5	1.5	13.2	0.12	None
4/3/91	5-22B	0.15	1.7	0.6	7.1	0.08	None

*Flow rate is an average for total time bailing.

TABLE 6.5 SUMMARY OF SLUG DISPLACEMENT TESTS

Date	Monitor Well	K (ft/d)
8/89	5-2 B	1.13
8/89	5-3 B	1.20
9/90	5-12 B	0.30
9/90	5-13 B	1.30
9/90	5-16 B	3.50

Geometric Mean K = 1.20 ft/d

TABLE 6.6 SUMMARY OF AVERAGE HYDRAULIC CONDUCTIVITY VALUES FROM IN SITU AND LABORATORY TESTS

Method	No. of Wells or Samples	K (ft/d)
Constant-Rate Pumping	3	0.22
Bail - Recovery	7	0.12
Two-Point Bail Recovery	3	1.70
Slug Displacement	5	1.20
Falling and Constant Head (Lab)	6	0.03

Geometric Mean K = 0.28 ft/d

TABLE 7.1 SUMMARY OF ANALYTICAL RESULTS THROUGH MAY 1991
THOREAU MONITOR WELLS
(Page 1 of 12)

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb)				
		PCB	Benzene	Toluene	Ethyl-benzene	Xylene
T 5-01A	05/89	*	*	*	*	NS
	12/89	*	*	*	*	NS
	09/90	*	*	*	*	*
	11/90	*	*	*	*	*
	01/91	*	*	*	*	*
	02/91	*	*	*	*	*
	03/91	*	*	*	*	*
	04/91	*	*	*	*	*
T 5-01B	08/89	2.1	NS	NS	NS	NS
	12/89	2.0	*	6.3	*	NS
	03/90	94.0	*	*	*	25.0[e]
	06/90	11.0	*	*	*	*
	09/90	2.0	*	*	*	3.5
	11/90	5.5	*	*	*	3.0

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) standards:

PCB = 1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

* = Indicates the well was sampled but the concentrations were below the reporting limits.

NYR = Analysis not yet received

NS = Not sampled in Nov/Dec/Jan rounds

[a]Reporting Limit = 50.0
[b]Reporting Limit = 100.0
[c]Reporting Limit = 0.5
[d]Reporting Limit = 5.0
[e]Reporting Limit = 10.0
[f]Reporting Limit = 0.3
[g]Reporting Limit = 0.6
[h]Reporting Limit = 25.0
[i]Reporting Limit = 1.0
[j]Reporting Limit = 2.0
[k]Reporting Limit = 20.0
[l]Reporting Limit = 2.5
[m]Reporting Limit = 120.0
[n]Reporting Limit = 250.0
[o]Reporting Limit = 12.0

TABLE 7.1 SUMMARY OF ANALYTICAL RESULTS THROUGH MAY 1991 THOREAU MONITOR WELLS

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb) PCB	Benzene	Toluene	Ethyl-benzene	Xylene
	01/91	28.0	*	4.8	*	*
	02/91	*	1.6	*	*	4.6
	03/91	*	2.0	*	*	5.2
	04/91	*	1.2	*	*	3.6
	05/91	*	*	*	*	5.4
T 5-02A	08/89	*	*	*	*	NS
	12/89	*	*	490.0	56.0	NS
	01/90	*	42.0	210.0	24.0	NS
T 5-02B	05/89	*	1800.0	2000.0	*	NS
	08/89	*	2500.0	4700.0	*	NS
	11/89	*	1800.0	3100.0	50.0	NS
	03/90	*	2300.0[o]	3800.0[o]	2400.0[o]	*
	09/90	*	1400.0	2300.0	180.0	1700.0
	11/90	*	1500.0	2400.0	230.0	1900.0

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) standards:

PCB = .1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

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[i]Reporting Limit = 1.0
[j]Reporting Limit = 2.0
[k]Reporting Limit = 20.0
[l]Reporting Limit = 2.5
[m]Reporting Limit = 120.0
[n]Reporting Limit = 250.0
[o]Reporting Limit = 12.0

TABLE 7.1 SUMMARY OF ANALYTICAL RESULTS THROUGH MAY 1991
THOREAU MONITOR WELLS
(Page 3 of 12)

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb)				
		PCB	Benzene	Toluene	Ethyl-benzene	Xylene
	01/91	*	600.0[a]	730.0[a]	110.0[a]	940.0[b]
	02/91	*	460.0[a]	580.0[a]	75.0[a]	600.0[b]
	03/91	*	2400.0[m]	3300.0[m]	290.0[m]	2600.0[n]
	04/91	*	830.0[a]	1200.0[a]	110.0[a]	920.0[b]
	05/91	*	830.0[n]	1200.0[n]	150.0[h]	1300.0[a]
T 5-03A	12/89	*	*	*	*	NS
	09/90	*	*	11.6	*	*
	11/90	*	1.4	0.67	2.6	*
	01/91	*	*	0.50	*	0.70
	02/91	*	*	*	*	*
	03/91	*	1.5	0.9	*	*
	04/91	*	1.2	0.74	*	*
T 5-03B	05/89	*	*	*	*	NS
	11/89	*	*	*	*	NS

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) standards:

PCB = 1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

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[e]Reporting Limit = 10.0
[f]Reporting Limit = 0.3
[g]Reporting Limit = 0.6
[h]Reporting Limit = 25.0
[i]Reporting Limit = 1.0
[j]Reporting Limit = 2.0
[k]Reporting Limit = 20.0
[l]Reporting Limit = 2.5
[m]Reporting Limit = 120.0
[n]Reporting Limit = 250.0
[o]Reporting Limit = 12.0

TABLE 7.1 SUMMARY OF ANALYTICAL RESULTS THROUGH MAY 1991
THOREAU MONITOR WELLS

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb) PCB	Benzene	Toluene	Ethyl-benzene	Xylene
	09/90	*	*	*	*	*
	11/90	*	*	*	*	*
	01/91	*	*	*	*	*
	02/91	*	*	*	*	*
	03/91	*	*	*	*	*
	04/91	*	*	*	*	*
	05/91	*	*	*	*	*
T 5-04B	10/89	*	*	*	*	NS
	12/89	*	18.0	*	*	NS
	01/90	*	21.0	*	*	NS
	09/90	*	63.0	9.5	*	15.0
	11/90	*	25.0	*	*	*
	02/91	*	22.0	1.6	0.75	5.6
	03/91	*	76.0[d]	11.0	*	5.7

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) standards:

PCB = 1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

* = Indicates the well was sampled but the concentrations were below the reporting limits.

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[g]Reporting Limit = 0.6
[h]Reporting Limit = 25.0
[i]Reporting Limit = 1.0
[j]Reporting Limit = 2.0
[k]Reporting Limit = 20.0
[l]Reporting Limit = 2.5
[m]Reporting Limit = 120.0
[n]Reporting Limit = 250.0
[o]Reporting Limit = 12.0

TABLE 7.1 SUMMARY OF ANALYTICAL RESULTS THROUGH MAY 1991 THOREAU MONITOR WELLS

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb)				
		PCB	Benzene	Toluene	Ethyl-benzene	Xylene
	04/91	*	39.0[d]	0.66	*	2.9
	05/91	*	90.0[e]	1.1	0.96	13.0
T 5-05B	10/89	*	*	*	*	NS
	11/89	*	*	*	*	NS
	09/90	0.19	2.5	*	*	4.6
	11/90	2.4	1.4	*	*	2.9
	01/91	*	*	*	*	0.56[c]
	02/91	*	49.0[d]	35.0[d]	7.44[d]	56.0[e]
	03/91	*	12.0	1.2	*	*
	04/91	*	1.3	*	*	*
	05/91	*	4.6	*	*	*
T 5-06B	10/89	*	15.0	*	*	*
	12/89	170.0	7.4	35.0	21.0	NS
	01/90	100.0	*	*	8.3	NS

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) standards:

PCB = 1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

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[g]Reporting Limit = 0.6
[h]Reporting Limit = 25.0
[i]Reporting Limit = 1.0
[j]Reporting Limit = 2.0
[k]Reporting Limit = 20.0
[l]Reporting Limit = 2.5
[m]Reporting Limit = 120.0
[n]Reporting Limit = 250.0
[o]Reporting Limit = 12.0

TABLE 7.1 SUMMARY OF ANALYTICAL RESULTS THROUGH MAY 1991
THOREAU MONITOR WELLS

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb) PCB	Benzene	Toluene	Ethyl-benzene	Xylene
	06/90	39.0	*	*	*	19.0
	09/90	1.1	*	*	1.5	*
	11/90	65.0	1.8	*	0.5	21.0
	01/91	39.0[d]	*	*	*	31.0
	02/91	*	12.0	2.5	*	21.0
	03/91	*	2.0	*	*	5.1
	04/91	*	5.2	*	*	12.0
	05/91	*	7.7	*	*	18.0
T 5-07B	DRY ABOVE WATER TABLE					
T 5-08B	DRY ABOVE WATER TABLE					
T 5-12B	09/90	*	*	*	*	*
	11/90	*	*	*	*	*
	01/91	*	1.5	4.7	.79	3.8
	02/91	*	*	*	*	*

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) standards:

PCB = 1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

* = Indicates the well was sampled but the concentrations were below the reporting limits.

NYR = Analysis not yet received

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[d]Reporting Limit = 5.0
[e]Reporting Limit = 10.0
[f]Reporting Limit = 0.3
[g]Reporting Limit = 0.6
[h]Reporting Limit = 25.0
[i]Reporting Limit = 1.0
[j]Reporting Limit = 2.0
[k]Reporting Limit = 20.0
[l]Reporting Limit = 2.5
[m]Reporting Limit = 120.0
[n]Reporting Limit = 250.0
[o]Reporting Limit = 12.0

TABLE 7.1 SUMMARY OF ANALYTICAL RESULTS THROUGH MAY 1991
THOREAU MONITOR WELLS
(Page 7 of 12)

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb)				
		PCB	Benzene	Toluene	Ethyl-benzene	Xylene
	03/91	*	*	*	*	*
	04/91	*	*	*	*	*
	05/91	*	*	*	*	*
T 5-13B	09/90	*	63.0	12.0	1.3	350.0
	11/90	*	61.0	*	*	480.0
	01/91	*	180.0[d]	17.0[d]	*	310.0[e]
	02/91	*	270.0[e]	25.0[e]	*	460.0[k]
	03/91	*	240.0[a]	*[a]	*[a]	480.0[b]
	04/91	*	430.0[h]	*	*	620.0[a]
	05/91	*	290.0[e]	*	*	450.0[k]
T 5-14B	09/90	*	*	*	*	*
	11/90	*	*	*	*	*
	01/91	*	*	*	*	*
	02/91	*	*	*	*	*

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) standards:

PCB = 1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

* = Indicates the well was sampled but the concentrations were below the reporting limits.

NYR = Analysis not yet received

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[d]Reporting Limit = 5.0
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[g]Reporting Limit = 0.6
[h]Reporting Limit = 25.0
[i]Reporting Limit = 1.0
[j]Reporting Limit = 2.0
[k]Reporting Limit = 20.0
[l]Reporting Limit = 2.5
[m]Reporting Limit = 120.0
[n]Reporting Limit = 250.0
[o]Reporting Limit = 12.0

TABLE 7.1 SUMMARY OF ANALYTICAL RESULTS THROUGH MAY 1991
THOREAU MONITOR WELLS

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb)				
		PCB	Benzene	Toluene	Ethyl-benzene	Xylene
	03/91	*	*	*	*	*
	04/91	*	*	*	*	*
	05/91	*	*	*	*	*
T 5-15B	09/90	*	*	*	*	*
	11/90	*	2.1	*	*	*
	01/91	*	*	0.3[f]	*	1.0[g]
	02/91	*	*	*	*	*
	03/91	*	*	*	*	*
	04/91	*	*	*	*	*
	05/91	*	*	*	*	*
T 5-16B	09/90	*	19.0	25.0	50.0	320.0
	11/90	*	*	*	*	*
	01/91	*	*	*	*	*
	02/91	*	320.0[e]	46.0[e]	170.0[e]	860.0[k]

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) standards:

PCB = 1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

* = Indicates the well was sampled but the concentrations were below the reporting limits.

NYR = Analysis not yet received

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[a]Reporting Limit = 50.0
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TABLE 7.1 SUMMARY OF ANALYTICAL RESULTS THROUGH MAY 1991
THOREAU MONITOR WELLS

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb)				
		PCB	Benzene	Toluene	Ethyl-benzene	Xylene
	03/91	*	920.0[a]	*	*	130.0[b]
	04/91	*	92.0[d]	*	0.68	9.2
	05/91	*	270.0[o]	*	230.0[o]	1100.0[h]
T 5-17B	09/90	*	*	*	*	*
	11/90	*	*	*	*	*
	01/91	*	*	*	*	*
	02/91	*	*	*	*	*
	03/91	*	*	*	*	*
	04/91	*	*	*	*	*
	05/91	*	*	*	*	*
T 5-18B	08/90	*	1100.0	14.0	*	220.0
	11/90	*	1900.0	*	*	320.0
	01/91	*	1300.0[h]	*	*	170.0[h]
	02/91	*	970.0[h]	11.0[d]	*	170.0[e]

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) standards:

PCB = 1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

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[g]Reporting Limit = 0.6
[h]Reporting Limit = 25.0
[i]Reporting Limit = 1.0
[j]Reporting Limit = 2.0
[k]Reporting Limit = 20.0
[l]Reporting Limit = 2.5
[m]Reporting Limit = 120.0
[n]Reporting Limit = 250.0
[o]Reporting Limit = 12.0

TABLE 7.1 SUMMARY OF ANALYTICAL RESULTS THROUGH MAY 1991 THOREAU MONITOR WELLS (Page 10 of 12)

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb)				
		PCB	Benzene	Toluene	Ethyl-benzene	Xylene
	03/91	*	260.0[o]	1.8	*	23.0
	04/91	*	1000.0[h]	*[i]	*[i]	78.0[j]
T 5-19B	09/90	*	190.0	3.5	5.8	44.0
	11/90	*	180.0	11.0	*	*
	01/91	*	150.0[f]	*	0.6[f]	15.0[g]
	02/91	*	200.0[l]	5.8[l]	*	14.0[d]
	03/91	*	200.0[h]	30.0[h]	180.0[h]	880.0[a]
	04/91	*	290.0[h]	*	210.0[h]	880.0[a]
	05/91	*	240.0[o]	*	0.71	21.0
T 5-20B	09/90	*	58.0	8.0	*	51.0
	11/90	*	*	*	*	12.0
	01/91	*	93.0[i]	14.0[i]	*	23.0[j]
	02/91	*	280.0[e]	14.0[e]	*	46.0[k]
	03/91	*	200.0[d]	*[d]	*[d]	*[e]

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) standards:

PCB = 1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

* = Indicates the well was sampled but the concentrations were below the reporting limits.

NYR = Analysis not yet received

NS = Not sampled in Nov/Dec/Jan rounds

[a] Reporting Limit = 50.0
[b] Reporting Limit = 100.0
[c] Reporting Limit = 0.5
[d] Reporting Limit = 5.0
[e] Reporting Limit = 10.0
[f] Reporting Limit = 0.3
[g] Reporting Limit = 0.6
[h] Reporting Limit = 25.0
[i] Reporting Limit = 1.0
[j] Reporting Limit = 2.0
[k] Reporting Limit = 20.0
[l] Reporting Limit = 2.5
[m] Reporting Limit = 120.0
[n] Reporting Limit = 250.0
[o] Reporting Limit = 12.0

TABLE 7.1 SUMMARY OF ANALYTICAL RESULTS THROUGH MAY 1991
THOREAU MONITOR WELLS

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb)				
		PCB	Benzene	Toluene	Ethyl-benzene	Xylene
	04/91	*	180.0[o]	*[i]	*[i]	19.0[j]
T 5-22B	09/90	*	*	*	*	*
	11/90	2.2	180.0	*	*	*
	01/91	13.0	*	*	*	*
	02/91	*	*	*	*	*
	03/91	*	*	*	*	*
	04/91	*	*	*	*	*
	05/91	*	*	*	*	*
T 5-23B	09/90	*	*	*	*	*
	11/90	*	5.1	*	*	*
	01/91	*	3.0	*	*	*
	02/91	*	6.6	*	*	*
	03/91	*	8.5	*	*	1.2
	04/91	*	5.0	*	*	*

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) standards:

PCB = 1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

* = Indicates the well was sampled but the concentrations were below the reporting limits.

NYR = Analysis not yet received

NS = Not sampled in Nov/Dec/Jan rounds

[a]Reporting Limit = 50.0
[b]Reporting Limit = 100.0
[c]Reporting Limit = 0.5
[d]Reporting Limit = 5.0
[e]Reporting Limit = 10.0
[f]Reporting Limit = 0.3
[g]Reporting Limit = 0.6
[h]Reporting Limit = 25.0
[i]Reporting Limit = 1.0
[j]Reporting Limit = 2.0
[k]Reporting Limit = 20.0
[l]Reporting Limit = 2.5
[m]Reporting Limit = 120.0
[n]Reporting Limit = 250.0
[o]Reporting Limit = 12.0

TABLE 7.1 SUMMARY OF ANALYTICAL RESULTS THROUGH MAY 1991 THOREAU MONITOR WELLS

SITE WELL NO.	DATE mo/yr	CONCENTRATION (ppb)				
		PCB	Benzene	Toluene	Ethyl-benzene	Xylene
	05/91	*	120.0[d]	*	*	7.5
T 5-24B	09/90	*	*	*	*	*
	11/90	*	100.0	*	2.0	1.6
	01/91	*	40.0	0.55	0.74	*
	02/91	*	150.0[d]	16.0[d]	*	21.0[e]
	03/91	*	89.0[l]	9.8[l]	*	3.5
	04/91	*	230.0[o]	*[i]	*[i]	6.3[j]
	05/91	*	4.3	*	*	1.3
T 5-25B	12/90	DRY ABOVE WATER TABLE				
T 5-26B	12/90	DRY ABOVE WATER TABLE				
T 5-27B	12/90	DRY ABOVE WATER TABLE				

NOTES:

New Mexico Water Quality Control Commission (NM WQCC) standards:

PCB = 1 (ppb) Benzene = 10 (ppb) Toluene = 750 (ppb) Ethylbenzene = 750 (ppb) Xylene = 620 (ppb)

Normal Reporting limits from ENSECO's Houston laboratory:

PCB = 0.50 (ppb) Benzene = 0.50 (ppb) Toluene = 0.50 (ppb) Ethylbenzene = 0.50 (ppb) Xylene = 1.0 (ppb)

* = Indicates the well was sampled but the concentrations were below the reporting limits.

NYR = Analysis not yet received

NS = Not sampled in Nov/Dec/Jan rounds

[a]Reporting Limit = 50.0
[b]Reporting Limit = 100.0
[c]Reporting Limit = 0.5
[d]Reporting Limit = 5.0
[e]Reporting Limit = 10.0
[f]Reporting Limit = 0.3
[g]Reporting Limit = 0.6
[h]Reporting Limit = 25.0
[i]Reporting Limit = 1.0
[j]Reporting Limit = 2.0
[k]Reporting Limit = 20.0
[l]Reporting Limit = 2.5
[m]Reporting Limit = 120.0
[n]Reporting Limit = 250.0
[o]Reporting Limit = 12.0

TABLE 7.2 PCB CONCENTRATIONS (ppb) IN MONITOR WELL 5-6B AS A FUNCTION OF PUMPING RATE (Q)

	Concentration (µg/l)		
	Q = 150 ml/min	Q = 650 ml/min	Q = 1920 ml/min
Unfiltered	140	160	340
Filtered	13	110	230

Table 7.3
Summary of PCB and BTEX Concentrations in Ground-Water Samples as a Function of Purge Volume in Monitor Well 5-5B

Date: April 5, 1991
Laboratory: ENSECO, Houston
Lab ID: 001059 on all samples

Parameter	Reporting Limit (ug/l)	Concentration (ug/l)		
		36 gal.	96 gal.	156 gal.
Aroclor 1016	0.50	ND	ND	ND
Aroclor 1221	0.50	ND	ND	ND
Aroclor 1232	0.50	ND	ND	ND
Aroclor 1242	0.50	ND	ND	ND
Aroclor 1248	0.50	ND	ND	ND
Aroclor 1254	1.0	ND	ND	ND
Aroclor 1260	1.0	ND	ND	ND
Benzene	0.50	2.3	11	35
Toluene	0.50	ND	ND	ND
Ethylbenzene	0.50	ND	ND	ND
Total Xylenes	1.0	ND	1.9	14

ND = Not Detected

Table 7.4
Summary of PCB and BTEX Concentrations in Ground-Water Samples as a Function of Purge Volume in Monitor Well 5-6B

Date: April 2, 1990
Laboratory: ENSECO, Houston

Parameter	Reporting Limit (ug/l)	Concentration (ug/l)				
		12 gal.(1)	41 gal.(2)	62 gal.(3)	88 gal.(4)	102 gal.(5)
Aroclor 1016	0.50	ND	ND	ND	ND	ND
Aroclor 1221	0.50	ND	ND	ND	ND	ND
Aroclor 1232	0.50	ND	ND	ND	ND	ND
Aroclor 1242	0.50	ND	ND	ND	ND	ND
Aroclor 1248	0.50	ND	ND	ND	ND	ND
Aroclor 1254	1.0	ND	ND	ND	ND	ND
Aroclor 1260	1.0	ND	ND	ND	ND	ND
Benzene	1.0	11	11	13	12	11
Toluene	1.0	1.5	ND	1.2	1.2	ND
Ethylhenzene	1.0	6.2	7.2	9.8	9.3	2.9
Total Xylenes	2.0	45	54	68	64	37

ND = Not Detected

Lab ID's:
(1) 001030-0001-SA
(2) 001030-0003-SA
(3) 001030-0004-SA
(4) 001030-0005-SA
(5) 001030-0006-SA

Table 7.5 Summary of Special Test Results to Determine the Effect of Sampling Technique on BTEX Concentrations in Monitor Well 5-2B

Date: May, 1991
Laboratory: ENSECO, Houston
Lab ID: 001236

Concentration (ug/l)

Sample Method	Benzene		Toluene		Ethyl Benzene		Xylene	
	Detection Limit	Result	Detection Limit	Result	Detection Limit	Result	Detection Limit	Result
1	250	830	250	1200	25	150	50	1300
2	50	620	50	890	50	82	100	700
3	25	870	120	560	25	110	50	970

Method 1 Used standard collection method to minimize degassing of sample. Procedure employed low bladder pump flow rates and minimal exposure to atmosphere.

Method 2 Used standard collection methods modified to maximize the potential for degassing. Procedure involved using high bladder pump flow rates and maximal exposure to atmosphere.

Method 3 Used special sample collection cell that eliminated exposure of the sample to the atmosphere.

Table 7.6 Summary of Special Test Results to Determine the Effect of Sample Depth on BTEX Concentrations in Monitor Well 5-2B

Date: May, 1991
Laboratory: ENSECO, Houston
Lab ID: 0'- 001247
3.5 feet & 7 feet - 001266

Concentration (ug/l)

Sample Depth	Benzene		Toluene		Ethyl Benzene		Xylene	
	Detection Limit	Result	Detection Limit	Result	Detection Limit	Result	Detection Limit	Result
0 feet (Air-Water Interface)	25	250	25	320	25	53	50	460
3.5 feet (Midpoint of Water Column)	100	780	100	960	100	100	200	830
7 feet (Bottom of Well Screen)	100	1100	100	1300	50	250	100	2500

FIGURES

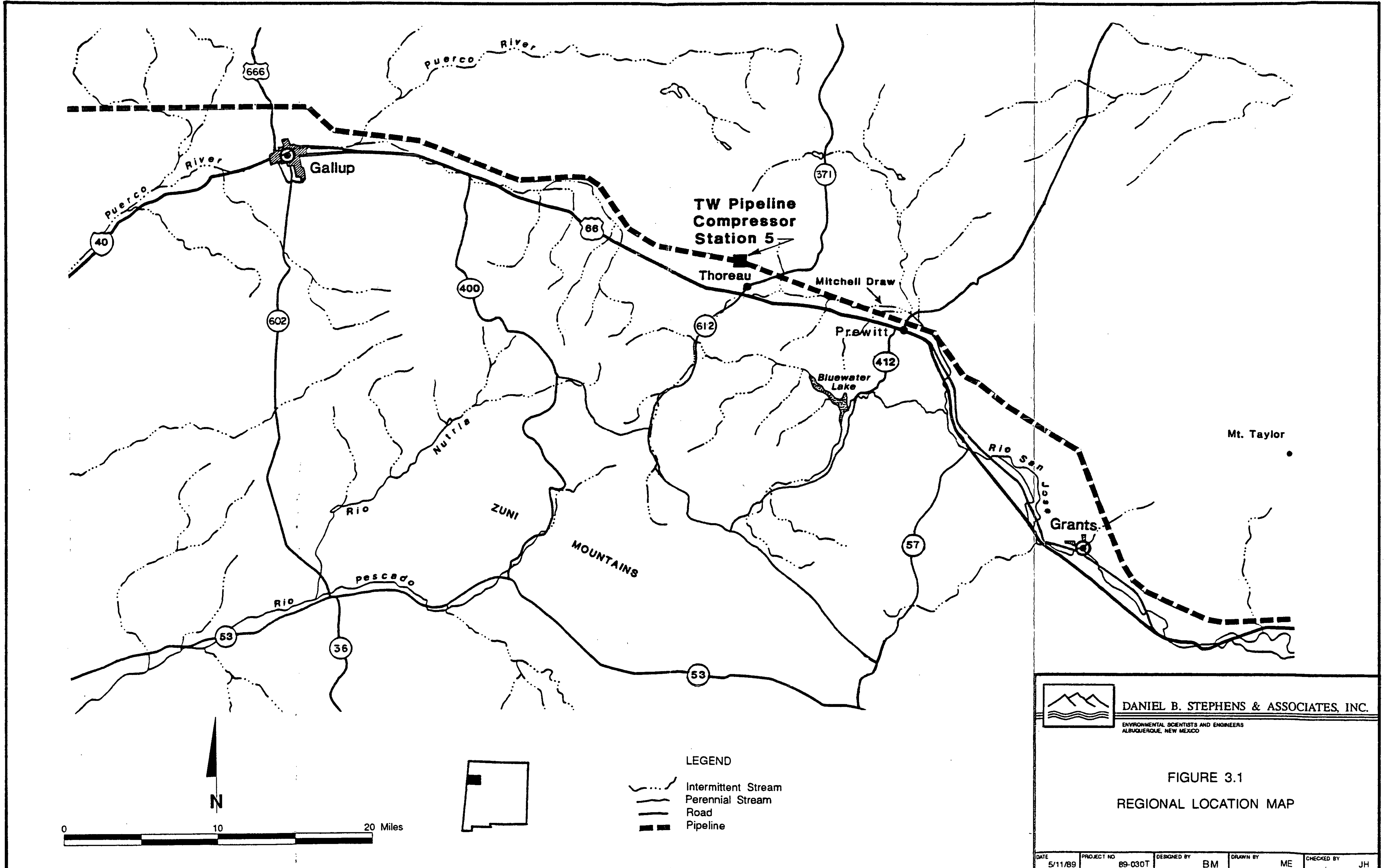

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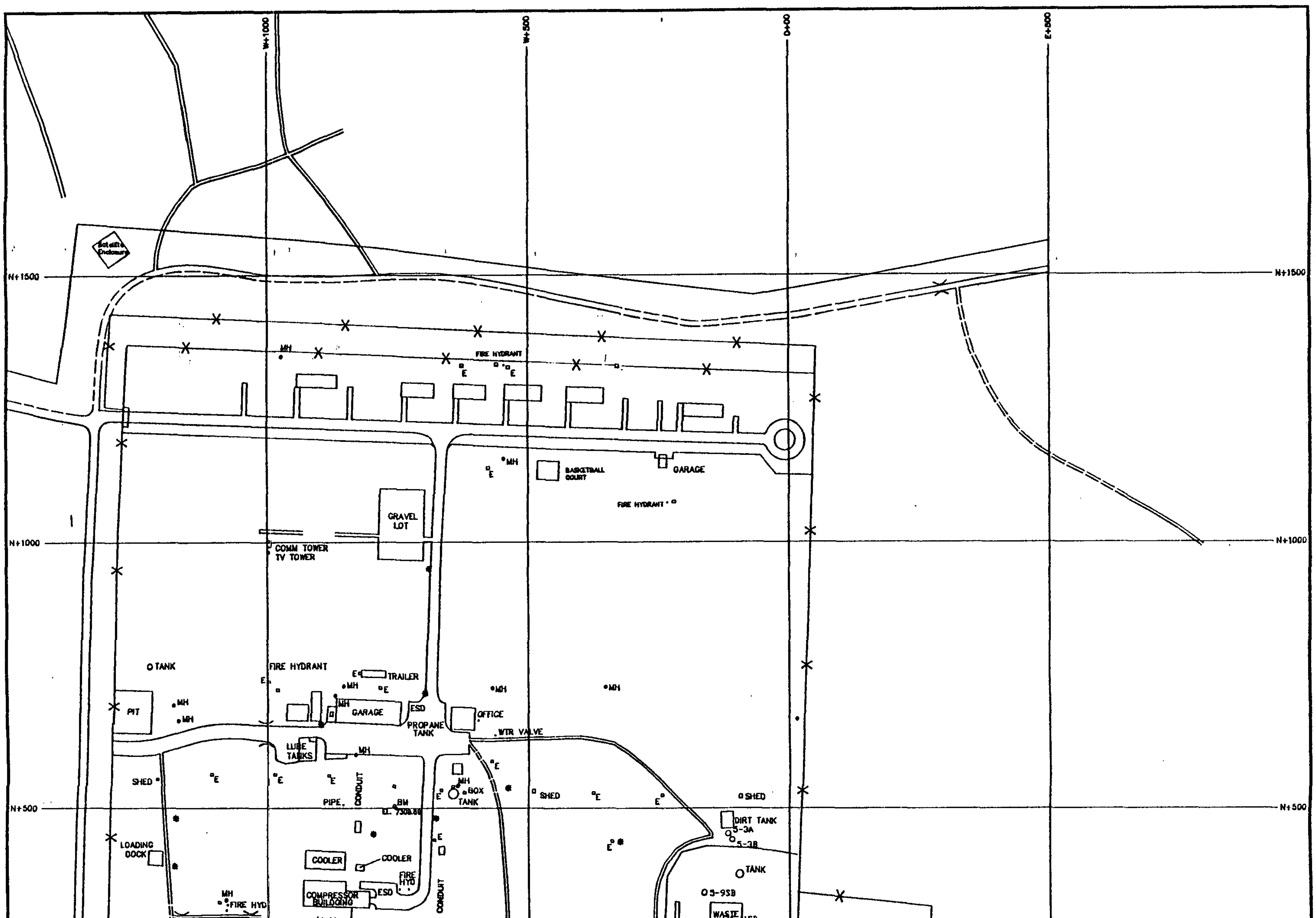
FIGURE 3.1
REGIONAL LOCATION MAP

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
5/11/89	89-030T	BM	ME	JH



LEGEND

- Monitor Well
- Fence
- Gravel Road
- Electric
- Light
- Manhole

0 125 250 Feet

N

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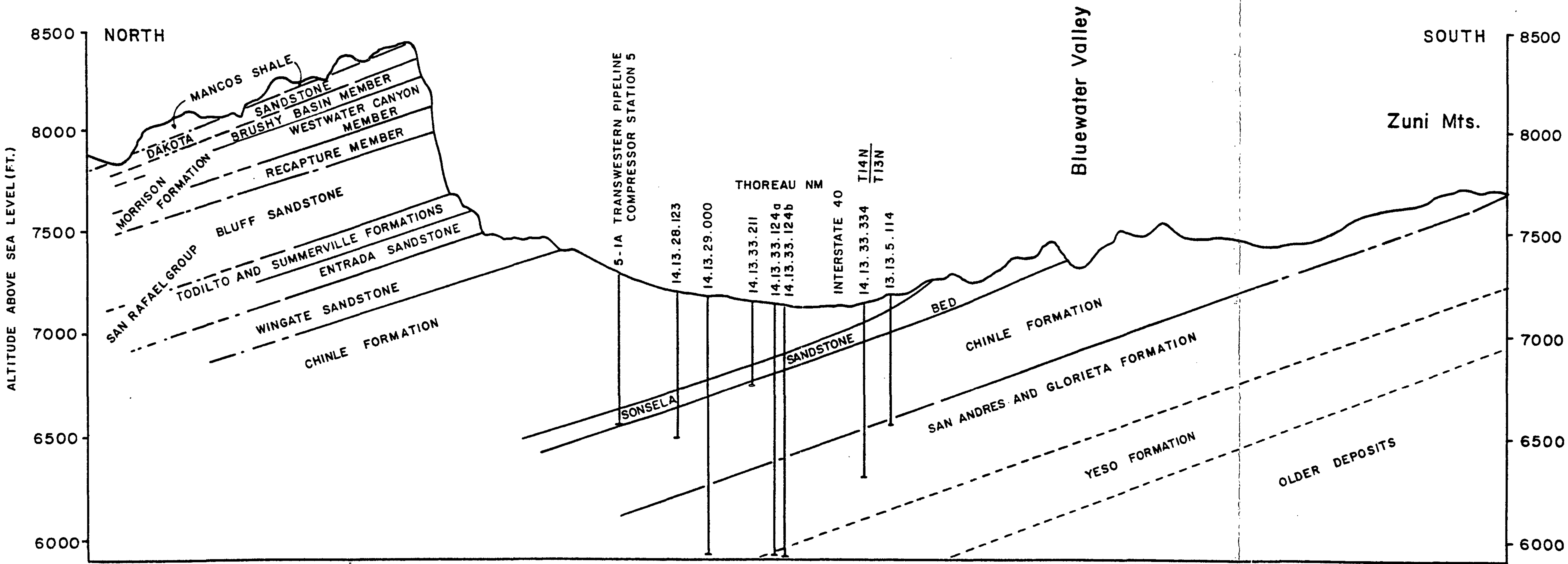
FIGURE 3.2
SITE MAP
TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
6/13/91	89-030T	BM	REA	DH



VERTICAL EXAGGERATION: 10x

AFTER [illegible]OHYDROLOGY ASSOC., 1981

LEGEND

Geologic Contact (dashed where inferred)

Well 14.13.28.123 = Township North.Range West.Section.1/4 Sections

0 1 2 Miles

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FIGURE 3.3

GEOLOGIC CROSS-SECTION
NEAR THOREAU, NEW MEXICO

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
2/19/90	89-030T	BM	EE	JH

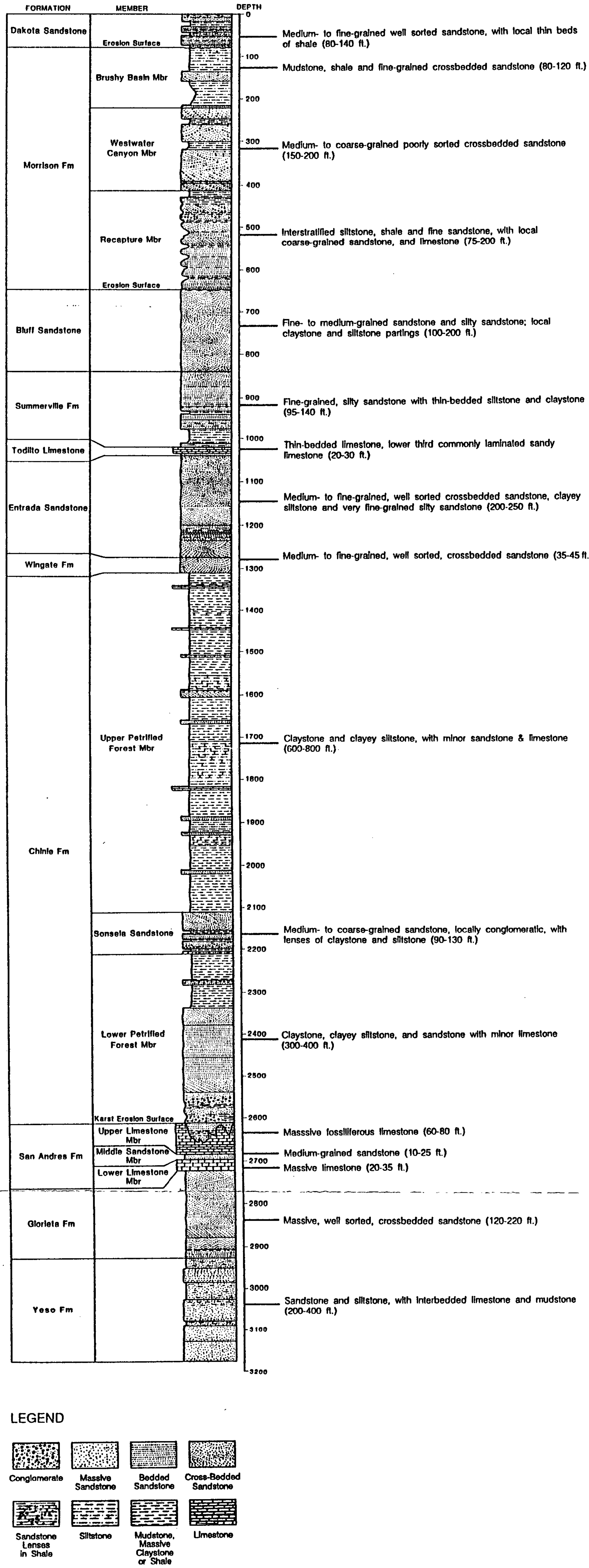

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FIGURE 3.4
STRATIGRAPHIC COLUMN
NEAR THOREAU, NEW MEXICO

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
1/90	89-030T	BM	RF/ME	JH

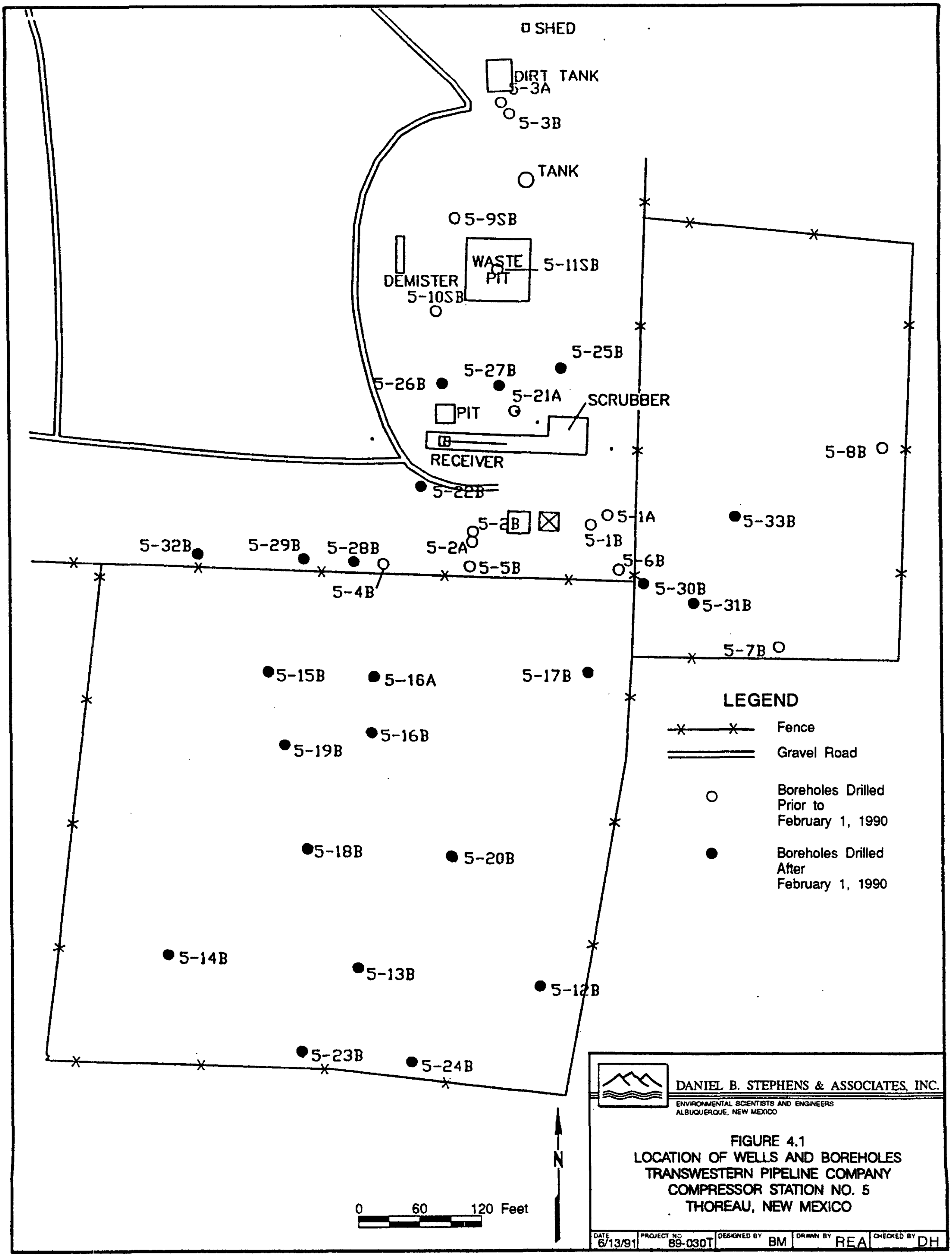

FIGURE 4.1
LOCATION OF WELLS AND BOREHOLES
TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO

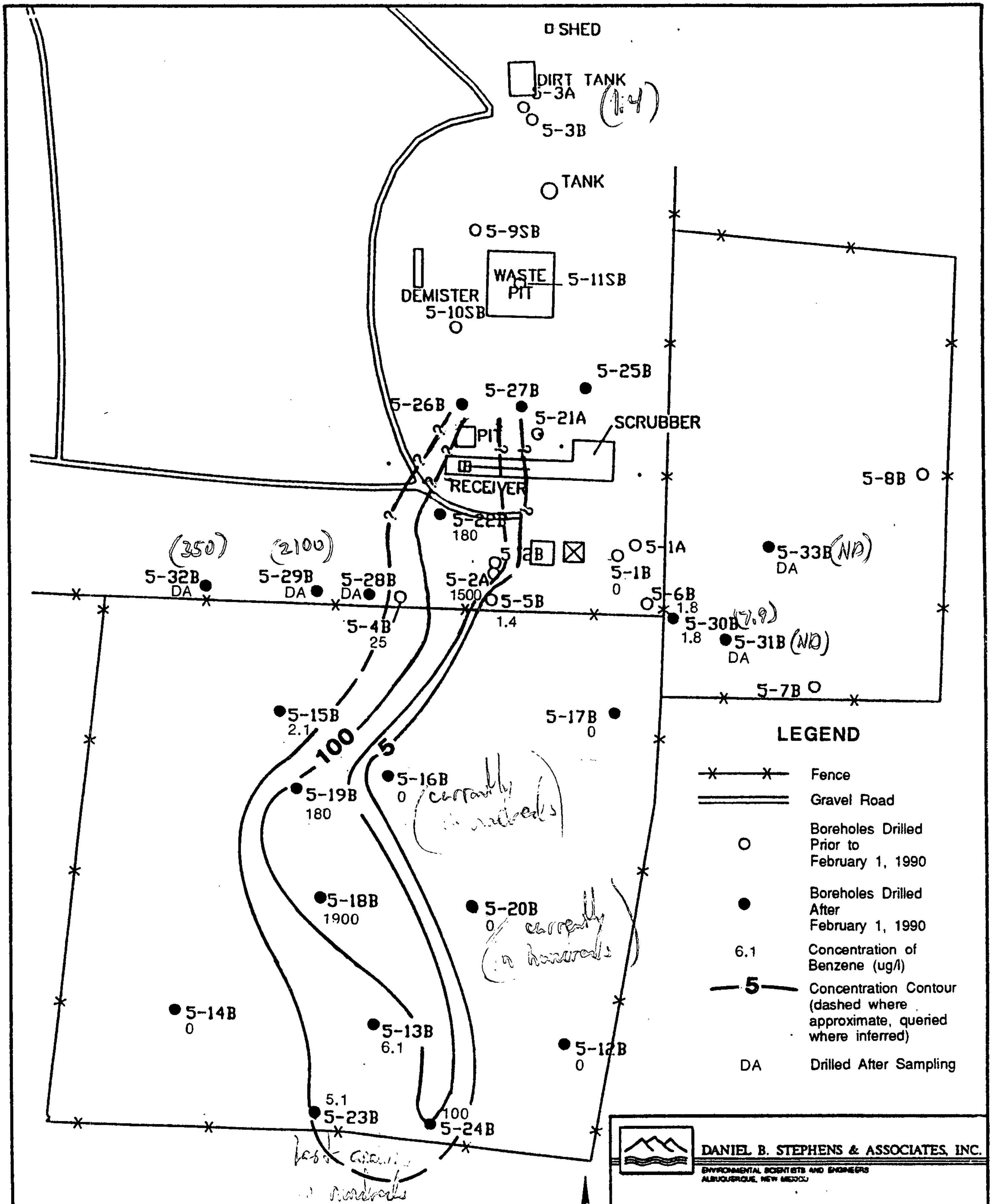

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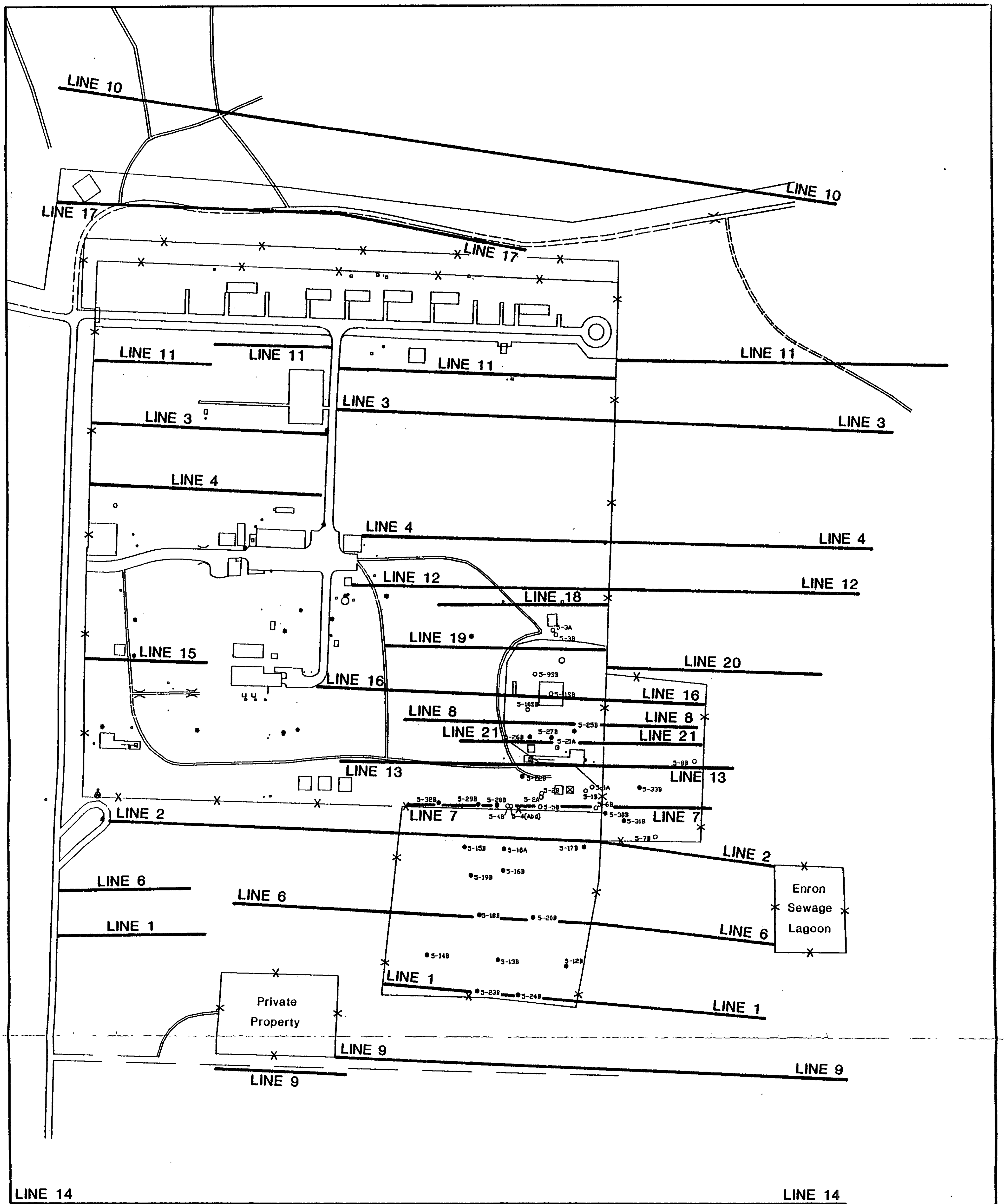
FIGURE 4.2
CONCENTRATION OF BENZENE (ug/l)
IN PERCHED AQUIFER
NOVEMBER 1990

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
6/13/91	89-030T	BM	REA	DH



LEGEND

- • Monitor Well
- —x——x— Fence
- ═══ Gravel Road
- LINE 1 ——— EM-Conductivity Line Location

0 125 250 Feet

N

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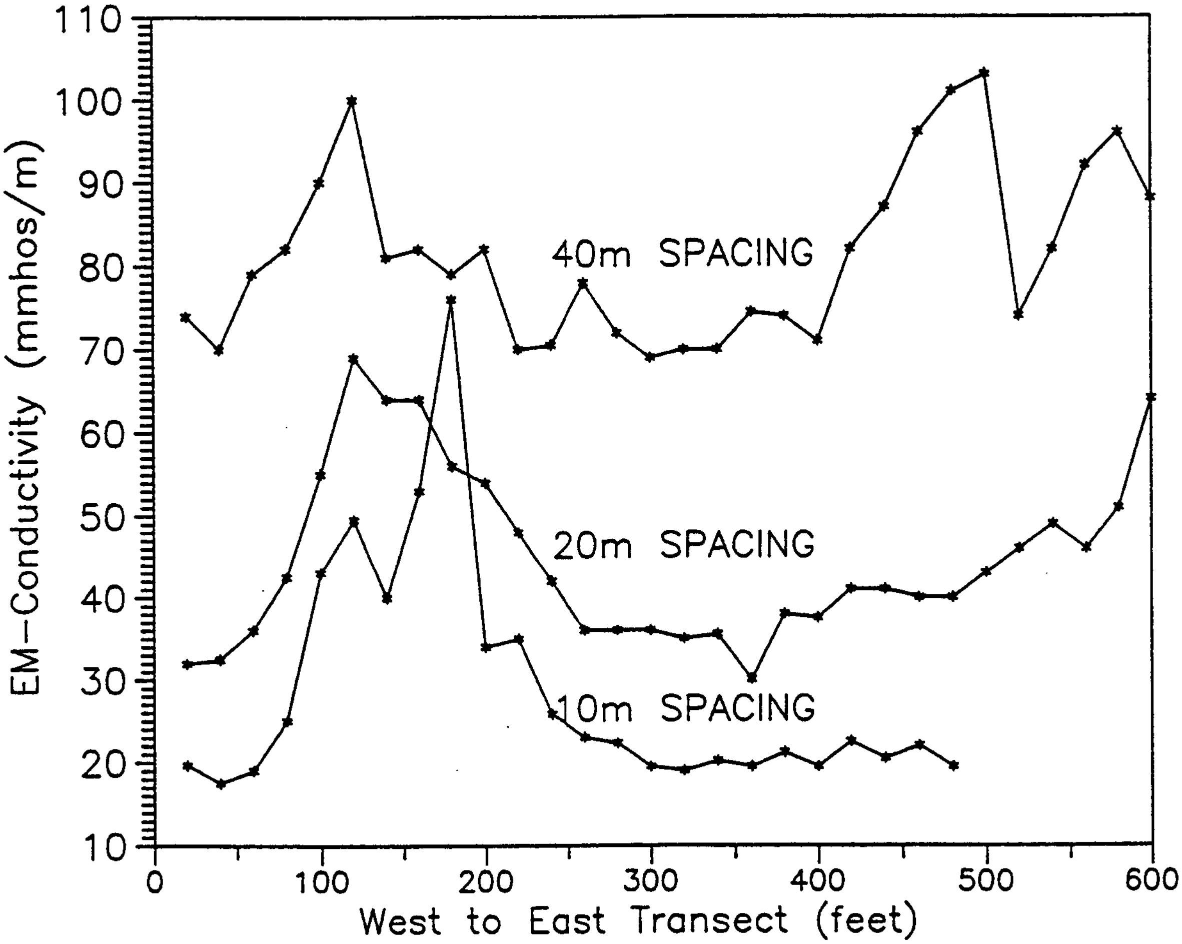
FIGURE 5.1
LOCATION OF
EM-CONDUCTIVITY SURVEY LINES

DATE	PROJECT NO.	DESIGNED BY	DRAWN BY	CHECKED BY
6/13/91	89-030T	CC	REA	DH



Explanation
EM-34 Conductivity data points from Line 7
Scale as shown

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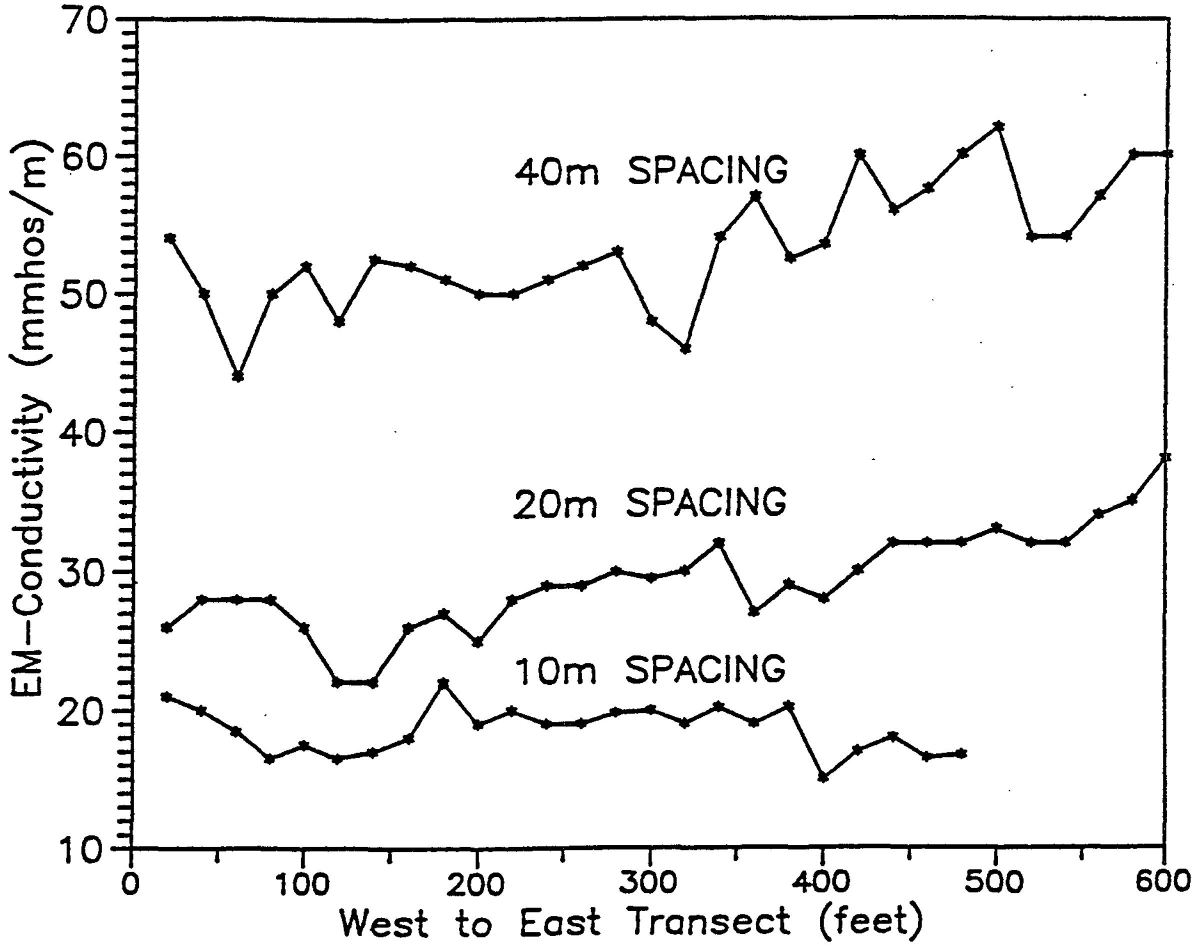
FIGURE 5.2
EM-CONDUCTIVITY VS COIL SPACING
VERTICAL DIPOLE ORIENTATION

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
6/13/91	89-030T	BM	LH	DH



Explanation
EM-34 Conductivity data points from Line 7
Scale as shown

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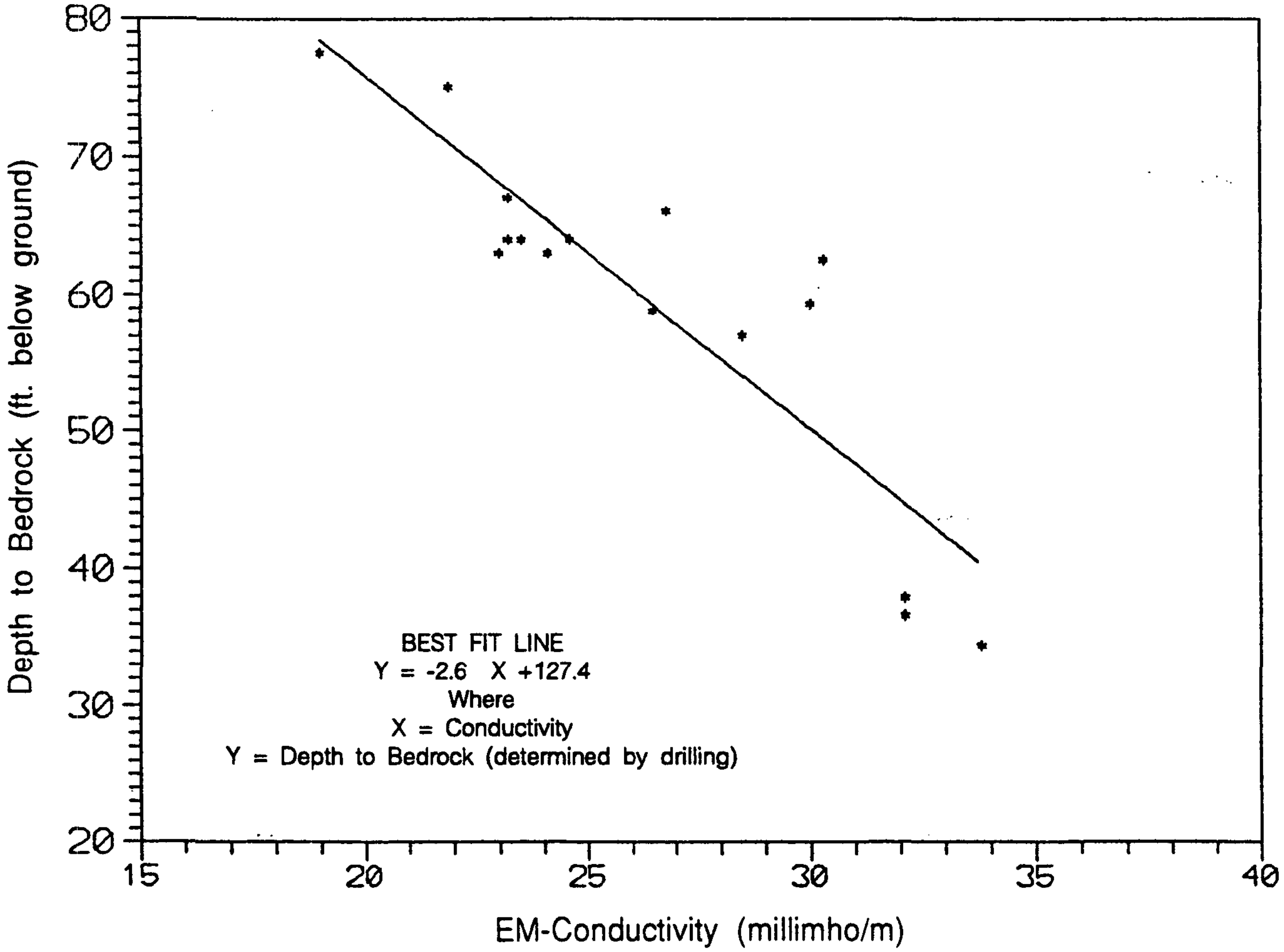
FIGURE 5.3
EM-CONDUCTIVITY VS COIL SPACING
HORIZONTAL DIPOLE ORIENTATION

DATE	PROJECT NO.	DESIGNED BY	DRAWN BY	CHECKED BY
6/13/91	89-030T	BM	LH	DH



20 Meter Coil Spacing
Horozontal Dipole

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FIGURE 5.4
CORRELATION PLOT
DEPTH TO BEDROCK VS CONDUCTIVITY
JANUARY 1991 SURVEY

DATE	PROJECT NO.	DESIGNED BY	DRAWN BY	CHECKED BY
6/13/91	89-030T	BM	LH	DH

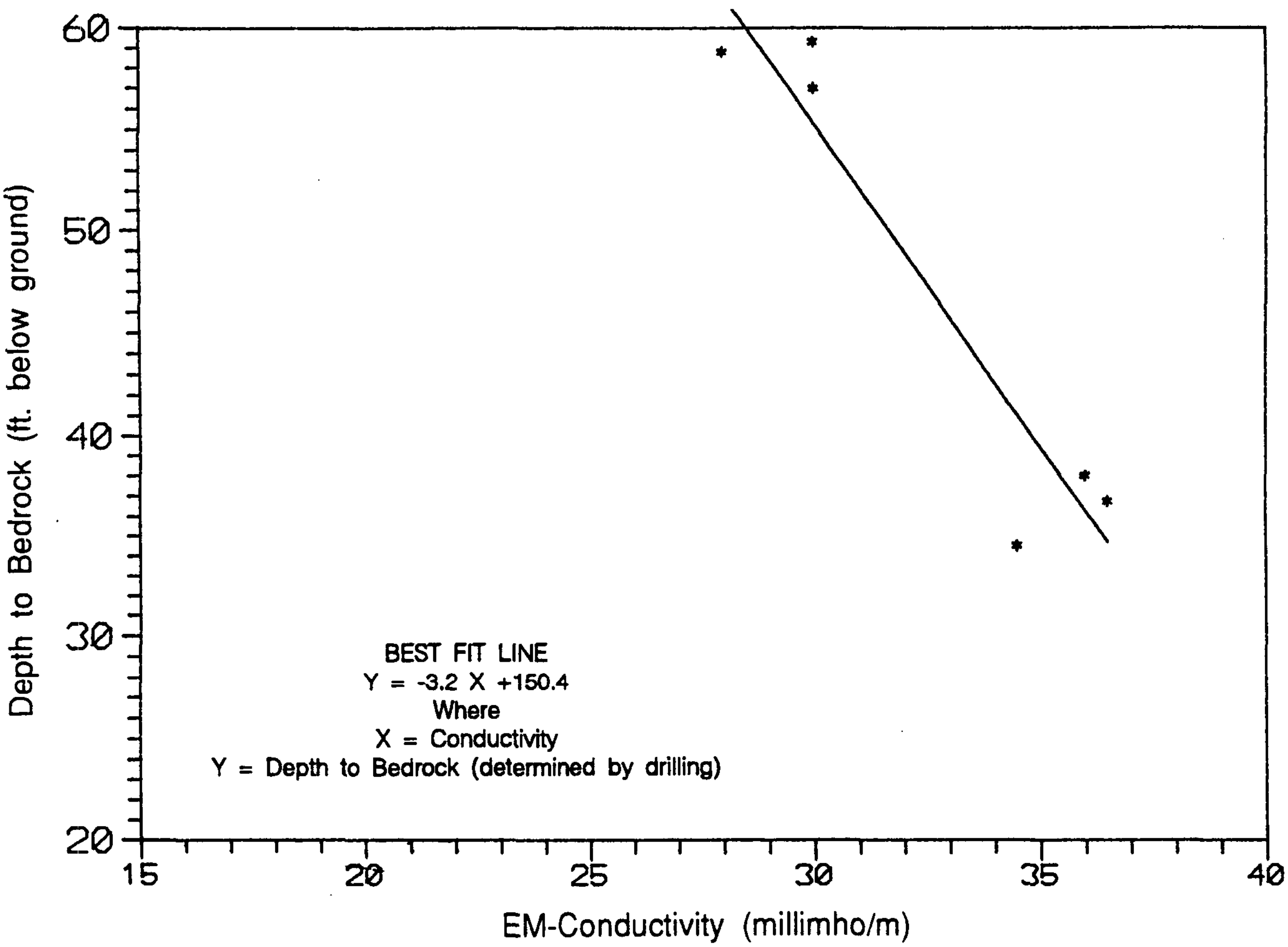

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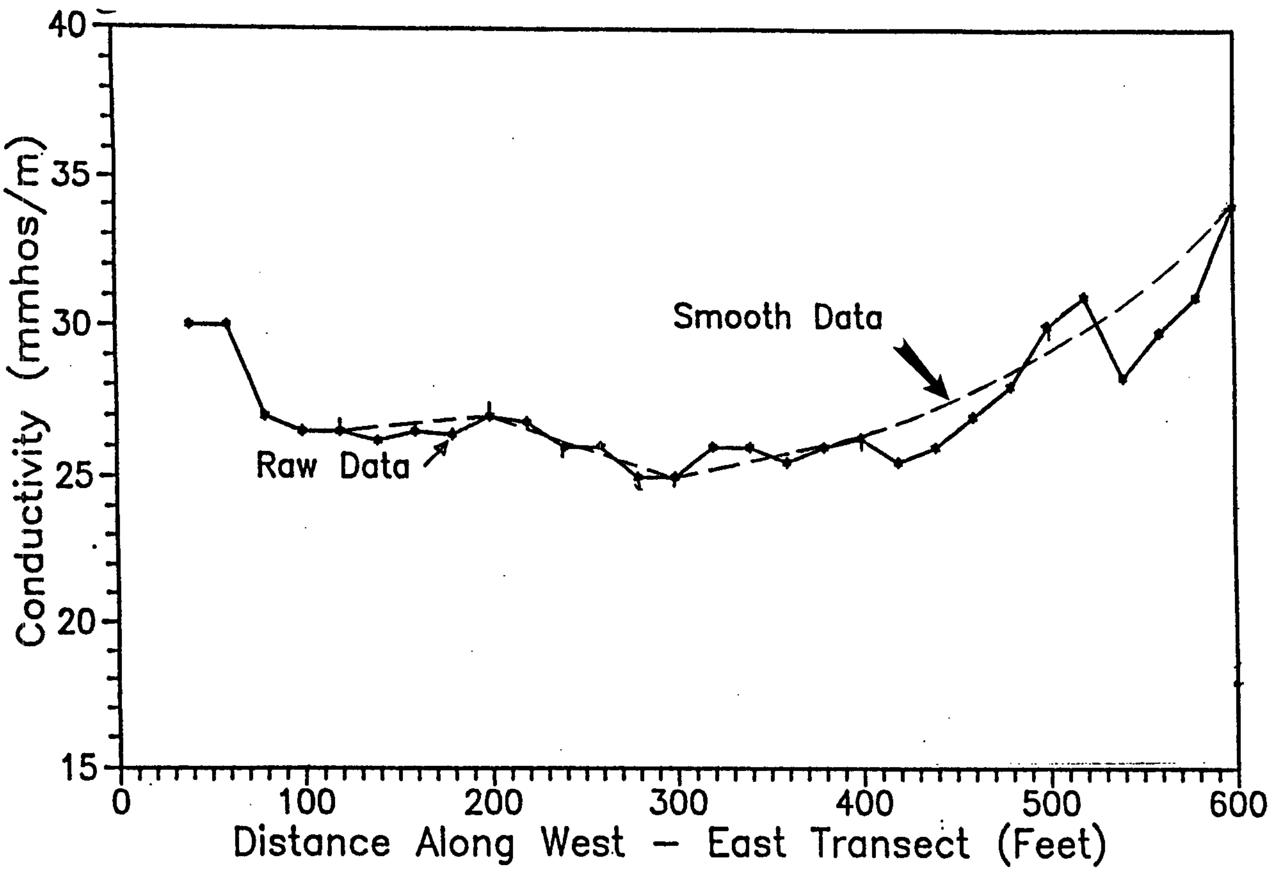
FIGURE 5.5
CORRELATION PLOT
DEPTH TO BEDROCK VS CONDUCTIVITY
MARCH 1991 SURVEY

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
6/13/91	89-030T	BM	LH	DH



FROM: Line 4-B Continuation of West to East Transect, from NE Corner of Office to Eastern Property Boundary

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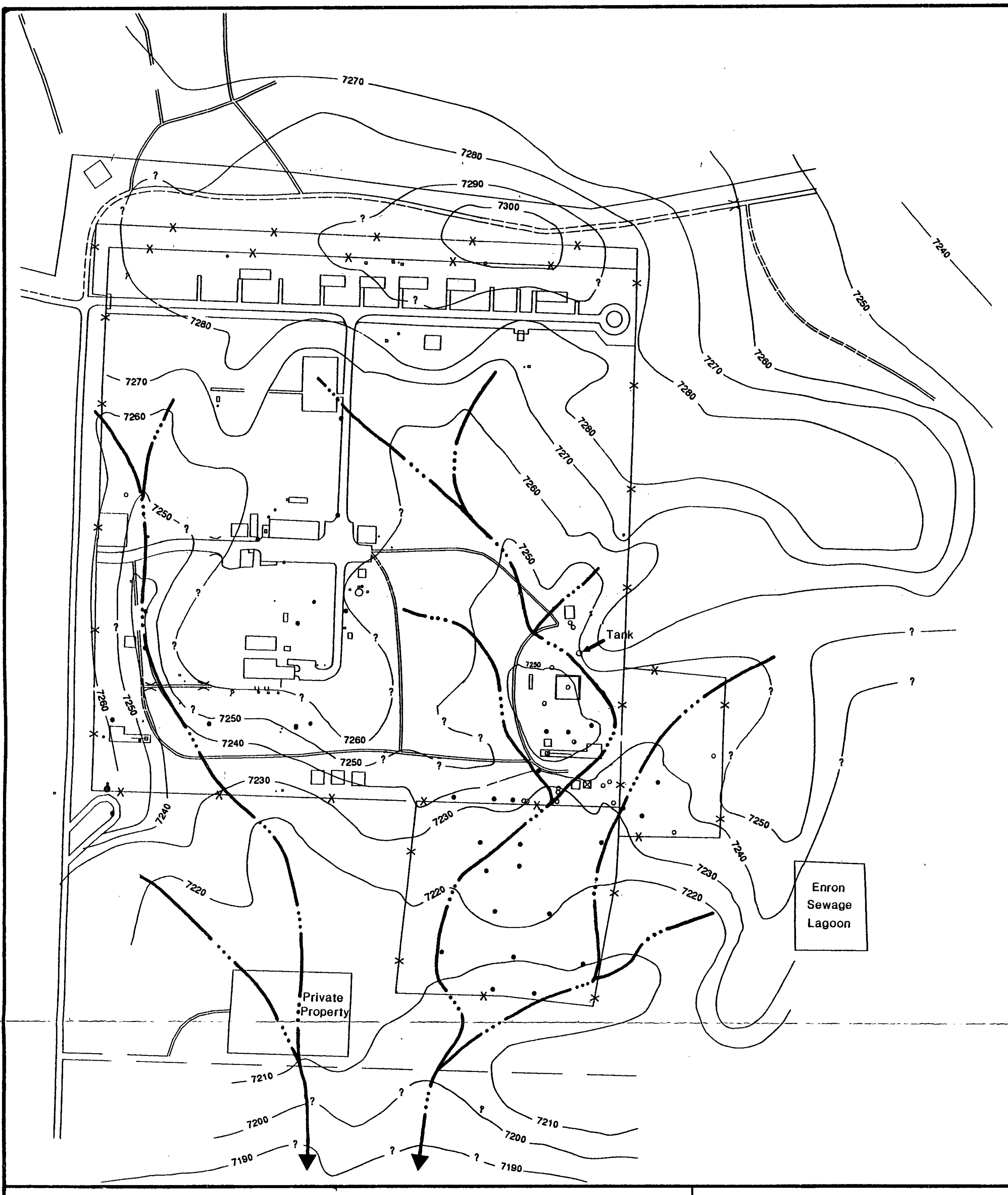
FIGURE 5.6
EXAMPLE OF METHOD USED TO SMOOTH EM-CONDUCTIVITY DATA

DATE	PROJECT NO.	DESIGNED BY	DRAWN BY	CHECKED BY
6/13/91	89-030T	BM	LH	DH



LEGEND

- Fence
- Paleochannels
- 7220 Chinle Formation Bedrock Contours Based on EM-Conductivity Survey

0 125 250 Feet

N

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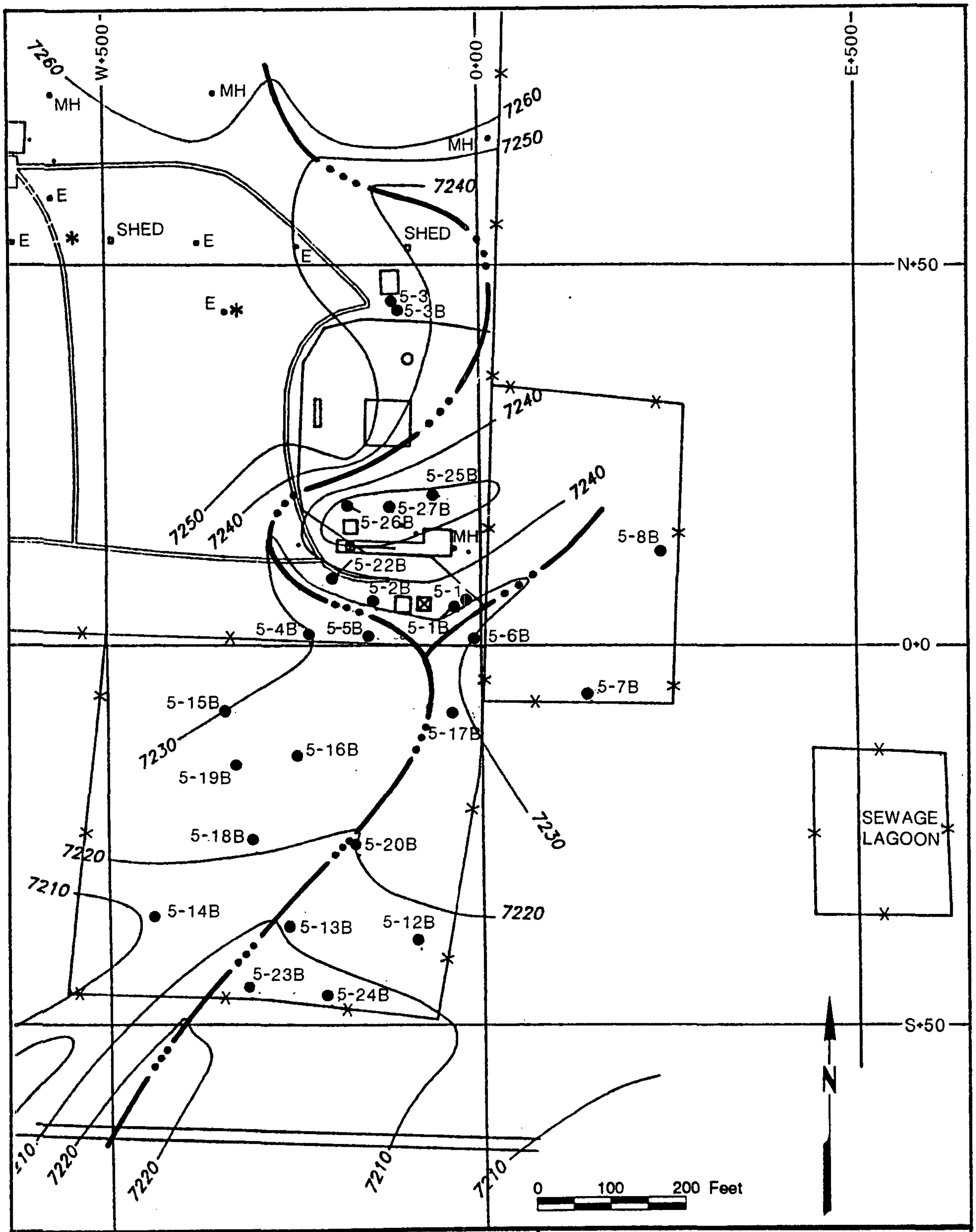
FIGURE 5.7
BEDROCK ELEVATION MAP
BASED ON EM-CONDUCTIVITY SURVEY

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
6/13/91	89-030T	BM	REA	DH



LEGEND

		E	Electric
—x——x—	Fence	*	Light
═══	Gravel Road	MH	Manhole
▬ • • ▬	Paleochannels	●	Monitor Well
7250 ——	Structure Contour - Chinle Formation Elevation (feet, msl, 10' interval)		

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FIGURE 5.8
BEDROCK ELEVATION MAP
BASED ON SEISMIC REFRACTION SURVEY

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
6/11/91	89-030T	CC	REA	BM

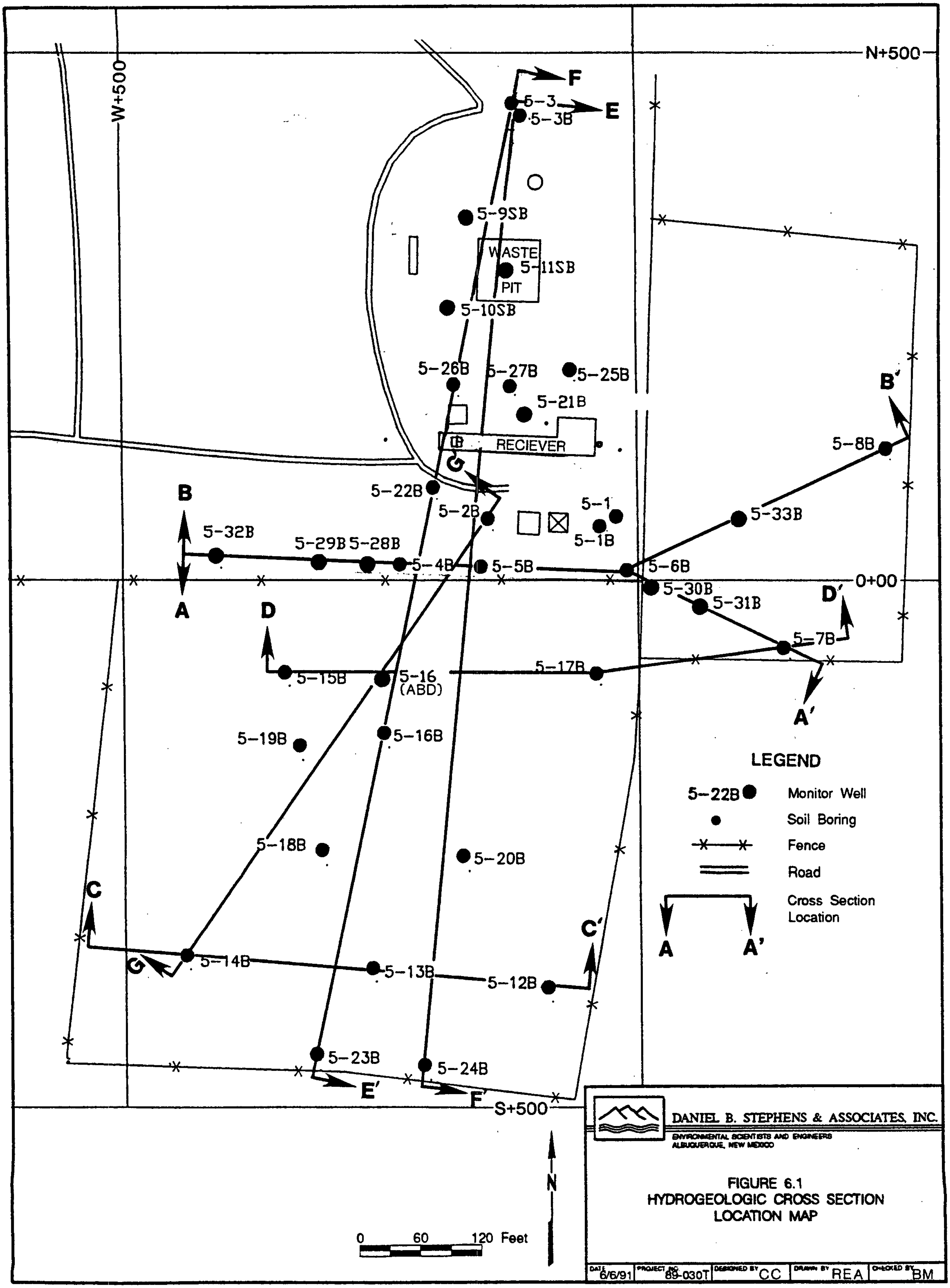

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FIGURE 6.1
HYDROGEOLOGIC CROSS SECTION
LOCATION MAP

DATE	PROJECT NO.	DESIGNED BY	DRAWN BY	CHECKED BY
6/6/91	89-030T	CC	REA	BM

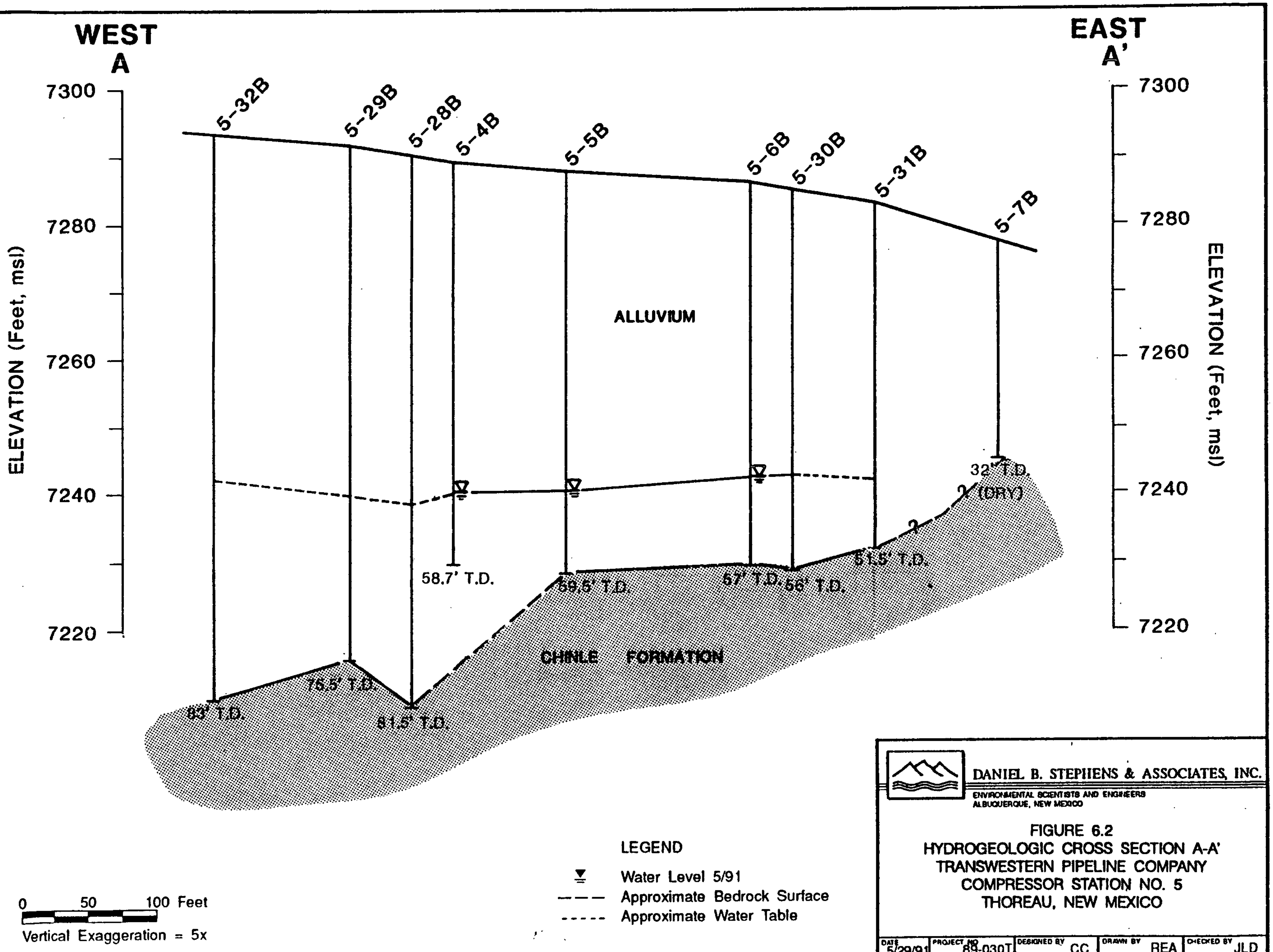

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FIGURE 6.2
HYDROGEOLOGIC CROSS SECTION A-A'
TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO

DATE	PROJECT NO.	DESIGNED BY	DRAWN BY	CHECKED BY
5/29/91	89-030T	CC	REA	JLD

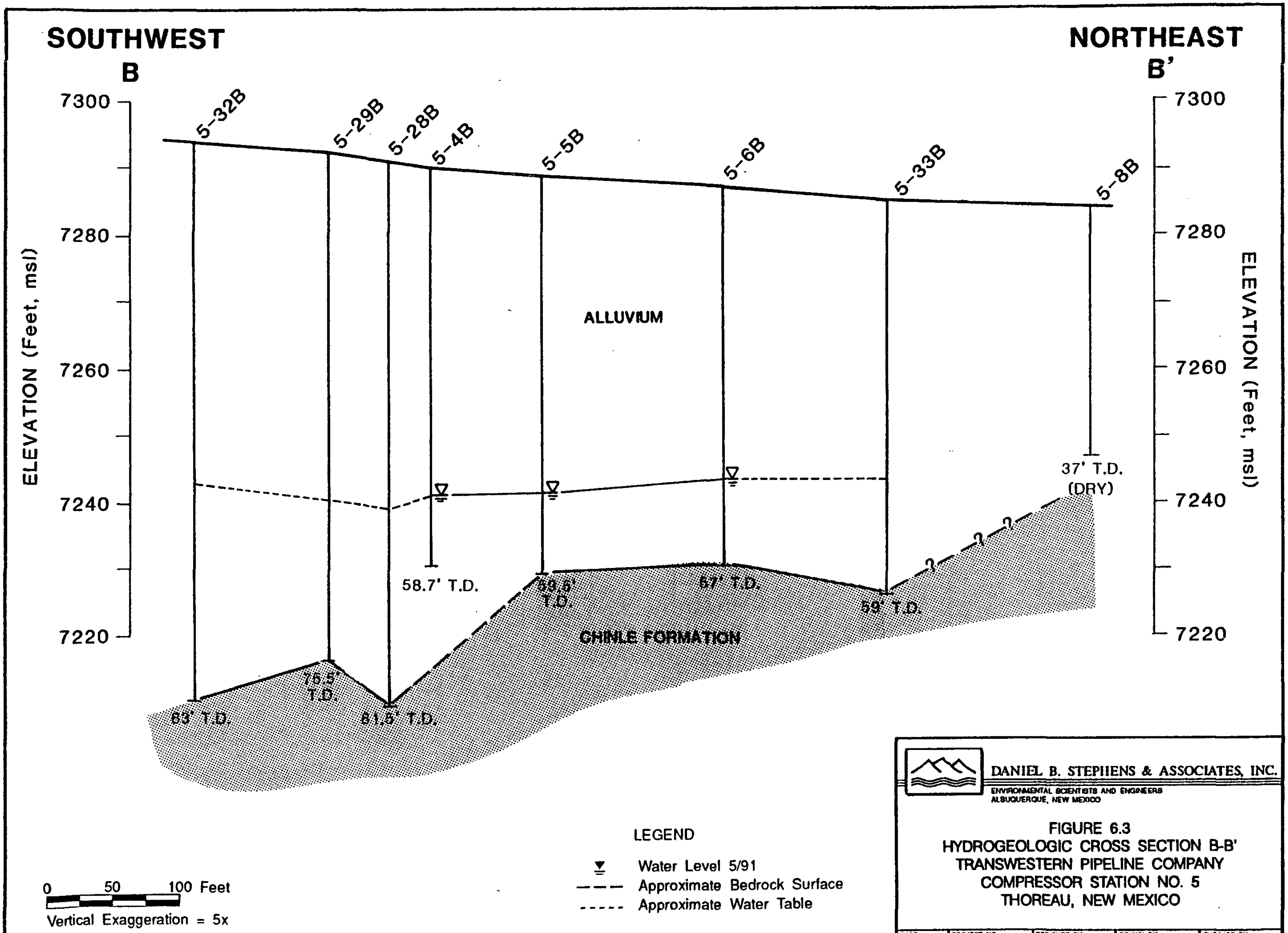

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FIGURE 6.3
HYDROGEOLOGIC CROSS SECTION B-B'
TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
5/29/91	89-030T	KCT	REA	JLD

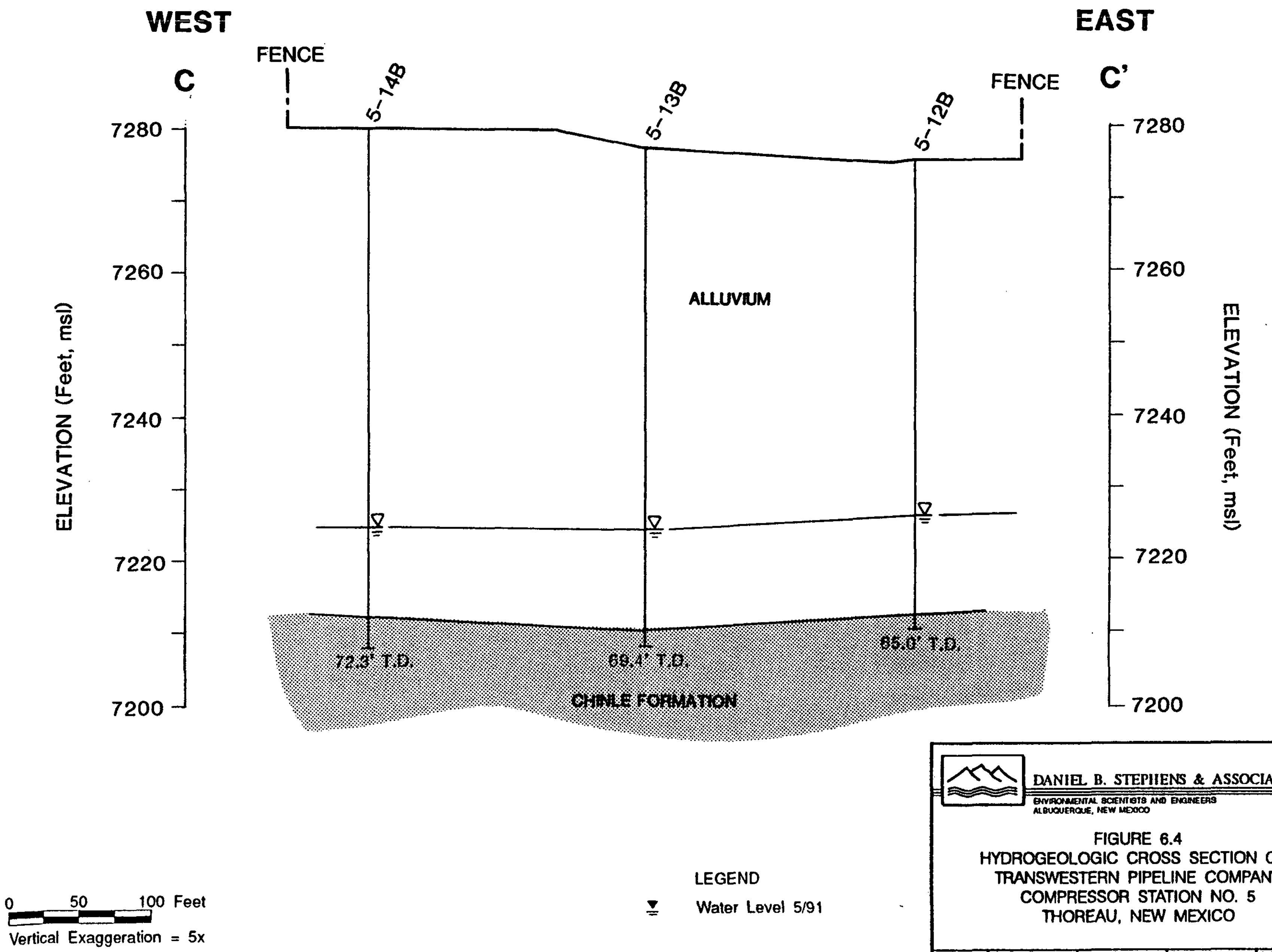

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FIGURE 6.4
HYDROGEOLOGIC CROSS SECTION C-C'
TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO

DATE	PROJECT NO.	DESIGNED BY	DRAWN BY	CHECKED BY
5/30/91	89-030T	CC	REA	JLD

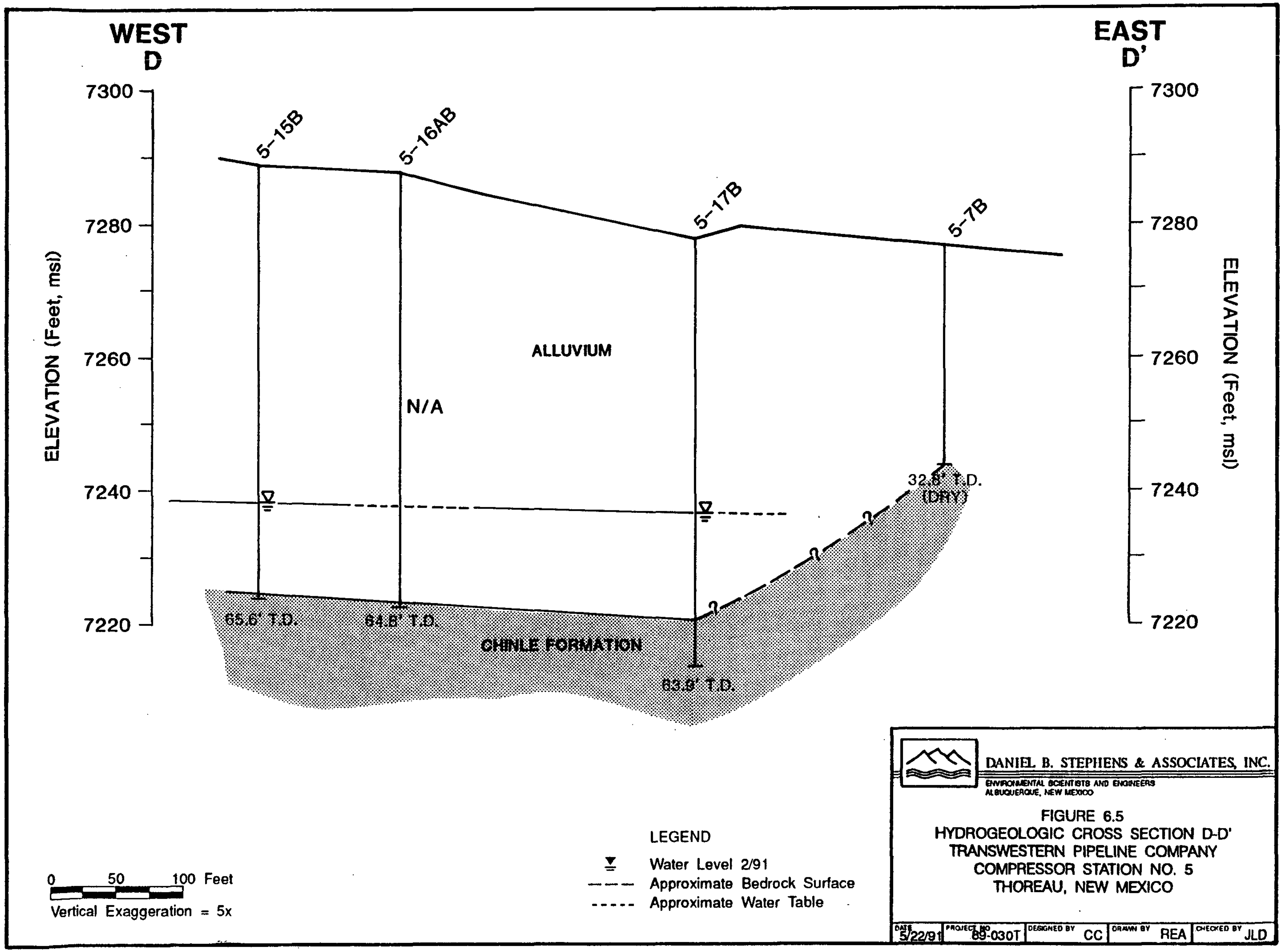
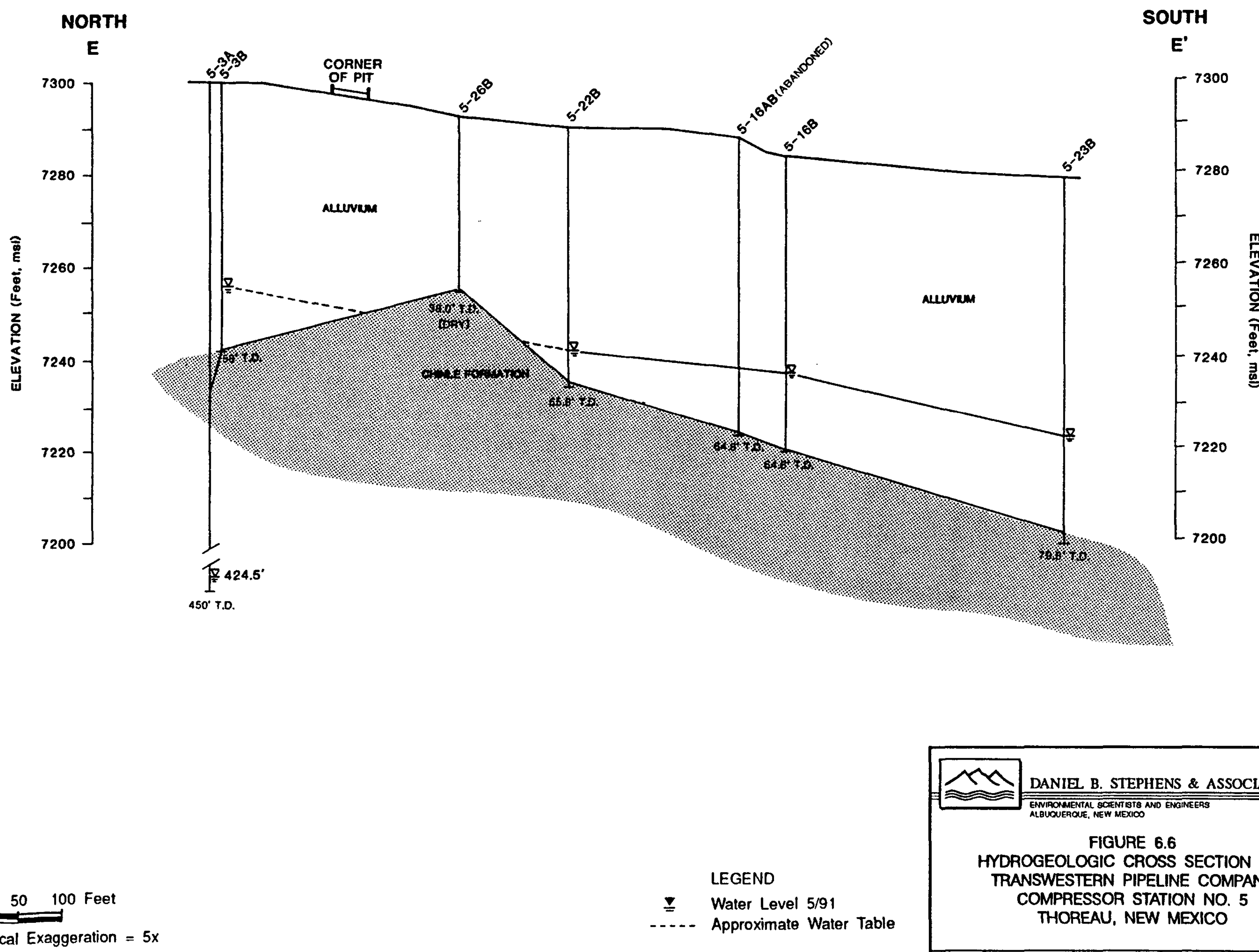


FIGURE 6.5
HYDROGEOLOGIC CROSS SECTION D-D'
TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO



LEGEND

- Water Level 5/91
- ----- Approximate Water Table

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FIGURE 6.6
HYDROGEOLOGIC CROSS SECTION E-E'
TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
5/24/91	89-030T	CC	REA	JLD

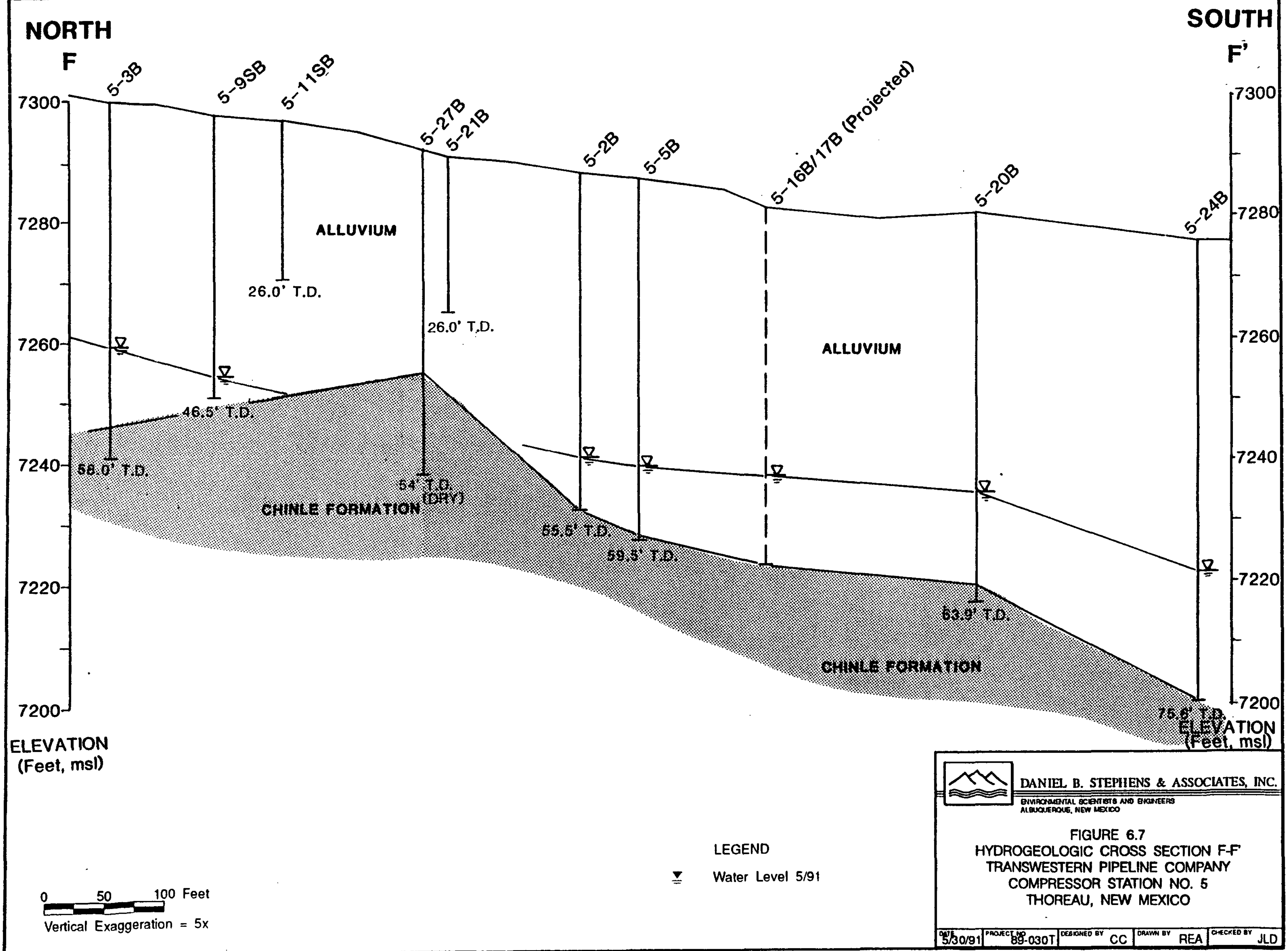

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FIGURE 6.7
HYDROGEOLOGIC CROSS SECTION F-F'
TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
5/30/91	89-030T	CC	REA	JLD

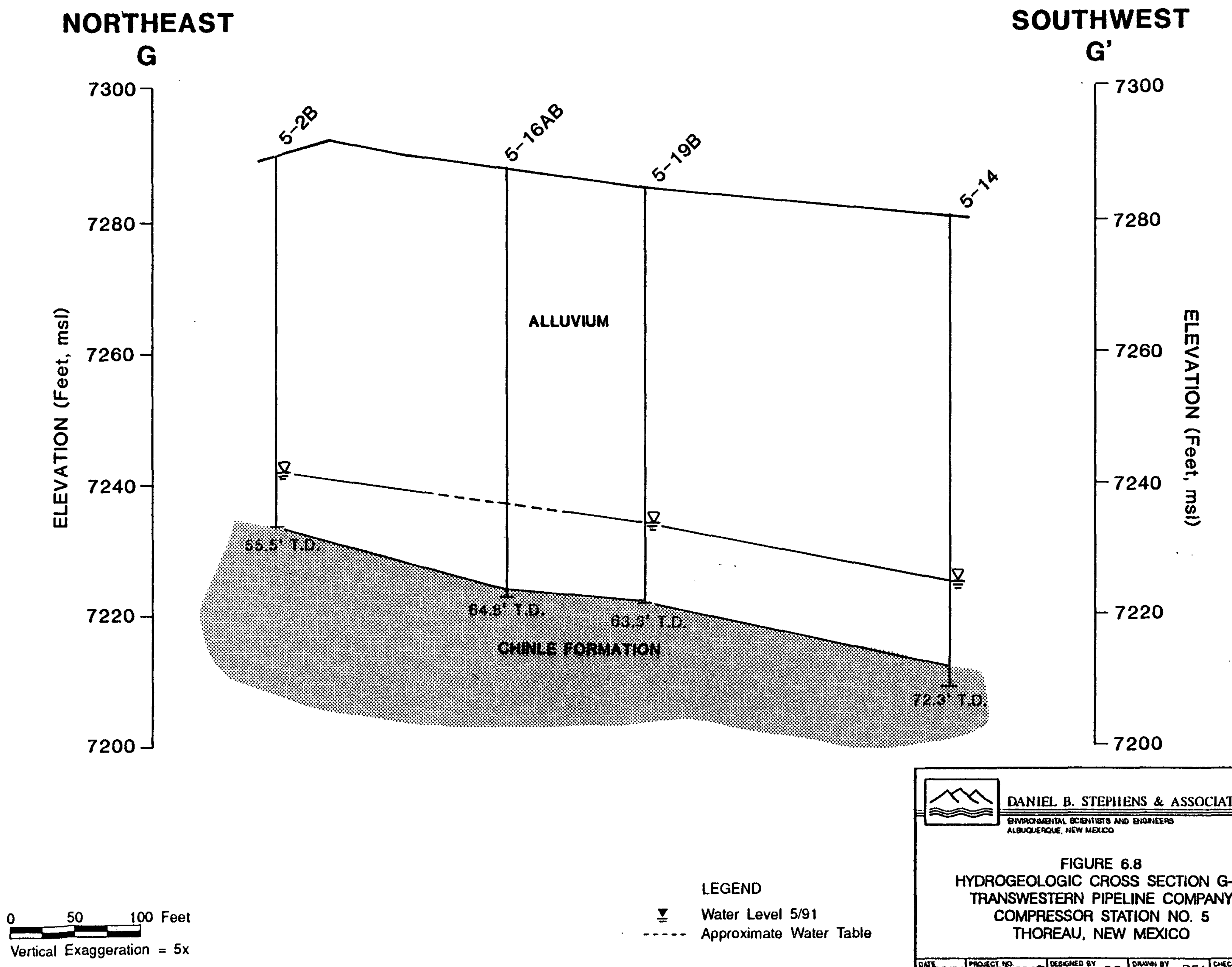

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FIGURE 6.8
HYDROGEOLOGIC CROSS SECTION G-G'
TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO

DATE	PROJECT NO.	DESIGNED BY	DRAWN BY	CHECKED BY
5/22/91	89-030T	CC	REA	JLD

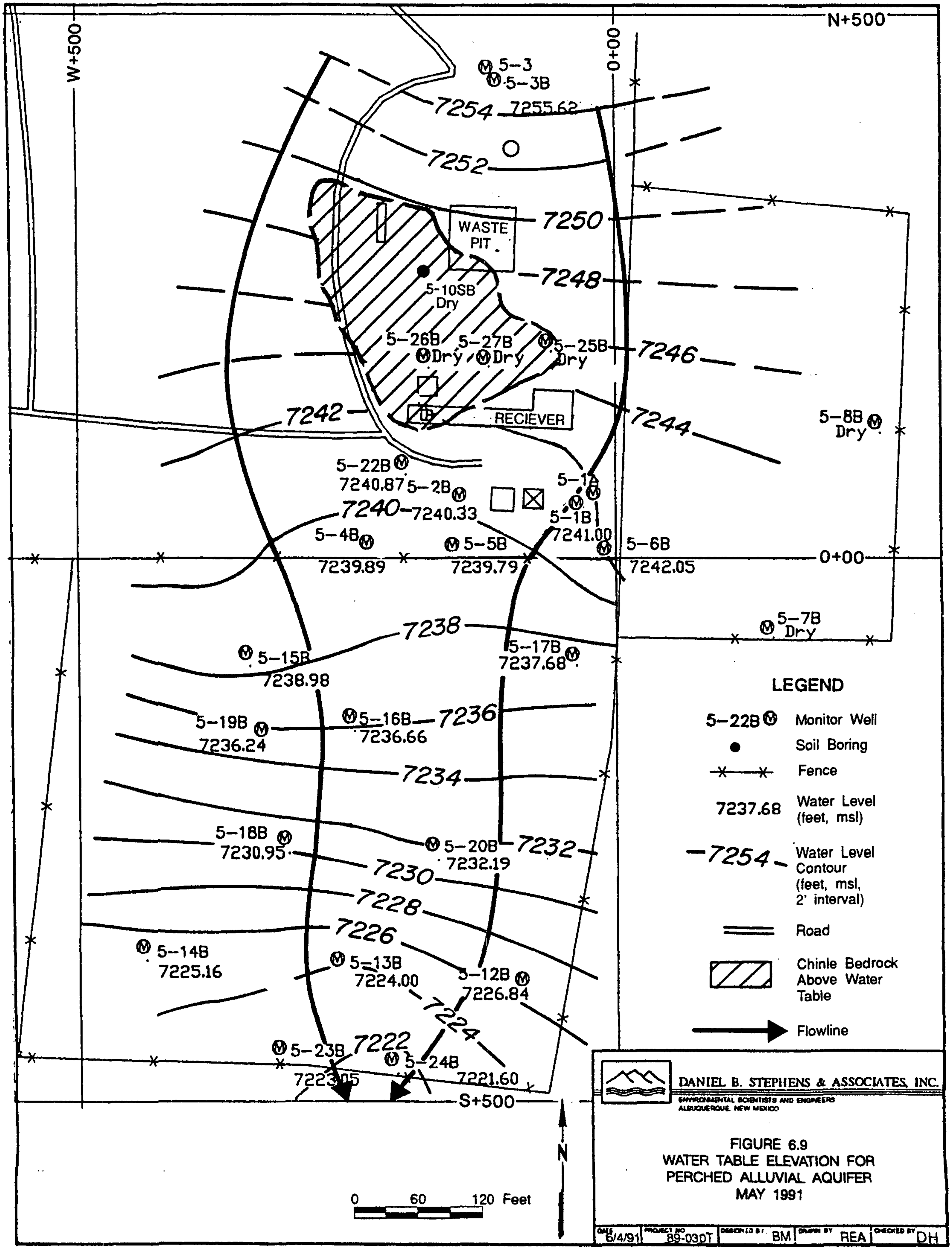
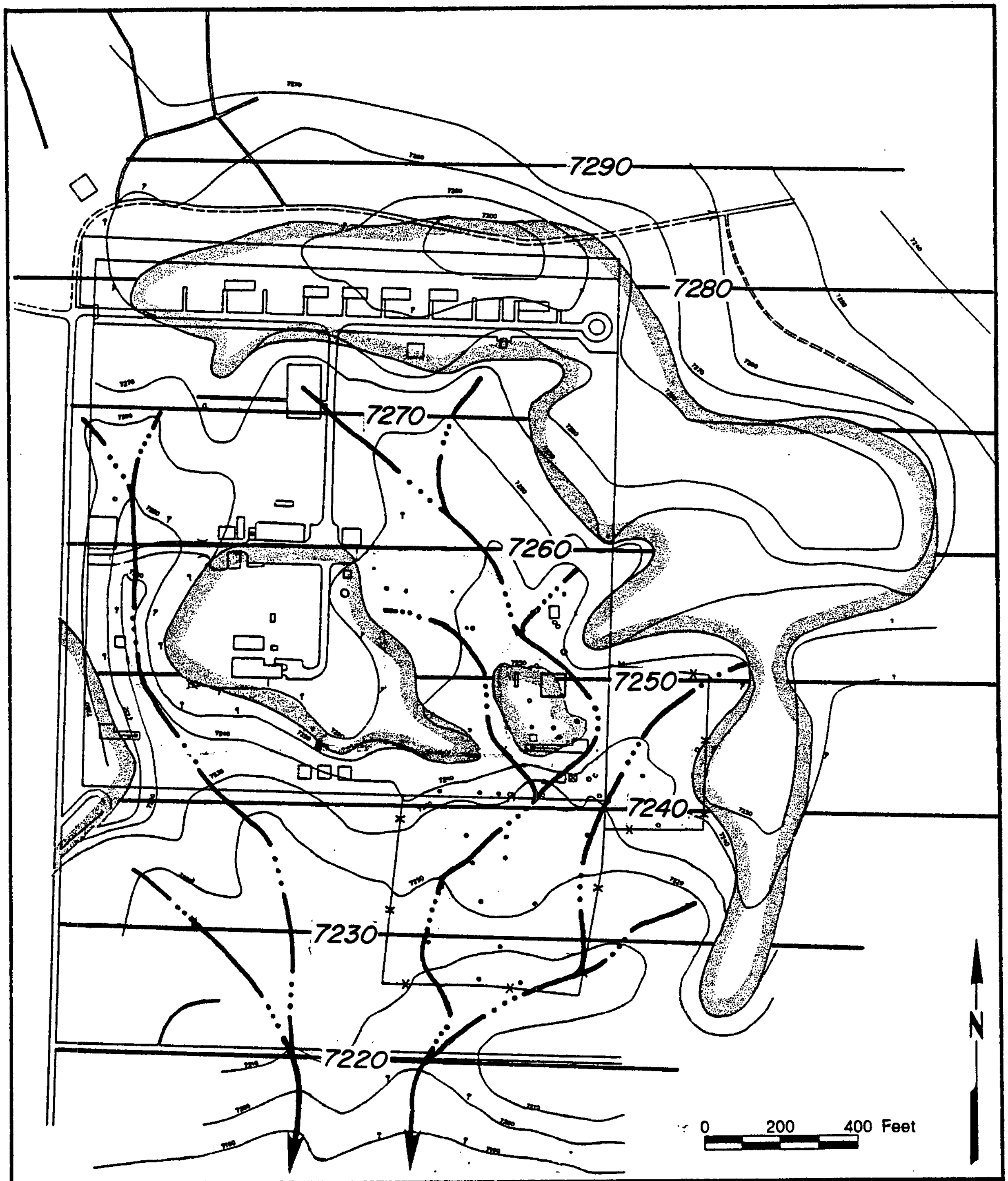


FIGURE 6.9
WATER TABLE ELEVATION FOR
PERCHED ALLUVIAL AQUIFER
MAY 1991



LEGEND

- Paleochannels
- Chinle Bedrock Above Water Table
- 7260 — Projected Water Table Contours (feet, msl, 10' interval)
- Chinle Formation Bedrock Contours Based on EM Conductivity Survey

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FIGURE 6.10
GENERAL HYDROGEOLOGIC MAP
TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
6/10/91	89-030T	BM	REA	DH

Fig. 7.1 - Time Series of Benzene Concentrations in Monitor Wells 5-4B and 5-19B

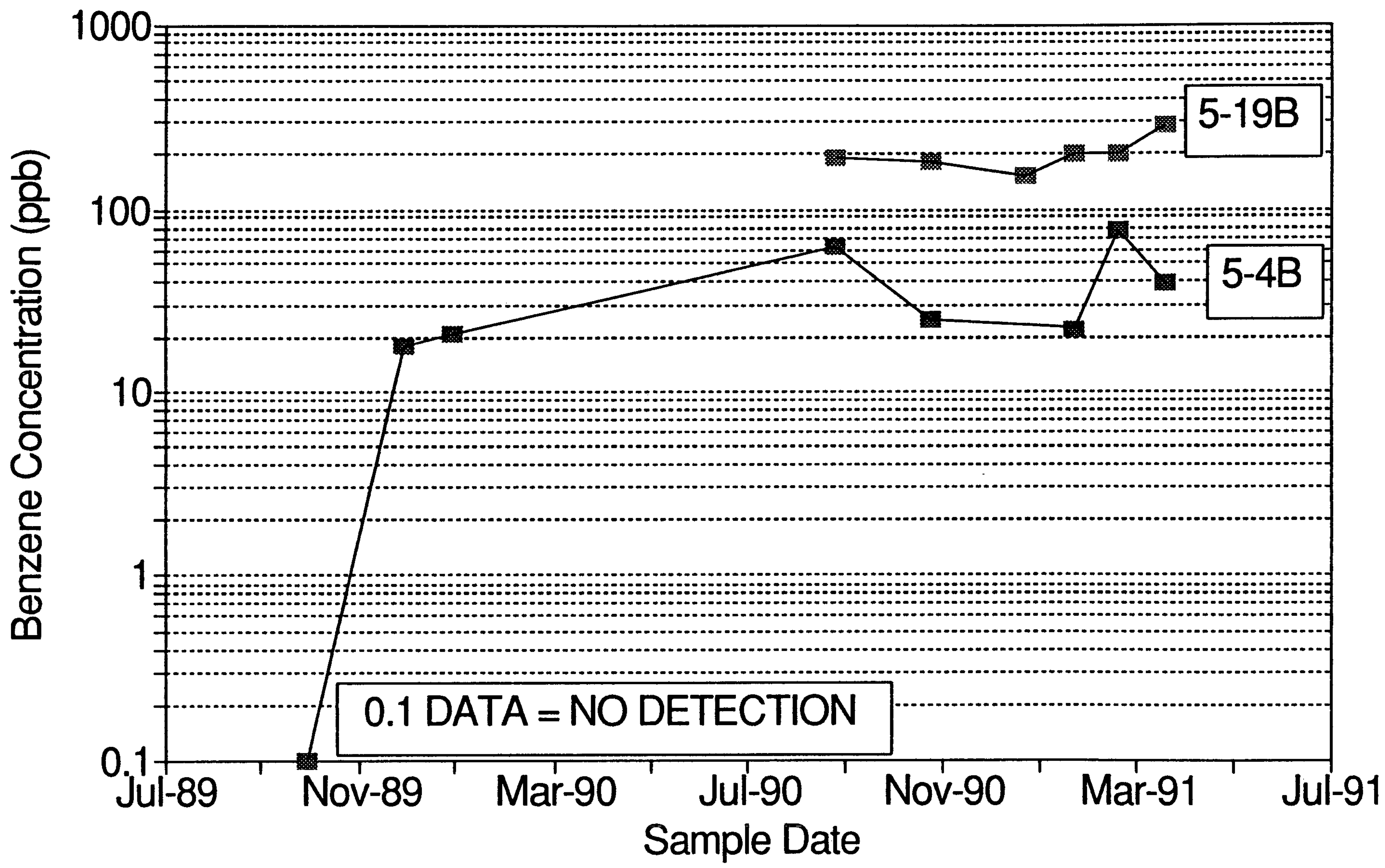
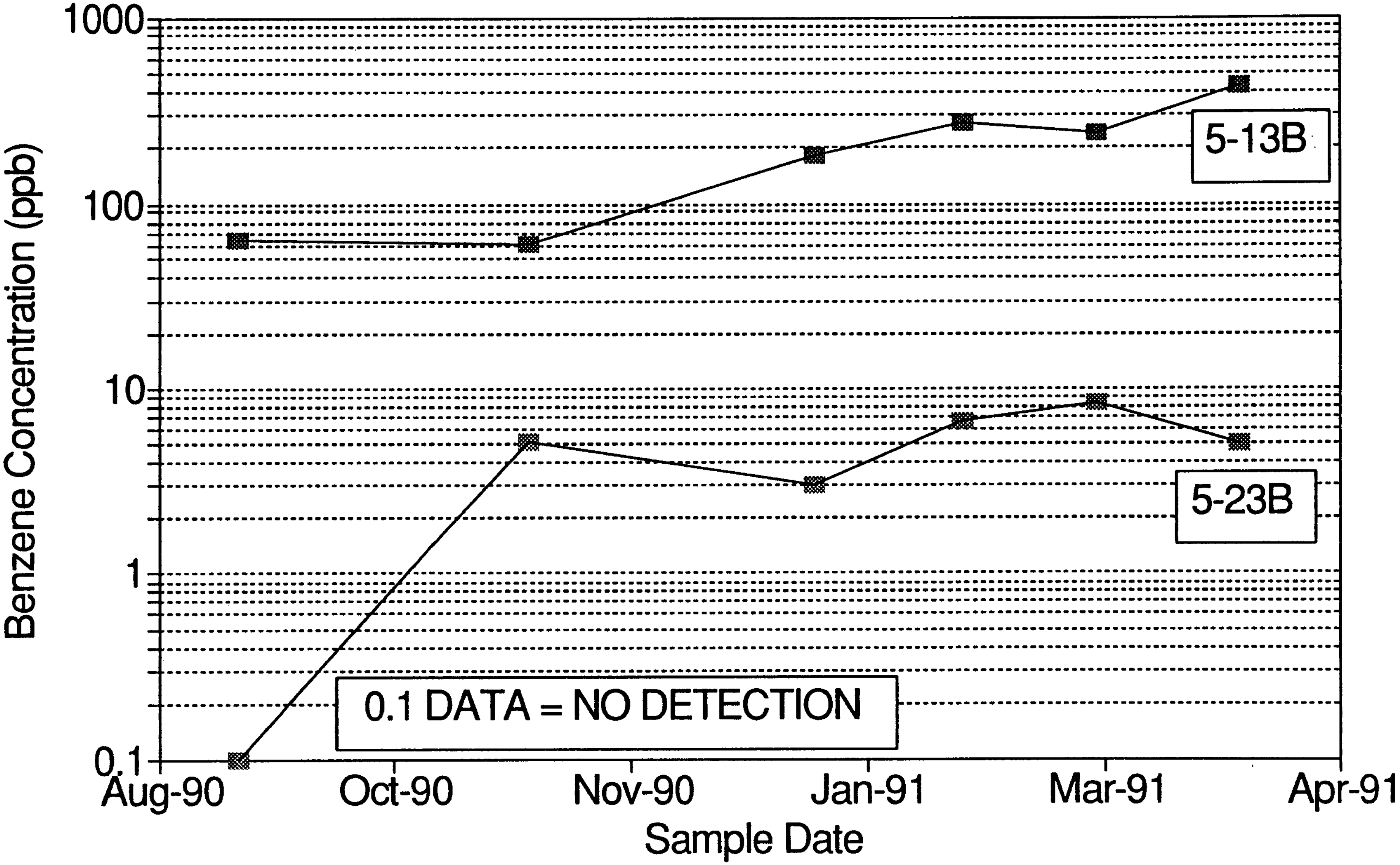


Fig 7.2- Time Series of Benzene Concentration in Monitor Wells 5-13B and 5-23B



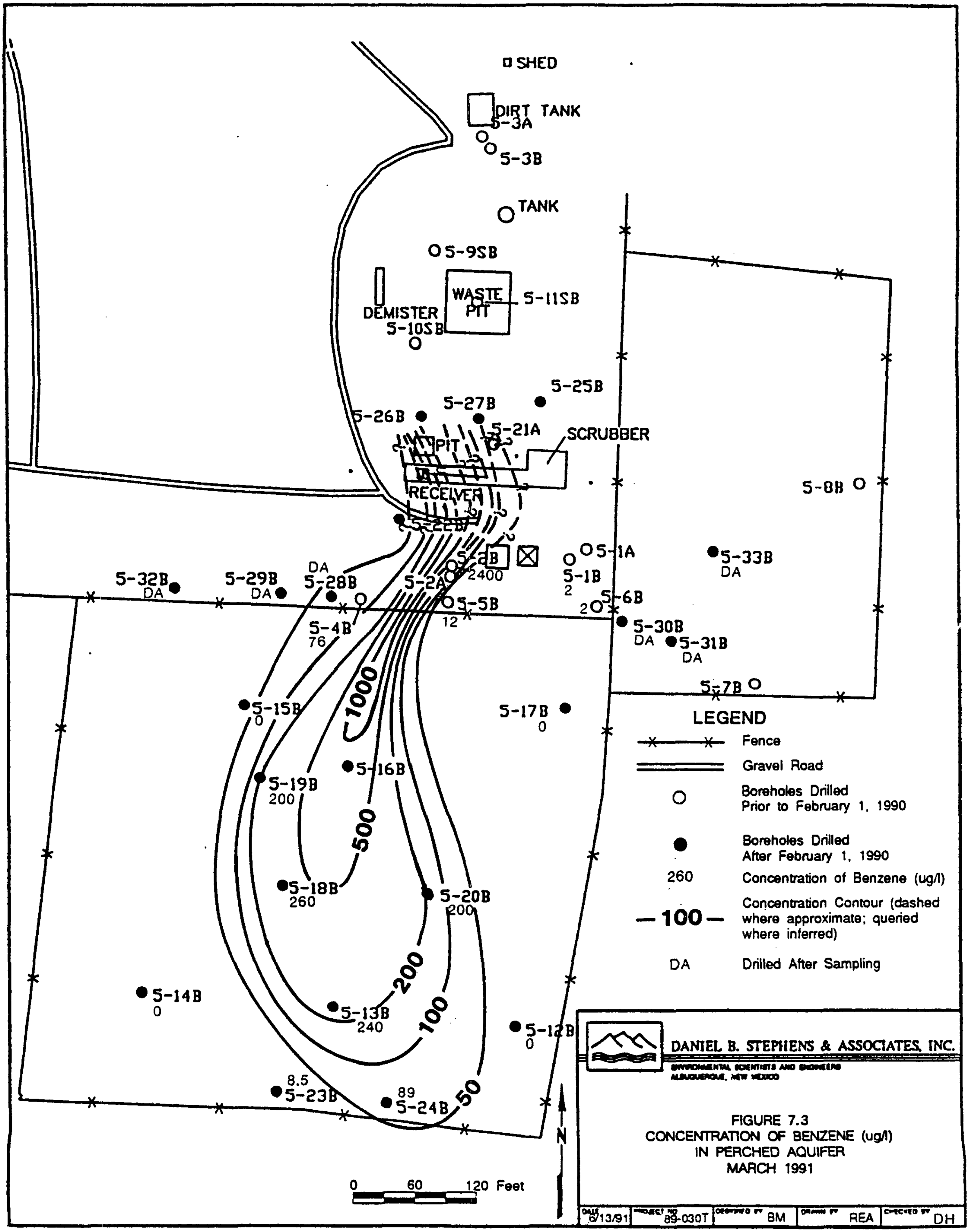


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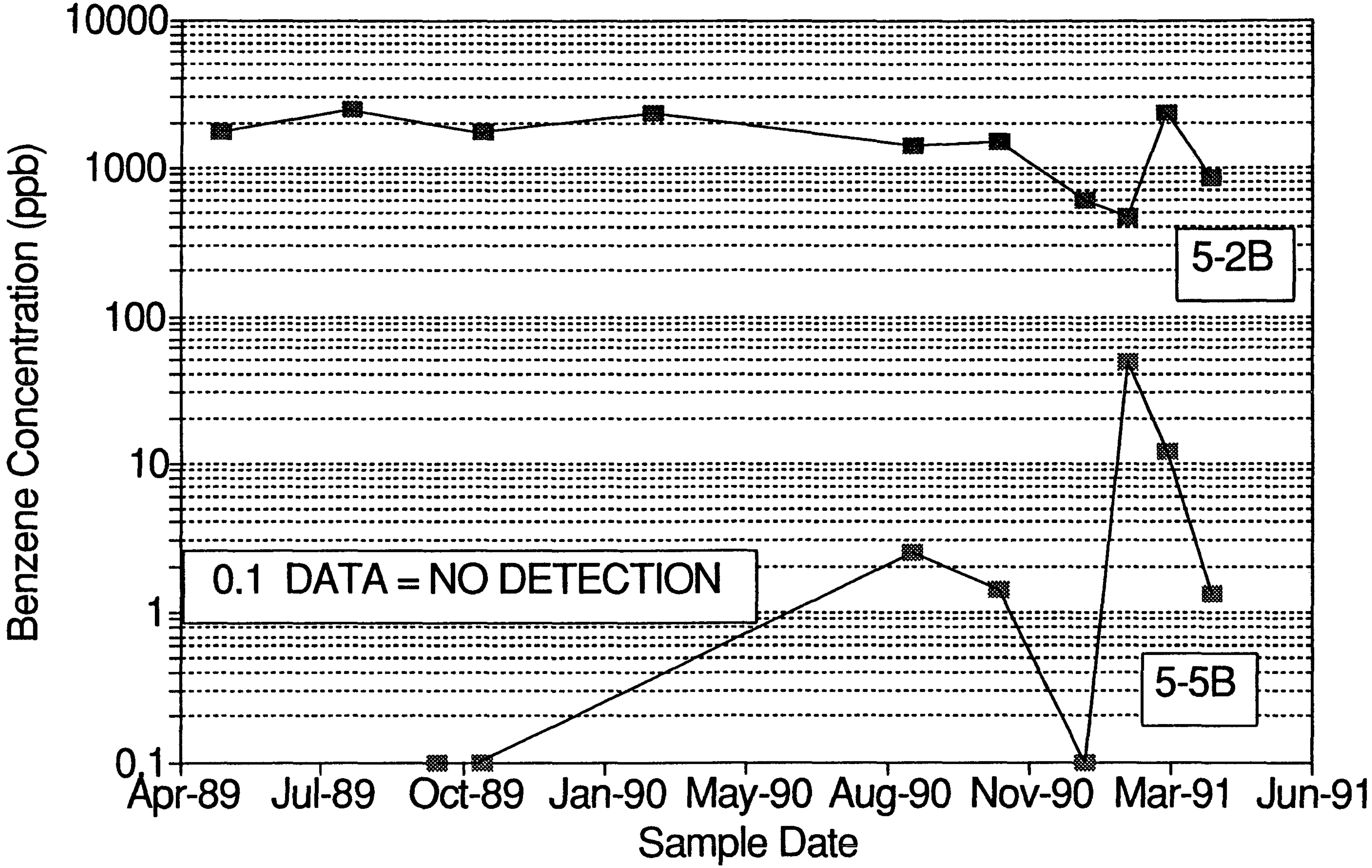
FIGURE 7.3
CONCENTRATION OF BENZENE (ug/l)
IN PERCHED AQUIFER
MARCH 1991

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
6/13/91	89-030T	BM	REA	DH

Fig 7.4 - Time Series of Benzene Concentrations in Monitor Wells 5-2B and 5-5B



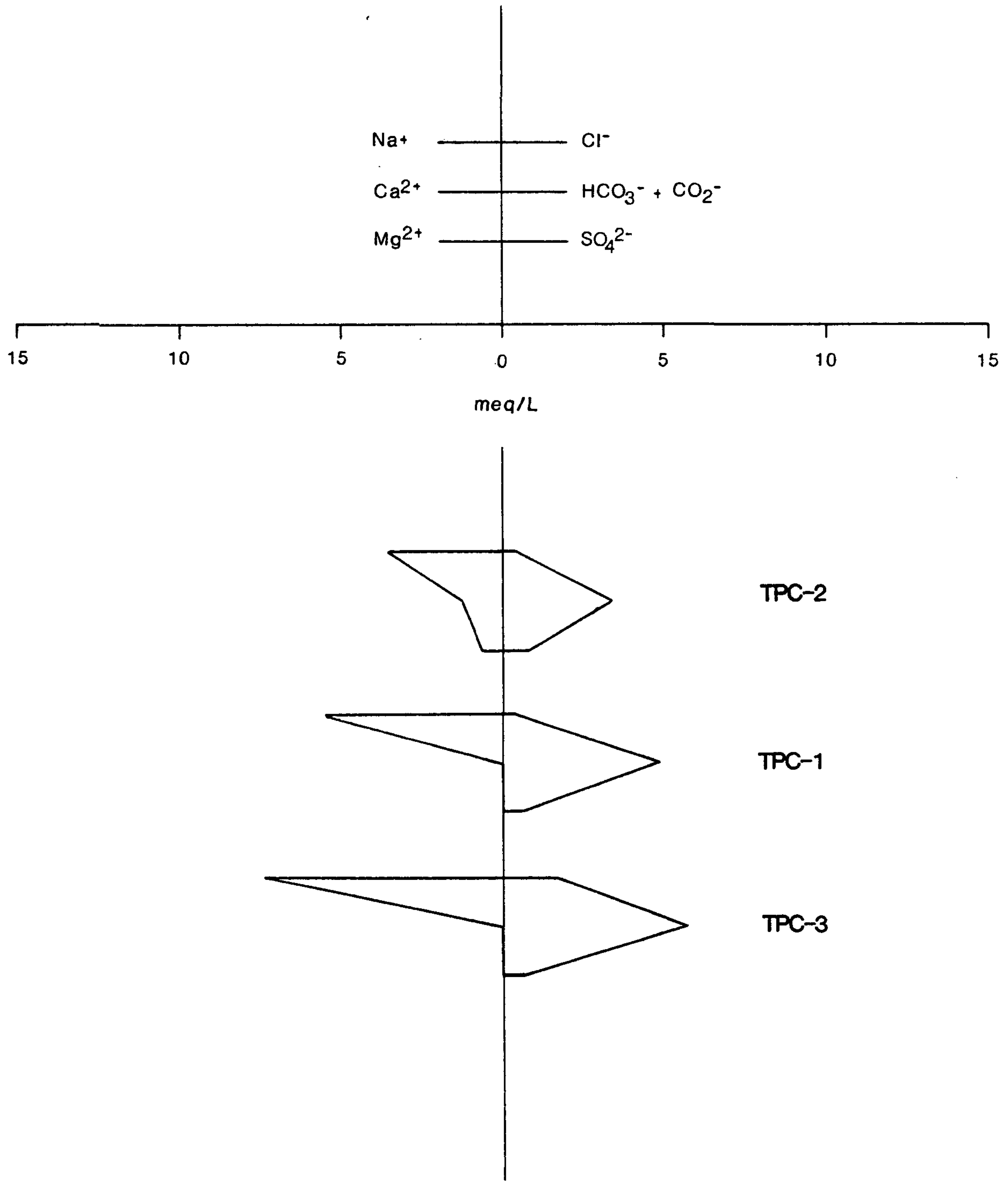


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FIGURE 7.5
STIFF DIAGRAMS SHOWING INORGANIC CHEMISTRY FOR TRANSWESTERN WATER SUPPLY WELLS

DATE	PROJECT NO	DESIGNED BY	DRAWN BY	CHECKED BY
6/13/91	89-030T	BM	REA	DH

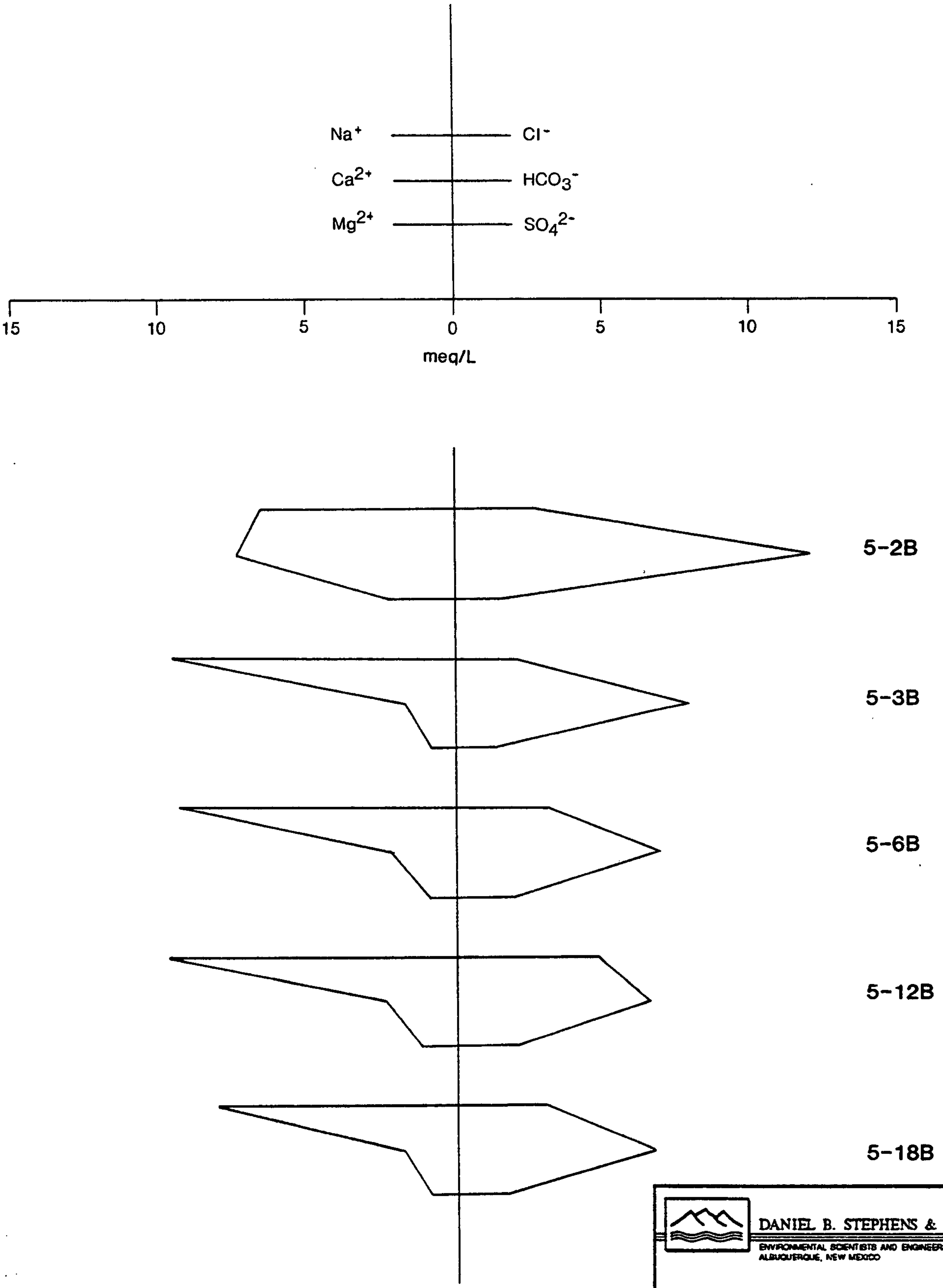

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FIGURE 7.6
STIFF DIAGRAMS SHOWING INORGANIC CHEMISTRY FOR SHALLOW MONITOR WELLS

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6/13/91	89-030T	BM	REA	DH

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ENVIRONMENTAL SCIENTISTS AND ENGINEERS

GROUND-WATER ASSESSMENT REPORT

FOR

COMPRESSOR STATION NO. 5

THOREAU, NEW MEXICO

VOLUME II: APPENDICES A-H

PREPARED FOR:

**TRANSWESTERN PIPELINE CO.
HOUSTON, TEXAS**

JULY 26, 1991

6020 ACADEMY NE • SUITE 100 • ALBUQUERQUE, NM 87109 • (505) 822-9400

APPENDIX A

BOREHOLE DRILLING LOGS, WELL COMPLETION FORMS, AND ABANDONMENT INFORMATION

BOREHOLE DRILLING LOGS

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Western Technologies, Inc. Albuquerque, NM
Boring No.:	5-9SB	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	CME-75	**Drilling Fluids:**	None
Date Started:	6/21/90	**Total Depth Drilled:**	46.5 ft
Date Completed:	6/21/90		

Depth Interval (ft)	Material	Description
0 - 1.5	Clayey sand	Fine-grained, dry, light reddish brown (5 YR 6/13). At 0 ft, BC = 3, 4, 5.
1.5 - 6.5	Clayey sand	Fine-grained, damp, moderate to dark reddish brown. At 5 ft, BC = 13, 10, 10.
6.5 - 10	Silt/clay	Sandy, slightly damp, hard, sand is very fine-grained, moderately to well sorted, reddish brown (2.5 YR 5/4). At 10 ft, BC = 7, 6, 6.
10 - 13	Sand	Clayey/silty, fine-grained, moderately sorted, unconsolidated, damp, yellowish red (5 YR 5/6).
13 - 14.5	Gravel	Silty/clayey, dominantly limestone particles, to 1.5-inch diameter, average 0.75-inch diameter, angular to subrounded.
14.5 - 20	Sand	Clayey/silty, fine-grained, poorly sorted, unconsolidated, some gravel, to 0.5-inch diameter, rounded, composed of limestone, chert and sandstone, reddish brown (2.5 YR 5/4). At 15 ft., BC = 6.5, 5; At 20 ft., BC = 24, 24, 28.
20 - 23	Gravel	Sandy and clayey silty, poorly sorted, fine-grained to 1/2" diameter, rounded, composed of limestone, chert and sandstone. Sand lense 21.5 to 22 ft.
23 - 28	Sand	Clayey, fine-grained, moderately to well sorted, hard, dry, traces of root fragments, traces of gypsum/caliche, reddish brown (2.5 YR 5/4). At 25 ft, BC = 7, 14, 16.
28 - 36.5	Clay	Sandy, hard, dry, sand is very fine-grained, reddish brown (2.5 YR 5/4). At 30 ft, BC = 50 for 3inches.
36.5 - 40	Sand	Silty/clayey fine to medium-grained, moderately sorted, unconsolodated, some light gray sandstone gravel zones, very damp, reddish brown (10 R 4/6) at 35 ft, BC = 23, 14, 12.
40 - 45	Sand	Silty/clayey, fine-grained, well sorted, unconsolidated, slightly damp, reddish brown (2.5 YR 5/4). At 40 ft, BC = 11, 20, 26.
45 - 46.5	Sand	Trace to some silt, fine-grained, moderately to well sorted, unconsoilidated, saturated from 43.3, reddish brown (2.5 YR 5/4).

Note: Borehole abandoned by grouting from 46.5 ft. to 0 ft.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Western Technologies, Inc. Albuquerque, NM
Boring No.:	5-10SB	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	CME-75	**Drilling Fluids:**	None
Date Started:	6/21/90	**Total Depth Drilled:**	55.5 ft
Date Completed:	6/22/90		

Depth Interval (ft)	Material	Description
0 - 20	Sand	Silty/clayey, fine-grained, moderately to well sorted, dry, reddish brown (2.5 YR 5/4). At 0 ft, BC = 8, 14, 12; at 5 ft, BC = 3, 4, 6; at 10 ft, BC = 4, 4, 7; at 15 ft, BC = 6, 8, 10.
20 - 25	Sand	Silty, fine-grained and very coarse-grained, moderately to poorly sorted, angular, traces of fine gravel, dry to damp, reddish brown (2.5 YR 5/4). At 20 ft, BC = 3, 5, 6.
25 - 31.5	Sand	Silty, fine to coarse-grained, moderately to poorly sorted, trace to some gravel/pebbles, golf ball in cuttings, reddish brown (2.5 YR 4/6). At 25 ft, BC = 7, 14, 26.
31.5 - 35	Sand	Silty, coarse-grained, moderately to well sorted is light reddish brown (5 YR 6/4), with gravelly interbeds, gravel are 0.25-inch to 1-inch diameter. At 30 ft, BC = 16, 16, 20.
35 - 40	Sand	Silty/clayey, moderately to well sorted, traces of fine gravel, red (2.5 YR 4/6), with interbeds of clay, sticky, plastic, with trace sand and fine gravel, traces of gypsum, hard. At 35 ft, BC = 10, 18, 27.
40 - 55.5	Clay/Claystone	Chinle Formation, traces of fine to coarse sands, very hard, conchoidal fractures, trace damp to dry, reddish brown (2.5 YR 4/4) with light gray/green reduction spots. At 40 ft, BC = 20, 63, 100+; at 45 ft, BC = 93/refusal at 6 inches; at 50 ft, BC = 99 for 6 inches (refusal); and at 55 ft, BC = 50 for 3 inches (refusal).

Note: Borehole abandoned by grouting from 55.5 ft. to 0 ft.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-11SB	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F10-WT	**Drilling Fluids:**	None
Date Started:	7/6/90	**Total Depth Drilled:**	26 ft
Date Completed:	7/6/90		

Depth Interval (ft)	Material	Description
0 - 1	Sand	Silty/clayey, fine-grained, moderately sorted, wet, reddish brown (5 YR 5/3). At 0 ft, BC = 3, 3, 4.
1 - 5	Sand	Trace to some silt, well sorted, wet to damp. Plastic pit cover encountered at 1 ft: Below 1 foot oil saturated, very dark brown (10 YR 2/2) to black (10 YR 2/1). HNu in sample hole = 30 ppm. Drillers note rotten gas odor passing through respirator cartridges.
5 - 10	Sand	Silty, fine-grained, moderately to well sorted, wet, dark gray (2.6 YR N4/) to dark brown (7.5 YR 3/2). At 5 ft, BC = 2, 4, 6.
10 - 14	Sand	Silty, fine-grained, moderately to well sorted, damp, brown (7.5 YR 4/2). At 10 ft, BC = 6 for 18-inches. HNu = 20 ppm on cuttings.
14 - 18	Sand	Silty, fine-grained, trace fine gravel, moderately sorted, damp, very dark grayish brown (10 YR 3/2). At 15 ft, BC = 5 for 18 inches.
18 - 26	Sand	Silty, fine-grained, moderately to well sorted, damp, brown (10 YR 3/2). At 20 ft, BC = 7 for 18 inches; at 25 ft, BC = 19 for 18 inches.

NOTE: Borehole terminated at 26 ft due to strong solvent-like odor passing through respirator cartridges of all drilling personnel. HNu = 150 ppm on soil headspace. Borehole abandoned by grouting from 26 ft. to 0 ft.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-12B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	6/28/90	**Total Depth Drilled:**	65.0 ft
Date Completed:	6/28/90		

Depth Interval (ft)	Material	Description
0 - 8	Sand	Silty, fine to very fine-grained, traces of fine gravel, moderately sorted, silty interbeds, dry (damp from 6 ft to 8 ft), reddish brown (5 YR 5/4).
8 - 26.5	Sand	Medium to fine-grained, trace to some silt, moderately to well sorted, dry (damp 8 ft to 9 ft), reddish brown (5 YR 5/4).
26.5 - 31	Sand	Silty, medium to fine-grained, traces of caliche interbeds, damp, reddish brown (5 YR 5/4).
31 - 38	Gravel	Up to 2-inch diameter, subangular to subrounded, dominantly limestone with caliche coatings, dry.
38 - 40	Sand	Medium to fine-grained, moderately to well sorted, dry, reddish brown (5 YR 5/4).
40 - 48	Sandy Gravel/ Gravelly Sand	Sand is medium to fine-grained, damp, reddish brown (5 YR 5/4); gravel is subrounded to subangular, to 1.5-inch diameter, sandstone and limestone fragments with caliche coatings. Sand dominant from 46 ft to 48 ft.
48 - 53	Clay/silt	Sandy, sand is medium-grained, moist from 50-53 ft, reddish brown (5 YR 5/4).
53 - 58	Clay/silt	Sandy, damp to dry, reddish brown, (5 YR 4/4) becomes wet 53 ft to 56 ft.
58 ≈ 63	Sand	Silty/clayey, medium to coarse-grained, moderately sorted, with some limestone, sandstone and dry claystone gravels, saturated, hard, dark reddish brown (5 YR 3/4).
≈63 - 65	Claystone	Chinle Formation, thin bedded, numerous light gray reduction spots to 0.5-inch diameter, dry, red, (10 R 4/6).

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-13B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	6/28/90	**Total Depth Drilled:**	69.4 ft
Date Completed:	6/28/90		

Depth Interval (ft)	Material	Description
0 - 6	Sand	Silty, fine to very fine-grained, moderately sorted, silty interbeds, dry, reddish brown (5 YR 5/3).
6 - 7	Gravel	Dominantly sandstone.
7 - 21	Sand	Silty/clayey, moderately to well sorted, dry to trace damp, reddish brown (5 YR 5/3).
21 - 31	Sand	Silty, fine to medium-grained, moderately to well sorted, yellowish red (5 YR 5/8), interbedded with sand, silty, fine to medium-grained, reddish brown (5 YR 5/3). Slightly damp from 30 ft to 31 ft.
31 - 32	Gravel	To 1.5-inch diameter, equidimensional, angular, dominantly limestone, with caliche coatings.
32 - 35	Sand	Silty, fine to medium-grained, moderately to well sorted, dry, reddish brown (5 YR 5/3).
35 - 41	Gravel	To 1.75-inch diameter, caliche coatings, dry.
41 - 47	Sand	Silty, medium to fine-grained, reddish brown (5 YR 5/3). From 44 ft to 47 ft, becomes gravelly (sandstone and limestone, average 0.5-inch diameter).
47 - 48	Gravel	To 1.5-inch diameter, average 0.5-inch diameter, subrounded to subangular, some sand and silt. Dominantly limestone.
48 ≈ 58	Silt	Sandy and clayey, traces of organics, sand is medium to fine-grained, rounded, dark reddish brown (5 YR 5/4).
≈58 - 60.5	Sand	Silty/clayey, medium to coarse-grained, damp, reddish brown (5 YR 5/3).
60.5 - 62.5	Sand	Silty/clayey, medium to fine-grained, dark reddish brown and reddish brown (5 YR 5/3). Possible water at 60 ft.
62.5 - 67	?	Cuttings saturated, clayey and sandy, reddish brown (5 YR 5/4).
67 - 69.4	Claystone	Chinle Formation, sandy claystone with light gray reduction spots, dry, red/purple.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-14B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	6/27/90	**Total Depth Drilled:**	72.3 ft
Date Completed:	6/27/90		

Depth Interval (ft)	Material	Description
0 - 31	Sand	Silty, fine to very fine-grained, moderately sorted, dry with traces of dampness at 15 ft and 18 ft, reddish brown (5 YR 5/3).
31 - 32	Clay/Silt	Sandy, traces of caliche, reddish brown (5 YR 5/3).
32 - 37	Gravel	Sandy and silty, dominantly limestone, to 1.5-inch diameter, subangular.
37 - 47	Sand	Silty, fine to very fine-grained, moderately to well sorted, dry, traces of dampness, reddish brown (5 YR 5/3).
47 - 48	Gravel	To 1-inch diameter, dominantly limestone with caliche coatings.
48 - 53	Sand	Silty, fine-grained, moderately to well sorted, dry with traces of dampness, reddish brown (5 YR 5/3).
53 - 57	Sand	Silty/clayey, medium to fine-grained, damp to moist, reddish brown (5 YR 5/3). Gravel from 55 ft to 55.5 ft.
57 - 59	Clayey Silt/ Silty Clay	Sandy, moist, reddish brown (25 YR 5/4).
59 ≈ 60	Gravel	No cuttings return.
60 - 68	?	Interbedded clays and sands? No cuttings return.
68 - 72	Claystone	Chinle Formation, closely spaced conchoidal fractures, moderately weathered, white to light gray reduction spots, red (10 R 4/6).

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-15B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	6/29/90	**Total Depth Drilled:**	65.6 ft
Date Completed:	6/29/90		

Depth Interval (ft)	Material	Description
0 - 8	Sand	Silty, fine to very fine-grained, moderately to well sorted, dry reddish brown (5 YR 5/4).
8 - 11	Sand	Silty, fine to very fine-grained, modertely to well sorted, dry, light brown (7.5 YR 6/4).
11 - 24	Sand	Silty, medium to fine-grained, with sandy silt/clay interbeds, traces of dampness, reddish brown (5 YR 5/4).
24 - 25	Gravel	Sandy, coarse to fine, caliche coatings.
25 - 39	Sand	Silty, medium to fine-grained, dry, damp from 33 ft to 39 ft, reddish brown (5 YR 5/3), becomes redder from 36 ft to 39 ft.
39 - 47	Gravel	Sandy, composed of red sandstones, gray limestones and light grayish brown sandstones, to 1.5-inch diameter, dry, equidimensional, subangular to subrounded. Sand interbeds at 42 to 43 ft and 43.5 to 44 ft.
47 - 60	Sandy Clay/ Clayey Sand	Sand is fine to coarse-grained, moderately to poorly sorted, traces of fine gravel, damp to moist, dark reddish brown (5 YR 3/4).
60 - 64	Clay	Heavily weathered Chinle Formation, fractured, no reduction spots, damp, saturated medium-grained sand, red (10 R 4/6).
64 - 65.6	Clay/Claystone	Chinle Formation fractured, damp, no reduction spots, red (10 R 4/6).

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Western Technologies, Inc. Albuquerque, NM
Boring No.:	5-16B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	7/5/90	**Total Depth Drilled:**	64.6 ft
Date Completed:	7/5/90		

Depth Interval (ft)	Material	Description
0 - 7	Sand	Silty, fine to very fine-grained, moderately sorted, dry, light reddish brown (5 YR 6/4). Trace interbeds silt/clay and very fine to fine gravel.
7 - 12	Sand	Silty, fine to very fine-grained, moderately to well sorted, trace damp, brown to reddish brown, (7.5 YR 4/4 to 5 YR 5/4). Trace silt/clay interbeds.
12 - 15	Sand	Silty, fine to very fine-grained, moderate to well sorted, dry, light reddish brown to reddish brown, (5 YR 6/4).
15 - 24	Silt	Sandy, sand is fine to medium-grained, damp, brown, (7.5 YR 4/4).
24 - 28.5	Sand	Silty, fine to very fine-grained, moderately sorted, slightly damp, trace fine gravel, reddish brown (5 YR 4/4). 3-inch thick gravel bed at 28 ft.
28.5 - 36	Sand	Locally silty, fine to very fine-grained, moderately sorted, light yellow brown and reddish brown, (10 YR 6/4 to 5 YR 5/4), trace fine to medium gravel. Gravels are interbeds at 34 ft and 36 ft. Gravel is fine to medium, mixed lithology with calcite coatings, rounded to subrounded to 1.5-inch average, 0.5-inch diameter.
36 - 40	Sand	Silty, fine to medium-grained , moderately sorted, traces of fine gravel, reddish brown, (5 YR 5/4) subrounded to subangular.
40 - 45	Gravel	Silty and sandy, to 1-inch diameter, average 0.5-inch diameter, dominantly limestone, slightly damp.
45 ≈ 48	Clay/Silt	Sandy, damp, dark reddish brown (5 YR 3/4).
≈48 - 61	Sandy Clay/ Clayey Sand	Sand is very fine to medium-grained, clay is plastic, damp to moist, reddish brown (5 YR 5/4).
61 ≈ 64	Clay	Probable top of weathered Chinle Formation. Sandy, with surface gravel, plastic, red (10 R 4/6).
≈64 - 65	Claystone?	Unweathered Chinle Formation, sandy, dry, red, (10 R 4/6) with light gray reduction spots. Strong mercaptan-like odor in sample at 64 to 65 ft.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Western Technologies, Inc. Albuquerque, NM
Boring No.:	5-17B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	7/3/90	**Total Depth Drilled:**	63.9 ft
Date Completed:	7/3/90		

Depth Interval (ft)	Material	Description
0 - 7	Sand	Silty, fine to very fine-grained, moderately sorted, dry, light reddish brown (5 YR 6/4).
7 - 15	Sand	Silty, fine to medium-grained, moderately sorted, dry, silty interbeds at 12 ft, dark reddish brown (5 YR 3/4).
15 - 23	Sand	Silty, medium to coarse-grained, moderately sorted, trace fine gravels of mixed lithology, gravels are dry, sand is damp, reddish brown (5 YR 5/4 to 7.5 YR 5/4).
23 - 25	Gravel	Gravel to cobble size. No cuttings return.
25 - 27	Sand	Silty, medium to coarse-grained, moderately sorted, reddish brown to brown (5 YR 5/4 to 7.5 YR 5/4).
27 - 31	Gravel	0.25-inch to 1.5-inch diameter, mixed lithology, caliche coatings.
31 - 34	Clay/Silt	Sandy, stiff, sand is medium to fine-grained, moderately sorted, slightly damp, dark reddish brown (5 YR 3/4).
34 - 39	Sand	Trace to some silt, medium to coarse-grained, dark reddish brown, damp.
39 - 42	Sand	Trace to some plastic clay, fine to medium-grained, poorly to moderately sorted, moist to very moist, dark reddish brown (5 YR 3/4). Gravel/cobble zone 43 to 44 ft.
44 - 45	Sand?	No cuttings return.
45 - 51.5	Clay	Sandy, stiff, sand is fine to very fine-grained, clay is moist to very moist, dark reddish brown to red (5 YR 3/4 to 2.5 YR 4/6).
51.5 - 56	Sand?	No cuttings return
56 - 57	Clay	Weathered Chinle Formation hard, dark, reddish brown to red (5 YR 4/4 to 2.5 YR 4/6).
57 - 63.9	Claystone	Chinle Formation, sandy claystone, thin bedded, light gray reduction spots, dry, red (10 R 4/6).

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Western Technologies, Inc. Albuquerque, NM
Boring No.:	5-18B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	7/9/90	**Total Depth Drilled:**	69.9 ft
Date Completed:	7/9/90		

Depth Interval (ft)	Material	Description
0 - 3	Sand	Silty, fine to very fine-grained, moderately sorted, dry, reddish brown (5 YR 5/4).
3 - 5	Silt	Sandy, reddish brown, dry.
5 - 8	Sand	Silty, fine to very fine-grained, moderately sorted, reddish brown (5 YR 5/4).
8 ≈ 10	Gravel	Sandy and silty, fine gravel, rounded.
10 ≈ 13	Silt?	Sandy, caliche fracture fill, dry, strong brown (7.5 YR 5/6) and reddish brown (5 YR 5/4).
13 - 16	Sand	Silty, fine to medium-grained, moderately to well sorted, silty interbeds, dry, reddish brown (5 YR 5/4).
16 - 17	Silt	Sandy, dry, brown (7.5 YR 5/4).
17 - 26	Sand	Silty, very fine to medium-grained, moderately to well sorted, slightly damp, reddish brown, (5 YR 5/4).
26 - 29	Silt/Clay	Sandy, hard, dry, grayish brown (10 YR 5/2).
29 - 36	Sand	Silty, very fine-grained, moderately to well sorted, dry, reddish brown (5 YR 4/4).
36 - 37.5	Gravel	Angular to subrounded, mixed lithology, caliche coatings, dry.
37.5 - 44	Sand	Silty, very fine-grained, moderately to well sorted, dry, reddish brown (5 YR 4/4), becomes moist and medium-grained at 42 ft.
44 - 53	Clay/Silt	Sandy, with sand interbeds, damp to dry, dark reddish brown (5 YR 3/4).
53 - 60	?	No cuttings return. Sand contact not detected.
60 - 60.5	Sand	Very fine-grained, moderately to well sorted, saturated, running, reddish brown (5 YR 4/4).
60.5 - 66	Clay	Weathered Chinle Formation, sandy, some fine gravel, damp, red (10 R 4/6).

Boring No: 5-18B (continuted)

66 - 69.9		
	Claystone	Unweathered Chinle Formation, sandy, red (10 R 4/6), claystone with light gray reduction spots.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Western Technologies, Inc. Albuquerque, NM
Boring No.:	5-19B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	7/10/90	**Total Depth Drilled:**	63.3 ft
Date Completed:	7/10/90		

Depth Interval (ft)	Material	Description
0 - 25	Sand	Silty, fine o very fine-grained, moderately to poorly sorted, dry to slightly damp, silty interbeds, traces of gravel to 1.25-inch diameter, reddish brown (5 YR 5/4)..
25 - 38	Sand	Silty, fine o very fine-grained, dry, silty interbeds, no gravels, reddish brown (5 YR 5/4).
38 - 39.5	Gravel	No cuttings return.
39.5 - 46	Sand	Silty, fine o very fine-grained, moderately sorted, dry, silty interbeds, reddish brown (5 YR 5/4).
46 - 48	Gravel	To 1-inch diameter, average 0.5-inch diameter, subangular to subrounded, mixed lithology, dry, caliche coatings.
48 - 52.5	Sand	Silty, fine-grained, moderately to well sorted, dry, silty interbeds, reddish brown (5 YR 5/4).
52.5 - 60.5	Clay/Silt	Sandy, plastic, moist, dark reddish brown (5 YR 3/4).
60.5 - 63	Clay	Weathered Chinle Formation, sandy, trace grravel, wet, red (10 R 4/6).
63 - 63.3	Claystone	Chinle Formation, hard, dry, red (10 R 4/6) with light gray reduction spots.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Western Technologies, Inc. Albuquerque, NM
Boring No.:	5-20B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	7/11/90	**Total Depth Drilled:**	64.0 ft
Date Completed:	7/11/90		

Depth Interval (ft)	Material	Description
0 - 10	Sand	Silty, fine to very fine-grained, moderately sorted, dry, silty interbeds, trace to some gravel, reddish brown (5 YR 5/4).
10 - 11	Sand	Silty, fine to very fine-grained, moderately sorted, dry, brown (7.5 YR 4/4).
11 - 13.5	Sand	Silty, fine-grained, moderately to well sorted, dry reddish brown (5 YR 5/4).
13.5 - 16	Clay/Silt	Sandy, sand is medium to fine-grained, damp, trace to some fine gravel, hard, reddish brown (5 YR 5/4).
16 ≈ 17	Caliche?	Possible caliche horizon, silty sand, fine to very fine-grained, light gray to light brown (5 YR 7/1 to 7.5 YR 6/4)..
≈17 - 30	Sand	Silty, fine-grained, moderatedly to well sorted, dry, damp from 20 to 23 ft, reddish brown (5 YR 5/4).
30 - 35	Sand	Silty, fine-grained, moderately to well sorted, dry, reddish brown (5 YR 5/4), more silt/clay from 17 to 30 ft.
35 - 41.5	Gravel	Sandy and silty, to 1.5-inch diameter, subangular to subrounded, sand interbed from 38 to 39 ft.
41.5 - 51	Sand	Silty, fine-grained, moderately to well sorted, dry to damp, reddish brown (5 YR 4/4).
51 - 61.5	Sandy Clay	Fine-grained sands, moist, plastic, probably top of water, dark reddish brown (5 YR 3/4).
61.5 - 62.5	Clay	Weathered Chinle Formation, sandy, wet, trace fine gravel, red (10 R 4/6).
62.5 - 64	Clay	Chinle Formation, sandy, fine-grained, dry, with bedding planes, dusky red (5 R 3/4) light gray reduction spots.

NOTE: While running tool in auger at 60 ft, a vapor was displaced that gave an OVA meter reading of 90 ppm total hydrocarbon.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-21B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	9/19/90	**Total Depth Drilled:**	26.0 ft
Date Completed:	9/19/90		

Depth Interval (ft)	Material	Description
0 - 5	Sand	Silty, fine-grained, moderately sorted, reddish brown (2.5 YR 5/4), damp, becomes dry at 1 ft, becomes light yellowish brown (10 YR 6/4) from 3 to 4.5 ft.
5 - 12	Sand	Silty, medium to fine-grained, moderately sorted, slightly damp, reddish brown (2.5 YR 5/4). At 10 ft, possible detrital organics; at 5 ft, BC = 5, 6; at 10 ft, BC = 2, 3.
12 - 20	Sand	Trace silt, medium to coarse-grained, moderately to well sorted, traces of fine gravel, damp, silt/clay interbeds, reddish brown (2.5 YR 5/4). At 20 ft, BC = 8, 12.
20 - 25	Sand	Trace silt, medium to coarse-grained, poorly to moderately sorted, trace to some sandstone cobbles to > 2-inch diameter (sandstone cobbles are friable, white, possibly bleached), reddish brown (2.5 YR 4/4). At 25 ft, BC = 9, 18. OVA meter > 100 ppm total hydrocarbon in workspace.
25 - 26	Gravel/Cobble	Strong solvent odor broke through respirator cartridges. OVA meter in headspace sample > 1000 ppm total hydrocarbon. Borehole abandoned at 26 ft.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-22B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	9/13/90	**Total Depth Drilled:**	55.0 ft
Date Completed:	9/13/90		

Depth Interval (ft)	Material	Description
0 - 0.5	Sand	Silty, very fine-grained, well sorted, dry, light brown (7.5 YR 6.4).
0.5 - 8	Sand	Silty, or sandy silt, medium to fine-grained, moderately sorted, with thin clayey/silty interbeds, damp to slightly damp, sand is dark reddish brown (5 YR 3/3?), clays/silts are dark brown (7.5 YR 3/2). At 5 ft, BC = 4, 5.
8 - 10	Sand	Silty, medium to fine-grained, moderately sorted, trace fine gravels, slightly damp to dry, reddish brown (5 YR 4?/4). At 10 ft, BC = 6, 11.
10 - 14	Gravel	No cuttings return.
14 - 15	Sand	Silty, medium to fine-grained, moderately sorted, traces of fine gravel, slightly damp, reddish brown (5 YR 4?/4). At 15 ft, BC = 3,8.
15 - 18	Gravel	Sandy, to 1-inch diameter, subangular to subrounded, gravel is caliche coated, dry. From 17 to 18 ft, OVA meter = 70 ppm on cuttings.
18 - 19.5	Sand	Slightly silty, traces of fine gravel, moderately sorted, damp, reddish brown (5 YR 4?/4), at 20 ft, BC = 6, 13, OVA = 35 ppm total hydrocarbons from 20 to 25 ft. At 25 ft, BC = 3, 6, OVA = 146 ppm from 25 to 30 ft. At 30 ft, BC = 12, 28.
19.5 - 31	Gravel	Sandy, to 1.5-inch diameter, average 0.5-inch to 0.75-inch diameter, angular to subangular, dominantly limestone, caliche coatings, dry, sand is silty, mediumto coarse-grained, reddish brown (5 YR 5/4).
31 - 34	Sand	Silty, medium-grained, moderately to well sorted, trace gravel, damp to dry, reddish brown (5 YR 5/4).
34 - 40	Clay	Sandy, with thin sandy interbeds and traces of limestone gravel to 0.5-inch diameter, clay is slightly damp, contains fragments of weathered Chinle Formation claystones, red (10 R 4/6) to dark red (10 R 3/6), sands are silty, mediumto fine-grained, red (10 R 3/6). From 35 to 40 ft, OVA meter = 15 ppm total hydrocarbons. At 35 ft, BC = 8, 13; at 40 ft, BC = 21, 25.

Boring No.: 5-22B (continued)

Depth Interval (ft)	Material	Description
40 - 45	Sand	Silty, medium to fine-grained, traces of sandstone gravel to 0.5-inch diameter, moderately sorted, damp, reddish brown (5 YR 5/4). From 40 to 45 ft, OVA meter = 5 ppm total hydrocarbons; at 45 ft, BC = 19, 25.
45 - 48	Sand	Traces of silt, fine to very fine-grained, moderately to well sorted, saturated and running, reddish brown (5 YR 5/4). At 50 ft, BC = 12, 25.
48 - 55	Claystone	Chinle Formation, sandy, dry, dark red (10 R 3/6), with very light gray (N8) reduction spots.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-23B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	9/20/90	**Total Depth Drilled:**	80.1 ft
Date Completed:	9/21/90		

Depth Interval (ft)	Material	Description
0 - 4	Sand	Silty, fine to very fine-grained, moderately to poorly sorted, damp to slightly damp, reddish brown (5 YR 5/4).
4 - 4.5	Sand	Silty, fine-grained, moderately sorted, slightly damp to dry, one gravel clast width 3.5-inch diameter, some roots, reddish brown (5 YR 5/4).
4.5 - 7.5	Sand	Silty, fine-grained, moderately to well sorted, dry to trace damp slightly moist, brown (7.5 YR 4/4?).
7.5 - 9.5	Sand	Trace to some silt, fine to very fine-grained, some fine gravels, moderately to poorly sorted, dark reddish brown (2.5 YR 3?/4). At 10 ft, OVA meter = 1.5 ppm total hydrocarbon.
9.5 - 13	Sand	Silty, gravelly (15 to 25%), gravels are subangular to subrounded and composed of fine-grained sandstone, sand is fine-grained, moderately to well sorted, slightly damp to dry, reddish brown (5 YR 4?/4).
13 - 13.5	Sand	Silty/clayey, fine-grained, moderately sorted, slightly damp, dark reddish brown (2.5 YR 3?/4) to reddish brown (5 YR 4?/4).
13.5 - 14	Sand	Silty, fine-grained, moderately to well sorted, slightly damp, reddish brown (5 YR 4?/4).
14 - 15	Sand	Clayey, very fine-grained, trace to some medium-grained sand, moderately to well sorted, damp, dark reddish brown (2.5 YR 3/4).
15 ≈ 16	Sand	Silty, fine to very fine-grained, moderately to well sorted, damp, reddish brown (5 YR 4/4).
≈16 - 18	Sand	Silty, fine-grained, trace to some gravel (caliche coated?), moderately to well sorted, damp, reddish brown (2.5 YR 3?/4).
18 - 19.5	Sand	Silty, fine-grained, possibly thin-bedded, slightly damp, gravelly to 1-inch diameter at 21 ft, moderately sorted, reddish brown (5 YR 4/4) to dark reddish brown (2.5 YR 3/4). At 20 ft, OVA meter = 10 ppm total hydrocarbon.

Boring No.: 5-23B (continued)

Depth Interval (ft)	Material	Description
19.5 - 21	Sand	Silty to slightly silty, fine to very fine-grained, moderately to well sorted, slightly damp, reddish brown (5 YR 4/4) with grayish zone from 26 to 27 ft. At 25 ft, OVA meter = 20 ppm total hydrocarbon.
29 - 38.5	Gravel/Cobble	Sandy and silty, to 3-inch diameter, subangular to subrounded, composed of limestone and sandstone. At 30 ft and 50 ft, OVA meter = 0 ppm total hydrocarbon; at 35 ft, BC = refusal.
38.5 - 50.5	Sand	Silty, fine to very fine-grained, moderately sorted, slightly moist to dry, some caliche streaks, trace to some fine to coarse gravel from 45 to 50 ft, gravel is subangular to subrounded, reddish brown (5 YR 4/4). At 40 ft, BC = 15, 30; OVA meter = 0 ppm total hydrocarbon. At 45 ft, BC = 10, 15; OVA meter = 0 ppm. At 50 ft, BC = 6, 15; OVA meter = 0 ppm.
50.5 - 55.5	Sand/Silt	Clayey, sand is fine to very fine-grained, traces of coarse sand and fine gravels, poorly sorted, moist, reddish brown (5 YR 4/4). At 55 ft, OVA meter = 0 ppm total hydrocarbon.
55.5 ≈ 57	Sand	Silty, fine to very fine-grained, trace cobbles, some medium-grained sand, saturated, reddish brown (5 YR 4/4). OVA meter = 0 ppm total hydrocarbons.
≈57 ≈ 74.5	Sand	Silty and clayey, fine to very fine-grained, moderately to poorly sorted, very moist to saturated, trace to some fine gravel at 65 ft, gravel is light gray sandstone. At 60, 65, and 70 ft, OVA meter = 0 ppm total hydrocarbons.
74.5 - 77.5	Clay	Weathered Chinle Formation, sandy with thin interbeds of silty/clayey sand and sandstone, slightly damp, red (10 R 4/6) to reddish brown (2.6 YR 4/4).
77.5 - 80.05	Claystone	Unweathered Chinle Formation, slightly sandy, slightly moist, thin laminates to beds of 2-inch thickness, fractured with carbon/manganese on fracture planes, red (10 R 4/6) with light gray (5 YR 7/1) reduction spots.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-24B	**Drilling Method:**	7.5-inch O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	9/24/90	**Total Depth Drilled:**	75.7 ft
Date Completed:	9/25/90		

Depth Interval (ft)	Material	Description
0 - 5	Sand	Silty, very fine to fine-grained, moderately sorted, dry, light reddish brown (2.5 YR 6/4).
5 - 10	Sand	Silty, fine to very fine-grained, moderately sorted, slightly damp, light reddish brown (5 YR 6/4).
10 - 29	Sand	Silty, fine to very fine-grained, moderately sorted, slightly damp to dry, light reddish brown (5 YR 6/4) to reddish brown (2.5 YR 4/4).
29 - 35	Sand	Silty, and gravelly, fine to very fine-grained, moderately to poorly sorted, slightly damp to dry, reddish brown (2.5 YR 5/4), gravels are pebble to cobble size and dominantly gray limestone.
35 - 36	Sand	Silty, very fine-grained, moderately sorted, slightly damp, with minor caliche stringers in fractures, light reddish brown (5 YR 4/4). At 35 ft, BC = 7, 17; OVA meter = 0 ppm total hydrocarbons.
36 - 40	Gravel	No cuttings return.
40 - 41	Sand	Silty, very fine-grained, moderatedly sorted, slightly damp, with minor caliche stringers in fractures, light reddish brown (5 YR 4/4). At 40 ft, BC = 18, 40; OVA meter = 0 ppm total hydrocarbons.
41 - 50	Unknown	No cuttings return, water added. At 45 ft, BC = 15, 15; OVA meter = 0 ppm total hydrocarbons.
50 - 56	Sand	Silty/clayey, very fine-grained, moderately to well sorted, damp, traces of calcite/caliche fracture fill, reddish brown (2.5 YR 4/4). At 50 ft, BC = 10, 16; OVA meter = 0 ppm total hydrocarbons. At 55 ft, BC = 7, 15; OVA meter = 0 ppm total hydrocarbons.
56 - 75	Sand	Silty/clayey, fine to very fine-grained, moderately sorted, traces of caliche, saturated, reddish brown (2.5 YR 4/4).
75 - 75.5	Claystone	Chinle Formation, slightly sandy, conchoidal/hackly fracture, dry to slightly damp, light gray (5 YR 7/1), reduction spots, red (10 R 4/6).

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Sergent, Hauskins, Beckwith Albuquerque, NM
Boring No.:	5-25B	**Drilling Method:**	8.0-inch O.D. Hollow Stem Auger
Rig Type:	CME-55	**Drilling Fluids:**	None
Date Started:	12/6/90	**Total Depth Drilled:**	36 ft
Date Completed:	12/7/90		

Depth Interval (ft)	Material	Description
0 - 5	Sand	Silty, fine to very fine-grained, moderately sorted, dry to slightly damp, reddish brown (2.5 YR 5/4). At 5 ft, BC = 4, 6.
5 - 10	Sand	Silty to very silty, fine to very fine-grained, moderately to poorly sorted, slightly damp, hard, traces of caliche, reddish brown (2.5 YR 5/4). At 10 ft, BC = 6,5.
10 - 19	Sand	Silty, fine to very fine-grained, moderately sorted, damp, traces of caliche, dark reddish brown (5 YR 3/3). At 15 ft, BC = 8, 12.
19 - 19.5	Gravel	Sandy?, medium to fine, dry.
19.5 - 24	Silt?	Clayey, or Clay-silty, trace to some fine to medium gravel, dry, trace to some caliche, hard, reddish brown (2.5 YR 5/4). At 20 ft, BC = 33, 38; at 22 ft, BC = 33, 62.
24 - 28	Sand	Silty, fine to very fine-grained, trace to no fine gravel, moderately sorted, becomes more silty at 26 ft, hard, dry, reddish brown (2.5 YR 5/4). At 24 ft, BC = 44, 36; at 26 ft, BC = 21, 33; at 28 ft, BC = 27, 41.
28 - 30	Sand	Silty, fine to very fine-grained, moderately sorted, dry to trace damp, unconsolidated, reddish brown (2,5 YR 5/4). At 30 ft, BC = 20, 82.
30 - 34.5	Gravel	Silty and sandy, coarse to very coarse, dominantly limestone, angular to subrounded, silty/sandy matrix is reddish brown (2.5 YR 5/4). At 32 ft, BC = 108/6-inches; at 34 ft, BC = 125/6-inches.
34.5 - 36	Claystone	Chinle Formation, trace sandy, heavily fractured, very hard, dry, red (2.5 YR 4/8) with light gray reduction spots. At 36 ft, BC = not recorded.

Note: Monitor well abandoned 5/7/91.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Sergent, Hauskins, Beckwith Albuquerque, NM
Boring No.:	5-26B	**Drilling Method:**	8.0-inch O.D. Hollow Stem Auger
Rig Type:	CME-55	**Drilling Fluids:**	None
Date Started:	12/5/90	**Total Depth Drilled:**	38 ft
Date Completed:	12/6/90		

Depth Interval (ft)	Material	Description
0 - 5	Sand	Silty, fine to very fine-grained, moderately sorted, dry to slightly damp, reddish brown (2.5 YR 5/4) to light reddish brown (2.5 Yr 6/6). At 5 ft, BC = 7, 8.
5 - 15	Sand	Silty, fine to very fine-grained, moderately sorted, dry to slightly damp, traces of caliche, traces of root fragments, unconsolidated, yellowish red (5 YR 4/6). At 50 ft, BC = 7, 8.
15 - 20	Clay	Sandy or clayey sand, sand is fine to very fine-grained, dry, trace to some caliche as veinlets, hard, reddish brown (2.5 YR 5/4). At 15 ft, BC = 9, 15; at 20 ft, BC = 12, 15.
20 - 28	Sand	Silty, fine to very fine-grained, moderately sorted, dry, no caliche, unconsolidated, reddish brown (2.5 YR 5/4). At 22 ft, BC = 12, 15; at 24 ft, BC = 16, 21; at 26 ft, BC = 12, 40; at 28 ft, BC = 27, 66.
28 - 32	Sand	Silty, fine to very fine-grained, moderately sorted, dry, traces of caliche as veinlets, slightly consolidated, dry, light reddish brown (2.5 YR 6/4). At 30 ft, BC = 42, 30; at 31 ft, OVA = 18 ppm total hydrocarbons.
32 - 33.5	Sand	Silty to very silty, fine to very fine-grained, moderately to poorly sorted, dry to slightly damp, traces of caliche as veinlets, medium to fine gravelly zones ≈1-inch thick, slightly consolidated, reddish brown (2.5 YR 5/4). At 32 ft, BC = 16, 35.
33.5 - 34	Gravel	To 1-inch diameter, average 0.4-inch diameter, rounded, dominantly limestone, dry.
34 ≈ 37	Clay	Sandy, silty and gravelly, dry, trace to some caliche as gravel coatings and veinlets, clay is composed of massive to blocky fragments of weathered Chinle Formation material, 1-inch diameter, fine-grained, light gray sand at 34.5 ft, cobble at 34 ft, dry, red (2.5 YR 4/6). At 34 ft, BC = 80.52, OVA = 18 ppm total hydrocarbon peak; at 36 ft, BC = 146/6-inches.
≈37 - 38	Claystone	Chinle Formation, trace fine sand, slightly weathered, dry, red (2.5 YR 4/6) with light gray reduction spots.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Sergent, Hauskins, Beckwith Albuquerque, NM
Boring No.:	5-27B	**Drilling Method:**	8.0-inch O.D. Hollow Stem Auger
Rig Type:	CME-55	**Drilling Fluids:**	None
Date Started:	12/7/90	**Total Depth Drilled:**	54 ft
Date Completed:	12/11/90		

Depth Interval (ft)	Material	Description
0 - 11	Sand	Silty, fine to very fine-grained, moderately sorted, becomes very moist at 3 ft, unconsolidated, dark reddish brown (2.5 YR 5/4). At 5 ft, BC = 6, 8; at 10 ft, BC = 4, 3.
11 - 17	Sand	Silty, fine to very fine-grained, moderately sorted, trace moist to moist, unconsolidated, reddish brown (5 YR 3/4 and 4/4). At 15 ft, BC = 10, 15.
17 - 18	Clay?	Sandy, sand is medium to very fine-grained, damp to dry, dark reddish brown (2.5 YR 2.5/4).
18 - 22	Sand	Silty, fine to very fine-grained, moderately sorted, dry to slightly damp, slightly indurated, light reddish brown (5 YR 4/4). At 20 ft, BC = 28, 46.
22 - 27.5	Sand	Silty, fine to very fine-grained, local traces of fine gravel, moderately to poorly sorted, dry to slightly damp, slightly indurated, light reddish brown (5 YR 4/4) to reddish brown (2.5 YR 5/4). At 22 ft, BC = 40, 30; at 24 ft, BC = 23, 19; at 26 ft, BC = 26, 19.
27.5 - 36.2	Gravel	Sandy with traces of silt, to 2-inch diameter, average 0.75-inch diameter, subangular to subrounded, equidimensional to platy, dominantly gray limestone, silty fine-grained sand from 30 to 31 ft. At 28 ft, BC = 27, 83; at 30 ft, BC = 28, 50/3 inches; at 32 ft, BC = 60/3-inches; at 34 ft, BC = 50/1-inch; at 36 ft, BC = 49, 50/1-inch.
36.2 - 36.7	Sand	Silty, fine-grained, moderately to well sorted, dry, unconsolidated, light reddish brown (5 YR 4/4).
36.7 - 54	Claystone	Chinle Formation traces of sand, hackly fractures, dry, red (10 R 4/6) with light gray (5 YR 7/1) reduction spots. At 38 ft, BC = 65/6-inches; at 40 ft, BC = 73/6-inches; at 42 ft, BC = 70/3-inches; at 44 ft, BC = 100/6-inches; at 46 ft, BC = 100/4.5-inches; at 48 ft, BC = 74/6-inches; at 50 ft, BC = 52, 50/2-inches; at 52 ft, BC = 100/7-inches; at 54 ft, BC = 100/4.6-inches.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-28B	**Drilling Method:**	6 5/8" O.D. Hollow Stem Auger
Rig Type:	CP 650 SS	**Drilling Fluids:**	None
Date Started:	5/8/91	**Total Depth Drilled:**	81.5 ft
Date Completed:	5/8/91		

Sample Depth (ft)	Material	Description
0-9	Sand	Silty, very fine-grained, moderately to well sorted, damp, red, (2.5 YR 4/6).
9-19	Sand	Silty, very fine-grained, damp, red, (2.5 YR 4/6).
19-24	Sand	Silty, fine-grained, moderately sorted, slightly damp, locally clayey, red (2.5 YR 4/6).
24-29	Sand	Slightly silty, fine-grained, well sorted, red, (2.5 YR 4/8).
29-34	Sand	Fine-grained trace gravel, moderately to poorly sorted, red (2.5 YR 4/8) at 34' HNu = 12 ppm on workspace, dry.
34-44	Sand	Silty, very fine-grained, trace limestone gravel, moderately to poorly sorted, dry, reddish brown (2.5 YR 4/4). At 35 feet, HNu meter = 125. ppm peak on cuttings.
39-45	Gravel	Subangular to rounded, composed of limestone with caliche coatings. At 39 feet HNu meter = >200. ppm on cuttings.
49-52	Sand	Silty, clayey, very fine-grained, moderately to poorly sorted, damp, red (2.5 YR 4/8).
65-69	Clay	Silty, plastic, saturated, reddish brown (5 YR 5/4).
69-77	Clay	Silty, plastic, saturated, reddish brown (5 YR 5/4).
77-81.5	Claystone	Chinle Formation, thin bedded, dry, red (10 R 4/6) with numerous light gray reduction spots.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-29B	**Drilling Method:**	6 5/8" O.D. Hollow Stem Auger
Rig Type:	CP 650 SS	**Drilling Fluids:**	None
Date Started:	5/9/91	**Total Depth Drilled:**	75.5 ft
Date Completed:	5/9/91		

Sample Depth (ft)	Material	Description
0-10	Sand	Fine-grained, trace silt, moderately sorted, damp, reddish brown (2.5 YR 4/4).
10-15	Sand	Silty, fine-grained, trace clay, moderately to poorly sorted, damp, reddish brown (2.5 YR 4/4).
15-25	Sand	Silty, fine-grained, clayey, moderately to poorly sorted, clayey, moist, reddish brown (2.5 YR 4/4).
25-30	Sand	Silty, clayey, fine-grained, moderately sorted, dry, reddish brown (2.5 YR 4/4).
30-33	Clay	Silty, dry, dark reddish brown (2.5 YR 3/4).
33-40	Sand	Silty, very fine-grained, trace clay, slightly damp, dark reddish brown (2.5 YR 3/4).
40-42	Gravel	Subangular to rounded limestone with caliche coatings.
42-55	Gravelly Sand	Silty, fine-grained trace clay, moderately sorted, slightly damp weak red to reddish brown (2.5 YR 5/4). At 48 ft. HNu =>20 ppm peak on cuttings.
55-58	Sand	Silty, clayey, very fine-grained with some gravel, moderately to poorly sorted, damp, dark reddish brown (2.5 YR 3/4). At 58 ft. HNu = 8 ppm peak on cuttings.
58-73.5	Sand	Silty, clayey very fine-grained, very moist to saturated, moderately to well sorted, reddish borwn, (5 YR 5/4). At 60 ' HNu = 70 ppm peak, at 65 ft. HNu = 150 ppm.
73.5-75.5	Claystone	Chinle Formation, thin bedded, dry, red (10 R 4/6) with numerous light gray reduction spots.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-30B	**Drilling Method:**	6 5/8" O.D. Hollow Stem Auger
Rig Type:	CP 650 SS	**Drilling Fluids:**	None
Date Started:	5/13/91	**Total Depth Drilled:**	56.5 ft
Date Completed:	5/13/91		

Sample Depth (ft)	Material	Description
0-5	Fill	Sandy with cobble, metal shavings.
5-20	Sand	Silty, fine to very fine-grained, moderately sorted, slightly damp, reddish brown, (5 YR 5/4).
15-20-35	Sand	Silty, clayey, very fine-grained, moderately to poorly sorted, slightly damp, reddish brown (5 YR 5/4).fine to very fine-grained,
35-40	Sand	Clayey, silty very fine-grained, moderately to poorly sorted, dark red (2.5 YR 3/6).
40-50	Clay/Silt	Trace very fine-grained sand, damp to very damp, dark red (2.5 YR 3/6).
50-56	Sand	Silty, very fine-grained, moderately to well sorted, saturated, reddish brown (5 YR 5/4). Gravelly at 50 ft.
56-56.5	Claystone	Chinle Formation, thin bedded, sandy, dry, red (10 R 6/4) with gray reduction spots, gray clay-filled fractures.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-31B	**Drilling Method:**	6 5/8" O.D. Hollow Stem Auger
Rig Type:	CP 650 SS	**Drilling Fluids:**	None
Date Started:	5/14/91	**Total Depth Drilled:**	53 ft
Date Completed:	5/14/91		

Sample Depth (ft)	Material	Description
0-24	Sand	Silty, very fine-grained, moderately sorted, slightly damp, trace clay, reddish brown, (5 YR 5/4).
24-25	Gravel	Sub-angular to rounded, composed of gray limestone,dry.
25-30	Sand	Silty, very fine to fine-grained, trace clay, moderately to poorly sorted, damp, reddish brown (2.5 YR 5/4).
30-33	Sand	Silty, very fine-grained, moderately sorted, some clay, dry, reddish brown (2.5 YR 5/4).
33-35	Sand	Silty, clayey, very fine-grained, moderately to poorly sorted, damp, reddish brown (2.5 YR 5/4).
35-40	Sand	Clayey, silty, fine-grained with trace gravel, moderately to poorly sorted, reddish brown (5 YR 5/6).
40-50	Clay	Silty, slightly damp, plastic, reddish brown (5 YR 4/4).
50-51.5	Clay	Silty, saturated, plastic, reddish brown (5 YR 4/4).
51.5-53	Claystone	Chinle Formation with modium to fine basal gravel, sandy, red (10 R 6/4) with gray to light gray clay reduction spots.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
		Drilling Method:	6 5/8" O.D. Hollow Stem Auger
Boring No.:	5-32B	**Drilling Fluids:**	None
Rig Type:	CP 650SS	**Total Depth Drilled:**	83.5 ft
Date Started:	5/14/91		
Date Completed:	5/14/91		

Sample Depth (ft)	Material	Description
0-10	Sand	Silty, fine-grained, trace clay, moderately to poorly sorted, dry, dark reddish brown (5 YR 3/4).
10-15	Sand	Clayey, fine-grained, moderately sorted, damp yellowish red (5 YR 4/6).
15-20	Clay	Silty, damp, brown (7.5 YR 4/4).
20-25	Sand	Silty, very fine-grained, trace clay damp, brown (7.5 YR 4/4).
25-36	Sand	Silty, fine-grained, damp, strong brown (7.5 YR 4/6).
36-37.5	Gravel	Silty, fine-grained, damp, strong brown (7.5 YR 4/6).
37.5-43	Sand	Silty, fine-grained, trace clay, damp, reddish brown (5 YR 4/4).
43-46	Gravel	Sub-angular to rounded, dominently limestone, dry.
46-60	Sand	Silty, fine-grained, moderately sorted, dry, reddish brown (5 YR 4/4).
60-65	Sand	Clayey, silty, fine-grained, moderately to poorly sorted, saturated, reddish brown (5 YR 4/4).
65-75	Sand	Fine-grained, well sorted, saturated, reddish brown (5 YR 4/4).
75-80	Sand	Silty, fine-grained, trace clay, moderately to poorly sorted, saturated, reddish brown (5 YR 4/4).
80-83	Sand	Fine-grained, well sorted, trace clay, saturated, yellowish red (5 YR 4/6).
83-83.5	Claystone	Chinle Formation, thin bedded, dry, red (10 R 6/4) with gray reduction spots.

Client:	Transwestern Pipeline Compressor Station No. 5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-33B	**Drilling Method:**	6 O.D.Hollow Stem Auger
Rig Type:	CP 650SS	**Drilling Fluids:**	None
Date Started:	5/15/91	**Total Depth Drilled:**	59 ft
Date Completed:	5/15/91		

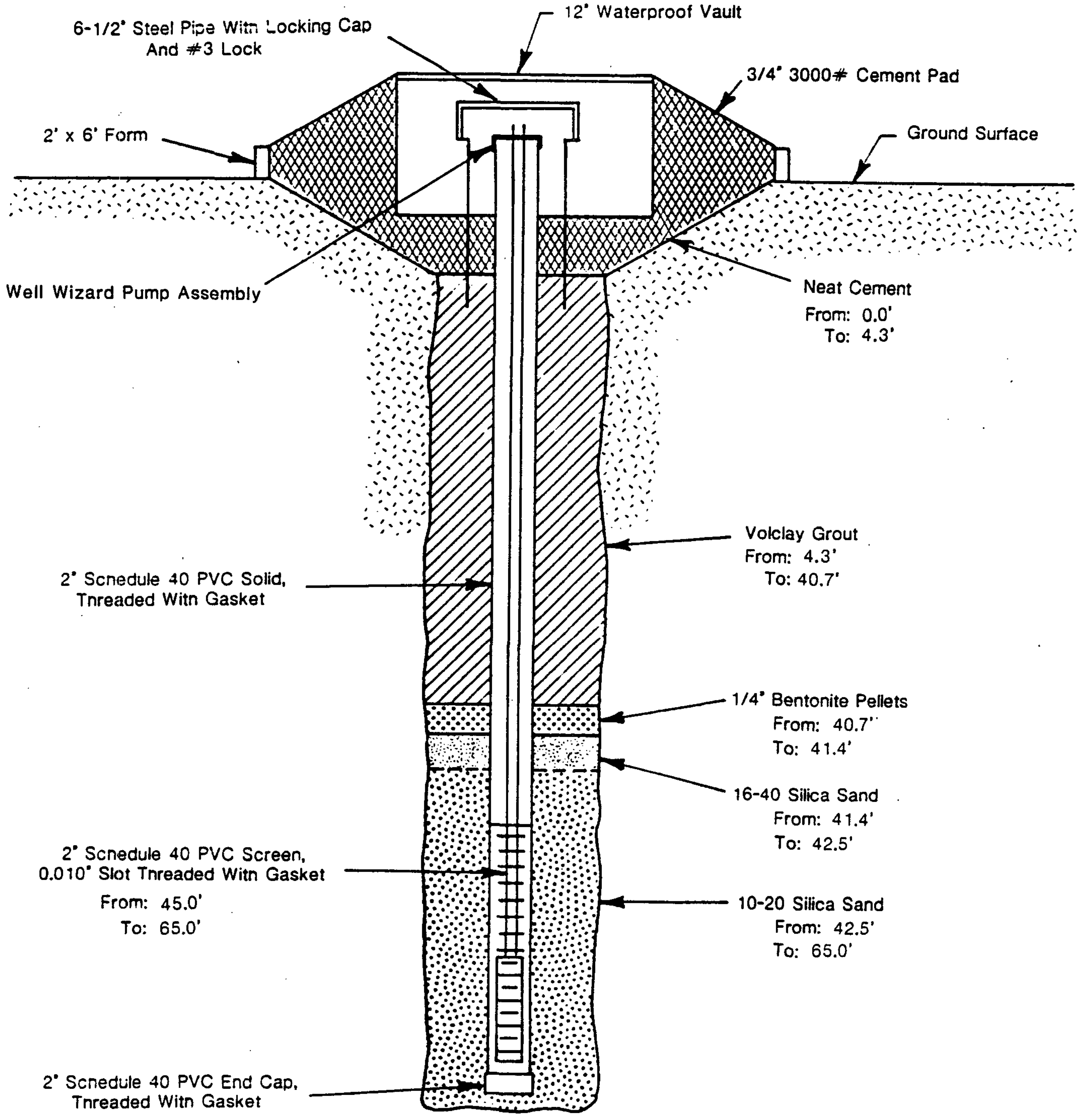
Sample Depth (ft)	Material	Description
0-15	Sand	Silty, very fine-grained, moderately sorted, dry, reddish brown (5 YR 4/4).
15-20	Sand	Silty, very fine-grained, trace gravel, dry, moderately to poorly sorted, reddish brown (5 YR 4/4).
20-25	Sand	Silty, fine to very fine-grained, poorly sorted, dry, reddish brown (5 YR 4/4), gravelly 24-25A.
25-29	Sand	Silty, very fine-grained, trace gravel, 27.5-29 feet, reddish brown (5 YR 4/4).
29-35	Sand	Silty, very fine-grained, trace clay, minor gravel, slightly damp, yellowish red (5 YR 4/6).
35-45	Clay	Silty, sandy, damp, red (2.5 YR 4/6).
45-50	Clay	Silty, plastic, saturated, red (2.5 YR 4/6).
50-55	Clay	Minor, silt, plastic, saturated, red (2.5 YR 4/6).
55-59	Claystone	Weathered Chinle?, trace fine sand, damp, red (2.5 YR 5/6).
59-59.5	Claystone	Chinle Formation, slightly damp, red (10 R 6/4) with light gray reduction spots.

Client:	Enron Compressor Station #5 Thoreau, NM	**Drilling Contractor:**	Stewart Brothers Grants, NM
Boring No.:	5-16A (Abandoned)	**Drilling Method:**	7 1/2" O.D. Hollow Stem Auger
Rig Type:	Failing F-10 WT	**Drilling Fluids:**	None
Date Started:	7/2/90	**Total Depth Drilled:**	64.8 ft
Date Completed:	7/5/90		

Sample Depth (ft)	Material	Description
0-17	Sand	Fine-grained, silty/clayey, traces of caliche, dry, reddish brown. Below 5' with thin sandy clay interbeds.
17-27	Clay	Sandy, damp, brown, with clayey sand interbeds, 3" thick gravel at 21 ft.
27-39	Sand	Silty, fine-grained, moderately to poorly sorted, dry, reddish brown to dark reddish brown (5 YR 5/4 to 2.5 YR 3/4), thin gravel interbeds at 32 and 35 feet.
39-42	Gravel	Sandy, traces of silt, dry, unconsolidated gravel composed of limestone and red and gray sandstone. Sand and silt are reddish brown (5 YR 4/4). At 40 ft,BC = 15,32,42.
42-43.5	Sand	Silty/clayey, medium to coarse-grained, moderately sorted, damp, dark reddish brown (2.5 YR 3/4). At 42 ft, BC = 11,17,22.
43.5-50	Gravel	Sandy, to 2-inch diameter, dry, subangular to subrounded, dominantly limestone with trace sandstone.
50-62	Sand	Silty, fine to coarse-grained moderately to poorly sorted, damp, to saturated, some fine gravel, dark reddish brown (2.5 YR 3/4) to brown.
62-64	Clay	Sandy, trace to some gravel, damp, red (2.5 YR 4/6).
64-64.8	Claystone	Chinle Formation, hackley fractures with manganese oxide coatings, dry hard, red (10 R 4/6) with light gray reduction spots.

Note: Borehole abandoned 7/5/90 due to running formation sands.

WELL COMPLETION FORMS

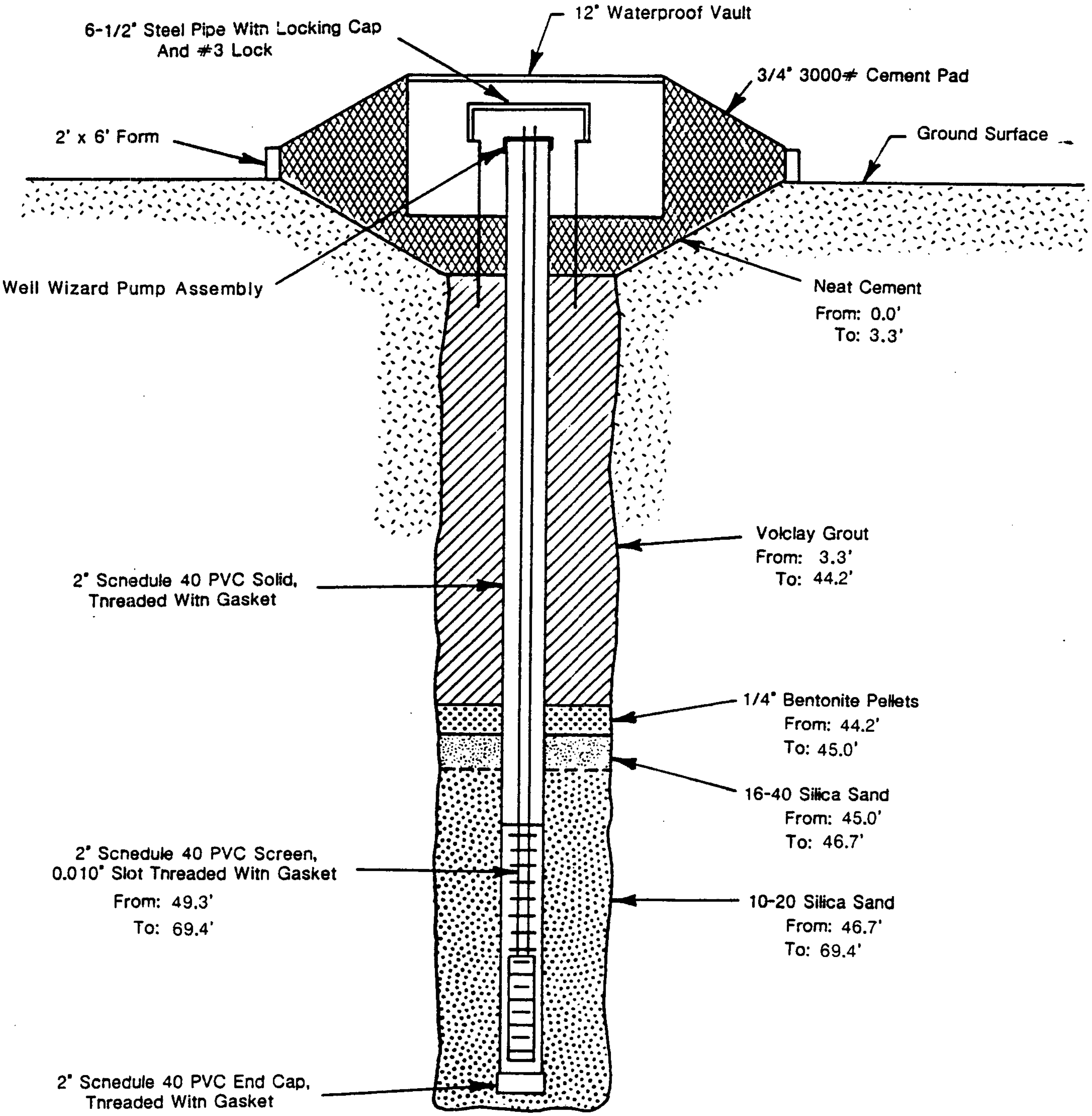


WELL #: 5-12B

DATE DRILLED: 6/28/90

TOTAL DEPTH: 65.0' (taped)

ALL FOOTAGES FROM GROUND SURFACE

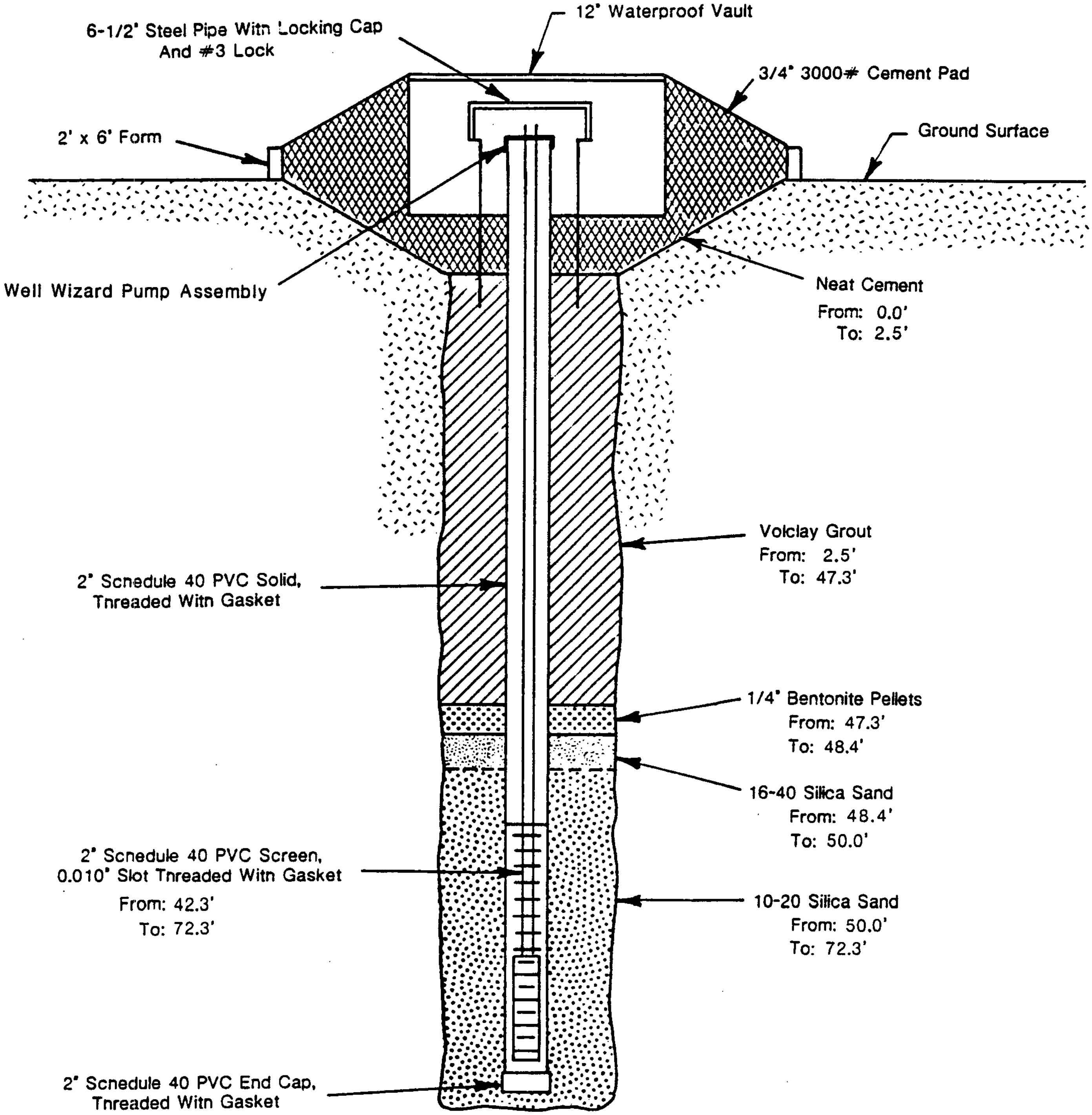


WELL #: 5-13B

DATE DRILLED: 6/28/90

TOTAL DEPTH: 69.4' (taped)

ALL FOOTAGES FROM GROUND SURFACE

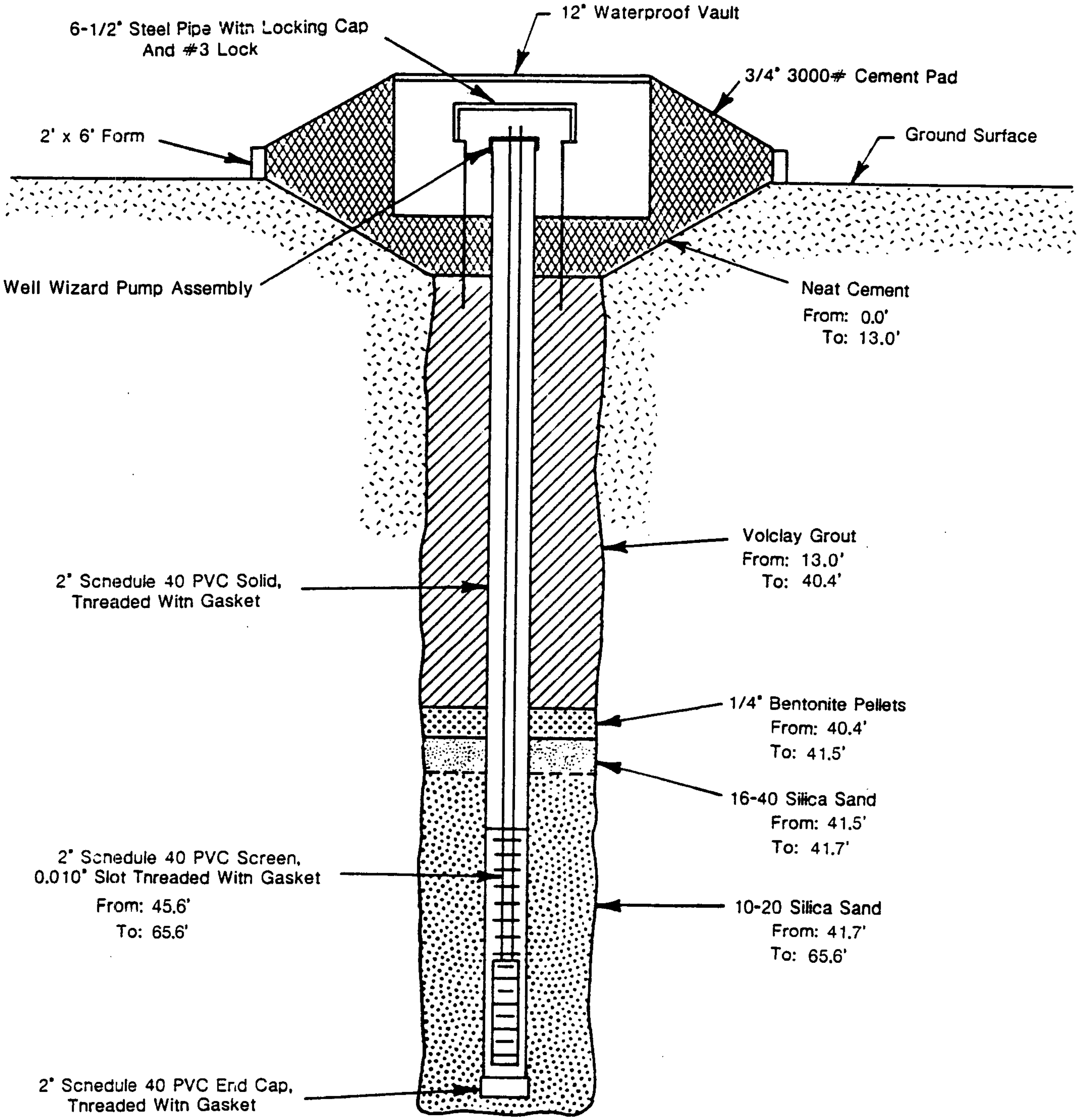


WELL #: 5-14B

DATE DRILLED: 6/27/90

TOTAL DEPTH: 72.3' (taped)

ALL FOOTAGES FROM GROUND SURFACE

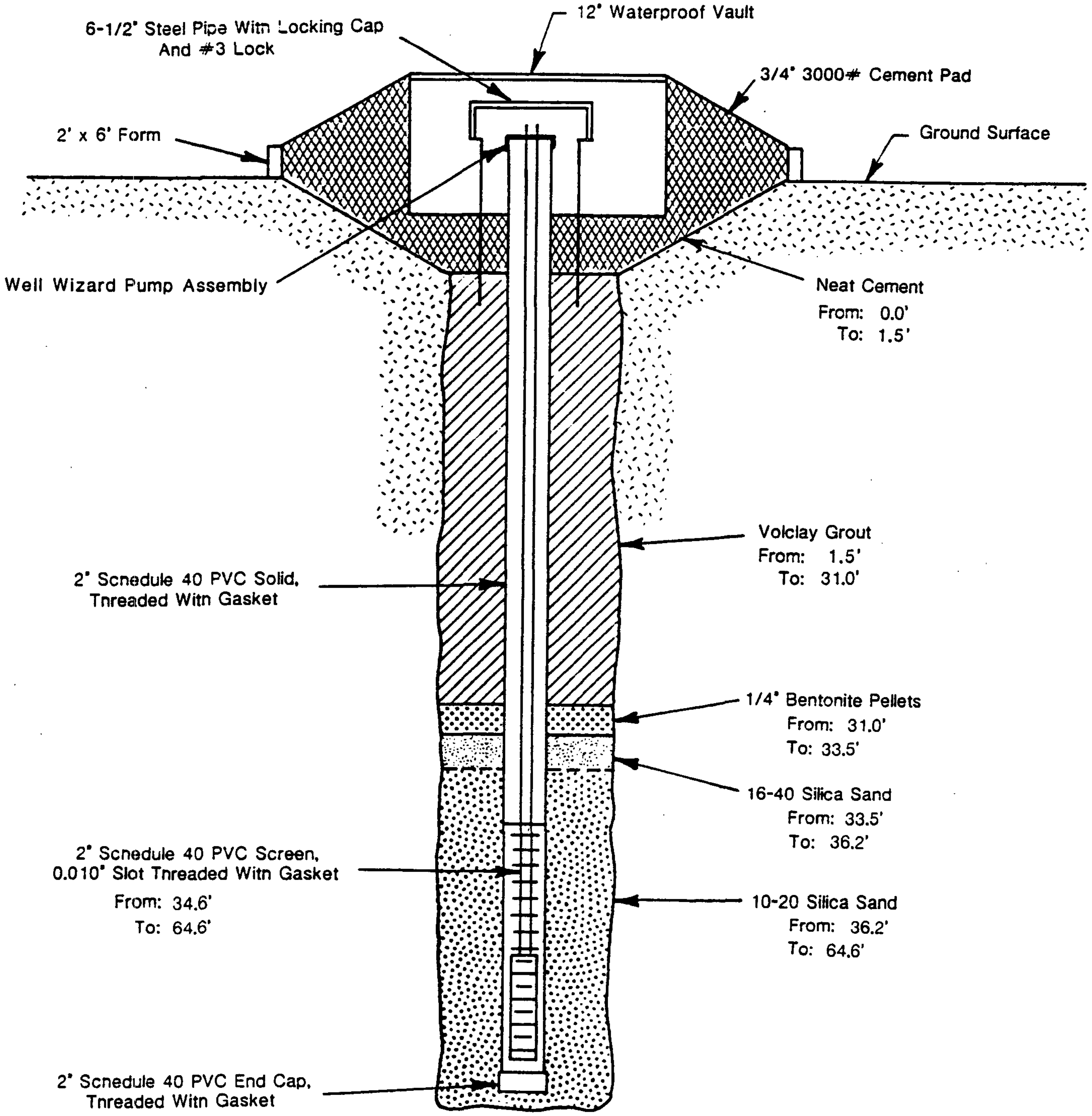


WELL #: 5-15B

DATE DRILLED: 6/29/90

TOTAL DEPTH: 65.55' (taped)

ALL FOOTAGES FROM GROUND SURFACE

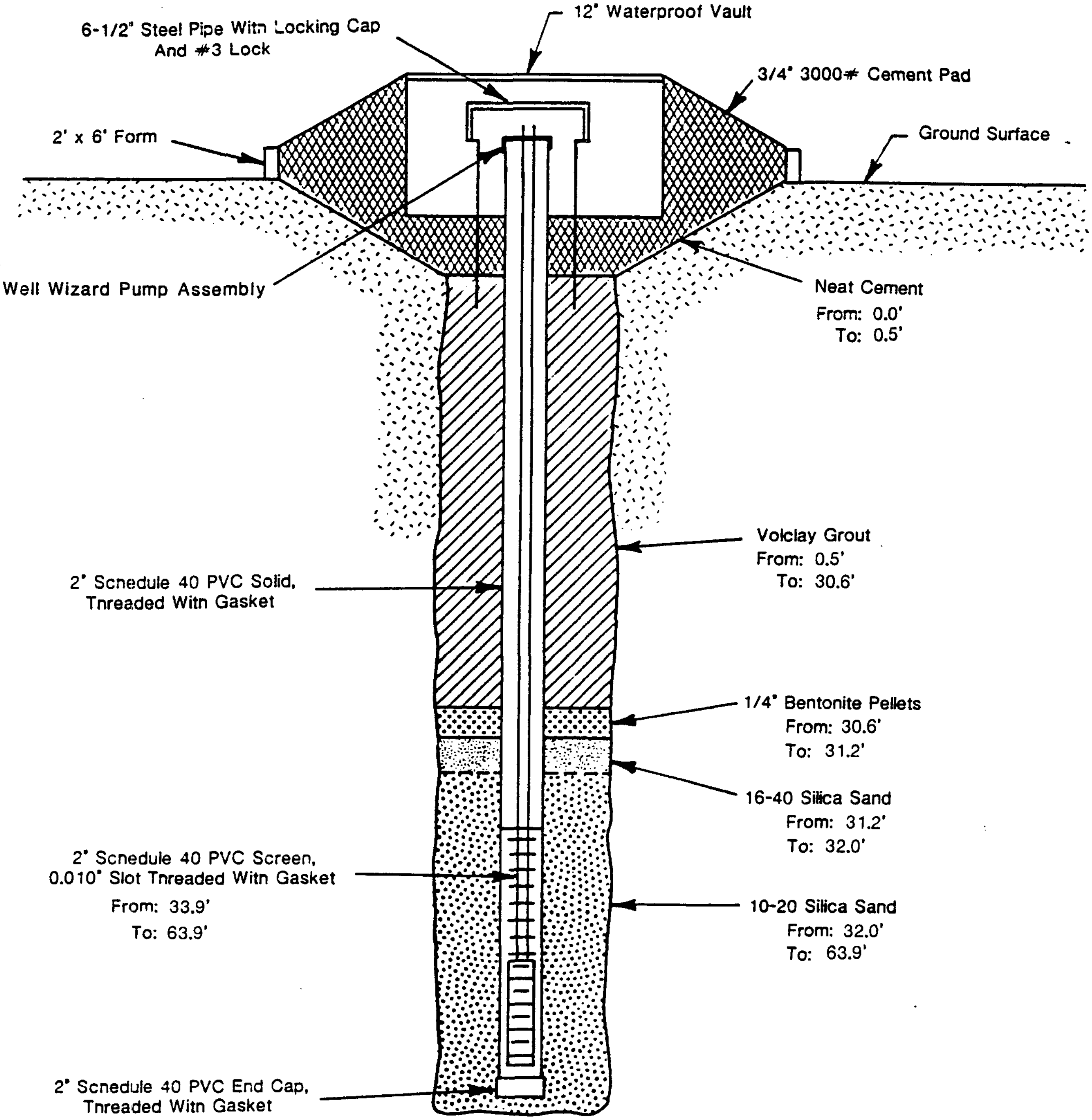


WELL #: 5-16B

DATE DRILLED: 7/5/90

TOTAL DEPTH: 64.6' (taped)

ALL FOOTAGES FROM GROUND SURFACE

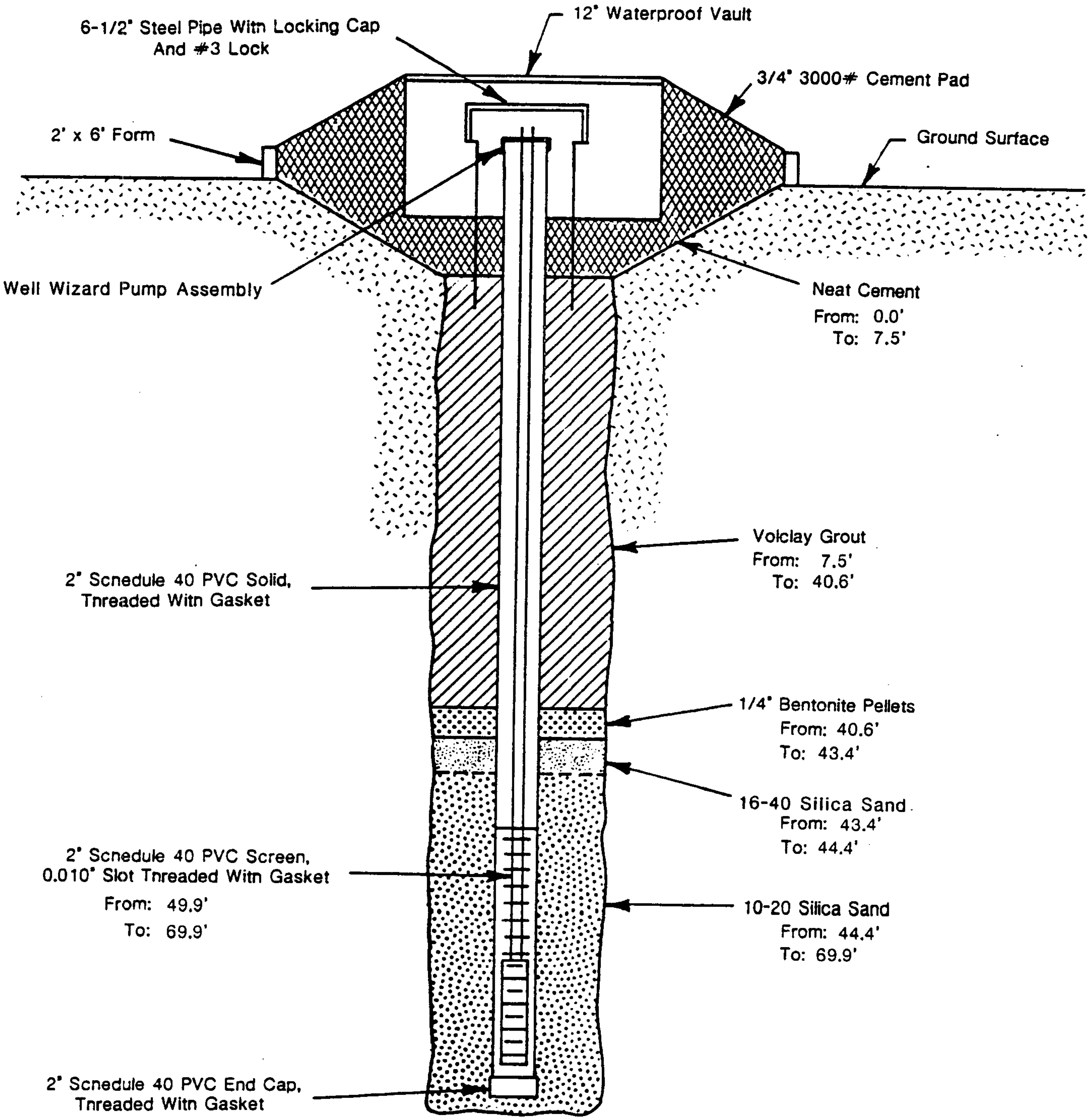


WELL #: 5-17B

DATE DRILLED: 7/3/90

TOTAL DEPTH: 63.9' (taped)

ALL FOOTAGES FROM GROUND SURFACE

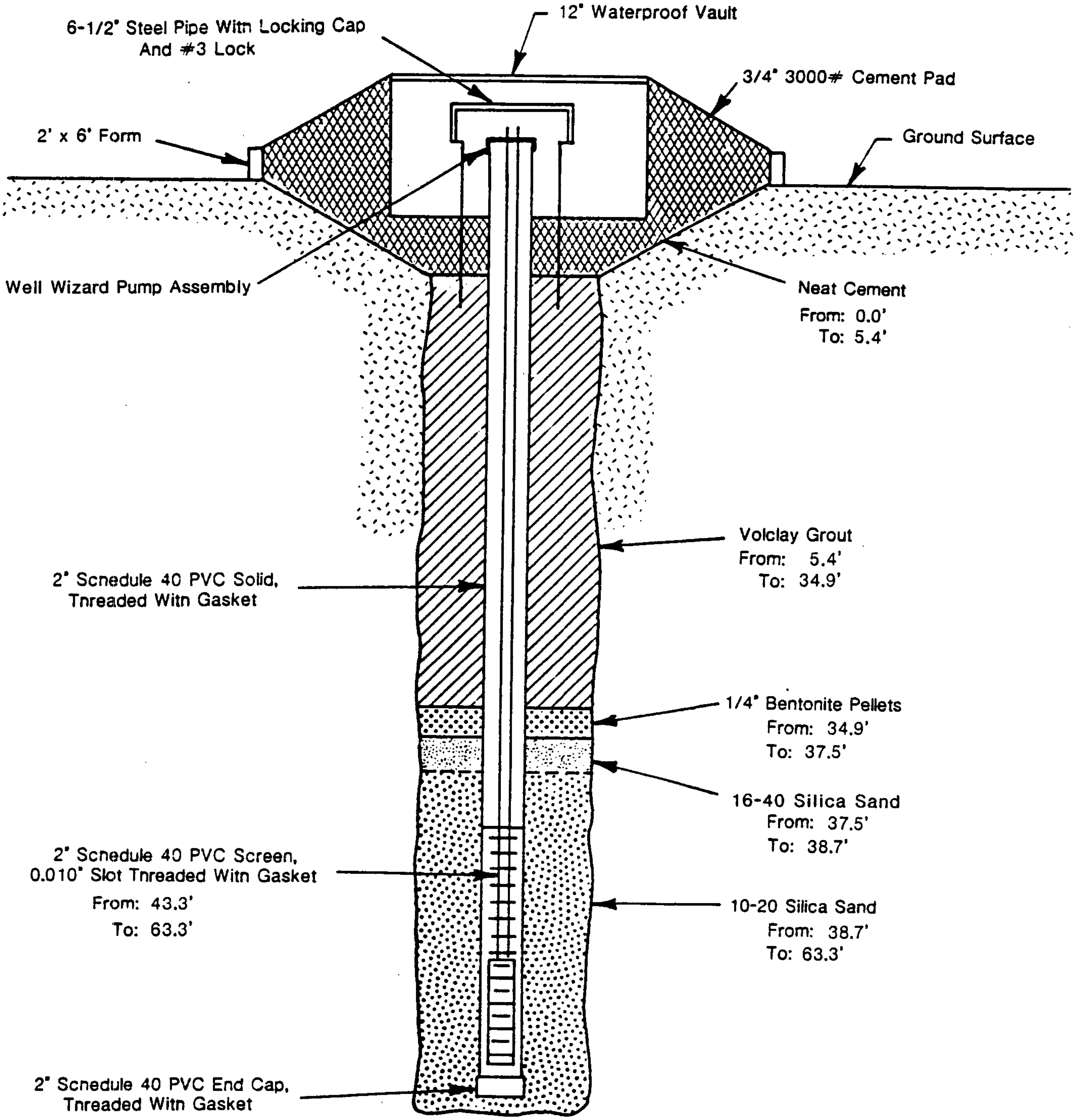


WELL #: 5-18B

DATE DRILLED: 7/9/90

TOTAL DEPTH: 69.9' (taped)

ALL FOOTAGES FROM GROUND SURFACE

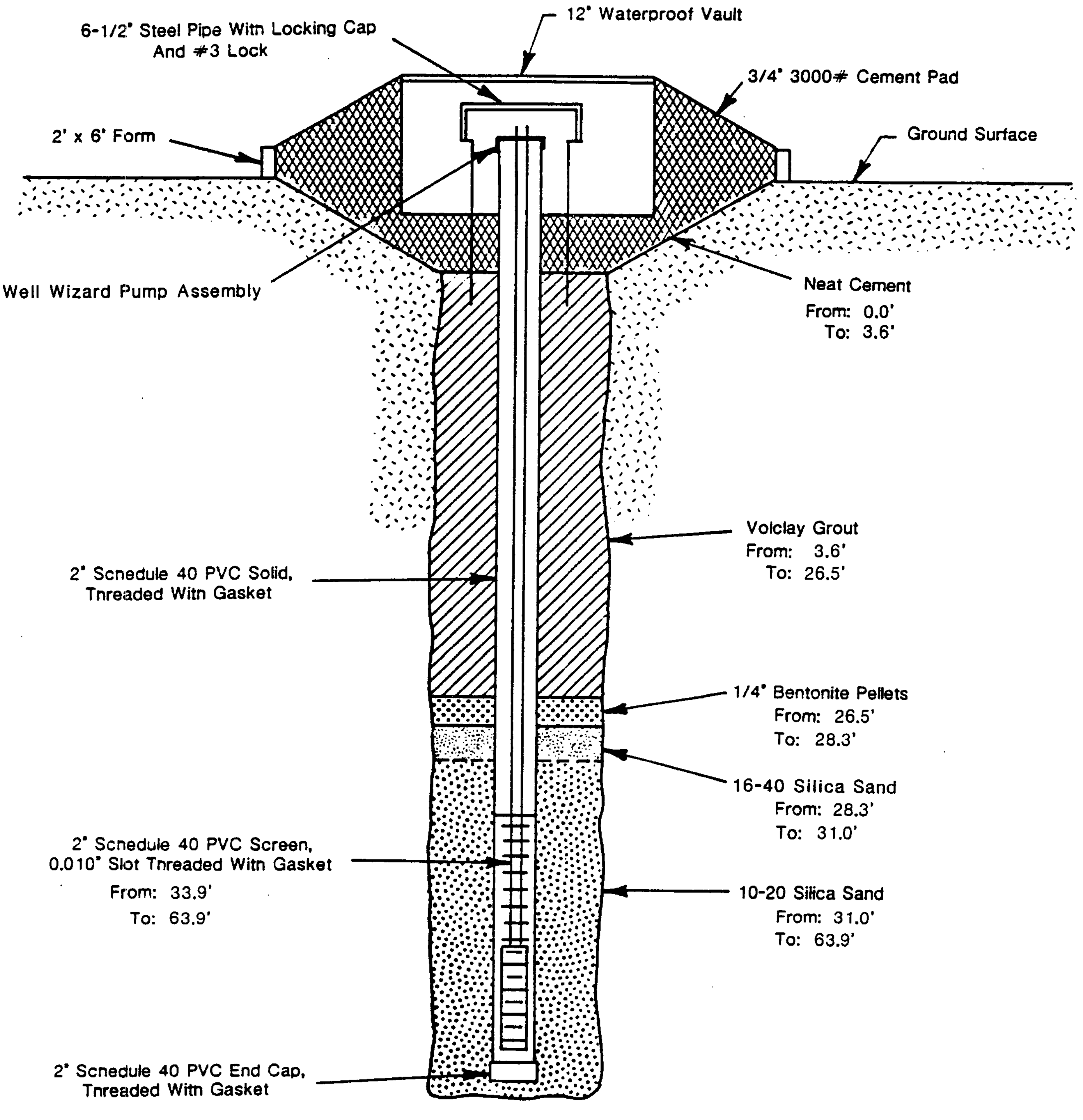


WELL #: 5-19B

DATE DRILLED: 7/10/90

TOTAL DEPTH: 63.3' (taped)

ALL FOOTAGES FROM GROUND SURFACE

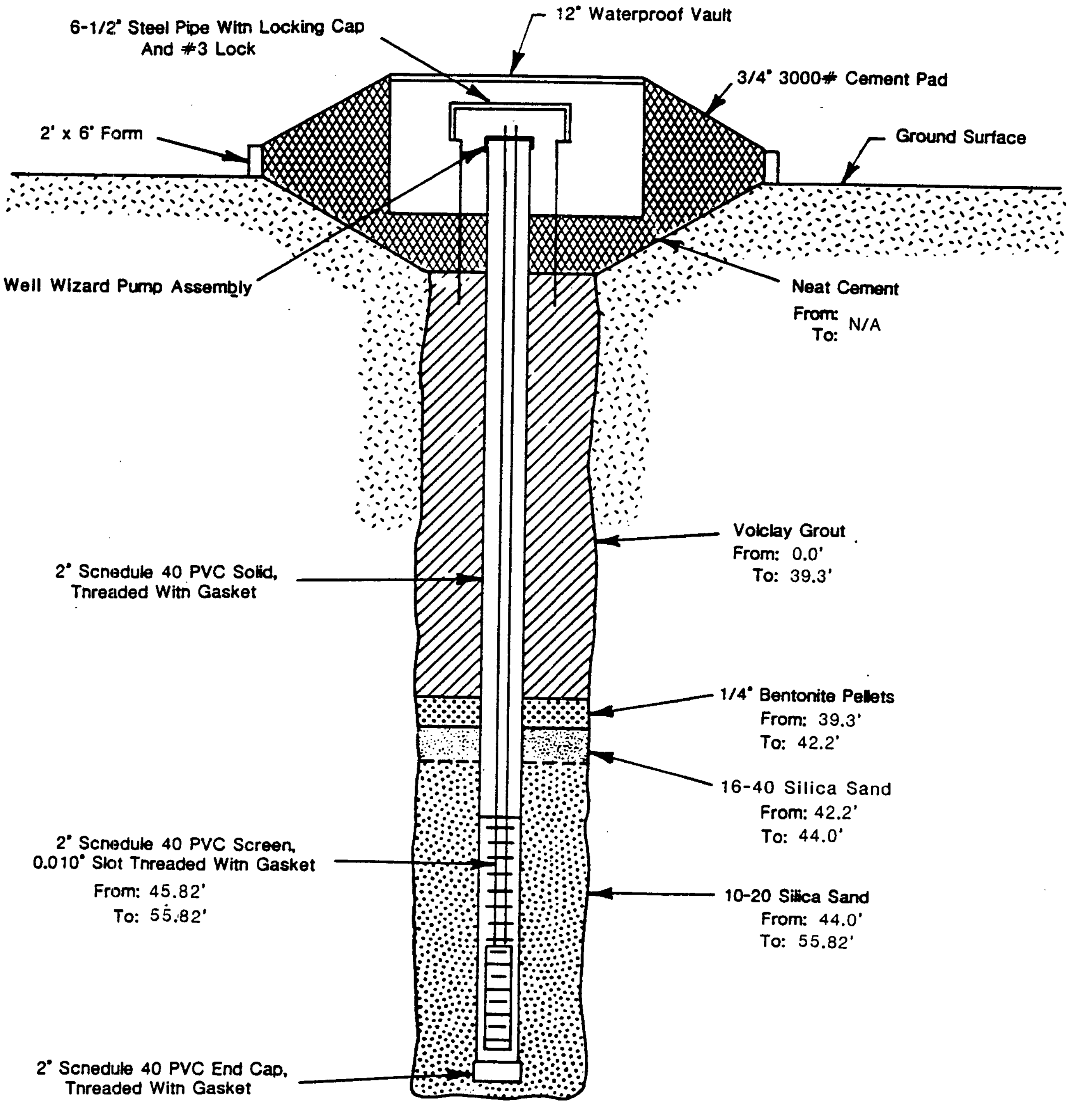


WELL #: 5-20B

DATE DRILLED: 7/11/90

TOTAL DEPTH: 63.9 (taped)

ALL FOOTAGES FROM GROUND SURFACE

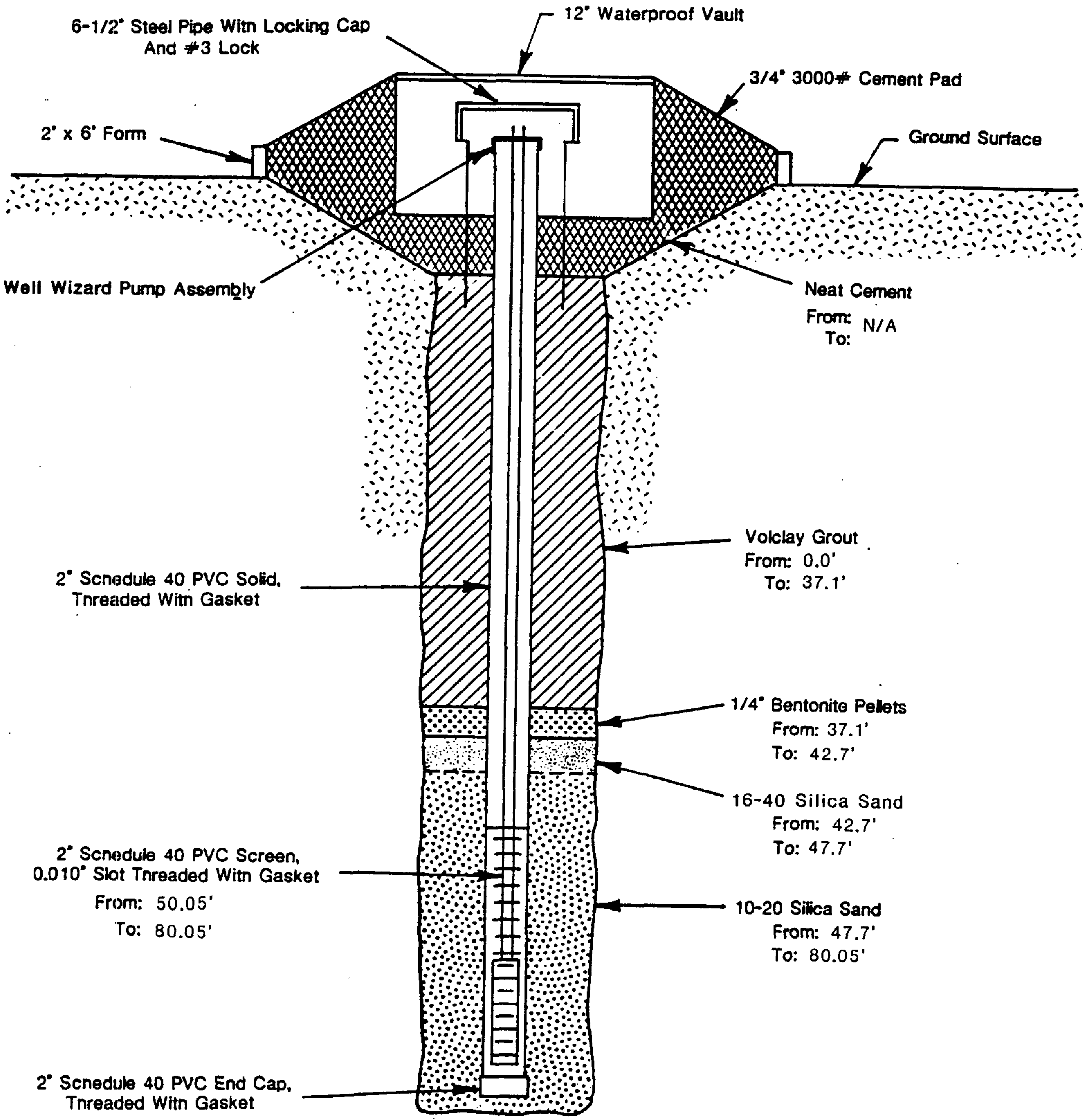


WELL #: 5-22B

DATE DRILLED: 9/13 & 18/90

TOTAL DEPTH: 55.82' (taped)

ALL FOOTAGES FROM GROUND SURFACE

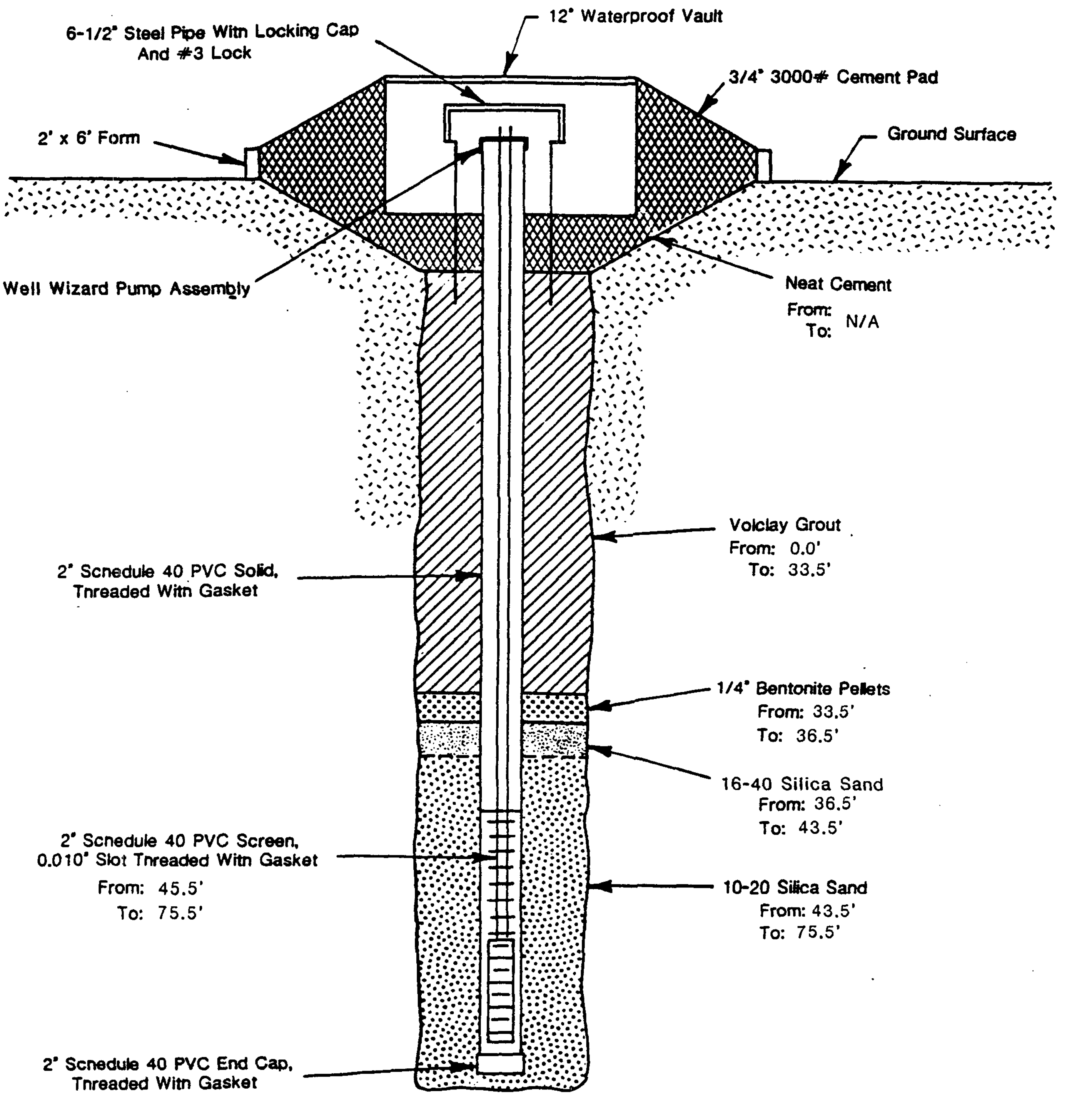


WELL #: 5-23B

DATE DRILLED: 9/20 & 21/90

TOTAL DEPTH: 80.05' (taped)

ALL FOOTAGES FROM GROUND SURFACE

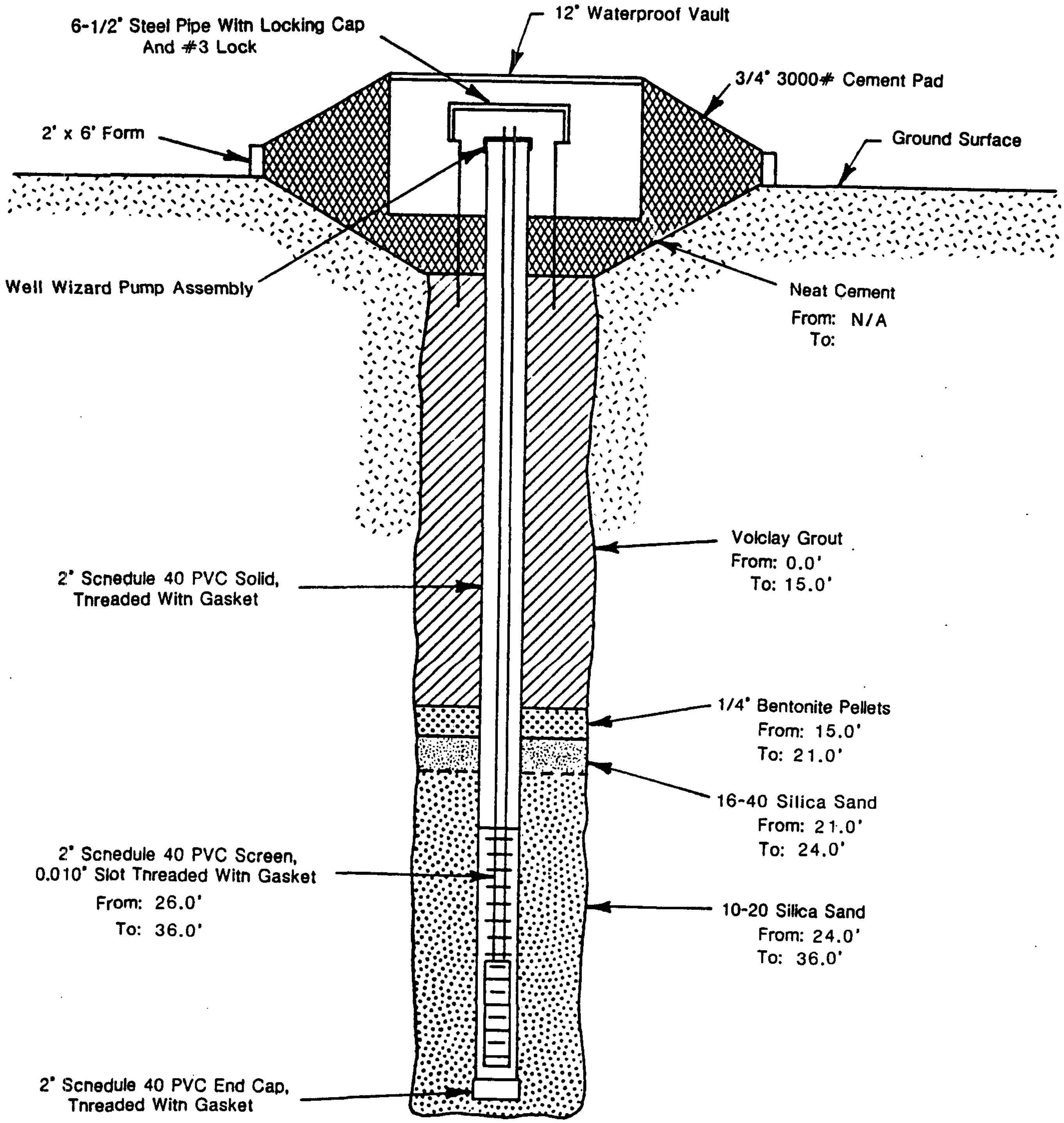


WELL #: 5-24B

DATE DRILLED: 9/24 & 25/90

TOTAL DEPTH: 75.5' (taped)

ALL FOOTAGES FROM GROUND SURFACE

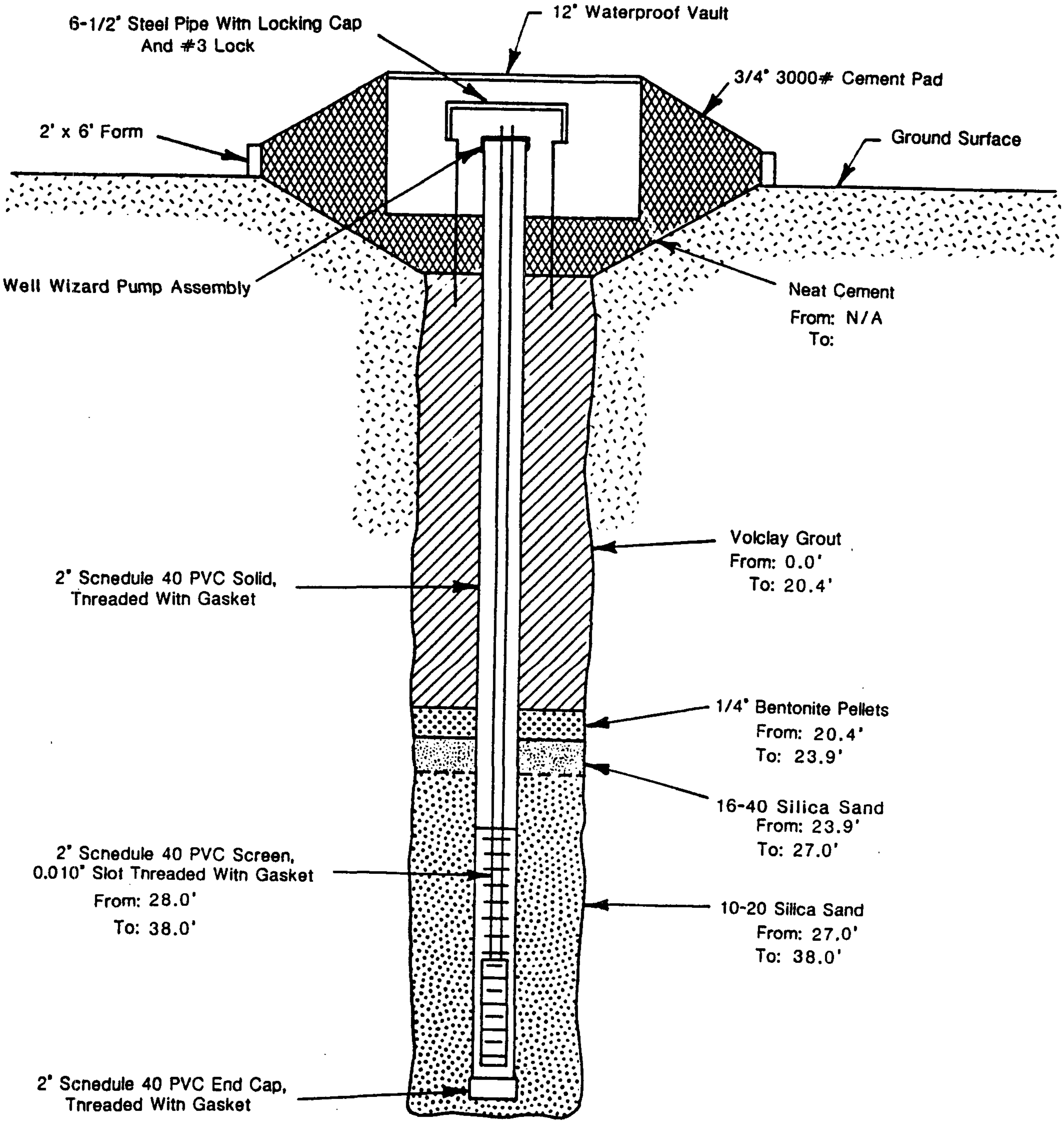


WELL #: 5-25B

DATE DRILLED: 12/6 & 7/90

TOTAL DEPTH: 36.0 (taped)

ALL FOOTAGES FROM GROUND SURFACE

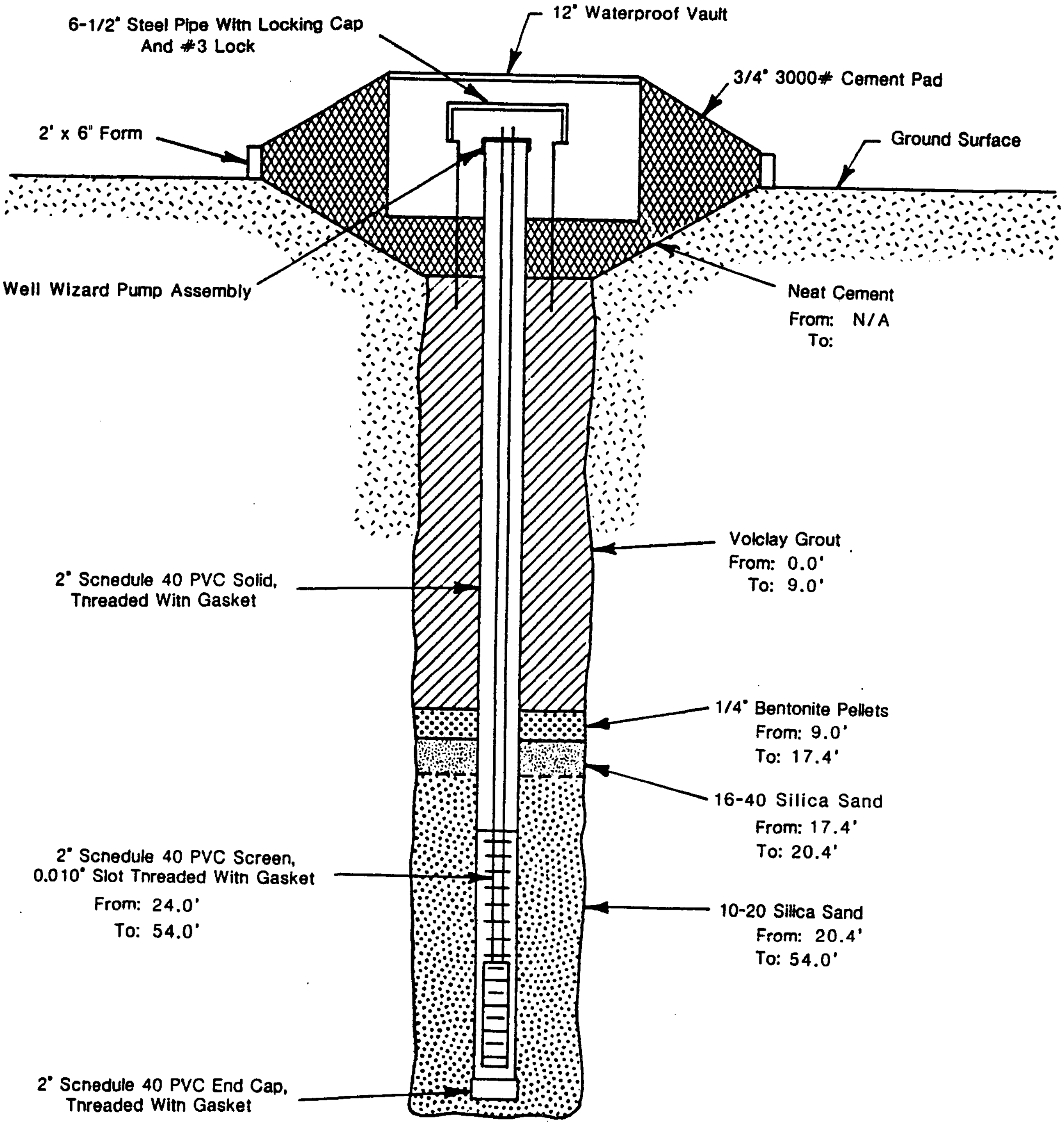


WELL #: 5-26B

DATE DRILLED: 12/5 & 6/90

TOTAL DEPTH: 38.0' (taped)

ALL FOOTAGES FROM GROUND SURFACE



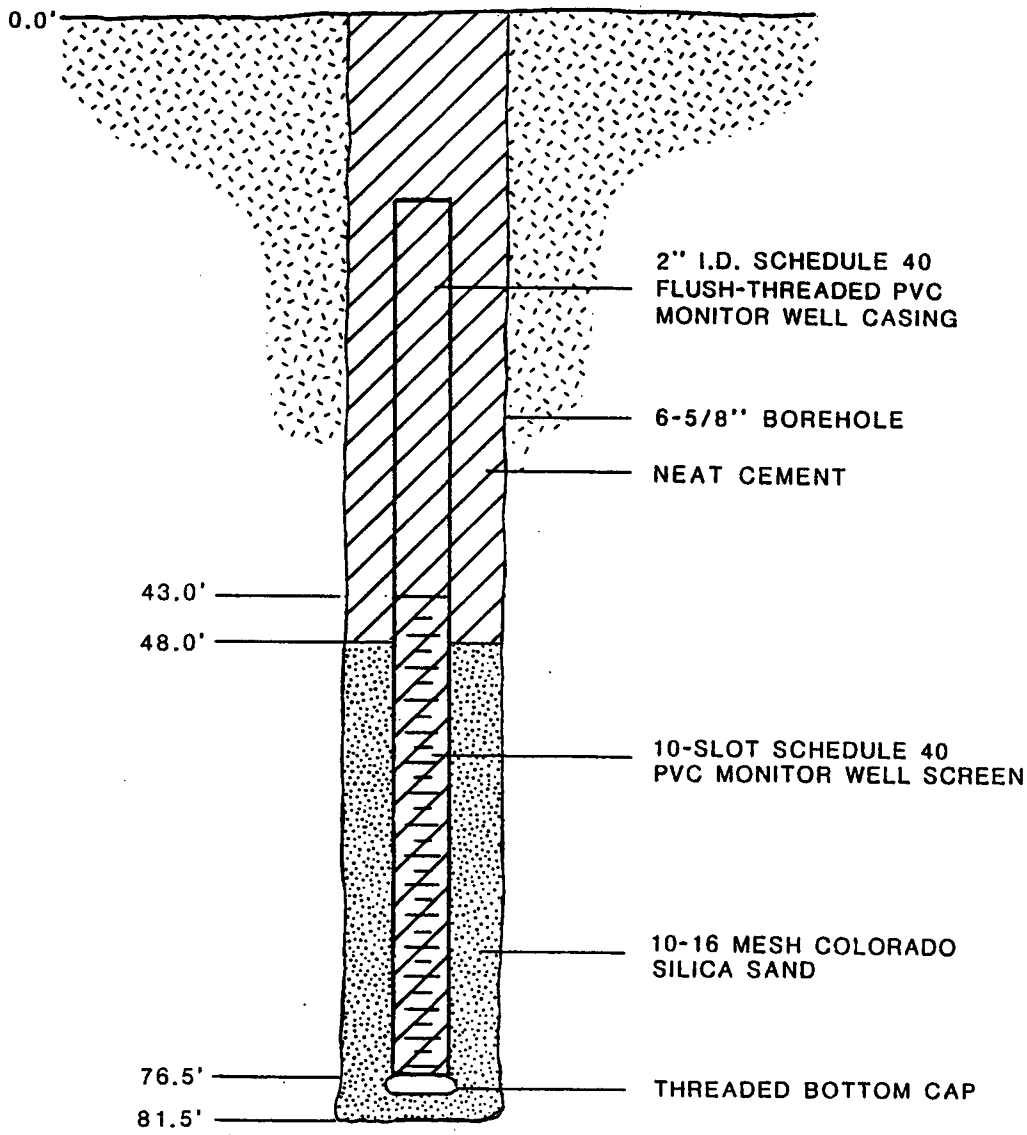
WELL #: 5-27B

DATE DRILLED: 12/7, 10 & 11/90

TOTAL DEPTH: 54.0' (taped)

ALL FOOTAGES FROM GROUND SURFACE

EXPLORATORY WELL SCHEMATIC



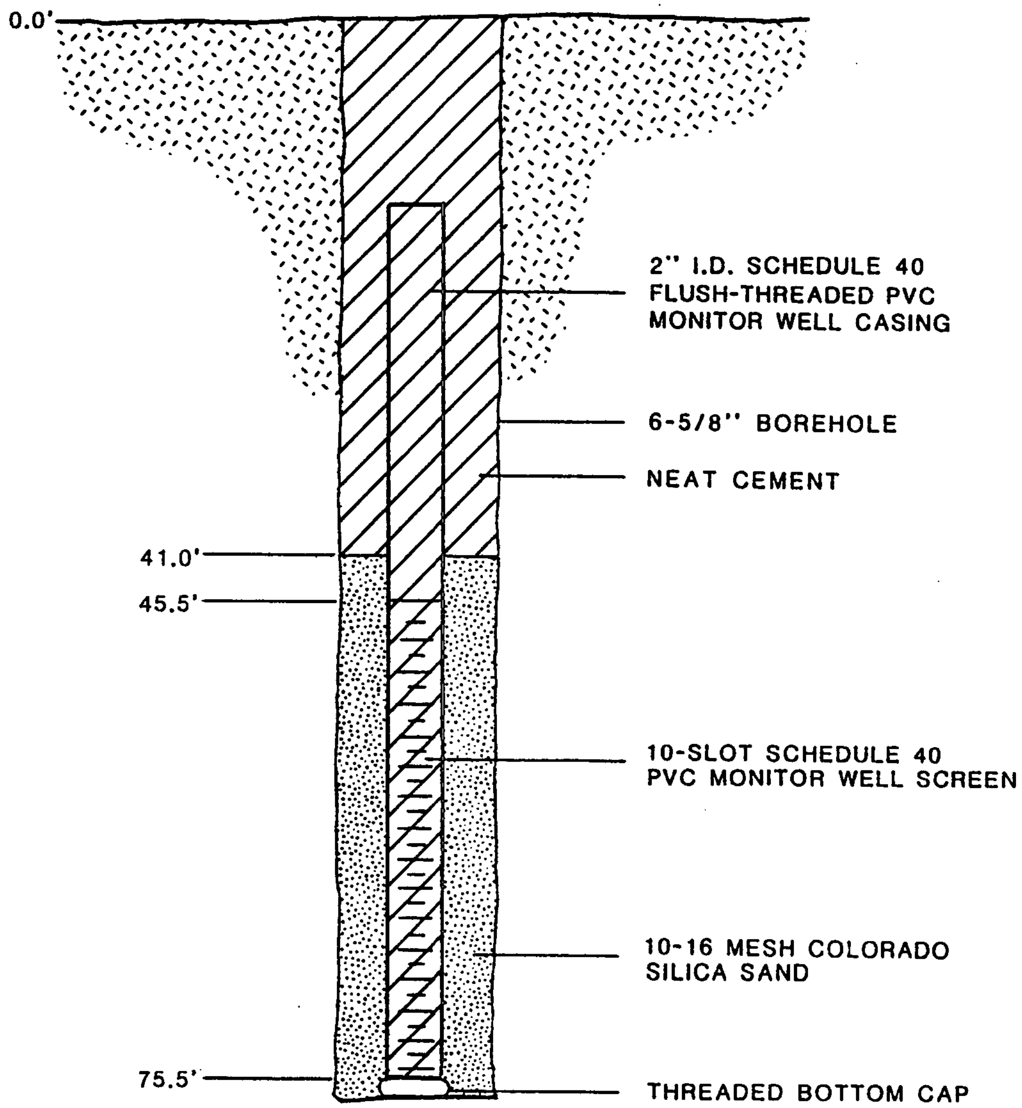
WELL #: 5-28B

DATE DRILLED: 5/8/91

TOTAL DEPTH: 81.5'

ALL FOOTAGES FROM GROUND SURFACE

EXPLORATORY WELL SCHEMATIC



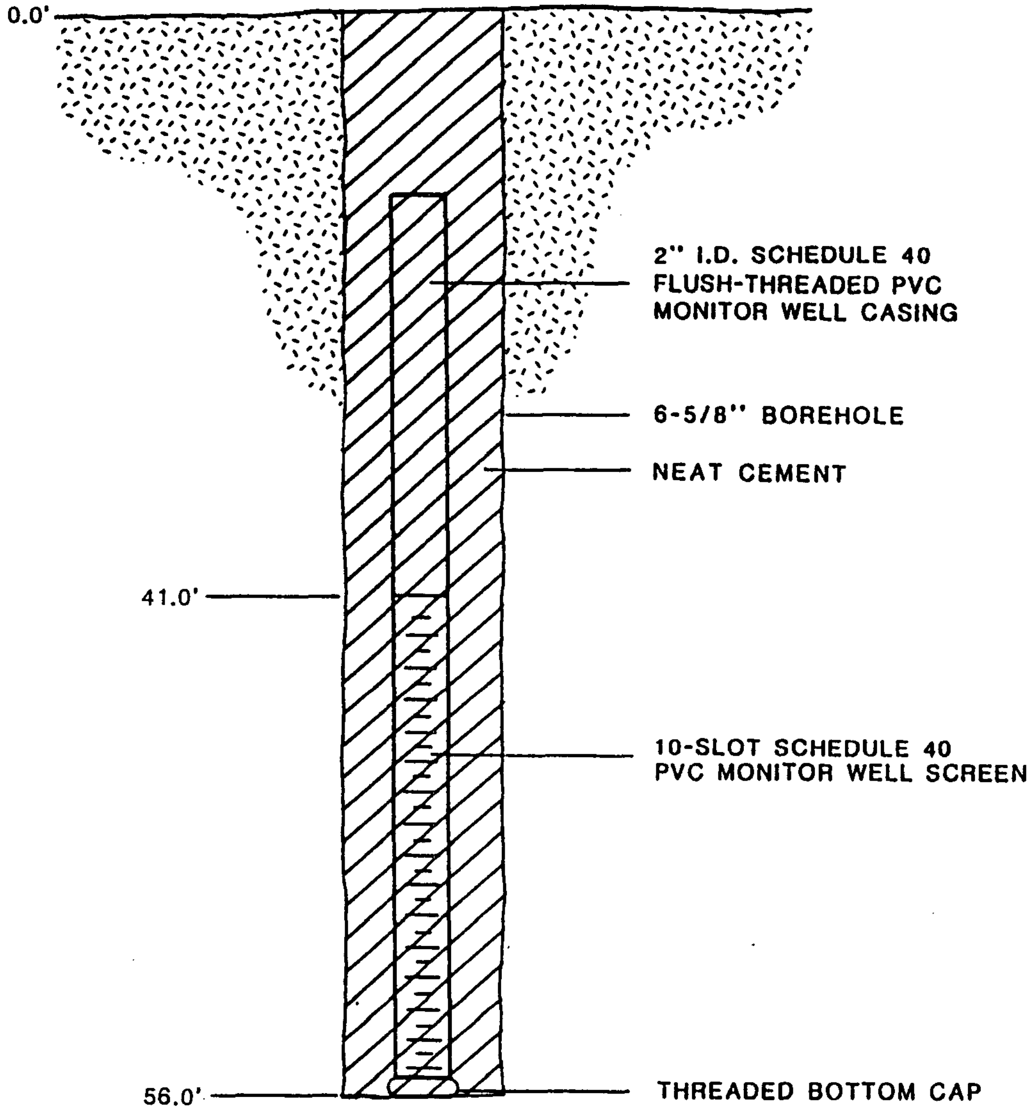
WELL #: 5-29B

DATE DRILLED: 5/9/91

TOTAL DEPTH: 75.5'

ALL FOOTAGES FROM GROUND SURFACE

EXPLORATORY WELL SCHEMATIC



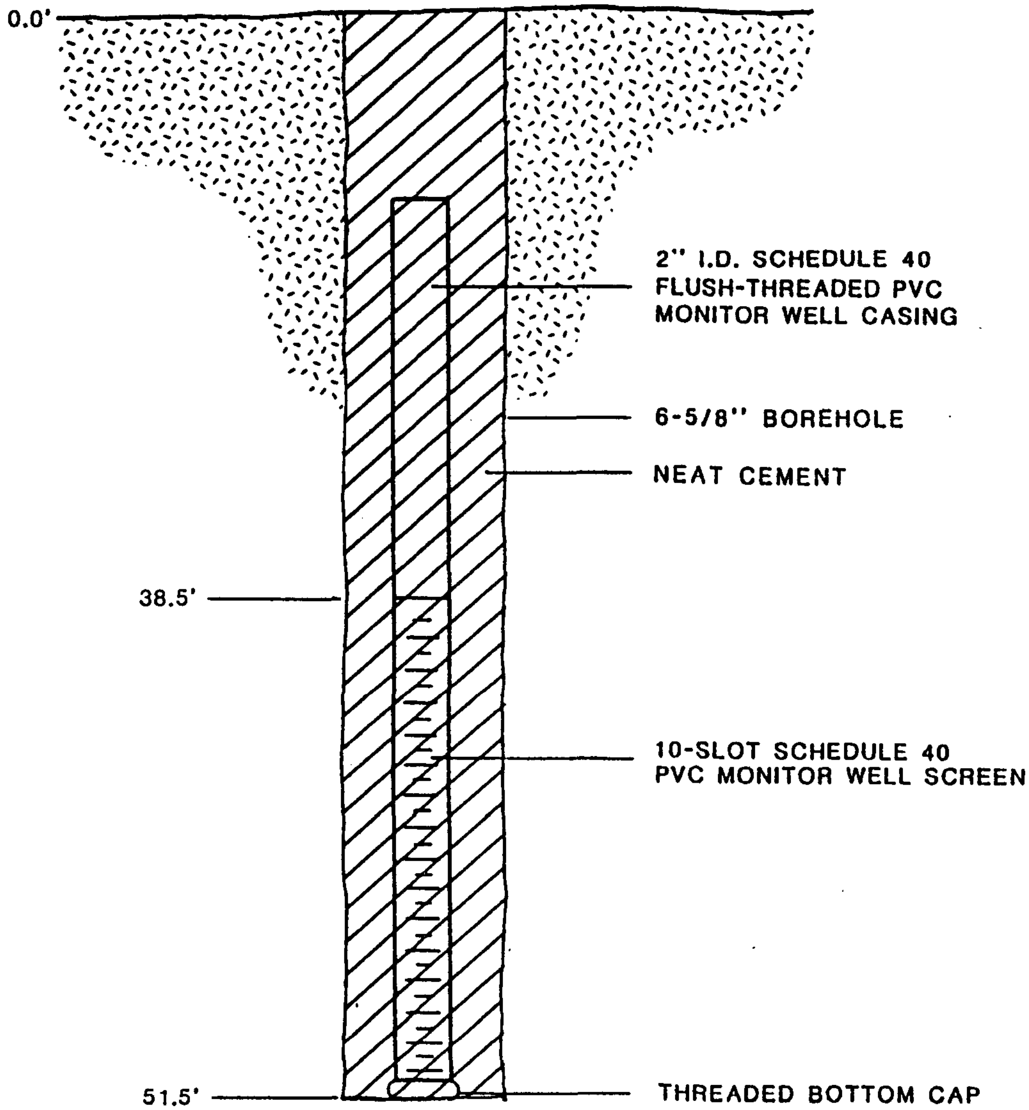
WELL #: 5-30B

DATE DRILLED: 5/13/91

TOTAL DEPTH: 56.0'

ALL FOOTAGES FROM GROUND SURFACE

EXPLORATORY WELL SCHEMATIC



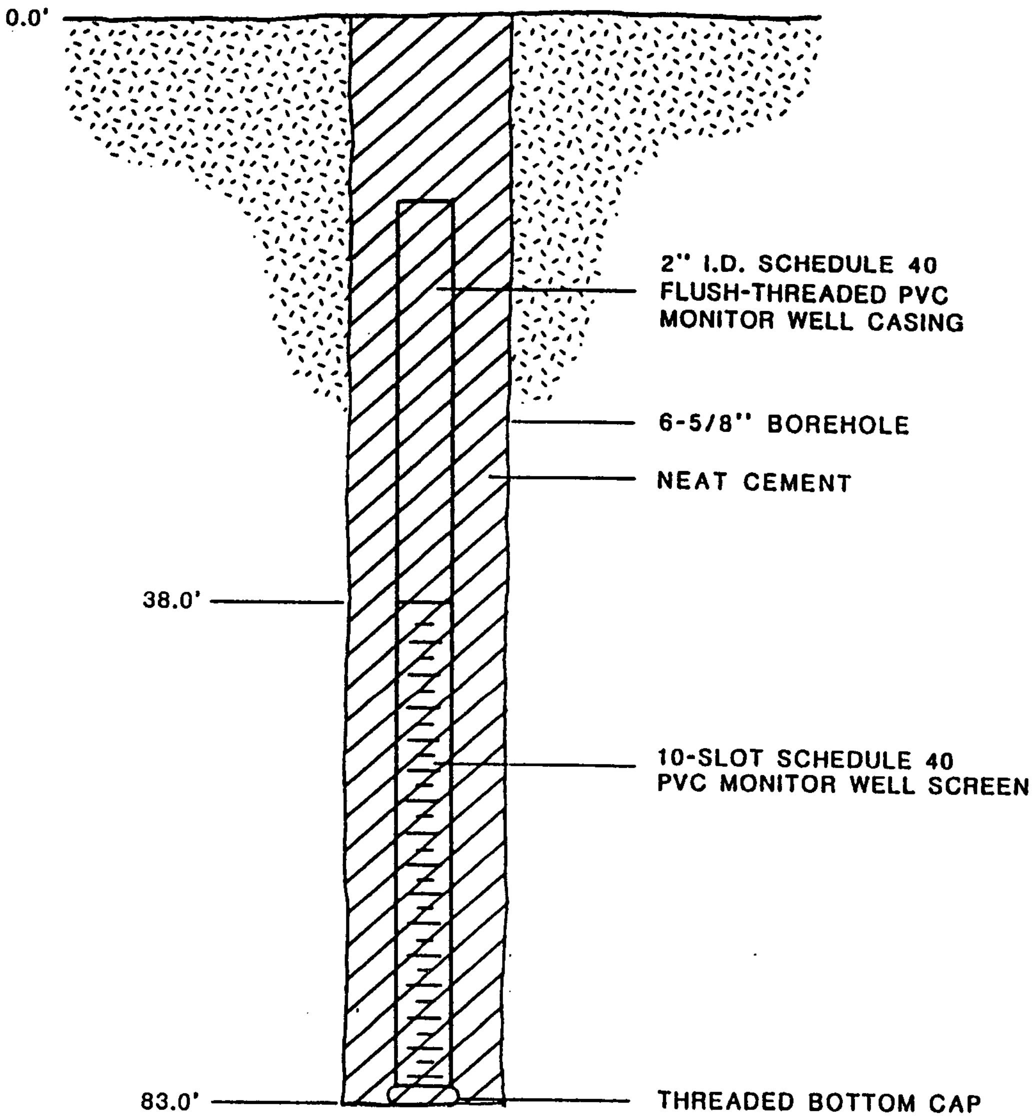
WELL #: 5-31B

DATE DRILLED: 5/14/91

TOTAL DEPTH: 51.5'

ALL FOOTAGES FROM GROUND SURFACE

EXPLORATORY WELL SCHEMATIC



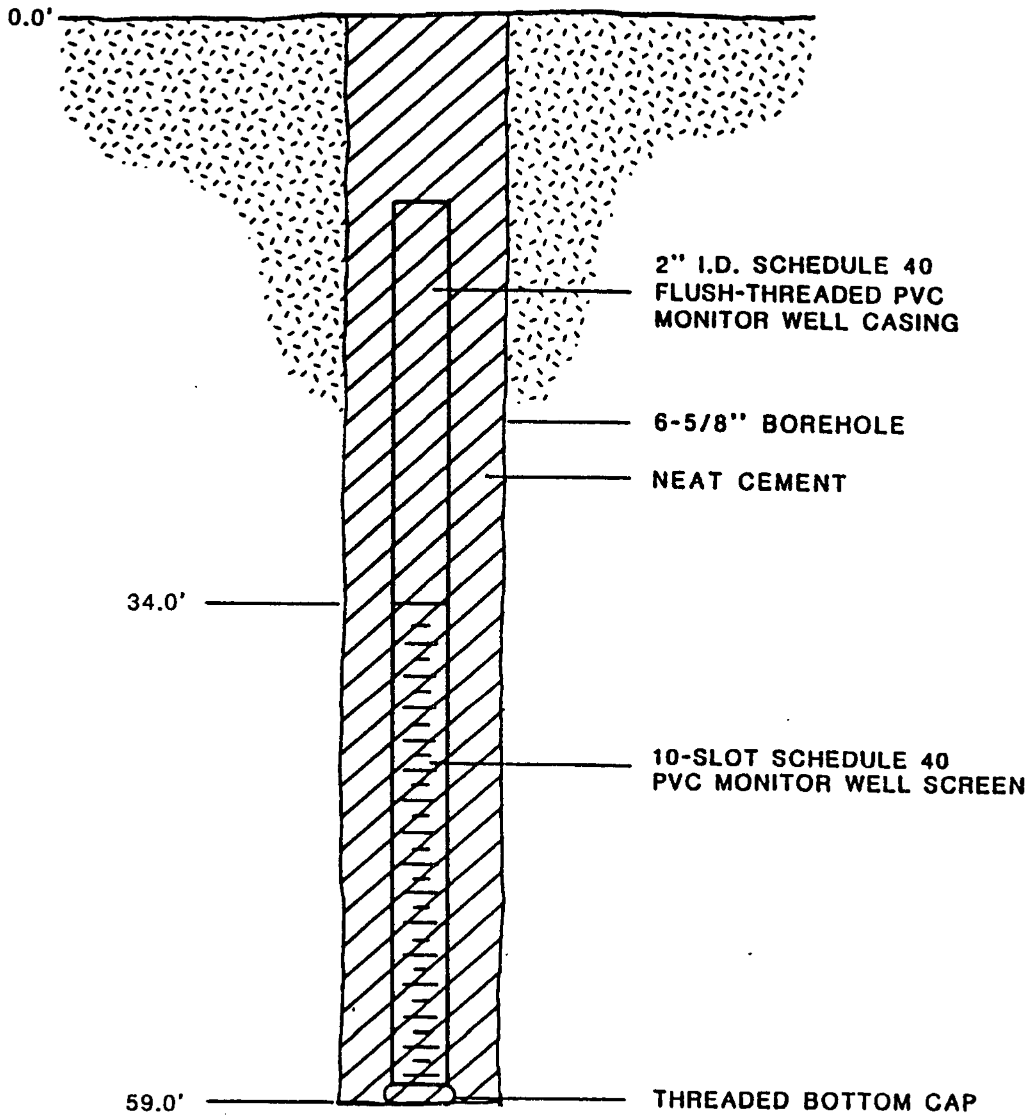
WELL #: 5-32B

DATE DRILLED: 5/14/91

TOTAL DEPTH: 83.0'

ALL FOOTAGES FROM GROUND SURFACE

EXPLORATORY WELL SCHEMATIC



WELL #: 5-33B

DATE DRILLED: 5/15/91

TOTAL DEPTH: 59.0'

ALL FOOTAGES FROM GROUND SURFACE

ABANDONMENT INFORMATION

APPENDIX A
ABANDONMENT OF BOREHOLES

This section describes steps taken to abandon or close boreholes not suitable and/or not required for monitoring purposes. Abandonment procedures have been designed to eliminate real or potential pathways from sources of contamination to ground-water aquifers. The abandonment procedures described below are consistent with both state regulations and with proposed draft ASTM procedures (New Standard Practice for the Decommissioning of Groundwater Wells, Vadose Zone Monitoring Devices, Boreholes, and Other Devices for Environmental Activities).

Abandonment of Shallow Soil Borings and Uncompleted Monitor Wells

Table A.1 summarizes the abandonment procedures for the subject boreholes. Soil Borings 5-9SB, 5-10SB, and 5-11SB were planned as temporary boreholes to help delineate the source of PCBs and BTEX. These wells were abandoned immediately after the total depth was reached. Wells 5-16A and 5-21A were planned as monitor wells; however, neither could be completed because of difficulties encountered during drilling, as described in Section 4.0. Again, each of these wells was abandoned immediately after drilling was terminated.

Each of these boreholes was abandoned by filling it with bentonite grout (American Colloid Inc. Pure Gold) via a tremmie pipe placed inside the hollow stem auger. Grout was pumped into the region of the open hole created by reversing the auger out of the hole. Pure Gold bentonite grout is superior to cement grout because it does not contain contaminants (such as CaO, detected in cement) that would adversely affect the shallow aquifer. At the same time its low permeability prevents potential contaminants (e.g., PCBs and BTEX) from preferentially migrating from surface or vadose zone sources to the shallow aquifer.

Abandonment of Exploratory Boreholes

Well screen and blank were temporarily placed into exploratory boreholes to permit obtaining a one-time-only representative ground-water sample for chemical analysis. A grout backfill was not placed above the well screen to facilitate abandonment procedures. Once a ground-water sample was collected, these boreholes were abandoned.

These boreholes were abandoned by unscrewing the casing below grade and filling (in stages) the annulus and remaining well bore with cement grout to the ground surface.

Abandonment of Deep Aquifer Test Well 5-2A

PCBs and BTEX concentrations were below detection limits in the initial ground-water sample collected from Test Well 5-2A in August of 1989 (Table 7.1). However, in December 1989 detectable levels of toluene and ethylbenzene were detected in the ground-water sample. These same constituents plus benzene were detected in January 1990, after the well had been purged five separate times prior to sampling. These results suggested that BTEX had not been introduced into the well as a result of sampling. Moreover, the most logical explanation for the presence of BTEX in this deep well was that it was somehow migrating from the upper perched aquifer around or through the grout seal in the borehole separating the upper and lower aquifers. To prevent further impact to the deep aquifer, it was necessary to abandon this test well. Procedures described below were undertaken to eliminate this potential pathway from the upper alluvial aquifer to the deeper bedrock aquifer.

To ensure that grout would flow into the annular space between the well casing and the formation, the casing was perforated by explosives at approximately 50-foot intervals over its entire length. Cement grout was then tremmied under pressure into the borehole. Initial pressure grouting efforts resulted in large amounts of grout being lost to the formation. Borehole geophysical logs (bond logs) were run after pressure grouting to confirm that an acceptable grout seal was attained in the annular space around the well casing. External pressure on the grout was eliminated in subsequent grouting stages, which resulted in less grout being lost to the formation while producing an acceptable seal. Prior to the final grout stage, the well casing was cut off below the ground surface.

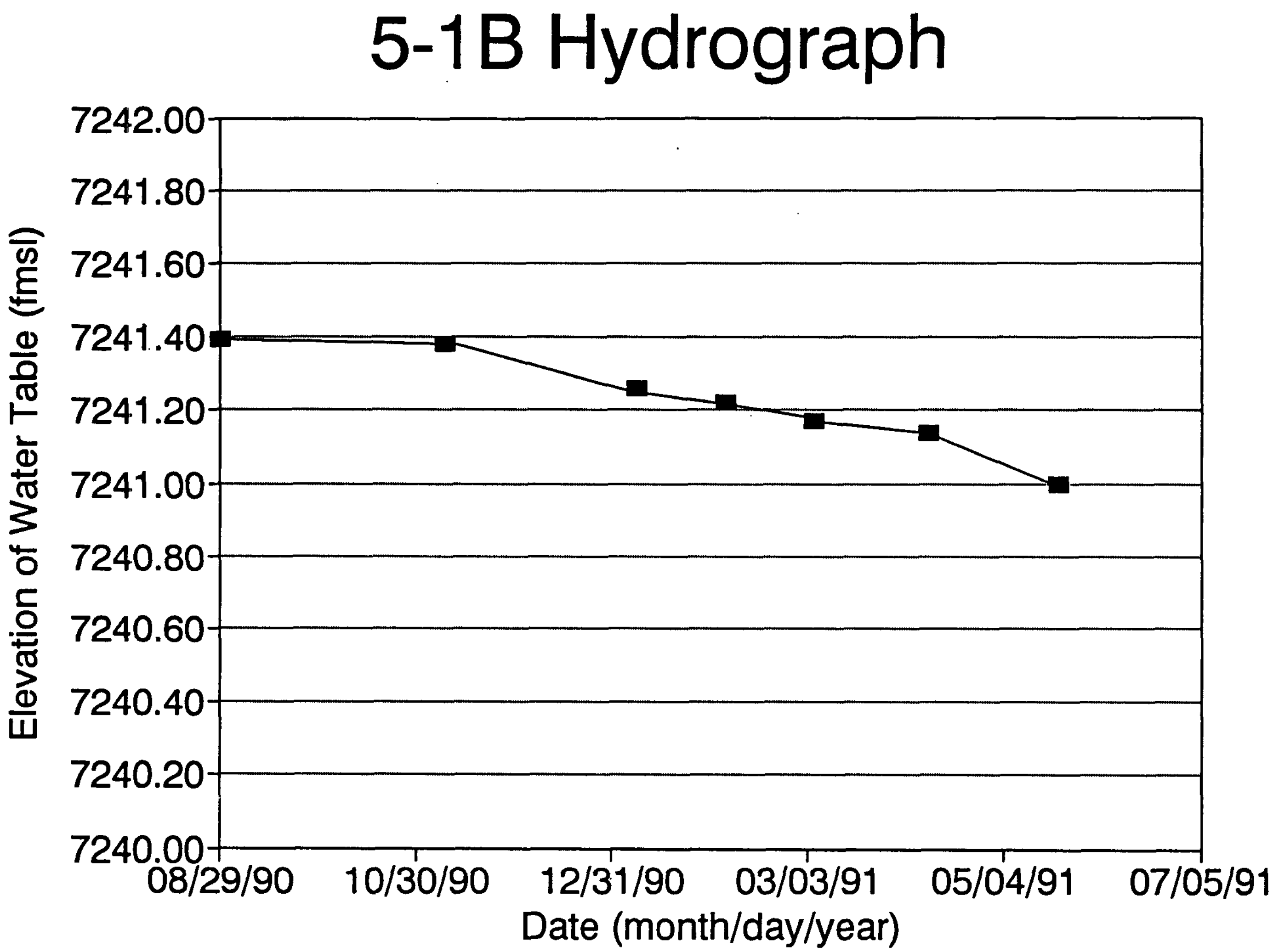
TABLE A.1 ABANDONMENT DATA FOR SHALLOW BORINGS

Boring	Date	Total Depth	Comments
5-9 SB	6/21/90	46.5 ft.	Planned Abandonment Water encountered at 45 ft. Backfilled with Pure Gold$_{TM}$ grout placed via tremmie through auger.
5-10 SB	6/21 & 12/90	55.5 ft.	Planned Abandonment. Dry to total depth. Backfilled with Pure Gold$_{TM}$ grout placed via tremmie through auger.
5-11 SB	7/6/90	26 ft.	Planned Abandonment. Dry to total depth. Backfilled with Pure Gold$_{TM}$ grout placed via tremmie through auger. Respirator cartridge breakthrough.
5-16 A	7/5/90	64.8 ft.	Unplanned Abandonment due to adverse borehole conditions. Water encountered at 61 ft? Backfilled with Pure Gold$_{TM}$ grout placed via tremmie through auger.
5-21 B	9/1/90	26 ft.	Unplanned Abandonment due to respirator cartridge breakthrough. Dry to total depth. Backfilled with Pure Gold$_{TM}$ grout placed via tremmie through auger.
5-25 B	5/7/91	36 ft.	Unplanned abandonment to facilitate placement of HDPE liner.

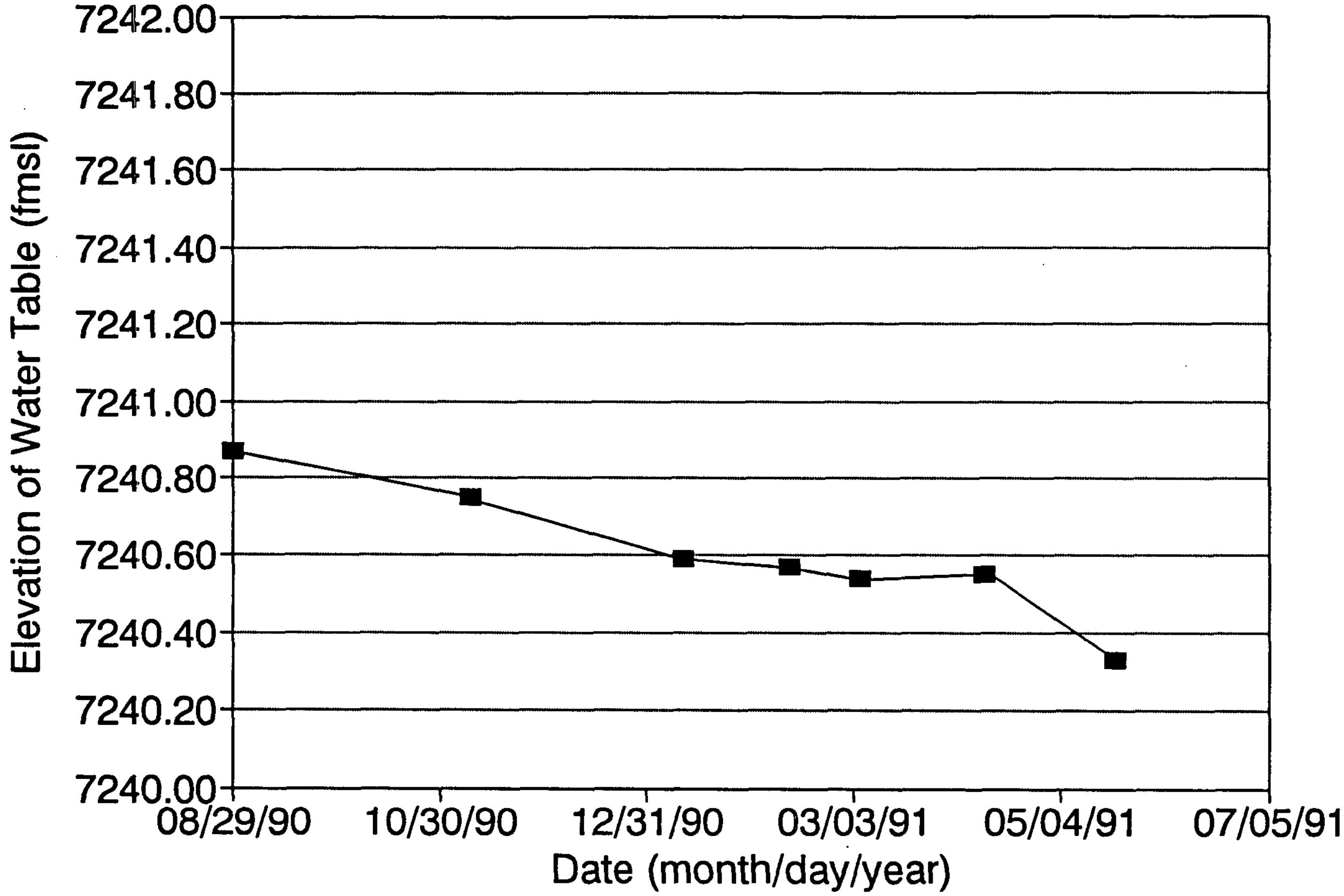
APPENDIX B

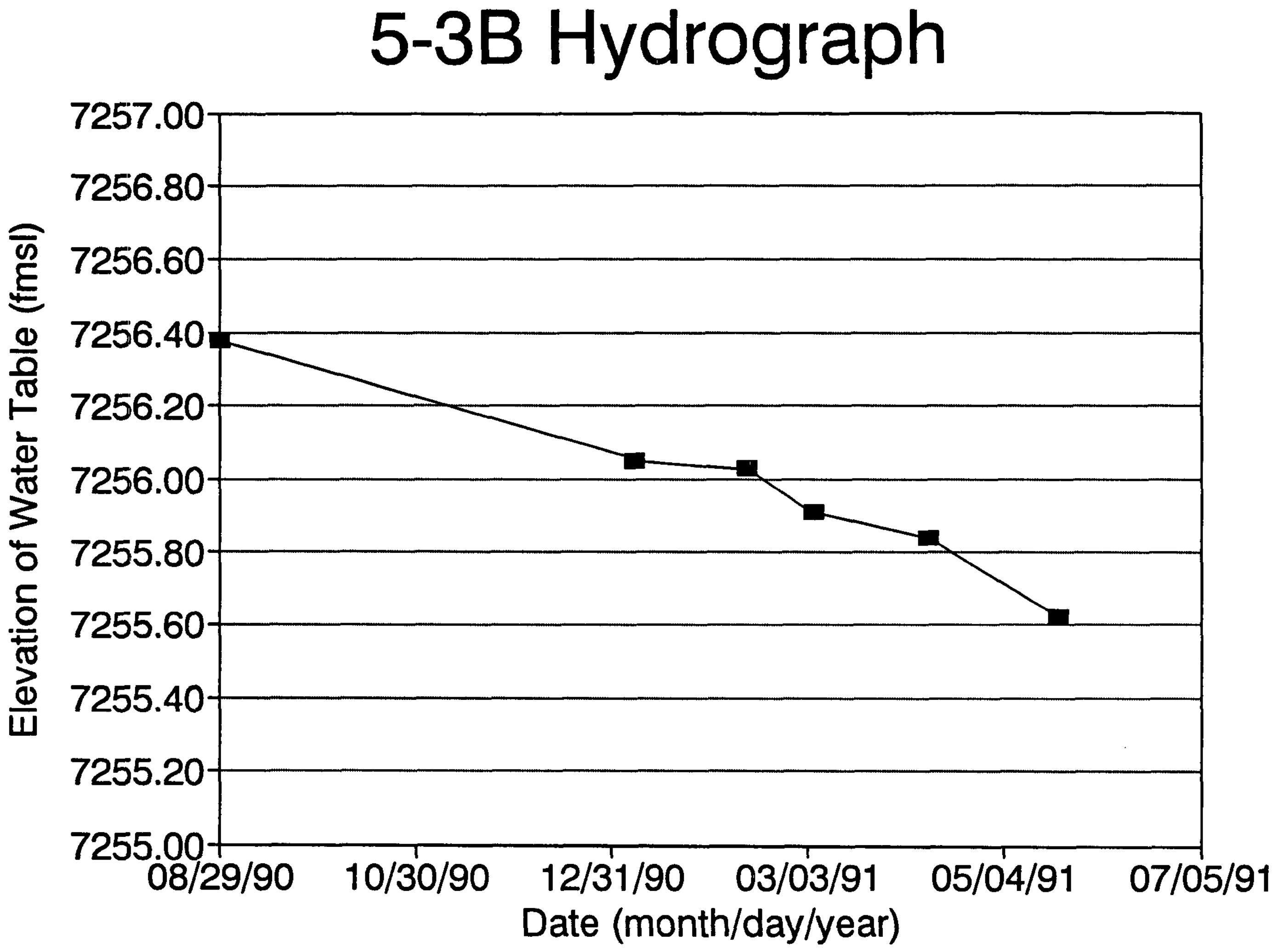
IN-SITU HYDROLOGIC PARAMETER TEST DATA

HYDROGRAPHS

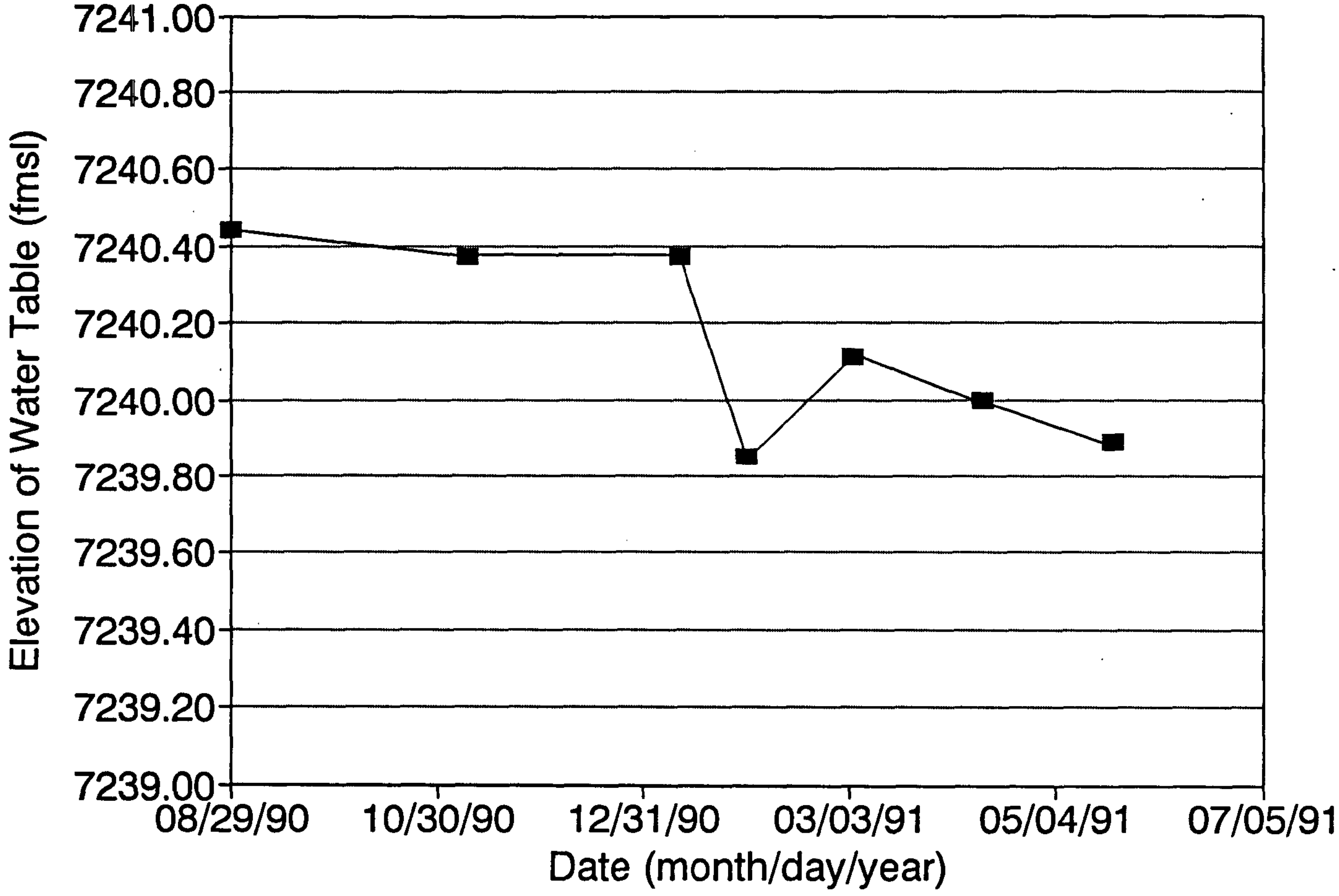

5-1B Hydrograph
Elevation of Water Table (fmsl)
7242.00
7241.80
7241.60
7241.40
7241.20
7241.00
7240.80
7240.60
7240.40
7240.20
7240.00
08/29/90
10/30/90
12/31/90
03/03/91
05/04/91
07/05/91
Date (month/day/year)

5-2B Hydrograph

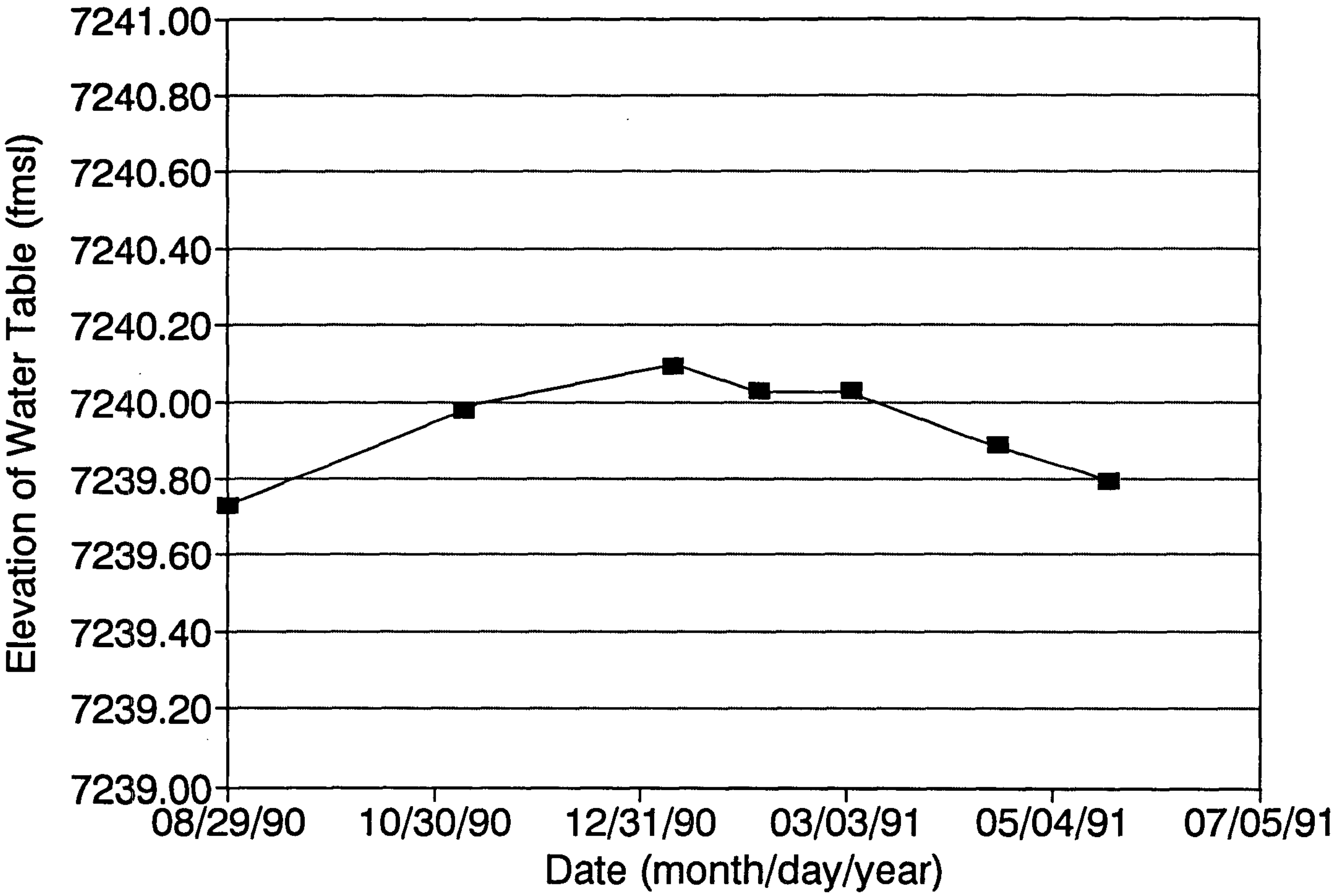



5-3B Hydrograph
Elevation of Water Table (fmsl)
7257.00
7256.80
7256.60
7256.40
7256.20
7256.00
7255.80
7255.60
7255.40
7255.20
7255.00
08/29/90
10/30/90
12/31/90
03/03/91
05/04/91
07/05/91
Date (month/day/year)

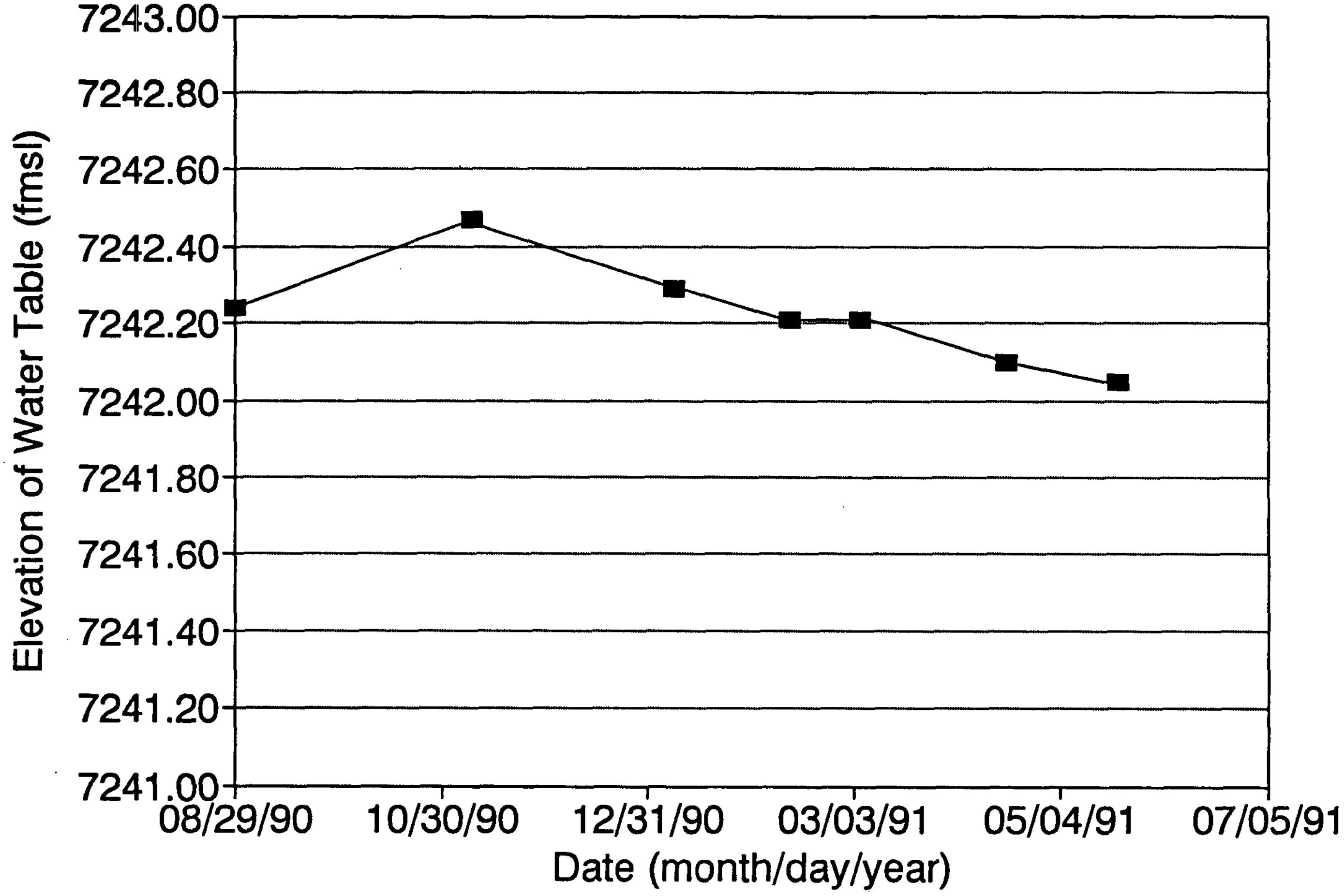
5-4B Hydrograph



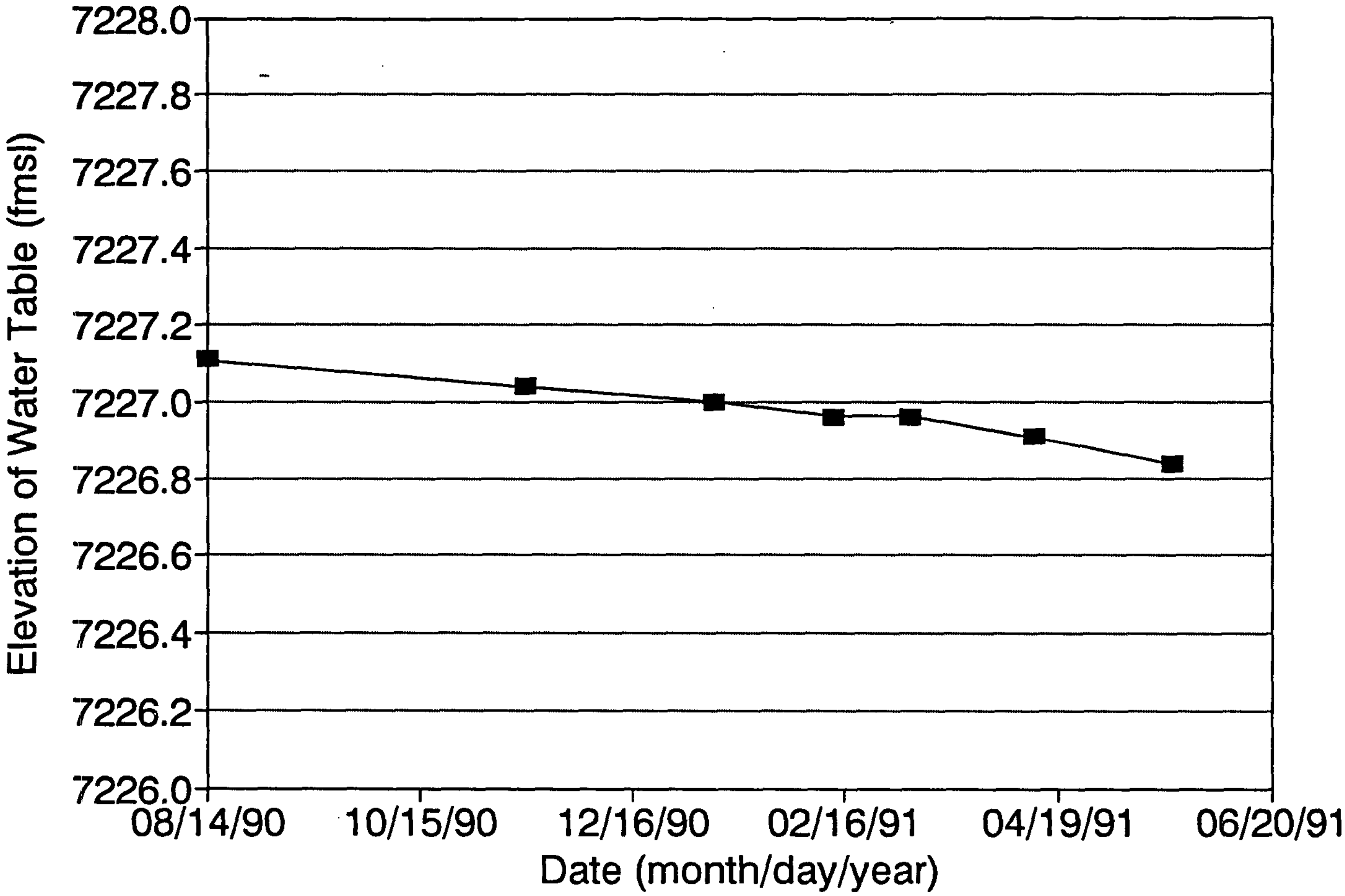
5-5B Hydrograph



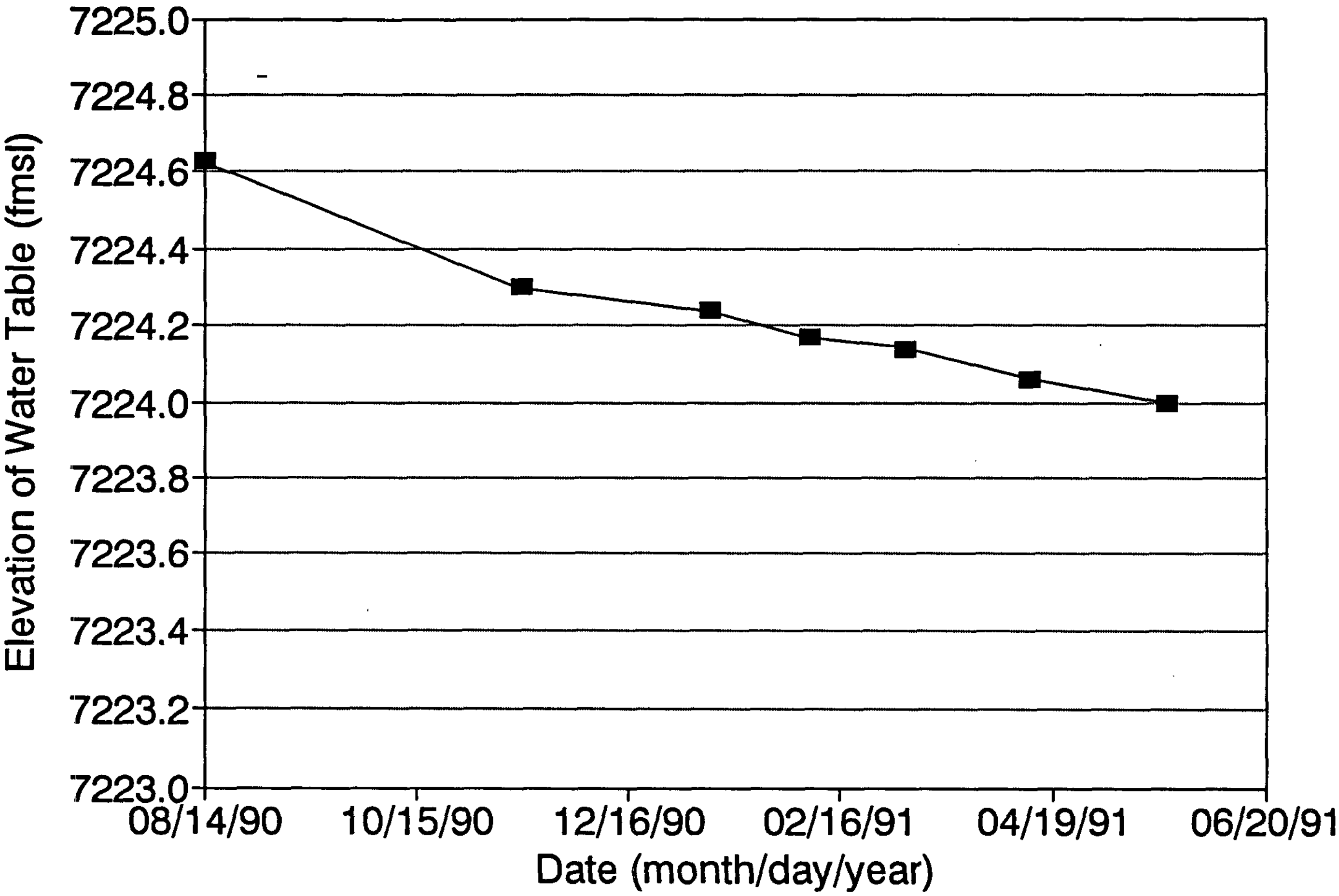
5-6B Hydrograph



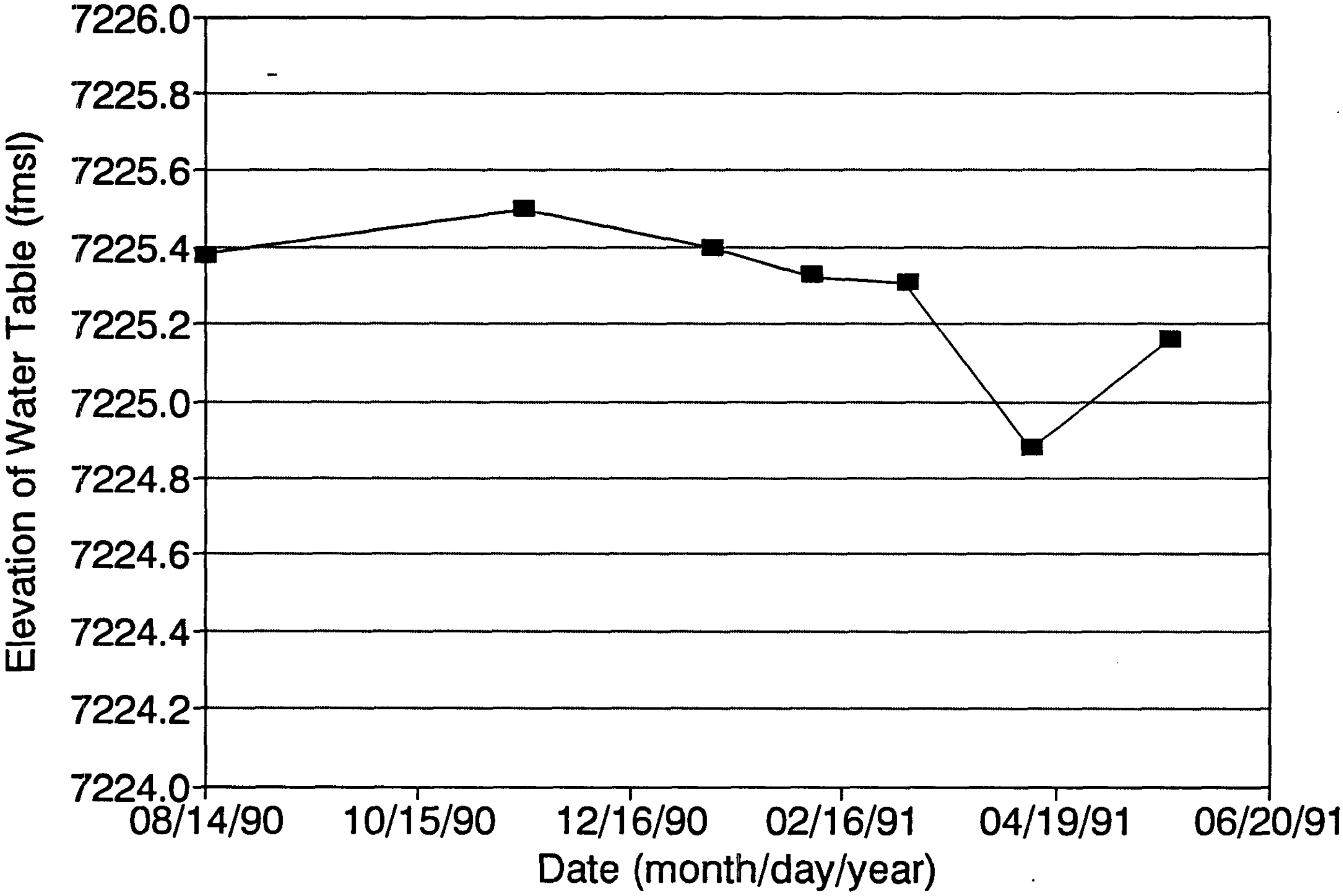
5-12B Hydrograph

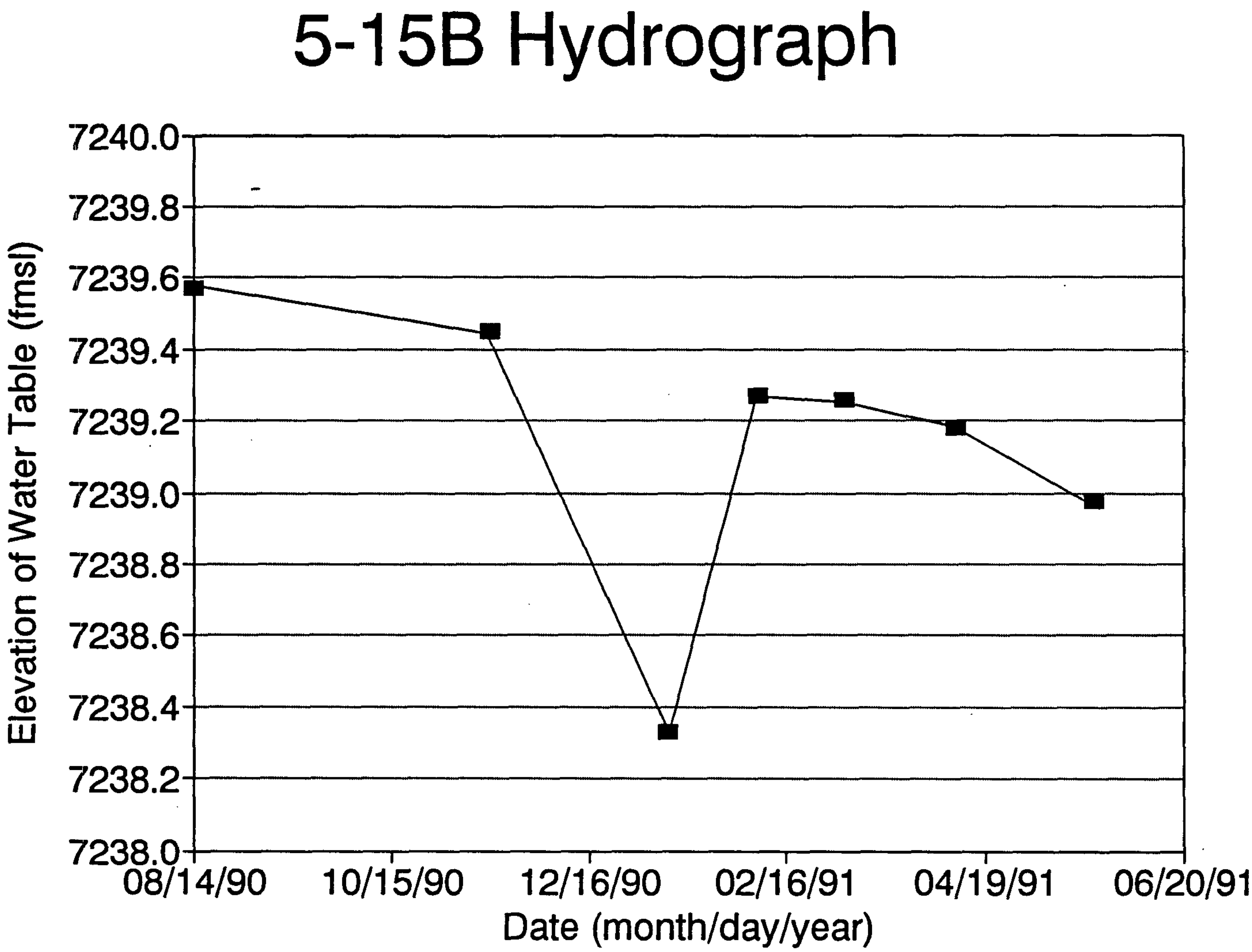


5-13B Hydrograph

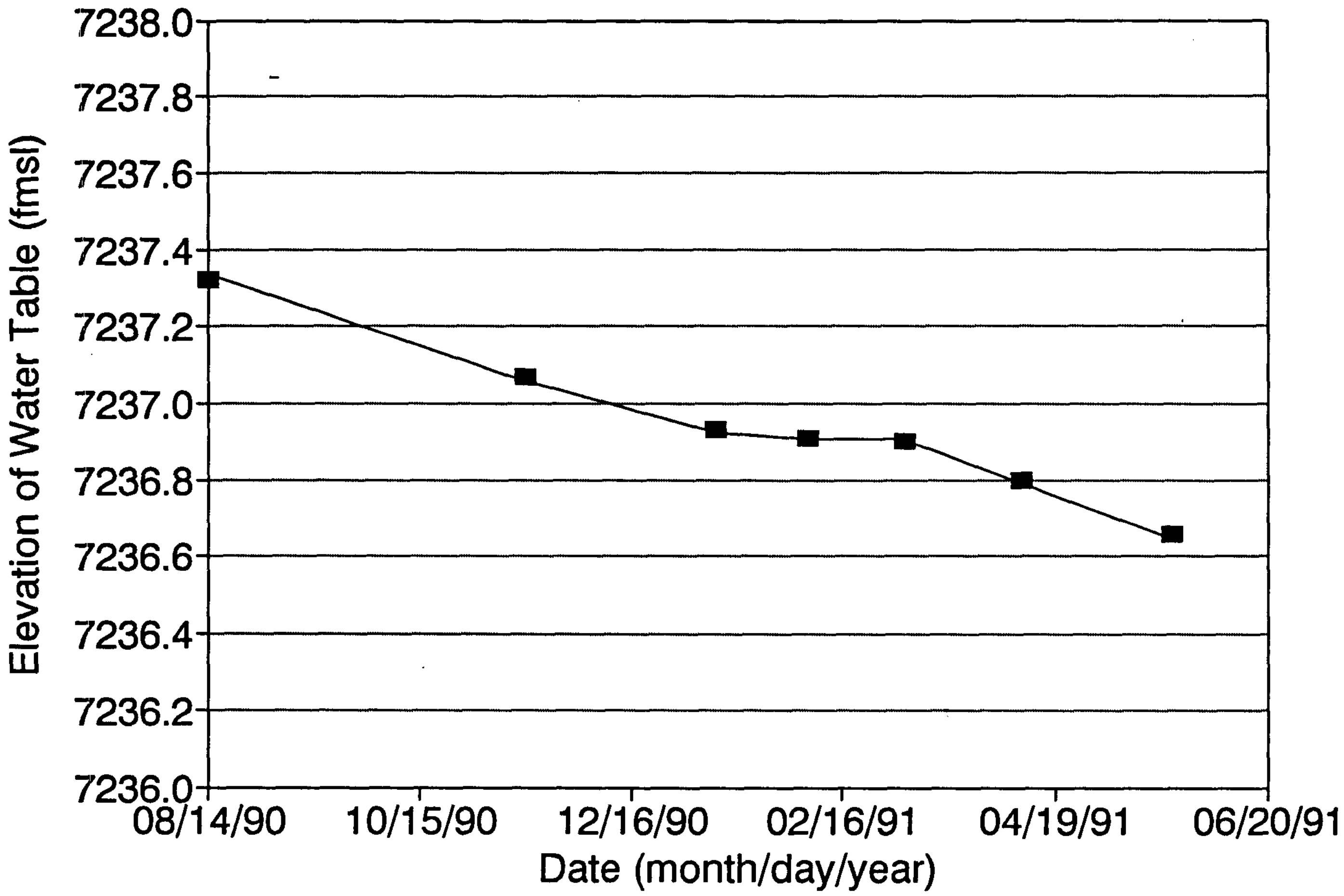


5-14B Hydrograph

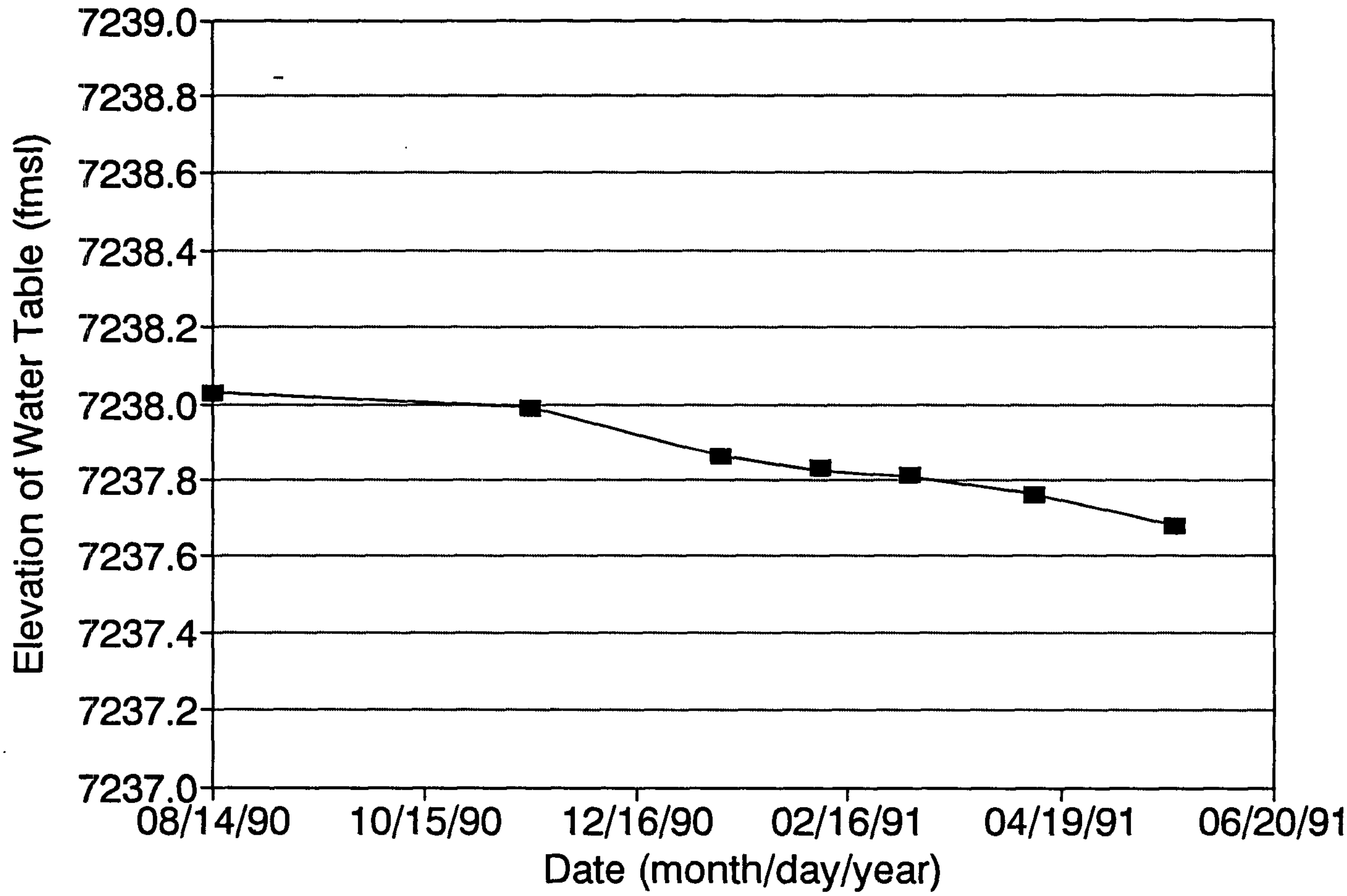



5-15B Hydrograph
Elevation of Water Table (fmsl)
7240.0
7239.8
7239.6
7239.4
7239.2
7239.0
7238.8
7238.6
7238.4
7238.2
7238.0
08/14/90
10/15/90
12/16/90
02/16/91
04/19/91
06/20/91
Date (month/day/year)

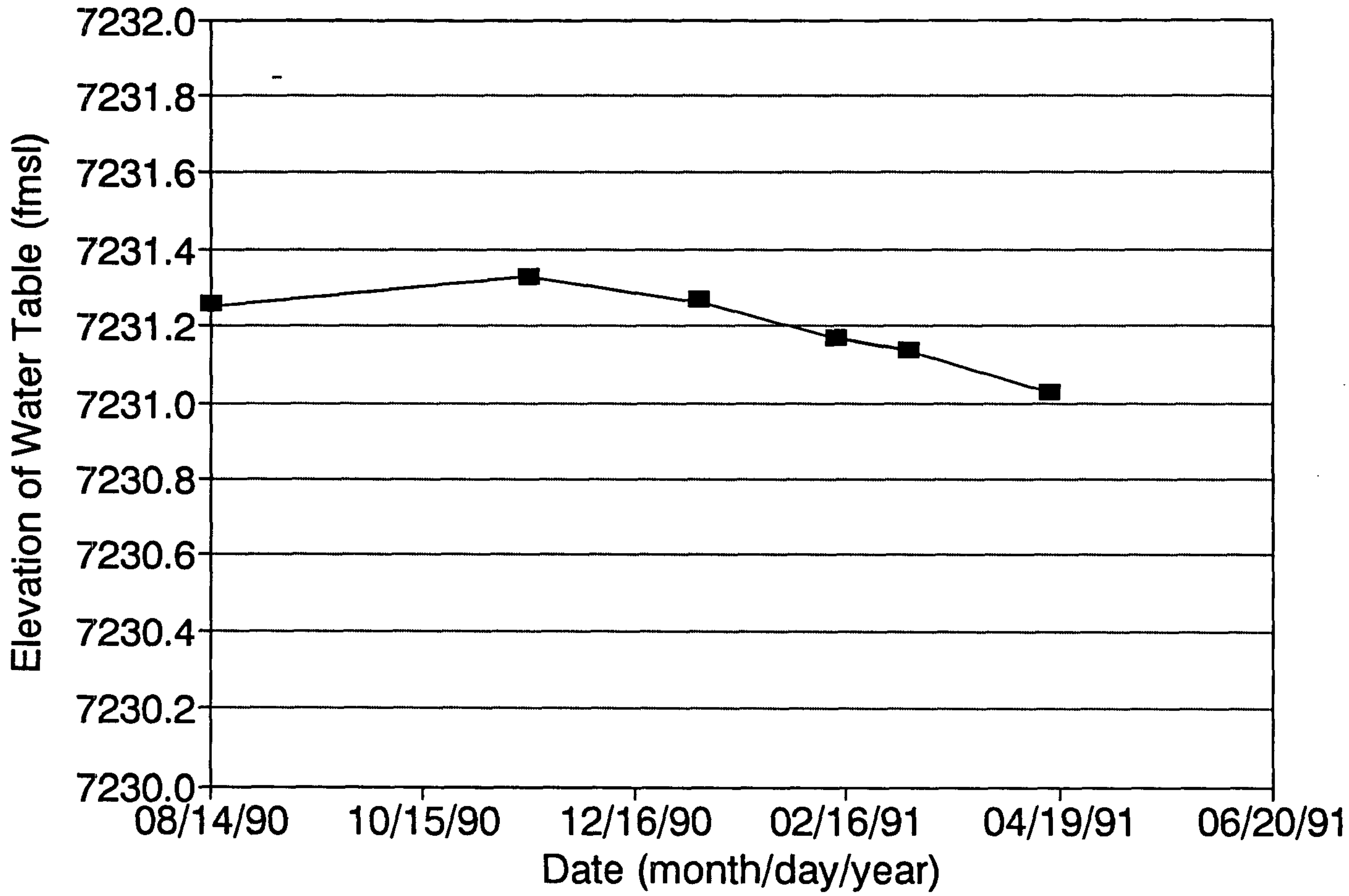
5-16B Hydrograph



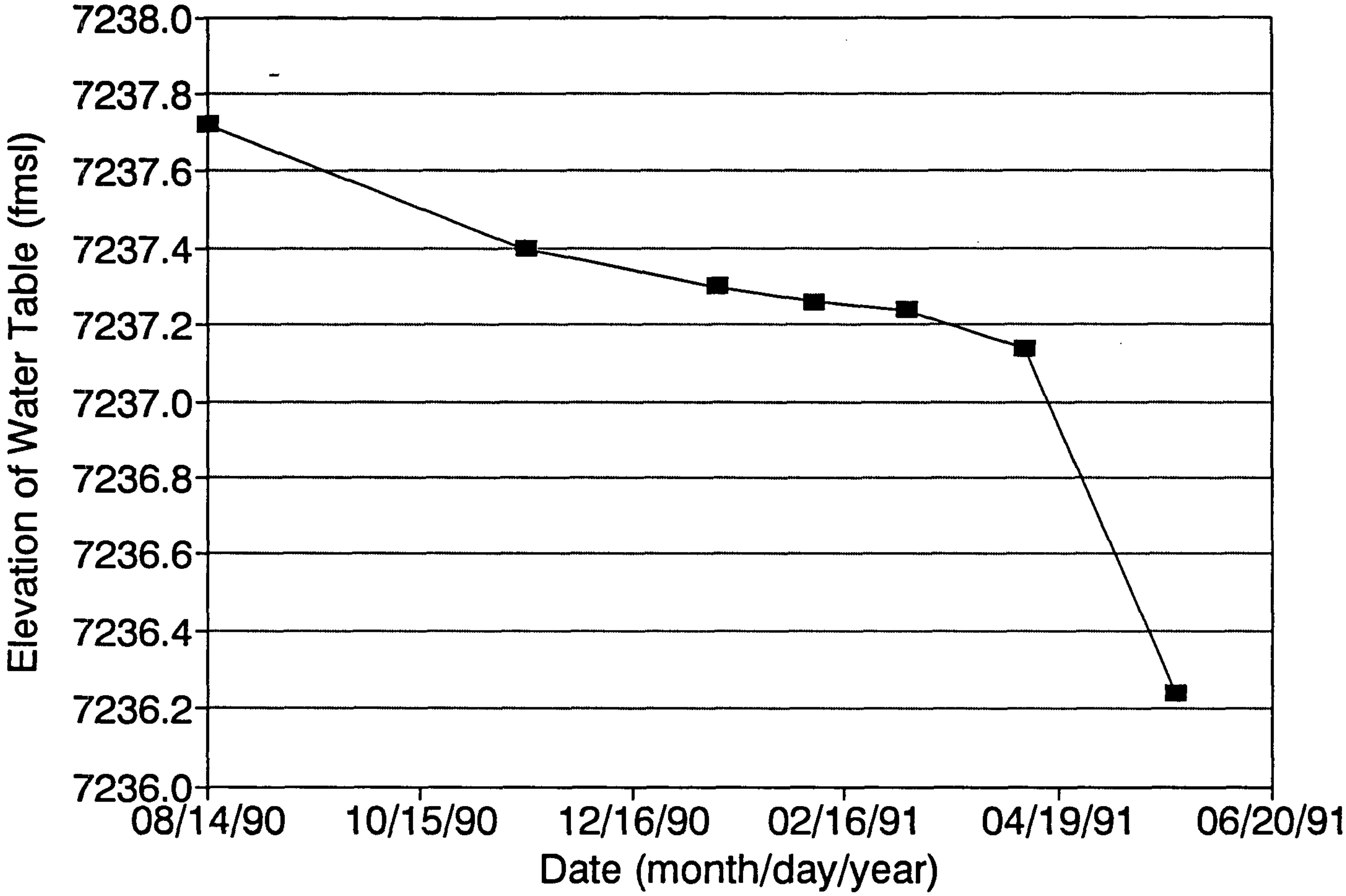
5-17B Hydrograph

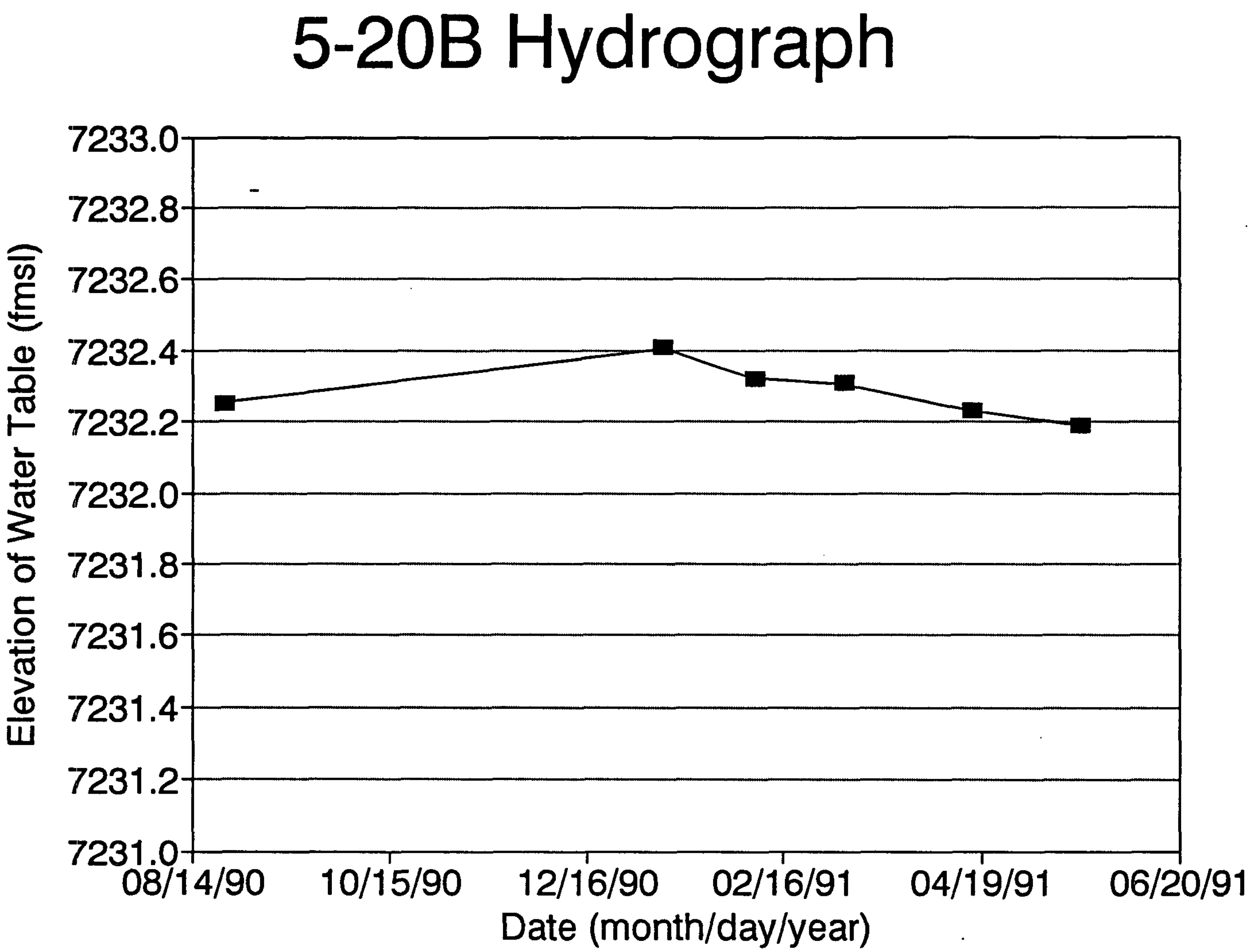


5-18B Hydrograph



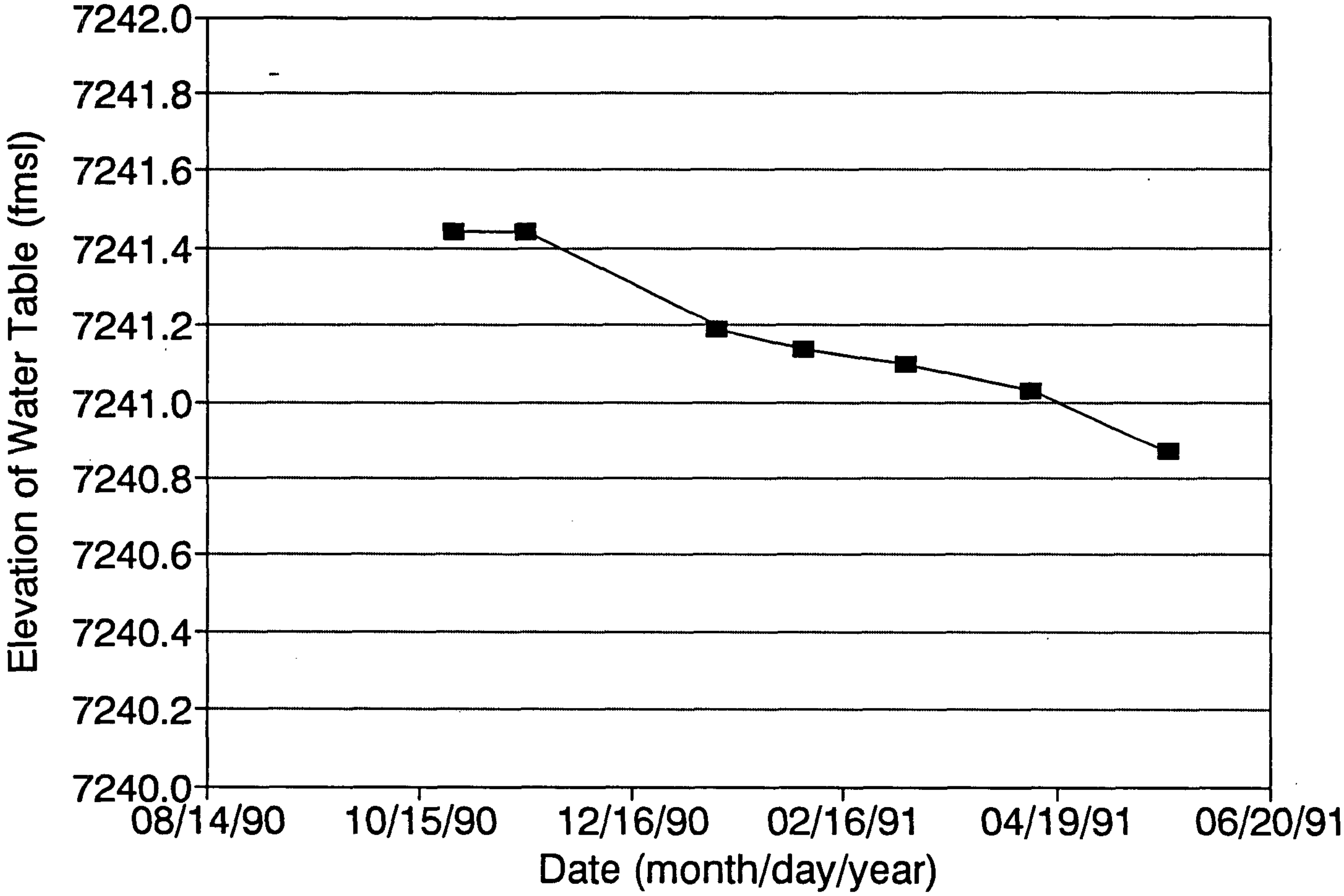
5-19B Hydrograph



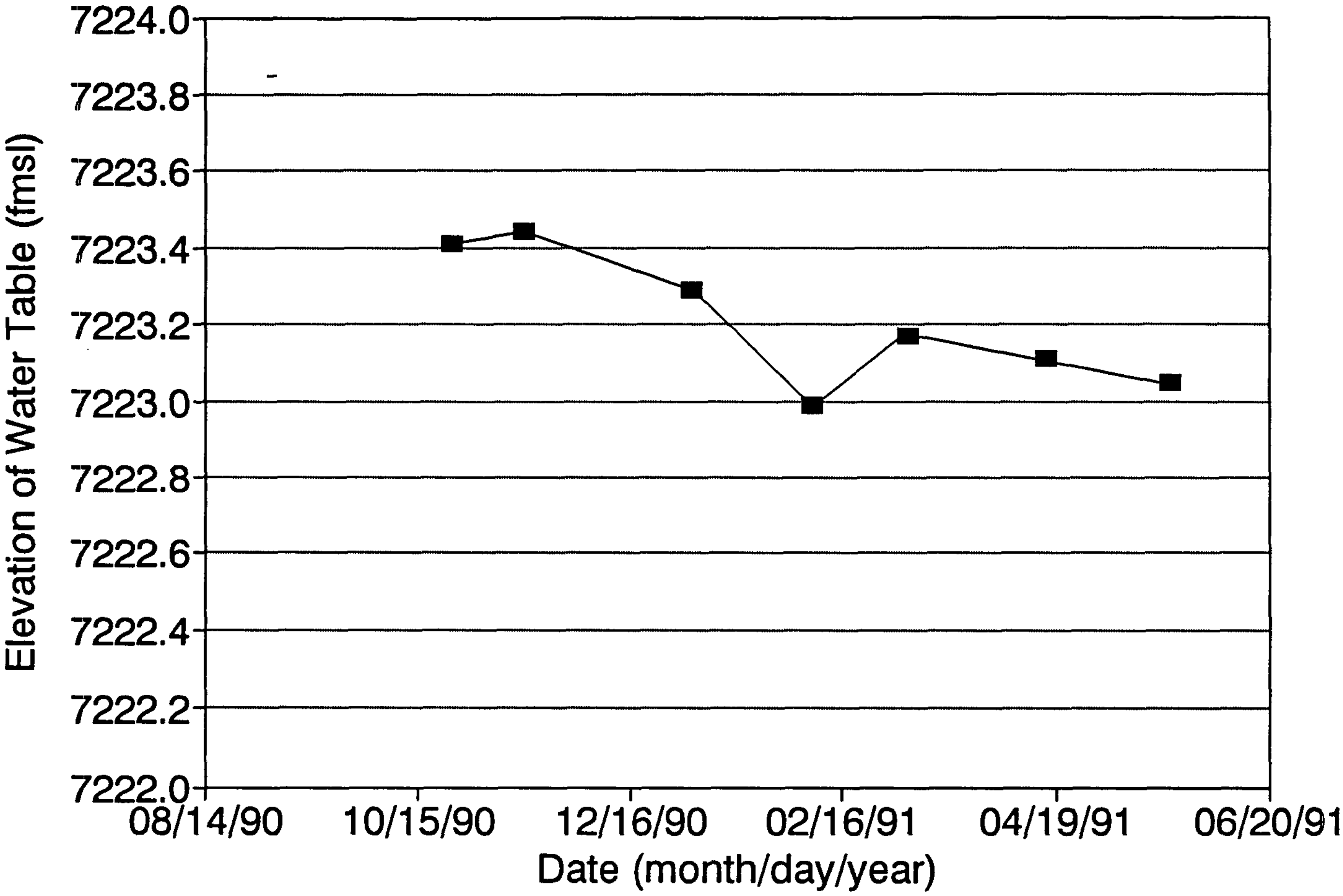


5-20B Hydrograph
Elevation of Water Table (fmsl)
7233.0
7232.8
7232.6
7232.4
7232.2
7232.0
7231.8
7231.6
7231.4
7231.2
7231.0
08/14/90
10/15/90
12/16/90
02/16/91
04/19/91
06/20/91
Date (month/day/year)

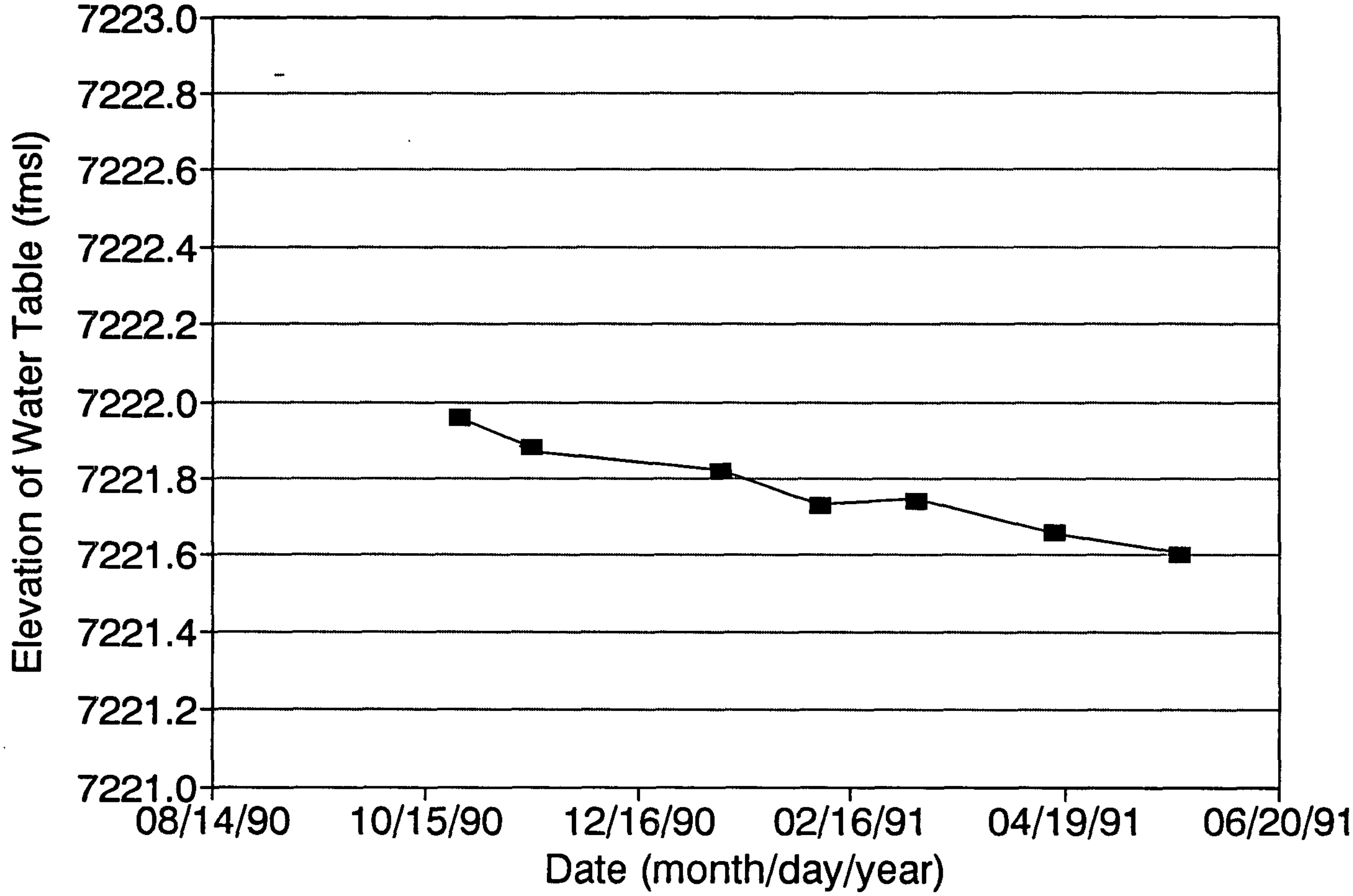
5-22B Hydrograph



5-23B Hydrograph



5-24B Hydrograph



PUMPING TEST RECOVERY DATA FOR MONITOR WELL 5-4B

AQUIFER PUMPING TEST 5-4B
DISCHARGE RATE vs. TIME
DATE: 3/26/91

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (HR:MIN)	DISCHARGE RATE (gpm)
01:20:00 PM	00:09	0.12
01:43:00 PM	00:32	0.12

RECOVERY DATA FOR 5-4B AQUIFER PUMPING TEST
DATE: MARCH 26, 1991
PUMP OFF: 13:47.00 PM

TIME (HR:MIN:SEC	ELAPSE TIME SINCE PUMPING STARTED T (MINUTES)	ELAPSE TIME SINCE PUMPING ENDED T' (MINUTES)	T/T'	RECOVERY (FEET)
01:47:05 PM	36.09	0.09	416.38	3.33
01:47:35 PM	36.59	0.59	62.36	2.77
01:48:05 PM	37.09	1.09	34.13	2.21
01:48:35 PM	37.59	1.59	23.69	1.97
01:49:05 PM	38.09	2.09	18.25	1.77
01:49:35 PM	38.59	2.59	14.92	1.73
01:50:05 PM	39.09	3.09	12.66	1.72
01:50:35 PM	39.59	3.59	11.04	1.71
01:51:05 PM	40.09	4.09	9.81	1.70
01:51:35 PM	40.59	4.59	8.85	1.69
01:52:05 PM	41.09	5.09	8.08	1.69
01:52:35 PM	41.59	5.59	7.44	1.67
01:53:05 PM	42.09	6.09	6.91	1.66
01:53:35 PM	42.59	6.59	6.47	1.66
01:54:05 PM	43.09	7.09	6.08	1.64
01:54:35 PM	43.59	7.59	5.75	1.63
01:55:05 PM	44.09	8.09	5.45	1.62
01:55:35 PM	44.59	8.59	5.19	1.62
01:56:05 PM	45.09	9.09	4.96	1.61
01:56:35 PM	45.59	9.59	4.76	1.60
01:57:05 PM	46.09	10.09	4.57	1.58
01:57:35 PM	46.59	10.59	4.40	1.58
01:58:05 PM	47.09	11.09	4.25	1.57
01:58:35 PM	47.59	11.59	4.11	1.56
01:59:05 PM	48.09	12.09	3.98	1.55
01:59:35 PM	48.59	12.59	3.86	1.55
02:00:05 PM	49.09	13.09	3.75	1.54
02:00:35 PM	49.59	13.59	3.65	1.54
02:01:05 PM	50.09	14.09	3.56	1.53
02:01:35 PM	50.59	14.59	3.47	1.51
02:02:05 PM	51.09	15.09	3.39	1.51
02:02:35 PM	51.59	15.59	3.31	1.51
02:03:05 PM	52.09	16.09	3.24	1.51
02:03:35 PM	52.59	16.59	3.17	1.49
02:04:05 PM	53.09	17.09	3.11	1.49
02:04:35 PM	53.59	17.59	3.05	1.49
02:05:05 PM	54.09	18.09	2.99	1.48
02:05:35 PM	54.59	18.59	2.94	1.47

RECOVERY DATA FOR 5-4B AQUIFER PUMPING TEST
DATE: MARCH 26, 1991
PUMP OFF: 13:47.00 PM

TIME (HR:MIN:SEC	ELAPSE TIME SINCE PUMPING STARTED T (MINUTES)	ELAPSE TIME SINCE PUMPING ENDED T' (MINUTES)	T/T'	RECOVERY (FEET)
02:06:05 PM	55.09	19.09	2.89	1.47
02:06:35 PM	55.59	19.59	2.84	1.46
02:07:05 PM	56.09	20.09	2.79	1.45
02:07:35 PM	56.59	20.59	2.75	1.45
02:08:05 PM	57.09	21.09	2.71	1.44
02:08:35 PM	57.59	21.59	2.67	1.44
02:09:05 PM	58.09	22.09	2.63	1.44
02:09:35 PM	58.59	22.59	2.59	1.43
02:10:05 PM	59.09	23.09	2.56	1.43
02:10:35 PM	59.59	23.59	2.53	1.42
02:11:05 PM	60.09	24.09	2.49	1.43
02:11:35 PM	60.59	24.59	2.46	1.41
02:12:05 PM	61.09	25.09	2.44	1.41
02:12:35 PM	61.59	25.59	2.41	1.40
02:13:05 PM	62.09	26.09	2.38	1.40
02:13:35 PM	62.59	26.59	2.35	1.40
02:14:05 PM	63.09	27.09	2.33	1.38
02:14:35 PM	63.59	27.59	2.30	1.38
02:15:05 PM	64.09	28.09	2.28	1.37
02:15:35 PM	64.59	28.59	2.26	1.36
02:16:05 PM	65.09	29.09	2.24	1.36
02:16:35 PM	65.59	29.59	2.22	1.32
02:17:05 PM	66.09	30.09	2.20	1.33
02:17:35 PM	66.59	30.59	2.18	1.30
02:18:05 PM	67.09	31.09	2.16	1.30
02:18:35 PM	67.59	31.59	2.14	1.30
02:19:05 PM	68.09	32.09	2.12	1.29
02:19:35 PM	68.59	32.59	2.10	1.29
02:20:05 PM	69.09	33.09	2.09	1.29
02:20:35 PM	69.59	33.59	2.07	1.28
02:21:05 PM	70.09	34.09	2.06	1.28
02:21:35 PM	70.59	34.59	2.04	1.27
02:22:05 PM	71.09	35.09	2.03	1.25
02:22:35 PM	71.59	35.59	2.01	1.26
02:23:05 PM	72.09	36.09	2.00	1.25
02:23:35 PM	72.59	36.59	1.98	1.24
02:24:05 PM	73.09	37.09	1.97	1.23
02:24:35 PM	73.59	37.59	1.96	1.22

RECOVERY DATA FOR 5-4B AQUIFER PUMPING TEST
DATE: MARCH 26, 1991
PUMP OFF: 13:47.00 PM

TIME (HR:MIN:SEC	ELAPSE TIME SINCE PUMPING STARTED T (MINUTES)	ELAPSE TIME SINCE PUMPING ENDED T' (MINUTES)	T/T'	RECOVERY (FEET)
02:25:05 PM	74.09	38.09	1.95	1.21
02:25:35 PM	74.59	38.59	1.93	1.21
02:26:05 PM	75.09	39.09	1.92	1.21
02:26:35 PM	75.59	39.59	1.91	1.20
02:27:05 PM	76.09	40.09	1.90	1.19
02:27:35 PM	76.59	40.59	1.89	1.19
02:28:05 PM	77.09	41.09	1.88	1.17
02:28:35 PM	77.59	41.59	1.87	1.17
02:29:05 PM	78.09	42.09	1.86	1.17
02:29:35 PM	78.59	42.59	1.85	1.17
02:30:05 PM	79.09	43.09	1.84	1.15
02:30:35 PM	79.59	43.59	1.83	1.22
02:31:05 PM	80.09	44.09	1.82	1.21
02:31:35 PM	80.59	44.59	1.81	1.21
02:32:05 PM	81.09	45.09	1.80	1.23

CONSTANT RATE PUMPING TEST DATA
FOR MONITOR WELL 5-5B

AQUIFER PUMPING TEST 5-5B
DISCHARGE RATE vs. TIME
DATE: 4/5/91

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (HR:MIN)	DISCHARGE RATE (gpm)
01:27:00 PM	00:03	1.1
01:34:00 PM	00:10	1.0
01:43:00 PM	00:19	1.0
01:55:00 PM	00:31	1.0
02:09:00 PM	00:45	1.0
02:23:00 PM	00:59	1.0
02:40:00 PM	01:16	1.0
03:10:00 PM	01:46	1.0
03:30:00 PM	02:06	1.0
03:40:00 PM	02:16	1.0
03:50:00 PM	02:26	1.0
04:00:00 PM	02:36	1.0

AQUIFER PUMPING TEST 5-5B
DATE: APRIL 5, 1991
PUMP ON: 01:24:00 PM
PUMP OFF: 04:10:00 PM
TEST DURATION: 166 MINUTES

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
01:24:10 PM	0.17	0.26
01:24:40 PM	0.67	0.26
01:25:10 PM	1.17	0.31
01:25:40 PM	1.67	0.38
01:26:10 PM	2.17	0.45
01:26:40 PM	2.67	0.51
01:27:10 PM	3.17	0.57
01:27:40 PM	3.67	0.66
01:28:10 PM	4.17	0.72
01:28:40 PM	4.67	0.81
01:29:10 PM	5.17	0.91
01:29:40 PM	5.67	1.02
01:30:10 PM	6.17	1.17
01:30:40 PM	6.67	1.31
01:31:10 PM	7.17	1.46
01:31:40 PM	7.67	1.60
01:32:10 PM	8.17	1.71
01:32:40 PM	8.67	1.81
01:33:10 PM	9.17	1.92
01:33:40 PM	9.67	2.00
01:34:10 PM	10.17	2.09
01:34:40 PM	10.67	2.18
01:35:10 PM	11.17	2.27
01:35:40 PM	11.67	2.34
01:36:10 PM	12.17	2.40
01:36:40 PM	12.67	2.47
01:37:10 PM	13.17	2.53
01:37:40 PM	13.67	2.59
01:38:10 PM	14.17	2.64
01:38:40 PM	14.67	2.68
01:39:10 PM	15.17	2.73
01:39:40 PM	15.67	2.78
01:40:10 PM	16.17	2.81
01:40:40 PM	16.67	2.82
01:41:10 PM	17.17	2.86
01:41:40 PM	17.67	2.87
01:42:10 PM	18.17	2.91
01:42:40 PM	18.67	2.94
01:43:10 PM	19.17	2.96
01:43:40 PM	19.67	3.00

AQUIFER PUMPING TEST 5-5B
DATE: APRIL 5, 1991
PUMP ON: 01:24:00 PM
PUMP OFF: 04:10:00 PM
TEST DURATION: 166 MINUTES

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
01:44:10 PM	20.17	3.01
01:44:40 PM	20.67	3.04
01:45:10 PM	21.17	3.05
01:45:40 PM	21.67	3.07
01:46:10 PM	22.17	3.10
01:46:40 PM	22.67	3.10
01:47:10 PM	23.17	3.12
01:47:40 PM	23.67	3.15
01:48:10 PM	24.17	3.18
01:48:40 PM	24.67	3.18
01:49:10 PM	25.17	3.21
01:49:40 PM	25.67	3.22
01:50:10 PM	26.17	3.25
01:50:40 PM	26.67	3.27
01:51:10 PM	27.17	3.28
01:51:40 PM	27.67	3.32
01:52:10 PM	28.17	3.32
01:52:40 PM	28.67	3.32
01:53:10 PM	29.17	3.34
01:53:40 PM	29.67	3.35
01:54:10 PM	30.17	3.36
01:54:40 PM	30.67	3.36
01:55:10 PM	31.17	3.38
01:55:40 PM	31.67	3.40
01:56:10 PM	32.17	3.42
01:56:40 PM	32.67	3.43
01:57:10 PM	33.17	3.45
01:57:40 PM	33.67	3.47
01:58:10 PM	34.17	3.50
01:58:40 PM	34.67	3.50
01:59:10 PM	35.17	3.51
01:59:40 PM	35.67	3.54
02:00:10 PM	36.17	3.55
02:00:40 PM	36.67	3.57
02:01:10 PM	37.17	3.58
02:01:40 PM	37.67	3.61
02:02:10 PM	38.17	3.61
02:02:40 PM	38.67	3.63
02:03:10 PM	39.17	3.65
02:03:40 PM	39.67	3.66

AQUIFER PUMPING TEST 5-5B
DATE: APRIL 5, 1991
PUMP ON: 01:24:00 PM
PUMP OFF: 04:10:00 PM
TEST DURATION: 166 MINUTES

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
02:04:10 PM	40.17	3.68
02:04:40 PM	40.67	3.69
02:05:10 PM	41.17	3.72
02:05:40 PM	41.67	3.73
02:06:10 PM	42.17	3.75
02:06:40 PM	42.67	3.76
02:07:10 PM	43.17	3.78
02:07:40 PM	43.67	3.82
02:08:10 PM	44.17	3.83
02:08:40 PM	44.67	3.85
02:09:10 PM	45.17	3.85
02:09:40 PM	45.67	3.88
02:10:10 PM	46.17	3.90
02:10:40 PM	46.67	3.92
02:11:10 PM	47.17	3.94
02:11:40 PM	47.67	3.97
02:12:10 PM	48.17	4.01
02:12:40 PM	48.67	4.03
02:13:10 PM	49.17	4.07
02:13:40 PM	49.67	4.08
02:14:10 PM	50.17	4.10
02:14:40 PM	50.67	4.13
02:15:10 PM	51.17	4.16
02:15:40 PM	51.67	4.19
02:16:10 PM	52.17	4.23
02:16:40 PM	52.67	4.28
02:17:10 PM	53.17	4.32
02:17:40 PM	53.67	4.35
02:18:10 PM	54.17	4.38
02:18:40 PM	54.67	4.41
02:19:10 PM	55.17	4.44
02:19:40 PM	55.67	4.50
02:20:10 PM	56.17	4.54
02:20:40 PM	56.67	4.57
02:21:10 PM	57.17	4.61
02:21:40 PM	57.67	4.66
02:22:10 PM	58.17	4.70
02:22:40 PM	58.67	4.73
02:23:10 PM	59.17	4.77
02:23:40 PM	59.67	4.82

AQUIFER PUMPING TEST 5-5B
DATE: APRIL 5, 1991
PUMP ON: 01:24:00 PM
PUMP OFF: 04:10:00 PM
TEST DURATION: 166 MINUTES

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
02:24:10 PM	60.17	4.85
02:24:40 PM	60.67	4.91
02:25:10 PM	61.17	4.97
02:25:40 PM	61.67	5.01
02:26:10 PM	62.17	5.06
02:26:40 PM	62.67	5.10
02:27:10 PM	63.17	5.13
02:27:40 PM	63.67	5.18
02:28:10 PM	64.17	5.23
02:28:40 PM	64.67	5.25
02:29:10 PM	65.17	5.29
02:29:40 PM	65.67	5.32
02:30:10 PM	66.17	5.35
02:30:40 PM	66.67	5.36
02:31:10 PM	67.17	5.41
02:31:40 PM	67.67	5.42
02:32:10 PM	68.17	5.45
02:32:40 PM	68.67	5.49
02:33:10 PM	69.17	5.53
02:33:40 PM	69.67	5.57
02:34:10 PM	70.17	5.60
02:34:40 PM	70.67	5.67
02:35:10 PM	71.17	5.70
02:35:40 PM	71.67	5.74
02:36:10 PM	72.17	5.80
02:36:40 PM	72.67	5.85
02:37:10 PM	73.17	5.89
02:37:40 PM	73.67	5.95
02:38:10 PM	74.17	5.99
02:38:40 PM	74.67	6.04
02:39:10 PM	75.17	6.08
02:39:40 PM	75.67	6.14
02:40:10 PM	76.17	6.17
02:40:40 PM	76.67	6.20
02:41:10 PM	77.17	6.25
02:41:40 PM	77.67	6.29
02:42:10 PM	78.17	6.33
02:42:40 PM	78.67	6.37
02:43:10 PM	79.17	6.41
02:43:40 PM	79.67	6.44

AQUIFER PUMPING TEST 5-5B
DATE: APRIL 5, 1991
PUMP ON: 01:24:00 PM
PUMP OFF: 04:10:00 PM
TEST DURATION: 166 MINUTES

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
02:44:10 PM	80.17	6.50
02:44:40 PM	80.67	6.53
02:45:10 PM	81.17	6.57
02:45:40 PM	81.67	6.61
02:46:10 PM	82.17	6.66
02:46:40 PM	82.67	6.70
02:47:10 PM	83.17	6.73
02:47:40 PM	83.67	6.78
02:48:10 PM	84.17	6.82
02:48:40 PM	84.67	6.85
02:49:10 PM	85.17	6.91
02:49:40 PM	85.67	6.94
02:50:10 PM	86.17	6.98
02:50:40 PM	86.67	7.03
02:51:10 PM	87.17	7.09
02:51:40 PM	87.67	7.13
02:52:10 PM	88.17	7.19
02:52:40 PM	88.67	7.24
02:53:10 PM	89.17	7.28
02:54:10 PM	90.17	7.39
02:55:10 PM	91.17	7.48
02:56:10 PM	92.17	7.55
02:57:10 PM	93.17	7.63
02:58:10 PM	94.17	7.69
02:59:10 PM	95.17	7.75
03:00:10 PM	96.17	7.81
03:01:10 PM	97.17	7.88
03:02:10 PM	98.17	7.94
03:03:10 PM	99.17	7.99
03:04:10 PM	100.17	8.03
03:05:10 PM	101.17	8.07
03:06:10 PM	102.17	8.08
03:07:10 PM	103.17	8.11
03:08:10 PM	104.17	8.14
03:09:10 PM	105.17	8.17
03:10:10 PM	106.17	8.21
03:11:10 PM	107.17	8.23
03:12:10 PM	108.17	8.26
03:13:10 PM	109.17	8.28
03:14:10 PM	110.17	8.34

AQUIFER PUMPING TEST 5-5B
DATE: APRIL 5, 1991
PUMP ON: 01:24:00 PM
PUMP OFF: 04:10:00 PM
TEST DURATION: 166 MINUTES

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
03:15:10 PM	111.17	8.35
03:16:10 PM	112.17	8.40
03:17:10 PM	113.17	8.44
03:18:10 PM	114.17	8.46
03:19:10 PM	115.17	8.50
03:20:10 PM	116.17	8.51
03:21:10 PM	117.17	8.53
03:22:10 PM	118.17	8.57
03:23:10 PM	119.17	8.60
03:24:10 PM	120.17	8.63
03:25:10 PM	121.17	8.64
03:26:10 PM	122.17	8.67
03:27:10 PM	123.17	8.68
03:28:10 PM	124.17	8.69
03:29:10 PM	125.17	8.70
03:30:10 PM	126.17	8.69
03:31:10 PM	127.17	8.70
03:32:10 PM	128.17	8.72
03:33:10 PM	129.17	8.71
03:34:10 PM	130.17	8.70
03:35:10 PM	131.17	8.69
03:36:10 PM	132.17	8.68
03:37:10 PM	133.17	8.69
03:38:10 PM	134.17	8.68
03:39:10 PM	135.17	8.66
03:40:10 PM	136.17	8.63
03:41:10 PM	137.17	8.61
03:42:10 PM	138.17	8.61
03:43:10 PM	139.17	8.63
03:44:10 PM	140.17	8.66
03:45:10 PM	141.17	8.68
03:46:10 PM	142.17	8.69
03:47:10 PM	143.17	8.69
03:48:10 PM	144.17	8.69
03:49:10 PM	145.17	8.70
03:50:10 PM	146.17	8.69
03:51:10 PM	147.17	8.93
03:52:10 PM	148.17	9.24
03:53:10 PM	149.17	9.56
03:54:10 PM	150.17	9.86

AQUIFER PUMPING TEST 5-5B
DATE: APRIL 5, 1991
PUMP ON: 01:24:00 PM
PUMP OFF: 04:10:00 PM
TEST DURATION: 166 MINUTES

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
03:55:10 PM	151.17	9.98
03:56:10 PM	152.17	10.03
03:57:10 PM	153.17	10.09
03:58:10 PM	154.17	10.14
03:59:10 PM	155.17	10.18
04:00:10 PM	156.17	10.23
04:01:10 PM	157.17	10.26
04:02:10 PM	158.17	10.28
04:03:10 PM	159.17	10.29
04:04:10 PM	160.17	10.32

RECOVERY DATA FOR 5-5B AQUIFER PUMPING TEST
DATE: APRIL 5, 1991
PUMP OFF: 04:10:00 PM

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (minutes)	ELAPSE TIME SINCE PUMPING ENDED (minutes)	T/T'	DEPTH BELOW STATIC LEVEL (feet)
04:10:20 PM	166.34	0.34	494.07	7.74
04:10:25 PM	166.42	0.42	396.24	7.15
04:10:30 PM	166.50	0.50	330.80	6.67
04:10:35 PM	166.59	0.59	283.95	6.18
04:10:40 PM	166.67	0.67	248.76	5.58
04:10:45 PM	166.75	0.75	221.35	5.14
04:10:50 PM	166.84	0.84	199.41	4.86
04:10:55 PM	166.92	0.92	181.43	4.67
04:11:00 PM	167.00	1.00	166.45	4.42
04:11:05 PM	167.09	1.09	153.76	4.23
04:11:10 PM	167.17	1.17	142.88	4.05
04:11:15 PM	167.25	1.25	133.45	3.90
04:11:20 PM	167.34	1.34	125.19	3.75
04:11:25 PM	167.42	1.42	117.90	3.61
04:11:30 PM	167.50	1.50	111.42	3.48
04:11:35 PM	167.59	1.59	105.62	3.39
04:11:40 PM	167.67	1.67	100.40	3.30
04:11:45 PM	167.75	1.75	95.68	3.21
04:11:50 PM	167.84	1.84	91.38	3.13
04:11:55 PM	167.92	1.92	87.46	3.04
04:12:00 PM	168.00	2.00	83.86	2.95
04:12:05 PM	168.09	2.09	80.55	2.85
04:12:10 PM	168.17	2.17	77.50	2.75
04:12:15 PM	168.25	2.25	74.67	2.69
04:12:20 PM	168.34	2.34	72.04	2.63
04:12:25 PM	168.42	2.42	69.60	2.56
04:12:30 PM	168.50	2.50	67.31	2.49
04:12:35 PM	168.59	2.59	65.18	2.42
04:12:40 PM	168.67	2.67	63.17	2.36
04:12:45 PM	168.75	2.75	61.29	2.31
04:12:50 PM	168.84	2.84	59.52	2.25
04:12:55 PM	168.92	2.92	57.85	2.20
04:13:00 PM	169.00	3.00	56.27	2.14
04:13:05 PM	169.09	3.09	54.78	2.10
04:13:10 PM	169.17	3.17	53.37	2.06
04:13:15 PM	169.25	3.25	52.02	2.00
04:13:20 PM	169.34	3.34	50.75	1.96
04:13:25 PM	169.42	3.42	49.54	1.92
04:13:30 PM	169.50	3.50	48.38	1.88

RECOVERY DATA FOR 5-5B AQUIFER PUMPING TEST
DATE: APRIL 5, 1991
PUMP OFF: 04:10:00 PM

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (minutes)	ELAPSE TIME SINCE PUMPING ENDED (minutes)	T/T'	DEPTH BELOW STATIC LEVEL (feet)
04:13:35 PM	169.59	3.59	47.28	1.85
04:13:40 PM	169.67	3.67	46.23	1.81
04:13:45 PM	169.75	3.75	45.23	1.76
04:13:50 PM	169.84	3.84	44.27	1.73
04:13:55 PM	169.92	3.92	43.35	1.70
04:14:00 PM	170.00	4.00	42.47	1.67
04:14:05 PM	170.09	4.09	41.62	1.63
04:14:10 PM	170.17	4.17	40.81	1.60
04:14:15 PM	170.25	4.25	40.03	1.56
04:14:20 PM	170.34	4.34	39.28	1.54
04:14:25 PM	170.42	4.42	38.56	1.51
04:14:30 PM	170.50	4.50	37.86	1.49
04:14:35 PM	170.59	4.59	37.19	1.45
04:14:40 PM	170.67	4.67	36.55	1.43
04:14:45 PM	170.75	4.75	35.92	1.40
04:14:50 PM	170.84	4.84	35.32	1.38
04:14:55 PM	170.92	4.92	34.74	1.34
04:15:00 PM	171.00	5.00	34.18	1.32
04:15:05 PM	171.09	5.09	33.63	1.30
04:15:10 PM	171.17	5.17	33.11	1.28
04:15:15 PM	171.25	5.25	32.60	1.26
04:15:20 PM	171.34	5.34	32.11	1.23
04:15:25 PM	171.42	5.42	31.63	1.22
04:15:30 PM	171.50	5.50	31.16	1.20
04:15:35 PM	171.59	5.59	30.71	1.16
04:15:40 PM	171.67	5.67	30.28	1.16
04:15:45 PM	171.75	5.75	29.85	1.13
04:15:50 PM	171.84	5.84	29.44	1.13
04:15:55 PM	171.92	5.92	29.04	1.10
04:16:00 PM	172.00	6.00	28.65	1.08
04:16:05 PM	172.09	6.09	28.27	1.06
04:16:10 PM	172.17	6.17	27.90	1.05
04:16:15 PM	172.25	6.25	27.55	1.03
04:16:20 PM	172.34	6.34	27.20	1.01
04:16:25 PM	172.42	6.42	26.86	1.00
04:16:30 PM	172.50	6.50	26.53	0.98
04:16:35 PM	172.59	6.59	26.20	0.98
04:16:40 PM	172.67	6.67	25.89	0.95
04:16:45 PM	172.75	6.75	25.58	0.95

RECOVERY DATA FOR 5-5B AQUIFER PUMPING TEST
DATE: APRIL 5, 1991
PUMP OFF: 04:10:00 PM

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (minutes)	ELAPSE TIME SINCE PUMPING ENDED (minutes)	T/T'	DEPTH BELOW STATIC LEVEL (feet)
04:16:50 PM	172.84	6.84	25.28	0.93
04:16:55 PM	172.92	6.92	24.99	0.91
04:17:00 PM	173.00	7.00	24.70	0.91
04:17:05 PM	173.09	7.09	24.42	0.89
04:17:10 PM	173.17	7.17	24.15	0.88
04:17:15 PM	173.25	7.25	23.89	0.88
04:17:20 PM	173.34	7.34	23.63	0.85
04:17:25 PM	173.42	7.42	23.37	0.85
04:17:30 PM	173.50	7.50	23.12	0.84
04:17:35 PM	173.59	7.59	22.88	0.82
04:17:40 PM	173.67	7.67	22.64	0.82
04:17:45 PM	173.75	7.75	22.41	0.81
04:17:50 PM	173.84	7.84	22.18	0.79
04:17:55 PM	173.92	7.92	21.96	0.79
04:18:00 PM	174.00	8.00	21.74	0.78
04:18:05 PM	174.09	8.09	21.53	0.77
04:18:10 PM	174.17	8.17	21.32	0.76
04:18:15 PM	174.25	8.25	21.11	0.75
04:18:20 PM	174.34	8.34	20.91	0.73
04:18:25 PM	174.42	8.42	20.71	0.73
04:18:30 PM	174.50	8.50	20.52	0.73
04:18:35 PM	174.59	8.59	20.33	0.72
04:18:40 PM	174.67	8.67	20.15	0.70
04:18:45 PM	174.75	8.75	19.96	0.69
04:18:50 PM	174.84	8.84	19.79	0.69
04:18:55 PM	174.92	8.92	19.61	0.68
04:19:00 PM	175.00	9.00	19.44	0.66
04:19:05 PM	175.09	9.09	19.27	0.66
04:19:10 PM	175.17	9.17	19.10	0.65
04:19:15 PM	175.25	9.25	18.94	0.65
04:19:45 PM	175.75	9.75	18.02	0.62
04:20:15 PM	176.25	10.25	17.19	0.59
04:20:45 PM	176.75	10.75	16.44	0.58
04:21:15 PM	177.25	11.25	15.75	0.59
04:21:45 PM	177.75	11.75	15.12	0.56
04:22:15 PM	178.25	12.25	14.55	0.55
04:22:45 PM	178.75	12.75	14.02	0.54
04:23:15 PM	179.25	13.25	13.53	0.53
04:23:45 PM	179.75	13.75	13.07	0.52

RECOVERY DATA FOR 5-5B AQUIFER PUMPING TEST
DATE: APRIL 5, 1991
PUMP OFF: 04:10:00 PM

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (minutes)	ELAPSE TIME SINCE PUMPING ENDED (minutes)	T/T'	DEPTH BELOW STATIC LEVEL (feet)
04:24:15 PM	180.25	14.25	12.65	0.51
04:24:45 PM	180.75	14.75	12.25	0.51
04:25:15 PM	181.25	15.25	11.88	0.50
04:25:45 PM	181.75	15.75	11.54	0.48
04:26:15 PM	182.25	16.25	11.21	0.48
04:26:45 PM	182.75	16.75	10.91	0.47
04:27:15 PM	183.25	17.25	10.62	0.44
04:27:45 PM	183.75	17.75	10.35	0.45
04:28:15 PM	184.25	18.25	10.09	0.44
04:28:45 PM	184.75	18.75	9.85	0.44
04:29:15 PM	185.25	19.25	9.62	0.42
04:29:45 PM	185.75	19.75	9.40	0.42
04:30:15 PM	186.25	20.25	9.20	0.41
04:30:45 PM	186.75	20.75	9.00	0.41
04:31:15 PM	187.25	21.25	8.81	0.41
04:31:45 PM	187.75	21.75	8.63	0.40
04:32:15 PM	188.25	22.25	8.46	0.38
04:32:45 PM	188.75	22.75	8.30	0.38
04:33:15 PM	189.25	23.25	8.14	0.38
04:33:45 PM	189.75	23.75	7.99	0.38
04:34:15 PM	190.25	24.25	7.84	0.37
04:34:45 PM	190.75	24.75	7.71	0.37
04:35:15 PM	191.25	25.25	7.57	0.37
04:35:45 PM	191.75	25.75	7.45	0.37
04:36:15 PM	192.25	26.25	7.32	0.36
04:36:45 PM	192.75	26.75	7.20	0.36
04:37:15 PM	193.25	27.25	7.09	0.34
04:37:45 PM	193.75	27.75	6.98	0.34
04:38:15 PM	194.25	28.25	6.88	0.34
04:38:45 PM	194.75	28.75	6.77	0.34
04:39:15 PM	195.25	29.25	6.67	0.33
04:39:45 PM	195.75	29.75	6.58	0.34
04:40:15 PM	196.25	30.25	6.49	0.33
04:40:45 PM	196.75	30.75	6.40	0.33
04:41:15 PM	197.25	31.25	6.31	0.32
04:41:45 PM	197.75	31.75	6.23	0.32
04:42:15 PM	198.25	32.25	6.15	0.32
04:42:45 PM	198.75	32.75	6.07	0.32
04:43:15 PM	199.25	33.25	5.99	0.32

RECOVERY DATA FOR 5-5B AQUIFER PUMPING TEST
DATE: APRIL 5, 1991
PUMP OFF: 04:10:00 PM

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (minutes)	ELAPSE TIME SINCE PUMPING ENDED (minutes)	T/T'	DEPTH BELOW STATIC LEVEL (feet)
04:43:45 PM	199.75	33.75	5.92	0.32
04:44:15 PM	200.25	34.25	5.85	0.31
04:44:45 PM	200.75	34.75	5.78	0.30
04:45:15 PM	201.25	35.25	5.71	0.29
04:45:45 PM	201.75	35.75	5.64	0.30
04:46:15 PM	202.25	36.25	5.58	0.29
04:46:45 PM	202.75	36.75	5.52	0.29
04:47:15 PM	203.25	37.25	5.46	0.29
04:47:45 PM	203.75	37.75	5.40	0.29
04:48:15 PM	204.25	38.25	5.34	0.29
04:48:45 PM	204.75	38.75	5.28	0.28
04:49:15 PM	205.25	39.25	5.23	0.28
04:49:45 PM	205.75	39.75	5.18	0.28
04:50:15 PM	206.25	40.25	5.12	0.28
04:50:45 PM	206.75	40.75	5.07	0.27
04:51:15 PM	207.25	41.25	5.02	0.27
04:51:45 PM	207.75	41.75	4.98	0.27
04:52:15 PM	208.25	42.25	4.93	0.27
04:52:45 PM	208.75	42.75	4.88	0.27
04:53:15 PM	209.25	43.25	4.84	0.27
04:53:45 PM	209.75	43.75	4.79	0.27
04:54:15 PM	210.25	44.25	4.75	0.27
04:54:45 PM	210.75	44.75	4.71	0.27
04:55:15 PM	211.25	45.25	4.67	0.26
04:55:45 PM	211.75	45.75	4.63	0.26
04:56:15 PM	212.25	46.25	4.59	0.26
04:56:45 PM	212.75	46.75	4.55	0.26
04:57:15 PM	213.25	47.25	4.51	0.26
04:57:45 PM	213.75	47.75	4.48	0.26
04:58:15 PM	214.25	48.25	4.44	0.26
04:58:45 PM	214.75	48.75	4.40	0.25
04:59:15 PM	215.25	49.25	4.37	0.25
04:59:45 PM	215.75	49.75	4.34	0.25
05:00:15 PM	216.25	50.25	4.30	0.24
05:00:45 PM	216.75	50.75	4.27	0.24
05:01:15 PM	217.25	51.25	4.24	0.25
05:01:45 PM	217.75	51.75	4.21	0.24
05:02:15 PM	218.25	52.25	4.18	0.24
05:02:45 PM	218.75	52.75	4.15	0.25

RECOVERY DATA FOR 5-5B AQUIFER PUMPING TEST
DATE: APRIL 5, 1991
PUMP OFF: 04:10:00 PM

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (minutes)	ELAPSE TIME SINCE PUMPING ENDED (minutes)	T/T'	DEPTH BELOW STATIC LEVEL (feet)
05:03:15 PM	219.25	53.25	4.12	0.24
05:03:45 PM	219.75	53.75	4.09	0.24
05:04:15 PM	220.25	54.25	4.06	0.24
05:04:45 PM	220.75	54.75	4.03	0.23
05:05:15 PM	221.25	55.25	4.00	0.23

CONSTANT RATE PUMPING TEST DATA FOR MONITOR WELL 5-6B

AQUIFER PUMPING TEST 5-6B
DISCHARGE RATE vs. TIME
DATE: 3/27/91

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (HR:MIN)	DISCHARGE RATE (gpm)
03:26:00 PM	00:04	0.40
03:35:00 PM	00:13	0.40
03:39:00 PM	00:17	0.28
03:44:00 PM	00:22	0.26
03:48:00 PM	00:26	0.25
03:50:00 PM	00:28	0.26
03:58:00 PM	00:36	0.26
04:04:00 PM	00:42	0.25
04:20:00 PM	00:58	0.25
04:23:00 PM	01:01	0.25
04:36:00 PM	01:14	0.25
04:46:00 PM	01:24	0.25
05:01:00 PM	01:39	0.20
05:07:00 PM	01:45	0.25
05:19:00 PM	01:57	0.24
05:38:00 PM	02:16	0.24
06:01:00 PM	02:39	0.20
06:22:00 PM	03:00	0.20
06:33:00 PM	03:11	0.24
06:49:00 PM	03:27	0.22
07:12:00 PM	03:50	0.24
07:45:00 PM	04:23	0.23
08:11:00 PM	04:49	0.25
08:42:00 PM	05:20	0.23
09:25:00 PM	06:03	0.23

AQUIFER PUMPING TEST 5-6B
DATE: MARCH 27, 1991
PUMP ON: 03:22:00 PM
PUMP OFF: 10:30:00 PM
DISCHARGE RATE: 0.25 GPM
TEST DURATION: 428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
03:22:00 PM	0.00	0.00
03:22:05 PM	0.09	0.34
03:22:15 PM	0.25	0.39
03:22:20 PM	0.34	0.38
03:22:25 PM	0.42	0.41
03:22:30 PM	0.50	0.45
03:22:35 PM	0.59	0.48
03:22:40 PM	0.67	0.52
03:22:45 PM	0.75	0.54
03:22:50 PM	0.84	0.56
03:22:55 PM	0.92	0.56
03:23:00 PM	1.00	0.59
03:23:05 PM	1.09	0.60
03:23:10 PM	1.17	0.62
03:23:15 PM	1.25	0.63
03:23:20 PM	1.34	0.66
03:23:25 PM	1.42	0.66
03:23:30 PM	1.50	0.67
03:23:35 PM	1.59	0.69
03:23:40 PM	1.67	0.70
03:23:45 PM	1.75	0.71
03:23:50 PM	1.84	0.72
03:23:55 PM	1.92	0.75
03:24:00 PM	2.00	0.76
03:24:05 PM	2.09	0.78
03:24:10 PM	2.17	0.79
03:24:15 PM	2.25	0.81
03:24:20 PM	2.34	0.82
03:24:25 PM	2.42	0.82
03:24:30 PM	2.50	0.85
03:24:35 PM	2.59	0.86
03:24:40 PM	2.67	0.87
03:24:45 PM	2.75	0.88
03:24:50 PM	2.84	0.89

AQUIFER PUMPING TEST 5-6B

DATE:	MARCH 27, 1991
PUMP ON:	03:22:00 PM
PUMP OFF:	10:30:00 PM
DISCHARGE RATE:	0.25 GPM
TEST DURATION:	428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
03:24:55 PM	2.92	0.91
03:25:00 PM	3.00	0.91
03:25:05 PM	3.09	0.93
03:25:10 PM	3.17	0.94
03:25:15 PM	3.25	0.95
03:25:20 PM	3.34	0.97
03:25:25 PM	3.42	0.97
03:25:30 PM	3.50	0.98
03:25:35 PM	3.59	1.00
03:25:40 PM	3.67	1.01
03:25:45 PM	3.75	1.02
03:25:50 PM	3.84	1.04
03:25:55 PM	3.92	1.05
03:26:00 PM	4.00	1.05
03:26:05 PM	4.09	1.07
03:26:10 PM	4.17	1.07
03:26:15 PM	4.25	1.08
03:26:20 PM	4.34	1.09
03:26:25 PM	4.42	1.10
03:26:30 PM	4.50	1.11
03:26:35 PM	4.59	1.11
03:26:40 PM	4.67	1.13
03:26:45 PM	4.75	1.13
03:26:50 PM	4.84	1.15
03:26:55 PM	4.92	1.15
03:27:00 PM	5.00	1.16
03:27:05 PM	5.09	1.17
03:27:10 PM	5.17	1.18
03:27:15 PM	5.25	1.19
03:27:20 PM	5.34	1.19
03:27:25 PM	5.42	1.20
03:27:30 PM	5.50	1.22
03:27:35 PM	5.59	1.22
03:27:40 PM	5.67	1.23

AQUIFER PUMPING TEST 5-6B
DATE: MARCH 27, 1991
PUMP ON: 03:22:00 PM
PUMP OFF: 10:30:00 PM
DISCHARGE RATE: 0.25 GPM
TEST DURATION: 428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
03:27:45 PM	5.75	1.24
03:27:50 PM	5.84	1.26
03:27:55 PM	5.92	1.26
03:28:00 PM	6.00	1.27
03:28:05 PM	6.09	1.29
03:28:10 PM	6.17	1.30
03:28:15 PM	6.25	1.30
03:28:20 PM	6.34	1.31
03:28:25 PM	6.42	1.32
03:28:30 PM	6.50	1.33
03:28:35 PM	6.59	1.34
03:28:40 PM	6.67	1.35
03:28:45 PM	6.75	1.35
03:28:50 PM	6.84	1.36
03:28:55 PM	6.92	1.37
03:29:00 PM	7.00	1.38
03:29:05 PM	7.09	1.39
03:29:10 PM	7.17	1.40
03:29:15 PM	7.25	1.41
03:29:20 PM	7.34	1.42
03:29:25 PM	7.42	1.42
03:29:30 PM	7.50	1.43
03:29:35 PM	7.59	1.44
03:30:05 PM	8.09	1.48
03:30:35 PM	8.59	1.51
03:31:05 PM	9.09	1.54
03:31:35 PM	9.59	1.55
03:32:05 PM	10.09	1.58
03:32:35 PM	10.59	1.59
03:33:05 PM	11.09	1.61
03:33:35 PM	11.59	1.66
03:34:05 PM	12.09	1.71
03:34:35 PM	12.59	1.77
03:35:05 PM	13.09	1.85

AQUIFER PUMPING TEST 5-6B	
DATE:	MARCH 27, 1991
PUMP ON:	03:22:00 PM
PUMP OFF:	10:30:00 PM
DISCHARGE RATE:	0.25 GPM
TEST DURATION:	428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
03:35:35 PM	13.59	1.92
03:36:05 PM	14.09	1.99
03:36:35 PM	14.59	2.07
03:37:05 PM	15.09	2.14
03:37:35 PM	15.59	2.21
03:38:05 PM	16.09	2.27
03:38:35 PM	16.59	2.32
03:39:05 PM	17.09	2.36
03:39:35 PM	17.59	2.39
03:40:05 PM	18.09	2.43
03:40:35 PM	18.59	2.46
03:41:05 PM	19.09	2.50
03:41:35 PM	19.59	2.53
03:42:05 PM	20.09	2.55
03:42:35 PM	20.59	2.57
03:43:05 PM	21.09	2.60
03:43:35 PM	21.59	2.62
03:44:05 PM	22.09	2.63
03:44:35 PM	22.59	2.65
03:45:05 PM	23.09	2.70
03:45:35 PM	23.59	2.68
03:46:05 PM	24.09	2.71
03:46:35 PM	24.59	2.74
03:47:05 PM	25.09	2.76
03:47:35 PM	25.59	2.79
03:48:05 PM	26.09	2.81
03:48:35 PM	26.59	2.83
03:49:05 PM	27.09	2.87
03:49:35 PM	27.59	2.92
03:50:05 PM	28.09	2.96
03:50:35 PM	28.59	3.00
03:51:05 PM	29.09	3.05
03:51:35 PM	29.59	3.10
03:52:05 PM	30.09	3.15

AQUIFER PUMPING TEST 5-6B

DATE:	MARCH 27, 1991
PUMP ON:	03:22:00 PM
PUMP OFF:	10:30:00 PM
DISCHARGE RATE:	0.25 GPM
TEST DURATION:	428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
04:09:35 PM	47.59	3.96
04:10:05 PM	48.09	3.96
04:10:35 PM	48.59	3.96
04:11:05 PM	49.09	3.97
04:11:35 PM	49.59	3.97
04:12:05 PM	50.09	4.03
04:12:35 PM	50.59	4.09
04:13:05 PM	51.09	4.14
04:13:35 PM	51.59	4.18
04:14:05 PM	52.09	4.24
04:14:35 PM	52.59	4.28
04:15:05 PM	53.09	4.32
04:15:35 PM	53.59	4.37
04:16:05 PM	54.09	4.40
04:16:35 PM	54.59	4.43
04:17:05 PM	55.09	4.47
04:17:35 PM	55.59	4.51
04:18:05 PM	56.09	4.56
04:18:35 PM	56.59	4.59
04:19:05 PM	57.09	4.62
04:19:35 PM	57.59	4.65
04:20:05 PM	58.09	4.69
04:20:35 PM	58.59	4.74
04:21:05 PM	59.09	4.77
04:21:35 PM	59.59	4.80
04:22:05 PM	60.09	4.83
04:22:35 PM	60.59	4.84
04:23:05 PM	61.09	4.87
04:23:35 PM	61.59	4.89
04:24:05 PM	62.09	4.91
04:24:35 PM	62.59	4.94
04:25:05 PM	63.09	4.94
04:25:35 PM	63.59	4.96
04:26:05 PM	64.09	4.98

AQUIFER PUMPING TEST 5-6B
DATE: MARCH 27, 1991
PUMP ON: 03:22:00 PM
PUMP OFF: 10:30:00 PM
DISCHARGE RATE: 0.25 GPM
TEST DURATION: 428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
04:26:35 PM	64.59	4.98
04:27:05 PM	65.09	5.00
04:27:35 PM	65.59	5.01
04:28:05 PM	66.09	5.02
04:28:35 PM	66.59	5.03
04:29:05 PM	67.09	5.04
04:29:35 PM	67.59	5.05
04:30:05 PM	68.09	5.06
04:30:35 PM	68.59	5.06
04:31:05 PM	69.09	5.08
04:31:35 PM	69.59	5.09
04:32:05 PM	70.09	5.09
04:32:35 PM	70.59	5.09
04:33:05 PM	71.09	5.10
04:33:35 PM	71.59	5.12
04:34:05 PM	72.09	5.12
04:34:35 PM	72.59	5.12
04:35:05 PM	73.09	5.13
04:35:35 PM	73.59	5.13
04:36:05 PM	74.09	5.12
04:36:35 PM	74.59	5.13
04:37:05 PM	75.09	5.13
04:37:35 PM	75.59	5.13
04:38:05 PM	76.09	5.13
04:38:35 PM	76.59	5.13
04:39:05 PM	77.09	5.13
04:39:35 PM	77.59	5.13
04:40:05 PM	78.09	5.13
04:40:35 PM	78.59	5.13
04:41:05 PM	79.09	5.13
04:41:35 PM	79.59	5.11
04:42:05 PM	80.09	5.10
04:42:35 PM	80.59	5.09
04:43:05 PM	81.09	5.11

AQUIFER PUMPING TEST 5-6B

DATE:	MARCH 27, 1991
PUMP ON:	03:22:00 PM
PUMP OFF:	10:30:00 PM
DISCHARGE RATE:	0.25 GPM
TEST DURATION:	428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
04:43:35 PM	81.59	5.10
04:44:05 PM	82.09	5.10
04:44:35 PM	82.59	5.10
04:45:05 PM	83.09	5.09
04:45:35 PM	83.59	5.10
04:46:05 PM	84.09	5.09
04:46:35 PM	84.59	5.09
04:47:05 PM	85.09	5.09
04:47:35 PM	85.59	5.09
04:48:05 PM	86.09	5.09
04:48:35 PM	86.59	5.09
04:49:05 PM	87.09	5.09
04:49:35 PM	87.59	5.09
04:50:05 PM	88.09	5.07
04:50:35 PM	88.59	5.06
04:51:05 PM	89.09	5.06
04:51:35 PM	89.59	5.05
04:52:05 PM	90.09	5.06
04:52:35 PM	90.59	5.06
04:53:05 PM	91.09	5.05
04:53:35 PM	91.59	5.05
04:54:05 PM	92.09	5.06
04:54:35 PM	92.59	5.05
04:55:05 PM	93.09	5.06
04:55:35 PM	93.59	5.05
04:56:05 PM	94.09	5.06
04:56:35 PM	94.59	5.05
04:57:05 PM	95.09	5.06
04:57:35 PM	95.59	5.06
04:58:05 PM	96.09	5.06
04:58:35 PM	96.59	5.07
04:59:05 PM	97.09	5.07
04:59:35 PM	97.59	5.07
05:00:35 PM	98.59	5.07

AQUIFER PUMPING TEST 5-6B	
DATE:	MARCH 27, 1991
PUMP ON:	03:22:00 PM
PUMP OFF:	10:30:00 PM
DISCHARGE RATE:	0.25 GPM
TEST DURATION:	428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
05:01:35 PM	99.59	5.10
05:02:35 PM	100.59	5.13
05:03:35 PM	101.59	5.16
05:04:35 PM	102.59	5.18
05:05:35 PM	103.59	5.19
05:06:35 PM	104.59	5.20
05:07:35 PM	105.59	5.21
05:08:35 PM	106.59	5.22
05:09:35 PM	107.59	5.25
05:10:35 PM	108.59	5.25
05:11:35 PM	109.59	5.26
05:12:35 PM	110.59	5.27
05:13:35 PM	111.59	5.27
05:14:35 PM	112.59	5.27
05:15:35 PM	113.59	5.28
05:16:35 PM	114.59	5.29
05:17:35 PM	115.59	5.29
05:18:35 PM	116.59	5.29
05:19:35 PM	117.59	5.30
05:20:35 PM	118.59	5.31
05:21:35 PM	119.59	5.30
05:22:35 PM	120.59	5.30
05:23:35 PM	121.59	5.30
05:24:35 PM	122.59	5.30
05:25:35 PM	123.59	5.30
05:26:35 PM	124.59	5.30
05:27:35 PM	125.59	5.31
05:28:35 PM	126.59	5.31
05:29:35 PM	127.59	5.31
05:30:35 PM	128.59	5.31
05:31:35 PM	129.59	5.31
05:32:35 PM	130.59	5.31
05:33:35 PM	131.59	5.31
05:34:35 PM	132.59	5.31

AQUIFER PUMPING TEST 5-6B

DATE:	MARCH 27, 1991
PUMP ON:	03:22:00 PM
PUMP OFF:	10:30:00 PM
DISCHARGE RATE:	0.25 GPM
TEST DURATION:	428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
05:35:35 PM	133.59	5.30
05:36:35 PM	134.59	5.31
05:37:35 PM	135.59	5.30
05:38:35 PM	136.59	5.30
05:39:35 PM	137.59	5.30
05:40:35 PM	138.59	5.29
05:41:35 PM	139.59	5.29
05:42:35 PM	140.59	5.26
05:43:35 PM	141.59	5.26
05:44:35 PM	142.59	5.25
05:45:35 PM	143.59	5.24
05:46:35 PM	144.59	5.23
05:47:35 PM	145.59	5.23
05:48:35 PM	146.59	5.23
05:49:35 PM	147.59	5.22
05:50:35 PM	148.59	5.23
05:51:35 PM	149.59	5.22
05:52:35 PM	150.59	5.21
05:53:35 PM	151.59	5.20
05:54:35 PM	152.59	5.21
05:55:35 PM	153.59	5.22
05:56:35 PM	154.59	5.22
05:57:35 PM	155.59	5.22
05:58:35 PM	156.59	5.22
05:59:35 PM	157.59	5.20
06:00:35 PM	158.59	5.19
06:01:35 PM	159.59	5.17
06:02:35 PM	160.59	5.27
06:03:35 PM	161.59	5.34
06:04:35 PM	162.59	5.40
06:05:35 PM	163.59	5.45
06:06:35 PM	164.59	5.49
06:07:35 PM	165.59	5.54
06:08:35 PM	166.59	5.57

AQUIFER PUMPING TEST 5-6B
DATE: MARCH 27, 1991
PUMP ON: 03:22:00 PM
PUMP OFF: 10:30:00 PM
DISCHARGE RATE: 0.25 GPM
TEST DURATION: 428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
06:09:35 PM	167.59	5.60
06:10:35 PM	168.59	5.63
06:11:35 PM	169.59	5.64
06:12:35 PM	170.59	5.66
06:13:35 PM	171.59	5.68
06:14:35 PM	172.59	5.69
06:15:35 PM	173.59	5.70
06:16:35 PM	174.59	5.72
06:17:35 PM	175.59	5.73
06:18:35 PM	176.59	5.75
06:19:35 PM	177.59	5.75
06:20:35 PM	178.59	5.77
06:21:35 PM	179.59	5.81
06:22:35 PM	180.59	5.88
06:23:35 PM	181.59	5.93
06:24:35 PM	182.59	5.98
06:25:35 PM	183.59	6.02
06:26:35 PM	184.59	6.07
06:27:35 PM	185.59	6.10
06:28:35 PM	186.59	6.14
06:29:35 PM	187.59	6.15
06:30:35 PM	188.59	6.18
06:31:35 PM	189.59	6.20
06:32:35 PM	190.59	6.23
06:33:35 PM	191.59	6.25
06:34:35 PM	192.59	6.27
06:35:35 PM	193.59	6.29
06:36:35 PM	194.59	6.31
06:37:35 PM	195.59	6.32
06:38:35 PM	196.59	6.33
06:39:35 PM	197.59	6.34
06:40:35 PM	198.59	6.36
06:41:35 PM	199.59	6.36
06:42:35 PM	200.59	6.36

AQUIFER PUMPING TEST 5-6B

DATE:	MARCH 27, 1991
PUMP ON:	03:22:00 PM
PUMP OFF:	10:30:00 PM
DISCHARGE RATE:	0.25 GPM
TEST DURATION:	428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
06:43:35 PM	201.59	6.36
06:44:35 PM	202.59	6.38
06:45:35 PM	203.59	6.39
06:46:35 PM	204.59	6.39
06:47:35 PM	205.59	6.39
06:48:35 PM	206.59	6.39
06:49:35 PM	207.59	6.42
06:50:35 PM	208.59	6.42
06:51:35 PM	209.59	6.42
06:52:35 PM	210.59	6.43
06:53:35 PM	211.59	6.43
06:54:35 PM	212.59	6.45
06:55:35 PM	213.59	6.48
06:56:35 PM	214.59	6.50
06:57:35 PM	215.59	6.52
06:58:35 PM	216.59	6.52
06:59:35 PM	217.59	6.55
07:00:35 PM	218.59	6.58
07:01:35 PM	219.59	6.58
07:02:35 PM	220.59	6.58
07:03:35 PM	221.59	6.59
07:04:35 PM	222.59	6.60
07:05:35 PM	223.59	6.59
07:06:35 PM	224.59	6.61
07:07:35 PM	225.59	6.61
07:08:35 PM	226.59	6.61
07:09:35 PM	227.59	6.63
07:10:35 PM	228.59	6.64
07:11:35 PM	229.59	6.64
07:12:35 PM	230.59	6.67
07:13:35 PM	231.59	6.71
07:14:35 PM	232.59	6.76
07:15:35 PM	233.59	6.83
07:16:35 PM	234.59	6.85

AQUIFER PUMPING TEST 5-6B
DATE: MARCH 27, 1991
PUMP ON: 03:22:00 PM
PUMP OFF: 10:30:00 PM
DISCHARGE RATE: 0.25 GPM
TEST DURATION: 428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
07:17:35 PM	235.59	6.90
07:18:35 PM	236.59	6.94
07:19:35 PM	237.59	6.98
07:20:35 PM	238.59	7.01
07:21:35 PM	239.59	7.05
07:22:35 PM	240.59	7.08
07:23:35 PM	241.59	7.10
07:24:35 PM	242.59	7.13
07:25:35 PM	243.59	7.14
07:26:35 PM	244.59	7.17
07:27:35 PM	245.59	7.19
07:28:35 PM	246.59	7.20
07:29:35 PM	247.59	7.23
07:30:35 PM	248.59	7.24
07:31:35 PM	249.59	7.25
07:32:35 PM	250.59	7.27
07:33:35 PM	251.59	7.27
07:34:35 PM	252.59	7.31
07:35:35 PM	253.59	7.31
07:36:35 PM	254.59	7.33
07:37:35 PM	255.59	7.34
07:38:35 PM	256.59	7.42
07:39:35 PM	257.59	7.49
07:40:35 PM	258.59	7.56
07:41:35 PM	259.59	7.63
07:42:35 PM	260.59	7.67
07:43:35 PM	261.59	7.71
07:44:35 PM	262.59	7.76
07:45:35 PM	263.59	7.82
07:46:35 PM	264.59	7.86
07:47:35 PM	265.59	7.89
07:48:35 PM	266.59	7.92
07:49:35 PM	267.59	7.95
07:50:35 PM	268.59	7.98

AQUIFER PUMPING TEST 5-6B
DATE: MARCH 27, 1991
PUMP ON: 03:22:00 PM
PUMP OFF: 10:30:00 PM
DISCHARGE RATE: 0.25 GPM
TEST DURATION: 428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
07:51:35 PM	269.59	8.01
07:52:35 PM	270.59	8.02
07:53:35 PM	271.59	8.03
07:54:35 PM	272.59	8.06
07:55:35 PM	273.59	8.08
07:56:35 PM	274.59	8.09
07:57:35 PM	275.59	8.11
07:58:35 PM	276.59	8.12
07:59:35 PM	277.59	8.12
08:00:35 PM	278.59	8.14
08:01:35 PM	279.59	8.14
08:02:35 PM	280.59	8.16
08:03:35 PM	281.59	8.15
08:04:35 PM	282.59	8.17
08:05:35 PM	283.59	8.17
08:06:35 PM	284.59	8.17
08:07:35 PM	285.59	8.17
08:08:35 PM	286.59	8.17
08:09:35 PM	287.59	8.19
08:10:35 PM	288.59	8.19
08:11:35 PM	289.59	8.19
08:12:35 PM	290.59	8.19
08:13:35 PM	291.59	8.20
08:14:35 PM	292.59	8.21
08:15:35 PM	293.59	8.21
08:16:35 PM	294.59	8.23
08:17:35 PM	295.59	8.22
08:18:35 PM	296.59	8.23
08:19:35 PM	297.59	8.23
08:20:35 PM	298.59	8.23
08:21:35 PM	299.59	8.23
08:22:35 PM	300.59	8.23
08:23:35 PM	301.59	8.23
08:24:35 PM	302.59	8.23

AQUIFER PUMPING TEST 5-6B

DATE:	MARCH 27, 1991
PUMP ON:	03:22:00 PM
PUMP OFF:	10:30:00 PM
DISCHARGE RATE:	0.25 GPM
TEST DURATION:	428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
08:25:35 PM	303.59	8.23
08:26:35 PM	304.59	8.23
08:27:35 PM	305.59	8.23
08:28:35 PM	306.59	8.23
08:29:35 PM	307.59	8.23
08:30:35 PM	308.59	8.23
08:31:35 PM	309.59	8.23
08:32:35 PM	310.59	8.22
08:33:35 PM	311.59	8.23
08:34:35 PM	312.59	8.23
08:35:35 PM	313.59	8.23
08:36:35 PM	314.59	8.22
08:37:35 PM	315.59	8.23
08:38:35 PM	316.59	8.23
08:39:35 PM	317.59	8.23
08:40:35 PM	318.59	8.23
08:41:35 PM	319.59	8.23
08:42:35 PM	320.59	8.23
08:43:35 PM	321.59	8.23
08:44:35 PM	322.59	8.30
08:45:35 PM	323.59	8.34
08:46:35 PM	324.59	8.37
08:47:35 PM	325.59	8.39
08:48:35 PM	326.59	8.42
08:49:35 PM	327.59	8.44
08:50:35 PM	328.59	8.45
08:51:35 PM	329.59	8.47
08:52:35 PM	330.59	8.48
08:53:35 PM	331.59	8.48
08:54:35 PM	332.59	8.50
08:55:35 PM	333.59	8.52
08:56:35 PM	334.59	8.52
08:57:35 PM	335.59	8.54
08:58:35 PM	336.59	8.54

AQUIFER PUMPING TEST 5-6B

DATE:	MARCH 27, 1991
PUMP ON:	03:22:00 PM
PUMP OFF:	10:30:00 PM
DISCHARGE RATE:	0.25 GPM
TEST DURATION:	428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
08:59:35 PM	337.59	8.57
09:00:35 PM	338.59	8.57
09:01:35 PM	339.59	8.57
09:02:35 PM	340.59	8.58
09:03:35 PM	341.59	8.59
09:04:35 PM	342.59	8.59
09:05:35 PM	343.59	8.59
09:06:35 PM	344.59	8.60
09:07:35 PM	345.59	8.60
09:08:35 PM	346.59	8.61
09:09:35 PM	347.59	8.61
09:10:35 PM	348.59	8.61
09:11:35 PM	349.59	8.61
09:12:35 PM	350.59	8.61
09:13:35 PM	351.59	8.60
09:14:35 PM	352.59	8.60
09:15:35 PM	353.59	8.60
09:16:35 PM	354.59	8.73
09:17:35 PM	355.59	8.83
09:18:35 PM	356.59	8.93
09:19:35 PM	357.59	9.02
09:20:35 PM	358.59	9.09
09:21:35 PM	359.59	9.15
09:22:35 PM	360.59	9.21
09:23:35 PM	361.59	9.27
09:24:35 PM	362.59	9.31
09:25:35 PM	363.59	9.37
09:26:35 PM	364.59	9.40
09:27:35 PM	365.59	9.43
09:28:35 PM	366.59	9.49
09:29:35 PM	367.59	9.55
09:30:35 PM	368.59	9.60
09:31:35 PM	369.59	9.65
09:32:35 PM	370.59	9.68

AQUIFER PUMPING TEST 5-6B
DATE: MARCH 27, 1991
PUMP ON: 03:22:00 PM
PUMP OFF: 10:30:00 PM
DISCHARGE RATE: 0.25 GPM
TEST DURATION: 428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
09:33:35 PM	371.59	9.71
09:34:35 PM	372.59	9.74
09:35:35 PM	373.59	9.78
09:36:35 PM	374.59	9.81
09:37:35 PM	375.59	9.84
09:38:35 PM	376.59	9.84
09:39:35 PM	377.59	9.87
09:40:35 PM	378.59	9.95
09:41:35 PM	379.59	10.07
09:42:35 PM	380.59	10.18
09:43:35 PM	381.59	10.29
09:44:35 PM	382.59	10.41
09:45:35 PM	383.59	10.50
09:46:35 PM	384.59	10.59
09:47:35 PM	385.59	10.69
09:48:35 PM	386.59	10.78
09:49:35 PM	387.59	10.85
09:50:35 PM	388.59	10.93
09:51:35 PM	389.59	11.00
09:52:35 PM	390.59	11.04
09:53:35 PM	391.59	11.09
09:54:35 PM	392.59	11.13
09:55:35 PM	393.59	11.16
09:56:35 PM	394.59	11.19
09:57:35 PM	395.59	11.21
09:58:35 PM	396.59	11.22
09:59:35 PM	397.59	11.22
10:00:35 PM	398.59	11.25
ERR	308.50	12.23
10:14:25 PM	412.42	11.43
10:14:30 PM	412.50	11.43
10:14:35 PM	412.59	11.42
10:14:40 PM	412.67	11.43
10:14:45 PM	412.75	11.44

AQUIFER PUMPING TEST 5-6B	
DATE:	MARCH 27, 1991
PUMP ON:	03:22:00 PM
PUMP OFF:	10:30:00 PM
DISCHARGE RATE:	0.25 GPM
TEST DURATION:	428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
10:14:50 PM	412.84	11.44
10:14:55 PM	412.92	11.44
10:15:00 PM	413.00	11.44
10:15:05 PM	413.09	11.45
10:15:10 PM	413.17	11.45
10:15:15 PM	413.25	11.45
10:15:20 PM	413.34	11.45
10:15:25 PM	413.42	11.45
10:15:30 PM	413.50	11.45
10:15:35 PM	413.59	11.45
10:15:40 PM	413.67	11.45
10:15:45 PM	413.75	11.45
10:15:50 PM	413.84	11.45
10:15:55 PM	413.92	11.45
10:16:00 PM	414.00	11.45
10:16:05 PM	414.09	11.45
10:16:10 PM	414.17	11.45
10:16:15 PM	414.25	11.45
10:16:20 PM	414.34	11.45
10:16:25 PM	414.42	11.45
10:16:30 PM	414.50	11.45
10:16:35 PM	414.59	11.46
10:16:40 PM	414.67	11.45
10:16:45 PM	414.75	11.47
10:16:50 PM	414.84	11.46
10:16:55 PM	414.92	11.47
10:17:00 PM	415.00	11.47
10:17:05 PM	415.09	11.47
10:17:10 PM	415.17	11.48
10:17:15 PM	415.25	11.48
10:17:20 PM	415.34	11.47
10:17:25 PM	415.42	11.48
10:17:30 PM	415.50	11.48
10:17:35 PM	415.59	11.48

AQUIFER PUMPING TEST 5-6B
DATE: MARCH 27, 1991
PUMP ON: 03:22:00 PM
PUMP OFF: 10:30:00 PM
DISCHARGE RATE: 0.25 GPM
TEST DURATION: 428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
10:17:40 PM	415.67	11.48
10:17:45 PM	415.75	11.48
10:17:50 PM	415.84	11.48
10:17:55 PM	415.92	11.48
10:18:00 PM	416.00	11.50
10:18:05 PM	416.09	11.50
10:18:10 PM	416.17	11.51
10:18:15 PM	416.25	11.51
10:18:20 PM	416.34	11.51
10:18:25 PM	416.42	11.51
10:18:30 PM	416.50	11.51
10:18:35 PM	416.59	11.52
10:18:40 PM	416.67	11.54
10:18:45 PM	416.75	11.54
10:18:50 PM	416.84	11.54
10:18:55 PM	416.92	11.54
10:19:00 PM	417.00	11.54
10:19:05 PM	417.09	11.55
10:19:10 PM	417.17	11.55
10:19:15 PM	417.25	11.56
10:19:20 PM	417.34	11.56
10:19:25 PM	417.42	11.56
10:19:30 PM	417.50	11.57
10:19:35 PM	417.59	11.57
10:19:40 PM	417.67	11.59
10:19:45 PM	417.75	11.59
10:19:50 PM	417.84	11.59
10:19:55 PM	417.92	11.59
10:20:00 PM	418.00	11.60
10:20:05 PM	418.09	11.60
10:20:10 PM	418.17	11.60
10:20:15 PM	418.25	11.60
10:20:20 PM	418.34	11.60
10:20:25 PM	418.42	11.60

AQUIFER PUMPING TEST 5-6B
DATE: MARCH 27, 1991
PUMP ON: 03:22:00 PM
PUMP OFF: 10:30:00 PM
DISCHARGE RATE: 0.25 GPM
TEST DURATION: 428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
10:20:30 PM	418.50	11.63
10:20:35 PM	418.59	11.63
10:20:40 PM	418.67	11.63
10:20:45 PM	418.75	11.63
10:20:50 PM	418.84	11.63
10:20:55 PM	418.92	11.63
10:21:00 PM	419.00	11.63
10:21:05 PM	419.09	11.64
10:21:10 PM	419.17	11.64
10:21:15 PM	419.25	11.64
10:21:20 PM	419.34	11.66
10:21:25 PM	419.42	11.67
10:21:30 PM	419.50	11.67
10:21:35 PM	419.59	11.67
10:21:40 PM	419.67	11.67
10:21:45 PM	419.75	11.67
10:21:50 PM	419.84	11.67
10:21:55 PM	419.92	11.67
10:22:00 PM	420.00	11.68
10:22:05 PM	420.09	11.69
10:22:10 PM	420.17	11.70
10:22:15 PM	420.25	11.70
10:22:20 PM	420.34	11.70
10:22:25 PM	420.42	11.70
10:22:30 PM	420.50	11.70
10:22:35 PM	420.59	11.70
10:22:40 PM	420.67	11.71
10:22:45 PM	420.75	11.71
10:22:50 PM	420.84	11.71
10:22:55 PM	420.92	11.72
10:23:00 PM	421.00	11.73
10:23:05 PM	421.09	11.73
10:23:10 PM	421.17	11.73
10:23:15 PM	421.25	11.71

AQUIFER PUMPING TEST 5-6B

DATE:	MARCH 27, 1991
PUMP ON:	03:22:00 PM
PUMP OFF:	10:30:00 PM
DISCHARGE RATE:	0.25 GPM
TEST DURATION:	428

TIME (HR:MIN:SEC)	ELAPSE TIME (minutes)	DRAWDOWN (feet)
10:23:20 PM	421.34	11.72
10:23:25 PM	421.42	11.73
10:23:30 PM	421.50	11.73
10:23:35 PM	421.59	11.75
10:23:40 PM	421.67	11.74
10:23:45 PM	421.75	11.74
10:23:50 PM	421.84	11.74
10:23:55 PM	421.92	11.75
10:24:00 PM	422.00	11.76
10:24:05 PM	422.09	11.76
10:24:10 PM	422.17	11.76
10:24:15 PM	422.25	11.76
10:24:20 PM	422.34	11.76
10:24:25 PM	422.42	11.76
10:24:55 PM	422.92	11.78
10:25:25 PM	423.42	11.79
10:25:55 PM	423.92	11.80
10:26:25 PM	424.42	11.81
10:26:55 PM	424.92	11.82
10:27:25 PM	425.42	11.84
10:27:55 PM	425.92	11.85
10:28:25 PM	426.42	11.85
10:28:55 PM	426.92	11.86
10:29:25 PM	427.42	11.89
10:29:55 PM	427.92	11.89

RECOVERY DATA FOR 5-6B AQUIFER PUMPING TEST
DATE: MARCH 27, 1991
PUMP OFF: 10:30:00 PM

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (minutes)	ELAPSE TIME SINCE PUMPING ENDED (minutes)	T/T'	DEPTH TO WATER (feet)
10:29:55 PM	427.92	-0.08		11.89
10:30:25 PM	428.42	0.42	1020.05	10.29
10:30:55 PM	428.92	0.92	466.22	10.19
10:31:25 PM	429.42	1.42	302.41	10.00
10:31:55 PM	429.92	1.92	223.92	9.84
10:32:25 PM	430.42	2.42	177.86	9.68
10:32:55 PM	430.92	2.92	147.58	9.52
10:33:25 PM	431.42	3.42	126.15	9.37
10:33:55 PM	431.92	3.92	110.18	9.18
10:34:25 PM	432.42	4.42	97.83	9.00
10:34:55 PM	432.92	4.92	87.99	8.83
10:35:25 PM	433.42	5.42	79.97	8.67
10:35:55 PM	433.92	5.92	73.30	8.48
10:36:25 PM	434.42	6.42	67.67	8.31
10:36:55 PM	434.92	6.92	62.85	8.12
10:37:25 PM	435.42	7.42	58.68	7.93
10:37:55 PM	435.92	7.92	55.04	7.73
10:38:25 PM	436.42	8.42	51.83	7.57
10:38:55 PM	436.92	8.92	48.98	7.43
10:39:25 PM	437.42	9.42	46.44	7.29
10:39:55 PM	437.92	9.92	44.15	7.16
10:40:25 PM	438.42	10.42	42.07	7.06
10:40:55 PM	438.92	10.92	40.19	6.96
10:41:25 PM	439.42	11.42	38.48	6.86
10:41:55 PM	439.92	11.92	36.91	6.75
10:42:25 PM	440.42	12.42	35.46	6.65
10:42:55 PM	440.92	12.92	34.13	6.55
10:43:25 PM	441.42	13.42	32.89	6.44
10:43:55 PM	441.92	13.92	31.75	6.34
10:44:25 PM	442.42	14.42	30.68	6.22
10:44:55 PM	442.92	14.92	29.69	6.10
10:45:25 PM	443.42	15.42	28.76	5.97
10:45:55 PM	443.92	15.92	27.88	5.86
10:46:25 PM	444.42	16.42	27.07	5.73
10:46:55 PM	444.92	16.92	26.30	5.62
10:47:25 PM	445.42	17.42	25.57	5.51
10:47:55 PM	445.92	17.92	24.88	5.40
10:48:25 PM	446.42	18.42	24.24	5.28
10:48:55 PM	446.92	18.92	23.62	5.16

RECOVERY DATA FOR 5-6B AQUIFER PUMPING TEST
DATE: MARCH 27, 1991
PUMP OFF: 10:30:00 PM

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (minutes)	ELAPSE TIME SINCE PUMPING ENDED (minutes)	T/T'	DEPTH TO WATER (feet)
10:49:25 PM	447.42	19.42	23.04	5.03
10:49:55 PM	447.92	19.92	22.49	4.92
10:50:25 PM	448.42	20.42	21.96	4.82
10:50:55 PM	448.92	20.92	21.46	4.71
10:51:25 PM	449.42	21.42	20.98	4.61
10:51:55 PM	449.92	21.92	20.53	4.50
10:52:25 PM	450.42	22.42	20.09	4.40
10:52:55 PM	450.92	22.92	19.67	4.29
10:53:25 PM	451.42	23.42	19.27	4.18
10:53:55 PM	451.92	23.92	18.89	4.08
10:54:25 PM	452.42	24.42	18.53	3.96
10:54:55 PM	452.92	24.92	18.17	3.85
10:55:25 PM	453.42	25.42	17.84	3.74
10:55:55 PM	453.92	25.92	17.51	3.62
10:56:25 PM	454.42	26.42	17.20	3.49
10:56:55 PM	454.92	26.92	16.90	3.34
10:57:25 PM	455.42	27.42	16.61	3.20
10:57:55 PM	455.92	27.92	16.33	3.09
10:58:25 PM	456.42	28.42	16.06	2.99
10:58:55 PM	456.92	28.92	15.80	2.91
10:59:25 PM	457.42	29.42	15.55	2.84
10:59:55 PM	457.92	29.92	15.30	2.77
11:00:25 PM	458.42	30.42	15.07	2.69
11:00:55 PM	458.92	30.92	14.84	2.62
11:01:25 PM	459.42	31.42	14.62	2.55
11:01:55 PM	459.92	31.92	14.41	2.47
11:02:25 PM	460.42	32.42	14.20	2.39
11:02:55 PM	460.92	32.92	14.00	2.31
11:03:25 PM	461.42	33.42	13.81	2.21
11:03:55 PM	461.92	33.92	13.62	2.11
11:04:25 PM	462.42	34.42	13.43	2.01
11:04:55 PM	462.92	34.92	13.26	1.89
11:05:25 PM	463.42	35.42	13.08	1.80
11:05:55 PM	463.92	35.92	12.92	1.68
11:06:25 PM	464.42	36.42	12.75	1.61
11:06:55 PM	464.92	36.92	12.59	1.55
11:07:25 PM	465.42	37.42	12.44	1.47
11:07:55 PM	465.92	37.92	12.29	1.44
11:08:25 PM	466.42	38.42	12.14	1.41

RECOVERY DATA FOR 5-6B AQUIFER PUMPING TEST
DATE: MARCH 27, 1991
PUMP OFF: 10:30:00 PM

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (minutes)	ELAPSE TIME SINCE PUMPING ENDED (minutes)	T/T'	DEPTH TO WATER (feet)
11:08:55 PM	466.92	38.92	12.00	1.38
11:09:25 PM	467.42	39.42	11.86	1.36
11:09:55 PM	467.92	39.92	11.72	1.33
11:10:25 PM	468.42	40.42	11.59	1.30
11:10:55 PM	468.92	40.92	11.46	1.27
11:11:25 PM	469.42	41.42	11.33	1.25
11:11:55 PM	469.92	41.92	11.21	1.21
11:12:25 PM	470.42	42.42	11.09	1.20
11:12:55 PM	470.92	42.92	10.97	1.17
11:13:25 PM	471.42	43.42	10.86	1.14
11:13:55 PM	471.92	43.92	10.74	1.11
11:14:25 PM	472.42	44.42	10.64	1.09
11:14:55 PM	472.92	44.92	10.53	1.08
11:15:25 PM	473.42	45.42	10.42	1.05
11:15:55 PM	473.92	45.92	10.32	1.02
11:16:25 PM	474.42	46.42	10.22	1.00
11:16:55 PM	474.92	46.92	10.12	0.97
11:17:25 PM	475.42	47.42	10.03	0.95
11:17:55 PM	475.92	47.92	9.93	0.92
11:18:25 PM	476.42	48.42	9.84	0.90
11:18:55 PM	476.92	48.92	9.75	0.88
11:19:25 PM	477.42	49.42	9.66	0.85
11:19:55 PM	477.92	49.92	9.57	0.83
11:20:25 PM	478.42	50.42	9.49	0.80
11:20:55 PM	478.92	50.92	9.41	0.77
11:21:25 PM	479.42	51.42	9.32	0.75
11:21:55 PM	479.92	51.92	9.24	0.72
11:22:25 PM	480.42	52.42	9.16	0.70
11:22:55 PM	480.92	52.92	9.09	0.67
11:23:25 PM	481.42	53.42	9.01	0.66
11:23:55 PM	481.92	53.92	8.94	0.62
11:24:25 PM	482.42	54.42	8.86	0.61
11:24:55 PM	482.92	54.92	8.79	0.58
11:25:25 PM	483.42	55.42	8.72	0.56
11:25:55 PM	483.92	55.92	8.65	0.55
11:26:25 PM	484.42	56.42	8.59	0.52
11:26:55 PM	484.92	56.92	8.52	0.50
11:27:25 PM	485.42	57.42	8.45	0.47
11:27:55 PM	485.92	57.92	8.39	0.45

RECOVERY DATA FOR 5-6B AQUIFER PUMPING TEST
DATE: MARCH 27, 1991
PUMP OFF: 10:30:00 PM

TIME (HR:MIN:SEC)	ELAPSE TIME SINCE PUMPING STARTED (minutes)	ELAPSE TIME SINCE PUMPING ENDED (minutes)	T/T'	DEPTH TO WATER (feet)
11:28:25 PM	486.42	58.42	8.33	0.44
11:28:55 PM	486.92	58.92	8.26	0.41
11:29:25 PM	487.42	59.42	8.20	0.39
11:29:55 PM	487.92	59.92	8.14	0.38
11:30:25 PM	488.42	60.42	8.08	0.36
11:30:55 PM	488.92	60.92	8.03	0.35
11:31:25 PM	489.42	61.42	7.97	0.32
11:31:55 PM	489.92	61.92	7.91	0.31
11:32:25 PM	490.42	62.42	7.86	0.29
11:32:55 PM	490.92	62.92	7.80	0.29
11:33:25 PM	491.42	63.42	7.75	0.26
11:33:55 PM	491.92	63.92	7.70	0.25
11:34:25 PM	492.42	64.42	7.64	0.23
11:34:55 PM	492.92	64.92	7.59	0.21
11:35:25 PM	493.42	65.42	7.54	0.20
11:35:55 PM	493.92	65.92	7.49	0.20
11:36:25 PM	494.42	66.42	7.44	0.18
11:36:55 PM	494.92	66.92	7.40	0.17
11:37:25 PM	495.42	67.42	7.35	0.16
11:37:55 PM	495.92	67.92	7.30	0.15
11:38:25 PM	496.42	68.42	7.26	0.14
11:38:55 PM	496.92	68.92	7.21	0.14
11:39:25 PM	497.42	69.42	7.17	0.12
11:39:55 PM	497.92	69.92	7.12	0.12
11:40:25 PM	498.42	70.42	7.08	0.10
11:40:55 PM	498.92	70.92	7.03	0.10
11:41:25 PM	499.42	71.42	6.99	0.10
11:41:55 PM	499.92	71.92	6.95	0.09
11:42:25 PM	500.42	72.42	6.91	0.08
11:42:55 PM	500.92	72.92	6.87	0.07
11:43:25 PM	501.42	73.42	6.83	0.06
11:43:55 PM	501.92	73.92	6.79	0.06
11:44:25 PM	502.42	74.42	6.75	0.06
11:44:55 PM	502.92	74.92	6.71	0.05
11:45:25 PM	503.42	75.42	6.67	0.04
11:45:55 PM	503.92	75.92	6.64	0.04
11:46:25 PM	504.42	76.42	6.60	0.03
11:46:55 PM	504.92	76.92	6.56	0.03
11:47:25 PM	505.42	77.42	6.53	0.02

CONSTANT RATE BAILING TEST DATA

5-1B BAIL/RECOVERY TEST

SWL: 45.26 ft
DATE: 4/2/91
START BAILING: 15:18:00
STOP BAILING 15:43:45
TOTAL TIME: 00:25:45
VOLUME OF WATER BAILED: 4.1 GALLONS

MEASURE TIME (minutes)	MEASURE TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	RECOVERY (feet)
0	40	51.18	1585	40	39.63	5.92
0	50	51.10	1595	50	31.90	5.84
0	56	51.04	1601	56	28.59	5.78
0	58	51.00	1603	58	27.64	5.74
1	3	50.95	1608	63	25.52	5.69
1	7	50.90	1612	67	24.06	5.64
1	11	50.85	1616	71	22.76	5.59
1	17	50.80	1622	77	21.06	5.54
1	24	50.75	1629	84	19.39	5.49
1	28	50.70	1633	88	18.56	5.44
1	32	50.65	1637	92	17.79	5.39
1	36	50.60	1641	96	17.09	5.34
1	42	50.55	1647	102	16.15	5.29
1	52	50.45	1657	112	14.79	5.19
1	56	50.40	1661	116	14.32	5.14
2	3	50.35	1668	123	13.56	5.09
2	5	50.30	1670	125	13.36	5.04
2	10	50.25	1675	130	12.88	4.99
2	15	50.20	1680	135	12.44	4.94
2	22	50.15	1687	142	11.88	4.89
2	27	50.10	1692	147	11.51	4.84
2	30	50.05	1695	150	11.30	4.79
2	39	50.00	1704	159	10.72	4.74
2	42	49.95	1707	162	10.54	4.69
2	47	49.90	1712	167	10.25	4.64
2	52	49.85	1717	172	9.98	4.59
2	57	49.80	1722	177	9.73	4.54
3	0	49.75	1725	180	9.58	4.49
3	6	49.70	1731	186	9.31	4.44
3	11	49.65	1736	191	9.09	4.39
3	17	49.60	1742	197	8.84	4.34
3	23	49.55	1748	203	8.61	4.29

5-1B BAIL/RECOVERY TEST

SWL: 45.26 ft
DATE: 4/2/91
START BAILING: 15:18:00
STOP BAILING 15:43:45
TOTAL TIME: 00:25:45
VOLUME OF WATER BAILED: 4.1 GALLONS

MEASURE TIME (minutes)	MEASURE TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	RECOVERY (feet)
3	29	49.50	1754	209	8.39	4.24
3	33	49.45	1758	213	8.25	4.19
3	39	49.40	1764	219	8.05	4.14
3	44	49.35	1769	224	7.90	4.09
3	49	49.30	1774	229	7.75	4.04
3	54	49.25	1779	234	7.60	3.99
3	58	49.20	1783	238	7.49	3.94
4	3	49.15	1788	243	7.36	3.89
4	10	49.10	1795	250	7.18	3.84
4	23	49.00	1808	263	6.87	3.74
4	33	48.90	1818	273	6.66	3.64
4	40	48.85	1825	280	6.52	3.59
4	44	48.80	1829	284	6.44	3.54
4	49	48.75	1834	289	6.35	3.49
4	55	48.70	1840	295	6.24	3.44
5	7	48.60	1852	307	6.03	3.34
5	17	48.50	1862	317	5.87	3.24
5	28	48.40	1873	328	5.71	3.14
5	40	48.30	1885	340	5.54	3.04
5	51	48.20	1896	351	5.40	2.94
6	0	48.10	1905	360	5.29	2.84
6	13	48.00	1918	373	5.14	2.74
6	27	47.90	1932	387	4.99	2.64
6	41	47.80	1946	401	4.85	2.54
6	57	47.70	1962	417	4.71	2.44
7	11	47.60	1976	431	4.58	2.34
7	27	47.50	1992	447	4.46	2.24
7	44	47.40	2009	464	4.33	2.14
8	4	47.30	2029	484	4.19	2.04
8	28	47.20	2053	508	4.04	1.94
8	53	47.10	2078	533	3.90	1.84
9	27	47.00	2112	567	3.72	1.74

5-1B BAIL/RECOVERY TEST

SWL:	45.26 ft
DATE:	4/2/91
START BAILING:	15:18:00
STOP BAILING	15:43:45
TOTAL TIME:	00:25:45
VOLUME OF WATER BAILED:	4.1 GALLONS

MEASURE TIME (minutes)	MEASURE TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	RECOVERY (feet)
9	59	46.90	2144	599	3.58	1.64
10	37	46.80	2182	637	3.43	1.54
11	12	46.70	2217	672	3.30	1.44
11	46	46.60	2251	706	3.19	1.34
13	2	46.40	2327	782	2.98	1.14
13	37	46.30	2362	817	2.89	1.04
14	13	46.20	2398	853	2.81	0.94
14	57	46.10	2442	897	2.72	0.84
15	40	46.00	2485	940	2.64	0.74
16	21	45.90	2526	981	2.57	0.64
17	9	45.80	2574	1029	2.50	0.54
18	0	45.70	2625	1080	2.43	0.44
18	58	45.60	2683	1138	2.36	0.34
20	13	45.50	2758	1213	2.27	0.24
21	57	45.40	2862	1317	2.17	0.14

5-12B BAIL/RECOVERY TEST

SWL:	49.4 ft
DATE:	4/3/91
START BAILING:	15:16:50
STOP BAILING	15:39:00
TOTAL TIME:	00:22:10
VOLUME OF WATER BAILED:	11.35 GALLONS

MEASURE TIME (minutes)	(seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	WATER LEVEL RECOVERY (feet)
0	50	60.50	1380	50	27.60	11.10
0	53	60.40	1383	53	26.09	11.00
0	59	60.30	1389	59	23.54	10.90
1	3	60.20	1393	63	22.11	10.80
1	6	60.10	1396	66	21.15	10.70
1	11	60.00	1401	71	19.73	10.60
1	16	59.90	1406	76	18.50	10.50
1	20	59.80	1410	80	17.63	10.40
1	26	59.70	1416	86	16.47	10.30
1	31	59.60	1421	91	15.62	10.20
1	37	59.50	1427	97	14.71	10.10
1	44	59.40	1434	104	13.79	10.00
1	50	59.30	1440	110	13.09	9.90
1	56	59.20	1446	116	12.47	9.80
2	2	59.10	1452	122	11.90	9.70
2	9	59.00	1459	129	11.31	9.60
2	17	58.90	1467	137	10.71	9.50
2	20	58.80	1470	140	10.50	9.40
2	28	58.70	1478	148	9.99	9.30
2	33	58.60	1483	153	9.69	9.20
2	38	58.50	1488	158	9.42	9.10
2	42	58.40	1492	162	9.21	9.00
2	48	58.20	1498	168	8.92	8.80
2	56	58.00	1506	176	8.56	8.60
3	0	57.90	1510	180	8.39	8.50
3	4	57.80	1514	184	8.23	8.40
3	7	57.70	1517	187	8.11	8.30
3	10	57.60	1520	190	8.00	8.20
3	14	57.50	1524	194	7.86	8.10
3	18	57.40	1528	198	7.72	8.00
3	20	57.30	1530	200	7.65	7.90
3	23	57.20	1533	203	7.55	7.80
3	28	57.10	1538	208	7.39	7.70

5-12B BAIL/RECOVERY TEST

SWL:	49.4 ft
DATE:	4/3/91
START BAILING:	15:16:50
STOP BAILING	15:39:00
TOTAL TIME:	00:22:10
VOLUME OF WATER BAILED:	11.35 GALLONS

MEASURE TIME (minutes)	MEASURE TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	WATER LEVEL RECOVERY (feet)
3	32	57.00	1542	212	7.27	7.60
3	39	56.90	1549	219	7.07	7.50
3	45	56.80	1555	225	6.91	7.40
3	52	56.70	1562	232	6.73	7.30
3	59	56.60	1569	239	6.56	7.20
4	8	56.50	1578	248	6.36	7.10
4	16	56.40	1586	256	6.20	7.00
4	23	56.30	1593	263	6.06	6.90
4	31	56.20	1601	271	5.91	6.80
4	38	56.10	1608	278	5.78	6.70
4	47	56.00	1617	287	5.63	6.60
4	53	55.90	1623	293	5.54	6.50
5	0	55.80	1630	300	5.43	6.40
5	7	55.70	1637	307	5.33	6.30
5	14	55.60	1644	314	5.24	6.20
5	21	55.50	1651	321	5.14	6.10
5	30	55.40	1660	330	5.03	6.00
5	36	55.30	1666	336	4.96	5.90
5	43	55.20	1673	343	4.88	5.80
5	51	55.10	1681	351	4.79	5.70
5	59	55.00	1689	359	4.70	5.60
6	6	54.90	1696	366	4.63	5.50
6	14	54.80	1704	374	4.56	5.40
6	20	54.70	1710	380	4.50	5.30
6	26	54.60	1716	386	4.45	5.20
6	34	54.50	1724	394	4.38	5.10
6	41	54.40	1731	401	4.32	5.00
6	48	54.30	1738	408	4.26	4.90
6	54	54.20	1744	414	4.21	4.80
7	2	54.10	1752	422	4.15	4.70
7	8	54.00	1758	428	4.11	4.60
7	16	53.90	1766	436	4.05	4.50
7	25	53.80	1775	445	3.99	4.40

5-12B BAIL/RECOVERY TEST

SWL:	49.4	ft
DATE:	4/3/91	
START BAILING:	15:16:50	
STOP BAILING	15:39:00	
TOTAL TIME:	00:22:10	
VOLUME OF WATER BAILED:	11.35 GALLONS	

MEASURE TIME (minutes)	(seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	WATER LEVEL RECOVERY (feet)
7	36	53.70	1786	456	3.92	4.30
7	50	53.60	1800	470	3.83	4.20
8	3	53.50	1813	483	3.75	4.10
88	17	53.40	6627	5297	1.25	4.00
8	30	53.30	1840	510	3.61	3.90
8	44	53.20	1854	524	3.54	3.80
8	59	53.10	1869	539	3.47	3.70
9	15	53.00	1885	555	3.40	3.60
9	30	52.90	1900	570	3.33	3.50
9	49	52.80	1919	589	3.26	3.40
10	6	52.70	1936	606	3.19	3.30
10	27	52.60	1957	627	3.12	3.20
10	48	52.50	1978	648	3.05	3.10
11	8	52.40	1998	668	2.99	3.00
11	25	52.30	2015	685	2.94	2.90
11	45	52.20	2035	705	2.89	2.80
12	6	52.10	2056	726	2.83	2.70
12	23	52.00	2073	743	2.79	2.60
12	34	51.90	2084	754	2.76	2.50
12	44	51.80	2094	764	2.74	2.40
12	54	51.70	2104	774	2.72	2.30
13	6	51.60	2116	786	2.69	2.20
13	18	51.50	2128	798	2.67	2.10
13	28	51.40	2138	808	2.65	2.00
13	43	51.30	2153	823	2.62	1.90
14	4	51.20	2174	844	2.58	1.80
14	35	51.10	2205	875	2.52	1.70
15	4	51.00	2234	904	2.47	1.60
15	35	50.90	2265	935	2.42	1.50
16	19	50.80	2309	979	2.36	1.40
17	2	50.70	2352	1022	2.30	1.30
17	47	50.60	2397	1067	2.25	1.20
18	35	50.50	2445	1115	2.19	1.10

5-12B BAIL/RECOVERY TEST

SWL:	49.4 ft
DATE:	4/3/91
START BAILING:	15:16:50
STOP BAILING	15:39:00
TOTAL TIME:	00:22:10
VOLUME OF WATER BAILED:	11.35 GALLONS

MEASURE (minutes)	TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	WATER LEVEL RECOVERY (feet)
19	25	50.40	2495	1165	2.14	1.00
20	26	50.30	2556	1226	2.08	0.90
21	12	50.20	2602	1272	2.05	0.80
22	19	50.10	2669	1339	1.99	0.70
23	39	50.00	2749	1419	1.94	0.60
25	0	49.90	2830	1500	1.89	0.50
26	42	49.80	2932	1602	1.83	0.40

5-13B BAIL/RECOVERY TEST

SWL:	53.08 ft
DATE:	4/3/91
START BAILING:	16:27:00
STOP BAILING	16:43:30
TOTAL TIME:	00:16:30
VOLUME OF WATER BAILED:	8.26 GALLONS

MEASURE TIME (minutes)	MEASURE TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	WATER LEVEL RECOVERY (feet)
0	42	62.00	1032	42	24.57	8.92
0	47	61.80	1037	47	22.06	8.72
1	28	60.90	1078	88	12.25	7.82
1	34	60.80	1084	94	11.53	7.72
1	41	60.70	1091	101	10.80	7.62
1	49	60.60	1099	109	10.08	7.52
1	58	60.50	1108	118	9.39	7.42
2	8	60.40	1118	128	8.73	7.32
2	14	60.30	1124	134	8.39	7.22
2	21	60.20	1131	141	8.02	7.12
2	26	60.10	1136	146	7.78	7.02
2	33	60.00	1143	153	7.47	6.92
2	39	59.90	1149	159	7.23	6.82
2	47	59.80	1157	167	6.93	6.72
2	52	59.70	1162	172	6.76	6.62
3	0	59.60	1170	180	6.50	6.52
3	8	59.50	1178	188	6.27	6.42
3	16	59.40	1186	196	6.05	6.32
3	32	59.20	1202	212	5.67	6.12
3	35	59.10	1205	215	5.60	6.02
3	47	59.00	1217	227	5.36	5.92
3	52	58.90	1222	232	5.27	5.82
3	58	58.80	1228	238	5.16	5.72
4	2	58.70	1232	242	5.09	5.62
4	6	58.60	1236	246	5.02	5.52
4	8	58.50	1238	248	4.99	5.42
4	11	58.40	1241	251	4.94	5.32
4	15	58.30	1245	255	4.88	5.22
4	19	58.20	1249	259	4.82	5.12
4	22	58.10	1252	262	4.78	5.02
4	29	58.00	1259	269	4.68	4.92
4	36	57.80	1266	276	4.59	4.72

5-13B BAIL/RECOVERY TEST

SWL:	53.08 ft
DATE:	4/3/91
START BAILING:	16:27:00
STOP BAILING	16:43:30
TOTAL TIME:	00:16:30
VOLUME OF WATER BAILED:	8.26 GALLONS

MEASURE TIME (minutes)	(seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	WATER LEVEL RECOVERY (feet)
4	41	57.60	1271	281	4.52	4.52
4	49	57.40	1279	289	4.43	4.32
4	57	57.20	1287	297	4.33	4.12
5	6	57.00	1296	306	4.24	3.92
5	15	56.80	1305	315	4.14	3.72
5	24	56.60	1314	324	4.06	3.52
5	33	56.40	1323	333	3.97	3.32
5	44	56.20	1334	344	3.88	3.12
5	54	56.00	1344	354	3.80	2.92
6	4	55.80	1354	364	3.72	2.72
6	15	55.60	1365	375	3.64	2.52
6	28	55.40	1378	388	3.55	2.32
6	41	55.20	1391	401	3.47	2.12
7	1	55.00	1411	421	3.35	1.92
7	16	54.80	1426	436	3.27	1.72
7	29	54.60	1439	449	3.20	1.52
7	44	54.40	1454	464	3.13	1.32
8	0	54.20	1470	480	3.06	1.12
8	50	54.00	1520	530	2.87	0.92
11	33	53.80	1683	693	2.43	0.72
15	57	53.60	1947	957	2.03	0.52

5-15B BAIL/RECOVERY TEST

SWL:	50.18 ft
DATE:	3/26/91
BEGIN BAILING:	11:10:20
STOP BAILING	11:45:20
TOTAL TIME:	00:30:00
VOLUME OF WATER BAILED:	13.76 GALLONS

MEASURE (minutes)	TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	RECOVERY (feet)
0	4	57.92	2104	4	526.00	7.74
0	8	57.80	2108	8	263.50	7.62
0	16	57.40	2116	16	132.25	7.22
0	25	57.40	2125	25	85.00	7.22
0	30	57.30	2130	30	71.00	7.12
0	35	57.20	2135	35	61.00	7.02
0	44	57.10	2144	44	48.73	6.92
0	52	57.00	2152	52	41.38	6.82
1	5	56.90	2165	65	33.31	6.72
1	16	56.80	2176	76	28.63	6.62
1	27	56.70	2187	87	25.14	6.52
1	37	56.60	2197	97	22.65	6.42
1	48	56.50	2208	108	20.44	6.32
2	0	56.40	2220	120	18.50	6.22
2	11	56.30	2231	131	17.03	6.12
2	20	56.20	2240	140	16.00	6.02
2	30	56.10	2250	150	15.00	5.92
2	40	56.00	2260	160	14.13	5.82
2	56	55.90	2276	176	12.93	5.72
3	8	55.80	2288	188	12.17	5.62
3	16	55.70	2296	196	11.71	5.52
3	28	55.60	2308	208	11.10	5.42
3	41	55.50	2321	221	10.50	5.32
3	55	55.40	2335	235	9.94	5.22
4	10	55.30	2350	250	9.40	5.12
4	26	55.20	2366	266	8.89	5.02
4	42	55.10	2382	282	8.45	4.92
5	0	55.00	2400	300	8.00	4.82
5	18	54.90	2418	318	7.60	4.72
5	36	54.80	2436	336	7.25	4.62
5	50	54.70	2450	350	7.00	4.52
6	14	54.60	2474	374	6.61	4.42
6	35	54.50	2495	395	6.32	4.32

5-15B BAIL/RECOVERY TEST

SWL:	50.18 ft
DATE:	3/26/91
BEGIN BAILING:	11:10:20
STOP BAILING	11:45:20
TOTAL TIME:	00:30:00
VOLUME OF WATER BAILED:	13.76 GALLONS

MEASURE (minutes)	TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	RECOVERY (feet)
6	55	54.40	2515	415	6.06	4.22
7	15	54.30	2535	435	5.83	4.12
7	38	54.20	2558	458	5.59	4.02
8	3	54.10	2583	483	5.35	3.92
8	35	54.00	2615	515	5.08	3.82
9	4	53.90	2644	544	4.86	3.72
9	30	53.80	2670	570	4.68	3.62
10	6	53.70	2706	606	4.47	3.52
10	40	53.60	2740	640	4.28	3.42
11	22	53.50	2782	682	4.08	3.32
11	56	53.40	2816	716	3.93	3.22
12	30	53.30	2850	750	3.80	3.12
13	9	53.20	2889	789	3.66	3.02
13	40	53.10	2920	820	3.56	2.92
14	38	53.00	2978	878	3.39	2.82
15	10	52.90	3010	910	3.31	2.72
15	50	52.80	3050	950	3.21	2.62
16	35	52.70	3095	995	3.11	2.52
17	26	52.60	3146	1046	3.01	2.42
18	21	52.50	3201	1101	2.91	2.32
19	17	52.40	3257	1157	2.82	2.22
20	7	52.30	3307	1207	2.74	2.12
21	7	52.20	3367	1267	2.66	2.02
21	58	52.10	3418	1318	2.59	1.92
22	57	52.00	3477	1377	2.53	1.82
23	54	51.90	3534	1434	2.46	1.72
24	46	51.80	3586	1486	2.41	1.62

5-17B BAIL/RECOVERY TEST

SWL:	41.62 ft
DATE:	4/2/91
START BAILING:	13:00:00
STOP BAILING	13:25:00
TOTAL TIME:	00:25:00
VOLUME OF WATER BAILED:	13.8 GALLONS

MEASURE (minutes)	TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	RECOVERY (feet)
0	30	60.86	1530	30	51.00	19.24
0	35	60.84	1535	35	43.86	19.22
0	40	60.80	1540	40	38.50	19.18
0	50	60.78	1550	50	31.00	19.16
0	55	60.76	1555	55	28.27	19.14
0	58	60.74	1558	58	26.86	19.12
1	4	60.72	1564	64	24.44	19.10
1	8	60.70	1568	68	23.06	19.08
1	16	60.68	1576	76	20.74	19.06
1	20	60.66	1580	80	19.75	19.04
1	27	60.64	1587	87	18.24	19.02
1	34	60.62	1594	94	16.96	19.00
1	39	60.60	1599	99	16.15	18.98
1	46	60.58	1606	106	15.15	18.96
1	55	60.56	1615	115	14.04	18.94
2	0	60.54	1620	120	13.50	18.92
2	5	60.52	1625	125	13.00	18.90
2	14	60.50	1634	134	12.19	18.88
2	18	60.48	1638	138	11.87	18.86
2	26	60.46	1646	146	11.27	18.84
2	35	60.44	1655	155	10.68	18.82
2	45	60.42	1665	165	10.09	18.80
2	52	60.40	1672	172	9.72	18.78
2	58	60.38	1678	178	9.43	18.76
3	2	60.36	1682	182	9.24	18.74
3	11	60.34	1691	191	8.85	18.72
3	19	60.32	1699	199	8.54	18.70
3	27	60.30	1707	207	8.25	18.68
3	35	60.28	1715	215	7.98	18.66
3	40	60.26	1720	220	7.82	18.64
3	48	60.24	1728	228	7.58	18.62
3	57	60.22	1737	237	7.33	18.60
4	4	60.20	1744	244	7.15	18.58

5-17B BAIL/RECOVERY TEST

SWL:	41.62 ft
DATE:	4/2/91
START BAILING:	13:00:00
STOP BAILING	13:25:00
TOTAL TIME:	00:25:00
VOLUME OF WATER BAILED:	13.8 GALLONS

MEASURE	TIME	DEPTH TO WATER	ELAPSE TIME SINCE BAILING STARTED T	ELAPSE TIME SINCE BAILING ENDED T'	T/T'	RECOVERY
(minutes)	(seconds)	(feet)	(seconds)	(seconds)		(feet)
4	10	60.18	1750	250	7.00	18.56
4	14	60.16	1754	254	6.91	18.54
4	20	60.14	1760	260	6.77	18.52
4	30	60.12	1770	270	6.56	18.50
4	38	60.10	1778	278	6.40	18.48
4	43	60.08	1783	283	6.30	18.46
4	48	60.06	1788	288	6.21	18.44
4	58	60.04	1798	298	6.03	18.42
5	2	60.02	1802	302	5.97	18.40
5	5	60.00	1805	305	5.92	18.38
5	14	59.98	1814	314	5.78	18.36
5	20	59.92	1820	320	5.69	18.30
5	24	59.90	1824	324	5.63	18.28
5	30	59.86	1830	330	5.55	18.24
5	36	59.84	1836	336	5.46	18.22
5	44	59.80	1844	344	5.36	18.18
5	50	59.76	1850	350	5.29	18.14
5	59	59.72	1859	359	5.18	18.10
6	6	59.68	1866	366	5.10	18.06
6	15	59.64	1875	375	5.00	18.02
6	27	59.60	1887	387	4.88	17.98
6	38	59.56	1898	398	4.77	17.94
6	55	59.52	1915	415	4.61	17.90
7	17	59.48	1937	437	4.43	17.86
8	38	59.44	2018	518	3.90	17.82
8	6	59.40	1986	486	4.09	17.78
8	30	59.36	2010	510	3.94	17.74
9	55	59.32	2095	595	3.52	17.70
9	20	59.28	2060	560	3.68	17.66
9	45	59.24	2085	585	3.56	17.62
10	8	59.20	2108	608	3.47	17.58
10	40	59.16	2140	640	3.34	17.54
10	59	59.12	2159	659	3.28	17.50

5-17B BAIL/RECOVERY TEST

SWL:	41.62 ft
DATE:	4/2/91
START BAILING:	13:00:00
STOP BAILING	13:25:00
TOTAL TIME:	00:25:00
VOLUME OF WATER BAILED:	13.8 GALLONS

MEASURE TIME (minutes)	MEASURE TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	RECOVERY (feet)
11	25	59.08	2185	685	3.19	17.46
11	50	59.04	2210	710	3.11	17.42
12	15	59.00	2235	735	3.04	17.38
12	40	58.96	2260	760	2.97	17.34
13	5	58.92	2285	785	2.91	17.30
13	28	58.88	2308	808	2.86	17.26
13	54	58.84	2334	834	2.80	17.22
14	20	58.80	2360	860	2.74	17.18
14	45	58.76	2385	885	2.69	17.14
15	15	58.72	2415	915	2.64	17.10
15	40	58.68	2440	940	2.60	17.06
16	15	58.64	2475	975	2.54	17.02
16	36	58.60	2496	996	2.51	16.98
16	59	58.56	2519	1019	2.47	16.94
17	26	58.52	2546	1046	2.43	16.90
17	55	58.48	2575	1075	2.40	16.86
18	30	58.44	2610	1110	2.35	16.82
19	10	58.40	2650	1150	2.30	16.78
19	49	58.36	2689	1189	2.26	16.74
20	26	58.32	2726	1226	2.22	16.70
21	0	58.28	2760	1260	2.19	16.66
21	35	58.24	2795	1295	2.16	16.62
22	18	58.20	2838	1338	2.12	16.58
23	45	58.12	2925	1425	2.05	16.50
24	22	58.08	2962	1462	2.03	16.46
24	58	58.04	2998	1498	2.00	16.42
25	38	58.00	3038	1538	1.98	16.38
26	28	57.96	3088	1588	1.94	16.34
27	6	57.92	3126	1626	1.92	16.30
27	46	57.88	3166	1666	1.90	16.26
28	30	57.84	3210	1710	1.88	16.22
29	15	57.80	3255	1755	1.85	16.18
30	4	57.76	3304	1804	1.83	16.14

5-17B BAIL/RECOVERY TEST

SWL:	41.62 ft
DATE:	4/2/91
START BAILING:	13:00:00
STOP BAILING	13:25:00
TOTAL TIME:	00:25:00
VOLUME OF WATER BAILED:	13.8 GALLONS

MEASURE TIME (minutes)	(seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	RECOVERY (feet)
30	54	57.72	3354	1854	1.81	16.10
31	40	57.68	3400	1900	1.79	16.06
32	30	57.64	3450	1950	1.77	16.02
33	25	57.60	3505	2005	1.75	15.98
35	30	57.50	3630	2130	1.70	15.88
36	25	57.45	3685	2185	1.69	15.83
37	30	57.40	3750	2250	1.67	15.78
38	20	57.35	3800	2300	1.65	15.73
39	6	57.30	3846	2346	1.64	15.68
39	48	57.25	3888	2388	1.63	15.63
40	20	57.20	3920	2420	1.62	15.58
40	50	57.15	3950	2450	1.61	15.53
41	38	57.10	3998	2498	1.60	15.48
42	20	57.05	4040	2540	1.59	15.43
43	30	57.00	4110	2610	1.57	15.38
44	20	56.95	4160	2660	1.56	15.33
45	20	56.90	4220	2720	1.55	15.28
46	26	56.85	4286	2786	1.54	15.23
47	36	56.80	4356	2856	1.53	15.18
48	47	56.75	4427	2927	1.51	15.13
49	59	56.70	4499	2999	1.50	15.08
52	24	56.60	4644	3144	1.48	14.98
54	54	56.50	4794	3294	1.46	14.88
57	12	56.40	4932	3432	1.44	14.78
59	30	56.30	5070	3570	1.42	14.68
61	51	56.20	5211	3711	1.40	14.58
64	0	56.10	5340	3840	1.39	14.48
66	0	56.00	5460	3960	1.38	14.38
68	15	55.90	5595	4095	1.37	14.28
69	38	55.80	5678	4178	1.36	14.18
70	53	55.70	5753	4253	1.35	14.08
72	28	55.60	5848	4348	1.34	13.98
74	45	55.50	5985	4485	1.33	13.88

5-17B BAIL/RECOVERY TEST

SWL:	41.62 ft
DATE:	4/2/91
START BAILING:	13:00:00
STOP BAILING	13:25:00
TOTAL TIME:	00:25:00
VOLUME OF WATER BAILED:	13.8 GALLONS

MEASURE (minutes)	TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	RECOVERY (feet)
76	46	55.40	6106	4606	1.33	13.78
83	0	55.10	6480	4980	1.30	13.48
88	40	54.90	6820	5320	1.28	13.28
94	30	54.70	7170	5670	1.26	13.08
103	50	54.40	7730	6230	1.24	12.78
110	0	54.20	8100	6600	1.23	12.58
123	50	53.60	8930	7430	1.20	11.98
136	0	53.12	9660	8160	1.18	11.50
151	0	52.34	10560	9060	1.17	10.72
162	0	51.88	11220	9720	1.15	10.26
173	0	51.50	11880	10380	1.14	9.88
188	0	51.05	12780	11280	1.13	9.43
196	0	50.80	13260	11760	1.13	9.18
208	0	50.44	13980	12480	1.12	8.82
241	0	49.26	15960	14460	1.10	7.64
283	0	47.93	18480	16980	1.09	6.31

5-19B BAIL/RECOVERY TEST

SWL: 50.1 ft
DATE: 4/3/91
START BAILING: 13:29:30
STOP BAILING 14:02:30
TOTAL TIME: 00:33:00
VOLUME OF WATER BAILED: 14.45 GALLONS

MEASURE (minutes)	TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	WATER LEVEL RECOVERY (feet)
0	30	60.85	2010	30	67.00	10.75
0	39	60.80	2019	39	51.77	10.70
0	42	60.75	2022	42	48.14	10.65
0	51	60.70	2031	51	39.82	10.60
1	2	60.45	2042	62	32.94	10.35
1	9	60.40	2049	69	29.70	10.30
1	12	60.30	2052	72	28.50	10.20
1	17	60.25	2057	77	26.71	10.15
1	22	60.15	2062	82	25.15	10.05
1	28	60.05	2068	88	23.50	9.95
1	30	60.00	2070	90	23.00	9.90
1	35	59.95	2075	95	21.84	9.85
1	40	59.90	2080	100	20.80	9.80
1	43	59.85	2083	103	20.22	9.75
1	46	59.80	2086	106	19.68	9.70
1	49	59.75	2089	109	19.17	9.65
1	52	59.70	2092	112	18.68	9.60
1	54	59.60	2094	114	18.37	9.50
2	0	59.50	2100	120	17.50	9.40
2	5	59.40	2105	125	16.84	9.30
2	9	59.30	2109	129	16.35	9.20
2	15	59.20	2115	135	15.67	9.10
2	22	59.10	2122	142	14.94	9.00
2	30	59.00	2130	150	14.20	8.90
2	38	58.90	2138	158	13.53	8.80
2	47	58.80	2147	167	12.86	8.70
2	55	58.70	2155	175	12.31	8.60
3	4	58.60	2164	184	11.76	8.50
3	12	58.50	2172	192	11.31	8.40
3	18	58.40	2178	198	11.00	8.30
3	22	58.30	2182	202	10.80	8.20
3	26	58.20	2186	206	10.61	8.10
3	31	58.10	2191	211	10.38	8.00

5-19B BAIL/RECOVERY TEST

SWL:	50.1 ft
DATE:	4/3/91
START BAILING:	13:29:30
STOP BAILING	14:02:30
TOTAL TIME:	00:33:00
VOLUME OF WATER BAILED:	14.45 GALLONS

MEASURE (minutes)	TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	WATER LEVEL RECOVERY (feet)
3	37	58.00	2197	217	10.12	7.90
3	44	57.90	2204	224	9.84	7.80
3	47	57.80	2207	227	9.72	7.70
3	55	57.70	2215	235	9.43	7.60
4	0	57.60	2220	240	9.25	7.50
4	20	57.50	2240	260	8.62	7.40
4	33	57.40	2253	273	8.25	7.30
4	45	57.30	2265	285	7.95	7.20
4	56	57.20	2276	296	7.69	7.10
5	7	57.10	2287	307	7.45	7.00
5	20	57.00	2300	320	7.19	6.90
5	29	56.90	2309	329	7.02	6.80
5	42	56.80	2322	342	6.79	6.70
5	54	56.70	2334	354	6.59	6.60
6	8	56.60	2348	368	6.38	6.50
6	19	56.50	2359	379	6.22	6.40
6	30	56.40	2370	390	6.08	6.30
6	42	56.30	2382	402	5.93	6.20
6	58	56.20	2398	418	5.74	6.10
7	11	56.10	2411	431	5.59	6.00
7	27	56.00	2427	447	5.43	5.90
7	40	55.90	2440	460	5.30	5.80
8	0	55.80	2460	480	5.13	5.70
8	15	55.70	2475	495	5.00	5.60
8	32	55.60	2492	512	4.87	5.50
8	49	55.50	2509	529	4.74	5.40
9	9	55.40	2529	549	4.61	5.30
9	29	55.30	2549	569	4.48	5.20
9	48	55.20	2568	588	4.37	5.10
10	6	55.10	2586	606	4.27	5.00
10	21	55.00	2601	621	4.19	4.90
10	41	54.90	2621	641	4.09	4.80
10	57	54.80	2637	657	4.01	4.70

5-19B BAIL/RECOVERY TEST

SWL: 50.1 ft
DATE: 4/3/91
START BAILING: 13:29:30
STOP BAILING 14:02:30
TOTAL TIME: 00:33:00
VOLUME OF WATER BAILED: 14.45 GALLONS

MEASURE (minutes)	TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	WATER LEVEL RECOVERY (feet)
11	19	54.70	2659	679	3.92	4.60
11	42	54.60	2682	702	3.82	4.50
12	6	54.50	2706	726	3.73	4.40
12	25	54.40	2725	745	3.66	4.30
12	43	54.30	2743	763	3.60	4.20
12	55	54.20	2755	775	3.55	4.10
13	12	54.10	2772	792	3.50	4.00
13	30	54.00	2790	810	3.44	3.90
13	48	53.90	2808	828	3.39	3.80
14	10	53.80	2830	850	3.33	3.70
14	28	53.70	2848	868	3.28	3.60
14	50	53.60	2870	890	3.22	3.50
15	14	53.50	2894	914	3.17	3.40
15	38	53.40	2918	938	3.11	3.30
16	4	53.30	2944	964	3.05	3.20
16	31	53.20	2971	991	3.00	3.10
16	56	53.10	2996	1016	2.95	3.00
17	21	53.00	3021	1041	2.90	2.90
17	55	52.90	3055	1075	2.84	2.80
18	30	52.80	3090	1110	2.78	2.70
19	6	52.70	3126	1146	2.73	2.60
19	38	52.60	3158	1178	2.68	2.50
20	14	52.50	3194	1214	2.63	2.40
20	45	52.40	3225	1245	2.59	2.30
21	21	52.30	3261	1281	2.55	2.20
22	0	52.20	3300	1320	2.50	2.10
22	45	52.10	3345	1365	2.45	2.00
23	22	52.00	3382	1402	2.41	1.90
24	10	51.90	3430	1450	2.37	1.80
25	5	51.80	3485	1505	2.32	1.70
25	59	51.70	3539	1559	2.27	1.60
26	55	51.60	3595	1615	2.23	1.50
27	40	51.50	3640	1660	2.19	1.40

5-19B BAIL/RECOVERY TEST

SWL:	50.1 ft
DATE:	4/3/91
START BAILING:	13:29:30
STOP BAILING	14:02:30
TOTAL TIME:	00:33:00
VOLUME OF WATER BAILED:	14.45 GALLONS

MEASURE (minutes)	TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	WATER LEVEL RECOVERY (feet)
28	39	51.40	3699	1719	2.15	1.30
29	34	51.30	3754	1774	2.12	1.20
30	32	51.20	3812	1832	2.08	1.10
31	18	51.10	3858	1878	2.05	1.00
33	30	50.90	3990	2010	1.99	0.80
34	49	50.80	4069	2089	1.95	0.70
36	15	50.70	4155	2175	1.91	0.60
37	30	50.60	4230	2250	1.88	0.50
38	38	50.50	4298	2318	1.85	0.40
40	24	50.40	4404	2424	1.82	0.30
45	15	50.30	4695	2715	1.73	0.20

5-22B BAIL/RECOVERY TEST

SWL:	48.71 ft
DATE:	4/3/91
START BAILING:	09:53:40
STOP BAILING	10:05:02
TOTAL TIME:	00:11:22
VOLUME OF WATER BAILED:	1.72 GALLONS

MEASURE TIME (minutes)	(seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	WATER LEVEL RECOVERY (feet)
0	50	53.01	732	50	14.64	4.30
1	10	53.00	752	70	10.74	4.29
1	20	52.95	762	80	9.53	4.24
1	41	52.90	783	101	7.75	4.19
1	55	52.85	797	115	6.93	4.14
2	15	52.80	817	135	6.05	4.09
2	36	52.75	838	156	5.37	4.04
2	55	52.70	857	175	4.90	3.99
3	12	52.65	874	192	4.55	3.94
3	36	52.60	898	216	4.16	3.89
3	50	52.55	912	230	3.97	3.84
4	14	52.50	936	254	3.69	3.79
4	30	52.45	952	270	3.53	3.74
4	51	52.40	973	291	3.34	3.69
5	6	52.35	988	306	3.23	3.64
5	29	52.30	1011	329	3.07	3.59
5	48	52.25	1030	348	2.96	3.54
6	10	52.20	1052	370	2.84	3.49
6	28	52.15	1070	388	2.76	3.44
6	50	52.10	1092	410	2.66	3.39
7	14	52.05	1116	434	2.57	3.34
7	40	52.00	1142	460	2.48	3.29
7	58	51.95	1160	478	2.43	3.24
8	20	51.90	1182	500	2.36	3.19
8	50	51.85	1212	530	2.29	3.14
9	22	51.80	1244	562	2.21	3.09
9	42	51.75	1264	582	2.17	3.04
10	8	51.70	1290	608	2.12	2.99
10	32	51.65	1314	632	2.08	2.94
10	56	51.60	1338	656	2.04	2.89
11	15	51.55	1357	675	2.01	2.84
11	45	51.50	1387	705	1.97	2.79
12	15	51.45	1417	735	1.93	2.74

5-22B BAIL/RECOVERY TEST

SWL:	48.71 ft
DATE:	4/3/91
START BAILING:	09:53:40
STOP BAILING	10:05:02
TOTAL TIME:	00:11:22
VOLUME OF WATER BAILED:	1.72 GALLONS

MEASURE (minutes)	TIME (seconds)	DEPTH TO WATER (feet)	ELAPSE TIME SINCE BAILING STARTED T (seconds)	ELAPSE TIME SINCE BAILING ENDED T' (seconds)	T/T'	WATER LEVEL RECOVERY (feet)
13	6	51.35	1468	786	1.87	2.64
13	31	51.30	1493	811	1.84	2.59
13	55	51.25	1517	835	1.82	2.54
14	21	51.20	1543	861	1.79	2.49
14	47	51.15	1569	887	1.77	2.44
15	14	51.10	1596	914	1.75	2.39
15	40	51.05	1622	940	1.73	2.34
15	55	51.00	1637	955	1.71	2.29
16	26	50.90	1668	986	1.69	2.19
16	52	50.80	1694	1012	1.67	2.09
17	22	50.70	1724	1042	1.65	1.99
17	49	50.60	1751	1069	1.64	1.89
18	18	50.50	1780	1098	1.62	1.79
18	51	50.40	1813	1131	1.60	1.69
19	24	50.30	1846	1164	1.59	1.59
20	0	50.20	1882	1200	1.57	1.49
20	56	50.10	1938	1256	1.54	1.39
22	56	50.00	2058	1376	1.50	1.29
25	31	49.90	2213	1531	1.45	1.19
28	17	49.80	2379	1697	1.40	1.09
31	30	49.70	2572	1890	1.36	0.99
34	47	49.60	2769	2087	1.33	0.89
42	16	49.40	3218	2536	1.27	0.69
52	55	49.18	3857	3175	1.21	0.47
61	48	49.08	4390	3708	1.18	0.37

GRAPHS OF CONSTANT RATE PUMPING AND BAILING TESTS

Figure B.1
Aquifer test 5-4B, semi-log recovery

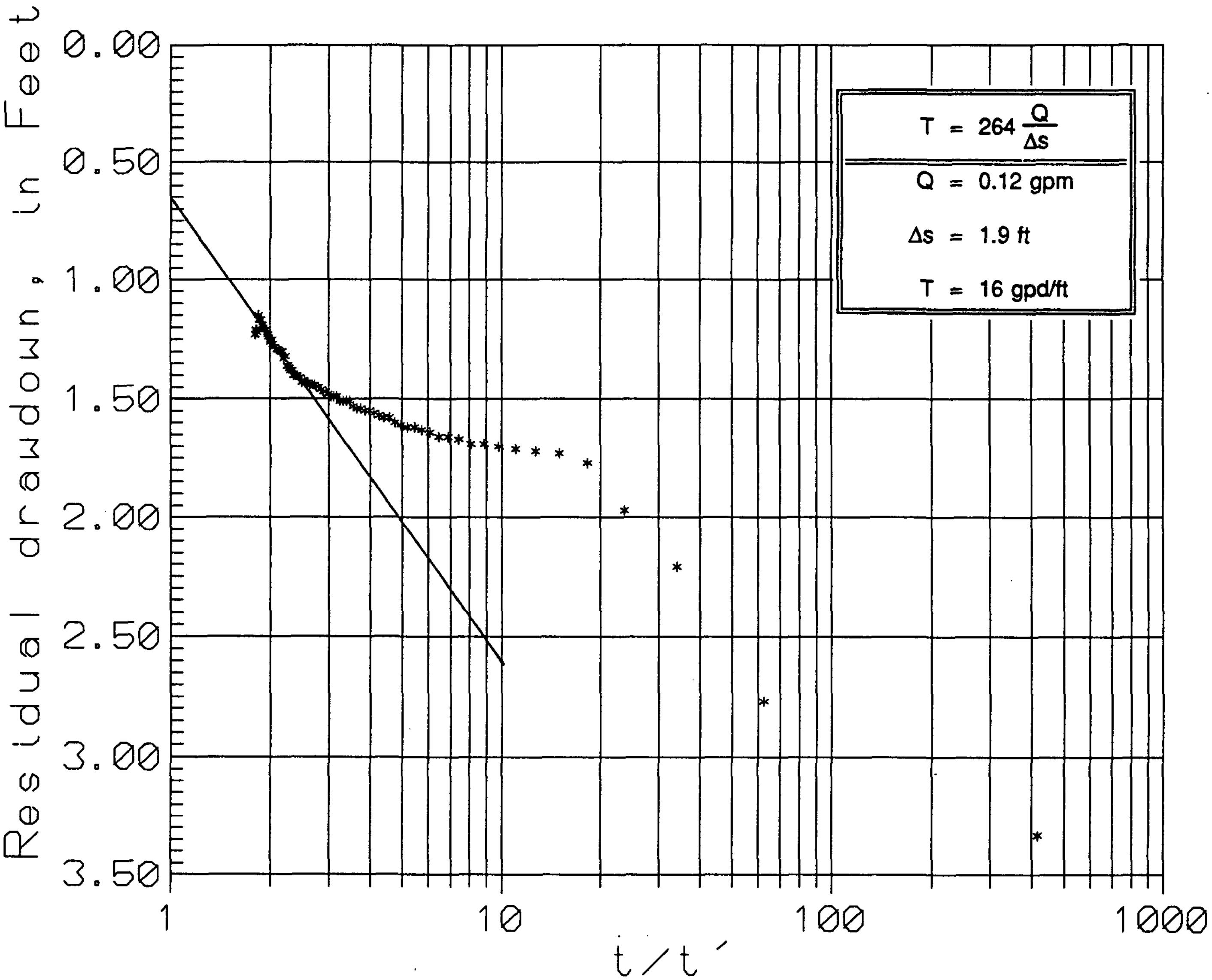


Figure B.2
Aquifer test 5-5B, semi-log drawdown

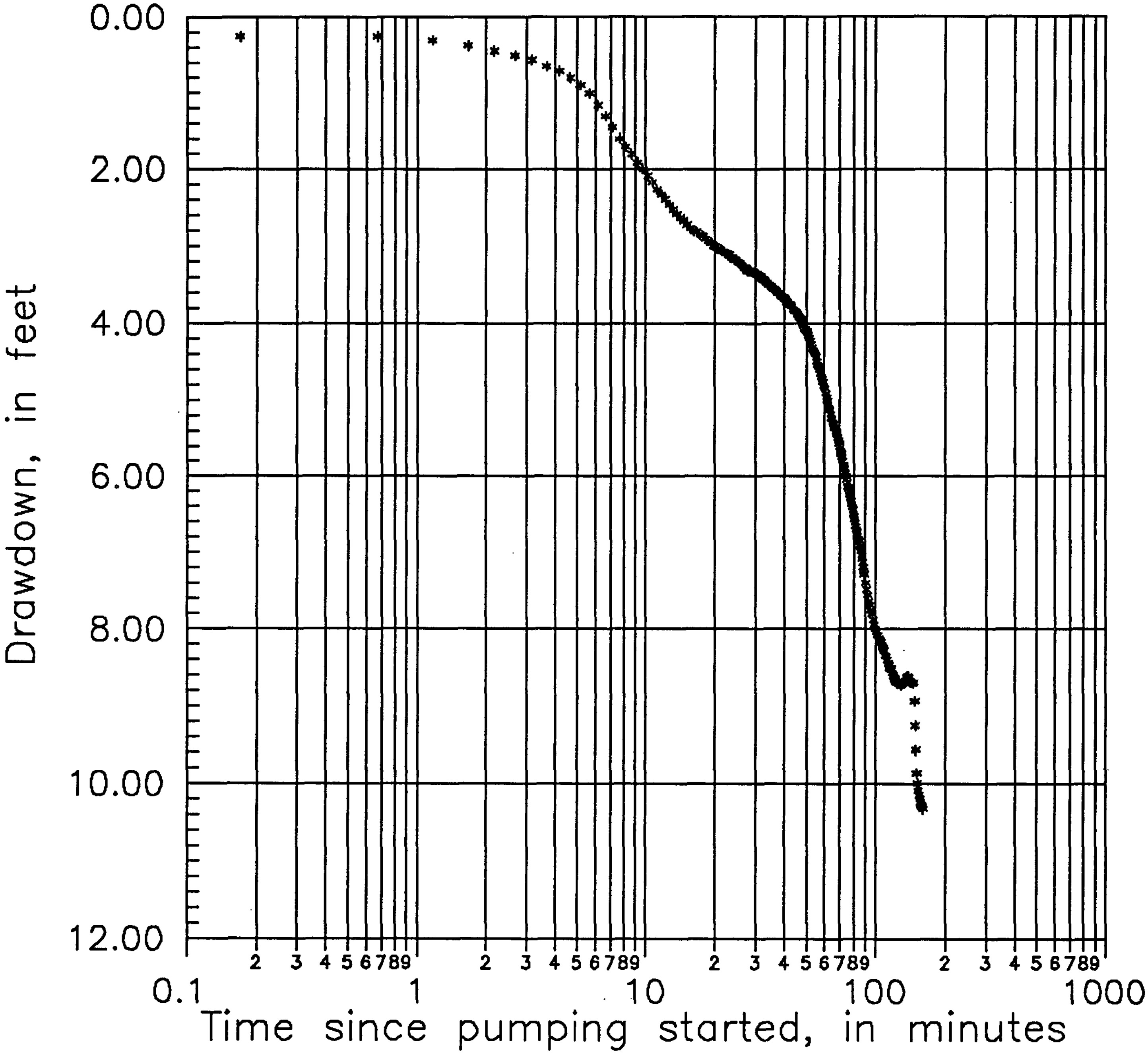


Figure B.3
Aquifer test 5–5B, semi–log recovery

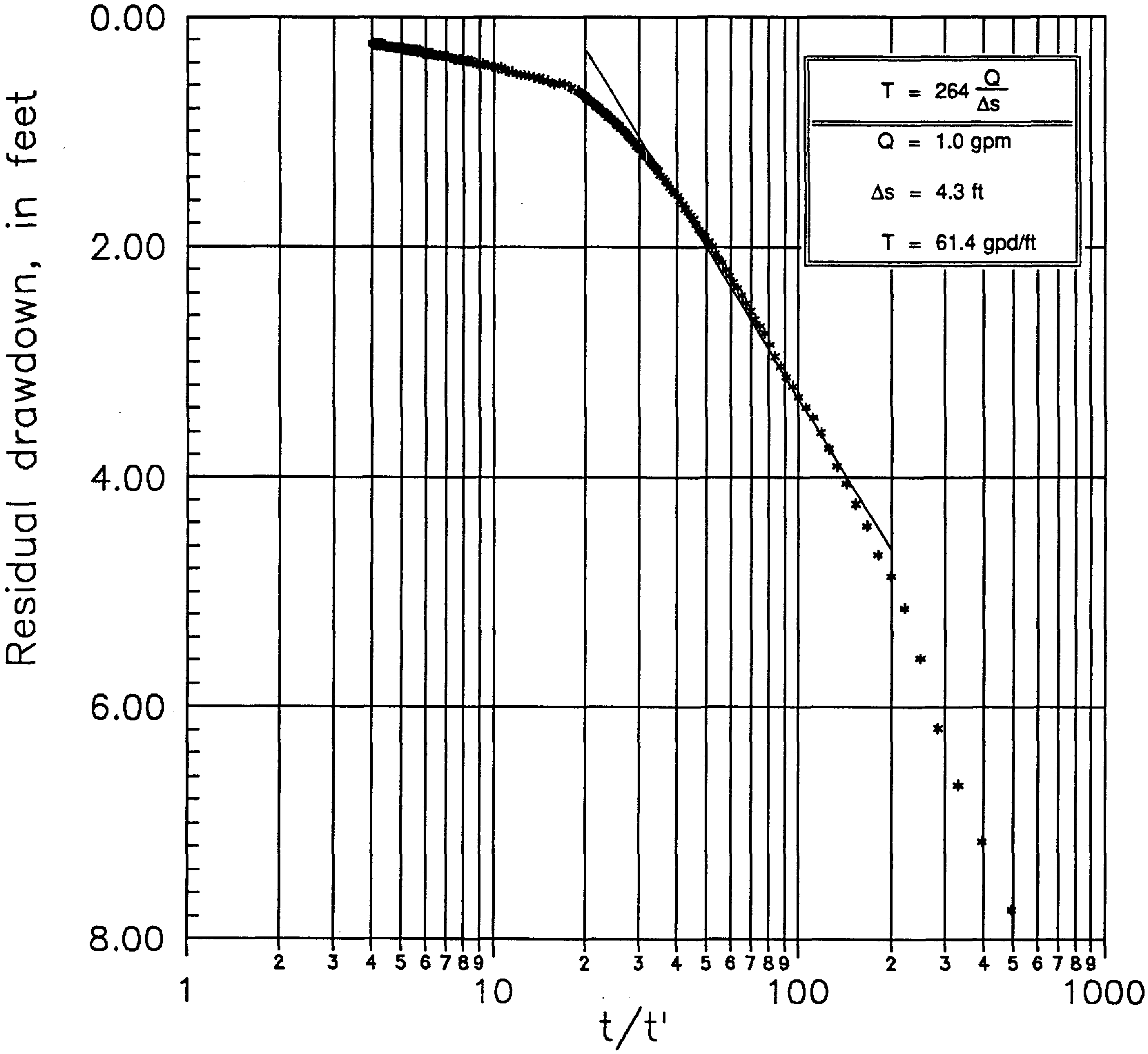


Figure B.4
Aquifer test 5-5B, log-log drawdown

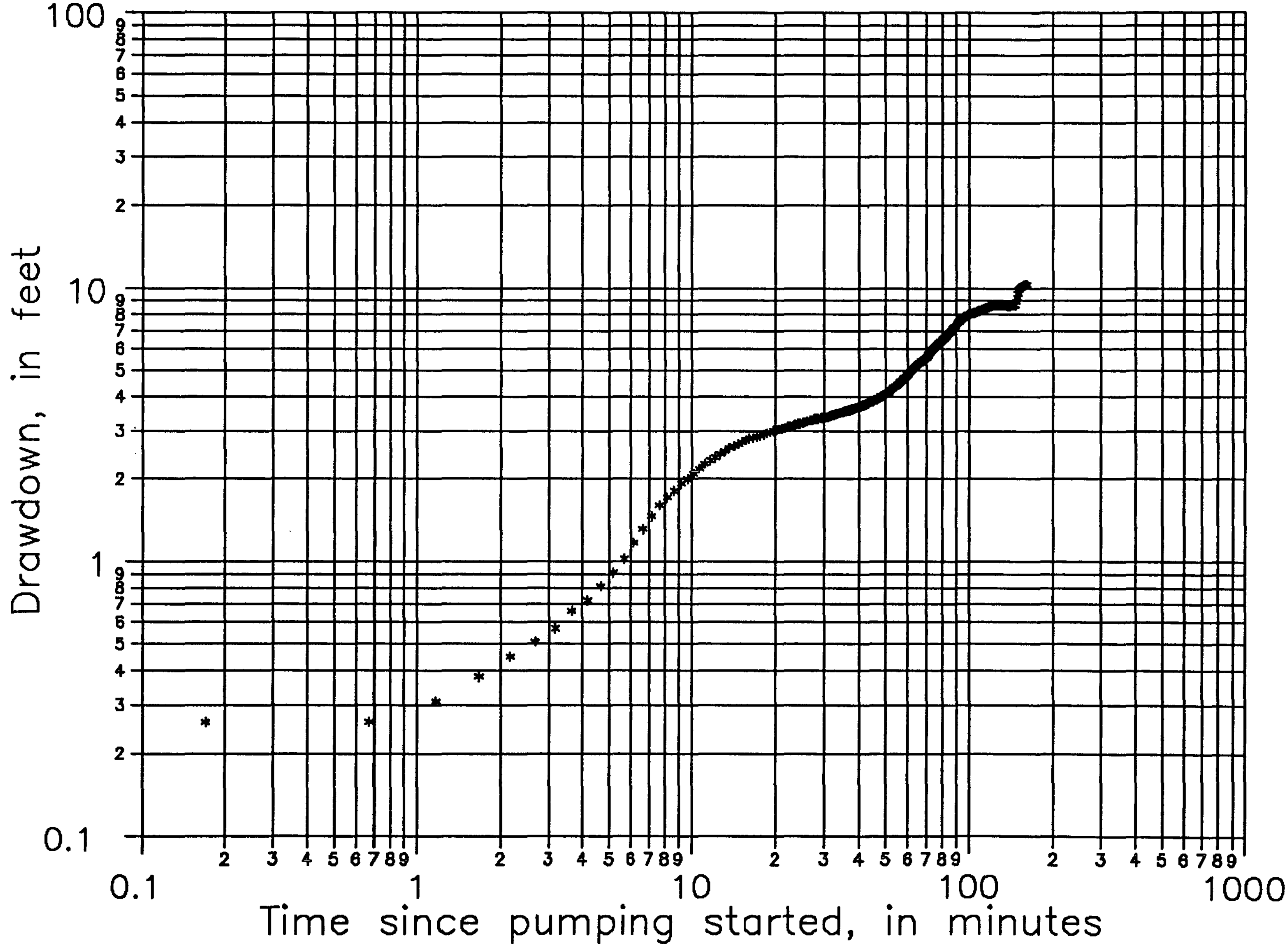


Figure B.5
Aquifer test 5-5B, log-log recovery

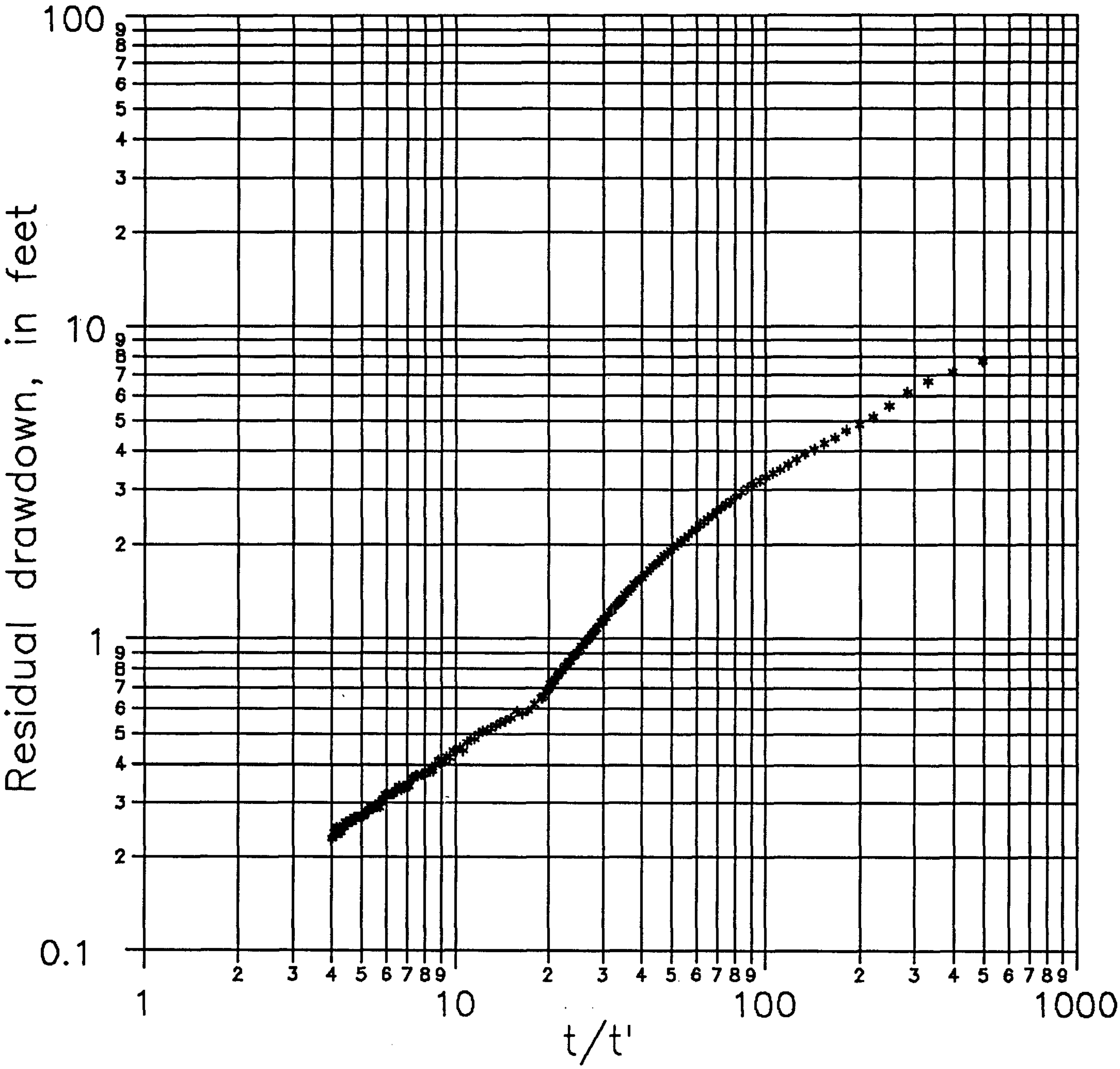


Figure B.6
Aquifer test 5-6B, semi-log drawdown

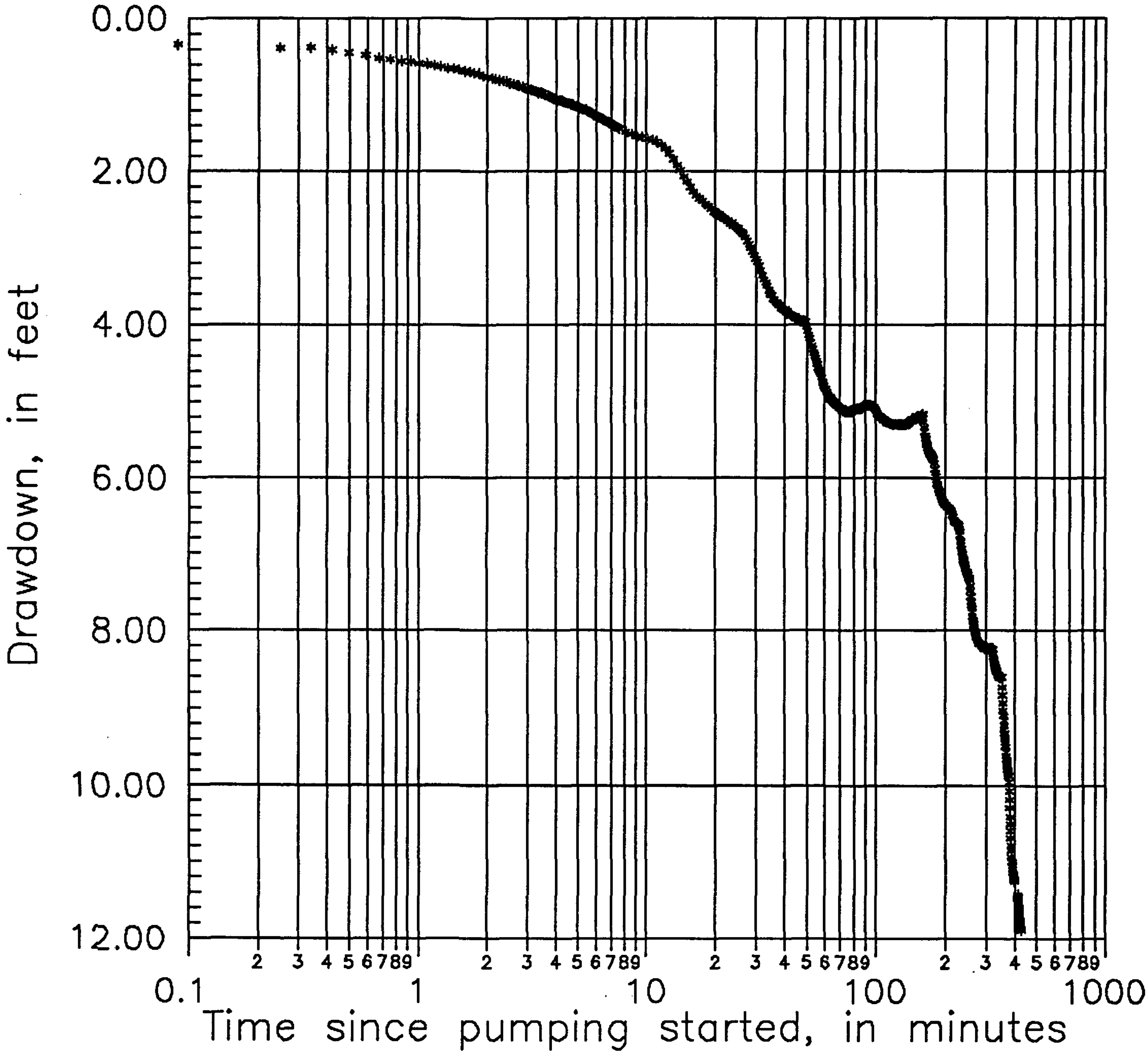


Figure B.7
Aquifer test 5–6B, semi-log recovery

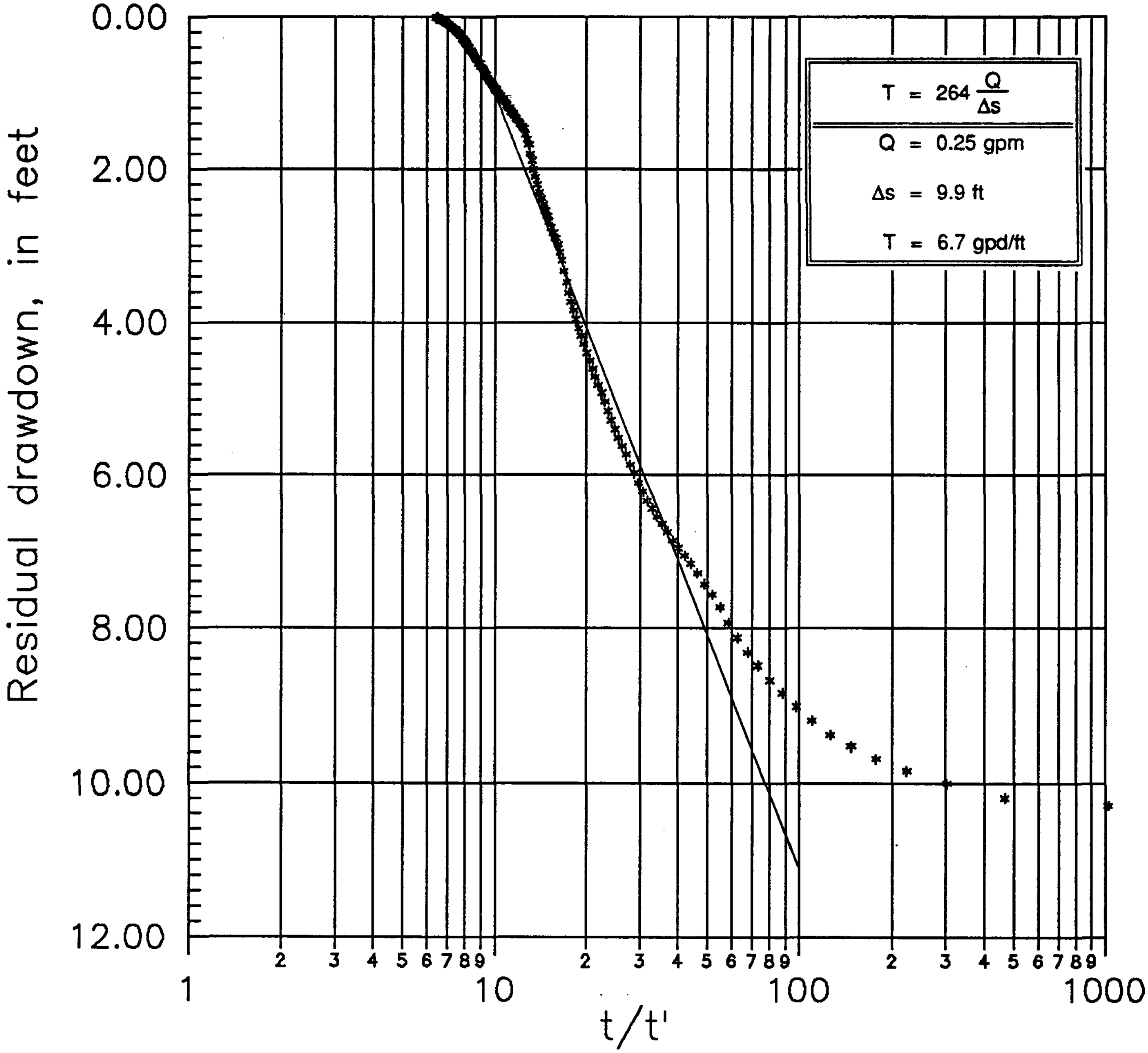


Figure B.8
Aquifer test 5–6B, log–log drawdown

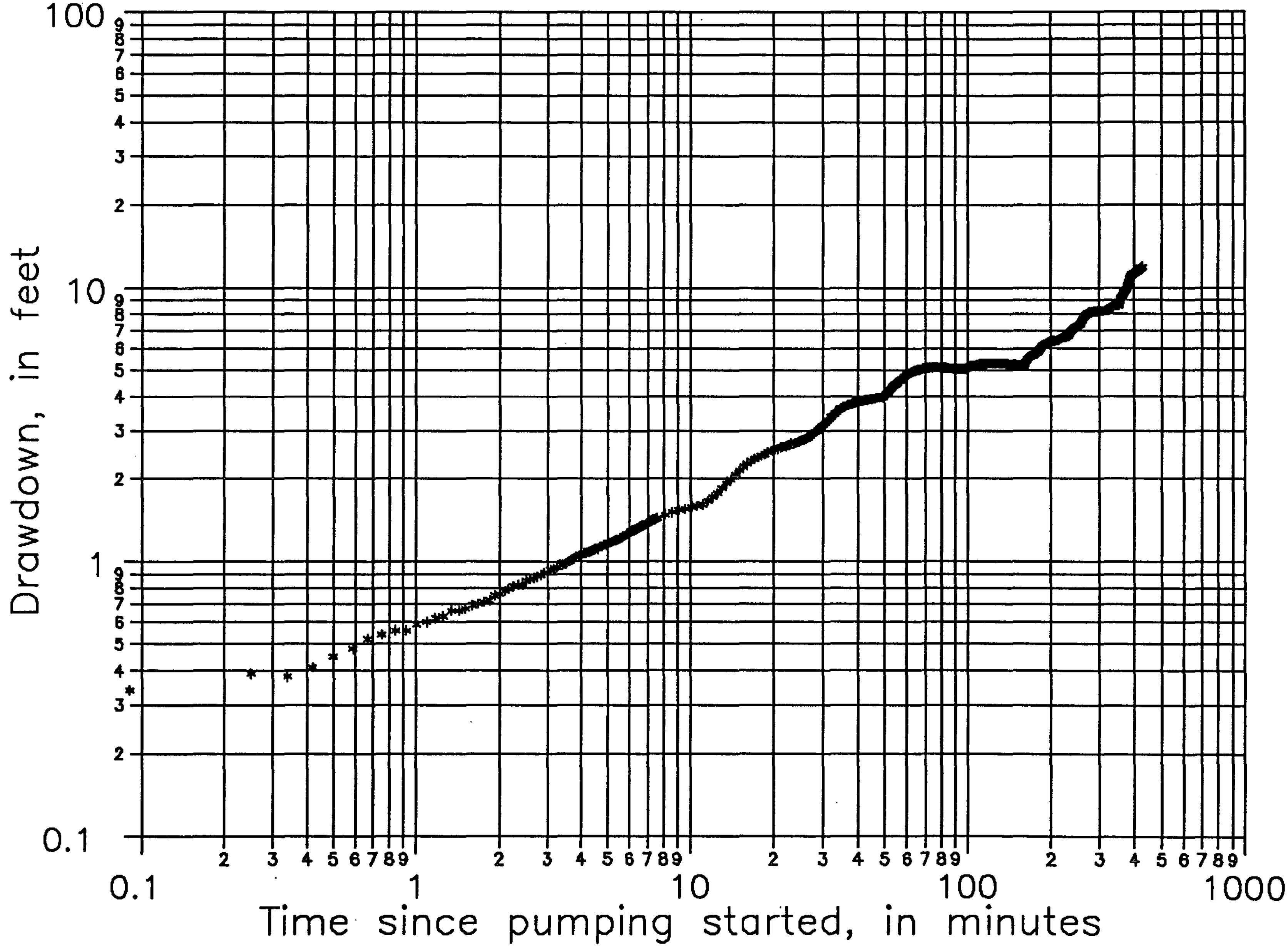


Figure B.9
Aquifer test 5-6B, log-log recovery

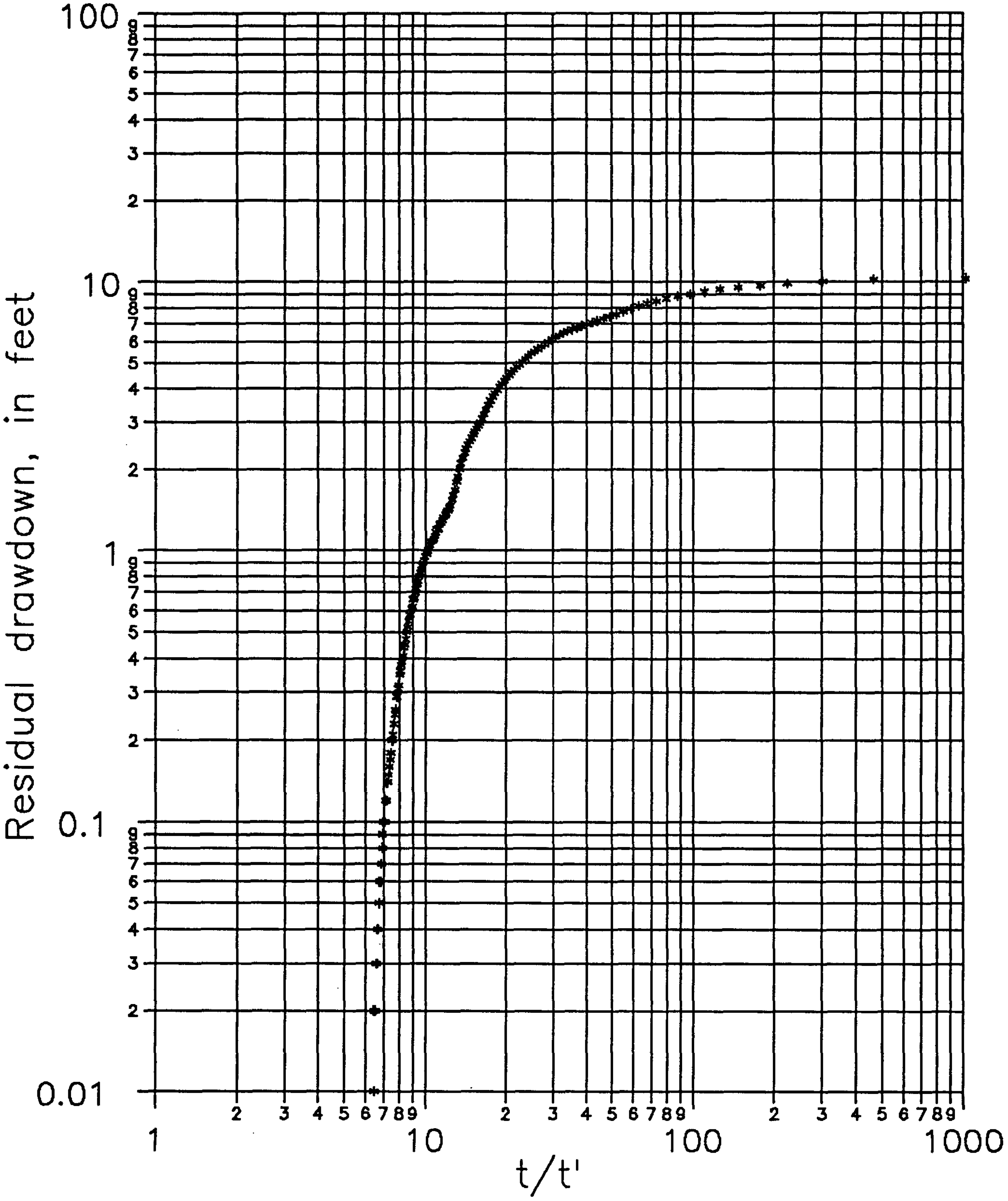


Figure B.10
5–1B Constant–Rate Bailing Test

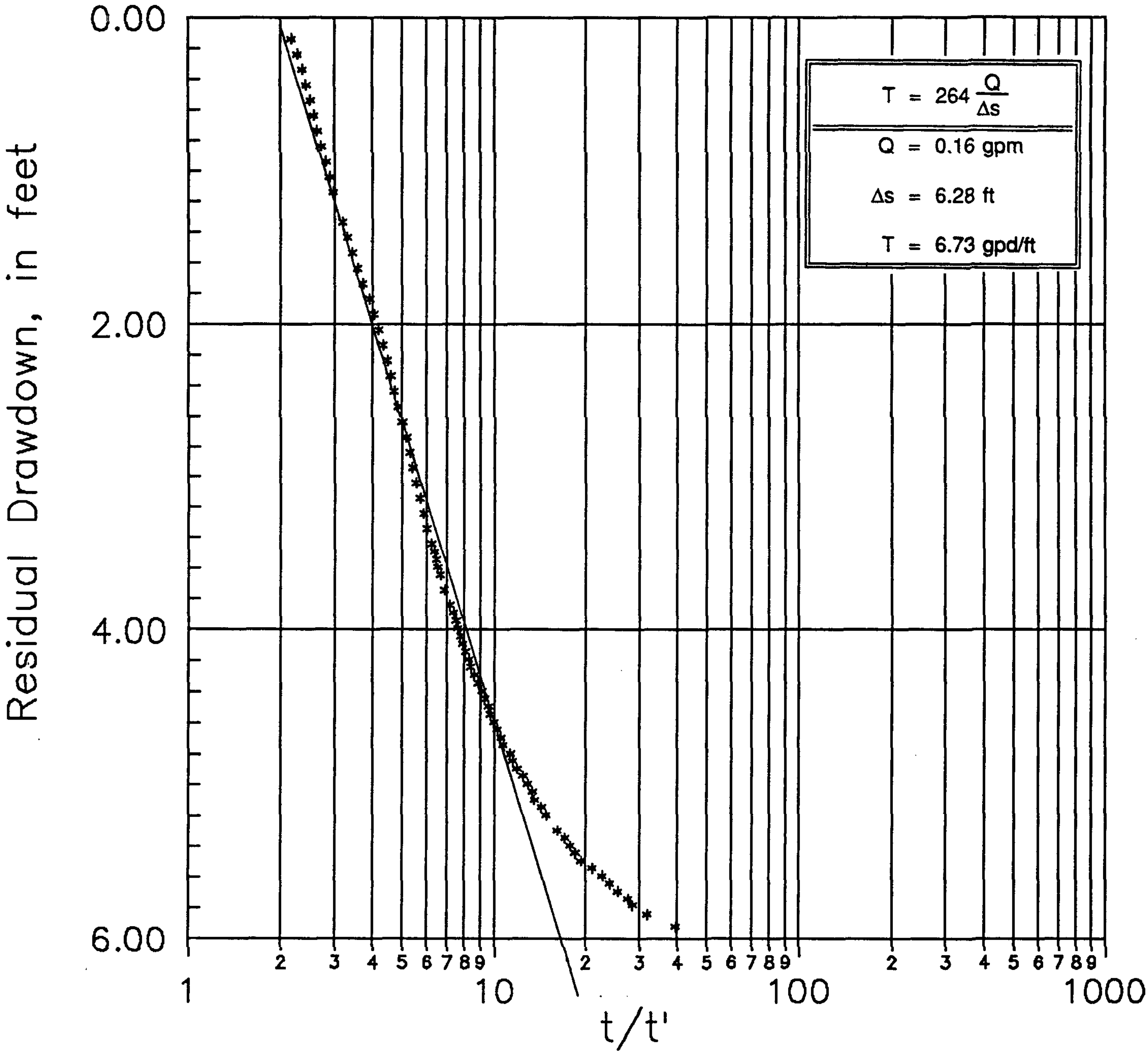


Figure B.11
5-12B Constant-Rate Bailing Test

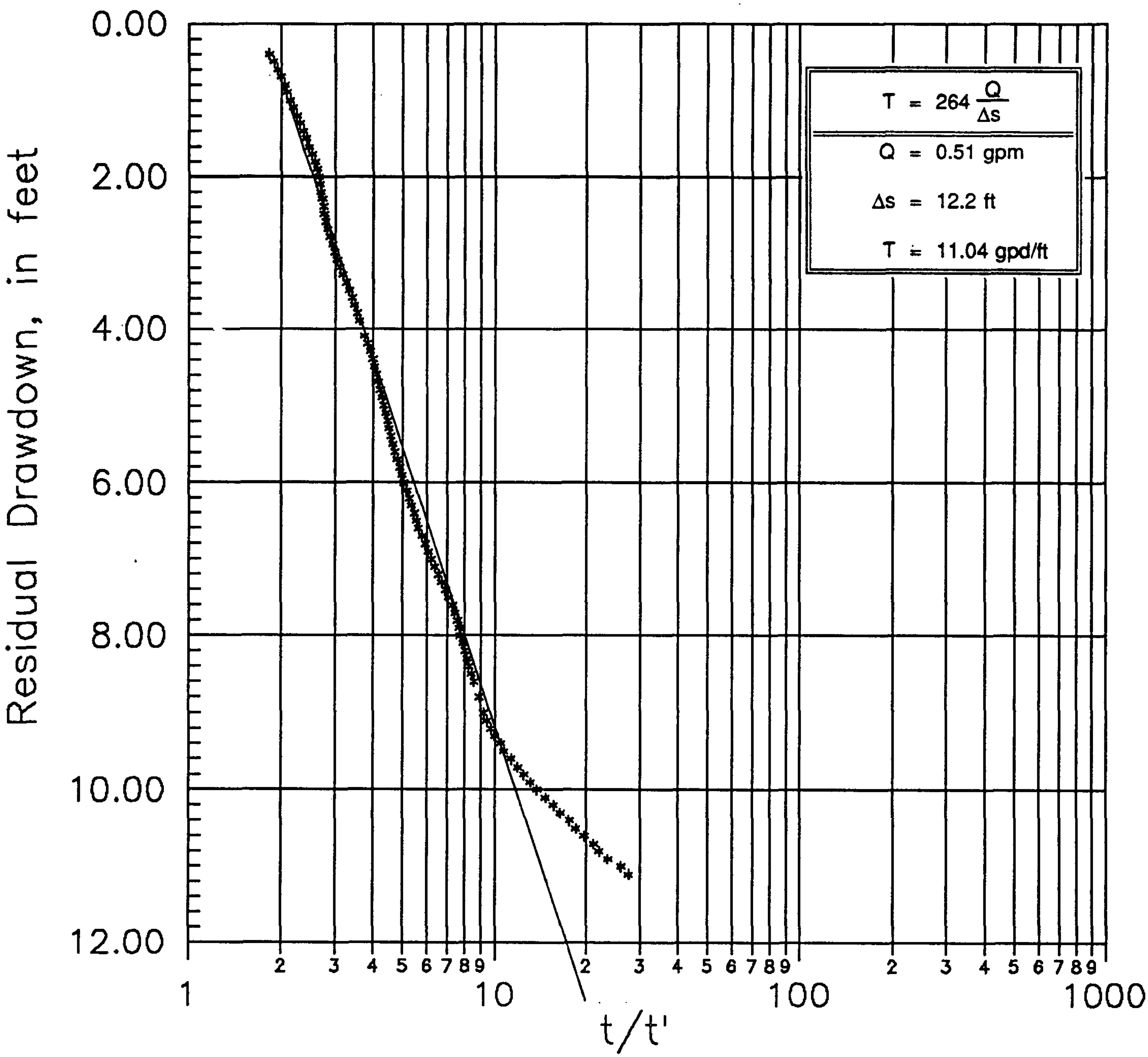


Figure B.13
5–15B Constant–Rate Bailing Test

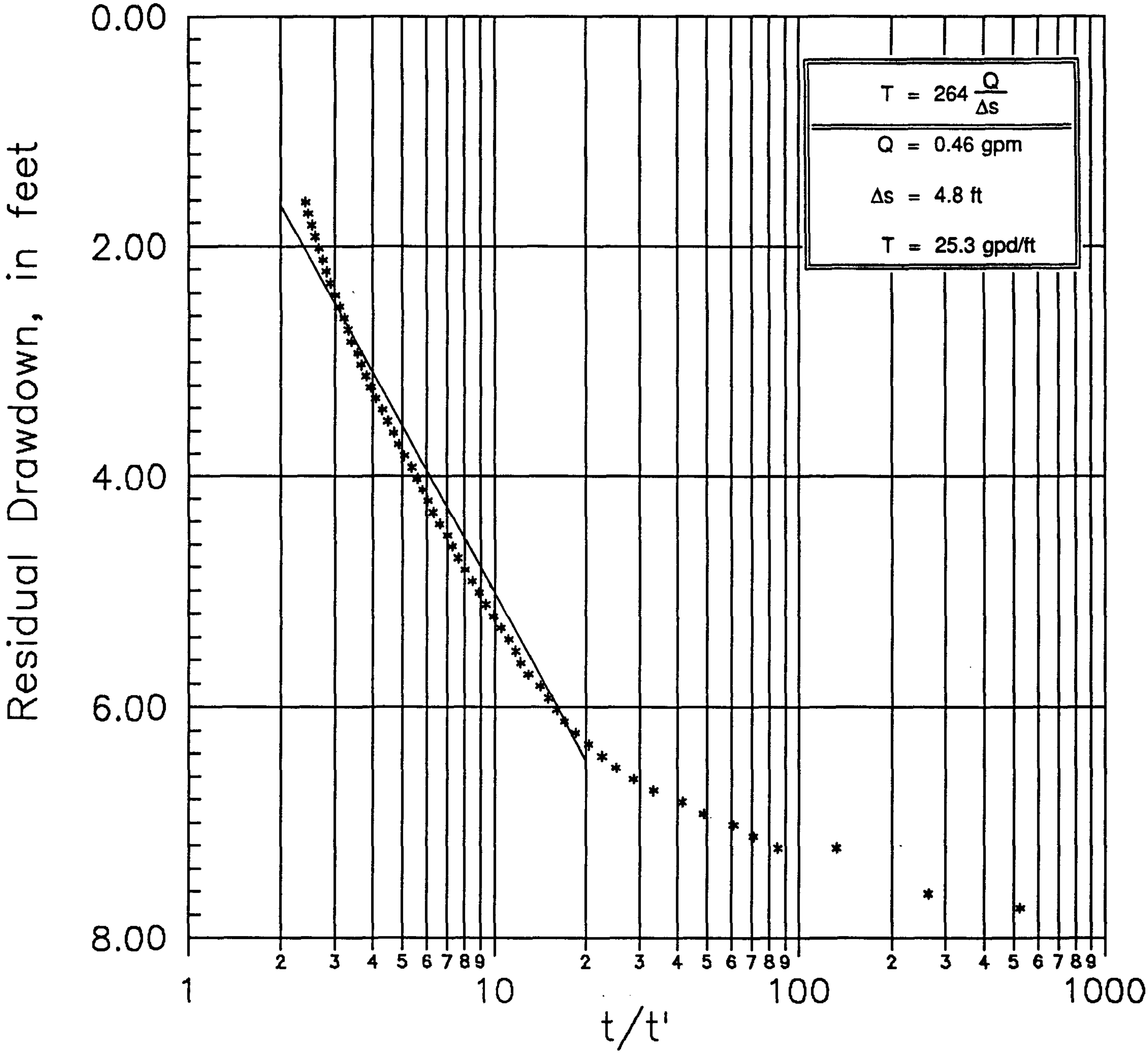


Figure B.14
5–17B Constant–Rate Bailing Test

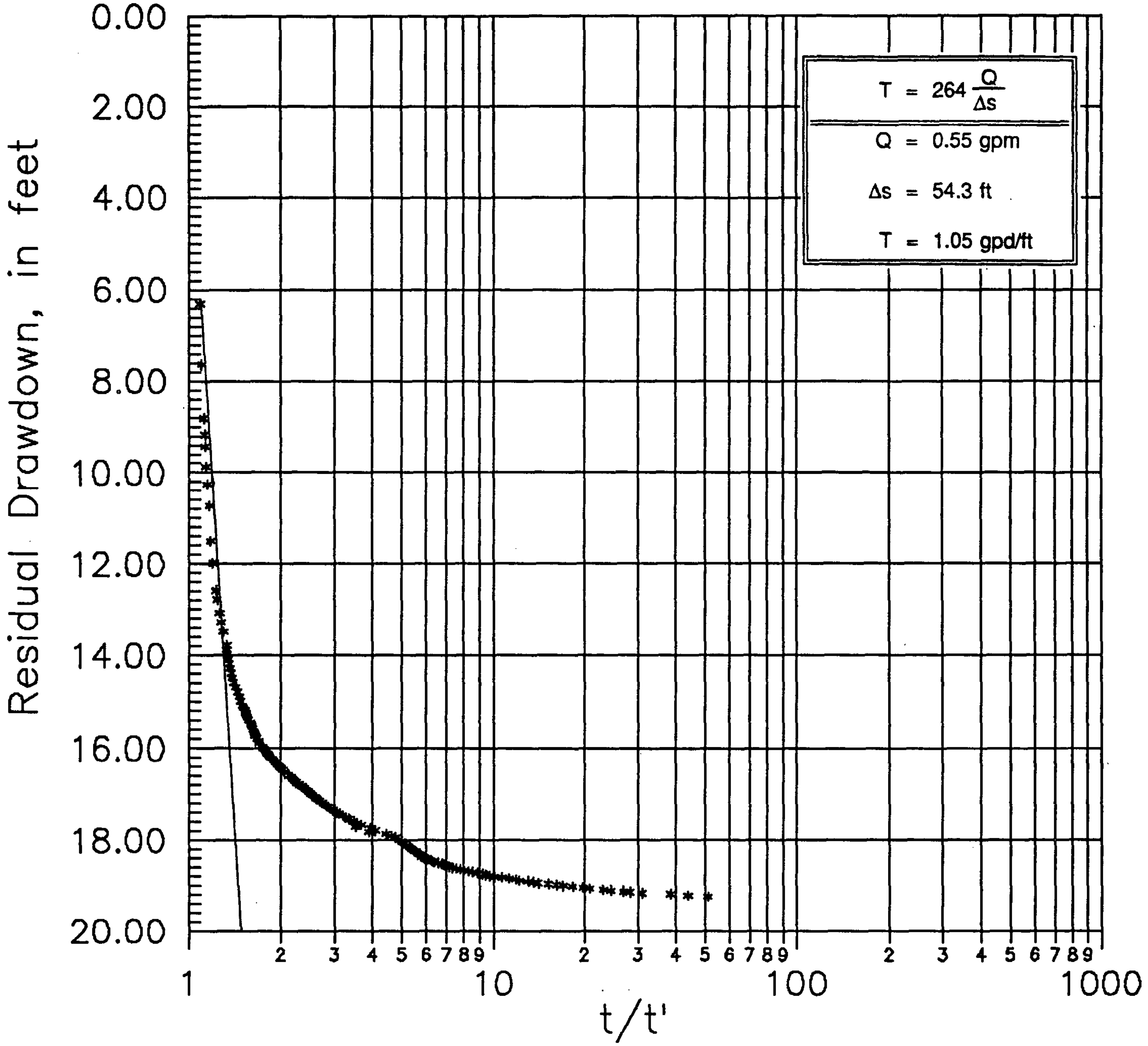


Figure B.15
5–19B Constant–Rate Bailing Test

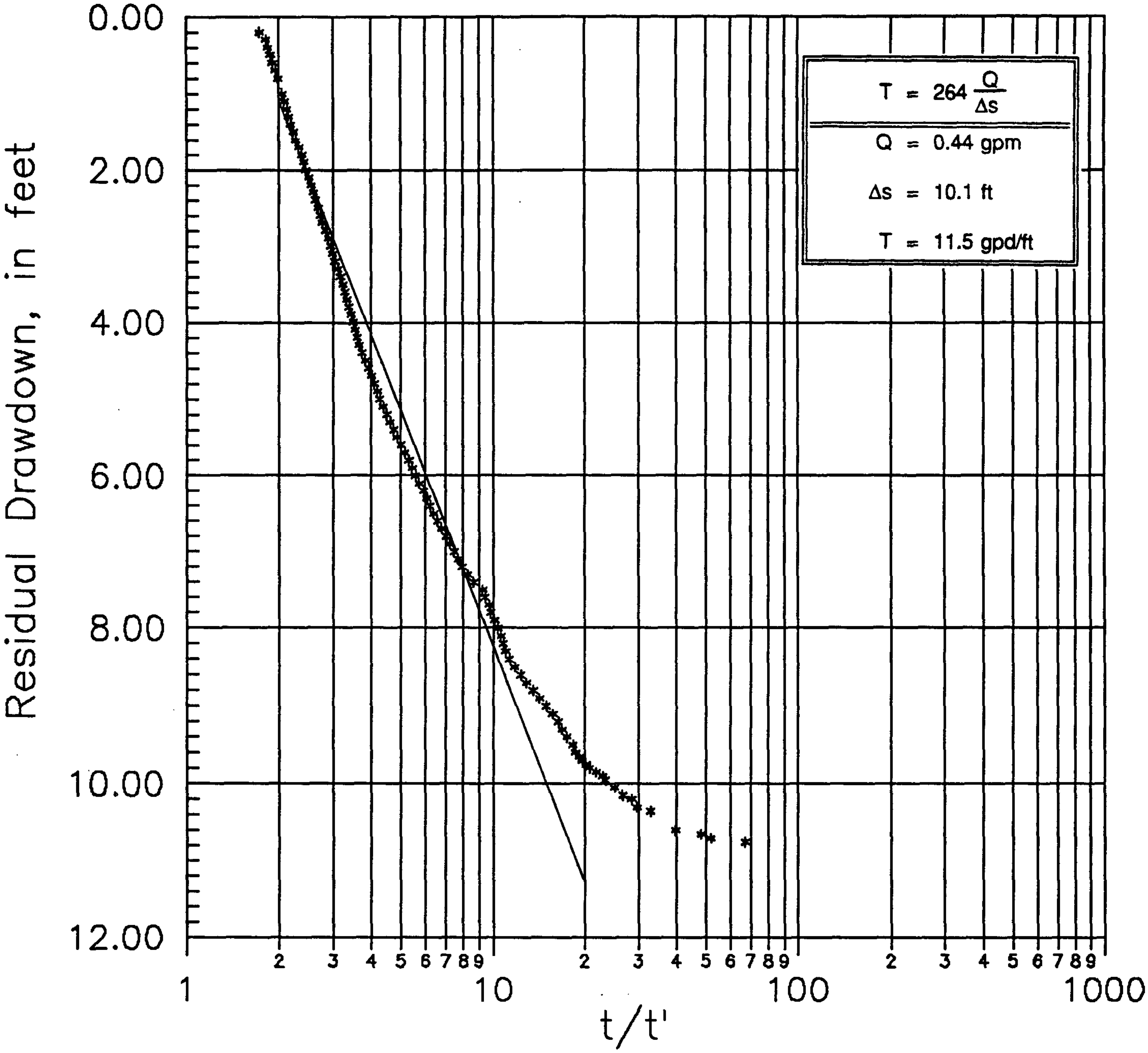
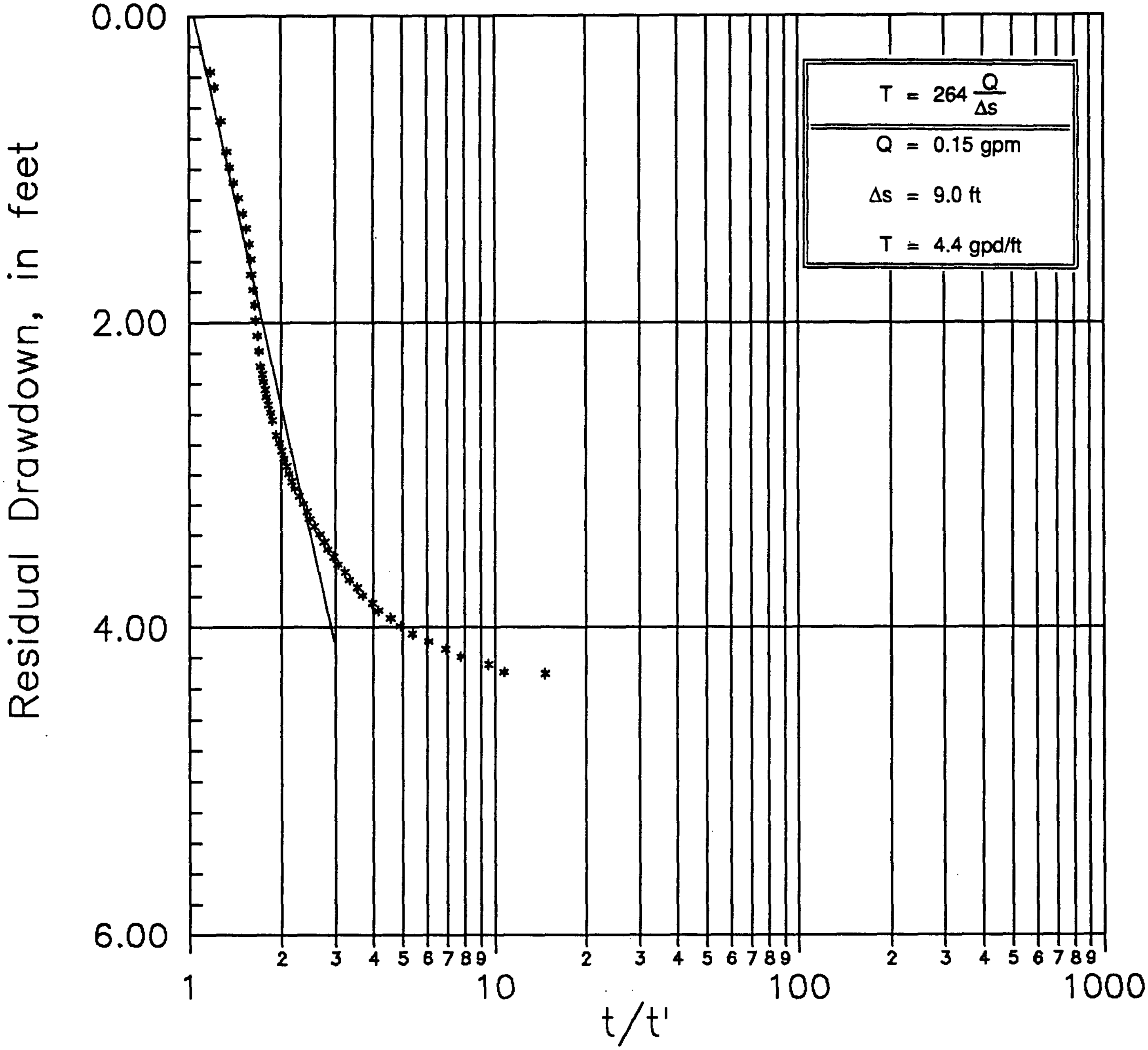


Figure B.16
5-22B Constant-Rate Bailing Test



APPENDIX C

LABORATORY HYDROLOGIC PARAMETER TEST DATA

APPENDIX C

The sample numbering system in the following laboratory report is as follows:

Lab Sample Number - Depth of Core Sample
(5-15A - 46.5)

In the sample number the letter "A" following the numeric number of the well (e.g., 5-15A) corresponds to the letter "B" in well numbers (e.g., 5-15B) in the ground-water assessment report, as shown below.

Well Number	Lab Sample Number
5-15B	5-15A
5-16B	5-16A
5-18B	5-18A
5-19B	5-19A

FINAL

LABORATORY ANALYSIS

OF

SOIL HYDRAULIC PROPERTIES

FROM

ENRON COMPRESSOR STATION

THOREAU, NM

PREPARED FOR

DBS&A IN-HOUSE MODELING

OCTOBER 1990

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TABLE 1. SUMMARY OF TESTS PERFORMED

Laboratory Sample No.	Saturated Hydraulic Conductivity	Moisture Characteristics		Initial Moisture Content	Dry Bulk Density	Calculated Porosity	Unsaturated Hydraulic Conductivity (Calculated)	Particle Size Distribution	
		Hanging Column	Pressure Plate					Sieve	Hydrometer
5-15A-46.5	X	X	X	X	X	X	X	X	
5-15A-47.5	X	X	X	X	X	X	X	X	
5-16A-40.5	X	X	X	X	X	X	X	X	
5-16A-42.5	X	X	X	X	X	X	X	X	
5-18A-60	X	X	X	X	X	X	X	X	X
5-19A-55	X			X	X	X		X	X

TABLE 2. SUMMARY OF SAMPLE CHARACTERISTICS

SAMPLE NO. (INCL. DEPTHS)	COLOR	VISUAL TEXTURE CLASSIFICATION ASTM D 2448-84	COMMENTS
5-15A-46.5	Reddish Brown	SW-SM	Medium- to fine-grained, well graded, damp, densely compacted.
5-15A-47.5	Reddish Brown	SW-SM	Damp, dirty, densely compacted.
5-16A-40.5	Tan	SP	Medium- to coarse-grained, well graded, dry, loosely compacted.
5-16A-42.5	Olive	SW-SM	Fine-grained, well graded, damp, densely compacted
5-18A-60	Olive	SM-SC	Fine-grained, well graded, saturated, densely compacted.
5-19A-55	Reddish Brown	SM-SC	Fine-grained, poorly graded, wet, densely compacted.

TABLE 3. SUMMARY OF INITIAL MOISTURE CONTENT, DRY BULK DENSITY, AND POROSITY

Sample Number	Initial Moisture Content: Gravimetric (%,g/g)	Initial Moisture Content: Volumetric (%,cm³/cm³)	Density (g/cm³)	Calculated Porosity (%)
5-15A-46.5	12.19	23.25	1.91	28.06
5-15A-47.5	10.86	21.02	1.94	26.92
5-16A-40.5	4.86	8.40	1.73	34.82
5-16A-42.5	10.42	19.03	1.83	31.09
5-18A-60	13.82	29.36	2.12	19.82
5-19A-55	22.68	42.24	1.86	29.70

TABLE 4. SUMMARY OF MOISTURE CHARACTERISTICS OF THE INITIAL DRAINAGE CURVE

Sample Number	Pressure Head (-cm water)	Moisture Content (%,cm^3/cm^3)
5-15A-46.5	0.0	35.81
	46.5	30.09
	182.0	25.80
	509.9	22.66
	917.8	21.58
	3059.4	19.17
	15501.0	17.40
5-15A-47.5	0.0	32.33
	41.5	26.64
	174.5	22.82
	509.9	19.97
	917.8	19.15
	3059.4	16.76
	15501.0	15.35
5-16A-40.5	0.0	31.47
	97.0	10.39
	193.5	8.29
	509.9	6.87
	917.8	6.64
	3059.4	5.79
	15501.0	5.62
5-16A-42.5	0.0	36.70
	54.0	29.67
	184.5	22.47
	509.9	19.03
	917.8	18.17
	3059.4	15.79
	15501.0	14.83

TABLE 4. SUMMARY OF MOISTURE CHARACTERISTICS OF THE INITIAL DRAINAGE CURVE (CONT.)

Sample Number	Pressure Head (-cm water)	Moisture Content (%,cm³/cm³)
5-18A-60	0.0	29.39
	51.0	28.44
	190.0	26.84
	509.9	24.52
	917.8	23.62
	3059.4	19.00
	15501.0	16.44
5-19A-55	0.0	34.07
	43.5	32.08
	184.5	30.25
	509.9	26.65
	917.8	25.92
	3059.4	18.67
	15501.0	17.85

TABLE 5. SUMMARY OF SATURATED HYDRAULIC CONDUCTIVITY TESTS

		Method of Analysis	
Sample Number	Ks(cm/sec)	Constant Head	Falling Head
5-15A-46.5	5.2×10^{-6}		X
5-15A-47.5	5.9×10^{-5}		X
5-16A-40.5	1.5×10^{-3}	X	
5-16A-42.5	3.2×10^{-5}		X
5-18A-60	1.5×10^{-7}		X
5-19A-55	3.4×10^{-7}		X

TABLE 6A. SUMMARY OF UNSATURATED HYDRAULIC PROPERTIES (CALCULATED)

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r (%, cm^3/cm^3)	θ_s (%, cm^3/cm^3)	K_{sat} (cm/sec)
5-15A-46.5	0.03357	1.45637	17.40	35.81	5.2×10^{-6}
5-15A-47.5	0.04382	1.43492	15.35	32.33	5.9×10^{-5}
5-16A-40.5	0.04069	2.32521	6.49	31.47	1.5×10^{-3}
5-16A-42.5	0.03314	1.58391	14.83	36.70	3.2×10^{-5}
5-18A-60	0.00318	1.65120	16.44	29.39	1.5×10^{-7}
5-19A-55	0.00404	1.71419	17.85	34.07	3.4×10^{-7}

TABLE 6B. SUMMARY OF UNSATURATED HYDRAULIC PROPERTIES (CALCULATED)

95% CONFIDENCE LIMITS

Sample Number	α Lower	α Upper	N Lower	N Upper
5-15A-46.5	0.0148	0.0523	1.3346	1.5781
5-15A-47.5	0.0147	0.0729	1.3051	1.5647
5-16A-40.5	-0.0114	0.0928	1.2284	3.4220
5-16A-42.5	0.0246	0.0417	1.4979	1.6699
5-18A-60	0.0008	0.0055	1.2608	2.0415
5-19A-55	-0.0002	0.0083	1.0995	2.3288

TABLE 7. SUMMARY OF PARTICLE SIZE CHARACTERISTICS

Sample Number	d_{10}	d_{50}	d_{60}	C_u	C_c
5-15A-46.5	0.09	0.57	0.85	9.4	0.88
5-15A-47.5	0.09	0.67	1.20	13.3	0.73
5-16A-40.5	0.12	0.41	0.69	5.8	0.88
5-16A-42.5	0.08	0.29	0.38	4.8	0.95
5-18A-60	0.05	0.23	0.31	6.2	2.5
5-19A-55	*	0.19	0.27	-----	-----

* d_{10} not reached with test(s) specified.

-- value dependent upon d_{10}

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

d_{50} = median particle diameter

APPENDIX A

INITIAL MOISTURE CONTENT, DRY BULK DENSITY, AND POROSITY

SUMMARY OF INITIAL MOISTURE CONTENT, DRY BULK DENSITY, AND POROSITY

Sample Number	Initial Moisture Content Gravimetric (%,g/g)	Initial Moisture Content Volumetric (%,cm^3/cm^3)	Density (g/cm^3)	Calculated Porosity (%)
5-15A-46.5	12.19	23.25	1.91	28.06
5-15A-47.5	10.86	21.02	1.94	26.92
5-16A-40.5	4.86	8.40	1.73	34.82
5-16A-42.5	10.42	19.03	1.83	31.09
5-18A-60	13.82	29.36	2.12	19.82
5-19A-55	22.68	42.24	1.86	29.70

DATA FOR INITIAL MOISTURE CONTENT,
BULK DENSITY, AND POROSITY

JOB NAME:	ENRON
JOB NUMBER:	89-034-L
SAMPLE NUMBER:	5-15A-46.5
RING NUMBER:	D-1
DEPTH:	46.5 Ft.

FIELD WEIGHT OF SAMPLE (W/CAP AND RING):	249.39 (g)
TARE WEIGHT, RING:	55.61 (g)
TARE WEIGHT, PAN:	0.00 (g)
SAMPLE VOLUME:	90.60 (cc)
DATE AND TIME INTO OVEN:	9/21/90 @ 1000
DATE AND TIME OUT OF OVEN:	9/22/90 @ 1300
DRY WEIGHT OF SAMPLE:	172.72 (g)
DRY BULK DENSITY:	1.91 (g/cc)
PARTICLE DENSITY:	2.65 (g/cc)

(METHOD: ASSUME MEAN PARTICLE DENSITY = 2.65 g/cc)

CALCULATED POROSITY:	28.06 (% vol)
INITIAL MOISTURE CONTENT (VOLUMETRIC):	23.25 (% vol)
INITIAL MOISTURE CONTENT (GRAVIMETRIC):	12.19 (%)

COMMENTS:

LABORATORY ANALYSIS PERFORMED BY: R. Hill
CALCULATIONS MADE BY: R. Hill
CHECKED BY: D. Hammermeister

DATA FOR INITIAL MOISTURE CONTENT,
BULK DENSITY, AND POROSITY

JOB NAME:	ENRON
JOB NUMBER:	89-034-L
SAMPLE NUMBER:	5-15A-47.5
RING NUMBER:	D-2
DEPTH:	47.5 Ft.

FIELD WEIGHT OF SAMPLE (W/CAP AND RING):	274.19 (g)
TARE WEIGHT, RING:	60.87 (g)
TARE WEIGHT, PAN:	0.00 (g)
SAMPLE VOLUME:	99.36 (cc)
DATE AND TIME INTO OVEN:	9/21/90 @ 1000
DATE AND TIME OUT OF OVEN:	9/22/90 @ 1300
DRY WEIGHT OF SAMPLE:	192.43 (g)
DRY BULK DENSITY:	1.94 (g/cc)
PARTICLE DENSITY:	2.65 (g/cc)
(METHOD:	ASSUME MEAN PARTICLE DENSITY = 2.65 g/cc)
CALCULATED POROSITY:	26.92 (% vol)
INITIAL MOISTURE CONTENT (VOLUMETRIC):	21.02 (% vol)
INITIAL MOISTURE CONTENT (GRAVIMETRIC):	10.86 (%)

COMMENTS:

LABORATORY ANALYSIS PERFORMED BY: R. Hill
CALCULATIONS MADE BY: R. Hill
CHECKED BY: D. Hammermeister

DATA FOR INITIAL MOISTURE CONTENT,
BULK DENSITY, AND POROSITY

JOB NAME:	ENRON
JOB NUMBER:	89-034-L
SAMPLE NUMBER:	5-16A-40.5
RING NUMBER:	5-16
DEPTH:	40.5 Ft.

FIELD WEIGHT OF SAMPLE (W/CAP AND RING):	214.56 (g)
TARE WEIGHT, RING:	50.52 (g)
TARE WEIGHT, PAN:	0.00 (g)
SAMPLE VOLUME:	90.57 (cc)
DATE AND TIME INTO OVEN:	9/21/90 @ 1000
DATE AND TIME OUT OF OVEN:	9/22/90 @ 1300
DRY WEIGHT OF SAMPLE:	156.43 (g)
DRY BULK DENSITY:	1.73 (g/cc)
PARTICLE DENSITY:	2.65 (g/cc)

(METHOD: ASSUME MEAN PARTICLE DENSITY = 2.65 g/cc)

CALCULATED POROSITY:	34.82 (% vol)
INITIAL MOISTURE CONTENT (VOLUMETRIC):	8.40 (% vol)
INITIAL MOISTURE CONTENT (GRAVIMETRIC):	4.86 (%)

COMMENTS:

LABORATORY ANALYSIS PERFORMED BY: R. Hill
CALCULATIONS MADE BY: R. Hill
CHECKED BY: D. Hammermeister

DATA FOR INITIAL MOISTURE CONTENT,
BULK DENSITY, AND POROSITY

JOB NAME: ENRON
JOB NUMBER: 89-034-L
SAMPLE NUMBER: 5-16A-42.5
RING NUMBER: 42.5
DEPTH: 42.5 Ft.

FIELD WEIGHT OF SAMPLE (W/CAP AND RING):	195.57 (g)
TARE WEIGHT, RING:	36.46 (g)
TARE WEIGHT, PAN:	0.00 (g)
SAMPLE VOLUME:	78.91 (cc)
DATE AND TIME INTO OVEN:	9/21/90 @ 1000
DATE AND TIME OUT OF OVEN:	9/22/90 @ 1300
DRY WEIGHT OF SAMPLE:	144.09 (g)
DRY BULK DENSITY:	1.83 (g/cc)
PARTICLE DENSITY:	2.65 (g/cc)

(METHOD: ASSUME MEAN PARTICLE DENSITY = 2.65 g/cc)

CALCULATED POROSITY:	31.09 (% vol)
INITIAL MOISTURE CONTENT (VOLUMETRIC):	19.03 (% vol)
INITIAL MOISTURE CONTENT (GRAVIMETRIC):	10.42 (%)

COMMENTS:

LABORATORY ANALYSIS PERFORMED BY: R. Hill
CALCULATIONS MADE BY: R. Hill
CHECKED BY: D. Hammermeister

DATA FOR INITIAL MOISTURE CONTENT,
BULK DENSITY, AND POROSITY

JOB NAME:	ENRON
JOB NUMBER:	89-034-L
SAMPLE NUMBER:	5-18A-60
RING NUMBER:	Z-8
DEPTH:	60.0 Ft.

FIELD WEIGHT OF SAMPLE (W/CAP AND RING):	135.53 (g)
TARE WEIGHT, RING:	26.07 (g)
TARE WEIGHT, PAN:	0.00 (g)
SAMPLE VOLUME:	45.26 (cc)
DATE AND TIME INTO OVEN:	9/21/90 @ 1000
DATE AND TIME OUT OF OVEN:	9/22/90 @ 1300
DRY WEIGHT OF SAMPLE:	96.17 (g)
DRY BULK DENSITY:	2.12 (g/cc)
PARTICLE DENSITY:	2.65 (g/cc)

(METHOD: ASSUME MEAN PARTICLE DENSITY = 2.65 g/cc)

CALCULATED POROSITY:	19.82 (% vol)
INITIAL MOISTURE CONTENT (VOLUMETRIC):	29.36 (% vol)
INITIAL MOISTURE CONTENT (GRAVIMETRIC):	13.82 (%)

COMMENTS:

LABORATORY ANALYSIS PERFORMED BY: R. Hill
CALCULATIONS MADE BY: R. Hill
CHECKED BY: D. Hammermeister

DATA FOR INITIAL MOISTURE CONTENT,
BULK DENSITY, AND POROSITY

JOB NAME:	ENRON
JOB NUMBER:	89-034-L
SAMPLE NUMBER:	5-19A-55
RING NUMBER:	Z-13
DEPTH:	55 Ft.

FIELD WEIGHT OF SAMPLE (W/CAP AND RING):	129.78 (g)
TARE WEIGHT, RING:	26.34 (g)
TARE WEIGHT, PAN:	0.00 (g)
SAMPLE VOLUME:	45.26 (cc)
DATE AND TIME INTO OVEN:	9/21/90 @ 1000
DATE AND TIME OUT OF OVEN:	9/22/90 @ 1300
DRY WEIGHT OF SAMPLE:	84.32 (g)
DRY BULK DENSITY:	1.86 (g/cc)
PARTICLE DENSITY:	2.65 (g/cc)
(METHOD: ASSUME MEAN PARTICLE DENSITY = 2.65 g/cc)	
CALCULATED POROSITY:	29.70 (% vol)
INITIAL MOISTURE CONTENT (VOLUMETRIC):	42.24 (% vol)
INITIAL MOISTURE CONTENT (GRAVIMETRIC):	22.68 (%)

COMMENTS:

LABORATORY ANALYSIS PERFORMED BY: R. Hill
CALCULATIONS MADE BY: R. Hill
CHECKED BY: D. Hammermeister

APPENDIX B

MOISTURE RETENTION CHARACTERISTICS

SUMMARY OF MOISTURE CHARACTERISTICS OF THE INITIAL DRAINAGE CURVE

Sample Number	Pressure Head (-cm water)	Moisture Content (%,cm^3/cm^3)
5-15A-46.5	0.0	35.81
	46.5	30.09
	182.0	25.80
	509.9	22.66
	917.8	21.58
	3059.4	19.17
	15501.0	17.40
5-15A-47.5	0.0	32.33
	41.5	26.64
	174.5	22.82
	509.9	19.97
	917.8	19.15
	3059.4	16.76
	15501.0	15.35
5-16A-40.5	0.0	31.47
	97.0	10.39
	193.5	8.29
	509.9	6.87
	917.8	6.64
	3059.4	5.79
	15501.0	5.62
5-16A-42.5	0.0	36.70
	54.0	29.67
	184.5	22.47
	509.9	19.03
	917.8	18.17
	3059.4	15.79
	15501.0	14.83

SUMMARY OF MOISTURE CHARACTERISTICS OF THE INITIAL DRAINAGE CURVE (CONT.)

Sample Number	Pressure Head (-cm water)	Moisture Content (%,cm^3/cm^3)
5-18A-60	0.0	29.39
	51.0	28.44
	190.0	26.84
	509.9	24.52
	917.8	23.62
	3059.4	19.00
	15501.0	16.44
5-19A-55	0.0	34.07
	43.5	32.08
	184.5	30.25
	509.9	26.65
	917.8	25.92
	3059.4	18.67
	15501.0	17.85

MOISTURE RETENTION DATA - HANGING COLUMN/15 BAR PRESSURE PLATE
(PORE SIZE DISTRIBUTION)

JOB NAME: ENRON
JOB NUMBER: 89-034-L
SAMPLE NUMBER: 5-15A-46.5
RING NUMBER: D-1
DEPTH: 46.5 FT.
SAMPLE VOLUME: 90.5 (cc)
SATURATED WEIGHT AT 0 CM TENSION
(WITH CAP AND RING): 285.46 (g)
TARE RING: 55.67 (g)
TARE CAP: 24.66 (g)
DRY WEIGHT OF SAMPLE: 172.72 (g)
SATURATED MOISTURE CONTENT: 35.81 (% vol)
INITIAL VOLUME OF WATER IN SAMPLE: 32.41 (cc)

DATE (1990)	TIME	HANGING COLUMN SUCTION (CM)	PRESSURE PLATE PRESSURE (BAR)	WEIGHT W/RING (G)	WEIGHT CHANGE (G)	TOTAL WEIGHT CHANGE (G)	MOISTURE CONTENT (% VOL)
8/26	1330	0.0	--	260.80	--	--	35.81
8/30	1350	46.5	--	255.62	5.18	5.18	30.09
9/07	1430	182.0	--	251.74	3.88	9.06	25.80
9/12	1500	--	0.5	248.90	2.84	11.90	22.66
9/14	1145	--	0.9	247.92	0.98	12.88	21.58
9/18	820	--	3.0	245.74	2.18	15.06	19.17
9/21	815	--	15.2	244.14	1.60	16.66	17.40

COMMENTS: Assume density of water is 1.0 g/cc

LABORATORY ANALYSIS PERFORMED BY: B. Horton/R. Hill
CALCULATION MADE BY: K. Evans
CHECKED BY: D. Hammermiester

MOISTURE RETENTION DATA - HANGING COLUMN/15 BAR PRESSURE PLATE
(PORE SIZE DISTRIBUTION)

JOB NAME:	ENRON
JOB NUMBER:	89-034-L
SAMPLE NUMBER:	5-15A-47.5
RING NUMBER:	D-2
DEPTH:	47.5 FT.
SAMPLE VOLUME:	99.4 (cc)
SATURATED WEIGHT AT 0 CM TENSION (WITH CAP AND RING):	312.36 (g)
TARE RING:	60.87 (g)
TARE CAP:	26.94 (g)
DRY WEIGHT OF SAMPLE:	192.43 (g)
SATURATED MOISTURE CONTENT:	32.33 (% vol)
INITIAL VOLUME OF WATER IN SAMPLE:	32.12 (cc)

DATE (1990)	TIME	HANGING COLUMN SUCTION (CM)	PRESSURE PLATE PRESSURE (BAR)	WEIGHT W/RING (G)	WEIGHT CHANGE (G)	TOTAL WEIGHT CHANGE (G)	MOISTURE CONTENT (% VOL)
8/26	1330	0.0	--	285.42	--	--	32.33
8/30	1350	41.5	--	279.77	5.65	5.65	26.64
9/07	1430	174.5	--	275.97	3.80	9.45	22.82
9/12	1500	--	0.50	273.14	2.83	12.28	19.97
9/14	1145	--	0.94	272.33	0.81	13.09	19.15
9/18	820	--	3.00	269.95	2.38	15.47	16.76
9/21	815	--	15.20	268.55	1.40	16.87	15.35

COMMENTS: Assume density of water is 1.0 g/cc

LABORATORY ANALYSIS PERFORMED BY: B. Horton/R. Hill
CALCULATION MADE BY: K. Evans
CHECKED BY: D. Hammermiester

MOISTURE RETENTION DATA - HANGING COLUMN/15 BAR PRESSURE PLATE
(PORE SIZE DISTRIBUTION)

JOB NAME: ENRON
JOB NUMBER: 89-034-L
SAMPLE NUMBER: 5-16A-40.5
RING NUMBER: 5-16
DEPTH: 40.5 FT.
SAMPLE VOLUME: 90.6 (cc)
SATURATED WEIGHT AT 0 CM TENSION
(WITH CAP AND RING): 259.93 (g)
TARE RING: 50.60 (g)
TARE CAP: 24.40 (g)
DRY WEIGHT OF SAMPLE: 156.43 (g)
SATURATED MOISTURE CONTENT: 31.47 (% vol)
INITIAL VOLUME OF WATER IN SAMPLE: 28.50 (cc)

DATE (1990)	TIME	HANGING COLUMN SUCTION (CM)	PRESSURE PLATE PRESSURE (BAR)	WEIGHT W/RING (G)	WEIGHT CHANGE (G)	TOTAL WEIGHT CHANGE (G)	MOISTURE CONTENT (% VOL)
8/26	1330	0.0	--	235.53	--	--	31.47
8/30	1350	97.0	--	216.44	19.09	19.09	10.39
9/07	1430	193.5	--	214.54	1.90	20.99	8.29
9/12	1500	--	0.5	213.25	1.29	22.28	6.87
9/14	1145	--	0.9	213.04	0.21	22.49	6.64
9/18	820	--	3.0	212.27	0.77	23.26	5.79
9/20	815	--	15.3	212.12	0.15	23.41	5.62

COMMENTS: Assume density of water is 1.0 g/cc

LABORATORY ANALYSIS PERFORMED BY: B. Horton/R. Hill
CALCULATION MADE BY: K. Evans
CHECKED BY: D. Hammermiester

MOISTURE RETENTION DATA - HANGING COLUMN/15 BAR PRESSURE PLATE
(PORE SIZE DISTRIBUTION)

JOB NAME: ENRON
JOB NUMBER: 89-034-L
SAMPLE NUMBER: 5-16A-42.5
RING NUMBER: 42.5
DEPTH: 42.5 FT.
SAMPLE VOLUME: 78.9 (cc)
SATURATED WEIGHT AT 0 CM TENSION
(WITH CAP AND RING): 234.71 (g)
TARE RING: 36.46 (g)
TARE CAP: 25.20 (g)
DRY WEIGHT OF SAMPLE: 144.09 (g)
SATURATED MOISTURE CONTENT: 36.70 (% vol)
INITIAL VOLUME OF WATER IN SAMPLE: 28.96 (cc)

DATE (1990)	TIME	HANGING COLUMN SUCTION (CM)	PRESSURE PLATE PRESSURE (BAR)	WEIGHT W/RING (G)	WEIGHT CHANGE (G)	TOTAL WEIGHT CHANGE (G)	MOISTURE CONTENT (% VOL)
8/26	1330	0.0	--	209.51	--	--	36.70
8/30	1350	54.0	--	203.96	5.55	5.55	29.67
9/07	1430	184.5	--	198.28	5.68	11.23	22.47
9/12	1500	--	0.5	195.57	2.71	13.94	19.03
9/14	1145	--	0.9	194.89	0.68	14.62	18.17
9/18	820	--	3.0	193.01	1.88	16.50	15.79
9/21	815	--	15.2	192.25	0.76	17.26	14.83

COMMENTS: Assume density of water is 1.0 g/cc

LABORATORY ANALYSIS PERFORMED BY: B. Horton/R. Hill
CALCULATION MADE BY: K. Evans
CHECKED BY: D. Hammermiester

MOISTURE RETENTION DATA - HANGING COLUMN/15 BAR PRESSURE PLATE
(PORE SIZE DISTRIBUTION)

JOB NAME:	ENRON
JOB NUMBER:	89-034-L
SAMPLE NUMBER:	5-18A-60
RING NUMBER:	Z-8
DEPTH:	60 FT.
SAMPLE VOLUME:	45.3 (cc)
SATURATED WEIGHT AT 0 CM TENSION (WITH CAP AND RING):	135.58 (g)
TARE RING:	26.11 (g)
TARE CAP:	0.00 (g)
DRY WEIGHT OF SAMPLE:	96.17 (g)
SATURATED MOISTURE CONTENT:	29.39 (% vol)
INITIAL VOLUME OF WATER IN SAMPLE:	13.30 (cc)

DATE (1990)	TIME	HANGING COLUMN SUCTION (CM)	PRESSURE PLATE PRESSURE (BAR)	WEIGHT W/RING (G)	WEIGHT CHANGE (G)	TOTAL WEIGHT CHANGE (G)	MOISTURE CONTENT (% VOL)
8/26	1330	0.0	--	135.58	--	--	29.39
8/30	1350	51.0	--	135.15	0.43	0.43	28.44
9/07	1430	190.0	--	134.43	0.72	1.15	26.84
9/12	1500	--	0.5	133.38	1.05	2.20	24.52
9/14	1145	--	0.9	132.97	0.41	2.61	23.62
9/18	820	--	3.0	130.88	2.09	4.70	19.00
9/21	815	--	15.2	129.72	1.16	5.86	16.44

COMMENTS: Assume density of water is 1.0 g/cc

LABORATORY ANALYSIS PERFORMED BY: B. Horton/R. Hill
CALCULATION MADE BY: K. Evans
CHECKED BY: D. Hammermiester

MOISTURE RETENTION DATA - HANGING COLUMN/15 BAR PRESSURE PLATE
(PORE SIZE DISTRIBUTION)

JOB NAME: ENRON
JOB NUMBER: 89-034-L
SAMPLE NUMBER: 5-19A-55
RING NUMBER: Z-13
DEPTH: 55 FT.
SAMPLE VOLUME: 45.3 (cc)
SATURATED WEIGHT AT 0 CM TENSION
(WITH CAP AND RING): 126.08 (g)
TARE RING: 26.34 (g)
TARE CAP: 0.00 (g)
DRY WEIGHT OF SAMPLE: 84.32 (g)
SATURATED MOISTURE CONTENT: 34.07 (% vol)
INITIAL VOLUME OF WATER IN SAMPLE: 15.42 (cc)

DATE (1990)	TIME	HANGING COLUMN SUCTION (CM)	PRESSURE PLATE PRESSURE (BAR)	WEIGHT W/RING (G)	WEIGHT CHANGE (G)	TOTAL WEIGHT CHANGE (G)	MOISTURE CONTENT (% VOL)
8/26	1330	0.0	--	126.08	--	--	34.07
8/30	1350	43.5	--	125.18	0.90	0.90	32.08
9/07	1430	184.5	--	124.35	0.83	1.73	30.25
9/12	1500	--	0.5	122.72	1.63	3.36	26.65
9/14	1145	--	0.9	122.39	0.33	3.69	25.92
9/18	820	--	3.0	119.11	3.28	6.97	18.67
9/21	815	--	15.2	118.74	0.37	7.34	17.85

COMMENTS: Assume density of water is 1.0 g/cc

LABORATORY ANALYSIS PERFORMED BY: B. Horton/R. Hill
CALCULATION MADE BY: K. Evans
CHECKED BY: D. Hammermiester

APPENDIX C

SATURATED HYDRAULIC CONDUCTIVITY

SUMMARY OF SATURATED HYDRAULIC CONDUCTIVITY TESTS

Sample Number	Ks(cm/sec)	Method of Analysis	
		Constant Head	Falling Head
5-15A-46.5	5.2×10^{-6}		X
5-15A-47.5	5.9×10^{-5}		X
5-16A-40.5	1.5×10^{-3}	X	
5-16A-42.5	3.2×10^{-5}		X
5-18A-60	1.5×10^{-7}		X
5-19A-55	3.4×10^{-7}		X

FALLING HEAD TEST DATA

JOB NAME: ENRON
JOB NUMBER: 89-034-L
SAMPLE NUMBER: 5-15A-46.5
RING NUMBER: D-1
DEPTH: 46.5 FT.
TYPE OF WATER USED: 0.01N $CaCl_2$ SOLUTION
SAMPLE X-SECTION AREA: 29.23 (sq. cm)
STANDPIPE X-SECTION AREA: 0.636 (sq. cm)
SAMPLE LENGTH: 3.1 (cm)

DATE (1990)	TIME (HOURS	DEL T (SEC)	TEMP (C)	RESERVOIR HEAD(CM)	K SAT (CM/SEC)	K SAT @ 20 C (CM/SEC)
TEST # 1:						
08/26/90	13:03:15		21.0	84.4		
08/26/90	13:32:30	1755	21.0	73.1	5.5E-06	5.4E-06
TEST # 2:						
08/26/90	13:32:30		21.0	73.1		
08/26/90	13:46:45	855	21.0	68.5	5.1E-06	5.0E-06

AVERAGE K SAT: 5.2E-06 (CM/SEC)

COMMENTS:

LABORATORY ANALYSIS BY: K. Evans
CALCULATIONS MADE BY: K. Evans
CHECKED BY: D. Hammermeister

FALLING HEAD TEST DATA

JOB NAME: ENRON
JOB NUMBER: 89-034-L
SAMPLE NUMBER: 5-15A-47.5
RING NUMBER: D-2
DEPTH: 47.5 FT.
TYPE OF WATER USED: 0.01N $CaCl_2$ SOLUTION
SAMPLE X-SECTION AREA: 29.23 (sq. cm)
STANDPIPE X-SECTION AREA: 0.636 (sq. cm)
SAMPLE LENGTH: 3.4 (cm)

DATE (1990)	TIME (HOURS	DEL T (SEC)	TEMP (C)	RESERVOIR HEAD(CM)	K SAT (CM/SEC)	K SAT @ 20 C (CM/SEC)
TEST # 1:						
08/22/90	07:23:00		22.0	69.3		
08/22/90	07:29:30	390	22.0	49.9	6.2E-05	6.0E-05
TEST # 2:						
08/22/90	07:29:30		22.0	49.9		
08/22/90	07:38:00	510	22.0	32.8	6.1E-05	5.8E-05

AVERAGE K SAT: 5.9E-05 (CM/SEC)

COMMENTS:

LABORATORY ANALYSIS BY: K. Evans
CALCULATIONS MADE BY: K. Evans
CHECKED BY: D. Hammermeister

CONSTANT HEAD TEST DATA

JOB NAME: ENRON
JOB NUMBER: 89-034-L
SAMPLE NUMBER: 5-16A-40.5
RING NUMBER: 5-16
DEPTH: 40.5 FT.
TYPE OF WATER USED: 0.01N CaCl2 SOLUTION
SAMPLE LENGTH: 3.0 (cm)
SAMPLE RADIUS: 3.1 (cm)
SAMPLE X-SECTIONAL AREA: 30.19 (sq. cm)

DATE (1990)	TIME (DAY)	TEMP (C)	CHANGE HEAD(CM)	FLOW VOL(CC)	ELAPSED TIME(SEC)	K SAT (CM/SEC)	K SAT @ 20 (CM/SEC)
8/22	717	21.0	1.2	9.5	405	1.9E-03	1.9E-03
8/22	1556	20.0	1.2	3.4	180	1.6E-03	1.6E-03
8/23	1407	25.0	1.2	3.4	255	1.1E-03	9.8E-04

AVERAGE K SAT: 1.5E-03 (CM/SEC)

COMMENTS:

LABORATORY ANALYSIS BY: K. Evans
CALCULATIONS MADE BY: K. Evans
CHECKED BY: D. Hammermeister

FALLING HEAD TEST DATA

JOB NAME: ENRON
JOB NUMBER: 89-034-L
SAMPLE NUMBER: 5-16A-42.5
RING NUMBER: 42.5
DEPTH: 42.5 FT.
TYPE OF WATER USED: 0.01N CaCl2 SOLUTION
SAMPLE X-SECTION AREA: 29.23 (sq. cm)
STANDPIPE X-SECTION AREA: 0.636 (sq. cm)
SAMPLE LENGTH: 2.7 (cm)

DATE (1990)	TIME (HOURS	DEL T (SEC)	TEMP (C)	RESERVOIR HEAD(CM)	K SAT (CM/SEC)	K SAT @ 20 C (CM/SEC)
TEST # 1:						
08/22/90	07:23:30		22.0	70.3		
08/22/90	07:28:30	300	22.0	59.1	3.4E-05	3.2E-05
TEST # 2:						
08/22/90	07:28:30		22.0	59.1		
08/22/90	07:37:30	555	22.0	43.2	3.3E-05	3.2E-05

AVERAGE K SAT: 3.2E-05 (CM/SEC)

COMMENTS:

LABORATORY ANALYSIS BY: K. Evans
CALCULATIONS MADE BY: K. Evans
CHECKED BY: D. Hammermeister

FALLING HEAD TEST DATA

JOB NAME: ENRON
JOB NUMBER: 89-034-L
SAMPLE NUMBER: 5-18A-60
RING NUMBER: 2-8
DEPTH: 60 FT.
TYPE OF WATER USED: 0.01N $CaCl_2$ SOLUTION
SAMPLE X-SECTION AREA: 18.86 (sq. cm)
STANDPIPE X-SECTION AREA: 0.636 (sq. cm)
SAMPLE LENGTH: 2.4 (cm)

DATE (1990)	TIME (HOURS	DEL T (SEC)	TEMP (C)	RESERVOIR HEAD(CM)	K SAT (CM/SEC)	K SAT @ 20 C (CM/SEC)
TEST # 1:						
08/22/90	07:13:00		22.0	64.1		
08/22/90	13:51:00	23880	22.0	60.9	1.7E-07	1.7E-07
TEST # 2:						
08/22/90	13:51:00		22.0	60.9		
08/23/90	14:07:45	87405	22.0	51.8	1.5E-07	1.4E-07

AVERAGE K SAT: 1.5E-07 (CM/SEC)

COMMENTS:

LABORATORY ANALYSIS BY: K. Evans
CALCULATIONS MADE BY: K. Evans
CHECKED BY: D. Hammermeister

FALLING HEAD TEST DATA

JOB NAME: ENRON
JOB NUMBER: 89-034-L
SAMPLE NUMBER: 5-19A-55
RING NUMBER: Z-16
DEPTH: 55 FT.
TYPE OF WATER USED: 0.01N $CaCl_2$ SOLUTION
SAMPLE X-SECTION AREA: 18.86 (sq. cm)
STANDPIPE X-SECTION AREA: 0.636 (sq. cm)
SAMPLE LENGTH: 2.4 (cm)

DATE (1990)	TIME (HOURS	DEL T (SEC)	TEMP (C)	RESERVOIR HEAD(CM)	K SAT (CM/SEC)	K SAT @ 20 C (CM/SEC)
TEST # 1:						
08/22/90	13:50:30		22.0	55.7		
08/23/90	14:08:00	87450	22.0	37.8	3.6E-07	3.4E-07
TEST # 2:						
08/24/90	14:08:00		22.0	37.8		
08/25/90	07:47:00	63540	21.0	28.6	3.6E-07	3.4E-07

AVERAGE K SAT: 3.4E-07 (CM/SEC)

COMMENTS:

LABORATORY ANALYSIS BY: K. Evans
CALCULATIONS MADE BY: K. Evans
CHECKED BY: D. Hammermeister

APPENDIX D

UNSATURATED HYDRAULIC PROPERTIES

(CALCULATED)

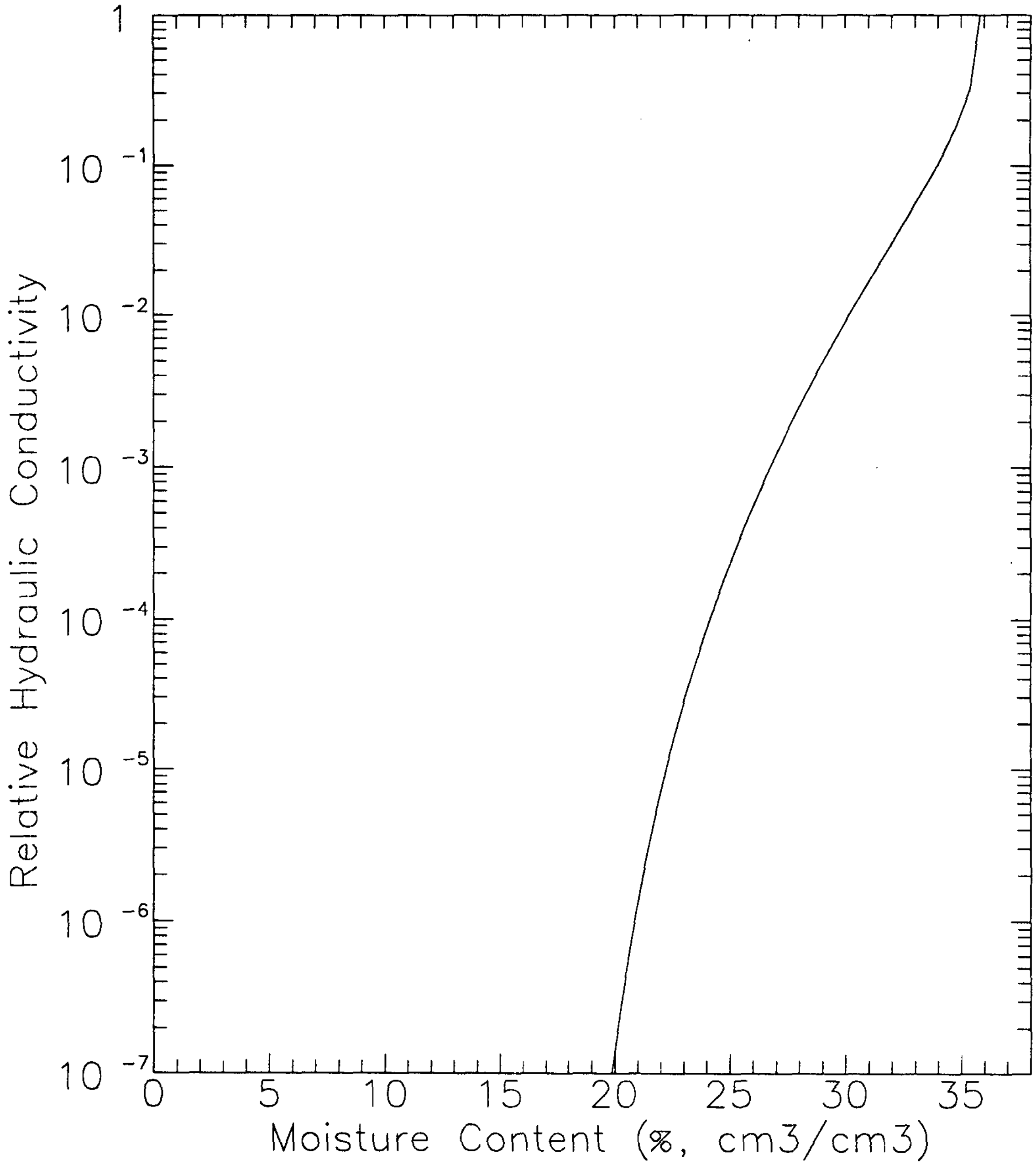
SUMMARY OF UNSATURATED HYDRAULIC PROPERTIES (CALCULATED)

Sample Number	α (cm^{-1})	N (dimensionless)	θ_r (%, cm^3/cm^3)	θ_s (%, cm^3/cm^3)	K_{sat} (cm/sec)
5-15A-46.5	0.03357	1.45637	17.40	35.81	5.2×10^{-6}
5-15A-47.5	0.04382	1.43492	15.35	32.33	5.9×10^{-5}
5-16A-40.5	0.04069	2.32521	6.49	31.47	1.5×10^{-3}
5-16A-42.5	0.03314	1.58391	14.83	36.70	3.2×10^{-5}
5-18A-60	0.00318	1.65120	16.44	29.39	1.5×10^{-7}
5-19A-55	0.00404	1.71419	17.85	34.07	3.4×10^{-7}

SUMMARY OF UNSATURATED HYDRAULIC PROPERTIES (CALCULATED)

95% CONFIDENCE LIMITS

Sample Number	α Lower	α Upper	N Lower	N Upper
5-15A-46.5	0.0148	0.0523	1.3346	1.5781
5-15A-47.5	0.0147	0.0729	1.3051	1.5647
5-16A-40.5	-0.0114	0.0928	1.2284	3.4220
5-16A-42.5	0.0246	0.0417	1.4979	1.6699
5-18A-60	0.0008	0.0055	1.2608	2.0415
5-19A-55	-0.0002	0.0083	1.0995	2.3288



Relative Hydraulic Conductivity vs. Moisture Content, Sample No. 5-15A-46.5

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NON-LINEAR LEAST SQUARES ANALYSIS

- ENRON 89-034-L -

Sample 5-15A-46.5 Drainage

****

INPUT PARAMETERS

MODEL NUMBER	2
NUMBER OF COEFFICIENTS	2
MAXIMUM NUMBER OF ITERATIONS	20
RATIO OF COEFFICIENTS CRITERION	.0001
RESIDUAL MOISTURE CONTENT (FOR MODEL 2)	.1740
SATURATED MOISTURE CONTENT	.3581
SATURATED HYDRAULIC CONDUCTIVITY	.0000

OBSERVED DATA

OBS. NO.	PRESSURE HEAD	MOISTURE CONTENT
1	.00	.3581
2	46.50	.3009
3	182.00	.2580
4	509.65	.2266
5	917.37	.2158
6	3057.90	.1917
7	15493.36	.1740

ITERATION NO	WCR	ALPHA	N	SSQ
0	.1740	.200000	2.1000	.0234809
1	.1740	.089619	1.5272	.0050732
2	.1740	.041172	1.3201	.0017506
3	.1740	.030834	1.4382	.0003015
4	.1740	.032931	1.4596	.0001998
5	.1740	.033580	1.4561	.0001996
6	.1740	.033575	1.4564	.0001996
7	.1740	.033575	1.4564	.0001996

CORRELATION MATRIX

	1	2
1	1.0000	
2	-.8742	1.0000

NON-LINEAR LEAST-SQUARES ANALYSIS: FINAL RESULTS

VARIABLE	VALUE	S.E.COEFF.	T-VALUE
ALPHA	.03357	.0073	4.60
N	1.45637	.0473	30.76

VARIABLE	95% CONFIDENCE LIMITS LOWER	UPPER
ALPHA	.0148	.0523
N	1.3346	1.5781

--------ORDERED BY COMPUTER INPUT--------

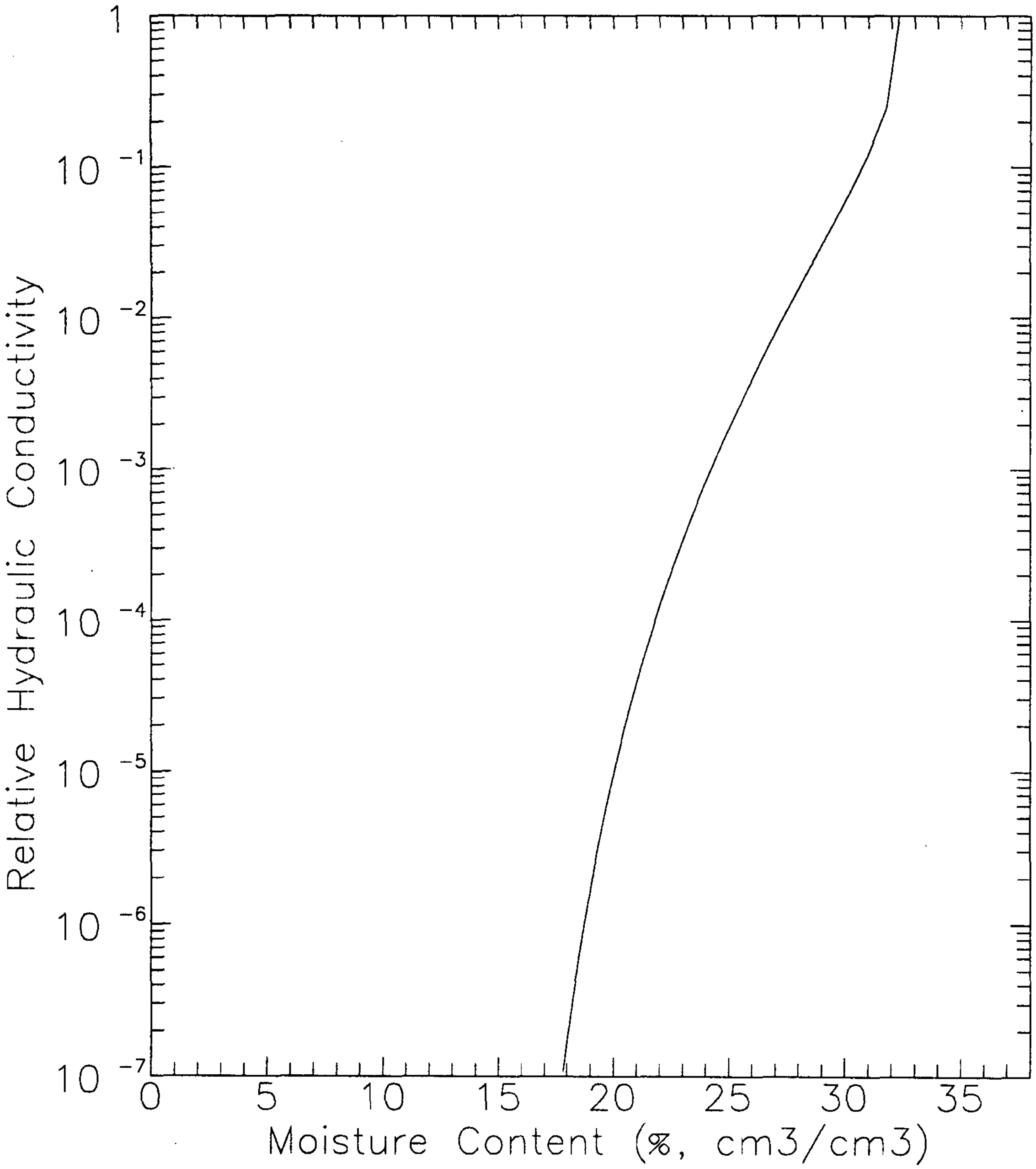
NO	PRESSURE	MOISTURE CONTENT OBS	FITTED	RESI-DUAL
1	.00	.3581	.3581	.0000
2	46.50	.3009	.3057	-.0048
3	182.00	.2580	.2529	.0051
4	509.65	.2266	.2241	.0025
5	917.37	.2158	.2124	.0034
6	3057.90	.1917	.1962	-.0045
7	15493.36	.1740	.1846	-.0106

----------ORDERED BY RESIDUALS----------

NO	PRESSURE	MOISTURE CONTENT OBS	FITTED	RESI-DUAL
3	182.00	.2580	.2529	.0051
5	917.37	.2158	.2124	.0034
4	509.65	.2266	.2241	.0025
1	.00	.3581	.3581	.0000
6	3057.90	.1917	.1962	-.0045
2	46.50	.3009	.3057	-.0048
7	15493.36	.1740	.1846	-.0106

PRESSURE	WC	REL K	ABS K	DIFFUS
.000E+00	.3581	1.000E+00	5.200E-06	
.141E+01	.3574	5.647E-01	2.936E-06	4.250E-03
.168E+01	.3572	5.347E-01	2.781E-06	3.735E-03
.200E+01	.3570	5.033E-01	2.617E-06	3.268E-03
.237E+01	.3567	4.706E-01	2.447E-06	2.844E-03
.282E+01	.3563	4.366E-01	2.271E-06	2.461E-03
.335E+01	.3558	4.016E-01	2.089E-06	2.117E-03
.398E+01	.3551	3.658E-01	1.902E-06	1.809E-03
.473E+01	.3543	3.295E-01	1.713E-06	1.534E-03
.562E+01	.3533	2.930E-01	1.524E-06	1.292E-03
.668E+01	.3520	2.569E-01	1.336E-06	1.079E-03
.794E+01	.3504	2.216E-01	1.152E-06	8.929E-04
.944E+01	.3484	1.877E-01	9.760E-07	7.326E-04
.112E+02	.3460	1.558E-01	8.102E-07	5.957E-04
.133E+02	.3432	1.265E-01	6.578E-07	4.799E-04
.158E+02	.3397	1.003E-01	5.213E-07	3.831E-04
.188E+02	.3357	7.743E-02	4.026E-07	3.031E-04
.224E+02	.3311	5.822E-02	3.027E-07	2.378E-04
.266E+02	.3259	4.258E-02	2.214E-07	1.852E-04
.316E+02	.3201	3.030E-02	1.575E-07	1.432E-04
.376E+02	.3139	2.099E-02	1.091E-07	1.100E-04
.447E+02	.3073	1.417E-02	7.370E-08	8.412E-05
.531E+02	.3004	9.349E-03	4.861E-08	6.402E-05
.631E+02	.2934	6.038E-03	3.140E-08	4.855E-05
.750E+02	.2863	3.828E-03	1.991E-08	3.670E-05
.891E+02	.2794	2.388E-03	1.242E-08	2.768E-05
.106E+03	.2726	1.470E-03	7.644E-09	2.084E-05

.126E+03	.2660	8.947E-04	4.652E-09	1.566E-05
.150E+03	.2597	5.395E-04	2.805E-09	1.176E-05
.178E+03	.2537	3.228E-04	1.679E-09	8.820E-06
.211E+03	.2480	1.920E-04	9.985E-10	6.611E-06
.251E+03	.2426	1.137E-04	5.910E-10	4.952E-06
.299E+03	.2376	6.701E-05	3.485E-10	3.708E-06
.355E+03	.2329	3.939E-05	2.048E-10	2.775E-06
.422E+03	.2286	2.310E-05	1.201E-10	2.077E-06
.501E+03	.2245	1.352E-05	7.030E-11	1.554E-06
.596E+03	.2207	7.902E-06	4.109E-11	1.162E-06
.708E+03	.2172	4.612E-06	2.398E-11	8.692E-07
.841E+03	.2140	2.690E-06	1.399E-11	6.500E-07
.100E+04	.2110	1.568E-06	8.153E-12	4.861E-07
.119E+04	.2082	9.133E-07	4.749E-12	3.635E-07
.141E+04	.2056	5.317E-07	2.765E-12	2.718E-07
.168E+04	.2032	3.095E-07	1.609E-12	2.032E-07
.200E+04	.2010	1.801E-07	9.364E-13	1.519E-07
.237E+04	.1990	1.048E-07	5.447E-13	1.136E-07
.282E+04	.1971	6.093E-08	3.168E-13	8.490E-08
.335E+04	.1953	3.544E-08	1.843E-13	6.348E-08
.398E+04	.1937	2.061E-08	1.072E-13	4.747E-08
.473E+04	.1922	1.199E-08	6.232E-14	3.549E-08
.562E+04	.1908	6.962E-09	3.620E-14	2.650E-08
.668E+04	.1896	4.050E-09	2.106E-14	1.982E-08
.794E+04	.1884	2.355E-09	1.225E-14	1.482E-08
.944E+04	.1873	1.369E-09	7.120E-15	1.108E-08
.112E+05	.1863	7.944E-10	4.131E-15	8.267E-09
.133E+05	.1854	4.628E-10	2.406E-15	6.192E-09
.158E+05	.1845	2.691E-10	1.399E-15	4.631E-09
.188E+05	.1837	1.565E-10	8.136E-16	3.462E-09
.224E+05	.1830	9.096E-11	4.730E-16	2.588E-09
.266E+05	.1823	5.288E-11	2.750E-16	1.935E-09
.316E+05	.1817	3.074E-11	1.599E-16	1.446E-09
.376E+05	.1811	1.787E-11	9.294E-17	1.081E-09
.447E+05	.1805	1.039E-11	5.403E-17	8.084E-10
.531E+05	.1800	6.040E-12	3.141E-17	6.043E-10
.631E+05	.1796	3.512E-12	1.826E-17	4.518E-10
.750E+05	.1792	2.041E-12	1.062E-17	3.378E-10
.891E+05	.1788	1.187E-12	6.171E-18	2.525E-10
.106E+06	.1784	6.899E-13	3.588E-18	1.888E-10
.126E+06	.1781	4.011E-13	2.086E-18	1.411E-10
.150E+06	.1778	2.332E-13	1.212E-18	1.055E-10
.178E+06	.1775	1.356E-13	7.049E-19	7.887E-11
.211E+06	.1772	7.880E-14	4.098E-19	5.896E-11
.251E+06	.1770	4.581E-14	2.382E-19	4.408E-11
.298E+06	.1767	2.663E-14	1.385E-19	3.295E-11
.355E+06	.1765	1.548E-14	8.051E-20	2.463E-11
.422E+06	.1763	9.001E-15	4.680E-20	1.842E-11
.501E+06	.1762	5.232E-15	2.721E-20	1.377E-11



Relative Hydraulic Conductivity vs. Moisture Content, Sample No. 5−15A−47.5

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NON-LINEAR LEAST SQUARES ANALYSIS

- ENRON 89-034-L -

Sample 5-15A-47.5 Drainage

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INPUT PARAMETERS

MODEL NUMBER	2
NUMBER OF COEFFICIENTS	2
MAXIMUM NUMBER OF ITERATIONS	20
RATIO OF COEFFICIENTS CRITERION	.0001
RESIDUAL MOISTURE CONTENT (FOR MODEL 2)	.1535
SATURATED MOISTURE CONTENT	.3233
SATURATED HYDRAULIC CONDUCTIVITY	.0001

OBSERVED DATA

OBS. NO.	PRESSURE HEAD	MOISTURE CONTENT
1	.00	.3233
2	41.50	.2664
3	174.50	.2282
4	509.65	.1997
5	917.37	.1915
6	3057.90	.1676
7	15493.36	.1535

ITERATION NO	WCR	ALPHA	N	SSQ
0	.1535	.200000	2.1000	.0180198
1	.1535	.112263	1.5869	.0058949
2	.1535	.047993	1.3072	.0018753
3	.1535	.045980	1.4077	.0002490
4	.1535	.042946	1.4378	.0002126
5	.1535	.043834	1.4346	.0002125
6	.1535	.043819	1.4349	.0002125
7	.1535	.043820	1.4349	.0002125

CORRELATION MATRIX

	1	2
1	1.0000	
2	-.8758	1.0000

NON-LINEAR LEAST-SQUARES ANALYSIS: FINAL RESULTS

VARIABLE	VALUE	S.E.COEFF.	T-VALUE
ALPHA	.04382	.0113	3.87
N	1.43492	.0505	28.42

VARIABLE	95% CONFIDENCE LIMITS LOWER	UPPER
ALPHA	.0147	.0729
N	1.3051	1.5647

--------ORDERED BY COMPUTER INPUT--------

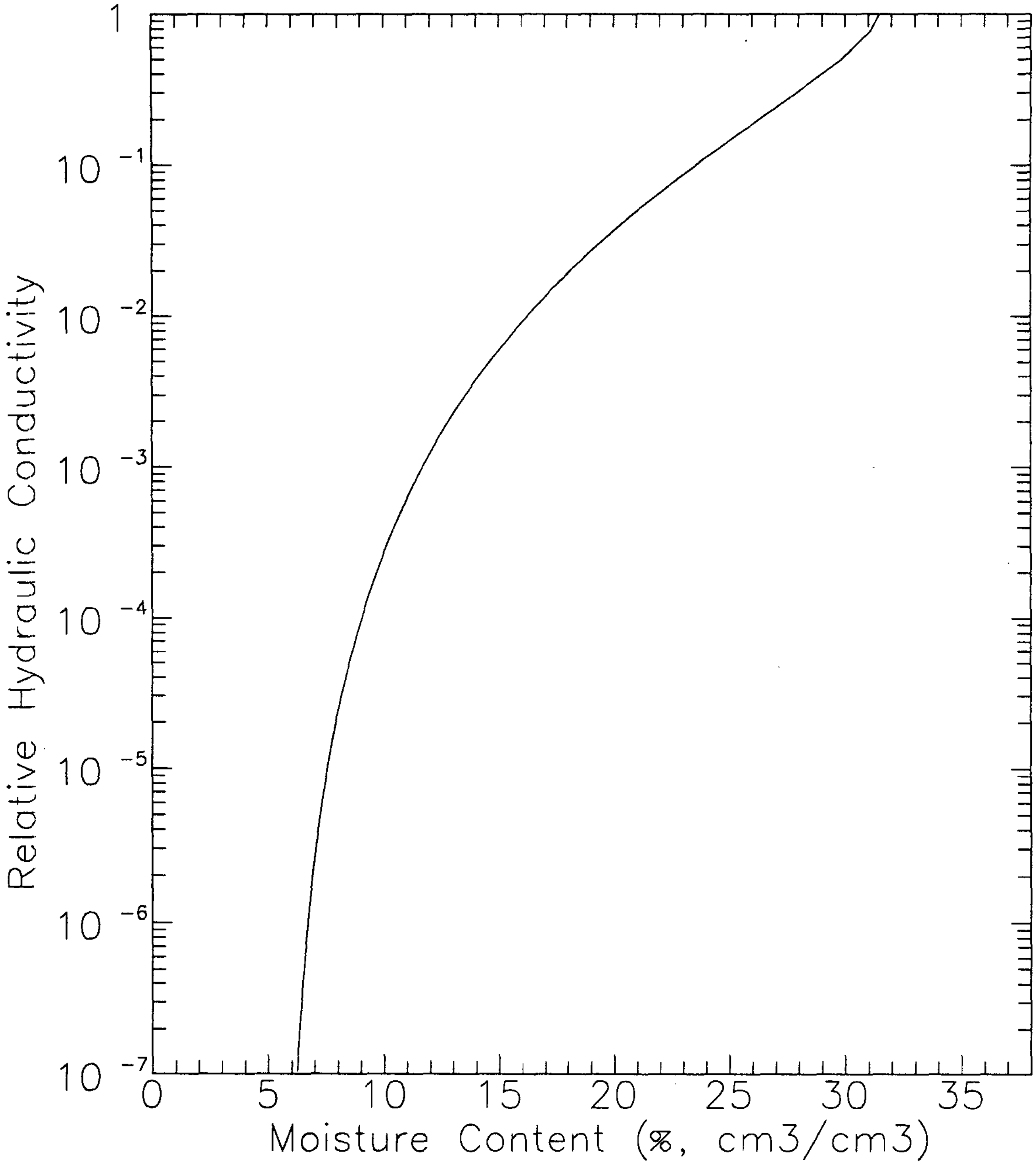
NO	PRESSURE	MOISTURE CONTENT OBS	FITTED	RESI-DUAL
1	.00	.3233	.3233	.0000
2	41.50	.2664	.2711	-.0047
3	174.50	.2282	.2225	.0057
4	509.65	.1997	.1973	.0024
5	917.37	.1915	.1875	.0040
6	3057.90	.1676	.1737	-.0061
7	15493.36	.1535	.1635	-.0100

----------ORDERED BY RESIDUALS----------

NO	PRESSURE	MOISTURE CONTENT OBS	FITTED	RESI-DUAL
3	174.50	.2282	.2225	.0057
5	917.37	.1915	.1875	.0040
4	509.65	.1997	.1973	.0024
1	.00	.3233	.3233	.0000
2	41.50	.2664	.2711	-.0047
6	3057.90	.1676	.1737	-.0061
7	15493.36	.1535	.1635	-.0100

PRESSURE	WC	REL K	ABS K	DIFFUS
.000E+00	.3233	1.000E+00	5.900E-05	
.141E+01	.3224	4.935E-01	2.912E-05	3.090E-02
.168E+01	.3221	4.619E-01	2.725E-05	2.701E-02
.200E+01	.3218	4.292E-01	2.532E-05	2.348E-02
.237E+01	.3214	3.956E-01	2.334E-05	2.029E-02
.282E+01	.3208	3.612E-01	2.131E-05	1.742E-02
.335E+01	.3202	3.264E-01	1.926E-05	1.486E-02
.398E+01	.3193	2.914E-01	1.719E-05	1.258E-02
.473E+01	.3183	2.568E-01	1.515E-05	1.056E-02
.562E+01	.3170	2.228E-01	1.315E-05	8.801E-03
.668E+01	.3153	1.901E-01	1.122E-05	7.269E-03
.794E+01	.3134	1.592E-01	9.392E-06	5.951E-03
.944E+01	.3110	1.305E-01	7.702E-06	4.829E-03
.112E+02	.3082	1.047E-01	6.175E-06	3.883E-03
.133E+02	.3048	8.190E-02	4.832E-06	3.096E-03
.158E+02	.3010	6.247E-02	3.686E-06	2.448E-03
.188E+02	.2966	4.641E-02	2.738E-06	1.920E-03
.224E+02	.2917	3.357E-02	1.980E-06	1.496E-03
.266E+02	.2864	2.365E-02	1.395E-06	1.158E-03
.316E+02	.2807	1.625E-02	9.588E-07	8.916E-04
.376E+02	.2747	1.091E-02	6.435E-07	6.833E-04
.447E+02	.2685	7.164E-03	4.227E-07	5.217E-04
.531E+02	.2622	4.616E-03	2.724E-07	3.970E-04
.631E+02	.2559	2.926E-03	1.726E-07	3.013E-04
.750E+02	.2497	1.828E-03	1.078E-07	2.283E-04
.891E+02	.2437	1.128E-03	6.656E-08	1.726E-04
.106E+03	.2379	6.894E-04	4.067E-08	1.304E-04

.126E+03	.2323	4.178E-04	2.465E-08	9.837E-05
.150E+03	.2270	2.516E-04	1.484E-08	7.416E-05
.178E+03	.2220	1.506E-04	8.888E-09	5.587E-05
.211E+03	.2172	8.983E-05	5.300E-09	4.208E-05
.251E+03	.2128	5.338E-05	3.149E-09	3.167E-05
.299E+03	.2086	3.163E-05	1.866E-09	2.384E-05
.355E+03	.2047	1.871E-05	1.104E-09	1.793E-05
.422E+03	.2010	1.104E-05	6.516E-10	1.349E-05
.501E+03	.1976	6.511E-06	3.842E-10	1.015E-05
.596E+03	.1945	3.835E-06	2.263E-10	7.631E-06
.708E+03	.1915	2.257E-06	1.332E-10	5.738E-06
.841E+03	.1888	1.327E-06	7.831E-11	4.315E-06
.100E+04	.1863	7.802E-07	4.603E-11	3.245E-06
.119E+04	.1839	4.585E-07	2.705E-11	2.440E-06
.141E+04	.1817	2.693E-07	1.589E-11	1.834E-06
.168E+04	.1797	1.582E-07	9.332E-12	1.379E-06
.200E+04	.1778	9.285E-08	5.478E-12	1.037E-06
.237E+04	.1760	5.453E-08	3.217E-12	7.796E-07
.282E+04	.1744	3.202E-08	1.889E-12	5.864E-07
.335E+04	.1729	1.878E-08	1.108E-12	4.404E-07
.398E+04	.1715	1.104E-08	6.512E-13	3.316E-07
.473E+04	.1702	6.476E-09	3.821E-13	2.492E-07
.562E+04	.1690	3.798E-09	2.241E-13	1.873E-07
.668E+04	.1679	2.231E-09	1.316E-13	1.409E-07
.794E+04	.1668	1.308E-09	7.717E-14	1.058E-07
.944E+04	.1659	7.714E-10	4.551E-14	7.996E-08
.112E+05	.1650	4.514E-10	2.663E-14	5.994E-08
.133E+05	.1641	2.657E-10	1.568E-14	4.521E-08
.158E+05	.1634	1.549E-10	9.141E-15	3.377E-08
.188E+05	.1627	9.091E-11	5.364E-15	2.539E-08
.224E+05	.1620	5.335E-11	3.147E-15	1.909E-08
.266E+05	.1614	3.130E-11	1.847E-15	1.435E-08
.316E+05	.1608	1.837E-11	1.084E-15	1.079E-08
.376E+05	.1603	1.078E-11	6.358E-16	8.108E-09
.447E+05	.1598	6.323E-12	3.731E-16	6.095E-09
.531E+05	.1593	3.710E-12	2.189E-16	4.582E-09
.631E+05	.1589	2.177E-12	1.284E-16	3.445E-09
.750E+05	.1585	1.277E-12	7.537E-17	2.590E-09
.891E+05	.1582	7.495E-13	4.422E-17	1.947E-09
.106E+06	.1578	4.398E-13	2.595E-17	1.463E-09
.126E+06	.1575	2.580E-13	1.522E-17	1.100E-09
.150E+06	.1572	1.514E-13	8.933E-18	8.270E-10
.178E+06	.1569	8.884E-14	5.242E-18	6.217E-10
.211E+06	.1567	5.213E-14	3.075E-18	4.674E-10
.251E+06	.1565	3.059E-14	1.805E-18	3.513E-10
.298E+06	.1563	1.795E-14	1.059E-18	2.641E-10
.355E+06	.1561	1.053E-14	6.213E-19	1.986E-10
.422E+06	.1559	6.179E-15	3.645E-19	1.493E-10
.501E+06	.1557	3.625E-15	2.139E-19	1.122E-10



Relative Hydraulic Conductivity vs. Moisture Content, Sample No. 5-16A-40.5

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NON-LINEAR LEAST SQUARES ANALYSIS

- ENRON 89-034-L -

Sample 5-16A-40.5 Drainage

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INPUT PARAMETERS

MODEL NUMBER....................................	2
NUMBER OF COEFFICIENTS..........................	2
MAXIMUM NUMBER OF ITERATIONS....................	20
RATIO OF COEFFICIENTS CRITERION...............	.0001
RESIDUAL MOISTURE CONTENT (FOR MODEL 2).......	.0649
SATURATED MOISTURE CONTENT....................	.3147
SATURATED HYDRAULIC CONDUCTIVITY..............	.0015

OBSERVED DATA

OBS. NO.	PRESSURE HEAD	MOISTURE CONTENT
1	.00	.3147
2	97.00	.1039
3	193.50	.0829
4	509.65	.0687
5	917.37	.0664
6	3057.90	.0579
7	15595.29	.0562

ITERATION NO	WCR	ALPHA	N	SSQ
0	.0649	.200000	2.1000	.0011834
1	.0649	.062565	1.9049	.0003904
2	.0649	.048996	2.1251	.0001677
3	.0649	.037684	2.3309	.0001525
4	.0649	.040489	2.3244	.0001363
5	.0649	.040690	2.3252	.0001361
6	.0649	.040690	2.3252	.0001361

CORRELATION MATRIX

	1	2
1	1.0000	
2	-.9813	1.0000

NON-LINEAR LEAST-SQUARES ANALYSIS: FINAL RESULTS

VARIABLE	VALUE	S.E.COEFF.	T-VALUE
ALPHA	.04069	.0203	2.01
N	2.32521	.4266	5.45

95% CONFIDENCE LIMITS

VARIABLE	LOWER	UPPER
ALPHA	-.0114	.0928
N	1.2284	3.4220

--------ORDERED BY COMPUTER INPUT--------

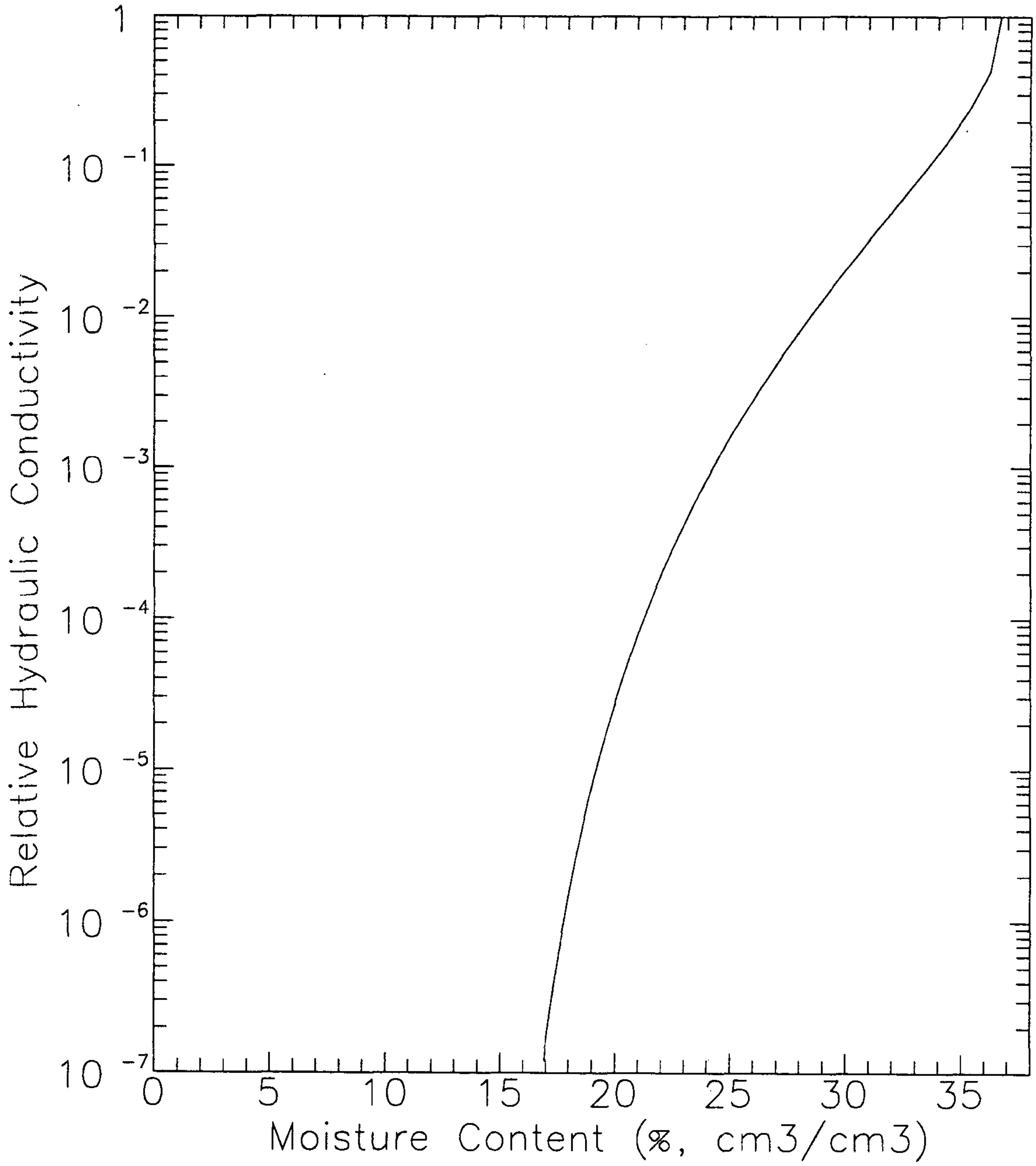
NO	PRESSURE	MOISTURE CONTENT OBS	MOISTURE CONTENT FITTED	RESI-DUAL
1	.00	.3147	.3147	.0000
2	97.00	.1039	.1045	-.0006
3	193.50	.0829	.0810	.0019
4	509.65	.0687	.0694	-.0007
5	917.37	.0664	.0670	-.0006
6	3057.90	.0579	.0653	-.0074
7	15595.29	.0562	.0649	-.0087

----------ORDERED BY RESIDUALS----------

NO	PRESSURE	MOISTURE CONTENT OBS	MOISTURE CONTENT FITTED	RESI-DUAL
3	193.50	.0829	.0810	.0019
1	.00	.3147	.3147	.0000
5	917.37	.0664	.0670	-.0006
2	97.00	.1039	.1045	-.0006
4	509.65	.0687	.0694	-.0007
6	3057.90	.0579	.0653	-.0074
7	15595.29	.0562	.0649	-.0087

PRESSURE	WC	REL K	ABS K	DIFFUS
.000E+00	.3147	1.000E+00	1.500E-03	
.141E+01	.3145	9.548E-01	1.432E-03	4.693E+00
.168E+01	.3144	9.433E-01	1.415E-03	3.692E+00
.200E+01	.3143	9.289E-01	1.393E-03	2.896E+00
.237E+01	.3141	9.109E-01	1.366E-03	2.264E+00
.282E+01	.3138	8.886E-01	1.333E-03	1.763E+00
.335E+01	.3133	8.609E-01	1.291E-03	1.365E+00
.398E+01	.3127	8.267E-01	1.240E-03	1.051E+00
.473E+01	.3117	7.850E-01	1.177E-03	8.025E-01
.562E+01	.3102	7.345E-01	1.102E-03	6.071E-01
.668E+01	.3081	6.742E-01	1.011E-03	4.542E-01
.794E+01	.3050	6.039E-01	9.059E-04	3.352E-01
.944E+01	.3005	5.24E-01	7.861E-04	2.436E-01
.112E+02	.2943	4.368E-01	6.552E-04	1.739E-01
.133E+02	.2857	3.462E-01	5.193E-04	1.217E-01
.158E+02	.2745	2.581E-01	3.872E-04	8.337E-02
.188E+02	.2603	1.792E-01	2.688E-04	5.585E-02
.224E+02	.2433	1.150E-01	1.725E-04	3.662E-02
.266E+02	.2242	6.794E-02	1.019E-04	2.353E-02
.316E+02	.2039	3.705E-02	5.558E-05	1.485E-02
.376E+02	.1837	1.880E-02	2.819E-05	9.238E-03
.447E+02	.1646	8.965E-03	1.345E-05	5.680E-03
.531E+02	.1473	4.071E-03	6.107E-06	3.462E-03
.631E+02	.1323	1.781E-03	2.671E-06	2.097E-03
.750E+02	.1196	7.576E-04	1.136E-06	1.264E-03
.891E+02	.1090	3.161E-04	4.741E-07	7.598E-04
.106E+03	.1003	1.301E-04	1.951E-07	4.556E-04
.126E+03	.0932	5.301E-05	7.951E-08	2.728E-04

.150E+03	.0875	2.147E-05	3.220E-08	1.632E-04
.178E+03	.0829	8.654E-06	1.298E-08	9.754E-05
.211E+03	.0793	3.469E-06	5.203E-09	5.811E-05
.251E+03	.0763	1.393E-06	2.089E-09	3.474E-05
.299E+03	.0740	5.583E-07	8.375E-10	2.076E-05
.355E+03	.0722	2.236E-07	3.353E-10	1.240E-05
.422E+03	.0707	8.945E-08	1.342E-10	7.406E-06
.501E+03	.0695	3.577E-08	5.366E-11	4.422E-06
.596E+03	.0686	1.430E-08	2.145E-11	2.640E-06
.708E+03	.0678	5.716E-09	8.574E-12	1.576E-06
.841E+03	.0672	2.284E-09	3.427E-12	9.410E-07
.100E+04	.0667	9.128E-10	1.369E-12	5.618E-07
.119E+04	.0664	3.647E-10	5.471E-13	3.353E-07
.141E+04	.0661	1.457E-10	2.186E-13	2.002E-07
.168E+04	.0658	5.822E-11	8.733E-14	1.195E-07
.200E+04	.0656	2.326E-11	3.489E-14	7.133E-08
.237E+04	.0655	9.293E-12	1.394E-14	4.258E-08
.282E+04	.0654	3.713E-12	5.569E-15	2.542E-08
.335E+04	.0653	1.483E-12	2.225E-15	1.517E-08
.398E+04	.0652	5.926E-13	8.889E-16	9.056E-09
.473E+04	.0651	2.368E-13	3.551E-16	5.406E-09
.562E+04	.0651	9.459E-14	1.419E-16	3.227E-09
.668E+04	.0650	3.779E-14	5.668E-17	1.926E-09
.794E+04	.0650	1.510E-14	2.265E-17	1.150E-09
.944E+04	.0650	6.031E-15	9.047E-18	6.863E-10
.112E+05	.0650	2.410E-15	3.614E-18	4.097E-10
.133E+05	.0650	9.627E-16	1.444E-18	2.445E-10
.158E+05	.0649	3.846E-16	5.769E-19	1.460E-10
.188E+05	.0649	1.537E-16	2.305E-19	8.714E-11
.224E+05	.0649	6.139E-17	9.208E-20	5.201E-11



Relative Hydraulic Conductivity vs. Moisture Content, Sample No. 5-16A-42.5

****

NON-LINEAR LEAST SQUARES ANALYSIS

- ENRON 89-034-L -

Sample 5-16A-42.5 Drainage

****

INPUT PARAMETERS
================

MODEL NUMBER....................................	2
NUMBER OF COEFFICIENTS..........................	2
MAXIMUM NUMBER OF ITERATIONS....................	20
RATIO OF COEFFICIENTS CRITERION...............	.0001
RESIDUAL MOISTURE CONTENT (FOR MODEL 2).......	.1483
SATURATED MOISTURE CONTENT....................	.3670
SATURATED HYDRAULIC CONDUCTIVITY..............	.0000

OBSERVED DATA
=============

OBS. NO.	PRESSURE HEAD	MOISTURE CONTENT
1	.00	.3670
2	43.50	.2967
3	184.50	.2247
4	509.65	.1903
5	917.37	.1817
6	3057.90	.1579
7	15493.36	.1483

ITERATION NO	WCR	ALPHA	N	SSQ
0	.1483	.200000	2.1000	.0244843
1	.1483	.088357	1.6382	.0060560
2	.1483	.026428	1.4370	.0033790
3	.1483	.035229	1.5385	.0001406
4	.1483	.032727	1.5851	.0000793
5	.1483	.033135	1.5839	.0000787
6	.1483	.033144	1.5839	.0000787
7	.1483	.033144	.5839	.0000787

CORRELATION MATRIX
==================

	1	2
1	1.0000	
2	-.8519	1.0000

NON-LINEAR LEAST-SQUARES ANALYSIS: FINAL RESULTS
==

VARIABLE	VALUE	S.E.COEFF.	T-VALUE
ALPHA	.03314	.0033	10.00
N	1.58391	.0335	47.34

VARIABLE	95% CONFIDENCE LIMITS LOWER	UPPER
ALPHA	.0246	.0417
N	1.4979	1.6699

--------ORDERED BY COMPUTER INPUT--------

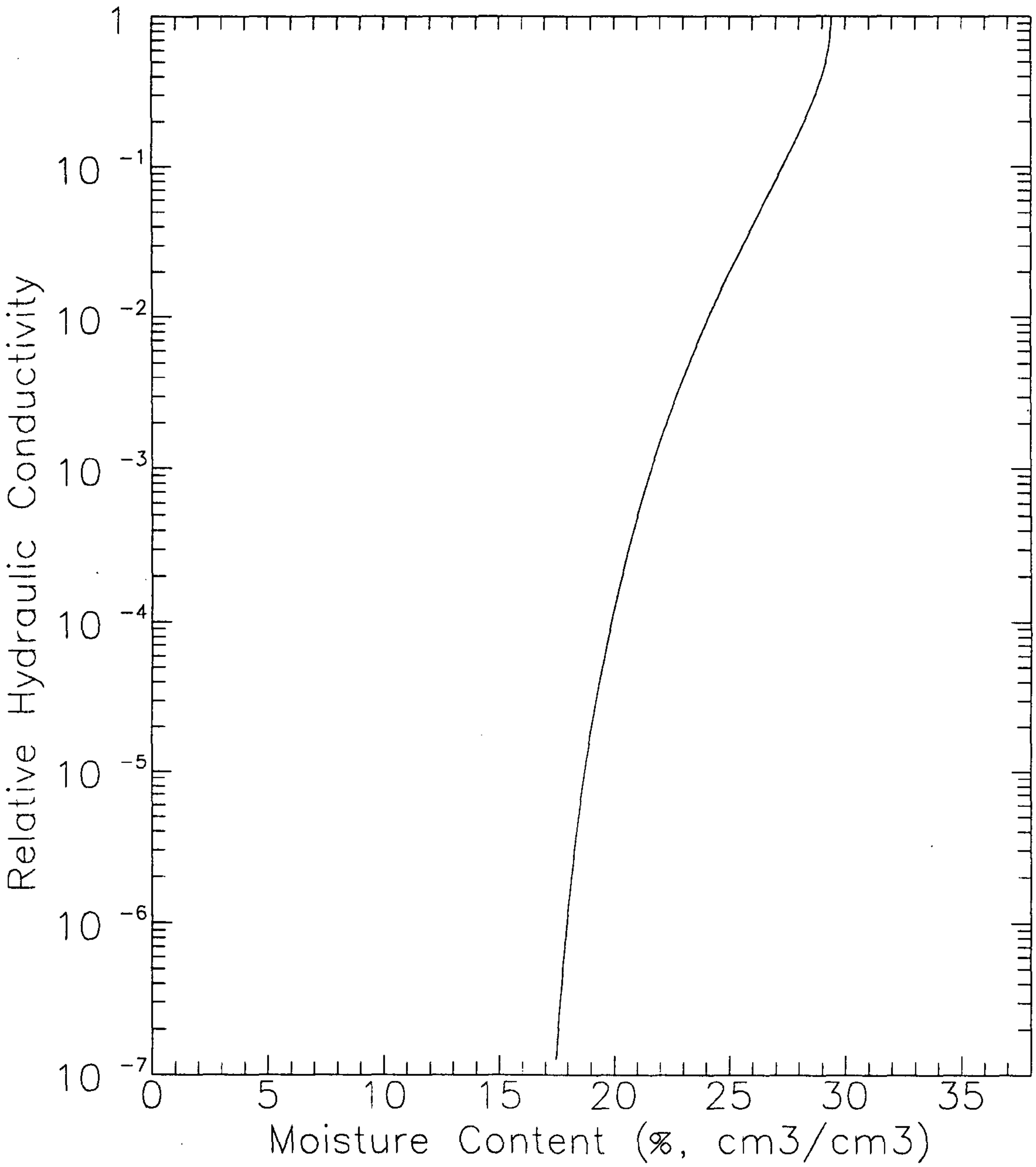
NO	PRESSURE	MOISTURE CONTENT OBS	FITTED	RESI-DUAL
1	.00	.3670	.3670	.0000
2	43.50	.2967	.2982	-.0015
3	184.50	.2247	.2227	.0020
4	509.65	.1903	.1901	.0002
5	917.37	.1817	.1780	.0037
6	3057.90	.1579	.1630	-.0051
7	15493.36	.1483	.1540	-.0057

----------ORDERED BY RESIDUALS----------

NO	PRESSURE	MOISTURE CONTENT OBS	FITTED	RESI-DUAL
5	917.37	.1817	.1780	.0037
3	184.50	.2247	.2227	.0020
4	509.65	.1903	.1901	.0002
1	.00	.3670	.3670	.0000
2	43.50	.2967	.2982	-.0015
6	3057.90	.1579	.1630	-.0051
7	15493.36	.1483	.1540	-.0057

PRESSURE	WC	REL K	ABS K	DIFFUS
.000E+00	.3670	1.000E+00	3.200E-05	
.141E+01	.3664	6.931E-01	2.218E-05	3.165E-02
.168E+01	.3662	6.639E-01	2.125E-05	2.750E-02
.200E+01	.3659	6.325E-01	2.024E-05	2.379E-02
.237E+01	.3656	5.987E-01	1.916E-05	2.047E-02
.282E+01	.3651	5.625E-01	1.800E-05	1.752E-02
.335E+01	.3646	5.241E-01	1.677E-05	1.491E-02
.398E+01	.3638	4.836E-01	1.548E-05	1.260E-02
.473E+01	.3629	4.412E-01	1.412E-05	1.056E-02
.562E+01	.3616	3.973E-01	1.271E-05	8.787E-03
.668E+01	.3600	3.524E-01	1.128E-05	7.246E-03
.794E+01	.3580	3.072E-01	9.831E-06	5.919E-03
.944E+01	.3554	2.626E-01	8.402E-06	4.786E-03
.112E+02	.3522	2.194E-01	7.020E-06	3.831E-03
.133E+02	.3483	1.787E-01	5.719E-06	3.033E-03
.158E+02	.3435	1.415E-01	4.529E-06	2.375E-03
.188E+02	.3378	1.087E-01	3.479E-06	1.841E-03
.224E+02	.3312	8.085E-02	2.587E-06	1.412E-03
.266E+02	.3237	5.813E-02	1.860E-06	1.073E-03
.316E+02	.3153	4.040E-02	1.293E-06	8.082E-04
.376E+02	.3063	2.716E-02	8.692E-07	6.042E-04
.447E+02	.2967	1.770E-02	5.664E-07	4.487E-04
.531E+02	.2869	1.121E-02	3.586E-07	3.314E-04
.631E+02	.2770	6.917E-03	2.213E-07	2.437E-04
.750E+02	.2671	4.176E-03	1.336E-07	1.785E-04
.891E+02	.2576	2.474E-03	7.916E-08	1.304E-04
.106E+03	.2485	1.443E-03	4.618E-08	9.504E-05

.126E+03	.2399	8.313E-04	2.660E-08	6.915E-05
.150E+03	.2318	4.740E-04	1.517E-08	5.024E-05
.178E+03	.2243	2.681E-04	8.580E-09	3.646E-05
.211E+03	.2173	1.507E-04	4.822E-09	2.644E-05
.251E+03	.2110	8.429E-05	2.697E-09	1.916E-05
.299E+03	.2051	4.696E-05	1.503E-09	1.388E-05
.355E+03	.1998	2.609E-05	8.349E-10	1.005E-05
.422E+03	.1949	1.446E-05	4.627E-10	7.277E-06
.501E+03	.1905	8.002E-06	2.561E-10	5.267E-06
.596E+03	.1865	4.421E-06	1.415E-10	3.812E-06
.708E+03	.1829	2.440E-06	7.810E-11	2.758E-06
.841E+03	.1796	1.346E-06	4.308E-11	1.996E-06
.100E+04	.1766	7.422E-07	2.375E-11	1.444E-06
.119E+04	.1739	4.089E-07	1.309E-11	1.044E-06
.141E+04	.1714	2.253E-07	7.208E-12	7.556E-07
.168E+04	.1692	1.240E-07	3.969E-12	5.465E-07
.200E+04	.1672	6.829E-08	2.185E-12	3.953E-07
.237E+04	.1654	3.759E-08	1.203E-12	2.860E-07
.282E+04	.1638	2.069E-08	6.620E-13	2.068E-07
.335E+04	.1623	1.140E-08	3.647E-13	1.498E-07
.398E+04	.1609	6.264E-09	2.004E-13	1.082E-07
.473E+04	.1597	3.447E-09	1.103E-13	7.824E-08
.562E+04	.1586	1.897E-09	6.070E-14	5.660E-08
.668E+04	.1576	1.044E-09	3.340E-14	4.094E-08
.794E+04	.1567	5.744E-10	1.838E-14	2.961E-08
.944E+04	.1559	3.160E-10	1.011E-14	2.142E-08
.112E+05	.1552	1.739E-10	5.565E-15	1.549E-08
.133E+05	.1545	9.568E-11	3.062E-15	1.121E-08
.158E+05	.1539	5.264E-11	1.685E-15	8.105E-09
.188E+05	.1534	2.897E-11	9.269E-16	5.862E-09
.224E+05	.1529	1.594E-11	5.100E-16	4.240E-09
.266E+05	.1525	8.769E-12	2.806E-16	3.067E-09
.316E+05	.1521	4.825E-12	1.544E-16	2.218E-09
.376E+05	.1517	2.655E-12	8.495E-17	1.604E-09
.447E+05	.1514	1.461E-12	4.674E-17	1.160E-09
.531E+05	.1511	8.036E-13	2.572E-17	8.393E-10
.631E+05	.1508	4.421E-13	1.415E-17	6.071E-10
.750E+05	.1506	2.433E-13	7.784E-18	4.391E-10
.891E+05	.1504	1.338E-13	4.283E-18	3.176E-10
.106E+06	.1502	7.364E-14	2.357E-18	2.297E-10
.126E+06	.1500	4.052E-14	1.297E-18	1.661E-10
.150E+06	.1498	2.229E-14	7.134E-19	1.202E-10
.178E+06	.1497	1.227E-14	3.925E-19	8.692E-11
.211E+06	.1495	6.748E-15	2.160E-19	6.287E-11
.251E+06	.1494	3.713E-15	1.188E-19	4.547E-11
.298E+06	.1493	2.043E-15	6.537E-20	3.289E-11
.355E+06	.1492	1.124E-15	3.597E-20	2.379E-11
.422E+06	.1491	6.184E-16	1.979E-20	1.721E-11
.501E+06	.1491	3.403E-16	1.089E-20	1.244E-11



Relative Hydraulic Conductivity vs. Moisture Content, Sample No. 5−18A−60

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NON-LINEAR LEAST SQUARES ANALYSIS

- ENRON 89-034-L -

Sample 5-18A-60 Drainage

****

INPUT PARAMETERS

MODEL NUMBER....................................	2
NUMBER OF COEFFICIENTS..........................	2
MAXIMUM NUMBER OF ITERATIONS....................	20
RATIO OF COEFFICIENTS CRITERION...............	.0001
RESIDUAL MOISTURE CONTENT (FOR MODEL 2).......	.1644
SATURATED MOISTURE CONTENT....................	.2939
SATURATED HYDRAULIC CONDUCTIVITY..............	.0000

OBSERVED DATA

OBS. NO.	PRESSURE HEAD	MOISTURE CONTENT
1	.00	.2939
2	51.00	.2844
3	190.00	.2684
4	509.65	.2452
5	917.37	.2362
6	3057.90	.1900
7	15493.36	.1644

ITERATION NO	WCR	ALPHA	N	SSQ
0	.1644	.200000	2.1000	.0345684
1	.1644	.061475	1.0592	.0138341
2	.1644	.073823	1.1485	.0037067
3	.1644	.069448	1.1614	.0033656
4	.1644	.026958	1.1934	.0027130
5	.1644	.006903	1.2761	.0022552
6	.1644	.006322	1.3970	.0007417
7	.1644	.004843	1.4755	.0005131
8	.1644	.003089	1.6033	.0004169
9	.1644	.003084	1.6677	.0003627
10	.1644	.003174	1.6497	.0003623
11	.1644	.003181	1.6512	.0003622
12	.1644	.003181	1.6512	.0003622

CORRELATION MATRIX

	1	2
1	1.0000	
2	-.8580	1.0000

NON-LINEAR LEAST-SQUAREANALYSIS: FINAL RESULTS

VARIABLE	VALUE	S.E.COEFF.	T-VALUE
ALPHA	.00318	.0009	3.49
N	1.65120	.1518	10.88

VARIABLE	95% CONFIDENCE LIMITS LOWER	UPPER
ALPHA	.0008	.0055
N	1.2608	2.0415

--------ORDERED BY COMPUTER INPUT--------

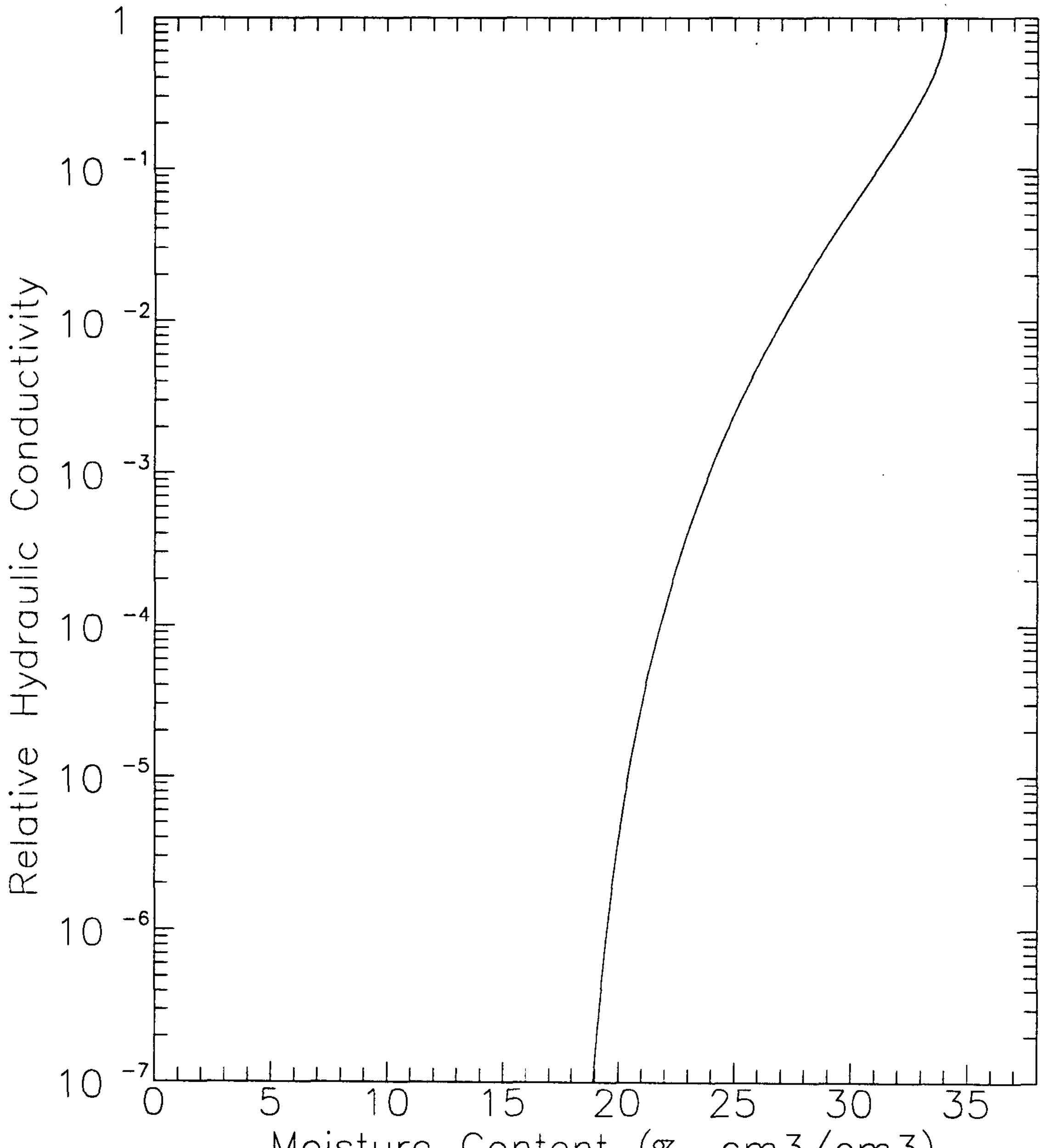
NO	PRESSURE	MOISTURE CONTENT OBS	FITTED	RESI-DUAL
1	.00	.2939	.2939	.0000
2	51.00	.2844	.2914	-.0070
3	190.00	.2684	.2767	-.0083
4	509.65	.2452	.2460	-.0008
5	917.37	.2362	.2250	.0112
6	3057.90	.1900	.1936	-.0036
7	15493.36	.1644	.1746	-.0102

----------ORDERED BY RESIDUALS----------

NO	PRESSURE	MOISTURE CONTENT OBS	FITTED	RESI-DUAL
5	917.37	.2362	.2250	.0112
1	.00	.2939	.2939	.0000
4	509.65	.2452	.2460	-.0008
6	3057.90	.1900	.1936	-.0036
2	51.00	.2844	.2914	-.0070
3	190.00	.2684	.2767	-.0083
7	15493.36	.1644	.1746	-.0102

PRESSURE	WC	REL K	ABS K	DIFFUS
.000E+00	.2939	1.000E+00	1.500E-07	
.141E+01	.2939	9.416E-01	1.412E-07	1.779E-02
.168E+01	.2939	9.348E-01	1.402E-07	1.578E-02
.200E+01	.2939	9.272E-01	1.391E-07	1.399E-02
.237E+01	.2939	9.187E-01	1.378E-07	1.239E-02
.282E+01	.2939	9.093E-01	1.364E-07	1.096E-02
.335E+01	.2939	8.987E-01	1.348E-07	9.681E-03
.398E+01	.2939	8.870E-01	1.331E-07	8.541E-03
.473E+01	.2939	8.740E-01	1.311E-07	7.523E-03
.562E+01	.2938	8.596E-01	1.289E-07	6.615E-03
.668E+01	.2938	8.435E-01	1.265E-07	5.805E-03
.794E+01	.2938	8.258E-01	1.239E-07	5.082E-03
.944E+01	.2937	8.061E-01	1.209E-07	4.438E-03
.112E+02	.2937	7.844E-01	1.177E-07	3.865E-03
.133E+02	.2936	7.605E-01	1.141E-07	3.355E-03
.158E+02	.2935	7.342E-01	1.101E-07	2.901E-03
.188E+02	.2934	7.054E-01	1.058E-07	2.499E-03
.224E+02	.2933	6.739E-01	1.011E-07	2.143E-03
.266E+02	.2930	6.396E-01	9.593E-08	1.828E-03
.316E+02	.2928	6.024E-01	9.036E-08	1.550E-03
.376E+02	.2924	5.624E-01	8.436E-08	1307E-03
.447E+02	.2919	5.197E-01	7.795E-08	1.093E-03

.531E+02	.2913	4.744E-01	7.116E-08	9.078E-04
.631E+02	.2905	4.271E-01	6.406E-08	7.472E-04
.750E+02	.2894	3.782E-01	5.673E-08	6.093E-04
.891E+02	.2880	3.286E-01	4.928E-08	4.919E-04
.106E+03	.2863	2.792E-01	4.189E-08	3.928E-04
.126E+03	.2841	2.314E-01	3.472E-08	3.101E-04
.150E+03	.2814	1.864E-01	2.797E-08	2.420E-04
.178E+03	.2781	1.455E-01	2.183E-08	1.867E-04
.211E+03	.2742	1.098E-01	1.646E-08	1.424E-04
.251E+03	.2697	7.982E-02	1.197E-08	1.074E-04
.299E+03	.2646	5.592E-02	8.387E-09	8.019E-05
.355E+03	.2589	3.774E-02	5.661E-09	5.934E-05
.422E+03	.2529	2.457E-02	3.686E-09	4.356E-05
.501E+03	.2467	1.547E-02	2.321E-09	3.177E-05
.596E+03	.2403	9.456E-03	1.418E-09	2.304E-05
.708E+03	.2340	5.629E-03	8.444E-10	1.663E-05
.841E+03	.2279	3.277E-03	4.916E-10	1.196E-05
.100E+04	.2221	1.873E-03	2.810E-10	8.581E-06
.119E+04	.2167	1.055E-03	1.582E-10	6.142E-06
.141E+04	.2116	5.870E-04	8.806E-11	4.389E-06
.168E+04	.2069	3.236E-04	4.854E-11	3.132E-06
.200E+04	.2026	1.771E-04	2.656E-11	2.233E-06
.237E+04	.1987	9.637E-05	1.446E-11	1.591E-06
.282E+04	.1951	5.221E-05	7.832E-12	1.133E-06
.335E+04	.1919	2.819E-05	4.229E-12	8.062E-07
.398E+04	.1890	1.519E-05	2.278E-12	5.736E-07
.473E+04	.1865	8.165E-06	1.225E-12	4.080E-07
.562E+04	.1841	4.383E-06	6.574E-13	2.902E-07
.668E+04	.1820	2.350E-06	3.525E-13	2.063E-07
.794E+04	.1802	1.259E-06	1.889E-13	1.467E-07
.944E+04	.1785	6.743E-07	1.012E-13	1.043E-07
.112E+05	.1770	3.609E-07	5.414E-14	7.416E-08
.133E+05	.1757	1.931E-07	2.897E-14	5.272E-08
.158E+05	.1745	1.033E-07	1.550E-14	3.749E-08
.188E+05	.1734	5.524E-08	8.287E-15	2.664E-08
.224E+05	.1724	2.955E-08	4.433E-15	1.895E-08
.266E+05	.1716	1.578E-08	2.367E-15	1.345E-08
.316E+05	.1708	8.437E-09	1.266E-15	9.563E-09
.376E+05	.1701	4.510E-09	6.766E-16	6.798E-09
.447E+05	.1695	2.411E-09	3.617E-16	4.832E-09
.531E+05	.1690	1.289E-09	1.933E-16	3.435E-09
.631E+05	.1685	6.889E-10	1.033E-16	2.442E-09
.750E+05	.1681	3.682E-10	5.523E-17	1.736E-09
.891E+05	.1677	1.968E-10	2.952E-17	1.234E-09
.106E+06	.1673	1.052E-10	1.578E-17	8.769E-10
.126E+06	.1670	5.621E-11	8.432E-18	6.233E-10
.150E+06	.1667	3.004E-11	4.507E-18	4.430E-10
.178E+06	.1665	1.606E-11	2.409E-18	3.149E-10
.211E+06	.1663	8.582E-12	1.287E-18	2.238E-10
.251E+06	.1661	4.587E-12	6.880E-19	1.591E-10
.298E+06	.1659	2.451E-12	3.677E-19	1.131E-10
.355E+06	.1657	1.310E-12	1.965E-19	8.038E-11
.422E+06	.1656	7.002E-13	1.050E-19	5.713E-11
.501E+06	.1655	3.742E-13	5.613E-20	4.061E-11



Relative Hydraulic Conductivity vs. Moisture Content, Sample No. 5-19A-55

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NON-LINEAR LEAST SQUARES ANALYSIS

- ENRON 89-034-L -

Sample 5-19A-55 Drainage

****

INPUT PARAMETERS

MODEL NUMBER....................................	2
NUMBER OF COEFFICIENTS..........................	2
MAXIMUM NUMBER OF ITERATIONS....................	20
RATIO OF COEFFICIENTS CRITERION..............	.0001
RESIDUAL MOISTURE CONTENT (FOR MODEL 2).......	.1785
SATURATED MOISTURE CONTENT....................	.3407
SATURATED HYDRAULIC CONDUCTIVITY..............	.0000

OBSERVED DATA

OBS. NO.	PRESSURE HEAD	MOISTURE CONTENT
1	.00	.3407
2	43.50	.3208
3	184.50	.3025
4	509.65	.2665
5	917.37	.2592
6	3057.90	.1867
7	15493.36	.1785

ITERATION NO	WCR	ALPHA	N	SSQ
0	.1785	.200000	2.1000	.0449094
1	.1785	.099185	1.2277	.0057274
2	.1785	.066534	1.2232	.0047790
3	.1785	.053411	1.2278	.0044551
4	.1785	.028026	1.2591	.0036012
5	.1785	.009974	1.3358	.0028722
6	.1785	.007955	1.4451	.0016886
7	.1785	.006266	1.5233	.0013905
8	.1785	.004081	1.6540	.0012335
9	.1785	.003927	1.7317	.0011651
10	.1785	.004035	1.7122	.0011648
11	.1785	.004044	1.7142	.0011645
12	.1785	.004044	1.7142	.0011645

CORRELATION MATRIX

	1	2
1	1.0000	
2	-.8620	1.0000

NON-LINEAR LEAST-SQUARES ANALYSIS: FINAL RESULTS

VARIABLE	VALUE	S.E.COEFF.	T-VALUE
ALPHA	.00404	.0016	2.47
N	1.71419	.2391	7.17

	95% CONFIDENCE LIMITS	
VARIABLE	LOWER	UPPER
ALPHA	-.0002	.0083
N	1.0995	2.3288

--------ORDERED BY COMPUTER INPUT--------

		MOISTURE	CONTENT	RESI-
NO	PRESSURE	OBS	FITTED	DUAL
1	.00	.3407	.3407	.0000
2	43.50	.3208	.3374	-.0166
3	184.50	.3025	.3117	-.0092
4	509.65	.2665	.2655	.0010
5	917.37	.2592	.2395	.0197
6	3057.90	.1867	.2053	-.0186
7	15493.36	.1785	.1869	-.0084

----------ORDERED BY RESIDUALS----------

		MOISTURE	CONTENT	RESI-
NO	PRESSURE	OBS	FITTED	DUAL
5	917.37	.2592	.2395	.0197
4	509.65	.2665	.2655	.0010
1	.00	.3407	.3407	.0000
7	15493.36	.1785	.1869	-.0084
3	184.50	.3025	.3117	-.0092
2	43.50	.3208	.3374	-.0166
6	3057.90	.1867	.2053	-.0186

PRESSURE	WC	REL K	ABS K	DIFFUS
.000E+00	.3407	1.000E+00	3.400E-07	
.141E+01	.3407	9.506E-01	3.232E-07	2.760E-02
.168E+01	.3407	9.442E-01	3.210E-07	2.423E-02
.200E+01	.3407	9.370E-01	3.186E-07	2.126E-02
.237E+01	.3407	9.289E-01	3.158E-07	1.863E-02
.282E+01	.3407	9.197E-01	3.127E-07	1.631E-02
.335E+01	.3407	9.094E-01	3.092E-07	1.426E-02
.398E+01	.3406	8.978E-01	3.053E-07	1.245E-02
.473E+01	.3406	8.848E-01	3.008E-07	1.085E-02
.562E+01	.3406	8.702E-01	2.959E-07	9.437E-03
.668E+01	.3406	8.538E-01	2.903E-07	8.191E-03
.794E+01	.3405	8.354E-01	2.840E-07	7.092E-03
.944E+01	.3405	8.149E-01	2.771E-07	6.123E-03
.112E+02	.3404	7.920E-01	2.693E-07	5.270E-03
.133E+02	.3402	7.665E-01	2.606E-07	4.519E-03
.158E+02	.3401	7.382E-01	2.510E-07	3.860E-03
.188E+02	.3399	7.068E-01	2.403E-07	3.281E-03
.224E+02	.3396	6.723E-01	2.286E-07	2.775E-03
.266E+02	.3392	6.345E-01	2.157E-07	2.333E-03
.316E+02	.3388	5.933E-01	2.017E-07	1.949E-03
.376E+02	.3381	5.487E-01	1.866E-07	1.616E-03
.447E+02	.3372	5.011E-01	1.704E-07	1.328E-03

.531E+02	.3361	4.507E-01	1.532E-07	1.082E-03
.631E+02	.3346	3.982E-01	1.354E-07	8.731E-04
.750E+02	.3327	3.447E-01	1.172E-07	6.967E-04
.891E+02	.3302	2.912E-01	9.900E-08	5.496E-04
.106E+03	.3271	2.392E-01	8.133E-08	4.283E-04
.126E+03	.3232	1.904E-01	6.475E-08	3.297E-04
.150E+03	.3185	1.464E-01	4.977E-08	2.506E-04
.178E+03	.3130	1.083E-01	3.682E-08	1.881E-04
.211E+03	.3065	7.697E-02	2.617E-08	1.396E-04
.251E+03	.2993	5.250E-02	1.785E-08	1.025E-04
.299E+03	.2915	3.440E-02	1.170E-08	7.459E-05
.355E+03	.2832	2.169E-02	7.375E-09	5.382E-05
.422E+03	.2748	1.321E-02	4.491E-09	3.857E-05
.501E+03	.2664	7.798E-03	2.651E-09	2.749E-05
.596E+03	.2581	4.484E-03	1.525E-09	1.950E-05
.708E+03	.2503	2.523E-03	8.577E-10	1.379E-05
.841E+03	.2430	1.394E-03	4.740E-10	9.724E-06
.100E+04	.2362	7.596E-04	2.583E-10	6.843E-06
.119E+04	.2299	4.093E-04	1.392E-10	4.808E-06
.141E+04	.2243	2.187E-04	7.435E-11	3.374E-06
.168E+04	.2192	1.161E-04	3.946E-11	2.366E-06
.200E+04	.2146	6.128E-05	2.084E-11	1.658E-06
.237E+04	.2105	3.224E-05	1.096E-11	1.161E-06
.282E+04	.2068	1.691E-05	5.749E-12	8.127E-07
.335E+04	.2036	8.851E-06	3.009E-12	5.688E-07
.398E+04	.2007	4.625E-06	1.573E-12	3.979E-07
.473E+04	.1982	2.414E-06	8.208E-13	2.784E-07
.562E+04	.1959	1.259E-06	4.280E-13	1.947E-07
.668E+04	.1939	6.560E-07	2.230E-13	1.362E-07
.794E+04	.1921	3.417E-07	1.162E-13	9.527E-08
.944E+04	.1905	1.779E-07	6.049E-14	6.663E-08
.112E+05	.1891	9.258E-08	3.148E-14	4.659E-08
.133E+05	.1879	4.817E-08	1.638E-14	3.257E-08
.158E+05	.1868	2.507E-08	8.523E-15	2.278E-08
.188E+05	.1858	1.304E-08	4.435E-15	1.593E-08
.224E+05	.1850	6.787E-09	2.307E-15	1.114E-08
.266E+05	.1842	3.531E-09	1.200E-15	7.793E-09
.316E+05	.1836	1.837E-09	6.245E-16	5.450E-09
.376E+05	.1830	9.554E-10	3.248E-16	3.811E-09
.447E+05	.1825	4.970E-10	1.690E-16	2.665E-09
.531E+05	.1820	2.585E-10	8.789E-17	1.864E-09
.631E+05	.1816	1.345E-10	4.571E-17	1.303E-09
.750E+05	.1812	6.993E-11	2.378E-17	9.115E-10
.891E+05	.1809	3.637E-11	1.237E-17	6.374E-10
.106E+06	.1806	1.892E-11	6.432E-18	4.457E-10
.126E+06	.1804	9.840E-12	3.346E-18	3.117E-10
.150E+06	.1802	5.118E-12	1.740E-18	2.180E-10
.178E+06	.1800	2.662E-12	9.050E-19	1.524E-10
.211E+06	.1798	1.384E-12	4.707E-19	1.066E-10
.251E+06	.1797	7.201E-13	2.448E-19	7.453E-11
.298E+06	.1795	3.745E-13	1.273E-19	5.212E-11
.355E+06	.1794	1.948E-13	6.623E-20	3.645E-11
.422E+06	.1793	1.013E-13	3.445E-20	2.549E-11
.501E+06	.1792	5.269E-14	1.792E-20	1.782E-11

APPENDIX E

PARTICLE SIZE CHARACTERISTICS

SUMMARY OF PARTICLE SIZE CHARACTERISTICS

Sample Number	d_{10}	d_{50}	d_{60}	C_u	C_c
5-15A-46.5	0.09	0.57	0.85	9.4	0.88
5-15A-47.5	0.09	0.67	1.20	13.3	0.73
5-16A-40.5	0.12	0.41	0.69	5.8	0.88
5-16A-42.5	0.08	0.29	0.38	4.8	0.95
5-18A-60	0.05	0.23	0.31	6.2	2.5
5-19A-55	*	0.19	0.27	-----	-----

* d_{10} not reached with test(s) specified.

-- value dependent upon d_{10}

$$C_u = \frac{d_{60}}{d_{10}}$$

$$C_c = \frac{(d_{30})^2}{(d_{10})(d_{60})}$$

d_{50} = median particle diameter

SIEVE ANALYSIS DATA

JOB NAME: ENRON
JOB NUMBER: 89-034-L
TEST DATE: 9/27/90
SAMPLE NUMBER: 5-15A-46.5
DEPTH: 46.5 FT.

TOTAL WEIGHT OF SAMPLE: 172.94 (g)

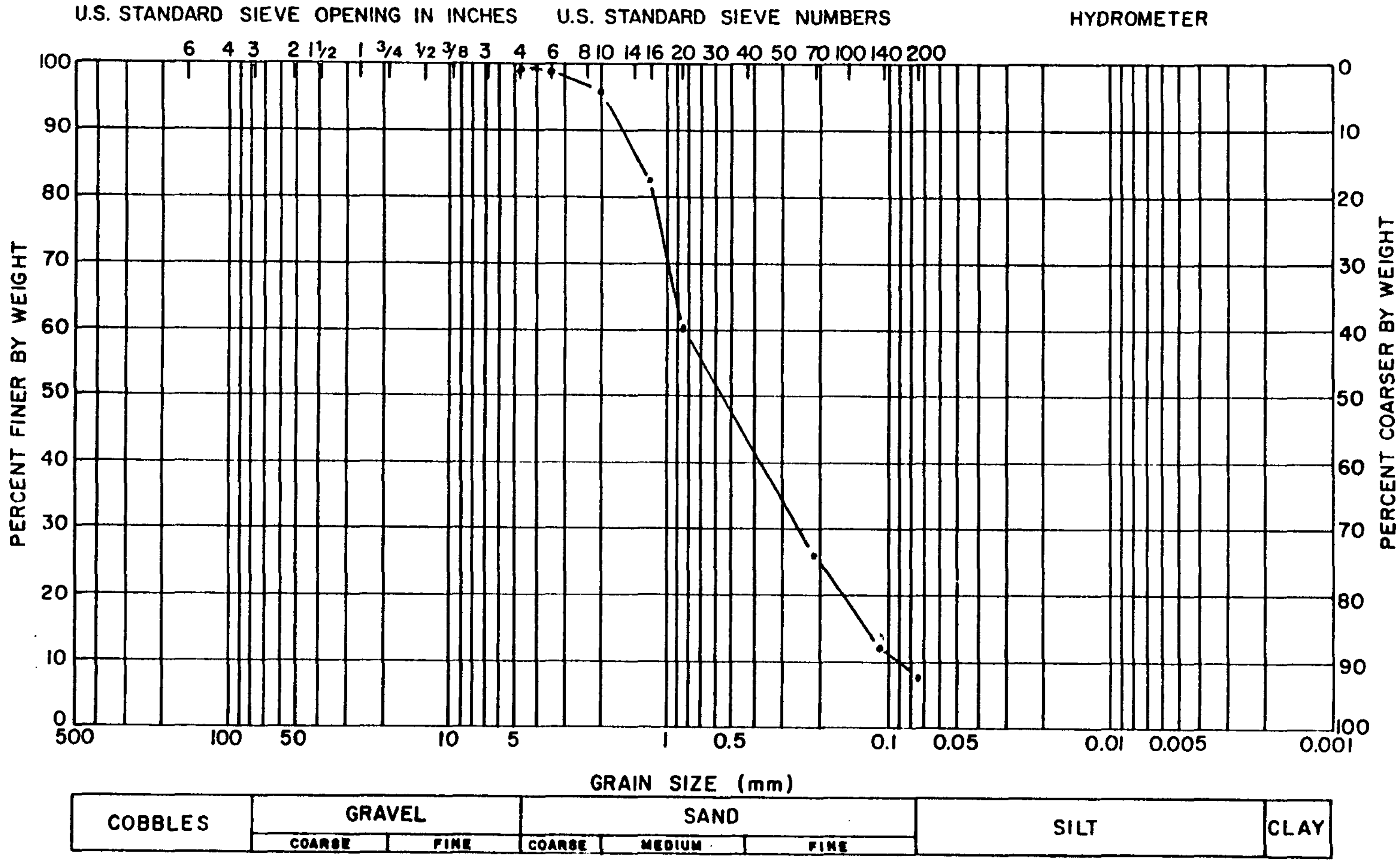
SIEVE NUMBER	DIAMETER (mm)	WT. RETAINED	CUM WT. RETAINED	WT. PASSING	% PASSING	LOG DIAMETER
4	4.750	1.29	1.29	171.65	99.25	0.677
6	3.350	0.55	1.84	171.10	98.94	0.525
10	2.000	4.55	6.39	166.55	96.31	0.301
16	1.180	22.53	28.92	144.02	83.28	0.072
40	0.425	40.12	69.04	103.90	60.08	-0.372
70	0.212	57.07	126.11	46.83	27.08	-0.674
140	0.106	25.17	151.28	21.66	12.52	-0.975
200	0.075	6.91	158.19	14.75	8.53	-1.125
pan		14.75	172.94	-0.00		

d10:	0.09 (mm)	d50:	0.57 (mm)
d16:	0.13 (mm)	d60:	0.85 (mm)
d30:	0.26 (mm)	d84:	1.3 (mm)

MEDIAN PARTICLE DIAMETER (d50): 0.57
UNIFORMITY COEFFICIENT, Cu (d60/d10): 9.4
COEFFICIENT OF CURVATURE, Cc,
[(d30)**2/(d10*d60)]: 0.88
MEAN PARTICLE DIAMETER, [(d16+d50+d84)/3]: 0.7

COMMENTS:

LABORATORY ANALYSIS PERFORMED BY: C. Pigman
CALCULATIONS MADE BY: K. Evans
CHECKED BY: D. Hammermeister



USCS PARTICLE SIZE LIMIT CLASSIFICATION

Θ_i = 23.25%	d_{10} = 0.09	d_{50} = 0.57	d_{60} = 0.85	C_u = 9.4	C_c = 0.88

SAMPLE NUMBER	DEPTH	CLASSIFICATION (USCS Classification)
5-15A-46.5	46.5 Ft.	Well graded sand with silt

SIEVE ANALYSIS DATA

JOB NAME: ENRON
JOB NUMBER: 89-034-L
TEST DATE: 9/27/90
SAMPLE NUMBER: 5-15A-47.5
DEPTH: 47.5 FT.

TOTAL WEIGHT OF SAMPLE: 192.58 (g)

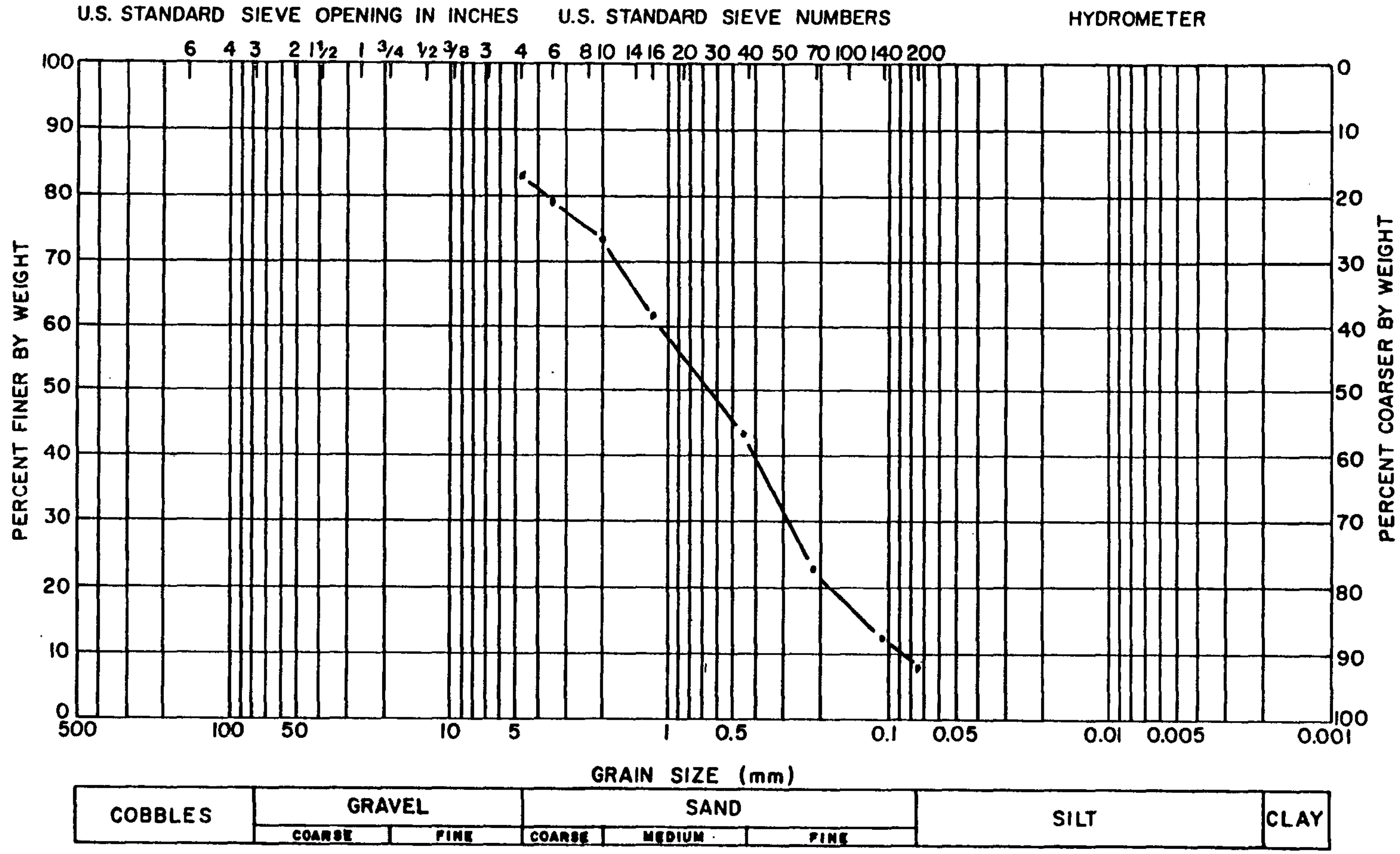
SIEVE NUMBER	DIAMETER (mm)	WT. RETAINED	CUM WT. RETAINED	WT. PASSING	% PASSING	LOG DIAMETER
4	4.750	31.84	31.84	160.74	83.47	0.677
6	3.350	7.64	39.48	153.10	79.50	0.525
10	2.000	11.40	50.88	141.70	73.58	0.301
16	1.180	23.47	74.35	118.23	61.39	0.072
40	0.425	34.78	109.13	83.45	43.33	-0.372
70	0.212	40.96	150.09	42.49	22.06	-0.674
140	0.106	19.92	170.01	22.57	11.72	-0.975
200	0.075	6.06	176.07	16.51	8.57	-1.125
pan		16.51	192.58	0.00		

d10:	0.09 (mm)	d50:	0.67 (mm)
d16:	0.15 (mm)	d60:	1.20 (mm)
d30:	0.28 (mm)	d84:	-- (mm)

MEDIAN PARTICLE DIAMETER (d50): 0.67
UNIFORMITY COEFFICIENT, Cu (d60/d10): 13.3
COEFFICIENT OF CURVATURE, Cc,
[(d30)**2/(d10*d60)]: 0.73
MEAN PARTICLE DIAMETER, [(d16+d50+d84)/3]: --

COMMENTS:

LABORATORY ANALYSIS PERFORMED BY: C. Pigman
CALCULATIONS MADE BY: K. Evans
CHECKED BY: D. Hammermeister



USCS PARTICLE SIZE LIMIT CLASSIFICATION

θ_i = 21.02%	d_{10} = 0.09	d_{50} = 0.67	d_{60} = 1.20	C_u = 13.3	C_c = 0.73
SAMPLE NUMBER		DEPTH	CLASSIFICATION (USCS Classification)		
5-15A-47.5		47.5 Ft.	Well graded sand with silt & gravel		

SIEVE ANALYSIS DATA

JOB NAME: ENRON
JOB NUMBER: 89-034-L
TEST DATE: 9/26/90
SAMPLE NUMBER: 5-16A-40.5
DEPTH: 40.5 FT.

TOTAL WEIGHT OF SAMPLE: 155.71 (g)

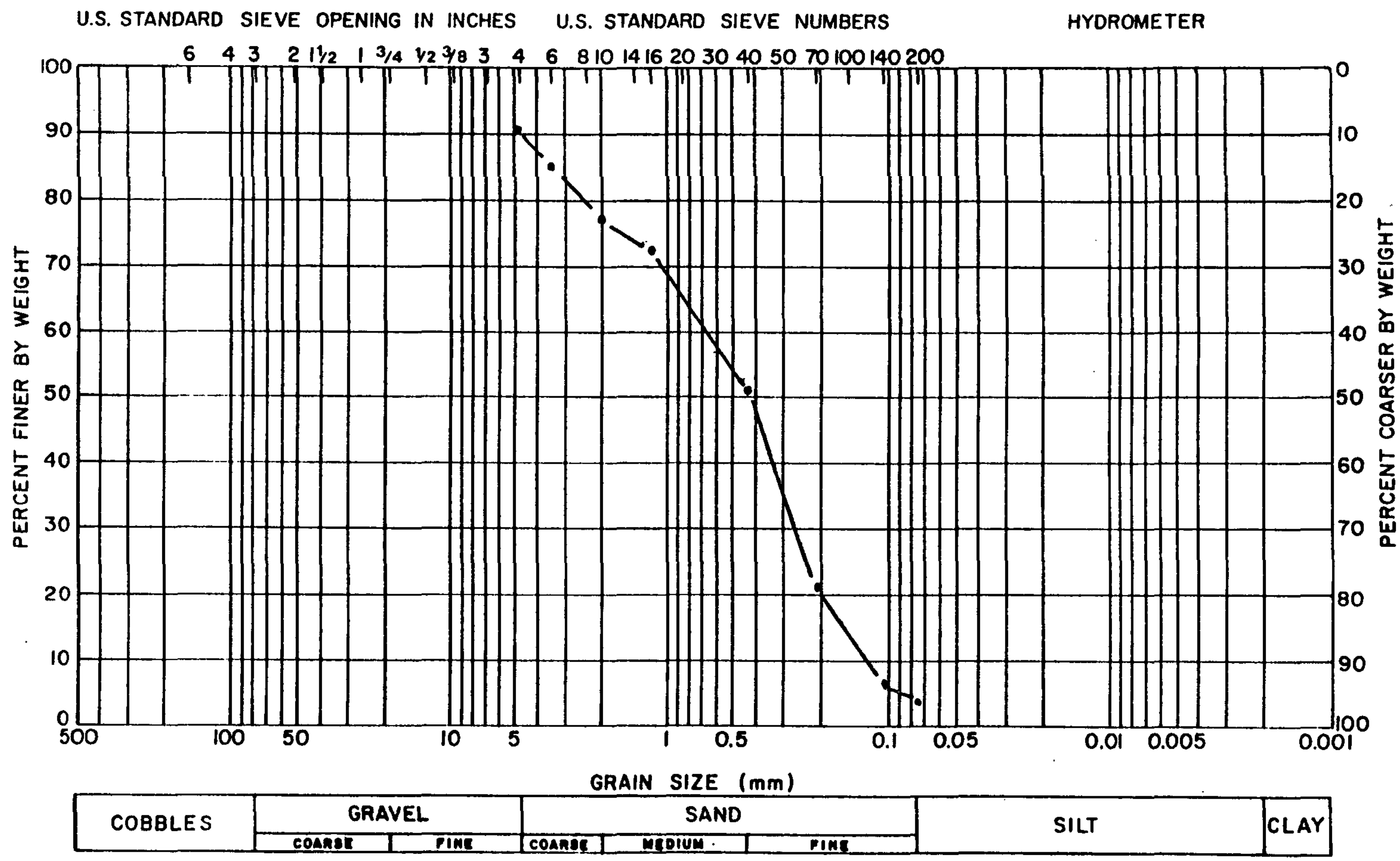
SIEVE NUMBER	DIAMETER (mm)	WT. RETAINED	CUM WT. RETAINED	WT. PASSING	% PASSING	LOG DIAMETER
4	4.750	14.12	14.12	141.59	90.93	0.677
6	3.350	8.70	22.82	132.89	85.34	0.525
10	2.000	11.62	34.44	121.27	77.88	0.301
16	1.180	9.41	43.85	111.86	71.84	0.072
40	0.425	33.21	77.06	78.65	50.51	-0.372
70	0.212	46.32	123.38	32.33	20.76	-0.674
140	0.106	23.25	146.63	9.08	5.83	-0.975
200	0.075	4.24	150.87	4.84	3.11	-1.125
pan		5.27	156.14	-0.43		

d10:	0.12 (mm)	d50:	0.41 (mm)
d16:	0.16 (mm)	d60:	0.69 (mm)
d30:	0.27 (mm)	d84:	3.2 (mm)

MEDIAN PARTICLE DIAMETER (d50): 0.41
UNIFORMITY COEFFICIENT, Cu (d60/d10): 5.8
COEFFICIENT OF CURVATURE, Cc,
[(d30)**2/(d10*d60)]: 0.88
MEAN PARTICLE DIAMETER, [(d16+d50+d84)/3]: 1.3

COMMENTS:

LABORATORY ANALYSIS PERFORMED BY: B. Horton
CALCULATIONS MADE BY: K. Evans
CHECKED BY: D. Hammermeister



USCS PARTICLE SIZE LIMIT CLASSIFICATION

θ_i = 6.15 %	d_{10} = 0.12	d_{50} = 0.41	d_{60} = 0.69	C_u = 5.8	C_c = 0.88

SAMPLE NUMBER	DEPTH	CLASSIFICATION (USCS Classification)
5-16A-40.5	40.5 FT.	Poorly Graded Sand

SIEVE ANALYSIS DATA

JOB NAME: ENRON
JOB NUMBER: 89-034-L
TEST DATE: 9/27/90
SAMPLE NUMBER: 5-16A-42.5
DEPTH: 42.5 FT.

TOTAL WEIGHT OF SAMPLE: 144.83 (g)

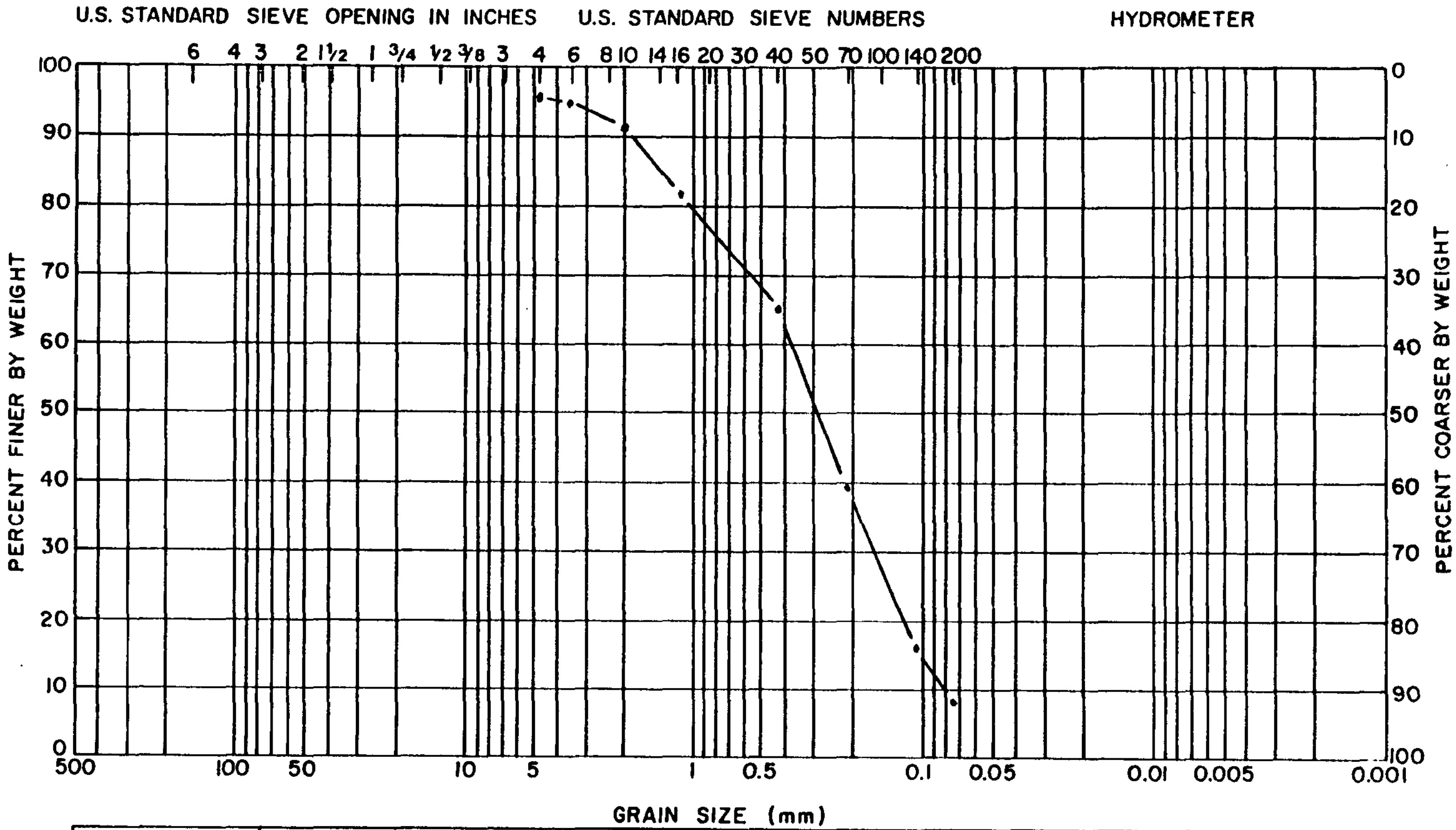
SIEVE NUMBER	DIAMETER (mm)	WT. RETAINED	CUM WT. RETAINED	WT. PASSING	% PASSING	LOG DIAMETER
4	4.750	5.02	5.02	139.81	96.53	0.677
6	3.350	2.43	7.45	137.38	94.86	0.525
10	2.000	6.08	13.53	131.30	90.66	0.301
16	1.180	12.86	26.39	118.44	81.78	0.072
40	0.425	22.52	48.91	95.92	66.23	-0.372
70	0.212	39.32	88.23	56.60	39.08	-0.674
140	0.106	33.56	121.79	23.04	15.91	-0.975
200	0.075	10.41	132.20	12.63	8.72	-1.125
pan		12.63	144.83	0.00		

d10:	0.08 (mm)	d50:	0.29 (mm)
d16:	0.12 (mm)	d60:	0.38 (mm)
d30:	0.17 (mm)	d84:	1.4 (mm)

MEDIAN PARTICLE DIAMETER (d50): 0.29
UNIFORMITY COEFFICIENT, Cu (d60/d10): 4.8
COEFFICIENT OF CURVATURE, Cc,
[(d30)**2/(d10*d60)]: 0.95
MEAN PARTICLE DIAMETER, [(d16+d50+d84)/3]: 0.6

COMMENTS:

LABORATORY ANALYSIS PERFORMED BY: C. Pigman
CALCULATIONS MADE BY: K. Evans
CHECKED BY: D. Hammermeister



COBBLES	GRAVEL		SAND			SILT	CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE		

USCS PARTICLE SIZE LIMIT CLASSIFICATION

θ_i = 19.03%	d_{10} = 0.07	d_{50} = 0.12	d_{60} = 0.38	C_u = 4.8	C_c = 0.95

SAMPLE NUMBER	DEPTH	CLASSIFICATION (USCS Classification)
5-16A-42.5	42.5 Ft.	Well graded sand with silt.

SIEVE ANALYSIS DATA

JOB NAME: ENRON
JOB NUMBER: 89-034-L
TEST DATE: 9/27/90
SAMPLE NUMBER: 5-18A-60
DEPTH: 60.0 FT.

TOTAL WEIGHT OF SAMPLE: 96.53 (g)

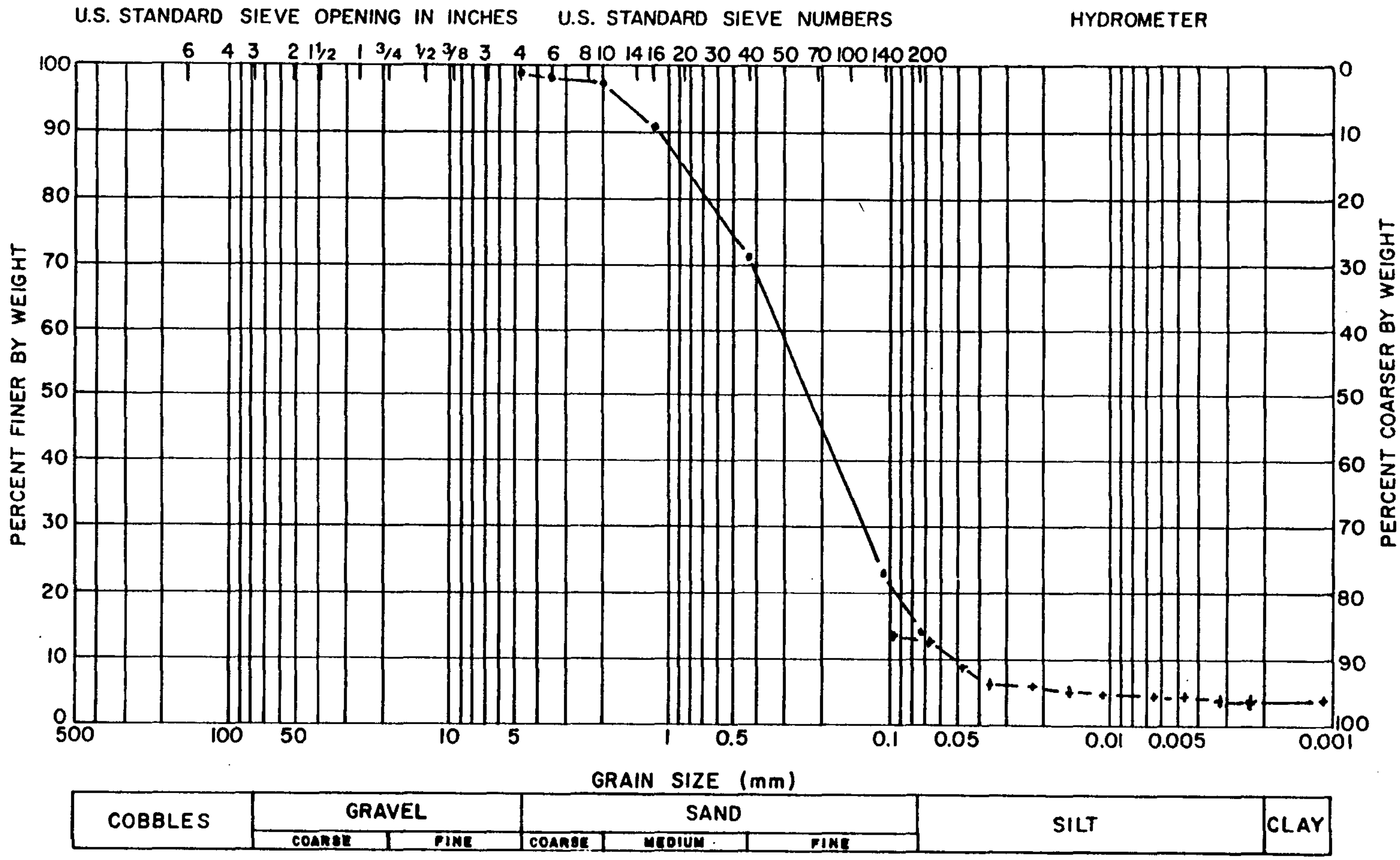
SIEVE NUMBER	DIAMETER (mm)	WT. RETAINED	CUM WT. RETAINED	WT. PASSING	% PASSING	LOG DIAMETER
4	4.750	1.40	1.40	95.13	98.55	0.677
6	3.350	0.30	1.70	94.83	98.24	0.525
10	2.000	0.81	2.51	94.02	97.40	0.301
16	1.180	6.74	9.25	87.28	90.42	0.072
40	0.425	18.64	27.89	68.64	71.11	-0.372
70	0.212	22.76	50.65	45.88	47.53	-0.674
140	0.106	23.84	74.49	22.04	22.83	-0.975
200	0.075	9.04	83.53	13.00	13.47	-1.125
pan		13.00	96.53	-0.00		

d10:	0.05 (mm)	d50:	0.23 (mm)
d16:	0.08 (mm)	d60:	0.31 (mm)
d30:	0.14 (mm)	d84:	0.9 (mm)

MEDIAN PARTICLE DIAMETER (d50): 0.23
UNIFORMITY COEFFICIENT, Cu (d60/d10): 6.2
COEFFICIENT OF CURVATURE, Cc, [(d30)**2/(d10*d60)]: 2.5
MEAN PARTICLE DIAMETER, [(d16+d50+d84)/3]: 0.4

COMMENTS:

LABORATORY ANALYSIS PERFORMED BY: C. Pigman
CALCULATIONS MADE BY: K. Evans
CHECKED BY: D. Hammermeister



USCS PARTICLE SIZE LIMIT CLASSIFICATION

θ_i = 29.36%	d_{10} = 0.051	d_{50} = 0.23	d_{60} = 0.31	C_u = 6.2	C_c = 2.5
SAMPLE NUMBER		DEPTH	CLASSIFICATION (USCS Classification)		
5-18A-60		60 Ft.	Silty Clayey Sand		

SIEVE ANALYSIS DATA

JOB NAME: ENRON
JOB NUMBER: 89-034-L
TEST DATE: 9/27/90
SAMPLE NUMBER: 5-19A-55
DEPTH: 55.0 FT.

TOTAL WEIGHT OF SAMPLE: 84.76 (g)

SIEVE NUMBER	DIAMETER (mm)	WT. RETAINED	CUM WT. RETAINED	WT. PASSING	% PASSING	LOG DIAMETER
4	4.750	0.65	0.65	84.11	99.23	0.677
6	3.350	0.18	0.83	83.93	99.02	0.525
10	2.000	0.46	1.29	83.47	98.48	0.301
16	1.180	2.44	3.73	81.03	95.60	0.072
40	0.425	15.62	19.35	65.41	77.17	-0.372
70	0.212	19.22	38.57	46.19	54.50	-0.674
140	0.106	25.61	64.18	20.58	24.28	-0.975
200	0.075	8.42	72.60	12.16	14.35	-1.125
pan		12.16	84.76	0.00		

d10:	-- (mm)	d50:	0.19 (mm)
d16:	0.08 (mm)	d60:	0.27 (mm)
d30:	0.14 (mm)	d84:	0.7 (mm)

MEDIAN PARTICLE DIAMETER (d50): 0.19
UNIFORMITY COEFFICIENT, Cu (d60/d10): --
COEFFICIENT OF CURVATURE, Cc,
[(d30)**2/(d10*d60)]: --
MEAN PARTICLE DIAMETER, [(d16+d50+d84)/3]: 0.3

COMMENTS:

LABORATORY ANALYSIS PERFORMED BY: C. Pigman
CALCULATIONS MADE BY: K. Evans
CHECKED BY: D. Hammermeister

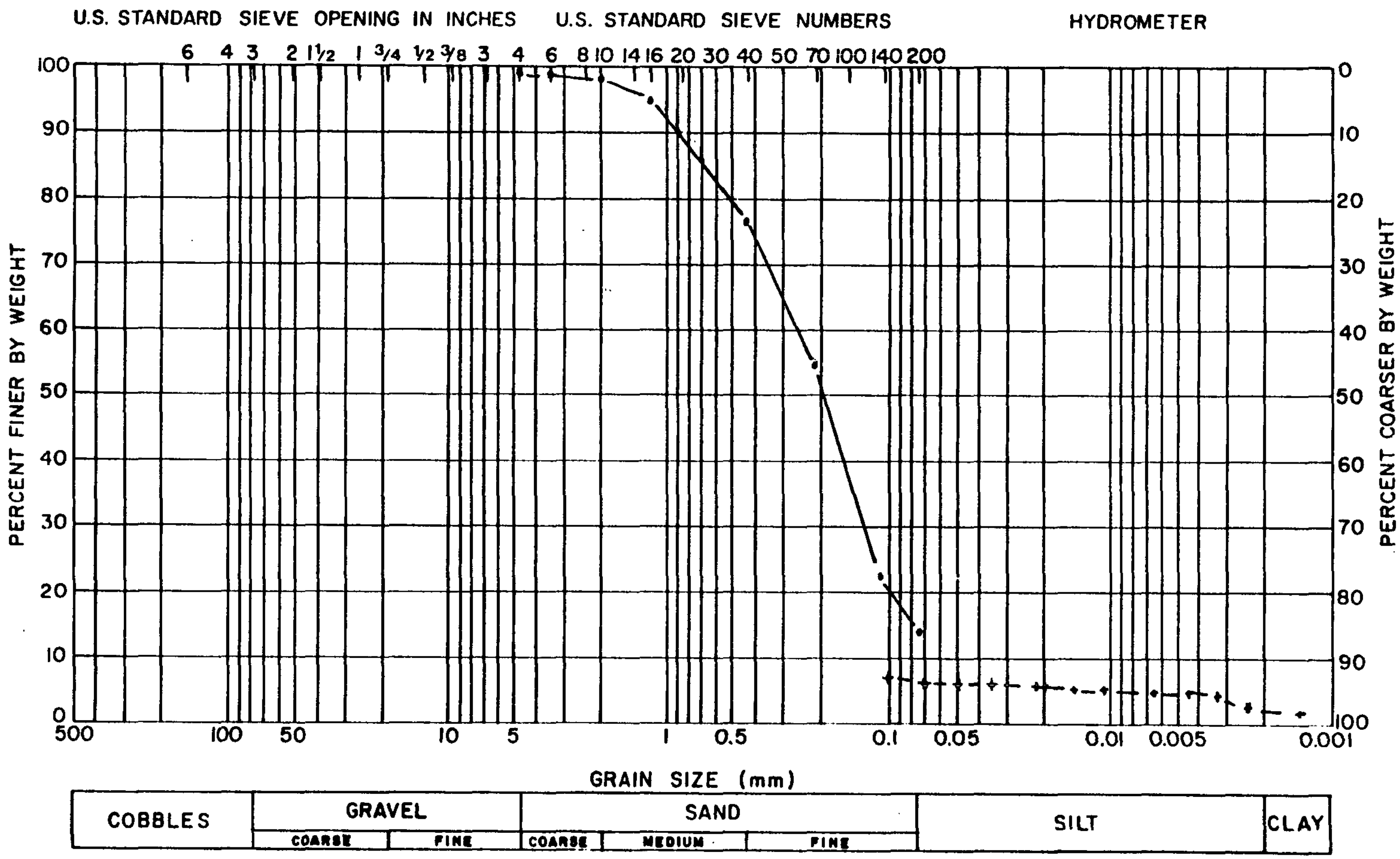
HYDROMETER DATA

JOB NAME:	ENRON	TEST DATE:	9/28/90
JOB NUMBER:	89-034-L	DEPTH:	55.00 FT.
SAMPLE NUMBER:	5-19A-55	INITIAL WT:	12.07 (g)
TYPE OF WATER USED:	DISTILLED	TOTAL SAMPLE WT:	84.76 (g)
REACTION WITH H2O2:	MODERATE	TOTAL WT PASSING #200:	12.16 (g)
DISPERSANT:	(NaPO3)6	START TIME:	9:52

DATE (1990)	TIME (MIN)	TEMP (C)	R (g/l)	Rl (g/l)	Rcorr (g/l)	L (CM)	D (MM)	P (%)	%FINER
10/01	0.25	22.5	12.5	5.5	7.0	14.3	0.10034	57.99503	8.32019
	0.50	22.5	12.0	5.5	6.5	14.3	0.07116	53.85253	7.72589
	1.00	22.5	11.5	5.5	6.0	14.4	0.05046	49.71002	7.13159
	2.00	22.5	11.5	5.5	6.0	14.4	0.03568	49.71002	7.13159
	5.00	23.0	11.5	6.0	5.5	14.4	0.02243	45.56752	6.53729
	10.00	23.0	11.0	6.0	5.0	14.5	0.01591	41.42502	5.94299
	20.00	23.0	11.0	6.0	5.0	14.5	0.01125	41.42502	5.94299
	60.00	23.0	10.0	5.5	4.5	14.7	0.00653	37.28252	5.34870
	120.00	23.0	10.0	5.5	4.5	14.7	0.00462	37.28252	5.34870
	240.00	22.0	9.5	6.0	3.5	14.7	0.00331	28.99751	4.16010
	459.00	22.0	9.0	6.0	3.0	14.8	0.00240	24.85501	3.56580
10/02	1492.00	22.0	9.0	5.0	4.0	14.8	0.00133	33.14002	4.75440
								0.00000	0.00000

COMMENTS: Assume mean particle density is 2.65 g/cc

LABORATORY ANALYSIS PERFORMED BY: R. Hill
CALCULATIONS MADE BY: R. Hill
CHECKED BY: D. Hammermeister



USCS PARTICLE SIZE LIMIT CLASSIFICATION

Θ_i = 42.24%	d_{10} = --	d_{50} = 0.19	d_{60} = 0.27	C_u = --	C_c = --
SAMPLE NUMBER		DEPTH	CLASSIFICATION (USCS Classification)		
5-19A-55		55 Ft.	Silty Clayey Sand		

APPENDIX F

LABORATORY METHODS

SUMMARY OF LABORATORY METHODS

Methods	Reference
Moisture Content	ASTM D 2216-80
Bulk Density	MOSA*, 1986, chp. 13, pp. 363-367
Porosity	MOSA*, 1986, chp. 18, pp. 444-445
Saturated Hydraulic Conductivity	
Constant Head	ASTM D 2434-68
Falling Head	MOSA*, 1986, chp. 28, pp. 700-703
Moisture Retention Characteristics	
Hanging Column	MOSA*, 1986, chp. 26, pp. 637-639
Pressure Plate Extractor	ASTM D 2325-68
Unsaturated Hydraulic Conductivity	Van Genuchten, M., 1980, "A Closed Form Equation for Predicting the Hydraulic Conductivity of Unsaturated Soils." Soil Sci. Soc. Am. J., V. 44, pp. 892-898.
Particle Size Characteristics	
Sieve	ASTM D 422-63 (72)
Hydrometer	ASTM D 422-63 (72)

* Methods of Soil Analysis, Part 1, A. Klute ed., American Society of Agronomy, Madison, WI.

APPENDIX D

STANDARD OPERATING PROCEDURE
FOR WATER SAMPLING OF MONITOR WELLS
AT TRANSWESTERN PIPELINE CO.
COMPRESSOR STATION NO. 5
THOREAU, NM

DANIEL B. STEPHENS & ASSOCIATES, INC.

ENVIRONMENTAL SCIENTISTS AND ENGINEERS

STANDARD OPERATING PROCEDURE

FOR

WATER SAMPLING OF OFF-SITE WELLS AT

THOREAU, NEW MEXICO

DISK: SOP IV (1991)
FILE: ENRON\ENRONSOP.591

1. PURPOSE

The intent of this Standard Operating Procedure (SOP) is to provide technical guidance to Daniel B. Stephens & Associates, Inc. (DBS&A) field personnel for the collection and handling of water quality samples from off-site wells at Thoreau, New Mexico. This document contains specific guidelines for:

1) Sampling equipment cleaning, preparation, and handling
2) Well and well-head preparation
3) Sample collection
4) Sample preservation, handling, and shipping
5) Quality control/quality assurance
6) Chain of custody procedure

2. DUTIES AND RESPONSIBILITIES

It is the direct responsibility of the DBS&A project manager to ensure that all requirements and procedures contained in this SOP are followed during the field program. In addition, the DBS&A project manager shall provide all DBS&A field personnel with copies of this SOP, which they are required to read and keep available at all times during the field work.

Project Manager/Health & Safety Officer
Staff Hydrologist
Staff Hydrologist
Staff Geologist

2.1 Project Manager

The project manager is responsible for the completion of all field activities as specified in this SOP. The project manager shall monitor daily manpower requirements and expenditures, and shall be responsible for compliance to preliminary budget estimates. The project manager shall approve and be responsible for the development and implementation of subcontractor contracts, work agreements, work plans, SOP's, and health and safety plans. The project managers shall be responsible for operational decisions necessary to implement the work plan, SOP's, and health and safety plan.

2.2 Health and Safety Officer

The health and safety officer shall be responsible for strict adherence to the site and project specific health and safety plan (H&S). The health and safety officer or the appointed health and safety facilitator will monitor on site health and safety issues, advise field personnel and subcontractors of site specific health and safety concerns, conduct daily tailgate health and safety meetings if appropriate, conduct the initial team health and safety briefing, and shall report directly to the project manager.

2.3 Staff Hydrologist/Engineer/Geologist

The staff hydrologist/engineer shall be responsible for executing the assigned tasks according to the procedures and techniques outlined in the work plan, the health and safety plan, and this SOP. The staff hydrologist shall read each of the above plans, and shall be familiar with the material contained therein; the staff hydrologist is responsible for the safe and timely completion of all assigned tasks.

3. EQUIPMENT PREPARATION

Care will be taken to ensure that all field equipment is clean and in proper operating condition prior to departure for the field. This requires that each piece of equipment be inspected, cleaned, calibrated, and bench-tested in the DBS&A soil-water laboratory at least three days prior to the start of field activities. Any deficiencies will be reported immediately to the project manager.

Table 1 lists the equipment that shall be taken to the site.

3.1 Sampling Equipment Cleaning

3.1.1 Ground-Water Sampling Equipment

All sampling equipment that may come in direct contact with surface or ground water shall be cleaned prior to each use in order to reduce the possibility of introducing contaminants into the water or sample. The cleaning method used shall be 1) appropriate for the type of analysis to be performed on the sample, or, 2) according to the location of the well or sampling site with respect to areas of known contamination, or, 3) according to the type of sampling equipment used, or, 4) according to the presence or absence of free product within the well.

For wells or surface waters to be sampled for inorganics and/or metals, or locations outside of the area of known contamination, the following procedures shall be used:

I) Wash the equipment in non-phosphate detergent (Liquinox) and tap water. All surfaces that may come in direct contact with surface or water are to be washed. A clean Nalgene tub will be used to contain the wash solution. Latex gloves will be worn during the entire washing and rinsing process.

II) The first rinse shall be dilute (0.1 N) hydrochloric acid

III) The final rinse shall be distilled/deionized water

IV) The equipment will be dried before use, to the extent practical.

Care shall be taken to ensure that clean sampling equipment does not contact the ground or any other potentially contaminated surface. All wash and rinse water from potentially contaminated equipment shall be contained on site in approved sealed and labeled 55 gallon drums, pending the results of analytical testing. The wash and rinse water will be changed frequently; wash and rinse water will be changed after each use when cleaning obviously contaminated equipment. Latex gloves will be worn for each cleaning event, or more frequently, as conditions require.

All cleaned equipment shall be stored in clean, labeled boxes. In addition any equipment that may come in direct contact with ground water or water quality samples shall be wrapped in clean, aluminum foil or inert plastic.

TABLE 1. FIELD EQUIPMENT

	Sample Bottles
24	Aqueous PNA
24	Aqueous VOA
12	Aqueous Inorganics
12	Dissolved Metals
5	VOA Trip Blanks
	Field Equipment (as needed)
3	Coolers
1	3-ft Teflon bailer with bottom emptying, VOA sampling device
1	Bailer tripod
1	Bailer reel
150 ft	Teflon coated bailer cord or natural twine
1	QED pump controller/driver with fittings
18	Sample pro filters
10	Hand filters with hand pump
1	Conductivity meter
1	pH/MV meter
1	D.O/Temp meter
5	Rolls of paper towels
5	Rolls of bubble wrap
1	Roll of duct tape
1	Roll of strapping tape
2	Rolls of package tape
1	Truck tool kit
1	M-Scope
1	Power electric well rounder
1	Steel tape for clean wells
4	Carpenter chalk
1	Miscellaneous equipment kit
1	Hand held depth-integrated sampler
1	Current meter
	Personal Protection
24	Tyvek suits
36 pr	Tyvek boot covers
2	North medium respirators

10 Organic vapor cartridges
10 Dust/Mists pre-filters
200 pr Latex gloves

Personal Protection (continued)

2 pr Neoprene gloves
2 pr Leather gloves
2 pr Safety goggles
1 doz Disposable ear plugs
3 Hard hats
2 pr Steel toed boots
2 pr Steel toed swamp boots

Decontamination Equipment (as needed)

2 Plastic cleaning trays
1 32-gallon plastic pail
2 2-gallon plastic buckets
2 6-gallon plastic water jugs
1 Nalgene dish pan
1 Plastic dish pan
1 Roll Plastic sheeting
1 Tarp
1 Roll 24" aluminum foil
1 gal Liquinox
10 Packets of Alconox
50 gal Distilled/Deionized water

Forms

1 Field log book
10 Chain of Custody Forms (Organics)
10 Chain of Custody Forms (Inorganics)
10 Chain of Custody Seals
Airbills
Sample labels

3.2 Equipment Calibration and Testing

All equipment shall be calibrated and bench-tested prior to departure for the field. The following equipment shall be calibrated, adjusted, and tested according to manufacturers instructions (enclosed in the individual equipment cases):

- pH/MV Meter
- Temperature Meter
- Conductivity Meter
- Pump Controller/driver

All calibration and bench-testing shall be documented, in addition to the initial calibration and bench-testing, all meters shall be inspected daily for operation and calibration. All equipment shall be cleaned after each day of use, or more often, as necessary.

4. GROUND-WATER SAMPLING

4.1 Well and Wellhead Preparation

Prior to ground-water sample collection, the following shall be conducted:

I) The area around the wellhead shall be inspected for integrity, cleanliness, and signs of possible contamination

II) A clean plastic sheet shall be spread over the ground around the wellhead, where required.

III) The cap on the wellhead shall be removed if possible. Any obvious odors within the wellbore should be noted.

IV) Where possible, the static water level shall be measured to the nearest 0.01 foot using a chalked steel tape, or an appropriate water level sounder. The presence of any contamination on the tape after use in order to prevent cross contamination.

V) If a floating product is suspected at the site a bailer shall be used to extract a sample from the surface of the water within the well wherever possible. After an initial visual inspection, the fluid from the bailer shall be slowly poured into a small tub or container in order to check for a sheen or any other sign of free product. Any obvious odors shall be also noted. If free product is detected, the bailer shall be used to remove as much free product as is possible from the wellbore. Whenever a bailer is used within the wellbore, it shall be lowered into the water slowly in order to prevent degassing. All recovered product shall be contained for proper disposal. After any free product has been removed from the wellbore, a fresh plastic sheet shall be emplaced around the wellhead, and all contaminated equipment shall be cleaned, or segregated from the clean equipment.

VI) The well shall be purged at a flow rate equal to, or greater than the sampling rate. The following field parameters: temperature, pH, MV, conductivity, and dissolved oxygen concentration, shall be measured at the pump outlet and within a clean container every 0.5 casing volume pumped, or more frequently. Purging shall be considered complete when the above parameters are approximately stable over at least one casing volume. However, wherever possible, a minimum of three (3) casing volumes shall be purged from each well. All fluid from obviously contaminated wells shall be contained for later disposal; anomalous values for the above field parameters, odor, visible sheen, or the presence of free product may be taken as signs of contamination.

Careful notes shall be taken during all of the above activities in order to document all pertinent conditions during the sampling event.

4.2 Ground-Water Sample Collection

Depending on the individual situation and the location of the sampling point (e.g.: outside hose bib, inside water faucet, or port at well head) it may be necessary to clean the sampling port prior to sample collection. At minimum, cleaning of the sampling port should be accomplished by allowing the faucet/hose bib/sampling port to run for at least 15 minutes prior to collection of sample, regardless of the condition of the sampling port.

Once the well has been sufficiently purged, and the sampling point has been cleaned, the water quality samples shall be collected. The samples should be collected as soon as is possible after purging is complete in order to reduce the possibility of volatilization within the wellbore. Under no circumstance should the well be allowed to stand for more than three hours between purging, sample point cleaning, and sample withdrawal.

Samples shall be collected in decreasing order of volatility; volatile organics samples shall be collected first. The pumping rate during sample collection should never equal or exceed the rate at which the well was purged, or, as specified for each suite of analyses. Samples shall be collected only in approved containers, according to the analysis to be performed.

Samples for volatile organics analysis EPA 624 shall be collected in pre-cooled, pre-acidified, certified-clean, 40 ml, borosilicate vials with teflon septa supplied by the analytical laboratory. Whenever possible, the pumping rate during collection shall be maintained at less than 100 ml per minute. The water stream shall be directed against the inside surface of the vial. A convex meniscus should be allowed to form across the mouth of the filled vial. The outlet of the sampling pump discharge tubing should never be allowed to come into direct contact with the sample vial or the water within the vial. The vial should then be carefully capped and checked for bubbles before being wrapped and placed into the cooler. If air bubbles are present, the vial shall not be reused and the entire procedure repeated.

Samples to be analyzed for PCB (via EPA Method 608) shall be collected in pre-cooled, certified-clean, 1 liter, narrow-mouth, glass bottles with teflon-lined cap. The flow rate shall not exceed that used during well purging. The outlet of the sampling pump discharge tubing shall not contact the sample bottle or the water within the sample bottle. The bottle shall be filled to approximately full by directing the sample stream down the inside surface to the bottle. The bottle shall be capped immediately after sample collection.

Samples to be analyzed for major ions/inorganics shall be collected in pre-cooled, clean, 1 liter, plastic bottles or cubitainers. The procedures to be followed during sampling shall be as listed above for polynuclear aromatic hydrocarbons. Samples to be analyzed for metals shall also be collected according to the above procedures, however, whenever possible the water sample shall be pressure filtered through a clean 0.45 micron filter, and the sample shall be acidified to a pH of <2 with nitric acid immediately upon collection.

After all water quality samples have been collected, the field parameters shall be measured for a final time, wherever possible, in order to ensure that samples are representative of the aquifer water. If the field parameters are significantly different from the pre-sampling measurement, then the well shall be repurged until the field parameters stabilize, and new samples shall be collected.

All full sample bottles and vials shall be wrapped and placed immediately in a cooler. The cooler shall be kept at 4°C by placing at least 8 pounds of cube ice within leak-proof plastic baggies in the cooler. The bags of ice shall be placed in close contact to the sample bottles and vials; both on the side of, and on top of, the bottle and vials. Sampling bottles and vials shall be protected from direct sunlight during and after sample collection. Full coolers shall be sealed with strapping tape, and mailed VIA Federal Express to the analytical laboratory. Coolers shall be mailed within 24 hours of collection; sooner if possible.

5. QUALITY ASSURANCE/QUALITY CONTROL

The key elements in the quality assurance/quality control (QA/QC) program are sample splits, replicates, blanks, spikes, and fictitious samples.

Table 2 lists the types and frequency of QA/QC samples.

TABLE 2. SAMPLE TYPE, DESCRIPTION, FREQUENCY OF COLLECTION

Sample Type	Description	Frequency of Collection
Aqueous Primary	Primary water quality sample.	Each well/sampling point
Replicate	Replicate to be collected at the same time as the Primary sample. To be labeled "Replicate."	Every 10th primary
Trip Blank	Distilled/deionized water.	One per cooler (VOA only)
Aqueous Equipment Blank	Distilled/deionized water to be run through field-cleaned sampling equipment.	When needed
Fictitious Sample	Replicate sample labeled with fictitious sample name.	Every 20th primary
Split	Replicate sample sent to different lab.	Every 20th primary
Spike	Blank prepared with known concentration of desired analyate.	Every 20th primary

6. CHAIN OF CUSTODY

The chain of custody program shall include the following elements:

I) Standardized sample labels, as provided by the analytical laboratory. Information to include: sample name/ID number, project ID number, parameters to analyzed for, date and time of sample collection, and collectors name. The labels are to be permanently affixed to each bottle and vial, and shall be filled out prior to sample collection.

II) Cooler seal. A chain of custody seal shall be placed across the gap between the cooler body and the lid in order to ensure that the samples have not been tampered with during transit. Each cooler seal shall be dated and initialed by the collector.

III) Field Logbook

A field logbook shall be maintained which includes entries on:

- Date and time of each activity
- Well ID
- Well depth
- Depth to water and measurement method
- Presence of free product
- Total purged volume
- Well purging method
- Purge pumping rate
- Approximate well yield
- Duration of purge pumping
- Sample collection and pumping method
- Sequence of sample collection
- Surface water sample locations
- Sample ID numbers
- Analyses requested
- Preservatives and sample containers used
- Field personnel involved in sample collection
- Field parameters
- Shipper and Shipping date/time
- Calibration and testing of equipment
- Field observations
- Weather conditions

IV) Chain of custody record. A chain of custody form shall be used.

7. REVISIONS TO THIS SOP

The methods and procedures contained within this SOP are to be followed rigorously by DBS&A field personnel during the field program. Any deviation from the guidelines contained herein shall not be allowed unless authorized in writing by the project manager. All such deviations shall be thoroughly documented by the project manager, who has ultimate responsibility for any variance from this SOP. Such documentation shall include reference to the procedure to be revised, a description of the revised procedure, reason for the revision, anticipated effects of the revision (especially with respect to the QA/QC program), personnel involved in the procedure, and the date and time of implementation of the revised procedure.

8. FIELD TEAM BRIEFINGS

Prior to departure to the field, the DBS&A field team shall meet to discuss the objectives and methods of the field program. The work plan, this SOP, and the health and safety plan shall be discussed in detail by the project manager during the briefing. All of the above plans and SOP's shall have been reviewed by the team members prior to the meeting; all aspects of the field program shall be familiar to all members of the team. In addition to the initial briefing, daily team meetings shall be conducted by the project hydrologist in conjunction with the tailgate health and safety meetings, in order to allow discussion on the anticipated activities of the day.

9. ACKNOWLEDGEMENT

The undersigned have read this SOP and shall adhere to the methods and procedures described therein:

Name	Title	Date

APPENDIX E

RESULTS OF CHEMICAL ANALYSES ON GEOLOGIC SAMPLES

Table E.1
Summary of Results of Chemical Analyses (EPA Method 8020/8080)
on Geologic Samples from different depths in Monitor Well 5-9SB

Date: June 25, 1990
Laboratory: ENSECO, Rocky Mountain
Lab ID: 010068

Parameter	Reporting Limit (ug/kg)	Concentration (ug/kg)									
		0 Feet	5 Feet	10 Feet	15 Feet	20 Feet	25 Feet	30 Feet	35 Feet	40 Feet	45 Feet
Benzene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	50	100	ND	53	ND	ND	ND	ND	ND	ND	80
Chlorobenzene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes (total)	100	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1016	80	ND	ND	ND	ND						
Aroclor 1221	80	ND	ND	ND	ND						
Aroclor 1232	80	ND	ND	ND	ND						
Aroclor 1242	80	ND	ND	ND	ND						
Aroclor 1248	80	250000	ND	ND	ND						
Aroclor 1254	160	ND	ND	ND	ND						
Aroclor 1260	160	ND	ND	ND	ND						

ND = Not Detected

Table E.2
Summary of Results of Chemical Analyses (EPA Method 8080)
on Geologic Samples from different depths in Soil Boring 5-10SB

Date: July 26, 1990
Laboratory: ENSECO, Houston
Lab ID: 010091

Parameter	Reporting Limit (ug/kg)	Concentration (ug/l)							
		0 Feet	5 Feet	10 Feet	20 Feet	25 Feet	30 Feet	35 Feet	40 Feet
Benzene	50	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	50	98	ND	ND	ND	ND	ND	ND	ND
Chlorobenzene	50	ND	ND	ND	ND	ND	ND	ND	ND
Ethylbenzene	50	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes (total)	100	ND	ND	ND	ND	ND	ND	ND	ND
1,3-Dichlorobenzene	50	ND	ND	ND	ND	ND	ND	ND	ND
1,4-Dichlorobenzene	50	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichlorobenzene	50	ND	ND	ND	ND	ND	ND	ND	ND
PCB **	0.1	9510	130	120	100	ND	2040	ND	1210

ND = Not detected
** Analyzed by Transwestern Pipeline Company

Table E.3
Summary of Results of Chemical Analyses (EPA Method 8240)
on Geologic Samples from different depths in Soil Boring 5-11SB

Date: July 17, 1990
Laboratory: ENSECO, Houston
Lab ID: 010291

Parameter	Reporting Limit (ug/kg) 0-20 ft	Reporting Limit (ug/kg) 25 ft	Concentration (ug/kg)					
			0 Feet	5 Feet	10 Feet	15 Feet	20 Feet	25 Feet
Chloromethane	1000	5000	ND	ND	ND	ND	ND	ND
Bromomethane	1000	5000	ND	ND	ND	ND	ND	ND
Vinyl chloride	1000	5000	ND	ND	ND	ND	ND	ND
Chloroethane	1000	5000	ND	ND	ND	ND	ND	ND
Methylene chloride	500	2500	ND	ND	ND	ND	ND	ND
Acetone	1000	5000	ND	ND	ND	ND	ND	ND
Carbon disulfide	500	2500	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	500	2500	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	500	2500	ND	ND	ND	ND	ND	ND
1,2-Dichloroethene (cis/trans)	500	2500	ND	ND	ND	ND	ND	ND
Chloroform	500	2500	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	500	2500	ND	ND	ND	ND	ND	ND
2-Butanone	1000	5000	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	500	2500	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	500	2500	ND	ND	ND	ND	ND	ND
Vinyl acetate	1000	5000	ND	ND	ND	ND	ND	ND
Bromodichloromethane	500	2500	ND	ND	ND	ND	ND	ND
1,2-Dichloropropane	500	2500	ND	ND	ND	ND	ND	ND
cis-1,3-Dichloropropene	500	2500	ND	ND	ND	ND	ND	ND
Trichloroethene	500	2500	ND	ND	ND	ND	ND	ND
Dibromochloromethane	500	2500	ND	ND	ND	ND	ND	ND
1,1,2-Trichloroethane	500	2500	ND	ND	ND	ND	ND	ND
Benzene	500	2500	ND	ND	ND	ND	ND	ND
trans-1,3-Dichloropropene	500	2500	ND	ND	ND	ND	ND	ND

Table E.3
Summary of Results of Chemical Analyses (EPA Method 8240)
on Geologic Samples from different depths in Soil Boring 5-11SB

Date: July 17, 1990
Laboratory: ENSECO, Houston
Lab ID: 010291

Parameter	Reporting Limit (ug/kg) 0-20 ft	Reporting Limit (ug/kg) 25 ft	Concentration (ug/kg)					
			0 Feet	5 Feet	10 Feet	15 Feet	20 Feet	25 Feet
2-Choloroethyl vinyl ether	1000	5000	ND	ND	ND	ND	ND	ND
Bromoform	500	2500	ND	ND	ND	ND	ND	ND
4-Methyl-2-pentanone	1000	5000	ND	ND	ND	ND	ND	ND
2-Hexanone	1000	5000	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	500	2500	ND	ND	ND	ND	ND	ND
Tetrachloroethene	500	2500	ND	ND	ND	ND	ND	ND
Toluene	500	2500	ND	ND	ND	ND	ND	570
Cholorobenzene	500	2500	ND	ND	ND	ND	ND	ND
Ethylbenzene	500	2500	ND	ND	ND	ND	ND	ND
Styrene	500	2500	ND	ND	ND	ND	ND	ND
Xylenes (total)	500	2500	ND	ND	ND	ND	ND	2500

ND = Not detected

Table E.3.1
Summary of Results of Chemical Analyses (EPA Method 8080)
on Geologic Samples from different depths in Soil Boring 5-11SB

Date: July 15, 1990
Laboratory: ENSECO, Rocky Mountain
Lab ID: 010291

Parameter	Reporting Limit (ug/kg)	Concentration (ug/kg)					
		0 Feet	5 Feet	10 Feet	15 Feet	20 Feet	25 Feet
Alpha-BHC	8000	ND	ND	ND	ND	ND	ND
Beta-BHC	8000	ND	ND	ND	ND	ND	ND
Delta-BHC	8000	ND	ND	ND	ND	ND	ND
Gamma-BHC (Lindane)	8000	ND	ND	ND	ND	ND	ND
Heptachlor	8000	ND	ND	ND	ND	ND	ND
Aldrin	8000	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	8000	ND	ND	ND	ND	ND	ND
Endlsulfan I	8000	ND	ND	ND	ND	ND	ND
Dieldrin	16000	ND	ND	ND	ND	ND	ND
4,4'-DDE	16000	ND	ND	ND	ND	ND	ND
Endrin	16000	ND	ND	ND	ND	ND	ND
Endolulan II	16000	ND	ND	ND	ND	ND	ND
4,4'-DDD	16000	ND	ND	ND	ND	ND	ND
Endosulfan sulfate	16000	ND	ND	ND	ND	ND	ND
4-4'-DDT	16000	ND	ND	ND	ND	ND	ND
Endrin ketone	16000	ND	ND	ND	ND	ND	ND
Methoxychlor	80000	ND	ND	ND	ND	ND	ND
Chlordane	80000	ND	ND	ND	ND	ND	ND
Toxaphene	16000	ND	ND	ND	ND	ND	ND

Table E.3.1
Summary of Results of Chemical Analyses (EPA Method 8080)
on Geologic Samples from different depths in Soil Boring 5-11SB

Date: July 15, 1990
Laboratory: ENSECO, Rocky Mountain
Lab ID: 010291

Parameter	Reporting Limit (ug/kg)	Concentration (ug/kg)					
		0 Feet	5 Feet	10 Feet	15 Feet	20 Feet	25 Feet
Aroclor 1016	80000	ND	ND	ND	ND	ND	ND
Aroclor 1221	80000	ND	ND	ND	ND	ND	ND
Aroclor 1232	80000	ND	ND	ND	ND	ND	ND
Aroclor 1242	80000	260000	320000	ND	ND	ND	1200000
Aroclor 1248	80000	ND	ND	ND	ND	ND	ND
Aroclor 1254	1600000	ND	ND	ND	ND	ND	ND
Aroclor 1260	1600000	ND	ND	ND	ND	ND	ND

ND = Not detected

Table E.4
Summary of Results of Chemical Analyses of Geologic Samples from Monitor Wells 5-12B, 5-13B and 5-15B

Date: June, 1990
Laboratory: Transwestern Pipeline Company

Well Name	Depth ft	Analytes	Reporting Limit (mg/kg)	Concentration (mg/kg)
5-13B	5	PCB	<.1	<.10
5-13B	74	PCB	<.1	.26
5-12B	5	PCB	<.1	.18
5-12B	60	PCB	<.1	.101
5-12B	65	PCB	<.1	.61
5-15B	5	PCB	<.1	.15
5-15B	63	PCB	<.1	1.02

Table E.5
Summary of Results of Chemical Analyses (EPA Method 8010/8020)
for Geologic Samples from Monitor Wells 5-16A and 5-17B

Date: July 16, 1990
Laboratory: Assaigai Analytical Laboratories
Lab ID: 3296

Parameter	Reporting Limit (mg/kg)	Concentration (mg/kg) 5-16A-63.5	5-17B-58
Bromoform	0.1	<0.1	<0.1
Bromodichloromethane	0.1	<0.1	<0.1
Bromomethane	0.1	<0.1	<0.1
Carbon Tetrachloride	0.1	<0.1	<0.1
Chlorobenzene	0.1	<0.1	<0.1
Chloroethane	0.1	<0.1	<0.1
2-Chloroethylvinyl ether	0.1	<0.1	<0.1
Chloroform	0.1	<0.1	<0.1
Chloromethane	0.1	<0.1	<0.1
Dibromochloromethane	0.1	<0.1	<0.1
1,2-Dichlorobenzene	0.1	<0.1	<0.1
1,3-Dichlorobenzene	0.1	<0.1	<0.1
1,4-Dichlorobenzene	0.1	<0.1	<0.1
Dichlorodifluoromethane	0.1	<0.1	<0.1
1,1-Dichloroethane	0.1	<0.1	<0.1
1,2-Dichloroethane	0.1	<0.1	<0.1
1,1-Dichloroethene	0.1	<0.1	<0.1
Trans-1,2-dichloroethene	0.1	<0.1	<0.1
Dichloromethane	0.1	<0.1	<0.1
1,2-Dichloropropane	0.1	<0.1	<0.1
Cis-1,3-dichloropropene	0.1	<0.1	<0.1
Trans-1,3-dichloropropene	0.1	<0.1	<0.1
1,1,2,2-Tetrachloroethane	0.1	<0.1	<0.1
Tetrachloroethene	0.1	<0.1	<0.1
1,1,1-Trichloroethane	0.1	<0.1	<0.1
1,1,2-Trichloroethane	0.1	<0.1	<0.1
Trichloroethene	0.1	<0.1	<0.1
Trichlorofluoromethane	0.1	<0.1	<0.1
Vinyl Chloride	0.1	<0.1	<0.1
Benzene	0.1	<0.1	<0.1
Toluene	0.1	<0.1	<0.1
Ethylbenzene	0.1	<0.1	<0.1

Table E.8
Summary of Results of Chemical Analyses on Geologic
(EPA Method 8220) on Samples from 5-21A at 26 ft.

Date: Oct. 2, 1990
Laboratory: ABB Environmental
Lab ID: Y009GP

Parameter	Reporting Limits (ug/kg)	Concentration (ug/kg)
Dimethyl phthalate	540	ND
4,6-Dinitro-2-methylphenol	540	ND
2,4-Dinitrophenol	540	ND
2,4-dinitrotoluene	540	ND
2,6-Dinitrotoluene	540	ND
Di-n-octyl phthalate	540	ND
Fluoranthene	540	ND
Fluorene	540	ND
Hexachlorobenzene	540	ND
Hexachlorobutadiene	540	ND
Hexachlorocyclopentadiene	540	ND
Hexachloroethane	540	ND
Indeno (1,2,3-cd) pyrene	540	ND
Isophorone	540	ND
2-Methylnaphthalene	540	3020
2-Methylphenol	540	ND
4-Methylphenol	540	ND
Napthhalene	540	1610
2-Nitroaniline	540	ND
3-Nitroaniline	540	ND
4-Nitroanaline	540	ND
Nitrobenzene	540	ND
2-Nitrophenol	540	ND
4-Nitrophenol	540	ND
n-Nitrosodiphenylamine**	540	ND
n-Nitrosodipropylamine	540	ND
Pentachlorophenol	540	ND
Phenanthrene	540	ND
Phenol	540	ND
Pyrene	540	ND

Table E.6
Summary of Results of Chemical Analyses (EPA Method 8010/8020) on Geological Samples from Monitor Wells 5-16B, 5-18B, 5-19B and 5-20B

Date: July 19, 1990
Laboratory: Assaigai Analytical Laboratories
Lab ID: 3301

Parameter	Reporting Limit (ug/g)	Concentration (ug/g) 5-16B-64	5-18B-60	5-19B-50	5-20B-60
Bromoform	0.1	<0.1	<0.1	<0.1	<0.1
Bromodichloromethane	0.1	<0.1	<0.1	<0.1	<0.1
Bromomethane	0.1	<0.1	<0.1	<0.1	<0.1
Carbon Tetrachloride	0.1	<0.1	<0.1	<0.1	<0.1
Chlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1
Chloroethane	0.1	<0.1	<0.1	<0.1	<0.1
2-Chloroethylvinyl ether	0.1	<0.1	<0.1	<0.1	<0.1
Chloroform	0.1	<0.1	<0.1	<0.1	<0.1
Chloromethane	0.1	<0.1	<0.1	<0.1	<0.1
Dibromochloromethane	0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1
1,3-Dichlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1
1,4-Dichlorobenzene	0.1	<0.1	<0.1	<0.1	<0.1
Dichlorodifluoromethane	0.1	<0.1	<0.1	<0.1	<0.1
1,1-Dichloroethane	0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichloroethane	0.1	<0.1	<0.1	<0.1	<0.1
1,1-Dichloroethene	0.1	<0.1	<0.1	<0.1	<0.1
Trans-1,2-dichloroethene	0.1	<0.1	<0.1	<0.1	<0.1

Table E.6
Summary of Results of Chemical Analyses (EPA Method 8010/8020) on Geological Samples from Monitor Wells 5-16B, 5-18B, 5-19B and 5-20B

Date: July 19, 1990
Laboratory: Assaigai Analytical Laboratories
Lab ID: 3301

Parameter	Reporting Limit (ug/g)	Concentration (ug/g)			
		5-16B-64	5-18B-60	5-19B-50	5-20B-60
Dichloromethane	0.1	<0.1	<0.1	<0.1	<0.1
1,2-Dichloropropane	0.1	<0.1	<0.1	<0.1	<0.1
Cis-1,3-dichloropropene	0.1	<0.1	<0.1	<0.1	<0.1
Trans-1,3-dichloropropene	0.1	<0.1	<0.1	<0.1	<0.1
1,1,2,2-Tetrachloroethane	0.1	<0.1	<0.1	<0.1	<0.1
Tetrachloroethene	0.1	<0.1	<0.1	<0.1	<0.1
1,1,1-Trichloroethane	0.1	<0.1	<0.1	<0.1	<0.1
1,1,2-Trichloroethane	0.1	<0.1	<0.1	<0.1	<0.1
Trichloroethene	0.1	<0.1	<0.1	<0.1	<0.1
Trichlorofluoromethane	0.1	<0.1	<0.1	<0.1	<0.1
Vinyl Chloride	0.1	<0.1	<0.1	<0.1	<0.1
Benzene	0.1	<0.1	<0.1	<0.1	<0.1
Toluene	0.1	0.31	<0.1	<0.1	<0.1
Ethylbenzene	0.1	0.160	<0.1	<0.1	<0.1
m.p - Xylene	0.1	0.779	<0.1	<0.1	<0.1
o - Xylene	0.1	0.330	<0.1	<0.1	<0.1

Table E.7
Summary of Results of Chemical Analyses of Geologic
(EPA Method 8240) on Samples from 5-21A at 26 ft.

Date: Oct. 2, 1990
Laboratory: ABB Environmental
Lab ID: Y009GP

Parameter	Reporting Limits (ug/kg)	Concentration (ug/kg)
Acetone	4000	ND
Acrolein	200	ND
Acrylonitrile	200	ND
Benzene	200	ND
Bromodichloromethane	200	ND
Bromoform	200	ND
Bromomethane	400	ND
2-Butanone	4000	ND
Carbon Disulfide	200	ND
Carbon Tetrachloride	200	ND
Chlorobenzene	200	ND
Chlorodibromomethane	200	ND
Chloroethane	2000	ND
2-Chloroethyl Vinyl Ether	400	ND
Chloroform	200	ND
Chloromethane	2000	ND
Dibromomethane	200	ND
1,4-Dichloro-2-butene	200	ND
Dichlorodifluoromethane	2000	ND
1,1-Dichloroethane	200	ND
1,2-Dichloroethane	200	ND
1,1-Dichloroethene	200	ND
trans-1,2-Dichloroethene	200	ND
1,2-dichloropropane	200	ND
cis-1,3-dichloropropene	200	ND
trans-1,2-dichloropropene	200	ND
Ethylbenzene	200	350
Ethyl Methacrylate	200	ND
2-Hexanone	2000	ND
Methylene Chloride	200	ND
4-Methyl-2-pentanone	200	ND

Table E.7
Summary of Results of Chemical Analyses of Geologic
(EPA Method 8240) on Samples from 5-21A at 26 ft.

Date: Oct. 2, 1990
Laboratory: ABB Environmental
Lab ID: Y009GP

Parameter	Reporting Limits (ug/kg)	Concentration (ug/kg)
Styrene	2000	ND
1,1,2,2-Tetrachloroethane	200	ND
Tetrachloroethene	200	ND
Toluene	200	680
1,1,1-Trichloroethane	200	ND
1,1,2-Trichloroethane	200	ND
Trichloroethylene	200	ND
Trichlorofluoromethane	200	ND
1,2,3-Trichloropropane	200	ND
Vinyl Acetate	2000	ND
Vinyl Chloride	1000	ND
Xylenes	200	6800

ND = Not Detected

Table E.8
Summary of Results of Chemical Analyses on Geologic
(EPA Method 8220) on Samples from 5-21A at 26 ft.

Date: Oct. 2, 1990
Laboratory: ABB Environmental
Lab ID: Y009GP

Parameter	Reporting Limits (ug/kg)	Concentration (ug/kg)
Acenaphthene	540	ND
Acenaphthylene	540	ND
Anthracene	540	ND
Benzo (1) anthracene	540	ND
Benzo (b & k) fluoranthenes	540	ND
Benzo (ghi) perylene	540	ND
Benzoic acid	540	ND
Benzyl alcohol	540	ND
Bis (2-chloroethoxy) methane	540	ND
Bis (2-chloroethyl) ether	540	ND
Bis (2-chloroisopropyl) ether	540	ND
Bis (2-ethlyhexyl) phthalate	540	110000
4-Bromophenyl phenyl ether	540	ND
Butyl benzyl phthalate	540	ND
4-Chloroaniline	540	ND
4-Chloro-3-methylphenol	540	ND
2-Chloronaphthalene	540	ND
2-Chlorophenol	540	ND
4-Chlorophenyl phenyl ether	540	ND
Chrysene	540	ND
Dibenzo (a,h) anthracene	540	ND
Dibenzofuran	540	ND
Di-n-butyl phthalate	540	ND
1,2-Dichlorobenzene	540	ND
1,3-Dichlorobenzene	540	ND
1,4-Dichlorobenzene	540	ND
3,3'-Dichlorobenzidine	540	ND
2,4-Dichlorophenol	540	ND
Diethyl phthalate	540	ND
2,4-Dimethylphenol	540	ND

Table E.8
Summary of Results of Chemical Analyses on Geologic
(EPA Method 8220) on Samples from 5-21A at 26 ft.

Date: Oct. 2, 1990
Laboratory: ABB Environmental
Lab ID: Y009GP

Parameter	Reporting Limits (ug/kg)	Concentration (ug/kg)
1,2,4-Trichlorobenzene	540	ND
2,4,5-Trichlorophenol	540	ND
2,4,6-Trichlorophenol	540	ND

ND = Not Detected

Table E.9
Summary of Results of Chemical Analyses (EPA Method 8010/8020) on Geologic Samples from different depths in Well 5-21A

Date: Sept. 27, 1990
Laboratory: Assaigai Analytical Laboratories
Lab ID: 5804

Parameters	Reporting Limit (ug/g)	Concentration (ug/g)			
		5 Feet	10 Feet	15 Feet	20 Feet
PCB	1.0	<1.0	<1.0	<1.0	<1.0
Benzene	0.1	<0.1	<0.1	<0.1	<0.1
Toluene	0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	0.1	<0.1	<0.1	<0.1	<0.1
Xylenes	0.1	<0.1	<0.1	<0.1	<0.1

Table E.10
Summary of Results of Chemical Analyses (EPA Method 8080/8020) on Geological Samples from different depths in Monitor Well 5-22B

Date: Sept. 21, 1990
Laboratory: Assaigai Analytical Laboratories
Lab ID: 5754

Parameter	Reporting Limit (ug/g)	Concentration (ug/g)										
		5 Feet	15 Feet	20 Feet	25 Feet	30 Feet	35 Feet	40 Feet	45 Feet	50 Feet	55 Feet	55.5 Feet
PCB	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Toluene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Xylenes	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Table E.11
Summary of Results of Chemical Analyses (EPA Method 8080/8020)
on Geologic Samples from different depths in Monitor Well 5-23B

Date: Sept. 29, 1990
Laboratory: Assaigai Analytical Laboratories
Lab ID: 5805

Parameter	Reporting Limit (ug/g)	Concentration (ug/g) 5 Feet	40 Feet	50 Feet	55.5 Feet	77 Feet	79 Feet
PCB	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Toluene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Xylenes	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Table E.12
Summary of Results of Chemical Analyses (EPA Method 8080/8020)
for Geological Samples from different depths in Monitor Well 5-24B

Date: Oct. 3, 1990
Laboratory: Assaigai Analytical Laboratories
Lab ID: 5826

Parameter	Reporting Limit (ug/g)	Concentration (ug/g) 5 Feet	40 Feet	45 Feet	50 Feet	55 Feet	75.5 Feet
PCB	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Toluene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Ethylbenzene	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Xylenes	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Table E.13
Summary of Results of Chemical Analyses (EPA Method 8080) for Total PCB's in Geologic Samples from Soil Borings 5-25B, 5-26B, 5-27B

Date: Dec., 1990
Laboratory: ENSECO, Houston

Sample Depth (feet)	Concentration (ug/kg)		
	5-25B	5-26B	5-27B
5	ND	ND	ND
10	ND	ND	ND
15	ND	ND	ND
20	ND	ND	ND
22	ND	ND	ND
24	ND	ND	ND
26	ND	ND	ND
28	ND	ND	NA
30	ND	ND	ND
32	ND	ND	NA
34	ND	ND	NA
36	ND	ND	ND
38	NA	ND	ND
40	NA	NA	ND
42	NA	NA	ND
44	NA	NA	ND
46	NA	NA	ND
48	NA	NA	ND
50	NA	NA	ND
52	NA	NA	ND
54	NA	NA	ND

ND = Not Detected

APPENDIX F

SURFACE GEOPHYSICS DATA

ELECTROMAGNETIC CONDUCTIVITY (EM-34) SURVEY DATA

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/7/91
Coil Separ.: 20 m, Horizontal Dipole
Line: West-East Transect, (line 1A)
South of SW Enron Corner

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	0	23.6	66.0	7226
2	20	24.2	64.5	7228
3	40	24.0	65.0	7227
4	60	23.9	65.3	7227
5	80	24.0	65.0	7227
6	100	23.9	65.3	7223
7	120	23.5	66.3	7222
8	140	22.8	68.1	7220
9	160	22.5	68.9	7219
10	180	22.0	70.2	7218
11	200	21.5	71.5	7217
12	220	21.5	71.5	7217
13	240	22.0	70.2	7218
14	260	21.5	71.5	7217
15	280	21.5	71.5	7217
16	300	21.0	72.8	7215
17	320	20.0	75.4	7213
18	340	20.7	73.6	7214
19	360	21.6	71.2	7217
20	380	21.5	71.5	7217

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/30/91
Coil Separ.: 20 m Horizontal Dipole
Line: Heading East Through 5-23B and 5-24B
(Line 1)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock(ft)	Top of Chinle (above msl)
1	22	22.0	70.2	7212
2	40	20.0	75.4	7207
3	60	19.5	76.7	7205
4	80	21.0	72.8	7209
5	100	20.0	75.4	7213
6	120	21.0	72.8	7215
7	140	21.0	72.8	7207
8	160	21.0	72.8	7207
9	180	21.5	71.5	7209
10	200	19.5	76.7	7201
11	220	21.0	72.8	7205
12	240	21.0	72.8	7205
13	260	19.0	78.0	7200
14	280	21.0	72.8	7205
15	300	18.5	79.3	7198
16	320	21.5	71.5	7206
17	340	21.5	71.5	7206
18	360	22.0	70.2	7207
19	380	21.5	71.5	7206
20	400	22.0	70.2	7205
21	420	21.8	70.7	7204
22	440	22.5	68.9	7206
23	460	21.5	71.5	7204
24	480	21.0	72.8	7202
25	500	20.0	75.4	7198
26	520	25.5	61.1	7212
27	540	24.0	65.0	7208
28	560	24.5	63.7	7209
29	580	25.0	62.4	7211
30	600	25.0	62.4	7209

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/30/91
Coil Separ.: 20 m Horizontal Dipole
Line: Heading East Through 5-23B and 5-24B
(Line 1)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock(ft)	Top of Chinle (above msl)
31	620	25.5	61.1	7210
32	640	26.4	58.8	7212
33	660	26.2	59.3	7212
34	680	27.0	57.2	7214
35	700	27.8	55.1	7213
36	720	28.4	53.6	7214
37	740	29.1	51.7	7216
38	760	31.0	46.8	7221
39	780	32.0	44.2	7224
40	800	36.0	33.8	7233
41	820	39.0	26.0	7241
42	840	33.0	41.6	7225
43	860	33.0	41.6	7225
44	880	37.0	31.2	7236
45	900	36.5	32.5	7235
46	920	32.0	44.2	7221
47	940	28.0	54.6	7210
48	960	29.0	52.0	7213
49	980	33.0	41.6	7223
50	1000	29.5	50.7	7214

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/7/91
Coil Separ.: 20 m, Horizontal Dipole
Line: West-East Transect, Line2A
South of SW Enron Corner

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	20	34.0	39.0	7257
2	40	30.0	49.4	7247
3	60	29.0	52.0	7244
4	80	28.3	53.8	7242
5	100	27.0	57.2	7238
6	120	26.0	59.8	7235
7	140	25.0	62.4	7233
8	160	24.5	63.7	7231
9	180	23.5	66.3	7229
10	200	23.0	67.6	7226
11	220	23.0	67.6	7226
12	240	22.3	69.4	7225
13	260	21.8	70.7	7223
14	280	21.5	71.5	7223
15	300	21.8	70.7	7223
16	320	20.5	74.1	7220
17	340	20.0	75.4	7219
18	360	20.2	74.9	7219
19	380	20.0	75.4	7219
20	400	20.2	74.9	7218
21	420	21.1	72.5	7220
22	440	21.5	71.5	7222
23	460	22.2	69.7	7223
24	480	23.0	67.6	7225
25	500	23.8	65.5	7227
26	520	24.5	63.7	7229
27	540	24.5	63.7	7229
28	560	25.4	61.4	7232
29	580	25.0	62.4	7231
30	600	25.0	62.4	7231

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/30/91
Coil Separ.: 20 m Horizontal Dipole
Line: West to East Transect Through 5-15B,5-16, and 5-17B.
(Line 2)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	0	24.5	63.7	7229
2	20	24.8	62.9	7230
3	40	25.0	62.4	7231
4	60	26.0	59.8	7233
5	80	19.5	76.7	7216
6	100	21.0	72.8	7219
7	120	21.0	72.8	7219
8	140	26.0	59.8	7232
9	160	24.0	65.0	7227
10	180	24.0	65.0	7227
11	200	23.2	67.1	7225
12	220	23.2	67.1	7225
13	240	23.2	67.1	7225
14	260	22.9	67.9	7224
15	280	23.0	67.6	7224
16	300	23.0	67.6	7223
17	320	23.0	67.6	7223
18	340	23.0	67.6	7223
19	360	23.3	66.8	7224
20	380	23.8	65.5	7225
21	400	24.0	65.0	7222
22	420	24.5	63.7	7223
23	440	25.0	62.4	7225
24	460	25.0	62.4	7225
25	480	26.5	58.5	7229
26	500	27.0	57.2	7228
27	520	27.3	56.4	7229
28	540	26.0	59.8	7225
29	560	28.0	54.6	7230
30	580	22.0	70.2	7215

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/30/91
Coil Separ.: 20 m Horizontal Dipole
Line: West to East Transect Through 5-15B,5-16, and 5-17B. (Line 2)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
31	600	24.0	65.0	7217
32	620	25.0	62.4	7220
33	640	24.0	65.0	7217
34	660	28.9	52.3	7230
35	680	30.0	49.4	7233
36	700	32.0	44.2	7234
37	720	35.0	36.4	7242
38	740	35.0	36.4	7242
39	760	35.0	36.4	7242
40	780	34.0	39.0	7239
41	800	33.0	41.6	7235
42	820	33.0	41.6	7235
43	840	33.0	41.6	7235
44	860	33.0	41.6	7235
45	880	34.0	39.0	7238
46	900	35.0	36.4	7238
47	920	35.0	36.4	7238
48	940	36.0	33.8	7240
49	960	36.0	33.8	7240
50	980	37.0	31.2	7243
51	1000	38.0	28.6	7242
52	1020	40.0	23.4	7248

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/6/91
Coil Separ.: 20 m, Horizontal Dipole
Line: Start @ western boundary fence (Line 3)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	20	23.6	66.0	7259
2	40	23.8	65.5	7259
3	60	23.4	66.6	7258
4	80	23.9	65.3	7260
5	100	23.5	66.3	7259
6	120	24.2	64.5	7261
7	140	25.3	61.6	7263
8	160	25.4	61.4	7264
9	180	26.5	58.5	7267
10	200	26.5	58.5	7267
11	220	25.5	61.1	7264
12	240	22.0	70.2	7255
13	260	22.5	68.9	7256
14	280	25.5	61.1	7264
15	300	29.2	51.5	7274
16	320	29.0	52.0	7273
17	340	29.0	52.0	7273
18	360	28.8	52.5	7272
19	380	28.0	54.6	7270
20	400	26.5	58.5	7267
21	420	26.0	59.8	7265
22	440	25.5	61.1	7264
23	460	25.0	62.4	7263
24	480	25.4	61.4	7264
25	500	26.9	57.5	7268
26	520	27.5	55.9	7269
27	540	25.0	62.4	7263
28	560	25.0	62.4	7263
29	580	25.0	62.4	7263
30	600	27.8	55.1	7268
31	663	26.3	59.0	7264

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/6/91
Coil Separ.: 20 m, Horizontal Dipole
Line: Start @ western boundary fence (Line 3)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
32	683	20.5	74.1	7249
33	703	20.0	75.4	7248
34	723	20.0	75.4	7248
35	743	25.5	61.1	7262
36	763	25.0	62.4	7263
37	783	24.8	62.9	7262
38	803	25.0	62.4	7263
39	823	24.5	63.7	7261
40	843	24.2	64.5	7261
41	863	24.0	65.0	7260
42	883	24.0	65.0	7260
43	903	24.1	64.7	7260
44	923	24.5	63.7	7261
45	943	25.0	62.4	7263
46	963	25.0	62.4	7262
47	983	26.5	58.5	7266
48	1003	27.0	57.2	7267
49	1023	27.5	55.9	7268
50	1043	28.5	53.3	7271
51	1063	29.5	50.7	7273
52	1083	30.0	49.4	7275
53	1103	30.7	47.6	7276
54	1123	32.0	44.2	7280
55	1143	32.0	44.2	7280
56	1163	33.0	41.6	7282
57	1183	34.0	39.0	7285
58	1203	34.0	39.0	7285
59	1223	34.0	39.0	7285
60	1243	36.0	33.8	7290
61	1263	35.0	36.4	7286
62	1283	34.0	39.0	7283

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/6/91
Coil Separ.: 20 m, Horizontal Dipole
Line: Start @ western boundary fence (Line 3)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
63	1303	35.0	36.4	7286
64	1323	39.0	26.0	7296
65	1346	38.0	28.6	7293
66	1366	37.0	31.2	7289
67	1386	36.0	33.8	7286
68	1406	34.5	37.7	7282
69	1426	34.2	38.5	7282
70	1446	34.0	39.0	7281
71	1466	35.0	36.4	7281
72	1486	34.0	39.0	7278
73	1506	34.2	38.5	7279
74	1526	34.0	39.0	7278
75	1546	34.2	38.5	7279
76	1566	34.0	39.0	7274
77	1586	35.0	36.4	7277
78	1606	36.0	33.8	7279
79	1626	35.0	36.4	7277
80	1646	35.0	36.4	7277
81	1666	36.0	33.8	7278
82	1686	35.8	34.3	7278
83	1706	35.8	34.3	7278
84	1726	35.8	34.3	7278
85	1746	35.8	34.3	7278
86	1766	36.3	33.0	7280
87	1786	34.3	38.2	7275
88	1806	34.3	38.2	7275
89	1826	35.0	36.4	7277
90	1846	34.8	36.9	7276
91	1866	34.0	39.0	7273
92	1886	35.0	36.4	7276
93	1906	34.0	39.0	7273

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/6/91
Coil Separ.: 20 m, Horizontal Dipole
Line: Start @ western boundary fence (Line 3)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
94	1926	34.2	38.5	7274
95	1946	34.8	36.9	7275
96	1966	36.4	32.8	7277
97	1986	36.0	33.8	7276
98	2006	34.3	38.2	7272
99	2026	34.3	38.2	7272
100	2046	34.3	38.2	7272
101	2066	33.0	41.6	7268
102	2086	32.0	44.2	7266
103	2106	31.0	46.8	7263
104	2126	29.8	49.9	7260
105	2146	28.0	54.6	7255
106	2166	27.0	57.2	7253
107	2186	26.0	59.8	7250
108	2206	25.0	62.4	7248
109	2226	24.0	65.0	7245
110	2246	23.5	66.3	7244
111	2266	23.0	67.6	7242
112	2286	22.8	68.1	7242
113	2306	22.9	67.9	7242
114	2326	22.4	69.2	7241
115	2346	22.0	70.2	7240
116	2366	21.9	70.5	7240
117	2386	22.5	68.9	7241
118	2406	22.5	68.9	7241
119	2426	21.8	70.7	7239
120	2446	21.5	71.5	7239
121	2466	21.4	71.8	7238
122	2486	21.0	72.8	7237
123	2506	20.1	75.1	7235
124	2526	19.9	75.7	7234

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/31/91 & 2/6/91
Coil Separ.: 20 m
Line: West-East from West Enron Fence
(Line 4A)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	20	25.0	62.4	7260
2	40	24.5	63.7	7258
3	60	23.5	66.3	7256
4	80	23.0	67.6	7254
5	100	23.0	67.6	7254
6	120	23.0	67.6	7254
7	140	23.0	67.6	7254
8	160	23.0	67.6	7254
9	180	23.3	66.8	7255
10	200	24.0	65.0	7257
11	220	23.5	66.3	7256
12	240	21.6	71.2	7251
13	260	21.1	72.5	7249
14	280	22.4	69.2	7253
15	300	25.0	62.4	7258
16	320	25.6	60.8	7259
17	340	25.4	61.4	7259
18	360	26.4	58.8	7261
19	380	26.4	58.8	7261
20	400	27.1	56.9	7262
21	420	27.5	55.9	7263
22	440	28.5	53.3	7266
23	460	29.0	52.0	7267
24	480	29.0	52.0	7267
25	500	28.4	53.6	7264
26	520	29.6	50.4	7268
27	540	27.0	57.2	7261
28	560	27.0	57.2	7261
29	580	28.0	54.6	7263
30	600	30.0	49.4	7268

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/31/91 & 2/7/91
Coil Separ.: 20 m Horizontal Dipole
Line: West to East from NE Corner of Enron Office
(Line 4)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	20	8.0	106.6	
2	40	30.0	49.4	7267
3	60	30.0	49.4	7267
4	80	27.0	57.2	7259
5	100	26.5	58.5	7256
6	120	26.5	58.5	7256
7	140	26.2	59.3	7255
8	160	26.5	58.5	7256
9	180	26.4	58.8	7255
10	200	27.0	57.2	7257
11	220	26.8	57.7	7256
12	240	26.0	59.8	7254
13	260	26.0	59.8	7254
14	280	25.0	62.4	7252
15	300	25.0	62.4	7251
16	320	26.0	59.8	7253
17	340	26.0	59.8	7253
18	360	25.5	61.1	7252
19	380	26.0	59.8	7253
20	400	26.3	59.0	7253
21	420	25.5	61.1	7251
22	440	26.0	59.8	7252
23	460	27.0	57.2	7255
24	480	28.0	54.6	7257
25	500	30.0	49.4	7263
26	520	31.0	46.8	7265
27	540	28.3	53.8	7258
28	560	29.8	49.9	7262
29	580	31.0	46.8	7265
30	600	34.0	39.0	7271

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/31/91 & 2/7/91
Coil Separ.: 20 m Horizontal Dipole
Line: West to East from NE Corner of Enron Office
(Line 4)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
31	624	34.0	39.0	7271
32	644	33.0	41.6	7268
33	664	33.0	41.6	7268
34	684	33.0	41.6	7268
35	704	32.0	44.2	7263
36	724	32.5	42.9	7264
37	744	33.0	41.6	7265
38	764	33.0	41.6	7265
39	784	33.0	41.6	7265
40	804	33.0	41.6	7266
41	824	33.0	41.6	7266
42	844	33.0	41.6	7266
43	864	33.0	41.6	7266
44	884	32.5	42.9	7265
45	904	33.0	41.6	7262
46	924	34.0	39.0	7265
47	944	34.0	39.0	7265
48	964	34.0	39.0	7265
49	984	34.0	39.0	7265
50	1004	36.0	33.8	7272
51	1024	35.2	35.9	7270
52	1044	36.0	33.8	7272
53	1064	37.0	31.2	7275
54	1084	35.9	34.1	7272
55	1104	37.4	30.2	7281
56	1124	37.0	31.2	7280
57	1144	36.5	32.5	7279
58	1164	38.0	28.6	7282
59	1184	39.5	24.7	7286
60	1204	38.6	27.0	7284

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/31/91 & 2/7/91
Coil Separ.: 20 m Horizontal Dipole
Line: West to East from NE Corner of Enron Office
(Line 4)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
61	1224	40.5	22.1	7289
62	1244	40.5	22.1	7289
63	1264	42.0	18.2	7293
64	1284	41.0	20.8	7290
65	1304	40.5	22.1	7284
66	1324	40.5	22.1	7284
67	1344	40.5	22.1	7284
68	1364	40.0	23.4	7283
69	1384	39.0	26.0	7280
70	1404	38.0	28.6	7277
71	1424	35.5	35.1	7271
72	1444	34.0	39.0	7267
73	1464	32.5	42.9	7263
74	1484	32.0	44.2	7262
75	1504	30.0	49.4	7257

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/31/91 & 2/7/91
Coil Separ.: 20 m Horizontal Dipole (Line 5)
Line: West to East From USPCI Trailer Hitch

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	20	28.5	53.3	7255
2	40	28.5	53.3	7255
3	60	27.0	57.2	7251
4	80	26.8	57.7	7250
5	100	27.5	55.9	7251
6	120	27.2	56.7	7250
7	140	28.0	54.6	7252
8	160	28.0	54.6	7252
9	180	28.2	54.1	7253
10	200	28.0	54.6	7249
11	220	28.0	54.6	7249
12	240	28.0	54.6	7249
13	260	28.5	53.3	7251
14	280	28.5	53.3	7251
15	300	28.4	53.6	7248
16	320	28.8	52.5	7249
17	340	31.5	45.5	7257
18	360	42.0	18.2	7284
19	380	43.0	15.6	7286
20	400	42.0	18.2	7284
21	420	42.0	18.2	7284
22	440	33.0	41.6	7260
23	460	32.0	44.2	7258
24	480	30.0	49.4	7253
25	500	33.0	41.6	7260
26	520	32.0	44.2	7258
27	540	30.5	48.1	7254
28	560	30.0	49.4	7253
29	593	35.0	36.4	7266
30	613	33.0	41.6	7260
31	633	32.0	44.2	7258

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/31/91 & 2/7/91
Coil Separ.: 20 m Horizontal Dipole (Line 5)
Line: West to East From USPCI Trailer Hitch

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
32	653	32.0	44.2	7258
33	673	31.5	45.5	7257
34	693	31.5	45.5	7257
35	713	30.6	47.8	7252
36	733	31.0	46.8	7253
37	753	31.0	46.8	7253
38	773	30.0	49.4	7251
39	793	31.0	46.8	7253
40	813	31.0	46.8	7250
41	833	31.5	45.5	7252
42	853	32.0	44.2	7253
43	873	33.5	40.3	7257
44	893	33.6	40.0	7257
45	913	33.5	40.3	7255
46	933	34.0	39.0	7256
47	953	34.0	39.0	7256
48	973	33.0	41.6	7253
49	993	34.0	39.0	7256
50	1013	34.0	39.0	7258
51	1033	34.0	39.0	7258
52	1053	33.0	41.6	7255
53	1073	32.0	44.2	7253
54	1093	33.5	40.3	7257
55	1113	32.4	43.2	7257
56	1133	31.8	44.7	7255
57	1153	31.0	46.8	7253
58	1173	30.5	48.1	7252
59	1193	30.0	49.4	7251
60	1213	29.5	50.7	7251
61	1233	29.0	52.0	7250
62	1253	29.5	50.7	7251

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/31/91 & 2/7/91
Coil Separ.: 20 m Horizontal Dipole (Line 5)
Line: West to East From USPCI Trailer Hitch

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
63	1273	29.8	49.9	7252
64	1293	30.0	49.4	7253
65	1313	30.0	49.4	7252
66	1333	30.0	49.4	7252
67	1353	30.0	49.4	7252
68	1373	31.0	46.8	7254
69	1393	32.0	44.2	7257

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/7/91
Coil Separ.: 20 m, Horizontal Dipole
Line: West-East Transect, Line 6A
South of SW Enron Corner

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	0	24.5	63.7	7229
2	20	23.0	67.6	7225
3	40	23.0	67.6	7225
4	60	22.5	68.9	7224
5	80	23.0	67.6	7225
6	100	22.8	68.1	7222
7	120	22.0	70.2	7220
8	140	22.0	70.2	7220
9	160	22.0	70.2	7220
10	180	22.0	70.2	7220
11	200	21.8	70.7	7217
12	220	20.0	75.4	7213
21	400	24.5	63.7	7223
22	420	23.2	67.1	7220
23	440	23.0	67.6	7219
24	460	22.5	68.9	7218
25	480	21.8	70.7	7216
26	500	21.3	72.0	7215
27	520	21.4	71.8	7215
28	540	21.3	72.0	7215
29	560	21.1	72.5	7214
30	580	20.9	73.1	7214
31	600	21.0	72.8	7214
32	620	21.0	72.8	7214
33	640	21.0	72.8	7214
34	660	21.2	72.3	7215
35	680	21.5	71.5	7216
36	700	22.5	68.9	7218
37	720	22.3	69.4	7218
38	740	23.0	67.6	7219
39	760	22.4	69.2	7218
40	780	22.8	68.1	7219
41	800	23.0	67.6	7219
42	820	23.8	65.5	7221

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/31/91
Coil Separ.: 20 m Horizontal Dipole
Line: Wesr to East Line Through 5-18B andd 5-20B
(Line 6B)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	20	23.5	66.3	7220
2	40	23.4	66.6	7219
3	60	23.5	66.3	7220
4	80	23.2	67.1	7219
5	100	23.0	67.6	7218
6	120	22.9	67.9	7218
7	140	23.2	67.1	7216
8	160	23.9	65.3	7218
9	180	24.5	63.7	7219
10	200	25.5	61.1	7222
11	220	26.9	57.5	7226
12	240	28.8	52.5	7229
13	260	32.0	44.2	7238
14	280	33.0	41.6	7240
15	300	33.0	41.6	7240
16	320	30.0	49.4	7233
17	340	28.0	54.6	7224
18	360	27.0	57.2	7222
19	380	25.0	62.4	7217
20	400	24.5	63.7	7215
21	420	25.0	62.4	7217
22	440	25.8	60.3	7217
23	460	25.0	62.4	7215
24	480	25.0	62.4	7215
25	500	26.2	59.3	7215

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/13/91 (Line 6c)
Coil Separ.: 20 m Horizontal Dipole
Line: East Fence = 0

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	20	26.4	58.8	7213
2	40	26.9	57.5	7215
3	60	27.0	57.2	7215
4	80	27.8	55.1	7217
5	100	28.0	54.6	7217
6	120	27.5	55.9	7216
7	140	28.4	53.6	7215
8	160	28.5	53.3	7216
9	180	29.0	52.0	7217
10	200	28.7	52.8	7216
11	220	28.8	52.5	7216
12	240	29.2	51.5	7217
13	260	29.8	49.9	7218
14	280	30.0	49.4	7219
15	300	31.0	46.8	7221
16	320	33.0	41.6	7226
17	340	32.0	44.2	7223
18	360	34.2	38.5	7229
19	380	38.0	28.6	7238

Thoreau Compressor Station # 5 EM-34 Survey

Date: 1/31/91
Coil Separ.: 20 m Horizontal Dipole
Line: West to East Line Through 5-4B,5-5B, 5-5B, 5-6B (Line 7)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (feet)	Top of Chinle (above msl)
1	20	26.0	59.8	7233.2
2	40	28.0	54.6	7238.4
3	60	28.0	59.8	7233.2
4	80	28.0	54.6	7238.4
5	100	26.0	59.8	7232.2
6	120	22.0	70.2	7221.8
7	140	22.0	70.2	7221.8
8	160	26.0	59.8	7232.2
9	180	27.0	57.2	7234.8
10	200	25.0	62.4	7226.6
11	220	28.0	54.6	7234.4
12	240	29.0	52.0	7237.0
13	260	29.0	52.0	7237.0
14	280	30.0	49.4	7239.6
15	300	29.5	50.7	7236.3
16	320	30.0	49.4	7237.6
17	340	32.0	44.2	7242.8
18	360	27.0	57.2	7229.8
19	380	29.0	52.0	7235.0
20	400	28.0	54.6	7228.4
21	420	30.0	49.4	7233.6
22	440	32.0	44.2	7238.8
23	460	32.0	44.2	7238.8
24	480	32.0	44.2	7238.8
25	500	33.0	41.6	7237.4
26	520	32.0	44.2	7234.8
27	540	32.0	44.2	7234.8
28	560	34.0	39.0	7240.0
29	580	35.0	36.4	7242.6
30	600	38.0	28.6	7249.4

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/1/91
Coil Separ.: 20 m Horizontal Dipole
Line: Line Near 5-26B,5-27B, 5-25B
(Line 8)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (feet)	Top of Chinle (above msl)
1	20	27.5	55.90	7243.10
2	40	24.5	63.70	7235.30
3	60	28.0	54.60	7244.40
4	80	28.0	54.60	7244.40
5	100	29.0	52.00	7246.00
6	120	28.5	53.30	7244.70
7	140	30.0	49.40	7248.60
8	160	30.0	49.40	7248.60
9	180	30.5	48.10	7249.90
10	200	32.0	44.20	7250.80
11	220	32.0	44.20	7250.80
12	240	33.0	41.60	7253.40
13	260	34.0	39.00	7256.00
14	280	33.0	41.60	7253.40
15	300	34.0	39.00	7256.00
16	320	34.0	39.00	7256.00
17	340	32.0	44.20	7250.80
18	360	31.0	46.80	7248.20
19	380	30.0	49.40	7245.60
20	400	30.0	49.40	7243.60
21	420	29.5	50.70	7242.30
22	440	27.3	56.55	7236.45
23	460	30.0	49.40	7243.60
24	480	30.0	49.40	7243.60
25	500	29.5	50.70	7241.30
26	520	30.0	49.40	7242.60
27	540	29.5	50.70	7241.30
28	560	30.0	49.40	7242.60
29	580	30.0	49.40	7242.60
30	600	31.5	45.50	7242.50
31	620	32.0	44.20	7243.80
32	640	33.0	41.60	7246.40
33	660	36.0	33.80	7254.20
34	680	32.0	44.20	7243.80
35	700	32.0	44.20	7242.80
36	720	34.0	39.00	7248.00

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/4/91 (line 9)
Coil Separ.: 20 m, Horizontal Dipole
Line: Heading East along Landfill Rd

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	0	23.0	67.6	7216
2	20	22.8	68.1	7216
3	40	22.8	68.1	7216
4	60	22.3	69.4	7215
5	80	22.2	69.7	7214
6	100	22.5	68.9	7214
7	120	22.0	70.2	7213
8	140	21.2	72.3	7211
9	160	22.0	70.2	7213
10	180	21.1	72.5	7210
11	200	20.5	74.1	7209
12	220	20.5	74.1	7209
13	240	20.0	75.4	7208
14	260	20.0	75.4	7208
15	280	20.5	74.1	7209
16	300	22.0	70.2	7211
17	320	21.0	72.8	7208
18	340	20.0	75.4	7206
19	360	20.0	75.4	7206
20	380	20.0	75.4	7206
21	400	20.4	74.4	7206
22	420	20.9	73.1	7207
23	440	21.1	72.5	7207
24	460	22.2	69.7	7210
25	480	22.8	68.1	7212
26	500	22.9	67.9	7211
27	520	23.1	67.3	7211
28	540	23.6	66.0	7212
29	560	23.5	66.3	7212
30	580	23.1	67.3	7211
31	600	23.0	67.6	7209
32	620	23.3	66.8	7210
33	640	24.1	64.7	7212

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/4/91 (line 9)
Coil Separ.: 20 m, Horizontal Dipole
Line: Heading East along Landfill Rd

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
34	660	24.0	65.0	7212
35	680	24.0	65.0	7212
36	700	24.5	63.7	7211
37	720	25.0	62.4	7213
38	740	24.5	63.7	7211
39	760	25.0	62.4	7213
40	780	25.8	60.3	7215
41	800	26.0	59.8	7214
42	820	26.5	58.5	7215
43	840	27.4	56.2	7217
44	860	28.0	54.6	7219
45	880	28.5	53.3	7220
46	900	28.0	54.6	7217
47	920	26.5	58.5	7214
48	940	27.0	57.2	7215
49	960	27.5	55.9	7216
50	980	27.2	56.7	7215
51	1000	28.0	54.6	7216
52	1020	28.5	53.3	7217
53	1040	28.6	53.0	7217
54	1060	28.5	53.3	7217
55	1080	27.8	55.1	7215
56	1100	29.0	52.0	7217
57	1120	27.5	55.9	7213
58	1140	25.5	61.1	7208
59	1160	26.2	59.3	7210
60	1180	27.0	57.2	7212
61	1200	27.2	56.7	7211
62	1220	25.0	62.4	7206
63	1240	25.8	60.3	7208
64	1260	30.0	49.4	7219
65	1280	28.3	53.8	7214
66	1300	27.2	56.7	7209

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/4/91 (line 9)
Coil Separ.: 20 m, Horizontal Dipole
Line: Heading East along Landfill Rd

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
67	1320	28.5	53.3	7213
68	1340	31.5	45.5	7221
69	1360	30.0	49.4	7217
70	1380	27.2	56.7	7209
71	1400	27.0	57.2	7208
72	1420	26.8	57.7	7207
73	1440	25.9	60.1	7205
74	1460	26.0	59.8	7205
75	1480	25.0	62.4	7203
76	1500	24.5	63.7	7200
77	1520	25.0	62.4	7201
78	1540	25.5	61.1	7202
79	1560	27.0	57.2	7206
80	1580	27.6	55.6	7206

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/5/91
Coil Separ.: 20 m, Horizontal Dipole (Line 10)
Line: Heading East North of Enron

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	0	17.1	82.9	7279
2	20	16.1	85.5	7276
3	40	17.0	83.2	7279
4	60	17.0	83.2	7279
5	80	18.1	80.3	7282
6	100	18.1	80.3	7277
7	120	19.0	78.0	7279
8	140	19.2	77.5	7280
9	160	19.0	78.0	7279
10	180	19.4	77.0	7280
11	200	19.5	76.7	7275
12	220	19.0	78.0	7274
13	240	19.0	78.0	7274
14	260	19.1	77.7	7274
15	280	18.8	78.5	7273
16	300	18.0	80.6	7269
17	320	18.0	80.6	7269
18	340	18.0	80.6	7269
19	360	17.9	80.9	7269
20	380	18.0	80.6	7269
21	400	18.1	80.3	7273
22	420	18.5	79.3	7274
23	440	18.8	78.5	7274
24	460	18.8	78.5	7274
25	480	19.0	78.0	7275
26	500	19.0	78.0	7276
27	520	19.0	78.0	7276
28	540	19.1	77.7	7276
29	560	19.5	76.7	7277
30	580	20.0	75.4	7279

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/5/91
Coil Separ.: 20 m, Horizontal Dipole (Line 10)
Line: Heading East North of Enron

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
31	600	20.5	74.1	7280
32	620	20.6	73.8	7280
33	640	21.0	72.8	7281
34	660	21.1	72.5	7281
35	680	21.0	72.8	7281
36	700	21.0	72.8	7282
37	720	21.1	72.5	7282
38	740	20.8	73.3	7282
39	760	21.0	72.8	7282
40	780	20.5	74.1	7281
41	800	20.5	74.1	7278
42	820	21.0	72.8	7279
43	840	20.8	73.3	7279
44	860	20.0	75.4	7277
45	880	20.0	75.4	7277
46	900	20.2	74.9	7277
47	920	20.4	74.4	7278
48	940	20.8	73.3	7279
49	960	21.1	72.5	7279
50	980	21.1	72.5	7279
51	1000	21.0	72.8	7278
52	1020	21.5	71.5	7280
53	1040	21.2	72.3	7279
54	1060	21.2	72.3	7279
55	1080	21.1	72.5	7278
56	1100	20.8	73.3	7276
57	1120	20.5	74.1	7275
58	1140	20.2	74.9	7274
59	1160	19.5	76.7	7272
60	1180	19.4	77.0	7272

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/5/91
Coil Separ.: 20 m, Horizontal Dipole (Line 10)
Line: Heading East North of Enron

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
61	1200	19.2	77.5	7271
62	1220	19.0	78.0	7270
63	1240	18.5	79.3	7269
64	1260	18.8	78.5	7269
65	1280	18.5	79.3	7269
66	1300	18.8	78.5	7268
67	1320	18.8	78.5	7268
68	1340	19.0	78.0	7269
69	1360	18.0	80.6	7266
70	1380	19.0	78.0	7269
71	1400	19.0	78.0	7268
72	1420	18.4	79.6	7266
73	1440	19.9	75.7	7270
74	1460	19.0	78.0	7268
75	1480	18.9	78.3	7268
76	1500	19.5	76.7	7267
77	1520	19.0	78.0	7266
78	1540	19.6	76.4	7268
79	1560	19.8	75.9	7268
80	1600	19.3	77.2	7262
81	1620	19.0	78.0	7261
82	1640	18.9	78.3	7261
83	1660	21.0	72.8	7266
84	1680	19.2	77.5	7262
85	1700	19.0	78.0	7259
86	1720	19.2	77.5	7260
87	1740	18.2	80.1	7257
88	1760	18.9	78.3	7259
89	1780	18.8	78.5	7258
90	1800	19	78.0	7257

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/7/91 & 2/7/91
Coil Separ.: 20 m Horizontal Dipole
Line: West to East from Firehouse (Line 12)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	20	25.4	61.4	7252
2	40	27.9	54.9	7258
3	60	38.0	28.6	7284
4	80	27.0	57.2	7256
5	100	30.0	49.4	7263
6	120	28.5	53.3	7259
7	140	28.0	54.6	7257
8	160	27.5	55.9	7256
9	180	27.0	57.2	7255
10	200	26.5	58.5	7252
11	220	26.0	59.8	7250
12	240	26.2	59.3	7251
13	260	26.0	59.8	7250
14	280	25.5	61.1	7249
15	300	25.0	62.4	7248
16	320	25.0	62.4	7248
17	340	24.9	62.7	7247
18	360	25.3	61.6	7248
19	380	26.1	59.5	7250
20	400	27.5	55.9	7251
21	420	27.0	57.2	7250
22	440	26.0	59.8	7247
23	460	26.9	57.5	7250
24	480	28.0	54.6	7252
25	500	26.0	59.8	7245
26	520	25.9	60.1	7245
27	540	27.5	55.9	7249
28	560	29.5	50.7	7254
29	593	30.0	49.4	7256

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/5/91
Coil Separ.: 20 m, Horizontal Dipole (Line 10)
Line: Heading East North of Enron

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
91	1820	18.9	78.3	7257
92	1840	18.6	79.0	7256
93	1860	18.8	78.5	7256
94	1880	19.1	77.7	7257
95	1900	19.1	77.7	7252
96	1920	19	78.0	7252
97	1940	19.2	77.5	7253
98	1960	19.5	76.7	7253
99	1980	19.2	77.5	7253
100	2000	19.2	77.5	7245
101	2020	19.8	75.9	7246
102	2040	19.6	76.4	7246
103	2060	20	75.4	7243

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/7/91
Coil Separ.: 20 m, Horizontal Dipole
Line: West-East Transect, (Line 13)
Start Just South of Scrubbers

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	0	29.4	50.96	7236.04
2	20	30.0	49.40	7237.60
3	40	30.0	49.40	7237.60
4	60	30.2	48.88	7238.12
5	80	32.0	44.20	7242.80
6	100	32.0	44.20	7239.80
7	120	32.5	42.90	7241.10
8	140	34.0	39.00	7245.00
9	160	34.5	37.70	7246.30
10	180	32.5	42.90	7241.10
11	200	33.4	40.56	7241.44
12	220	34.0	39.00	7243.00
13	240	34.8	36.92	7245.08
15	280	38.0	28.60	7253.40
16	300	38.0	28.60	7252.40
17	320	37.0	31.20	7249.80
18	340	37.0	31.20	7249.80
19	360	37.0	31.20	7249.80
20	380	39.5	24.70	7254.30

Thoreau Compressor Station # 5 EM-34 Survey

Date: Feb 13, 1991
Coil Separ.: 20 m Horizontal Dipole
Line: Heading East Toward Scrubbers (line 13a)

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	0	38.0	28.6	7258.4
2	20	36.0	33.8	7253.2
3	40	35.0	36.4	7250.6
4	60	35.0	36.4	7250.6
5	80	34.0	39.0	7248.0
6	100	32.0	44.2	7245.8
7	120	30.0	49.4	7240.6
8	140	32.0	44.2	7245.8
9	160	33.0	41.6	7248.4
10	180	32.0	44.2	7245.8
11	200	41.3	20.0	7273.0
12	220	38.0	28.6	7264.4
13	240	34.0	39.0	7254.0
14	260	33.0	41.6	7251.4
15	280	32.0	44.2	7248.8
16	300	32.0	44.2	7251.8
17	320	31.0	46.8	7249.2
18	340	30.0	49.4	7246.6
19	360	33.0	41.6	7254.4
20	380	38.0	28.6	7267.4
21	400	42.0	18.2	7278.8
22	420	30.5	48.1	7248.9
23	440	71.0	-57.2	7354.2
24	480	32.0	44.2	7252.8
25	500	66.0	-44.2	7342.2
26	520	51.0	-5.2	7303.2
27	540	53.0	-10.4	7308.4
28	560	18.0	80.6	7217.4
29	580	28.0	54.6	7243.4
30	600	28.3	53.8	7246.2

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/13/91
Coil Separ.: 20 m, Horizontal Dipole
Line: Start @ East Fence Line 38' South of E-W Fence
Through Waste Pit ~25' S of USPCI Trailer
(Line 16)

Station	Distance (feet)	Conductivity (mmhos/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	20	30.0	49.40	7242.60
2	40	36.0	33.80	7258.20
3	60	38.0	28.60	7263.40
4	80	34.0	39.00	7253.00
5	100	32.0	44.20	7248.80
6	120	29.0	52.00	7241.00
7	140	29.0	52.00	7241.00
8	160	25.5	61.10	7231.90
9	180	22.0	70.20	7222.80
10	200	27.5	55.90	7239.10
11	220	24.0	65.00	7230.00
12	240	24.5	63.70	7231.30
13	260	29.4	50.96	7244.04
14	280	28.2	54.08	7240.92
15	300	28.5	53.30	7242.70
16	300	29.0	52.00	7244.00
17	320	29.0	52.00	7244.00
18	340	29.0	52.00	7244.00
19	360	29.8	49.92	7246.08
20	380	31.5	45.50	7250.50
21	400	32.5	42.90	7254.10
22	420	30.0	49.40	7247.60
23	440	30.0	49.40	7247.60
24	460	30.0	49.40	7247.60

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/13/91
Coil Separ.: 20 m, Horizontal Dipole
Line: Start @ East Fence Line 38' South of E-W Fence
Through Waste Pit ~25' S of USPCI Trailer
(Line 16)

Station	Distance (feet)	Conductivity (mmhos/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
25	480	31.0	46.80	7250.20
26	500	34.0	39.00	7258.00
27	520	32.5	42.90	7254.10
28	540	32.0	44.20	7252.80
29	560	32.0	44.20	7252.80
30	580	30.3	48.62	7248.38
31	600	29.0	52.00	7248.00
32	620	28.5	53.30	7246.70
33	640	30.0	49.40	7250.60
34	660	30.0	49.40	7250.60
35	680	30.0	49.40	7250.60
36	700	29.8	49.92	7251.08
37	720	29.6	50.44	7250.56
38	740	29.6	50.44	7250.56
39	760	30.0	49.40	7251.60
40	780	32.0	44.20	7256.80
41	800	32.0	44.20	7258.80
42	820	33.0	41.60	7261.40
43	840	34.0	39.00	7264.00
44	860	33.8	39.52	7263.48
45	880	35.0	36.40	7266.60

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/13/91
Coil Separ.: 20 m, Horizontal Dipole
Line: On Road North of ENRON Property
Line 17

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	20	15.5	87.10	7257.90
2	40	15.0	88.40	7256.60
3	60	18.2	80.08	7264.92
4	80	20.0	75.40	7269.60
5	100	21.5	71.50	7274.50
6	120	22.8	68.12	7277.88
7	140	22.8	68.12	7277.88
8	160	22.8	68.12	7277.88
9	180	22.5	68.90	7277.10
10	200	22.8	68.12	7284.90
11	220	22.8	68.12	7285.16
12	240	23.4	66.56	7286.20
13	260	23.5	66.30	7285.68
14	280	23.4	66.56	7286.20
15	300	24.0	65.00	7281.00
16	300	24.5	63.70	7282.30
17	320	24.7	63.18	7282.82
18	340	25.4	61.36	7284.64
19	360	25.2	61.88	7284.12
20	380	25.5	61.10	7284.90
21	400	25.6	60.84	7286.16
22	420	26.0	59.80	7287.20
23	440	25.8	60.32	7286.68
24	460	26.0	59.80	7287.20
25	480	26.0	59.80	7287.20
26	500	25.6	60.84	7286.16
27	520	25.0	62.40	7284.60
28	540	25.0	62.40	7284.60
29	560	25.0	62.40	7284.60
30	580	25.0	62.40	7284.60
31	600	25.0	62.40	7284.60
32	620	25.0	62.40	7284.60

Thoreau Compressor Station # 5 EM-34 Survey

Date: 2/13/91
Coil Separ.: 20 m, Horizontal Dipole
Line: On Road North of ENRON Property
Line 17

Station	Distance (feet)	Conductivity (mmho/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
33	640	25.0	62.40	7284.60
34	660	25.0	62.40	7284.60
35	680	25.0	62.40	7284.60
36	700	26.0	59.80	7287.20
37	720	26.0	59.80	7287.20
38	740	26.5	58.50	7288.50
39	760	27.0	57.20	7289.80
40	780	27.0	57.20	7289.80
41	800	28.0	54.60	7291.40
42	820	28.0	54.60	7291.40
43	840	28.5	53.30	7292.70
44	860	29.0	52.00	7294.00
45	880	29.0	52.00	7294.00
46	900	30.0	49.40	7295.60
47	920	31.0	46.80	7298.20
48	940	32.0	44.20	7300.80
49	960	32.0	44.20	7300.80
50	980	33.0	41.60	7303.40
51	1000	35.0	36.40	7306.60
52	1020	34.0	39.00	7304.00
53	1040	35.0	36.40	7306.60
54	1060	35.8	34.32	7308.68
55	1080	36.0	33.80	7309.20
56	1100	35.0	36.40	7305.60
57	1120	35.0	36.40	7305.60
58	1140	34.0	39.00	7303.00
59	1160	34.5	37.70	7304.30

Thoreau Compressor Station # 5 EM-34 Survey

Date: 3/21/91
Coil Separ.: 20 m, Horizontal Dipole
Line: Immediately South of Pump House Shed (line 18)

Station	Distance (feet)	Conductivity (mmhos/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
1	100	88.0	-101.40	
2	200	35.0	36.40	7231.2
3	300	38.0	28.60	7247.8
4	400	36.0	33.80	7236.4

Thoreau Compressor Station # 5 EM-34 Survey

Date: 3/21/91
Coil Separ.: 20 m, Horizontal Dipole
Line: Immediately North of Condensate Holding Tank (Line 19)

Station	Distance (feet)	Conductivity (mmhos/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
0	0	30.0	49.40	7208.20
1	40	29.5	50.70	7224.80
2	140	31.0	46.80	7209.40
3	240	30.5	48.10	7203.80
4	340	33.0	41.60	7216.80
5	440	35.0	36.40	7227.20

Thoreau Compressor Station #5 EM-34 Survey

Date: 3/21/91
Coil Separ. 20 m, Horizontal Dipole
Line: Extension to East North of BLM Annex
(Line 20A)

Station	Distance (Feet)	Conductivity (mmohs/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
0	0	31.5	49.6	7248.4
1	100	32.0	48.0	7249.0
2	200	29.0	57.6	7236.0
3	300	32.5	46.4	7244.6
4	400	35.0	38.4	7249.6
5	500	33.0	44.8	7244.2
6	600	31.0	51.2	7238.8

Thoreau Compressor Station # 5 EM-34 Survey

Date: 3/21/91
Coil Separ.: 20 m, Horizontal Dipole
Line: North of Demister to NW Corner of BLM Annex (Line 20)

Station	Distance (feet)	Conductivity (mmhos/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
0	20	29.5	50.70	7248.30
1	100	32.0	44.20	7253.80
2	160	32.0	44.20	7253.80

Thoreau Compressor Station # 5 EM-34 Survey

Date:	3/21/91
Coil Separ.:	20 m, Horizontal Dipole
Line:	South of 5-25 Through 5-27 Line 21

Station	Distance (feet)	Conductivity (mmhos/m)	Depth to Bedrock (Feet)	Top of Chinle (above msl)
0	0	28.5	59.20	7233.80
1	60	30.0	54.40	7237.60
2	160	29.5	56.00	7234.00
3	260	33.50	43.20	7244.80
4	360	34.00	41.60	7243.40
5	340	36.00	35.20	7248.80

SEISMIC REFRACTION SURVEY REPORT

Telephone (505) 881-4780

Charles B. Reynolds & Associates
Consulting Geophysicists and Geologists
4409 San Andres Avenue NE
Albuquerque, New Mexico 87110

March 15, 1991

SHALLOW SEISMIC REFRACTION SURVEY
Transwestern Pipeline Company Compressor Station No. 5
Thoreau, New Mexico

SUMMARY

During January and February, 1991, a shallow seismic refraction survey, consisting of eight lines which total 4,344 line feet in length, was recorded for Enron Corporation at the Transwestern Pipeline Company Compressor Station No. 5, near Thoreau, New Mexico. The purposes of the survey were to map the top of bedrock (Triassic Chinle fm), trace a buried, alluvium-filled stream channel incised into bedrock and to attempt to detect groundwater perched in the alluvium of the buried channel.

The seismic data, combined with drillhole information, show a south to southwest-flowing ancient stream system with as many as three tributaries, entering from the northeast, suggested.

The stream channel seems to bifurcate around a buried hill of Chinle fm of increased resistance to erosion near the center of the study area. Indirect seismic and subsurface information suggest that the possible branch around the east side of the buried hill may be the younger and deeper stream bed, carrying more and coarser sediment. An alluvial fan originating from this tributary may have spread an apron of sediments, including some gravel, across the south-central part of the area. The lateral containment of the stream system appears to be weakest in this part of the area (in the vicinity of Line TH-4). The stream bed evidently deepens again to the south (Line TH-6).

The seismic data also suggest that the perched water body may thicken, from five feet or less to ten feet or more, immediately south of the buried hill.

March 15, 1991

SHALLOW SEISMIC REFRACTION SURVEY
Transwestern Pipeline Company Compressor Station No.5
Thoreau, New Mexico

Introduction - During the period from January 11, 1991, through February 4, 1991, eight shallow seismic refraction lines were recorded for Enron Corporation at the site of the Transwestern Pipeline Company Compressor Station No. 5, near Thoreau, New Mexico. The lines, TH-1 and TH-3 through TH-9, are oriented more or less east-west and total 4,344 line feet in length. The locations of the lines are shown on the enclosed Seismic Line Location Map. Programmed Line TH-2 could not be done because of a large archeological site which it would have crossed.

The purposes of the survey were to attempt to map the top of bedrock (Triassic Chinle fm.) and trace a buried stream channel incised into it. Another purpose was to try to detect the top of groundwater perched in the alluvium above bedrock.

Weather was an inhibiting factor during the field operation, as were frozen ground, melting snow and locally deep snow drifts. At times operations were delayed or made difficult by movement of heavy equipment in the area.

Method - All the lines were recorded using a "soft" dropped weight, which consists of a heavy leather bag containing lead birdshot. This weight, which weighs 550 lb., is dropped free-fall a distance of six and one-half feet to the ground. It has the advantages of being environmentally acceptable and, because it does not bounce, produces a very clean and repeatable impulse which varies little with different soil types. One to nine drops were summed at different source points, depending on soil conditions; the average was about five drops of the weight.

The receiver array consists of twelve Mark Products 8-Hz refraction geophones spaced 16.5 ft apart along the line (Lines TH-1 and TH-3 through TH-7) or 8 ft apart (Lines TH-8 and TH-9). Lines TH-8 and TH-9 were recorded with a smaller receiver interval in an effort to obtain greater detail in areas of known or suspected small-scale geologic complications. Each geophone was recorded with a separate channel. All profiles were fully reversed (recorded with the source at first one end and then the other) to make possible relatively accurate and sophisticated methods of analysis and interpretation. Every effort was made to ensure that the differences in reciprocal times (times from each end of a profile to the other end) were 0.005 second or less, which is a major quality control factor.

The seismic intruments used are an EG&G Geometrics ES1210F 12-

channel system with frequency filters and G724S digital recorder. Recordings were for one-half second, with one-half millisecond sample interval. Recording frequency filters were out-200 Hz, with 60 Hz notch filters in use at all times because of strong electrical interference. Both analog (paper) and digital (magnetic tape) records were taken at each recording position.

After completion of the field recording operations, the lines were surveyed by alidade and plane table. Basic survey control was provided by "shooting in" drill holes on or near the lines. The lines were also tied together by the survey. The lines and wells, as surveyed, fit very well with the base map provided by Daniel B. Stephens & Associates, with ten feet or less of evident disagreement.

Once the data were returned to Albuquerque, the records were examined carefully by experienced seismologists. First breaks were "picked" and converted to travel times, first by computer and then by hand. Inverse velocity lines were fitted to the time-distance data using least squares and depths were computed by the zero-distance time intercept method. More accurate and sophisticated determinations of the depth and form of the deepest refractor (or the two deepest refractors) were made by a wavefront reconstruction method, which assumes only the average velocity of the overburden as a known and yields, as well as the form of the refractor, its velocity to a reasonable degree of accuracy.

In an effort to enhance any possible refractions from perched water zones in the alluvium above bedrock, the refraction data were filtered with a higher band-pass digital filter (50-100 Hz). The rationale is that thin refractors can carry higher frequency refractions, but not the more powerful lower frequency refractions. These higher-frequency data were treated in the same way as the normal data; they were studied by seismologists, picked, timed, inverse velocity lines were fit and depth calculations made. Where possible, wavefront reconstructions were also carried out.

<u>Results</u> - Refraction break quality is generally very good, though interference from nearby mobile or fixed equipment locally produced detectable noise. The very considerable increase (roughly an order of magnitude) in energy input from the dropped weight, as compared to the sledge hammer tried earlier, proved to be adequate to overcome the background noise in the area.

Surface layer velocity varies from less than 1,000 ft/sec to nearly 1,800 ft/sec, implying that soil ranges from very soft and compactible to reasonably compacted and firm. The lowest of these surface velocities may be from soil brought in from elsewhere. The mean surface velocity on different lines varies from 1,100 ft/sec to 1,500 ft/sec.

In general, velocities from within the alluvium above bedrock are from just over 1,000 ft/sec to slightly more than 5,000 ft/sec.

A major exception is Line TH-4, where several refractors about 10-15 ft above bedrock show calculated velocities from roughly 6,500 ft/sec to more than 15,000 ft/sec. These high velocity zones appear to correspond at least approximately to zones of gravel within the alluvium encountered by the drill holes in this area. This condition has been noted in some other localities also, and is thought to indicate grain-to-grain contact between particles of high velocity, such as quartzite or limestone pebbles.

Velocities evidently associated with bedrock (Triassic Chinle formation) range from less than 5,000 ft/sec to more than 16,000 ft/sec. The lower range of these velocities, those less than 8500 ft/sec, probably represent weathered Chinle, whereas those above about 8,500 ft/sec are probably from fresh or relatively unweathered rock. The highest velocities from the Chinle, those greater than about 12,000 ft/sec, probably come from sandy or calcareous zones.

Interpretation - After completion of the time-intercept and wavefront reconstruction solutions of the data, a depth section of each of the seismic lines was constructed (enclosed). The sections were made with a 2:1 vertical exaggeration in order to make depth variations more readily visible.

The refractor solutions from the deeper refractors, determined by wavefront reconstruction, are shown as relatively long, generally almost horizontal lines, with the calculated refractor velocity written beneath. The average velocity used from the surface down to the refractor is 1,700 feet per second, determined from the shallower solutions. The shallower solutions, made by the zero-distance time-intercept method, are shown as short lines with the calculated velocity of the refractor shown beneath. The refractor velocities are shown as calculated, but are probably accurate only to about the nearest hundred feet per second. Possible correlations between refractors are shown as dashed lines.

On each of the depth sections a seismic horizon (locally, a phantom horizon) near the top of the Chinle fm (top of bedrock) has been drawn, except for Lines TH-8 and TH-9. This seismic horizon appears, in most cases, to be from near the top of the weathered Chinle fm, though in some areas it may represent the top of unweathered Chinle (probably where there is little or no weathered Chinle present). The horizon has not been drawn on Lines TH-8 or TH-9, because the short spreads did not detect data from that horizon.

The most northerly line, Line TH-7, shows a clear indication of a buried stream channel at the depth of the top of bedrock near position R4E/R2W (see Depth Section). At this depth the channel seems to have about five feet of relief on its west flank and about seven feet on its eastern flank. Shallower refractions suggest that the channel may be centered near position R2E within the upper part of the alluvium.

Line TH-5, the next line south, does not appear to show a buried channel. Here the near top Chinle horizon is mostly a phantom horizon passing between alluvial low-velocity refractors above and high-velocity refractors below, which are obviously from within the Chinle. This line shows mainly apparent easterly slopes, suggesting that here the buried channel lies to the east. The steeply-dipping refractors below the top of bedrock are presumably sandy or calcareous streaks within the Chinle.

Continuing southward, Line TH-3 passes a short distance south of the large waste pit and drillhole 5-10SB (see Seismic Line Location Map). It suggests the presence of a deep buried channel passing through the center of the line and south of drillhole 5-10SB (see Depth Section). Here the channel may have an east bank about 10 ft high and a west bank as much as 20 ft high.

Line TH-1 lies to the south of Line TH-3, passing near drillholes 5-4B, 5-5B and 5-6B. At the depth of the top of Chinle fm, a channel about 10-12 ft deep is indicated near the center of the line. At intermediate depth within the alluvium (7250-7265 ft elevation), the channel may have migrated east of the line. At the shallowest depths (above 7270 ft elevation) the stream course seems to have returned to its earlier position near the center of the line.

Line TH-2, planned to be run east-west about 200 feet south of Line TH-1, could not be recorded because of the presence of a large restricted archeological site area. The next line south, consequently, is Line TH-4 (see Seismic Line Location Map). Line TH-4 has the condition, unique to this area, of having several high-velocity refractors indicated some 10-20 ft above the top of bedrock (See Depth Section). As mentioned earlier, these unusual high-velocity refractions from within the alluvium may come from gravel streaks. Such a condition has been observed previously at a few other locations. A phantom horizon parallel to these lowest refractors may be a good representation of the top of bedrock or Chinle fm. This phantom horizon and the three drillholes along the line (5-14B, 5-134B and 5-12B) suggest that the buried channel at the top of bedrock may be at its shallowest here, with perhaps as little as three to five feet of relief. At shallower depth, above 7250 ft elevation, the later stream channel suggests much greater relief, perhaps as much as 20 ft.

The longest of the seismic lines, Line TH-6, is also the farthest south (see Seismic Line Location Map and Depth Section). This line indicates an apparent buried channel cut in the top of bedrock and centered at about position R3E/R5W. Bounding divides are suggested at about positions R1E/R3W and R7E/R9W. The banks of the channel at this location appear to be about 20 ft high on the east and about 25 feet high on the west. Both bounding divides or ridges, and especially the one on the east, seem to have mounds of higher-velocity alluvium above them, and the channel evidently persists strongly to the surface. This deep, very well developed channel contrasts strongly with the much shallower stream bed suggested on the next line north, Line TH-4.

Lines TH-8 and TH-9, as mentioned earlier, were recorded in an attempt to add detail to two locations where locally complicated geological conditions were indicated. Neither line produced data from the top of bedrock, probably mainly because of the shortened receiver spreads used. Both, however, do provide useful geologic information, as will be seen later.

The best ties of the near top of Chinle fm refractor horizon to good well control, on Lines TH-1 and TH-5, suggest that the seismic horizon is plotted about five feet too high, that is, above the true top of bedrock. This apparent miss-tie may be due to using too slow an average velocity from the surface to the refractor, in calculating the depth of the refractor, or it might be that the refractor actually is that far above the top of Chinle as called from the drilling information. To correct for this disagreement with the drillhole data, the seismic horizon was lowered five feet in construction of the Structure Contour Map (enclosed).

The Structure Contour Map, drawn at a scale of one inch equals 100 feet, shows contours on the seismic horizon near the top of the Chinle fm, with a contour interval of 10 feet and elevations in feet above sea level. Both seismic data and drillhole data are used in the construction of the map. The contours show a southward-declining surface dropping about 50 feet from north to south, cut by a drainage channel or stream bed which evidently crosses Line TH-7 near its center and swings in a wide meander around the east end of Line TH-5. A tributary stream entering from the northeast along this meander seems likely. From here the channel seems to turn back to the southwest, crossing Line TH-3 in a narrow pass between wells 5-10SB to the north and 5-26B, 5-27B and 5-25B to the south.

The channel next appears to swing back to the southeast in another wide meander, before crossing Line TH-1 near its center. Here, at the position of Line TH-1, there is a suggestion of another stream bed coming in from the northeast. The seismic coverage is not adequate to determine whether this second stream bed is a separate tributary coming in from the northeast or simply another course of the same channel meandering around the northeast side of the buried hill demonstrated by wells 5-26B, 5-27B and 5-25B.

South of Line TH-1 the channel appears to turn to the southwest again, crossing Lines TH-4 and TH-6 in that direction. Another tributary may enter from the east or northeast between Lines TH-4 and TH-6.

The higher-frequency playbacks mentioned earlier were made in an effort to bring out evidence of thin perched water zones. Possible indications of groundwater perched in the alluvium above bedrock are present on, from north to south, Lines TH-7, TH-3, TH-1 and perhaps TH-6. On Line TH-7, a possible lens of wet alluvium, about 5 ft thick, may be present on the east side of the channel (under position R3E/R1W). The velocity of the refractor at the bottom of the apparent channel on Line TH-3 (about 4,673 ft/sec) may represent a small, probably thin, zone of wet alluvium. A refractor of about 5,326 ft/sec velocity near the center of the indicated channel of Line TH-1 is probably from the water table. Here the perched water zone appears to be about 15 feet thick and probably largely or entirely confined to the channel. Recognizing perched water under Line TH-4 is made unlikely by the presence of the high-velocity (gravel?) refractors discussed earlier. A confused group of refractions shown at an elevation of about 7,225 feet under position R3E/R5W on Line TH-6 may indicate a perched water body at this location; if so, the suggested thickness of the wet zone in the channel here is about 25 feet.

The buried hill demonstrated by wells 5-25B, 5-26B and 5-27B is a feature of potential importance with regard to movement of groundwater from north to south through the area. The seismic and subsurface evidence appear to indicate that a channel was cut through this hill at the center of Line TH-3 and around the west side of the hill. Line TH-8 also appears to support the presence of a deep, narrow channel here; it shows confused, disconnected refractions of alluvial velocities, such as might be expected over such a feature. The possibility also exists that another channel may have been cut around the east side of the hill, just east of Line TH-3. If this is true, one of the two stream beds presumably represents the later route, and hence may have been incised more deeply into bedrock. The map gives no clear suggestion as to which might be deeper; both may be at about 7,235 ft elevation next to the hill.

Line TH-9 may offer some evidence with regard to which stream bed around the hill is more important. It shows west-dipping refractors within the alluvium, which bear a resemblance to refractors observed in alluvial fans elsewhere. If this is correct, it would appear that here, at the apparent confluence of the two channels south of the hill, the stream bed coming from the northeast may have carried more sediment, and hence may have been dominant. Hence, the gravel noted in the drillholes along Line TH-4, and which affect refraction on this line, may be part of an alluvial fan possibly coming from the easterly channel. In sum, it appears that there is a suggestion that the possible buried stream bed around the east side of the buried hill is the more important in terms of volume and coarseness of sediment carried.

If the suggestions of perched water in the alluvium of the buried stream channel complex, discussed earlier, are correct, it appears that the thickness of the perched water zone may increase abruptly south of the buried hill.

All evidence seems to suggest that the buried hill represented a considerable barrier to drainage of the area to the north. Presumably this is because here there was a local increase in the resistance of the Chinle fm to erosion. Similar localities of increased erosion resistance in the Chinle fm observed at the surface have been caused by calcification or even silicification along fracture zones, by ancient springs and in some cases by baking near igneous intrusives such as basaltic dikes.

Conclusions - On the bases of the geophysical and geological evidence discussed above, the following conclusions are believed to be merited:

A. A buried channel system is incised into the Chinle fm bedrock in the area, flowing to the south-southwest, with perhaps as many as three tributaries entering from the northeast.

B. The channel appears to be at its narrowest passing a buried hill apparently composed of Chinle fm of locally increased resistance to erosion.

C. The ancient stream bed may have channels on both sides of the hill, and the possible channel on the east side may be the younger one bearing more and coarser sediment.

D. The water body perched in the alluvium of the ancient stream system may become abruptly thicker south of the buried hill.

E. An alluvial fan, locally including gravel, may have been spread across the area between Lines TH-1 and TH-4, where the stream bed also appears to be at its shallowest.

Recommendations - The following suggestions are believed to merit consideration:

A. Some additional seismic lines might be recorded to attempt to define the possible buried channel around the east side of the buried hill.

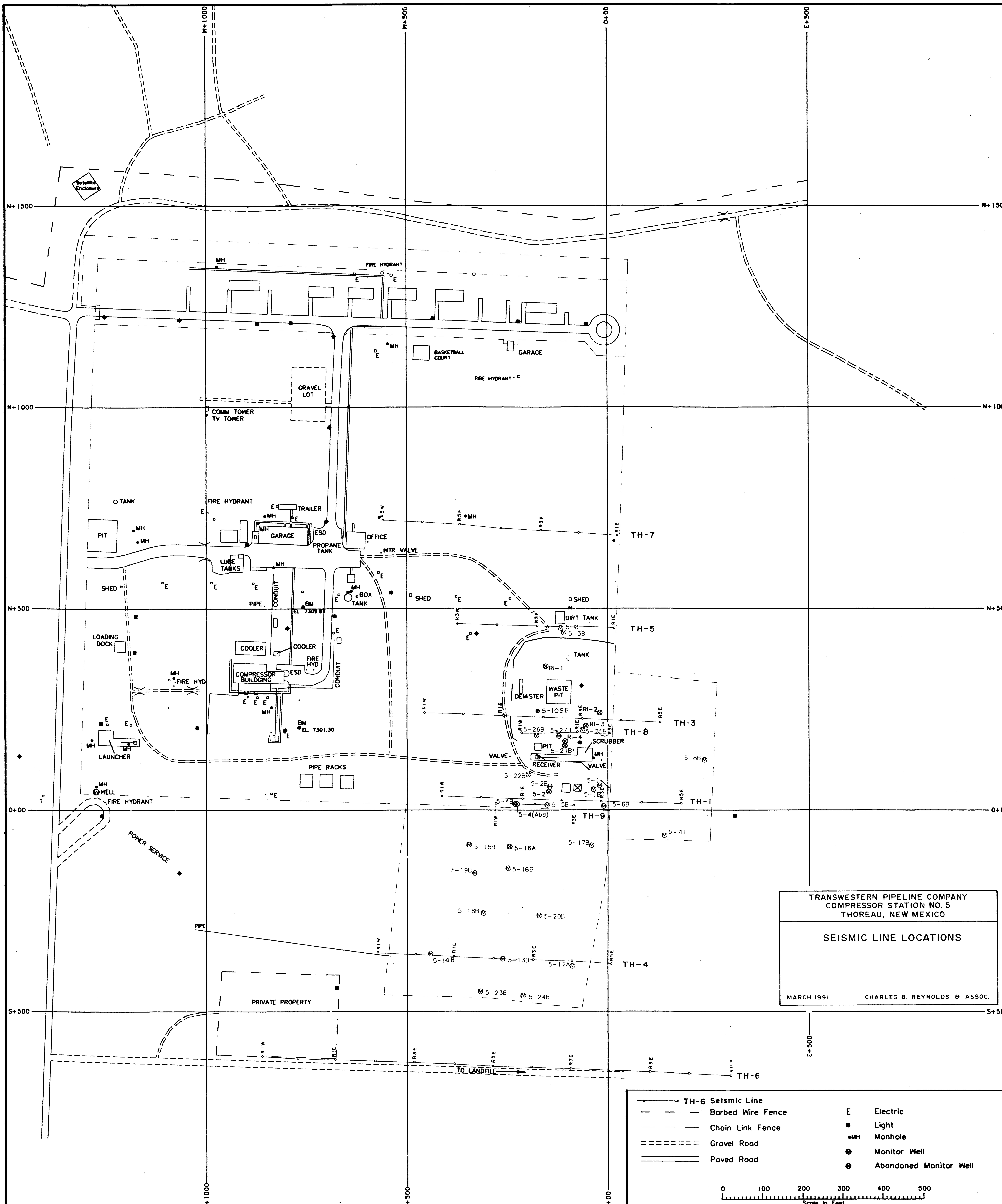
B. Once the form of the possible channel around the east side of the buried hill has been outlined by seismic investigation, one or more holes might be drilled to confirm or refute its presence and importance.

Respectfully submitted,

Charles B Reynolds

Charles B. Reynolds
Registered Geophysicist (CA)
Registered Geologist (AR)

3 Enclosures.



TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO
SEISMIC LINE LOCATIONS
MARCH 1991
CHARLES B. REYNOLDS & ASSOC.
W+1000
W+500
0+00
E+500
N+1500
N+1000
N+500
S+500
TH-1
TH-3
TH-4
TH-5
TH-6
TH-7
TH-8
TH-9
Satellite Enclosure
FIRE HYDRANT
BASKETBALL COURT
GARAGE
GRAVEL LOT
COMM TOWER
TV TOWER
TANK
PIT
TRAILER
ESD
OFFICE
PROPANE TANK
WTR VALVE
LUBE TANKS
SHED
CONDUIT
PIPE
BM EL. 7309.89
BOX TANK
DIRT TANK
LOADING DOCK
COOLER
FIRE HYD
COMPRESSOR BUILDING
DEMISTER
WASTE PIT
SCRUBBER
VALVE
RECEIVER
BM EL. 7301.30
LAUNCHER
PIPE RACKS
WELL
POWER SERVICE
PRIVATE PROPERTY
TO LANDFILL
5-1
5-2
5-3B
5-4(Abd)
5-5B
5-6B
5-7B
5-8B
5-10SF
5-12A
5-13B
5-14B
5-15B
5-16A
5-16B
5-17B
5-18B
5-19B
5-20B
5-21B
5-22B
5-23B
5-24B
5-25B
5-26B
5-27B
RI-1
RI-2
RI-3
RI-4
TH-6 Seismic Line
Barbed Wire Fence
Chain Link Fence
Gravel Road
Paved Road
E Electric
Light
MH Manhole
Monitor Well
Abandoned Monitor Well
0
100
200
300
400
500
Scale in Feet

EXPLANATION

2297	Refractor with velocity in ft/sec
(1500)	Assumed velocity
₸ch	Near top of Chinle formation
CH 7230	Top of Chinle formation in well

SCALE IN FEET

0 20 40 60 80 100

10, 20, 30, 40, 50

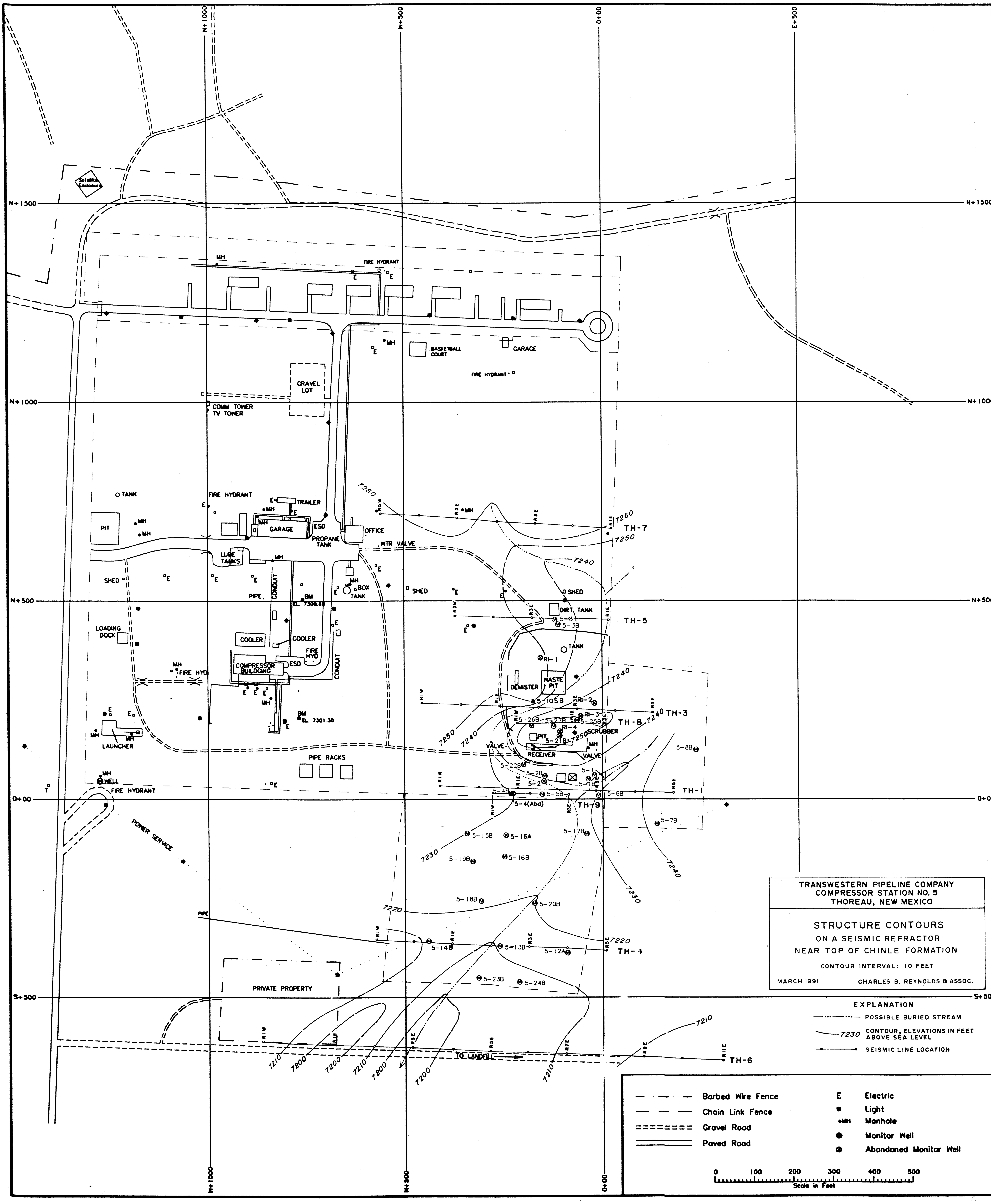
ELEVATIONS IN FEET ABOVE SEA LEVEL

TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO

DEPTH SECTIONS BASED ON SEISMIC REFRACTION

LINES TH-1, TH-3 THROUGH TH-9

MARCH 1991 Charles B. Reynolds & Associates


TRANSWESTERN PIPELINE COMPANY
COMPRESSOR STATION NO. 5
THOREAU, NEW MEXICO
STRUCTURE CONTOURS
ON A SEISMIC REFRACTOR
NEAR TOP OF CHINLE FORMATION
CONTOUR INTERVAL: 10 FEET
MARCH 1991
CHARLES B. REYNOLDS & ASSOC.
EXPLANATION
POSSIBLE BURIED STREAM
7230 CONTOUR, ELEVATIONS IN FEET ABOVE SEA LEVEL
SEISMIC LINE LOCATION
Barbed Wire Fence
Chain Link Fence
Gravel Road
Paved Road
E Electric
Light
MH Manhole
Monitor Well
Abandoned Monitor Well
0 100 200 300 400 500
Scale in Feet
W+1000
W+500
0+00
E+500
N+1500
N+1000
N+500
0+00
S+500
Satellite Enclosure
FIRE HYDRANT
BASKETBALL COURT
GARAGE
GRAVEL LOT
COMM TOWER
TV TOWER
TANK
PIT
TRAILER
GARAGE
ESD
OFFICE
PROPANE TANK
WTR VALVE
LUBE TANKS
SHED
PIPE
CONDUIT
BM EL. 7306.89
BOX TANK
LOADING DOCK
COOLER
FIRE HYD
COMPRESSOR BUILDING
BM EL. 7301.30
LAUNCHER
PIPE RACKS
WELL
POWER SERVICE
DIRT TANK
DEMISTER
WASTE PIT
SCRUBBER
RECEIVER
VALVE
PRIVATE PROPERTY
TO LANDFILL
TH-7
TH-5
TH-3
TH-8
TH-1
TH-9
TH-4
TH-6
5-105B
5-26B
5-27B
5-25B
5-21B
5-22B
5-2B
5-2
5-1
5-1B
5-4B
5-4(Abd)
5-5B
5-6B
5-3B
5-8B
5-7B
5-15B
5-16A
5-16B
5-17B
5-19B
5-18B
5-20B
5-14B
5-13B
5-12A
5-23B
5-24B
RI-1
RI-2
RI-3
RI-4
7260
7250
7240
7230
7220
7210
7200

APPENDIX G

GEOCHEMICAL SPECIAL STUDIES

PCB DESORPTION FROM CONTAMINATED THOREAU SOIL

Daniel B. Stephens & Associates Inc., Kirk Cantrell

An experiment was conducted to determine the distribution coefficient of PCBs on soil obtained from the Thoreau compressor site. The experiments were conducted by equilibrating PCB contaminated soil with clean groundwater obtained upgradient of the contaminated area (well 5-3B). Before use, the groundwater solution was filtered with a 0.45 micron (μ) filter. The soil samples were prepared by sieving with a 1.5 mm screen to remove course material. The soil samples were then air dried and thoroughly mixed. Six batch desorption experiments were run simultaneously. Each experiment consisted of five grams of air dried PCB contaminated soil added to a glass centrifuge tube (with a teflon lined screw cap) along with 50 ml of the clean filtered groundwater. After all six tubes were assembled they were equilibrated by rotating for 48 hours on a tube rotator. After equilibration, the samples were centrifuged and then analyzed. Table 1 shows the results. Included are the solution concentrations, concentrations in the soil (dry weight basis) after equilibration and concentration results for the soil before equilibration.

TABLE 1. PCB CONCENTRATION RESULTS FOR DESORPTION EXPERIMENTS

Soil Sample #	Solution (μg/l)	Equilibrated Soil (μg/g)	Soil Before Equilibration (μg/g)
448	77	1.0	4.0
449	4.6	1.3	2.1
451	120	2.8	7.9
453	160	21	85
454	59	<1	1.6
457	95	6.0	13

Using the data in Table 1 the distribution coefficient (D = (μg PCB/g soil)/(μg PCB/ml solution) = ml/g, dry wt) for each sample was calculated. The calculated distribution coefficients along with the mass of PCBs added to the tube initially and the total mass of PCBs in the soil and solution after equilibration are shown in Table 2. Significant variation is observed to occur among the distribution coefficient results. This amount of variation could be expected to result from our inability to effectively separate colloidal sized particles from solution during the centrifugation step. The soil samples used had varying proportions of clay and sand sized material. PCBs have a great affinity for organic matter and organic matter in soils tends to be associated with the finest material in the soil. As a result, particles with the greatest affinity for PCB adsorption may be the most difficult to separate from solution. The calculated average distribution coefficient (D = 88 g/ml), must therefore be considered as a lower bound of the actual distribution coefficient.

TABLE 2. PCB DISTRIBUTION COEFFICIENT AND MASS BALANCE (DRY WEIGHT BASIS)

Soil Sample #	D (ml/gm)	PCBs in Soil Before (μg)	PCBs in Soil and Solution After (μg)
448	13	20	9
449	283	11	7
451	23	40	20
453	131	425	113
454	<17	8	<8
457	63	65	35
average	88	(assuming D for sample 454 is 17)	

The average distribution coefficient shown in Table 2 compares well with that calculated from hydrophobic theory using the measured organic matter content of soils at Thoreau (245 mg/kg, f_{oc} = 0.000245). It should be pointed out, however, that this method is likely to underestimate the true distribution coefficient. It is recommended that the method not be used for f_{oc} values of less than 0.001. At f_{oc} values of less than 0.001 adsorption onto the inorganic components of the soil becomes significant. Since the hydrophobic theory does not account for adsorption of PCBs onto inorganic surfaces, the method is likely to underestimate PCB adsorption onto soils at f_{oc} values of less than 0.001.

Comparison of the second column in Table 2 with the third column indicates that a significant amount of the PCBs were adsorbed onto the surfaces of the glass tube and/or the teflon cap. This is not expected to effect our results since the actual amount of PCBs were measured in both the soil and solution after equilibrium.

APPENDIX H

RESULTS OF INORGANIC CHEMICAL ANALYSES ON SELECTED WELLS

Table H.1
Summary of Inorganic Chemical Analyses Conducted on Water Samples from Transwestern Pipeline Company Supply Well No. 2 (TPC-2)

Date: Feb 13th, 1991
Laboratory: ENSECO, Houston
Lab ID: 000867

Parmeter	Results	Reporting Limits
Specific Conductance @25C	444 umhos/cm	1.0 umhos/cm
Alkalinity, Total as CaCO3	166 mg/l	5.0 mg/l
Alkalinity, Bicarb. as CaCO3	166 mg/l	5.0 mg/l
Alkalinity, Carb. as CaCO3	ND	5.0 mg/l
Alkalinity, Hydrox. as CaCO3	ND	5.0 mg/l
Total Dissolved Solids	328 mg/l	10.0 mg/l
Sulfate	40 mg/l	25 mg/l
Fluoride	0.33 mg/l	0.1 mg/l
pH	7.8 units	
Ammonia as N	ND	0.1 mg/l
Nitrate as N	ND	0.1 mg/l
Chloride	9.9 mg/l	3.0 mg/l
Silica as SiO2	10.1 mg/l	0.2 mg/l
Calcium	27 mg/l	0.2 mg/l
Iron	0.29 mg/l	0.1 mg/l
Magnesium	8.1 mg/l	0.2 mg/l
Manganese	0.01 mg/l	0.01 mg/l
Potassium	ND	5.0 mg/l
Sodium	83.3 mg/l	5.0 mg/l
Hardness as CaCO3	100 mg/l	0.7 mg/l
Nitrite as N	ND	0.01 mg/l

ND = Not Detected

Table H.2
Summary of Inorganic Chemical Analyses Conducted on Water Samples from Transwestern Pipeline Company Supply Well No. 1 (TCP-1)

Date: Feb. 13, 1991
Laboratory: ENSECO, Houston
Lab ID: 000867

Parameter	Results	Reporting Limits
Specific Conductance @25C	482 umhos/cm	1.0 umhos/cm
Alkalinity, Total as $CaCO_3$	229 mg/l	5.0 mg/l
Alkalinity, Bicarb. as $CaCO_3$	167 mg/l	5.0 mg/l
Alkalinity, Carb. as $CaCO_3$	62.3 mg/l	5.0 mg/l
Alkalinity, Hydrox. as $CaCO_3$	ND	5.0 mg/l
Total Dissolved Solids	351 mg/l	10.0 mg/l
Sulfate	25 mg/l	25 mg/l
Fluoride	0.43 mg/l	0.1 mg/l
pH	8.8 units	
Ammonia as N	ND	0.1 mg/l
Nitrate as N	0.34 mg/l	0.1 mg/l
Chloride	11.9 mg/l	3.0 mg/l
Silica as SiO_2	9.7 mg/l	0.2 mg/l
Calcium	0.6 mg/l	0.2 mg/l
Iron	ND	0.1 mg/l
Magnesium	ND	0.2 mg/l
Manganese	ND	0.01 mg/l
Potassium	ND	5.0 mg/l
Sodium	130 mg/l	5.0 mg/l
Hardness as $CaCO_3$	1.5 mg/l	0.7 mg/l
Nitrite as N	ND	0.01 mg/l

ND = Not Detected

Table H.3
Summary of Inorganic Chemical Analyses Conducted on Water Samples from Transwestern Pipeline Company Supply Well No. 1 (TPC-3)

Date: Feb 13th, 1991
Laboratory: ENSECO, Houston
Lab ID: 000867

Parameter	Results	Reporting Limits
Specific Conductance @25C	637 umhos/cm	1.0 umhos/cm
Alkalinity, Total as CaCO3	281 mg/l	5.0 mg/l
Alkalinity, Bicarb. as CaCO3	198 mg/l	5.0 mg/l
Alkalinity, Carb. as CaCO3	83.1 mg/l	5.0 mg/l
Alkalinity, Hydrox. as CaCO3	ND	5.0 mg/l
Total Dissolved Solids	461 mg/l	10 mg/l
Sulfate	25 mg/l	25 mg/l
Fluoride	0.46 mg/l	0.1 mg/l
pH	9 units	
Ammonia as N	ND	0.1 mg/l
Nitrate as N	0.21 mg/l	0.1 mg/l
Chloride	54.6 mg/l	3.0 mg/l
Silica as SiO2	10.9 mg/l	0.2 mg/l
Calcium	1.0 mg/l	0.2 mg/l
Iron	ND	0.1 mg/l
Magnesium	ND	0.2 mg/l
Manganese	ND	0.01 mg/l
Potassium	ND	5.0 mg/l
Sodium	174 mg/l	5.0 mg/l
Hardness as CaCO3	2.5 mg/l	0.7 mg/l
Nitrite as N	0.016 mg/l	0.01 mg/l

ND = Not Detected

Table H.4
Summary of Inorganic Water Chemical Analyses Conducted on Samples from Monitor Well 5-2B

Date: Feb. 12, 1991
Laboratory: ENSECO, Houston
Lab ID: 000866

Parameter	Results	Reporting Limits
Specific Conductance @25C	1330 umhos/cm	1.0 umhos/cm
Alkalinity, Total as CaCO3	603 mg/l	5.0 mg/l
Alkalinity, Bicarb. as CaCO3	603 mg/l	5.0 mg/l
Alkalinity, Carb. as CaCO3	ND	5.0 mg/l
Alkalinity, Hydrox. as CaCO3	ND	5.0 mg/l
Total Dissolved Solids	919 mg/l	10 mg/l
Sulfate	80 mg/l	25 mg/l
Fluoride	0.21 mg/l	0.1 mg/l
pH	7 units	
Ammonia as N	ND	0.1 mg/l
Nitrate as N	1.6 mg/l	0.1 mg/l
Chloride	97.3 mg/l	3.0 mg/l
Silica as SiO2	20.1 mg/l	0.2 mg/l
Calcium	148 mg/l	0.2 mg/l
Iron	3.5 mg/l	0.1 mg/l
Magnesium	27 mg/l	0.2 mg/l
Manganese	1.8 mg/l	0.01 mg/l
Potassium	ND	5.0 mg/l
Sodium	152 mg/l	5.0 mg/l
Hardness as CaCO3	480 mg/l	0.7 mg/l
Nitrite as N	0.098 mg/l	0.01 mg/l

ND = Not Detected

Table H.5
Summary of Inorganice Water Chemical Analyses Conducted on Samples from Monitor Well 5-3B

Date: Feb. 13, 1991
Laboratory: ENSECO, Houston
Lab ID: 000867

Parameter	Results	Reporting Limits
Specific Conductance @25C	982 umhos/cm	1.0 umhos/cm
Alkalinity, Total as CaCO3	395 mg/l	5.0 mg/l
Alkalinity, Bicarb. as CaCO3	395 mg/l	5.0 mg/l
Alkalinity, Carb. as CaCO3	ND	5.0 mg/l
Alkalinity, Hydrox. as CaCO3	ND	5.0 mg/l
Total Dissolved Solids	716 mg/l	10 mg/l
Sulfate	65 mg/l	25 mg/l
Fluoride	0.42 mg/l	0.1 mg/l
pH	7.7 units	
Ammonia as N	ND	0.1 mg/l
Nitrate as N	3.1 mg/l	0.1 mg/l
Chloride	74.4 mg/l	3.0 mg/l
Silica as SiO2	20.4 mg/l	0.2 mg/l
Calcium	35.2 mg/l	0.2 mg/l
Iron	ND	0.1 mg/l
Magnesium	8.6 mg/l	0.2 mg/l
Manganese	ND	0.01 mg/l
Potassium	ND	5.0 mg/l
Sodium	221 mg/l	5.0 mg/l
Hardness as CaCO3	120 mg/l	0.7 mg/l
Nitrite as N	ND	0.01 mg/l

ND = Not Detected

Table H.6
Summary of Inorganic Water Chemical Analyses Conducted on Samples from Monitor Well 5-6B

Date: Feb. 13, 1991
Laboratory: ENSECO, Houston
Lab ID: 000867

Parameter	Results	Reporting Limits
Specific Conductance @25C	1050 umhos/cm	1.0 umhos/cm
Alkalinity, Total as CaCO3	341 mg/l	5.0 mg/l
Alkalinity, Bicarb. as CaCO3	341 mg/l	5.0 mg/l
Alkalinity, Carb. as CaCO3	ND	5.0 mg/l
Alkalinity, Hydrox. as CaCO3	ND	5.0 mg/l
Total Dissolved Solids	752 mg/l	10 mg/l
Sulfate	88 mg/l	25 mg/l
Fluoride	0.3 mg/l	0.1 mg/l
pH	7.6 units	
Ammonia as N	ND	0.1 mg/l
Nitrate as N	2.8 mg/l	0.1 mg/l
Chloride	107 mg/l	3.0 mg/l
Silica as SiO2	20.1 mg/l	0.2 mg/l
Calcium	43.9 mg/l	0.2 mg/l
Iron	ND	0.1 mg/l
Magnesium	10.8 mg/l	0.2 mg/l
Manganese	0.019 mg/l	0.01 mg/l
Potassium	ND	5.0 mg/l
Sodium	217 mg/l	5.0 mg/l
Hardness as CaCO3	150 mg/l	0.7 mg/l
Nitrite as N	0.16 mg/l	0.01 mg/l

ND = Not Detected

Table H.7
Summary of Inorganic Water Chemical Analyses Conducted on Samples from Monitor Well 5-12B

Date: Feb 13th, 1991
Laboratory: ENSECO, Houston
Lab: 000865

Parameter	Results	Reporting Limits
Specific Conductance @25C	1150 umhos/cm	1.0 umhos/cm
Alkalinity, Total as CaCO3	323 mg/l	5.0 mg/l
Alkalinity, Bicarb. as CaCO3	323 mg/l	5.0 mg/l
Alkalinity, Carb. as CaCO3	ND	5.0 mg/l
Alkalinity, Hydrox. as CaCO3	ND	5.0 mg/l
Total Dissolved Solids	837 mg/l	10 mg/l
Sulfate	95 mg/l	25 mg/l
Fluoride	0.29 mg/l	0.1 mg/l
pH	7.6 units	
Ammonia as N	ND	0.1 mg/l
Nitrate as N	5.7 mg/l	0.1 mg/l
Chloride	168 mg/l	3.0 mg/l
Silica as SiO2	22.3 mg/l	0.2 mg/l
Calcium	48.6 mg/l	0.2 mg/l
Iron	0.16 mg/l	0.1 mg/l
Magnesium	14.4 mg/l	0.2 mg/l
Manganese	ND	0.01 mg/l
Potassium	ND	5.0 mg/l
Sodium	225 mg/l	5.0 mg/l
Hardness as CaCO3	180 mg/l	0.7 mg/l
Nitrite as N	0.018 mg/l	0.01 mg/l

ND = Not Detected

Table H.8
Summary of Inorganic Water Chemcial Analyses Conducted on Samples from Monitor Well 5-18B

Date: Feb. 13, 1991
Laboratory: ENSECO, Houston
Lab ID: 000867

Parameter	Results	Reporting Limits
Specific Conductance @25C	944 umhos/cm	1.0 umhos/cm
Alkalinity, Total as CaCO3	328 mg/l	5.0 mg/l
Alkalinity, Bicarb. as CaCO3	328 mg/l	5.0 mg/l
Alkalinity, Carb. as CaCO3	ND	5.0 mg/l
Alkalinity, Hydrox. as CaCO3	ND	5.0 mg/l
Total Dissolved Solids	673 mg/l	10 mg/l
Sulfate	80 mg/l	25 mg/l
Fluoride	0.39 mg/l	0.1 mg/l
pH	7.6 units	
Ammonia as N	0.29 mg/l	0.1 mg/l
Nitrate as N	0.26 mg/l	0.1 mg/l
Chloride	105 mg/l	3.0 mg/l
Silica as SiO2	18.8 mg/l	0.2 mg/l
Calcium	39.5 mg/l	0.2 mg/l
Iron	0.16 mg/l	0.1mg/l
Magnesium	11.9 mg/l	0.2 mg/l
Manganese	0.1 mg/l	0.01 mg/l
Potassium	ND	5.0 mg/l
Sodium	190 mg/l	5.0 mg/l
Hardness as CaCO3	150 mg/l	0.7 mg/l
Nitrite as N	0.14 mg/l	0.01 mg/l

ND = Not Detected