Final Report

Remedial Investigation
Stages 1 and 2
Emerson Power Transmission (EPT)
Ithaca, New York

February 1990

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LIST OF STANDARD ABBREVIATIONS

General

ARARS	Applicable or Relevant and Appropriate Standards
CLP	Contract Laboratory Program
EPT	Emerson Power Transmission
HSL	Hazardous Substance List
NCP	National Contingency Plan
NYSDEC	New York State Department of Environmental Conservation
NYSEG	New York State Electric and Gas Corporation
POTW	Publicly Owned Treatment Works
SPDES	State Pollution Discharge Elimination System
USGS	United States Geological Survey

Constituents

CH_2Cl_2	Methylene Chloride
cis-1,2-DCE	cis-1,2-Dichloroethylene
MEK	Methyl Ethyl Ketone
PCBs	Polychlorinated Biphenyls
PCE	Tetrachloroethylene
TCA	Trichloroethane
TCE	Trichloroethylene
TOGS	Technical and Operational Guidance Series for Ambient Water Quality Standards and Guidance Values
TPHs	Total Petroleum Hydrocarbons
trans-1,2DCE	trans-1,2-Dichloroethylene
VC	Vinyl Chloride
VOCs	Volatile Organic Compounds
1,1-DCA	1,1-Dichloroethane
1,1-DCE	1,1-Dichloroethylene
1,1,1-TCA	1,1,1-Trichloroethane

Units of Measurement

cm/sec	Centimeters Per Second
CPS	Counts Per Second
ft	Feet
g/cc	Grams Per Cubic Centimeter
mg/g	Milligrams Per Gram
mg/kg	Milligrams Per Kilogram
mg/L	Milligrams Per Liter
ppb	Parts Per Billion
ppm	Parts Per Million
ppt	Parts Per Thousand
umhos/cm	Micromhos Per Centimeter
μg/g	Micrograms Per Gram
μg/L	Micrograms Per Liter
μg/kg	Micrograms Per Kilogram
°F	Degrees Fahrenheit

SECTION 1.0

1.0 INTRODUCTION

Stages 1 and 2 of the Remedial Investigation at Emerson Power Transmission (EPT) were performed in accordance with a Consent Order issued by the State of New York Department of Environmental Conservation (NYSDEC) to EPT on July 13, 1988. The Consent Order incorporates by reference the approved scope of work for Stage 1 and the May 30, 1989 scope of work for Stage 2, which was approved by NYSDEC in a letter dated July 11, 1989. The purposes of the Remedial Investigation were to: (1) evaluate the extent of any impacts on the ground water and subsurface environment around the plant from a release of volatile organic compounds at the plant, (2) evaluate these impacts with respect to applicable environmental standards and criteria, and (3) evaluate whether potential receptors that may be subject to impacts exist in the vicinity of the plant. The information generated from this study and previous studies will form the basis for a Feasibility Study that will evaluate remedial alternatives for the site, if necessary.

Emerson Power Transmission Company, formerly Morse Industrial Corporation, manufactures primarily steel roller chain, which is fabricated in a range of sizes. EPT/Morse has operated at the site since 1906, and is the original owner of all facilities on the property. EPT/Morse has been a subsidiary of Emerson Electric Co. since January 1983. Before January 1983, Morse was a division of Borg-Warner Corporation.

During early 1987, trichloroethylene (TCE) was detected in batches of waste oil that were comprised, in part, of oil skimmed from the surface of the water in the underground fire reservoir at the EPT facility. Subsequent sampling and analysis by plant personnel revealed that TCE was present in the reservoir water. At that time it was decided that a more detailed investigation of the reservoir and its contents was warranted.

As required by law, on February 9, 1987, EPT notified the New York State Department of Environmental Conservation (NYSDEC) about the existence of the solvents in the reservoir. EPT then began an assessment of the situation, which included sampling the liquids and sludges in the reservoir compartments and examining the concrete walls for leakage. The reservoir was emptied in accordance with applicable laws and regulations. New York State included the EPT site on its registry of Inactive Hazardous Waste Disposal Sites in July 1987.

After detailed negotiations, NYSDEC issued a Consent Order that governs the investigation and possible cleanup of the EPT facility to EPT on July 13, 1988. This report and the investigations discussed herein are required by paragraphs V, VI, and VII of the Consent Order.

Based on the detection of TCE in the fire water reservoir at EPT, Radian conducted a preliminary environmental assessment from February 1987 to July 1987.

The preliminary assessment included sampling numerous points on and off site and installing five monitoring wells. These activities and associated analytical results, findings, and conclusions were detailed in the Radian report entitled Preliminary Environmental Assessment of the Fire Water Reservoir, Morse Industrial Corporation, Ithaca, New York, dated July 13, 1987.

In the preliminary assessment report, Radian concluded that water and sludge in the reservoir contained significant levels of volatile organic compounds (VOCs); thus, the reservoir was one obvious source of VOC contamination at the site. Radian also concluded that hydraulic communication between the reservoir and the underlying ground-water regime was likely. Ground-water flow at the site is to the northeast and is strongly influenced by fractures in the bedrock. Analysis of samples collected on site demonstrated that volatile organic compounds were present in the overburden (unconsolidated materials), surface water, sediments, and ground water from wells and seeps, with the highest concentrations detected in samples collected from the vicinity of the fire reservoir. Radian further concluded that additional investigation of this area was warranted to verify the source(s) of these compounds on the property.

1.1 Remedial Investigation Objectives and Scope of Work

Paragraphs V, VI, and VII in the Consent Order issued by NYSDEC to EPT required EPT to conduct a Remedial Investigation. The Remedial Investigation was performed in two stages in accordance with the Work Plans approved by NYSDEC and referenced in the Consent Order. The central objective of the Remedial Investigation was to perform investigations of ground water and other environmental media to assess the potential impact of any contamination at the site on possible receptors in the area. These investigations continued the characterization initiated during the preliminary environmental site assessment.

In summary, the four specific objectives of the Remedial Investigation were to:

1) Collect data to further characterize the geology, hydrogeology, and chemistry of the site and adjacent area;
2) Collect data necessary to define the source, nature, and extent of chemical contaminants in the environment and to describe the nature of their movement;
3) Collect data needed to assess the potential human health risks associated with the chemical releases, both at the site and at the adjacent properties; and
4) Collect data to provide the basis for the development, evaluation, and selection of remedial alternatives, if necessary.

Radian performed the following activities as part of the Stage 1 Remedial Investigation, as required by the Consent Order and in accordance with the National Contingency Plan (NCP):

- Reviewed and incorporated existing data from previous efforts into Stage 1 activities;

- Collected and analyzed soil gas samples from on- and off-site areas to provide preliminary indicators of potential contaminant migration;

- Conducted geologic mapping of bedrock type, and the occurrence and orientation of fractures and other relevant features in the site vicinity;

- Drilled, logged, installed, and developed 13 monitoring wells;

- Acquired a suite of borehole geophysical logs from all rock holes;

- Measured water levels in all wells and in the fire reservoir during fieldwork on site;

- Purged all wells of standing water and collected ground-water samples for chemical analysis;

- Drilled, logged, and collected samples from 12 soil borings in the area of the former scrap conveyor and railroad car loading track;

- Collected samples of water from the fire reservoir; samples of surface water and sediment from three surface drainages; samples of ground water from on-site wells, off-site wells, and seeps at the base of the slope; and samples of water from two manholes;

- Performed field permeability (slug) tests in the monitoring wells;

- Analyzed the data obtained and prepared a report describing the investigation activities, analyses, results, and conclusions; and

- Prepared recommendations for a Stage 2 investigation that would fulfill the objectives previously set forth.

At the conclusion of Stage 1, the Consent Order and NYSDEC required that additional data be collected to complete the delineation of the extent of subsurface impacts from the EPT facility. Radian performed the following activities as part of the Stage 2 Remedial Investigation, as required by the Consent Order, as approved by NYSDEC and in accordance with the NCP:

- Evaluated which state and federal standards, criteria, advisories, and guidance were applicable or relevant and appropriate to the site;
- Performed a more focused and in-depth examination of plant chemical handling and housekeeping practices to clarify possible sources of contaminants detected in environmental media on and around the site;
- Installed additional monitoring wells to better define the lateral and vertical extent of contaminants in ground water;
- Conducted additional monitoring of the fire reservoir, and additional sampling and analysis of ground water, seeps and pipes, surface water, sanitary sewers, water supply, and bedrock;
- Conducted limited additional sampling and analysis of soils for total petroleum hydrocarbons (TPHs) and polychlorinated biphenyls (PCBs) from the scrap conveyor/loading area; and
- Evaluated instances in which contaminant concentrations exceed the applicable, relevant, or appropriate federal and state standards.

Proposed Work Plans discussing the specific study objectives, data collection and analysis methods, and quality assurance procedures for each stage were submitted to NYSDEC for its review and approval. The final versions of the Work Plans, revised in accordance with NYSDEC's comments and ultimately approved by NYSDEC, were incorporated by reference into the Consent Order and were included as an attachment thereto. (See the <u>Revised Work Plan for the Stage 1 Remedial</u>

Investigation Program (dated May 5, 1988) and the Revised Work Plan for the Stage 2 Remedial Investigation (dated May 30, 1989).

1.2 Applicable Environmental Standards and Criteria

As required by the Consent Order, environmental data obtained from the Remedial Investigation has been evaluated against applicable or relevant and appropriate environmental standards. NYSDEC indicated that the standards applicable to EPT are those for ground water classified as drinking water supply (Class GA) as promulgated in 6 NYCRR, Part 703. NYSDEC has provided EPT with the Division of Water's Technical and Operational Guidance Series for Ambient Water Quality Standards and Guidance Values (TOGS) that summarize the Part 703 standards for Class GA ground water. Tables 1-1 and 1-2 summarize the TOGS that exist for Class GA ground water for some of the compounds of interest in ground water. (All tables and figures for Section 1.0 are presented at the end of Section 1.0.)

The data obtained during the Remedial Investigation has been compared with the TOGS pursuant to NYSDEC's directive. (This evaluation is discussed in Section 4.0.) However, EPT does not believe that classification of ground water underlying the site as drinking water supply is appropriate given the low-yielding nature of the bedrock aquifers underlying the site, and given the current use of a municipal water supply system in all areas around the site. The Tompkins County Health Department (R. Ewald, October 13, 1989) has confirmed that all City of Ithaca residents obtain their drinking water supply from the Ithaca Reservoir in Six Mile Creek. The municipal system also serves locations upgradient of EPT in the Town of Ithaca. There are no existing records of past water supply wells in Ithaca. Further, EPT does not believe that the system underlying the site is properly termed a "ground water."

1.3 Site History and Operations

The site history is based on information available from employee interviews and plant files that cover the past 20 years. Reconstruction of past operations at the site indicates that on-site activities have included metal stamping, solvent degreasing, purification of spent TCE by distillation, copper plating, cadmium plating, and wire drawing.

Interviews with plant personnel indicate that Borg-Warner's automotive division operated a large number of metal stamping machines in the "507" area located inside the main plant building, just south of the fire water reservoir. One estimate indicated that at least 60 metal piercing and blanking machines were operated in this area from the early 1950s until 1977, when these operations were moved. The area also reportedly included a metal scrap conveyor and several solvent degreasers installed in the early 1960s.

In the early 1950s, the metal stamping machines may have operated without oil drip pans underneath the machinery, allowing spillage of oil onto the floor surrounding the machines. Solvents were periodically applied to the concrete floor with mops to remove accumulated build-up of residual oil. This practice provided the potential for solvents to seep through the concrete floor through visually apparent cracks or drilled holes that existed in the slab. Solvents from floor cleaning and routine maintenance of the degreasing units may also have been disposed via floor drains that were connected to the sanitary sewers.

In the 1960s, a steam-heated solvent distillation unit was reportedly installed to allow reuse of TCE from the degreasers in the "507" area. Interviews with plant personnel indicated that between 1970 and approximately 1978, spent TCE was recovered for reuse, in all likelihood, by distillation on site. A small batch distillation unit was installed in 1970 and was replaced by a larger still in 1973. Subsequently, the larger still was apparently removed. No documentation was found regarding the removal and disposal of the still or of any waste materials or by-products resulting from its operation. No usage of TCE after 1978 has been documented. It is known that all such usage had ceased by 1983.

A solvent degreaser was also located in area "116," the chain assembly area, on the ground floor of the western section of the main building. At one time, solvent reportedly leaked from the degreaser into the heating/cooling system and was subsequently released into a series of manholes and then to the sanitary sewer. The installation date of this unit and the date the leak occurred is not known. The leak was repaired and the solvent release to the sanitary sewer was eliminated. In 1986, the pipe connecting the degreaser to the manholes was removed and the manholes were pumped out and cleaned. Currently, the used solvents from the degreaser, primarily 1,1,1-trichloroethane (1,1,1-TCA), are drummed and disposed off site by a contractor.

Five in-ground oil quenching tanks were reportedly located in the main plant building, north and east of the "507" area. These tanks were cylindrical with an approximate diameter of 4 feet and a height of 20 feet. Large baskets containing metal parts to be quenched were lowered into the oil tanks and allowed to cool. Four of the five tanks have been taken out of service and are reportedly no longer accessible. The fifth tank is currently still in use. No inventory of the quench oil in the tank was maintained, and additional oil was added as it was consumed by the cooling operations. No leaks are known to have occurred from any of the tanks.

The copper plating operation was active for about 15 years, from 1967 to November 1982. This operation used copper cyanide and involved cleaning metal parts with water and soap, and etching with acid prior to plating. The cadmium plating operation was active from about 1960 to 1975, and involved essentially the same elements as the copper plating operation. A wire mill operated for approximately 15 years, from 1969 to early 1984. Wire pins were made for roller chain in a process that involved acid pickling and cleaning with phosphate soap before plating.

Current operations at the facility include metal stamping, heat treating, oil quenching, parts washing (using both alkaline cleaning solutions and organic halogenated and non-halogenated solvents), and final product assembly. Since 1983, metal stamping and steel roller chain assembly have been the primary operations. These manufacturing operations generate waste oil. Waste oil is stored on site in drums and in bulk containers for less than a month, and is then removed as a non-hazardous material by a commercial waste oil handling service.

Fluids used in present operations consist of machine oils and solvents. Two types of machine oil are used: a water-based synthetic lubricant called "Vantrol 293" and an oil-based substance called "Five Star". Solvents currently used at the facility include mineral spirits (non-halogenated, non-aromatic, petroleum-derived solvents) purchased from Safety Kleen Company; a Freon degreaser purchased under the trade name "TMC;" 1,1,1-trichloroethane (TCA), purchased under the trade name "chloroethene;" and methyl ethyl ketone (MEK). Trichloroethane has been used on site for the past 17 years (since 1973), while MEK has been used in small quantities for electron beam welding from 1983 to the present. All spent solvents are currently manifested by EPT as hazardous waste and are reclaimed off site.

Solvents which were used before 1983, but not used since that time, include trichloroethylene (TCE) and "Safe-Tee Solvent F.O.-128," a commercially available mixture of aliphatic and chlorinated compounds, including methylene chloride (CH_2Cl_2) and tetrachloroethylene (PCE). Safe-Tee Solvent F.O.-128 was used for 10 years, from 1973 to 1983. A document search revealed that the earliest record documenting the use of TCE was from 1967, and it was known to be used extensively until approximately 1978, when documentation of its use is no longer found. The peak usage of TCE was reported to have been 1,200 gallons per week from 1976 through 1978.

1.4 Physical Setting

The EPT plant occupies approximately 94 acres located adjacent to Highway 96B in Ithaca, New York. The property straddles the southern boundary between the city of Ithaca and the town of Ithaca, in Tompkins County (Figure 1-1). The surface of the property slopes toward the northwest. Elevations on site range between 450 and 720 feet above mean sea level.

The EPT site is located in the Oswego River basin (Crain, 1974). Surface water from the vicinity of the property drains into Six Mile Creek, which in turn drains into Lake Cayuga and eventually into Lake Ontario.

1.5 Regional Geological Setting

The EPT plant is located in the Finger Lake Region of the Appalachian Plateau province of the Appalachian basin. Figure 1-2 shows a generalized geological map of the Lake Cayuga area, which is part of the Finger Lake Region (Rickard and Fisher, 1970). Strata in this region consist of sedimentary rocks that are folded by broad, east-northeast-trending open folds (Wedel, 1932).

Glacial deposits in the Finger Lake Region consist of till, lake, and outwash deposits (Coates, 1974). Till consists of poorly-sorted, unstratified (unlayered), well-compacted clay with minor amounts of silt, sand, pebbles, and cobbles. Generally, till dominates on the hilltops and hillsides, is thinner than 100 feet, and in many areas is less than 10 feet thick. Glacial lake and outwash deposits consist of well-sorted, stratified (layered) sediment of either thin bedded silt and clay or of gravel and sand pockets surrounded by silt or clay, respectively. Glacial lake and outwash deposits dominate in the valleys and have been reported to be in excess of 1,000 feet thick in some areas. Outwash is typically much more permeable and thus yields greater amounts of ground water than does till.

Bedrock in the Finger Lake Region is comprised of Devonian-age sedimentary rocks covered in places by glacial deposits (Richard and Fisher, 1970). Surface exposure of these sedimentary rocks is sparse and is generally confined to road cuts or steeply sloping hillsides. The dominant bedrock lithology is siltstone, with lesser amounts of shale, and minor amounts of limestone. Figure 1-3 shows a generalized stratigraphic column for the Ithaca area.

Fractures are visible in nearly every exposure of bedrock in this region. The variation in trend and in morphology of individual fractures present in the Finger Lake Region, and specifically in the Ithaca area, has been studied in detail by Sheldon (1912), Parker (1942), Engelder and Geiser (1980), Podwysocki (1982), and Engelder (1986). These studies showed that these fractures have two consistent orientations. One set of fractures trends north-northwest and the other trends east-northeast. The studies indicate that these fracture sets are present throughout the entire bedrock sequence.

Although few faults are apparent in the surficial strata, Podwysocki, et al. (1982) showed that many north-south and north-northwest-trending linear stream segments correspond to strike slip faults that displace folds at depth. Moreover, Sheldon (1912) showed that thrust faults of minor displacement are present in outcrops in areas near Ithaca.

1.6 Report Organization

The remainder of this report describes in more detail the activities listed in the preceding section and discusses the results of the two stages of Remedial Investigation, as shown below:

- Section 2.0 summarizes the activities performed during the site investigation programs.
- Section 3.0 presents the current understanding of site geology and hydrogeology.
- Section 4.0 presents the analytical results and the relevant findings regarding site chemistry.
- Section 5.0 presents conclusions regarding site geology, hydrogeology, and chemistry.
- Section 6.0 provides references.

Accompanying appendices provide details of investigation activities and copies of analytical data reports. These discussions are supplemented by the previous environmental assessment report, as well as by the Work Plans prepared for Stages 1 and 2, which provide additional information and details about the site and about the problem being investigated.

TABLE 1-1. NEW YORK STATE AMBIENT WATER QUALITY STANDARDS AND GUIDANCE VALUES (TOGS)[a] FOR VOLATILE ORGANIC COMPOUNDS AND POLYCHLORINATED BIPHENYLS

Water Supply Classification	Standard (μg/L)		Guidance Value (μg/L)	
	A[b]	GA[c]	A[b]	GA[c]
Compound				
Trichloroethylene		10	3	
Trans-1,2-Dichloroethylene			50	50
Benzene		ND[d]	1.0	
1,1-Dichloroethane			50	50
Vinyl Chloride		5.0	0.3	
Chloroform	0.2	100		
1,1-Dichloroethene			0.07	0.07
Total Xylenes			50	50
Methylene Chloride			50	50
1,1,1-Trichloroethane			50	50
Bromodichloromethane			50	50
Tetrachloroethylene			0.7	0.7
Toluene			50	50
1,2-Dichloroethane	0.8			0.8
Polychlorinated Biphenyls	0.01	0.1		

[a] Technical and Operational Guidance Series.
[b] Applicable to drinking water supply (surface water).
[c] Applicable to drinking water supply (ground water).
[d] Not detectable.

TABLE 1-2. NEW YORK STATE AMBIENT WATER QUALITY STANDARDS AND GUIDANCE VALUES (TOGS)[a] FOR METALS AND INORGANIC COMPOUNDS

	Standard (µg/L)		Guidance Value (µg/L)	
Water Supply Classification	A[b]	GA[c]	A[b]	GA[c]
Compound				
Antimony			3	3
Arsenic	50	25		
Barium	1,000	1,000		
Beryllium			3	3
Cadmium	10	10		
Chromium	50	50		
Copper	200	1,000		
Iron	300	300		
Lead	50	25		
Magnesium	35,000			35,000
Manganese	300	300		
Mercury	2	2		
Selenium	10	20		
Silver	50	50		
Thallium			4	4
Zinc	300	5,000		
Cyanide	10	200		

[a] Technical and Operational Guidance Series.
[b] Applicable to drinking water supply (surface water).
[c] Applicable to drinking water supply (ground water).

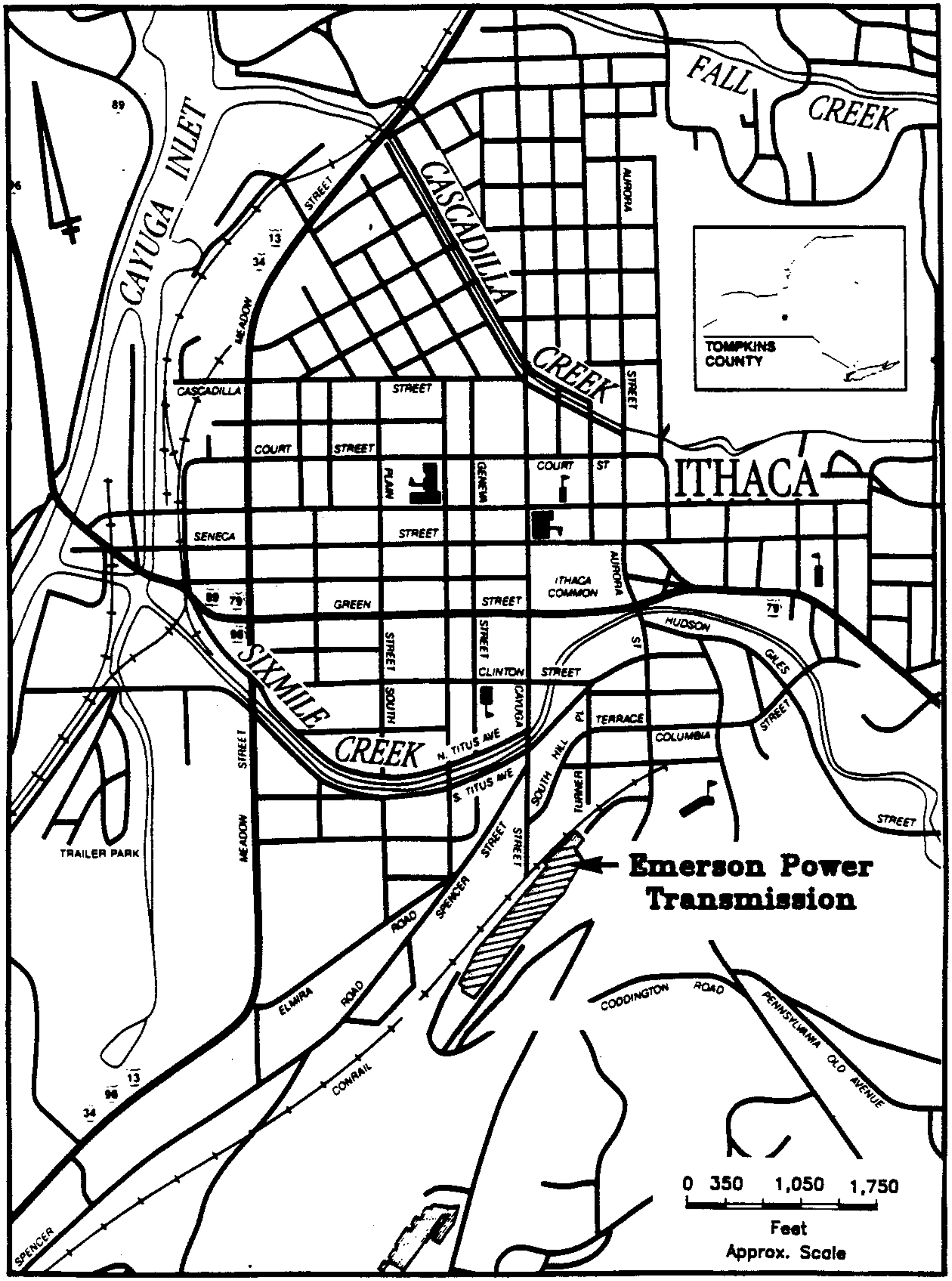

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Figure 1–1. Site Location Map, Emerson Power Transmission, Ithaca, New York

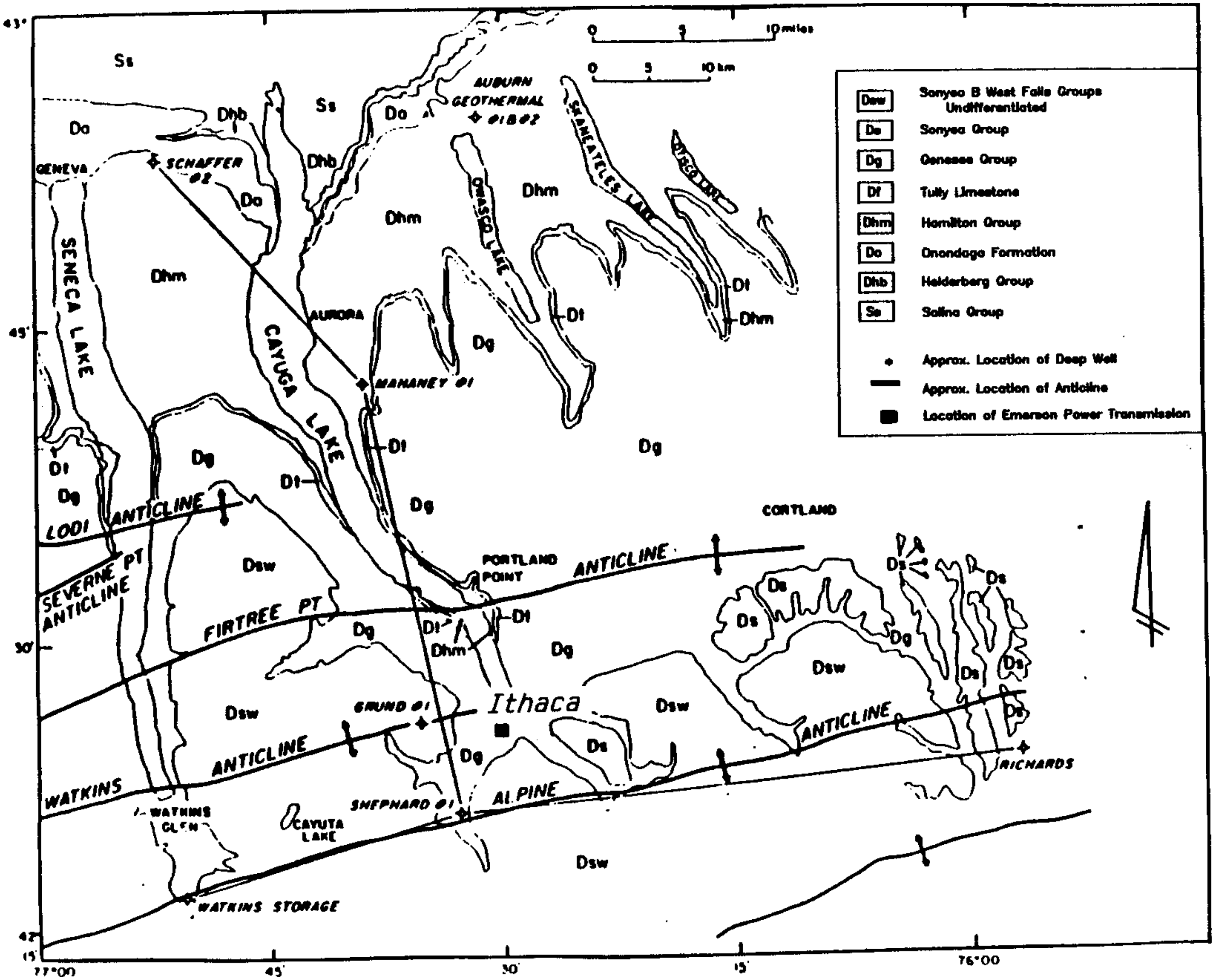
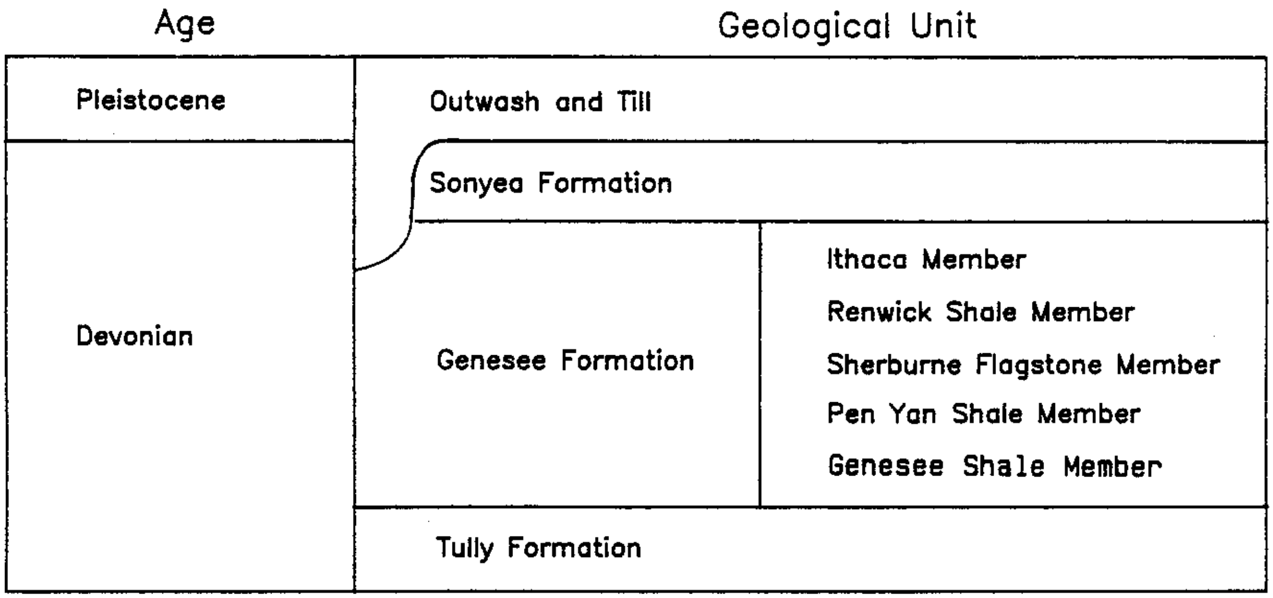


Figure 1–2. Generalized Geologic Map of Area Surrounding Emerson Power Transmission, Ithaca, New York (after Rickard and Fisher, 1970)



Age	Geological Unit	
Pleistocene	Outwash and Till	
Devonian	Sonyea Formation	
	Genesee Formation	Ithaca Member Renwick Shale Member Sherburne Flagstone Member Pen Yan Shale Member Genesee Shale Member
	Tully Formation	

Note: The outwash and till unconformably overlie the Sonyea and Genesee Formations in the Ithaca area. The geologic discussion in the text is confined to the Genesee Formation because the project site lies entirely within this unit. In the Ithaca area, the Genesee Formation is approximately 950 feet thick.

Figure 1-3. A Portion of the Upper Devonian Stratigraphic Column for the Ithaca Area (Modified after Dewitt and Coltan, 1978)

SECTION 2.0

2.0 SUMMARY OF SITE INVESTIGATION PROGRAM

All site investigation activities were conducted according to the specifications and protocols detailed in the Consent Order, the Stage 1 and Stage 2 Work Plans, and the Revised Sampling and Analysis Plan. This section discusses any modifications to field procedures (approved by NYSDEC) and provides additional details on actual protocols used during the investigation. All tables and figures for Section 2.0 are presented at the end of Section 2.0.

2.1 Soil Gas Sampling and Analysis

Soil gas sampling and analysis is used as a screening technique to identify volatile constituents and to approximate the extent of contamination in soils and shallow ground water. This technique does not provide direct sampling of soils and ground water, and is suitable only for chemical species that will volatilize in the vadose (unsaturated) zone, such as chlorinated solvents. Moreover, there is not always a direct correlation between concentrations of such constituents in soils and ground water and concentrations of such constituents measured in soil gas. The screening results must be confirmed by direct sampling of soils and ground water before the data generated can be used to reliably estimate the extent of subsurface contamination. The methods used for sampling and analyzing soil gas are detailed in Appendix A.

The soil gas surveys of the EPT plant property and surrounding area required by NYSDEC were conducted in two phases. On August 10 and 11, 1987, at the request of NYSDEC, a preliminary soil gas survey of selected areas of the site was performed. The sole objective of this study was to evaluate whether any contaminants that could be leaving the EPT property could be placing the residents of houses just northeast of the plant at risk.

In the preliminary survey, fifty-two soil gas samples were collected at intervals along four lines labeled A, B, C, and D (Plate 1) (Plate 1 is located at the end of the report text). Line A was located upgradient of the plant to serve as an indication of background levels. Lines B, C, and D were located directly downgradient of the plant and the New York State Electric and Gas Corporation (NYSEG) substation. The samples were analyzed for vinyl chloride (VC); methylene chloride (CH_2Cl_2); trans-1,2-dichloroethylene (trans-1,2DCE); 1,1-dichloroethane (1,1-DCA); trichloroethylene (TCE); toluene; xylene; and tetrachloroethylene (PCE). The analytical results of this preliminary survey are summarized in Section 4.1, and a detailed report of the results is provided in Appendix A.

A more extensive soil gas survey was performed at the site during November 17 - December 7, 1987, as part of the Remedial Investigation. This study was designed to provide screening data on the possible extent of subsurface contamination in the vicinity of the EPT plant. The specific objectives of this survey were to:

(1) Estimate the boundaries of the vapor plume(s), if any;

(2) Provide data to refine the siting of ground-water monitoring wells;

(3) Evaluate the extent of contaminant migration off site, if any; and

(4) Aid in the identification of subsurface contamination source(s), if any.

For this more extensive survey, 118 soil gas samples were collected at intervals along five lines and at individual locations around the plant, as approved by NYSDEC (Plate 1). One line of samples also was collected during this survey to represent background conditions. This line, also designated Line A, was located on the southeast side of the plant in the vicinity of the Line A used during the preliminary soil gas survey at the site. The remaining downgradient survey lines were labeled D, E, F, and G. In addition, 13 soil gas samples were taken at individual locations not on the survey lines, but within the soil gas survey area. All soil gas sample locations are shown on Plate 1. All samples, including quality control samples, were analyzed for 1,1,1-trichloroethane (1,1,1-TCA); CH_2Cl_2; cis-1,2-dichloroethylene (cis-1,2-DCE); 1,1-DCA; TCE; benzene; toluene; xylene; and PCE. The analytical results of this more extensive survey are summarized in Section 4.1, and copies of the analytical data are provided in Appendix A.

2.2 Geologic Mapping

As part of the Remedial Investigation, Radian developed a conceptual model of the geology of the site to describe the lithology and structural configuration of the strata and the nature of the fractures in bedrock at the site. This was done to examine those subsurface features that potentially control entry of contaminants into and migration of contaminants within the subsurface environment. Geologic mapping in the field was used to obtain the necessary information on bedrock type and occurrence of fracturing, features that likely influence the movement of ground water.

The orientation and nature of joints present in the bedrock outcrops were investigated in the field at 16 locations on and around the EPT property (Figure 2-1). Appendix B presents a detailed discussion of the locations investigated, methods used, and observations made in the field.

The occurrence of partings, as well as joints, in the bedrock was investigated by examining the rock cores obtained during the drilling of monitoring wells. Appendix C presents a detailed discussion of the cores obtained, the methods used to log the cores, the features observed in the cores, as well as copies of the core logs. Section 3.0 presents a detailed discussion of the site geology and the significance of these bedding plane partings and joint sets.

2.3 Drilling and Installation of Monitoring Wells

A total of 23 monitoring wells have been installed on the EPT property and its vicinity. Five wells were installed during the preliminary assessment and existed at the start of the Remedial Investigation. During the Remedial Investigation, in accordance with the Stage 1 and Stage 2 Work Plans referenced in the Consent Order, 18 monitoring wells were installed on the EPT property and on several adjacent off-site locations (Figure 2-2, Plate 1).

The locations of the Stage 1 and Stage 2 wells were selected after review of known site characteristics and soil gas survey results, and were modified in the field where necessary (with the approval of NYSDEC) to avoid access, utility, and other problems. The well locations were selected to enable collection of data on the potential areal extent of contamination and on the relevant physical and hydraulic characteristics of the potentially affected area. The finished depths of these wells were selected to represent three generalized depth zones in the materials underlying the site, and to provide additional information on the depth of vertical contaminant migration and the variation of physical and hydraulic aquifer characteristics with depth.

Wells designed to sample ground water in the overburden were the shallowest wells installed. These were designated by well numbers MW-__-25. (MW-_ is keyed to a location (see Plate 1), while the latter part of the number (-25) refers to the expected maximum depth of the well in feet below ground surface.) The actual finished depths of the overburden wells were less than 25 feet. Wells also were installed to sample ground water near the top of bedrock. These wells were designated MW-__-40, using the same nomenclature. The actual finished depths of the shallow bedrock wells ranged from 38 to 48 feet.

Wells also were installed to sample ground water at an intermediate depth in bedrock approximately 100 to 150 feet below ground surface. These wells were designated MW-__-100 or MW-3-150. The actual finished depths of the intermediate bedrock wells were approximately 100 feet for wells MW-__-100 and approximately 150 feet for well MW-3-150. Well numbers MW-1, MW-2, MW-3-31 (formerly MW-3), and MW-4 were shallow bedrock wells existing at the start of the Remedial Investigation. Well number MW-3-13 (formerly MW-3s) was an existing shallow overburden well. A detailed discussion of the rationale for well locations and depth selections can be found in the Revised Work Plan for the Stage 1 Remedial Investigation Program (dated May 5, 1988) and the Revised Work Plan for the Stage-2 Remedial Investigation (dated May 30, 1989), prepared by Radian Corporation, and attached to the Consent Order.

2.3.1 Borehole Drilling and Rock Coring

Drilling was performed by Empire Soils Investigations, Inc., under Radian's supervision, using hollow stem augers, a tri-cone roller bit with both water and air rotary, and NX (3-inch) core barrels. All borings and rock cores were logged in detail by Radian geologists. A discussion of drilling methods and copies of the boring logs and core logs are presented in Appendix C.

Several changes to well locations were made and approved by NYSDEC at the initiation of the Stage 1 study. The locations of wells MW-5-25, MW-5-40, MW-13-25, and MW-15-40 (all located on the driveway on the north side of the main plant building, as shown on Figure 2-2) were modified slightly to avoid numerous utility corridors in the driveway. The location for well MW-8-40 also was moved to the middle of the plant access road to avoid overhead utility lines at that location (Figure 2-2). The locations for wells MW-7-40 and MW-16-100 were modified because of the lack of physical access on the northeast side of South Cayuga Street, and the need to provide clear access to the NYSEG substation (Figure 2-2).

In addition, changes to well locations for MW-9-40 and MW-9-100 were made and approved by NYSDEC at the initiation of the Stage 2 study. The locations for these wells were modified because of the lack of physical access on the southeast corner of the intersection of South Cayuga Street, and the EPT access driveway downhill from the plant.

2.3.2 Well Installation and Development

The 18 Stage 1 and Stage 2 monitoring wells were installed in boreholes drilled to three depth ranges. Three shallow monitoring wells, ranging in depth from approximately 11 to 18 feet, were installed in the overburden. Nine shallow bedrock monitoring wells, ranging in depth from approximately 38 to 48 feet, were installed in the top of the bedrock. Six intermediate depth monitoring wells were installed in the bedrock, five to a depth of 100 feet and one to a depth of 150 feet.

Three different configurations of well construction were used to address differing considerations at each depth range. A typical well construction for overburden monitoring wells installed at the EPT site is shown in Figure 2-3. A typical well construction for shallow bedrock wells installed at EPT is shown in Figure 2-4, and for intermediate depth bedrock wells installed at EPT in Figure 2-5. Appendix D presents a summary of the specifications of each well completed, including the five wells installed during the preliminary environmental assessment. Appendix D also includes both a discussion of the well construction techniques used at the site and copies of the well completion logs.

Several wells were drilled at greater depths than originally planned, with the approval of NYSDEC. Well MW-15, originally planned to be a shallow overburden well, was deepened because ground water was not encountered in the overburden. Wells MW-8-40 and MW-17-40 also were deepened slightly to ensure a sufficient length of open interval below the first encountered water, and to ensure that the depth zone of interest would be monitored at these locations.

Based on the detection of contaminants of concern in the ground-water sample from well MW-3-100, the borehole for well MW-3-150 was cored down to a depth of 175 feet below the ground surface, with NYSDEC's concurrence. Examination of the rock core from this boring revealed no apparent fracture porosity below a depth of 150 feet. The well was screened from a depth of 130 to 150 feet.

All monitoring wells were developed following completion. Many of the on-site wells were pumped dry during development. Water extracted during this process was placed in 55-gallon drums adjacent to the wellhead for storage, until a decision could be made on final disposition based on the results of sample analysis. Additional details of well construction and development are presented in Appendix D.

2.3.3 Borehole Geophysical Logging

Geophysical logging of uncased and cased boreholes was used to investigate the physical characteristics of the bedrock underlying the site. In addition, the information obtained was used to correlate lithologic and structural features between borehole locations. Because the data is obtained in situ, at depth within the borehole, it can provide more direct and detailed information on the subsurface than is available from surface investigation methods. A variety of borehole geophysical logs were used to examine several different characteristics of the formation, such as lithology, fracture occurrence, ground-water flow, and other characteristics. As logging tools were lowered into the borehole, their depth positions were recorded on paper in conjunction with the measurements generated at those depths.

For boreholes or uncased wells, logging included caliper, gamma, neutron, density, temperature, fluid conductivity, resistivity, resistance, and spontaneous potential logs. For cased wells, logging included gamma and neutron logs. Appendix E describes the types of logs that were run in boreholes at the EPT site, provides copies of the logs, and discusses their use in interpreting subsurface characteristics. The results of the borehole geophysical logging have been incorporated into the understanding of site geology discussed in Section 3.0.

2.4 Sample Collection and Analysis

All samples were collected, handled, and transferred according to the specifications and protocols detailed in the Stage 1 and Stage 2 Work Plans, and the Revised Sampling and Analysis Plan. The following subsections provide supplemental details on sampling protocols used in the field. Chain-of-custody procedures were followed throughout the sampling and analysis effort. Table 2-1 summarizes the analyses performed for each type of sample, in accordance with the Stage 1 and Stage 2 Work Plans and the Revised Sampling and Analysis Plan. Appendix G presents more detailed information on analyses performed on each individual sample.

2.4.1 Ground-Water Sampling and Analysis

During the Stage 1 investigation, two ground-water samples were collected from well MW-3-100 (the first well completed during the Stage 1 investigation) on July 8, 1988 and on July 16, 1988, for immediate analysis of volatile organic compounds using EPA Methods 601 and 602. The results were obtained within 48 hours to provide guidance on the final depth of the well designated MW-3-C in the Stage 1 Work Plan (installed as MW-3-150). The first sample was collected after the well was developed and then purged with a teflon bailer. The second sample was collected using a teflon bailer, after well development and purging with an air displacement pump, to provide a quality assurance check on the first set of results.

During the Stage 1 investigation, between August 8 and 16, 1988, ground-water samples were collected from all 13 wells installed during Stage 1, as well as from the five wells installed during the preliminary assessment, after the wells were developed with an air displacement pump and after a dedicated stainless steel/teflon bladder sampling pump was installed in each well. Water level measurements were taken using a chalked metal tape calibrated in one hundredths of a foot. Before sample collection, the wells were purged, using the dedicated bladder pump, of a minimum of three well volumes or until they went dry. Well MW-17-40 was purged using a dedicated purge pump, due to the large volume of standing water in the well. To monitor stabilization, pH and specific conductivity measurements were taken during the purging process.

During the Stage 2 investigation, between September 13 and 18, 1989, ground-water samples were collected from all five wells installed during Stage 2, as well as from 17 of the 18 existing wells installed during the preliminary assessment and the Stage 1 investigation. One of the existing wells, MW-6-100, was dry during this time; therefore, no samples could be collected from this well. Samples were collected after the new wells were developed and after a dedicated stainless steel/teflon bladder sampling pump was installed in each well. Four of the new wells were developed with an air displacement pump, and one new well, MW-5-100, was developed using a teflon bailer. Water level measurements were taken using an electronic water level probe calibrated in feet, and a fiberglass tape calibrated in one-hundredths of a foot. Measurements were taken to the nearest five one-hundredths of a foot. Before sample collection, the wells were purged of a minimum of three well volumes or until they went dry. A dedicated bladder pump was used to purge each well.

Following recovery, all wells were sampled within 24 hours of purging using the dedicated bladder pump, with some exceptions. Several wells (MW-3-31, MW-5-25, and MW-16-100) were sampled over a 48-hour period due to insufficient recovery in a 24-hour period to provide the required sample volume for all the specified analyses. All sample containers were filled directly from the teflon-lined discharge tube of the bladder pump. Samples were shipped to the laboratory for analysis, as listed in Table 2-1 and in Appendix G.

At the conclusion of the Stage 2 investigation, on November 2, 1989, seven of the existing wells were resampled. Ground-water samples were collected from the four wells in the MW-3 well cluster and from the three wells in the MW-5 well cluster to evaluate the validity of the initial Stage 2 results for these wells. The samples were collected using procedures consistent with those described above for Stage 2. Each sample collected during this effort was split at the time of collection and was analyzed by two different laboratories to provide a greater degree of confidence in the results. The analytical data for the ground-water samples and their significance are presented and discussed in Section 4.3.

During Stage 1, sample pH, specific conductivity, and temperature measurements were recorded at the time of sample collection using a portable combination pH/conductivity meter and a digital temperature probe. During Stage 2, sample pH and specific conductivity were measured in the laboratory upon receipt of the samples. These measurements are presented in Appendix G.

2.4.2 Soil Sampling and Analysis

In accordance with the Stage 1 and 2 Work Plans, part of the EPT property was sampled for the suspected presence of oil contamination in soil (Figure 2-6). The area sampled is an inactive scrap loading area used from 1955 until the early 1970s (during the operation of the plant by a prior owner). Oily metal scrap was loaded into railroad cars on the track that runs through this area. Oil from this scrap is known to have escaped onto the ground and to have accumulated in a catch basin on South Cayuga Street.

Between July 19 and 22, 1988, and on September 12, 1989, soil samples were collected from the scrap conveyor/railroad track loading area and tested for contamination by oil and/or polychlorinated biphenyls (PCBs). A total of 15 boreholes (shown in Figure 2-6) were drilled down to the top of the bedrock in this area using the hollow stem auger method discussed in Appendix C. The boring logs for locations B-1 through B-15 are included in Appendix C. A total of 17 soil samples and two duplicate soil samples were selected for analysis. These soil samples were selected by the Radian geologist to represent both areas and zones of suspected oil contamination as well as areas potentially free of contamination, based on visual evidence of the presence of oily substances in the samples. The analytical results for the soil samples are presented and discussed in Section 4.8.

2.4.3 Other Sampling and Monitoring

In accordance with the Stage 1 and Stage 2 Work Plans, the following samples also were collected during the Remedial Investigation:

- Surface water and sediment samples from three surface drainages in the vicinity of the property;
- Surface water samples from three locations along Six Mile Creek;

- Ground-water samples from flowing seeps and pipes downgradient of the plant;
- Water samples from the fire water reservoir;
- Water samples from two sanitary sewers and one storm drainage culvert draining the property; and
- Water samples from the municipal water supply at the plant.

Surface Water and Sediment

As requested by NYSDEC, surface water and sediment samples were collected from an upstream and a downstream location in each of the three unnamed surface drainages between July 18 and 20, 1988. Sampling locations on the unnamed surface drainages were labeled SW-_ UP to represent locations at the upstream end of the drainage being sampled. Locations SW-1 UP and SW-2 UP also are upstream of the plant and are representative of background conditions in the streams. SW-3 UP represents the upstream end of the drainage, all of which is located downgradient of the plant. Similarly, sampling locations were labeled SW-_ DOWN to represent three locations at the downstream end of the drainage, all of which also are located downstream of the plant. Sampling locations were staked, mapped, and photographed for future reference.

Surface water samples were collected from three locations along Six Mile Creek on September 13, 1989 (see Plate 1). These samples were collected from upstream, mid-point, and downstream locations along Six Mile Creek. The upstream sampling location is upstream of any known drainage from the plant, and is representative of upgradient conditions in the stream. The mid-point sampling location is directly downstream of the storm sewer outfall draining the plant area. The downstream sampling location is located near the Geneva Street bridge, downstream of the plant's drainage area.

Surface water samples were collected by immersing the sample bottles in the stream until they were full. In the unnamed drainages, a sediment sample was collected from the same location, following collection of surface water, using a dedicated steel spoon to scoop material into the appropriate sample container. Surface water and sediment samples were sent to the laboratory for analysis as listed in Table 2-1 and in Appendix G. The analytical results for the surface water and sediment samples are presented and discussed in Section 4.5.

Seeps and Pipes

Provisions were made in the Stage 1 and Stage 2 Work Plans to collect samples from a maximum of 10 seep locations and from pipes in the retaining wall. The volume of ground water flowing from potential seep and pipe locations downgradient of the plant depends on seasonal variations in the ground-water regime underlying the site. During the Stage 1 sample collection period, on July 18, 1988, three ground-water seeps downgradient of the plant (labeled D, E, and G on Plate 1, consistent with locations used during the preliminary assessment) were found to be flowing. During the Stage 2 sample collection period, on September 12 and 14, 1989, four ground-water seeps downgradient of the plant (labeled D, E, G, and H on Plate 1) were found to be flowing. Seep F, which is the designated sampling point for EPT's SPDES permit, was not flowing during either the Stage 1 or the Stage 2 sampling periods. Samples were collected from these locations by allowing the flowing water to run directly into the sample containers.

Only one pipe was found to be flowing during both the Stage 1 and the Stage 2 sample collection periods. This pipe was designated Pipe 6, and was sampled on September 15, 1989 by allowing the flowing water to run directly into a 1-liter glass sample container attached to a rod of sufficient length to reach the end of the pipe. The sample containers for volatile organics analyses were filled from the 1-liter glass container. The 1-liter glass container was then refilled for petroleum hydrocarbon analysis. No other ground-water seeps or flowing pipes were apparent in the vicinity of the plant. The seep and pipe samples were shipped to the laboratory for analysis as listed in Table 2-1 and in Appendix G. The analytical results for the seep and pipe ground-water samples are presented and discussed in Section 4.3.

Fire Water Reservoir

As noted earlier, the fire water reservoir was emptied in accordance with applicable laws and regulations. Some water has collected in the reservoir since it was emptied and cleaned in early 1987. Water levels in the reservoir were measured at least weekly during each of the two stages of Remedial Investigation fieldwork. Samples of water were collected from the reservoir compartments during both stages of the Remedial Investigation to examine the results of past cleanup efforts and to compare contaminant levels with ground water from the surrounding wells.

During Stage 1, on July 19, 1988, there was approximately 4 feet of water in the reservoir, and water samples were collected from both compartments of the fire reservoir. During Stage 2, on September 12, 1989, there was approximately 5 feet of water in the reservoir, and water samples were again collected from both compartments. These samples were collected by lowering a dedicated 1-liter bottle on a dedicated length of rope into each compartment of the reservoir. The sample containers were filled from the 1-liter bottle and were analyzed as specified in Table 2-1 and in Appendix G. The analytical results for the fire water reservoir samples are presented and discussed in Section 4.4.

Sanitary Sewers

EPT has a municipal wastewater discharge permit which allows it to discharge wastewater from its laboratories and wastewater treatment system to the sanitary sewer connected to the City of Ithaca publicly-owned treatment works (POTW). Under the terms of its permit, EPT has been assigned discharge limits for oil and grease, pH, and 1,1,1-TCA. Samples of water were collected from two sanitary sewers that carry discharge from the plant (Plate 1) to evaluate the possible source(s) of elevated concentrations of VOCs in soil gas obtained from locations close to the sewers.

Manholes at the head of South Cayuga Street and Turner Place were used to gain access to and sample surface water and sediment from the two sanitary sewers. Water samples were collected by lowering a dedicated 1-liter bottle into each sewer location. The sample containers were then filled directly from the 1-liter bottle. No sediment was present in the sewers at these locations at the time of sample collection; therefore, no sediment samples were obtained. Two sets of water samples were collected on July 22, 1988 (Stage 1), and on September 12, 1989 (Stage 2). The laboratory subsequently reported the breakage of one of the Stage 1 sample containers from the Turner Place sampling location. A second set of water samples was collected from Turner Place on August 16, 1988 for Stage 1 analysis (Table 2-1 and Appendix G). The analytical results for the sanitary sewer samples are presented and discussed in Section 4.6.

Storm Drainage

Water samples were collected from a storm drainage culvert near the head of South Cayuga Street on September 12, 1989. This culvert receives water from the permitted State Pollution Discharge Elimination System (SPDES) discharge for EPT and was sampled to evaluate the possible source of elevated concentrations of

VOCs in soil gas obtained from locations along South Cayuga Street. These samples were collected from a trench on the east side of the street by allowing the water to flow directly into the sample containers. The samples were shipped to the laboratory for analysis as listed in Table 2-1 and in Appendix G. The analytical results for the storm drainage culvert samples are presented and discussed in Section 4.5.

Plant Water Supply

Samples of the municipal water supply to the plant were taken at a supply tap in the boiler room of the plant to evaluate the effects of chlorination on the supply. The supply water was sampled on September 12, 1989, by allowing water from the tap to run for approximately 5 minutes and then filling sample bottles directly from the tap. The samples were shipped to the laboratory for analysis as listed in Table 2-1 and in Appendix G. The analytical results for the plant water supply samples are presented and discussed in Section 4.6.

2.5 Field Permeability Testing

Field permeability tests were performed in a total of 12 monitoring wells to estimate in-situ hydraulic conductivity in the bedrock underlying the site. A falling head test (Hvorslev, 1951) was selected for the majority of the 12 wells to minimize the need for extracting contaminated ground water during field permeability testing. A rising head test (Bouwer, 1989) was performed between September 26 and 27, 1989, in four of the five Stage 2 wells in which the static water level was below the top of the screen intake section. Well MW-5-100 was dry at the time of testing; therefore, no permeability test was performed in this well.

The falling head tests were performed by introducing between 1 and 3 gallons of pure, deionized water into each well, as approved by NYSDEC. The rising head tests were performed by removing between 2 to 4 gallons of water from each well with dedicated bladder pumps. The recovery of the water level in each well was then timed and measured with a stopwatch and electric water level probe, and the data was recorded on test logs. The hydraulic conductivity was calculated, and the values obtained are presented and discussed in Section 3.2.

In addition, well MW-3-31 was pumped for a short time using the dedicated bladder pump, while water levels were monitored in nearby monitoring wells MW-1, MW-2, MW-3-13, MW-3-100, and MW-3-150. Approximately 5 gallons of water were removed from well MW-3-31 in about 25 minutes before the well went dry and pumping was discontinued. Water levels in the above-mentioned monitoring wells were not measurably affected, except in MW-3-13, which demonstrated a small but measurable decline in static water level. Details on the performance of the field permeability tests, as well as the pumping of MW-3-31, are provided in Appendix F.

TABLE 2-1. SUMMARY OF ANALYSES PERFORMED DURING THE STAGE 1 AND STAGE 2 REMEDIAL INVESTIGATIONS, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

Sample Type	Total Number of Samples Collected	Total Number of Samples Analyzed	Analysis Performed (EPA Method)
Ground Water	64	18	VOC's (601, 602)
		5	VOC's (624)
		37	VOC's (8010, 8020)
		5	Semivolatiles (625)
		17	HSL Metals
		9	PCB's (CLP)
		27	TPH's (418.1)
Soil	12	3	VOC's (8010, 8020)
		11	PCB's (CLP)
		11	TPH's (418.1)
Surface Water	14	10	VOC's (601, 601)
		4	VOC's (8010, 8020)
		14	TPH's (418.1)
Sediment	7	7	VOC's (8010, 8020)
		7	TPH's (418.1)
Fire Reservoir Water	5	3	VOC's (601, 602)
		2	VOC's (8010, 8020)
		2	HSL Metals
		5	TPH's (418.1)
Sewer Water	4	4	VOC's (8010, 8020)
		4	TPH's (418.1)
Supply Water	2	2	VOC's (8010, 8020)

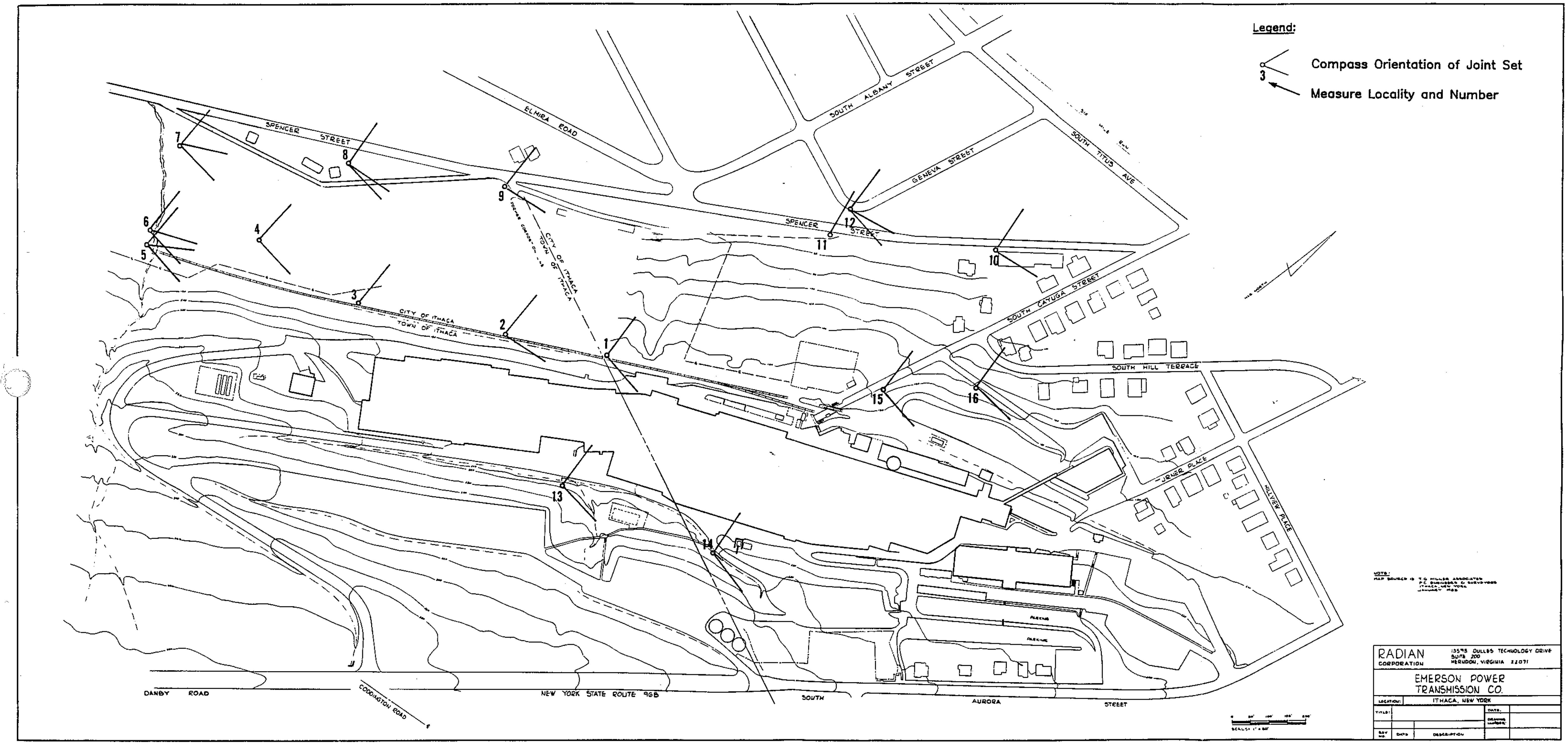


Figure 2-1. Orientation of Joints Measured in Outcrops, Emerson Power Transmission, Ithaca, New York

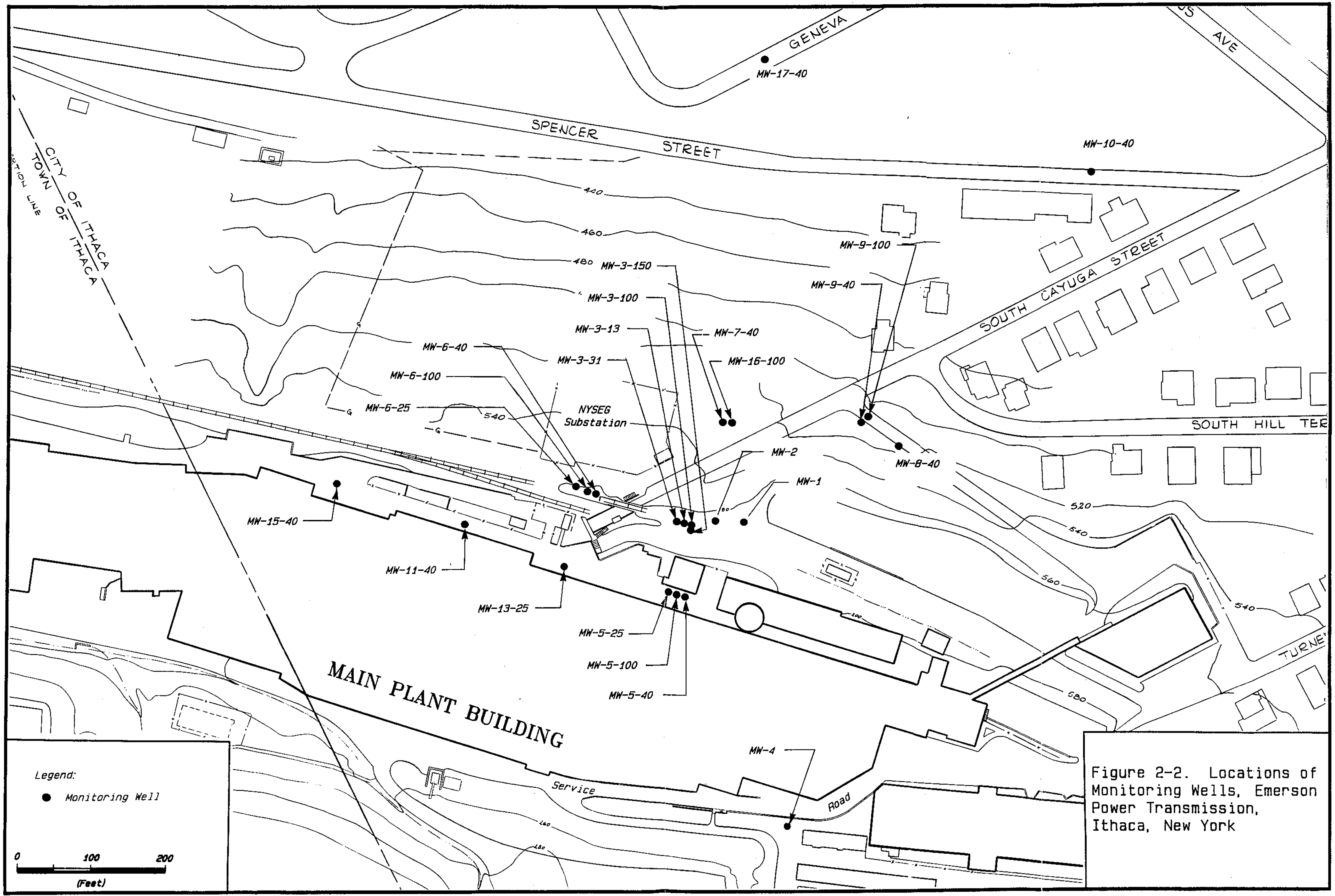
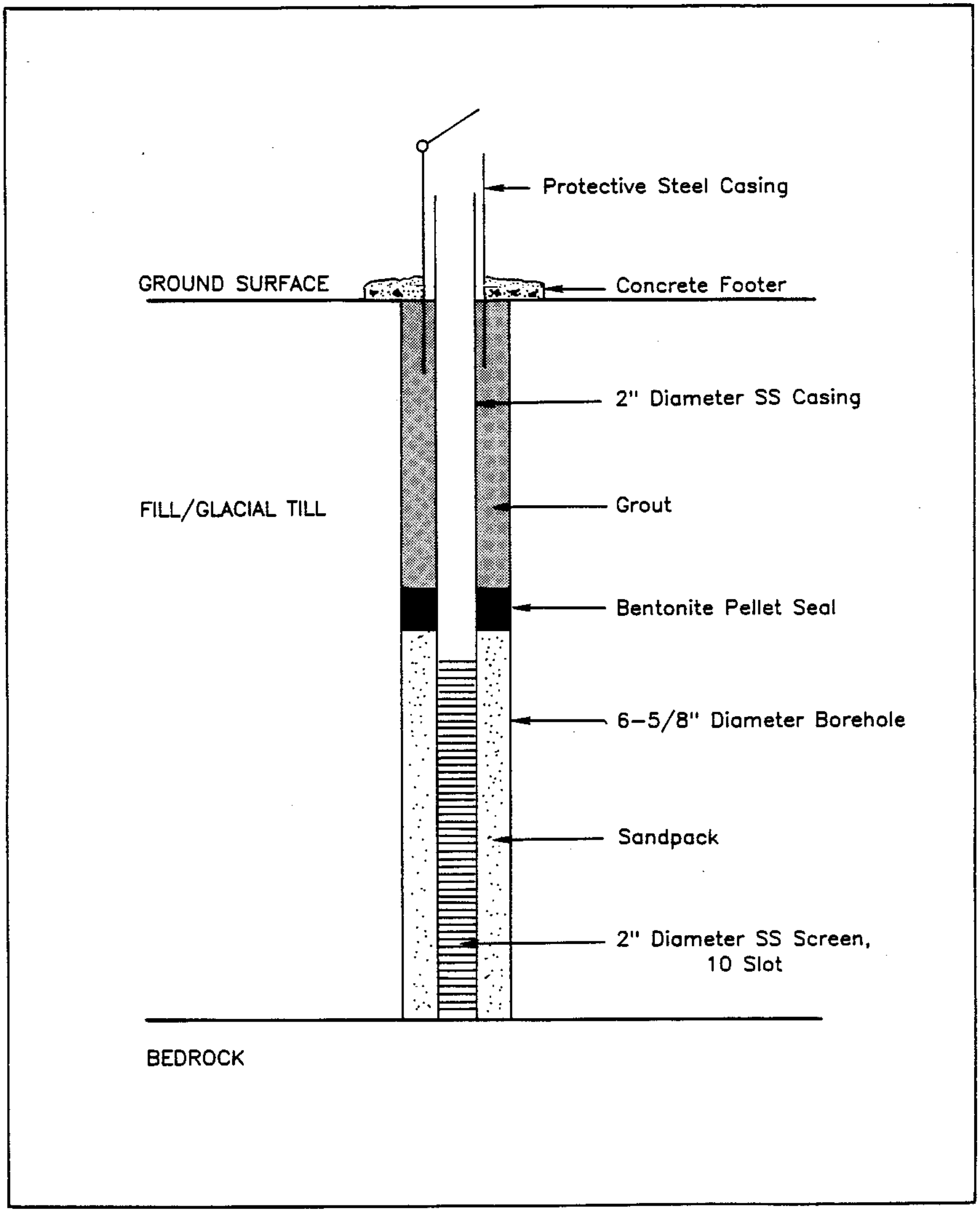


Figure 2-2. Locations of Monitoring Wells, Emerson Power Transmission, Ithaca, New York



RADIAN CORPORATION

Figure 2-3. Typical Well Construction for Overburded Wells Installed at Emerson Power Transmission, Ithaca, New York

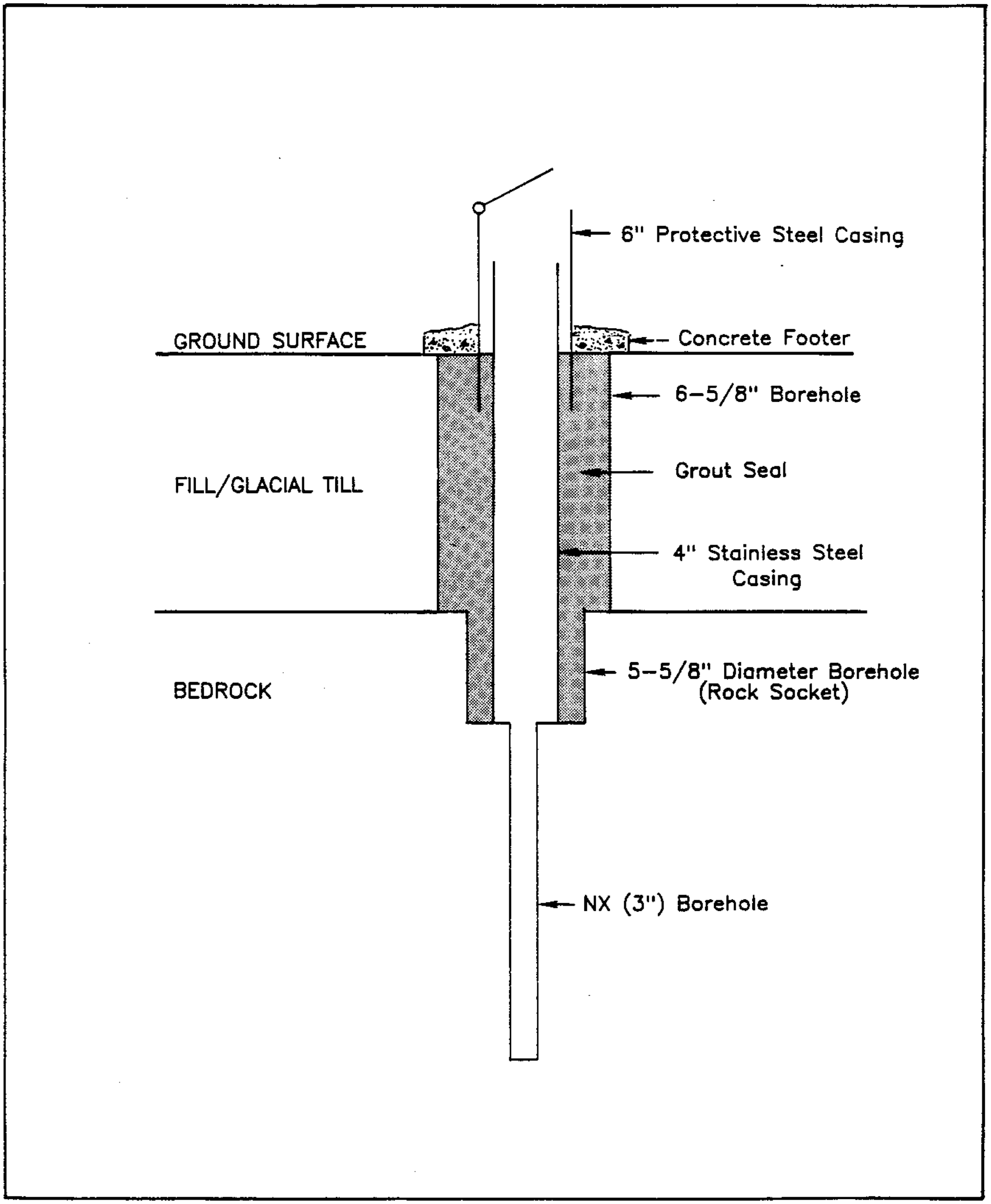
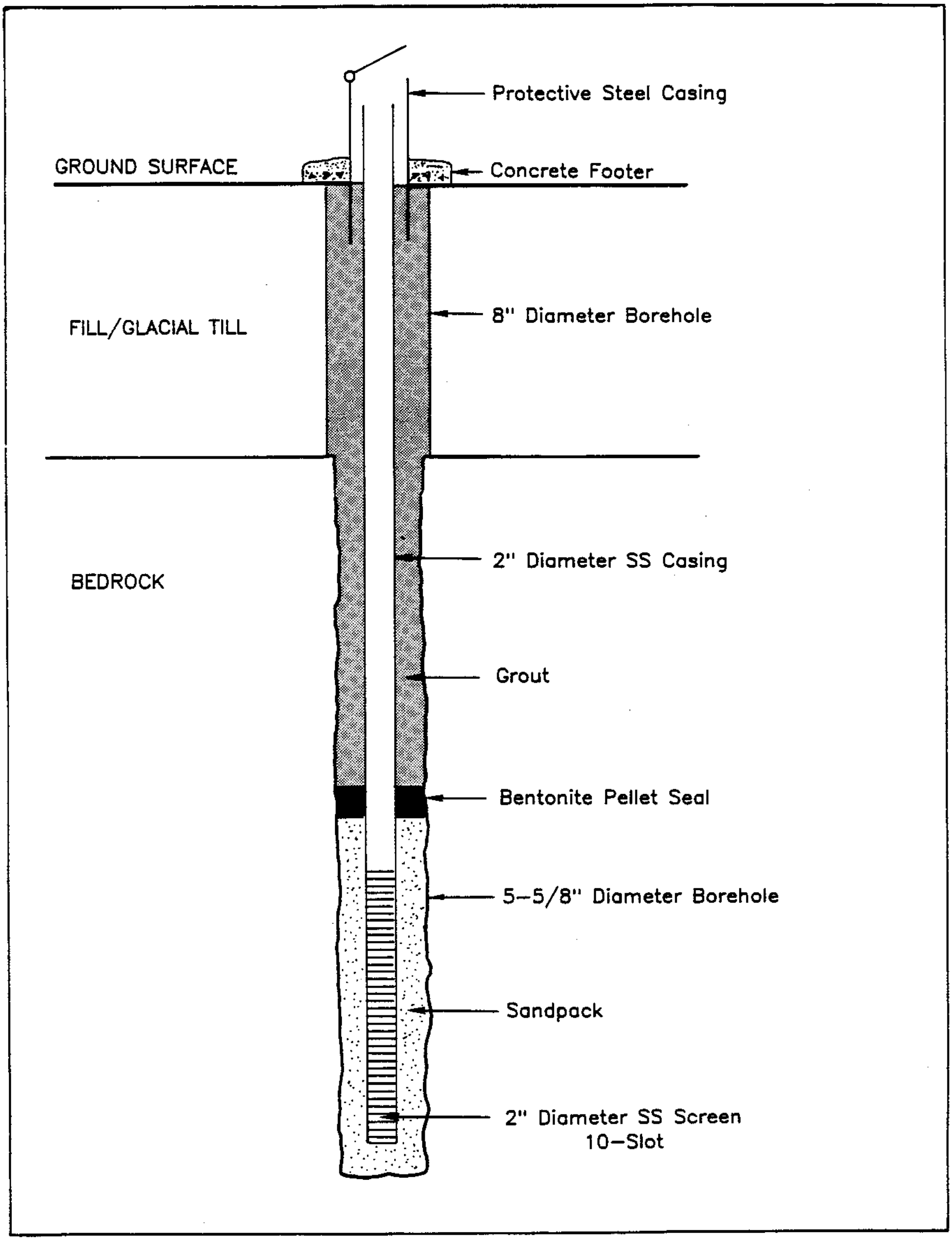


Figure 2-4. Typical Well Construction for Shallow Bedrock Wells Installed at Emerson Power Transmission, Ithaca, New York



RADIAN CORPORATION

Figure 2-5. Typical Well Construction for Intermediate Depth Bedrock Wells Installed at Emerson Power Transmission, Ithaca, New York

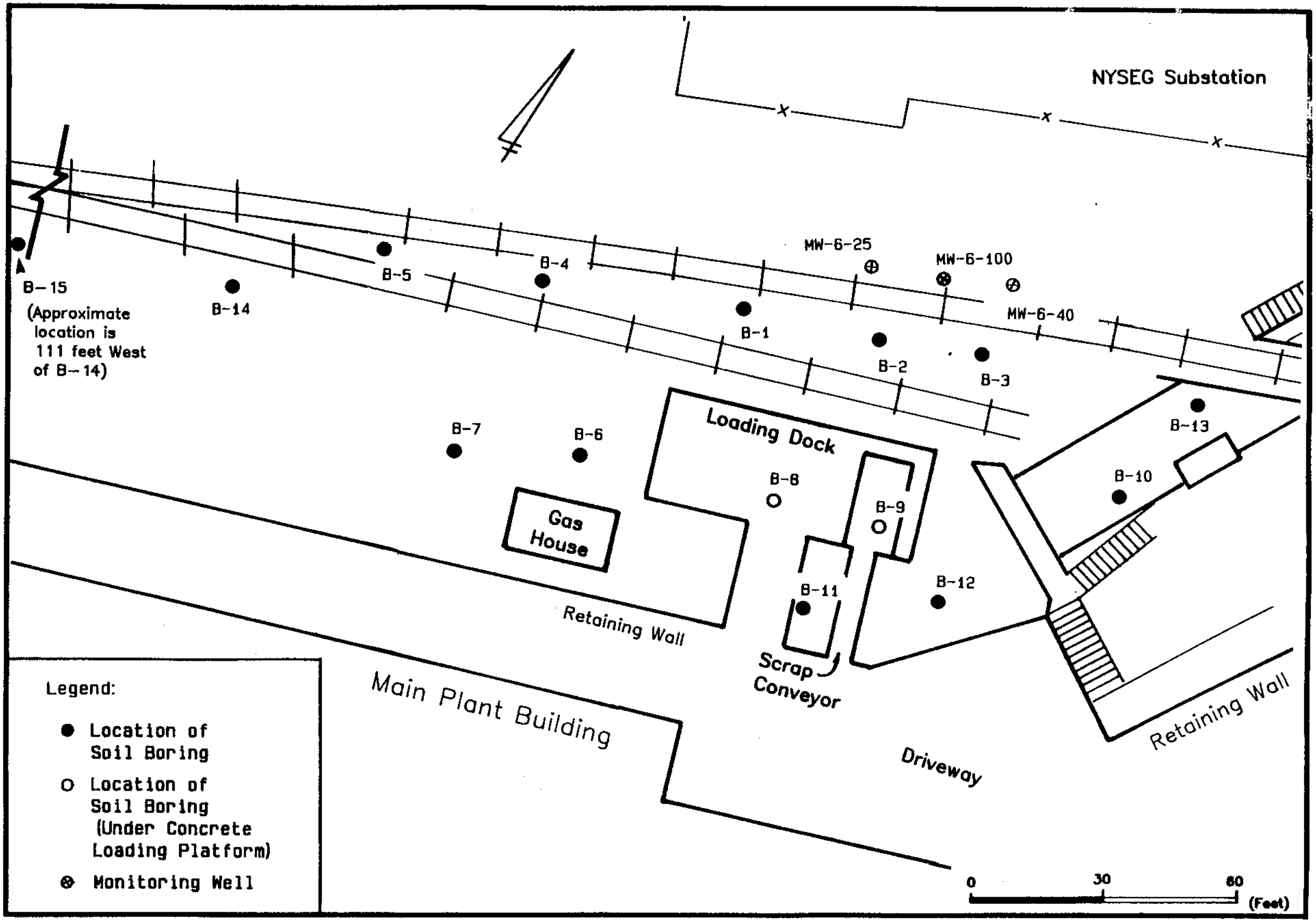


Figure 2-6. Approximate Locations of Soil Borings in the Scrap Conveyor/Loading Area, Emerson Power Transmission, Ithaca, New York

SECTION 3.0

3.0 SITE GEOLOGY AND HYDROGEOLOGY

An understanding of the site geology and site hydrogeology provides a basis for evaluating how physical characteristics of the site potentially influence the movement of ground water, soil gas, and any associated contaminants. The understanding developed from the preliminary assessment was further refined based on the data collected during the Stage 1 and Stage 2 Remedial Investigations. A summary of the current understanding is presented in the following subsections. All tables and figures for Section 3.0 are presented at the end of Section 3.0.

3.1 Site Geology

The EPT facility and the adjacent downhill properties located to the northwest of the plant are built on bedrock that is overlain by up to 33 feet of overburden. The bedrock at the site consists of siltstone, which comprises the Ithaca Member, a portion of the Upper Devonian Genesee Formation (Humes, 1960; Rickard and Fisher, 1970). Bedrock at the site is relatively impermeable, but is cut by well-defined fractures. Material overlying the bedrock consists of glacial till, glacial outwash deposits, and manmade fill. The description and understanding of the site geology presented below is based on data obtained during subsurface explorations and geologic mapping conducted at the EPT site during April and May 1987, July and August 1988, and August 1989.

3.1.1 Stratigraphy

At the EPT property and adjacent northwest downhill properties, between 2.5 and 33 feet of overburden overlies the bedrock. The thickness of overburden is thinnest on the slopes, progressively thickening downhill. At EPT and the adjacent NYSEG property, the overburden consists predominantly of manmade fill that overlies less than 3 feet of till. The manmade fill consists of uncompacted, poorly-sorted silt and clay, with minor amounts of pebbles and cobbles, and manmade debris. The till is comprised of dark gray compacted clay, with minor amounts of pebbles. Further downslope, in the vicinity of Spencer and Geneva Streets, the overburden consists of up to 3 feet of fill overlying 6 to 30 feet of glacial lake deposits. These deposits are comprised of sandy clayey silt, overlying silty clay, or clay that contains plant root zones.

Observation of outcrops on the site and cores of bedrock acquired during installation of the monitoring wells reveal that the bedrock consists of well-cemented Ithaca Siltstone, the uppermost member of the Genesee Formation. Bed thickness ranges from 0.1 inch to slightly less than 2.5 feet. Fossils are generally confined to densely packed fossil beds that range from approximately 0.5 to 4 inches thick. DeWitt and Colton (1978) show that the Ithaca Siltstone is approximately 450 feet thick and that the full Genesee Formation is approximately 950 feet thick in the Ithaca area.

Macroscopic visual inspection of outcrop samples and microscopic inspection of thin sections of core reveal that the Genesee Formation at this site contains essentially no intergranular (primary) porosity, but does contain substantial fracture (secondary) porosity. Aspects of the fracture porosity are summarized below and are detailed in Appendix B.

3.1.2 Bedrock Fractures

Outcrops and cores from bedrock display well-defined fractures that are oriented in distinct trends. Field observation indicates that two types of fractures are present in the bedrock at the site. The first type of fracture consists of bedding plane partings, which are nearly horizontal and parallel to the bedding. The second type of fracture consists of joints, which are fractures that are at an angle to the bedding, and do not offset the rocks on opposite sides of the fracture. Three sets of nearly vertical joints are present and trend north-northwest, east-northeast, and northeast, respectively (Figure 3-1). All the sets of fractures appear open and could act as conduits for ground water.

Bedding Plane Partings

Bedding plane partings were observed in cores of bedrock that were acquired during monitoring well installation, and in outcrops exposed at the site and adjacent properties. These fractures have slightly curved faces parallel to the bedding and are spaced from less than 0.5 inches to 36 feet apart. Bedding plane fractures observed in cores obtained from less than 21 feet below ground surface are stained with ferric oxide minerals, except at two locations. Below this depth, the faces of the bedding plane fractures generally are not coated or stained with minerals. Three bedding plane fractures are partially coated with calcite, indicating the existence of open fractures at depths of 99.5, 129.5, and 145.5 feet (Appendix B).

The frequency of occurrence of bedding plane fractures present in the cores appears to decrease with depth below the land surface, from a maximum fracture frequency of more than 27 per foot to less than 1 per foot of core (Appendix C). Three general depth zones (upper, middle, and lower) can be defined based on the frequency of fracture occurrence in cores obtained from the four deepest boreholes drilled during Stage 1 (Figure 3-1). The upper zone, referred to as the "stress relief" zone, extends to a maximum depth of 22 feet below the land surface and is very intensely to intensely fractured. The middle zone, referred to as the "transitional" zone, extends from the base of the upper zone (a maximum of approximately 22 feet) to a maximum of 55 feet below ground surface. This zone is highly fractured, and represents a transition between the overlying stress relief zone and the underlying lower density fracture zone. The lower zone, referred to as the "lithologically controlled" zone, extends from the bottom of the middle zone (a maximum of approximately 55 feet) to a minimum depth of 145 feet below ground surface. The bedding plane fractures within this zone are confined to highly fractured zones that are less than one foot thick and widely spaced. Therefore, the occurrence of these fractures appears to be lithologically controlled.

Based on the data collected, the maximum depth of occurrence of bedding plane fractures is at least 145 feet below ground surface. The deepest depth penetrated by borehole drilling on site was 175 feet. Site-specific geological data below this depth is not available. In summary, the frequency of occurrence of fractures generally decreases with depth in the bedrock.

Based on the borehole geophysical logs, the individual bedding plane fractures have a very small aperture. The density log indicates that fractured rock is only 10 percent less dense than unfractured rock. However, although individual fractures can be very small, the temperature and neutron logs indicate that they actively transmit ground water.

Joints

The three sets of nearly vertical fractures or joints are most easily observed in bedrock outcrops. These joints dip within eight degrees of vertical, and are oriented N13-21W (north-northwest), N85-89E and N70-72E (east-northeast) and N45-55E (northeast) (Figure 2-1). Measurements are adjusted to a magnetic declination 10 degrees west of north. The north-northwest-trending joints are well defined. The east-northeast-trending joints are less well defined. The northeast-trending joints are very widely spaced and in places form ledges several feet high.

No relationship is apparent between the occurrence of joints in the cores and the depths from which the cores were obtained, although there does appear to be a correlation between depth and the occurrence of partings. The maximum depth at which joints were observed was from 150.8 to 151.2 feet in MW-3-150. These joints are partially filled with calcite, indicating open fracture porosity is present at that depth. Investigations of similar rocks at other locations indicate that open fracture porosity associated with the presence of joints in the subsurface can be present at depths of thousands of feet below the land surface (Merin and Moore, 1986; Secor, 1965; Narr and Currie, 1982).

3.2 Site Hydrogeology

Data obtained from monitoring wells and field permeability testing confirm and supplement the understanding of the site hydrogeology developed during the preliminary environmental assessment.

Ground water occurs in both the overburden and in the fractured bedrock. Shallow wells screened in the overburden, as well as monitoring wells screened at various depths within the bedrock, yield ground water. No hydraulic barrier (confining layer) was encountered between the overburden and the bedrock in any of the boreholes drilled near the plant or on the hillside. Furthermore, as discussed in this section, testing in well cluster MW-3 shows a hydraulic connection between the overburden and shallow bedrock ground-water flow, indicating that the potential for vertical flow between the overburden and shallow bedrock exists at the site.

At one location (well MW-15-40), ground water was not encountered in the fill materials overlying the bedrock. The occurrence of shallow ground water over large areas of the site is likely influenced by the presence of manmade fill and other physical alterations due to the presence of pavement and plant facilities. MW-15-40 is located in a paved area close to the main plant building, a condition which may preclude local recharge of the overburden in this location from either the surface or the upgradient areas on the opposite side of the building.

Water levels measured in the monitoring wells during the Stage 1 and Stage 2 Remedial Investigations are summarized in Table 3-1. The two sets of contiguous water level elevations measured in all the monitoring wells (on October 19, 1988 and on September 26, 1989) are shown on Figures 3-2 and 3-3, respectively. These measurements confirm that ground water in the overburden and fractured bedrock is flowing northerly, in the general direction of the steeply declining land surface north of the plant. Flow directions appear to vary from northwesterly to northeasterly, depending on the depth in the formation at which water level measurements are made.

The two sets of water levels, measured almost one year apart, are very strongly correlated, with a maximum difference in water level elevations of 6 feet between the two sets. Comparison of water level elevations measured in shallow overburden wells indicates that the hydraulic gradient slopes towards the northwest. Comparison of water level elevations measured in both shallow bedrock wells and in intermediate bedrock wells shows a general slope in the hydraulic gradient towards the north-northeast.

Among the sets of water level elevations summarized in Table 3-1, some measurements appeared anomalous. Caution was exercised in interpreting information provided by wells at the site because the characteristics of flow in fractured rock can result in significant variations in measurements. Unlike flow through a porous medium, such as overburden, flow in fractured bedrock takes place primarily in the fractures rather than in the rock mass itself. In general, ground-water flow directions appear to be consistent with trends established for the three joint sets observed in the vicinity of the site, which influence subsurface flow patterns. However, small-scale discontinuities in observed hydraulic gradient, flow velocity, and flow path are present because they are governed by the degree of interconnection between the individual fractures, by the length and openness of the fractures, and by the general orientation and dip of the fractures.

Comparison of hydraulic head differences among wells located within the same location or cluster, but screened at different depths, confirms that steep downward hydraulic gradients exist within the ground-water regime underlying this area. For instance, water level elevations measured in October 1988 in the MW-3 well cluster ranged from 559.09 feet in overburden well MW-3-13 down to 467.13 feet in the deeper bedrock well MW-3-150. Similarly, water level elevations measured in October 1988 in the MW-6 well cluster ranged from 552.82 feet in the overburden well MW-6-25 down to 468.23 feet in the intermediate bedrock well MW-6-100. This downward gradient indicates that a ground-water recharge area exists in the vicinity of the plant. Ground water enters the ground-water regime underlying the site and tends to flow downward and away from this location.

At one location (well MW-17-40) at the base of the hill, ground water appears to occur under confined or semi-confined conditions. This condition produces an upward component of ground-water flow and represents a possible ground-water discharge area that may extend to Six Mile Creek. A confined or semi-confined condition occurs wholly or partially between two low permeability stratigraphic layers (i.e., clay layers). Pressures generated in confined or semi-confined conditions cause the water level in a well to rise above the top of the aquifer, as in the case of MW-17-40. The water level in this well appears to have rapidly stabilized at a level close to the ground surface, above the depth of the first water encountered during drilling at this location. Flow through MW-17-40 also could reflect a separate flow regime within the glacial lake and outwash deposits found at this location. This flow may be separate from the flow within the fill/till assemblage present on the hillside and around the EPT property.

As detailed in Section 2.5 and in Appendix F, short-duration pumping of shallow bedrock well MW-3-31 on October 20, 1988, indicated that ground water in the overburden and in the shallow bedrock are hydraulically connected in this vicinity. Pumping of well MW-3-31 produced a measurable decline in water level in the adjacent overburden well MW-3-13. No measurable response was detected in the deeper bedrock wells of the cluster, probably because the pumping duration in MW-3-31 was too short to produce an effect on the deeper wells. However, the pattern of chemical results discussed in Section 4.3 indicates a probable hydraulic connection between shallow and intermediate depths in bedrock.

The hydraulic conductivity of several depth zones within the bedrock was estimated from in-situ permeability tests conducted in selected monitoring wells between October 18 and 20, 1988, and between September 26 and 27, 1989. The testing procedures are summarized in Section 2.5, and detailed descriptions of the testing procedures and results are presented in Appendix F. The estimated hydraulic conductivities are summarized in Table 3-2 and, in general, indicate that bedrock becomes less conductive (permeable) with depth. This pattern is consistent with qualitative observations of well behavior, as well as with the zones of decreasing fracture (parting) frequency with depth observed in geologic mapping, core logging, and borehole geophysical logging. The hydraulic conductivity of the shallow bedrock ranges from a mean high of 1.6×10^{-4} cm/sec in the valley (MW-17-40) to 4.4×10^{-7} cm/sec further upslope (MW-9-40). The hydraulic conductivity of the intermediate bedrock ranges from 1.5 x 10^{-6} cm/sec in the vicinity of the MW-3 well cluster to 1.9 x 10^{-7} cm/sec in the vicinity of the NYSEG substation (MW-9-100).

While these values present a fairly consistent picture of hydraulic conductivity variations with depth, as well as of variations across the site, in-situ permeability tests, particularly in fractured rock, provide results representative of formation characteristics only in the immediate vicinity of the interval tested.

TABLE 3-1. GROUND-WATER ELEVATIONS, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

Well Number	Ground Surface Elevation	Water Level Elevation October 19, 1988	Water Level Elevation September 26, 1989
MW-1	567.11	548.35	548.92
MW-2	565.04	553.20	552.97
MW-3-13	565.48	559.09	559.78
MW-3-31	564.89	545.95	546.90
MW-3-100	565.39	481.49	482.02
MW-3-150	565.43	467.13	465.61
MW-4	622.18	606.33	601.80
MW-5-25	587.43	579.58	581.43
MW-5-40	587.42	555.78	556.29
MW-5-100	587.42	---[a]	Dry
MW-6-25	560.47	552.82	553.93
MW-6-40	562.00	546.40	547.40
MW-6-100	561.30	468.23	465.16
MW-7-40	531.57	513.56	513.91
MW-8-40	518.83	497.12	480.11
MW-9-40	507.7	---[a]	494.79
MW-9-100	507.35	---[a]	420.24
MW-10-40	417.22	---[a]	397.72
MW-11-40	585.61	---[a]	554.83
MW-13-25	587.69	574.99	575.21
MW-15-40	584.57	567.81	568.00
MW-16-100	531.28	461.68	462.31
MW-17-40	396.15	392.55	392.62

[a] Well did not exist during this measurement period.

TABLE 3-2. HYDRAULIC CONDUCTIVITY ESTIMATES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

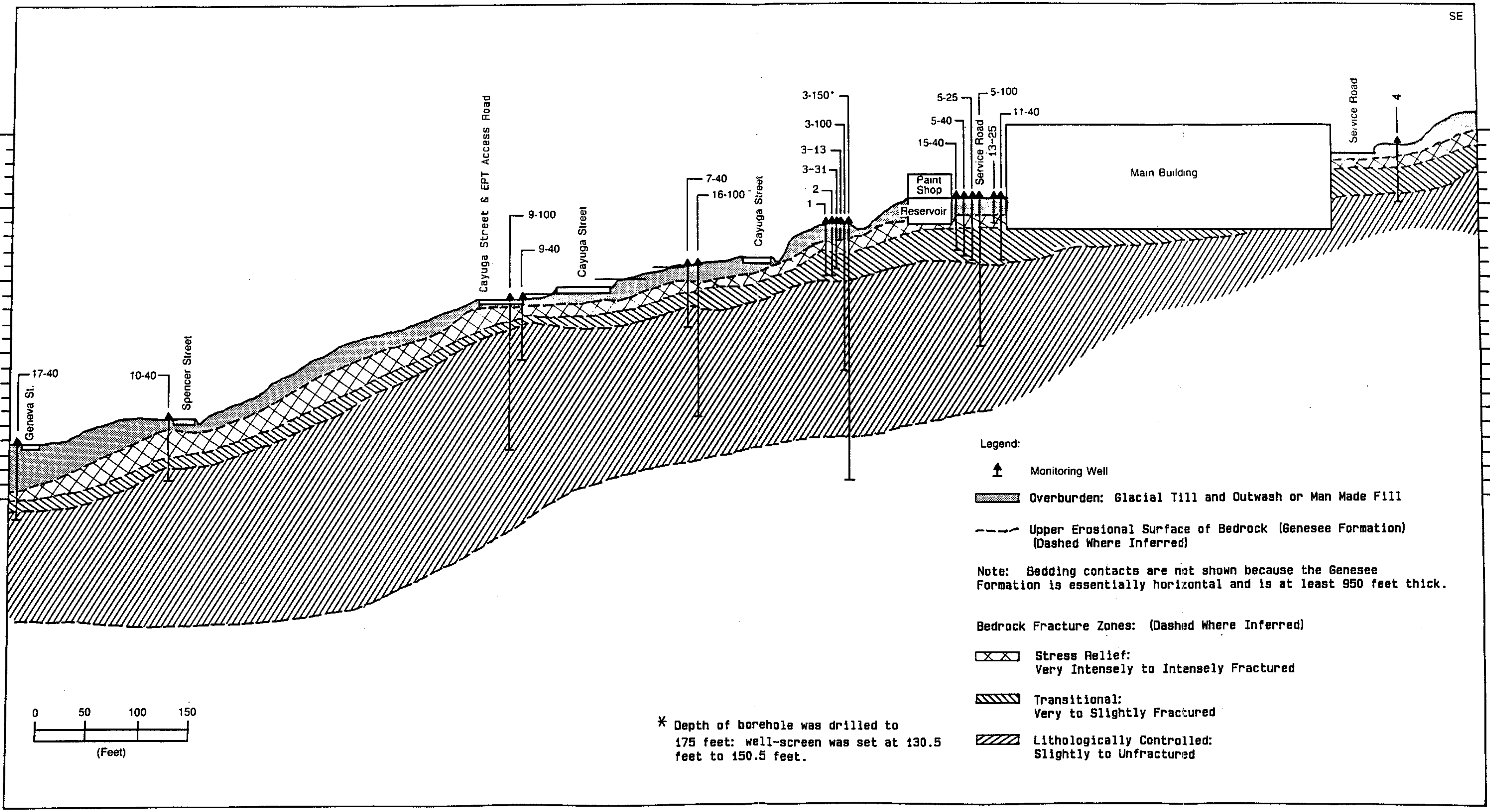
HVORSLEV (1951) FALLING HEAD TESTS

		Hydraulic Conductivity		
Well Number	Well Type	Time Lag (cm/sec)	2-Point (cm/sec)	Mean (cm/sec)
MW-1	SB	1.48×10^{-5}	1.28×10^{-5}	1.38×10^{-5}
MW-2	SB	1.20×10^{-5}	1.14×10^{-5}	1.17×10^{-5}
MW-3-31	SB	1.26×10^{-5}	1.19×10^{-5}	1.23×10^{-5}
MW-3-150	IB	1.45×10^{-6}	1.54×10^{-6}	1.50×10^{-6}
MW-6-40	SB	2.42×10^{-5}	1.77×10^{-5}	2.10×10^{-5}
MW-15-40	SB	4.38×10^{-5}	3.96×10^{-5}	4.17×10^{-5}
MW-16-100	IB	4.19×10^{-7}	4.03×10^{-7}	4.11×10^{-7}
MW-17-40	SB	1.68×10^{-4}	1.45×10^{-4}	1.57×10^{-4}

BOUWER (1989) RISING HEAD TESTS

Well Number	Well Type	Hydraulic Conductivity (cm/sec)
MW-9-40	SB	4.36×10^{-7}
MW-9-100	IB	1.88×10^{-7}
MW-10-40	SB	5.27×10^{-6}
MW-11-40	SB	5.22×10^{-5}

SB - Shallow Bedrock.
IB - Intermediate Bedrock.



Legend:

Monitoring Well

▨ Overburden: Glacial Till and Outwash or Man Made Fill

Upper Erosional Surface of Bedrock (Genesee Formation) (Dashed Where Inferred)

Note: Bedding contacts are not shown because the Genesee Formation is essentially horizontal and is at least 950 feet thick.

Bedrock Fracture Zones: (Dashed Where Inferred)

Stress Relief: Very Intensely to Intensely Fractured

Transitional: Very to Slightly Fractured

Lithologically Controlled: Slightly to Unfractured

* Depth of borehole was drilled to 175 feet: well-screen was set at 130.5 feet to 150.5 feet.

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Figure 3-1. Cross-Section Illustrating the Depth of Bedrock Fracture Zones, Emerson Power Transmission, Ithaca, New York

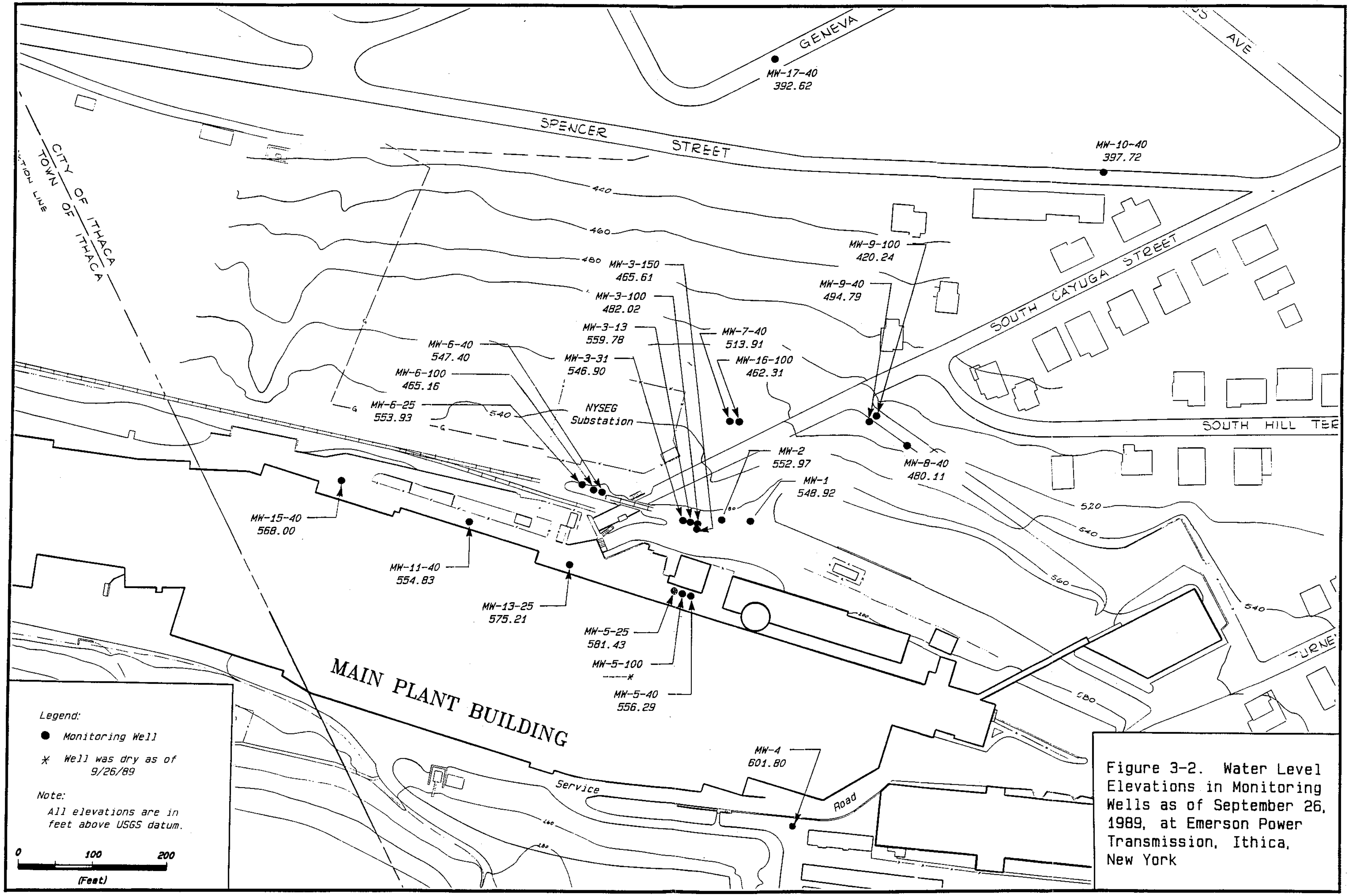

Figure 3-2. Water Level Elevations in Monitoring Wells as of September 26, 1989, at Emerson Power Transmission, Ithica, New York

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volatile organic compounds. The majority of positive readings at monitoring well locations occurred at depths in the boreholes, near the top of the bedrock. These measurements did not correlate in all cases to the presence of volatile organic compounds in ground water from these locations. The highest readings (30 ppm) occurred at locations MW-2 and MW-3-100, and are likely associated with the presence of organic compounds found in ground water from these locations. The positive readings from boring B-7 (5.0 ppm) appear to correlate with the presence of volatile organic compounds in the unconsolidated material, while the readings from boring B-10 (1.0 to 1.5 ppm) did not correlate with any constituents detected in the sample.

4.3 Ground Water

In analyzing the data obtained for volatile organic compounds present in ground water underlying the property, the following considerations are relevant to understanding the distribution of the most frequently detected compounds:

- Chlorinated organic solvents such as TCE are denser than water and tend to sink in the ground- water column. Therefore, they will tend to migrate differently than volatile compounds such as benzene and toluene, which are lighter than water and tend to "float" near the top of the water table.
- TCE, the primary constituent of concern, is relatively insoluble and does not readily dissolve in ground water; therefore, its migration may be controlled more by gravity and by the structural orientation of flow channels than by the direction of ground-water movement.

- Chlorinated organic solvents may be present in several phases in the subsurface environment: as dissolved concentrations in water, as a separate phase of pure substance, and as a vapor in the unsaturated zone.

- Chlorinated organic compounds may be gradually transformed or broken down in the subsurface environment. Biological processes aid in the transformation of PCE into TCE, which in turn is transformed into three compounds: 1,1-dichloroethylene (1,1-DCE), cis-1,2-dichloroethylene (cis-1,2-DCE), and trans-1,2-dichloroethylene (trans-1,2DCE). Each of these DCEs may be transformed at different rates into vinyl chloride (VC), which may be ultimately transformed into carbon dioxide.

- 1,1,1-Trichloroethane (1,1,1-TCA) can be transformed into 1,1-dichloroethane (1,1-DCA), which commonly transforms into ethyl chloride (mono-chloroethane). Ethyl chloride may be ultimately transformed into carbon dioxide.

- The mechanisms that control these transformation processes are complex and are not solely time-dependent.

Trichloroethylene (TCE) was detected in ground water from 13 of the 23 wells sampled during the study (Table 4-1 and Figures 4-1 through 4-3). The concentrations detected ranged from 3 to 470,000 ppb. The highest TCE concentrations were measured in samples from on-site wells, primarily in the vicinity of the fire reservoir. Four wells in the MW-3 cluster were located directly downgradient of the fire reservoir; concentrations detected at this location varied with depth in the subsurface. The highest concentrations were found near the top of the bedrock, with lower concentrations detected above and below this zone. Samples from off-site wells exhibited low or nondeductible concentrations of volatile organic compounds.

Concentrations of TCE averaged 790 ppb in the near-surface sample from MW-3-13; increased to an average of 399,000 ppb in MW-3-31 at a depth of approximately 30 feet; decreased to an average of 21,000 ppb in MW-3-100 at a depth of approximately 100 feet; and decreased to an average of 4,000 ppb in MW-3-150 at a depth of approximately 150 feet below ground surface. Correspondingly high concentrations of TCE, averaging 205,000 ppb were detected in the samples from shallow bedrock well MW-5-40. TCE concentrations decreased significantly to an average of 18 ppb in samples from the deeper bedrock well MW-5-100. The MW-5 wells are directly upgradient of and adjacent to the fire reservoir. An elevated concentration averaging 68,000 ppb also was detected in well MW-2, located to the northeast of the fire reservoir and the MW-3 wells. The concentration of TCE appeared to decrease with distance to the northeast, down to 60 ppb in the sample from well MW-1, which was at the same elevation as, but northeast of, MW-2.

Horizontal Distribution

In general, TCE and its associated degradation products (cis-1,2DCE and VC) were detected at elevated concentrations in the vicinity of the fire reservoir, both immediately downgradient and immediately upgradient of the structure. However, lateral migration of these compounds appears to be limited to the area closest to the reservoir. The highest concentration of TCE (399,000 ppb, average) was detected in ground water from shallow bedrock well MW-3-31, directly downgradient of the fire reservoir. Decreasing concentrations of TCE were evident to the northeast, in the direction of ground-water flow. This trend is consistent with lateral dispersion with migration of the chemical constituents in the shallow bedrock zone. At well MW-1, the concentration of TCE was 60 ppb, three orders of magnitude less than that in the area directly downgradient of the fire reservoir at MW-3-31. Concentrations of TCE and other organic compounds were not detected or detected at low concentrations in ground water obtained from the MW-6 well cluster to the northwest, indicating that chemicals from the fire reservoir area have not migrated or dispersed transversely to this location to any significant extent. A more likely source of these compounds was the small amounts of solvents associated with the metal scrap formerly handled in this area.

Low concentrations of TCE, ranging from 3 to 30 ppb, were detected in samples from several other wells located downgradient of the EPT property. TCE and associated compounds were not detected in the background well MW-4, in on-site well MW-11-40, or in off-site wells MW-9-40, MW-9-100, MW-10-40, and MW-17-40. Two of these wells are located at the base of the hill, the furthest off-site location from the plant. Low concentrations of TCE were detected in three seep samples and in one pipe sample.

A number of potential degradation products of TCE also were detected in ground-water samples, including cis- and trans-1,2-dichloroethylene, and vinyl chloride, indicating substantial degradation of TCE in the subsurface over time. The most prevalent compounds detected were isomers of 1,2DCE, generally found in association with TCE. The highest concentrations of both trans- and cis-1,2DCE (ranging from 250 to 28,000 ppb) were found in on-site wells directly downgradient of the fire reservoir (MW-1, MW-2, MW-3-13, MW-3-100, and MW-3-150). The sample from well MW-5-25 showed up to 30 ppb of 1,2DCE, although TCE was not detected. The maximum detection limit for samples from MW-3-31, which contained the highest levels of TCE, was 10,000 ppb. Therefore, concentrations of other compounds below 10,000 ppb would not be detected, although they could still be present. Lower concentrations of cis-1,2DCE, ranging from 12 to 140 ppb, were found in samples from the peripheral and downgradient wells and seeps.

Vinyl chloride was detected in samples from three on-site monitoring wells: MW-3-31, MW-3-100, MW-5-25, MW-5-40, MW-6-40, and MW-13-25, at average concentrations of 230, 200, 150, 825, 4, and 21 ppb, respectively. Vinyl chloride also was detected in the three seep samples at concentrations ranging from 1 to 7 ppb.

Tetrachloroethylene (PCE) was detected in on-site wells MW-1, MW-2, MW-3-31, MW-5-40, MW-13-25, and MW-16-100 at 50, 10,000, 400, 180, 4, and 1 ppb, respectively. Several other compounds were detected in various wells. 1,1,1-TCA and 1,1-DCE were detected at 1 ppb in Seep D. 1,1-DCE also was detected in on-site well MW-15-40 at 27 ppb. Benzene was detected in two quick-turnaround samples from well MW-3-100 at 1,500 and 1,600 ppb. However, its presence was not confirmed (concentrations were less than the detection limit of 1,000 ppb) in the most recent samples collected from this well. Chloroform was detected in several monitoring wells and all of the seep samples at concentrations ranging from 1 to 46 ppb. Chloroform is not used at the plant, but is present at comparable concentrations in the chlorinated municipal water supply that serves the plant. Acetone was detected at 1,200 ppb in the sample from MW-5-40. This isolated detection of acetone may have resulted from contamination introduced during sampling equipment decontamination procedures.

With the exception of 1 ppb of chloroform, no volatile organic compounds were detected in the samples from wells MW-4 (upgradient background), MW-10-40 (Spencer Street), MW-11-40, or MW-17-40 (Geneva Street).

Vertical Distribution

Concentrations of TCE and associated compounds also show a general trend of decreasing with depth. Concentrations of TCE at MW-3-31, immediately downgradient of the fire reservoir, decreased from an average concentration of 399,000 ppb at a depth of 31 feet to an average concentration of 4,000 ppb at a depth of 150 feet below ground surface. These concentrations represent a decrease of two orders of magnitude with depth at this location. This pattern is generally consistent with the expected dilution and dispersion of the compounds, and with the expected decrease in vertical migration due to restricted circulation in zones of infrequent fracturing at this depth.

An average concentration of 205,000 ppb of TCE also was detected in ground water associated with the shallow bedrock at the location of well MW-5-40, immediately upgradient of the fire reservoir. The concentration measured in the sample from 100 feet below ground surface at this location averaged 18 ppb. (This initial Stage 2 analysis indicating 270,000 ppb of TCE at this location at 100 feet was not confirmed by subsequent resampling and duplicate analysis, and is therefore judged to be erroneous.) This pattern of significant concentration decrease with depth at this location mirrors the distribution at the MW-3 location and is consistent with the site hydraulic regime described above. concentration is not consistent with results from other locations or with expected trends based on the characteristics of the bedrock; therefore, a second set of samples will be collected from this location and will be analyzed for TCE and associated compounds to confirm these results.

Dehalogenation

The presence of the full spectrum of degradation products of TCE at the site, generally in association with elevated concentrations of TCE, indicates that TCE was introduced to the subsurface environment in the past, and that there has been sufficient time for the dehalogenation process to proceed to some degree at most locations. In wells MW-5-25 and MW-13-25, between the main plant building and the reservoir, the degradation products of cis-1,2DCE and vinyl chloride were found either in the absence of TCE or in concentrations greater than that of TCE. Vinyl chloride also was detected at less than 10 ppb in one of three samples from MW-6-40 and in three of the seeps sampled. These relative concentrations may indicate that TCE has been present long enough to have completely or mostly degraded.

Metals

Samples from 13 wells and the fire reservoir were analyzed for Hazardous Substance List (HSL) metals. These results are presented in Table 4-2. Aluminum, barium, calcium, iron, magnesium, manganese, potassium, and sodium were detected in the parts-per-million concentration range. Antimony and cyanide were detected in the low parts-per-billion concentration range. Chromium, arsenic, copper, silver, and selenium were detected at or close to the detection limit or were not detected in these samples. In general, samples from the MW-3-31 location (located directly downgradient of the fire reservoir) showed the highest concentrations. To investigate the possibility that dissolved chemicals in ground water downgradient of the fire reservoir have impacted the aquifer, a sample of rock core obtained from each of the coreholes for MW-4 and MW-5 was analyzed for metals and for mineralogy and rock texture.

Analysis of metals concentrations in the two samples of rock core revealed that there was no substantial difference in the metals composition of rock from locations upgradient and downgradient of the fire reservoir (Table 4-3). Analysis for metals of each rock sample was compared to analysis for metals of ground water obtained from the borehole from which the rock core was obtained. For all major metals, there was little difference in major metals content between rocks from an area unaffected by TCE and rocks from an area where high concentrations of volatile organic compounds were present.

Other Analyses

As required by the Stage 1 Work Plan, samples from four wells (MW-3-31, MW-5-40, MW-6-40, and MW-15-40) were analyzed for semivolatile organic compounds and total petroleum hydrocarbons (TPHs) (Table 4-4). None were detected, with the exception of several compounds in the sample from on-site well MW-5-40. In this sample, napthalene (11 ppb) and phenanthrene (20 ppb) were detected. In addition, low concentrations (less than 10 ppb) of six other compounds were estimated to be present in this sample, but were not confirmed due to interferences in the analysis. Samples from four wells, six seeps, and one pipe were analyzed for TPHs. TPHs were detected at low concentrations (≤10 mg/L) in two seeps and in the one pipe sample.

4.4 Fire Reservoir

As noted earlier, the fire reservoir was emptied and cleaned in 1987. Samples of water that subsequently accumulated in the two compartments (FR1 and FR2) of the fire reservoir were collected and analyzed for volatile organic compounds

(VOCs), total petroleum hydrocarbons (TPHs), and polychlorinated biphenyls (PCBs). These analytical results are presented in Table 4-5.

Only relatively low concentrations of three volatile organic compounds were found in reservoir samples, indicating that the reservoir cleanup was successful. The only volatile organic compound confirmed to be present in more than one round of fire reservoir samples was TCE at concentrations ranging from 4 to 16 ppb in the west compartment (FR1). No volatile organic compounds were detected in the sample from the other compartment (FR2). TPHs were detected in samples from both compartments of the reservoir. A PCB (Aroclor 1254) also was detected in the sample from the west compartment (FR1) at a concentration of 27 ppb.

Concentrations of TCE from the reservoir are comparable to those in ground water from well MW-5-25 and are as much as four orders of magnitude less than those found in ground water from well MW-5-40 (both wells are immediately upgradient from the reservoir). Concentrations of TCE in reservoir waters are two to four orders of magnitude less than those found in the MW-3-31 monitoring well downgradient of the reservoir.

TPHs and PCBs were not detected in either well cluster MW-3 or MW-5. Since the fire reservoir is adjacent to both a plant driveway and a parking area, vehicle traffic and surface runoff is one possible source for the TPHs currently found in the reservoir waters. Another possible source of both TPHs and PCBs is the oily materials formerly found in the reservoir that may have migrated into the surrounding subsurface and may currently be serving as a source of low-level contamination as ground water seeps towards and into the reservoir. Although PCBs were not reported to have been handled near or disposed of in the reservoir, the oily material found in the reservoir water may have included PCB-containing oils.

4.5 Surface Water, Sediment, and Storm Drainage

As required in the Stage 1 and Stage 2 Work Plans, surface water samples were collected from Six Mile Creek, and surface water and sediment samples were collected from three unnamed surface drainages in the vicinity of the plant (See Plate 1 for locations). A water sample also was collected from a storm-water culvert along South Cayuga Street that drains into Six Mile Creek, downgradient of the plant. These samples were tested for total petroleum hydrocarbons (TPHs) and volatile organic compounds (VOCs). The results of the surface water and storm-water analyses are presented in Tables 4-6 and 4-7, respectively.

The analytical results indicate that neither surface water nor storm drainage from the plant and its vicinity were contributing any detectable concentrations of volatile organic compounds of interest to Six Mile Creek at the time these locations were sampled during the Stage 1 and Stage 2 investigations. The only compounds detected in the samples from Six Mile Creek were chloroform at 1 ppb in the samples upstream of and opposite the EPT plant, and TCE at 2 ppb in the sample taken upstream of the plant.

No significant contamination was leaving the site via surface water at the time the samples were collected. Concentrations of the few volatile organic compounds detected in surface water from the three unnamed drainages and the storm culvert were all less than 5 ppb. Low levels of TPHs (≤ 20 ppm), also found in these samples, are likely the result of surface runoff from parking lots and other paved areas crossed by vehicles.

Sediment in the unnamed surface drainages in the plant area are not likely to contribute any detectable concentrations of volatile organic compounds of interest to Six Mile Creek. With one exception, concentrations of VOCs detected in sediment samples were all less than 10 ppb. Methylene chloride was detected in two samples at concentrations ranging from 30 to 32 ppb. One of these samples was from a location upstream of the plant, indicating the potential for sources other than EPT. The other sample was taken from the upstream end of drainage SW3, which is located downgradient of the plant. The source of methylene chloride at this location has not been identified.

4.6 Sanitary Sewers and Plant Water Supply

As specified in the Stage 1 and Stage 2 Work Plans, water samples were collected from the sanitary sewers located along South Cayuga Street and Turner Place (Plate 1, locations MH-1 and MH-2, respectively). Because of the high velocity of flow in these sewer lines, no sediment was present to be sampled. The water samples were tested for total petroleum hydrocarbons (TPHs) and volatile organic compounds (VOCs). The results of these analyses are presented in Table 4-8. Because most of the flow in the sewer lines derives from water used at the plant (water that is supplied by the municipal water system), samples of the plant water supply were collected from a tap inside the boiler room at the plant, and were tested for the same set of parameters as the sewer samples. The results of these analyses are presented in Table 4-9.

The results of the analyses performed on the sewer and water supply samples indicate that the majority of the compounds found in the sewer samples are those commonly known to be byproducts of water chlorination, and are likely to be derived from the chlorinated municipal water supply system. The most prevalent compound detected in the sewer samples was chloroform, at concentrations ranging from 19 to 84 ppb. Chloroform is a known byproduct of water chlorination. The chloroform concentrations are comparable to those detected in the water supply samples. Other compounds known to be byproducts, including the trihalomethanes bromodichloromethane and dibromochloromethane, also were detected in the sewer samples. Of these, bromodichloromethane also was detected in the water supply samples.

Two other chlorinated hydrocarbons, tetrachloroethylene and 1,1,1-trichloroethane, were detected at low concentrations in the sewer samples and may be contributed by sources not related to plant production activities. Wastewater potentially containing low levels of 1,1,1-TCA and oil and grease is permitted to be discharged to the sewer from the plant. These compounds are also sometimes found in some commonly available household cleaners, which could be a potential source for the low levels observed. Trichloroethylene (TCE) was detected at 10 ppb in the water supply sample, and TPHs were detected at low levels in samples from the Turner Place sewer.

4.7 Field Parameters

Field measurements were made for pH, specific conductivity, and sample temperature using portable meters during Stage 1 water sample collection. No field parameters were measured in samples from the seeps because there was only sufficient volume for the sample itself. Measurements of pH and specific conductivity were made in the laboratory for the Stage 2 water samples. Table G-3 in Appendix G lists these measurements. The pH of ground water from wells ranged from 4.0 to 12.3 standard units. pH's of 11.0 to 12.0 occurred in the intermediate depth bedrock wells and may indicate the effects of grout used during the well construction process. These effects have diminished with time in well MW-3-150 but remain constant in wells MW-3-100 and MW-16-100. Specific conductivity measurements ranged from <1 to >10,000 umhos/cm; and temperatures ranged from 54.0 to 73.3 degrees Fahrenheit.

4.8 Scrap Conveyor/Loading Area

In accordance with the Stage 1 and Stage 2 Work Plans and as described in Section 2.4.2, a total of 17 samples and one duplicate sample of fill and other unconsolidated materials were selected for analysis from 15 borings (B1 through B15) drilled in the scrap conveyor/railroad track loading area. Samples were selected to represent a variety of depths ranging from ground surface to 10 feet below ground surface. All samples were analyzed for polychlorinated biphenyls (PCBs) and total petroleum hydrocarbons (TPHs). In addition, eight samples and one duplicate sample were selected for analysis of volatile organic compounds (VOCs) using EPA Methods 8010 and 8020.

Table 4-10 provides a summary of the analytical results for the soil samples tested. Figure 4-4 shows concentrations of the TPHs; the one PCB, Arochlor 1254; and the total VOCs detected in samples from each location. The TPHs and PCBs detected appear to be limited to samples from the vicinity of the scrap conveyor/loading area and from areas directly downgradient of it. Samples collected from the edges of the area investigated either contained only very low concentrations or none of these substances. In addition, samples of ground water from wells directly downgradient from this scrap conveyor/loading area, in line with the potential subsurface migration pathway from this area, did not demonstrate detectable concentrations of these substances.

TPHs were detected in the samples from borings B1, B2, B3, B12, B13, and B14. Samples from these borings (from depths ranging from 0 to 10.6 feet) showed concentrations of TPHs ranging from 1.6 to 73 parts per thousand (ppt). TPH concentrations in samples from B1, B2, and B3 demonstrated no apparent variation with depth. Concentrations in samples from B13 showed a decrease with depth, while samples from B14 showed an increase with depth.

One type of PCB, Arochlor 1254, was detected or estimated to be present in all of the samples where TPHs were detected. Only one sample, from B12, exhibited PCBs over 1 ppm, and none contained PCBs in concentrations greater than 2 ppm. Concentrations of PCBs above 0.2 ppm were limited to the area directly downgradient of the loading dock and at the head of South Cayuga Street. Concentrations of PCBs less than 0.2 ppm were detected in peripheral areas, such as along the railroad tracks.

While some of the oils that contaminated the scrap conveyor/loading area may have contained PCBs, no records have been found that document any use or disposal of PCBs in this area of the plant. The adjacent NYSEG substation may have contained dielectric fluids with PCBs; however, it is not known if PCBs were/are present and what handling practices, if any, have been employed by NYSEG at this location.

Low levels of volatile organic compounds were present in soils from the five locations tested. The presence of these compounds in areas directly downgradient of the loading dock, and at the head of South Cayuga Street, is consistent with the contamination of metal scrap with solvents from degreasing operations. The primary compounds detected in these areas included tetrachloroethylene (PCE); trichloroethylene (TCE); 1,1-dichloroethylene (1,1-DCE); vinyl chloride (VC); and methylene chloride (CH_2Cl_2). Total VOC concentrations detected in samples from borings B-3, B-8, and B-13 ranged from 35 to 620 ppb.

Some minor solvent contamination was detected in one area west of the loading dock, along the railroad track. The compounds detected in this area consisted primarily of 1,1,1-trichloroethane (1,1,1-TCA); 1,1-dichloroethane (1,1-DCA); and CH_2Cl_2. Total VOC concentrations ranged from 21 to 110 ppb in samples from borings B-14 and B-15. Ground water from wells downgradient of the loading dock contained less than 10 ppb volatile organic compounds. A likely potential source for these compounds in ground water is also the small amounts of solvent associated with the metal scrap formerly handled in this area. Standards for ground water were not exceeded at these locations. Standards or criteria for TPHs, PCBs, or VOCs in soils are not currently available.

4.9 Comparison of Concentrations of Various Compounds Detected at EPT with NYSDEC TOGS

Table 4-11 lists all locations where the concentrations of compounds detected in water were higher than the corresponding TOGS. The majority of locations where concentrations of these compounds were higher than the corresponding TOGS are on-site. Only four of the off-site locations yielded samples where concentrations of one or more chemical constituents were higher than the corresponding TOGS.

Trichloroethylene (TCE) was the organic compound most frequently detected in concentrations above the TOGS of 10 μg/L, primarily in on-site wells. Concentrations of other organic compounds, including PCE; trans-1,2-DCE; 1,1-DCE; vinyl chloride; CH_2Cl_2;, and 1,1,1-TCA, were occasionally detected at concentrations higher than the corresponding TOGS.

Several metals also were occasionally detected at concentrations higher than the corresponding TOGS. Based on the results of metals analysis of background ground-water samples and rock core samples, Radian has concluded that elevated levels of several metals, including barium, iron, magnesium, and manganese, are typical of the ground water in the area, and are due to in-situ geochemical conditions that are not a result of EPT's operations. The only other metals found at concentrations higher than the corresponding TOGS are two occurrences of antimony, one occurrence of lead, and three occurrences of chromium. The concentrations of lead and chromium are less than three times the corresponding TOGS. The concentrations of antimony, 65 μg/L at MW-3-31 and 73 μg/L at MW-6-40, exceed the guidance value of 3 μg/L. Antimony is not known to be used in any of the operations at EPT.

Chromium was detected at elevated levels in samples from three shallow wells: MW-3-13, MW-13-25, and MW-15-40. No major source of soluble chromium is known to have existed at the plant. Chromium was reportedly not used in any of the manufacturing processes at the plant, with the exception of any chromium content in steel stock used as raw materials. It also was reported that no chromium-containing materials were stored or disposed of in the vicinity of any of the three wells. One possible source of soluble chromium in ground water at these locations may be the overburden, which consists primarily of imported fill materials put in place during plant construction. Two of the three wells, including MW-3-13, which contains the highest reported concentrations of chromium in ground water on site, are screened wholly or partially in the overburden.

TABLE 4-1. VOLATILE ORGANIC COMPOUNDS DETECTED IN GROUND-WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	MW-1 08/10/88	MW-1 09/14/89	MW-2 08/09/88	MW-2 09/14/89	MW-3-13 08/10/88	MW-3-13 09/14/89	MW-3-13 11/2/89 R	MW-3-13 11/2/89 C	MW-3-31 08/09/88	MW-3-31 Dup 08/09/88
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Trichloroethylene	60		66,000	70,000	1,800	500	370	490	240,000	280,000
cis-1,2-Dichloroethylene	700		8,000		2,600					
trans-1,2-Dichloroethylene							700	1,100		
Benzene										
1,1-Dichloroethane										
1,2-Dichloroethene										
Vinyl chloride										
Chloroform										
1,1-Dichloroethylene										
Total Xylenes										
Methylene chloride										
Acetone										
1,1,1-Trichloroethane										
Bromodichloromethane										
Tetrachloroethylene		50		10,000						
Toluene										

Detection limits are presented in Appendix G.
C - CAMO Pollution Control, Inc.
R - Radian Analytical Services.

TABLE 4-1 (Continued). VOLATILE ORGANIC COMPOUNDS DETECTED IN GROUND-WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	MW-3-31 09/14/89	MW-3-31 Dup 09/14/89	MW-3-31 11/2/89 R	MW-3-31 11/2/89 C	MW-3-100 07/08/88	MW-3-100 07/16/88	MW-3-100 08/10/88	MW-3-100 09/14/89	MW-3-100 11/2/89 R	MW-3-100 11/2/89 C
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Trichloroethylene	470,000	12,000	290,000 D	1,100,000	48,500	29,500	18,000	7,000	9,000	16,000
cis-1,2-Dichloroethylene					0	0	1,000			
trans-1,2-Dichloroethylene			2,700	9,200	4,400	2,800			12,000	28,000
Benzene					1,500	1,600				
1,1-Dichloroethane										
1,2-Dichloroethene										
Vinyl chloride			230							200 V
Chloroform										
1,1-Dichloroethylene			64							
Total Xylenes					0	0				
Methylene chloride										
Acetone										
1,1,1-Trichloroethane										
Bromodichloromethane										
Tetrachloroethylene			180							
Toluene										

Detection limits are presented in Appendix G.
C - CAMO Pollution Control, Inc.
D - Sample diluted for this analyte.
R - Radian Analytical Services.
V - Vinyl chloride and Dichlorodifluoromethane coelute (CAMO Pollution Control, Inc.).

TABLE 4-1 (Continued). VOLATILE ORGANIC COMPOUNDS DETECTED IN GROUND-WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	MW-3-150 08/16/88	MW-3-150 09/18/89	MW-3-150 11/2/89 R	MW-3-150 11/2/89 C	MW-3-150 11/2/89 C Dup	MW-4 08/11/88	MW-4 09/13/89	MW-5-25 08/11/88	MW-5-25 09/13/89	MW-5-25 11/2/89 R
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Trichloroethylene	200	3,500	4,200	6,200	5,900					
cis-1,2-Dichloroethylene	250							30		
trans-1,2-Dichloroethylene			4,500	8,500	9,200					15
Benzene										
1,1-Dichloroethane										
1,2-Dichloroethene										
Vinyl chloride								110	200	110
Chloroform							1			
1,1-Dichloroethylene										
Total Xylenes										
Methylene chloride										
Acetone										
1,1,1-Trichloroethane										
Bromodichloromethane										
Tetrachloroethylene										
Toluene										

Detection limits are presented in Appendix G.
C - CAMO Pollution Control, Inc.
R - Radian Analytical Services.

TABLE 4-1 (Continued). VOLATILE ORGANIC COMPOUNDS DETECTED IN GROUND-WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	MW-5-25 11/2/89 C	MW-5-40 08/08/88	MW-5-40 09/13/89	MW-5-40 R 11/2/89	MW-5-40 C 11/2/89	MW-5-100 09/15/89	MW-5-100 R 11/2/89	MW-5-100 C 11/2/89	MW-6-25 08/10/88	MW-6-25 09/14/89
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Trichloroethylene		220,000 E	290,000	73,000 D	240,000	270,000	15	21		
cis-1,2-Dichloroethylene										
trans-1,2-Dichloroethylene	19			13,000 D	16,300		4.1	5		
Benzene										
1,1-Dichloroethane										
1,2-Dichloroethene		15,000								
Vinyl chloride	180 V			850	800 V					
Chloroform										
1,1-Dichloroethylene				110					2	
Total Xylenes										
Methylene chloride		3,800 X								
Acetone		1,200 J								
1,1,1-Trichloroethane										
Bromodichloromethane										
Tetrachloroethylene				400						
Toluene										

Detection limits are presented in Appendix G.

C - CAMO Pollution Control, Inc.
D - Sample diluted for this analyte.
E - Estimated value or not reported due to the presence of interference.
J - Estimated value.
R - Radian Analytical Services.
V - Vinyl chloride and Dichlorodifluoromethane coelute (CAMO Pollution Control, Inc.).
X - Estimated value; analyte was also found in associated blank.

TABLE 4-1 (Continued). VOLATILE ORGANIC COMPOUNDS DETECTED IN GROUND-WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	MW-6-40 08/08/88	MW-6-40 09/14/89	MW-6-40 Dup 09/14/89	MW-6-100 08/10/88	MW-7-40 08/16/88	MW-7-40 09/15/89	MW-8-40 08/16/88	MW-8-40 09/18/89	MW-9-40 09/18/89	MW-9-100 09/18/89
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Trichloroethylene				3	13		3			
cis-1,2-Dichloroethylene					140					
trans-1,2-Dichloroethylene										
Benzene										
1,1-Dichloroethane										
1,2-Dichloroethene										
Vinyl chloride			4							
Chloroform	1 X			7						20
1,1-Dichloroethylene										
Total Xylenes										
Methylene chloride	4 X									
Acetone										
1,1,1-Trichloroethane										
Bromodichloromethane										
Tetrachloroethylene										
Toluene										

Detection limits are presented in Appendix G.

X - Estimated value; analyte was also found in associated blank.

TABLE 4-1 (Continued). VOLATILE ORGANIC COMPOUNDS DETECTED IN GROUND-WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT	MW-10-40	MW-11-40	MW-13-25	MW-13-25	MW-15-40	MW-15-40	MW-16-100	MW-16-100	MW-17-40	MW-17-40
DATE	09/18/89	09/18/89	08/09/88	09/13/89	08/09/88	09/13/89	08/16/88	09/15/89	08/12/88	09/15/89
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Trichloroethylene			30	19		5	7	5		
cis-1,2-Dichloroethylene			80				40			
trans-1,2-Dichloroethylene										
Benzene										
1,1-Dichloroethane						11				
1,2-Dichloroethene										
Vinyl chloride			21							
Chloroform	1	1	7		16 B	5	46			
1,1-Dichloroethylene					27					
Total Xylenes							1			
Methylene chloride						2				
Acetone										
1,1,1-Trichloroethane					220 E	51				
Bromodichloromethane			1		2 J					
Tetrachloroethylene			4				1			
Toluene										

Detection limits are presented in Appendix G.

B - Analyte found in associated blank.

E - Estimated value or not reported due to the presence of interference.

J - Estimated value.

TABLE 4-1 (Continued). VOLATILE ORGANIC COMPOUNDS DETECTED IN GROUND-WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	PIPE 6 09/15/89	SEEP D 07/18/88	SEEP D 09/14/89	SEEP D Dup 09/14/89	SEEP E 07/18/88	SEEP E 09/14/89	SEEP F 07/18/88	SEEP G 09/12/89	SEEP H 09/14/89
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Trichloroethylene	65	4			3		4		
cis-1,2-Dichloroethylene		12			12		80		
trans-1,2-Dichloroethylene					1				1
Benzene									
1,1-Dichloroethane									
1,2-Dichloroethene									
Vinyl chloride		1			1		7		
Chloroform		1			2	1	5	2	
1,1-Dichloroethylene		1							
Total Xylenes									
Methylene chloride		1							
Acetone									
1,1,1-Trichloroethane		1							
Bromodichloromethane									
Tetrachloroethylene									
Toluene		8							

Detection limits are presented in Appendix G.

TABLE 4-2. METALS DETECTED IN WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT	MW-3-13	MW-3-31	MW-3-31 Dup.	MW-3-31	MW-3-31 Dup.	MW-3-100	MW-4
DATE	09/14/89	08/09/88	08/09/88	09/14/89	09/14/89	09/14/89	09/13/89
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Aluminum	114 BN*	110	128	151 BN*	2,400 N*	1,730 N*	265 N*
Antimony	< 26.00 U	101	165	30.50 B	< 26.00 U	< 26.00 U	< 26.00 U
Arsenic	1.70 B			< 1.00 U	24.10	19.00	2.50 B
Barium	503 E	7,780	7,650	2,640 E	497 E	387 E	1,780 E
Beryllium	< 1.00 U			< 1.00 U	< 1.00 U	< 1.00 U	< 1.00 U
Cadmium	< 2.00 U			< 2.00 U	< 2.00 U	< 2.00 U	< 2.00 U
Calcium	317,000	386,000 E	376,000 E	240,000	20,500	17,700	215,000
Chromium	927		11	< 3.00 U	14.20	7.80 B	10.90
Cobalt	< 21.00 U			< 21.00 U	< 21.00 U	< 21.00 U	< 21.00 U
Copper	14.60 B	10		< 5.00 U	19.90 B	15.20 B	< 5.00 U
Iron	4,880	158	147	217	146	238	995
Lead	7.40			37.80	6.30	8.50	< 1.00 UW
Magnesium	56,300	73,700	72,600	49,200	159 B	265 B	41,600
Manganese	1,120	2,470	2,430	430	5.70 B	10.80 B	937
Mercury	< 0.10 U			< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U
Nickel	123.00			< 5.00 U	< 5.00 U	< 5.00 U	16.60 B
Potassium	11,600	4,640	4,600	18,900	253,000	164,000	3,960 B
Selenium	< 1.00 UW			< 1.00 U	< 1.00 U	< 1.00 U	< 1.00 UW
Silver	< 3.00 U	13	10	< 3.00 U	< 3.00 U	< 3.00 U	< 3.00 U
Sodium	1,070,000	363,000 *	379,000	446,000	877,000	730,000	644,000
Thallium	< 1.00 UW			1.10 BW	< 1.00 UW	< 1.00 UW	< 1.00 UW
Vanadium	5.70 B			< 4.00 U	13.00 B	10.70 B	< 4.00 U
Zinc	< 11.00 U			< 11.00 U	< 11.00 U	< 11.00 U	< 11.00 U
Cyanide		21	20 *				

Detection limits are presented in Appendix G.

* - Duplicate analysis was not within control limits.

B - Result was between instrument detection limit and contract-required detection limit.

E - Estimated value or not reported due to the presence of interference.

N - Spike sample recovery was not within control limits.

U - Result was less than instrument detection limit.

W - Post-digest spike recovery furnace analysis was out of 85-115 % control limit, while sample absorbance was less than 50% of spike absorbance.

TABLE 4-2 (Continued). METALS DETECTED IN WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	MW-5-25 09/13/89	MW-5-40 08/08/88	MW-5-40 09/13/89	MW-6-25 09/14/89	MW-6-40 08/08/88	MW-8-40 09/18/89	MW-9-100 09/18/89
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Aluminum	355 N*	111	810 N*	1,070 N*		1,210 N*	7,610 N*
Antimony	< 26.00 U		< 26.00 U	< 26.00 U	73	< 26.00 U	< 26.00 U
Arsenic	6.00 B	2.2	1.00 B	2.10 B		1.40 BW	6.80 B
Barium	582 E	2,760	1,550 E	148 BE	1,330	715 E	59.30 BE
Beryllium	< 1.00 U		< 1.00 U	< 1.00 U		< 1.00 U	< 1.00 U
Cadmium	< 2.00 U		< 2.00 U	< 2.00 U		< 2.00 U	< 2.00 U
Calcium	329,000	213000 E	156,000	41,800	137,000 E	101,000	6,180
Chromium	< 3.00 U		< 3.00 U	< 3.00 U		8.70 B	20.00
Cobalt	< 21.00 U		< 21.00 U	< 21.00 U		< 21.00 U	< 21.00 U
Copper	11.80 B	5.2	< 5.00 U	14.80 B		7.30 B	16.40 B
Iron	1,850	231	1,480	16,000	977	3,870	12,400
Lead	3.40		< 1.00 U	3.10		55.90	7.60
Magnesium	57,100	42,700	35,000	6,520	32,600	28,700	3,450 B
Manganese	40,000	995	975	2,410	1,010	157	156
Mercury	< 0.10 U		< 0.10 U	< 0.10 U		0.21	< 0.10 U
Nickel	11.70 B		< 5.00 U	< 5.00 U		6.00 B	14.00 B
Potassium	23,200	6,170	4,800 B	3,620 B	6,370	6,440	4,570 B
Selenium	< 1.00 UW	1.10 N	< 1.00 UW	< 1.00 U		< 1.00 U	< 1.00 UW
Silver	< 3.00 U		< 3.00 U	< 3.00 U		< 3.00 U	< 3.00 U
Sodium	1,140,000	250,000	219,000	58,600	250,000	160,000	96,900
Thallium	< 1.00 UW		< 1.00 UW	< 1.00 U		1.20 BW	< 1.00 UW
Vanadium	< 4.00 U		< 4.00 U	< 4.00 U		5.00 B	11.60 B
Zinc	< 11.00 U		< 11.00 U	< 11.00 U		15.60 B	27.80
Cyanide		37 *			15 *		

Detection limits are presented in Appendix G.

* - Duplicate analysis was not within control limits.

B - Result was between instrument detection limit and contract-required detection limit.

E - Estimated value or not reported due to the presence of interference.

N - Spike sample recovery was not within control limits.

U - Result was less than instrument detection limit.

W - Post-digest spike recovery furnace analysis was out of 85-115 % control limit, while sample absorbance was less than 50% of spike absorbance.

TABLE 4-2 (Continued). METALS DETECTED IN WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	MW-13-25 09/13/89	MW-15-40 08/09/88	MW-15-40 09/13/89	MW-16-100 09/15/89	Fire Reservoir 1 09/12/89	Fire Reservoir 2 09/12/89
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Aluminum	403 N*		599 N*	5,240 N*	1,770 N*	158 BN*
Antimony	< 26.00 U		< 26.00 U	< 26.00 U	< 26.00 U	< 26.00 U
Arsenic	4.40 B		2.50 B	32.30	1.20 B	< 1.00 U
Barium	93.80 BE	75	205 E	92.40 BE	158 BE	91.10 BE
Beryllium	< 1.00 U		< 1.00 U	< 1.00 U	< 1.00 U	< 1.00 U
Cadmium	< 2.00 U		< 2.00 U	< 2.00 U	8.80	< 2.00 U
Calcium	60,200	34400 E	32,100	7,650	124,000	58,100
Chromium	136		123	6.20 B	4.00 B	< 3.00 U
Cobalt	< 21.00 U		< 21.00 U	< 21.00 U	< 21.00 U	30.80 B
Copper	10.30 B		13.20 B	30.10	31.20	5.40 B
Iron	18,900	130	1,780	6,620	2,940	539
Lead	2.30 B		2.40 B	6.40	20.30	4.10
Magnesium	11,600	7,350	6,630	1,450 B	8,660	8,200
Manganese	499	370	1,850	65.00	327	25.10
Mercury	< 0.10 U		< 0.10 U	< 0.10 U	< 0.10 U	< 0.10 U
Nickel	84.50		34.40 B	12.20 B	14.10 B	< 5.00 U
Potassium	4,900 B	2,520	2,730 B	37,000	3,590 B	6,760
Selenium	1.00 BW		< 1.00 U	< 1.00 UW	< 1.00 U	< 1.00 U
Silver	< 3.00 U		< 3.00 U	< 3.00 U	< 3.00 U	< 3.00 U
Sodium	102,000	58,800	65,600	390,000	162,000	210,000
Thallium	< 1.00 UW		< 1.00 UW	< 1.00 UW	< 1.00 U	< 1.00 U
Vanadium	4.10 B		< 4.00 U	22.60 B	< 4.00 U	< 4.00 U
Zinc	89.70		< 11.00 U	29.70	126	13.20 B
Cyanide		82 *				

Detection limits are presented in Appendix G.

* - Duplicate analysis was not within control limits.

B - Result was between instrument detection limit and contract-required detection limit.

E - Estimated value or not reported due to the presence of interference.

N - Spike sample recovery was not within control limits.

U - Result was less than instrument detection limit.

W - Post-digest spike recovery furnace analysis was out of 85-115 % control limit, while sample absorbance was less than 50% of spike absorbance.

TABLE 4-3. METALS DETECTED IN ROCK SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT	Rock Sample #1	Rock Sample #2
DATE	08/10/89	08/10/89
	(mg/kg)	(mg/kg)
Aluminum	15,900	24,500
Antimony	< 4.50 UN	< 4.00 UN
Arsenic	7.40	14.80 S
Barium	42.00	90.70
Beryllium	< 0.17 U	1.50
Cadmium	< 0.35 UN	< 0.31 UN
Calcium	4,290	2,680
Chromium	21.70	38.20
Cobalt	16.60	20.50
Copper	5.40	4.40
Iron	33,000	47,700
Lead	4.90	4.20
Magnesium	7,070	10,700
Manganese	320.00	374.00
Mercury	1.70 *	< 0.23 U*
Nickel	30.40	43.80
Potassium	1,280	2,130
Selenium	< 0.20 U	< 0.20 U
Silver	2.20	0.74 B
Sodium	304.00 B	252.00 B
Thallium	< 0.20 U	< 0.20 U
Vanadium	20.20	34.10
Zinc	51.50	80.00

Detection limits are presented in Appendix G.

* - Duplicate analysis was not within control limits.

B - Result was between instrument detection limit and contract-required detection limit.

N - Spike sample recovery was not within control limits.

S - Value was determined by the method of standard additions (MSA).

U - Result was less than instrument detection limit.

TABLE 4-4. TOTAL PETROLEUM HYDROCARBONS AND SEMIVOLATILE ORGANICS DETECTED IN GROUND-WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	MW-3-31 08/09/88	MW-3-31 Dup 08/09/88	MW-5-40 08/08/88	MW-6-40 08/08/88	MW-15-40 08/09/88	Pipe 6 09/15/89
Naphthalene (ug/L)			11			
2-Methylnaphthalene (ug/L)			4 Z			
Dibenzofuran (ug/L)			5 J			
Fluorene (ug/L)			6 J			
Phenanthrene (ug/L)			20			
Anthracene (ug/L)			2 Z			
Fluoranthene (ug/L)			7 J			
Pyrene (ug/L)			3 Z			
Total Petroleum Hydrocarbons (mg/L)						3.1

Detection limits are presented in Appendix G.

J - Estimated value.

Z - Estimated value; number was entered manually during production of a computer-generated report.

TABLE 4-5. TOTAL PETROLEUM HYDROCARBONS, VOLATILE ORGANIC COMPOUNDS, AND POLYCHLORINATED BIPHENYLS DETECTED IN FIRE WATER RESERVOIR SAMPLE EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	Fire Reservoir 1 07/19/88	Fire Reservoir 1 Dup 07/19/88	Fire Reservoir 1 09/12/89	Fire Reservoir 2 07/19/88	Fire Reservoir 2 09/12/89
Total Petroleum Hydrocarbons (mg/L)		9.2	740	71	
Chloroform (ug/L)			2		1
Trichloroethylene (ug/L)	13	16	4		
cis-1,2-Dichloroethylene (ug/L)	10	10			
Aroclor-1254 (ug/L)			27		

Detection limits are presented in Appendix G.

TABLE 4-6. TOTAL PETROLEUM HYDROCARBONS AND VOLATILE ORGANIC COMPOUNDS DETECTED IN SURFACE-WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	Six Mile Creek Downstream 09/13/89	Six Mile Creek Midpoint 09/13/89	Six Mile Creek Midpoint 09/13/89	Six Mile Creek Upstream 09/13/89	Cayuga St. Storm Drainage 09/12/89
Total Petroleum Hydrocarbons (mg/L)					20
Chloroform (ug/L)		1	1	1	4
1,1,1-Trichloroethane (ug/L)					
Bromodichloromethane (ug/L)					
Trichloroethylene (ug/L)				2	
Dibromochloromethane (ug/L)					
Tetrachloroethylene (ug/L)					

Detection limits are presented in Appendix G.

TABLE 4-6 (Continued). TOTAL PETROLEUM HYDROCARBONS AND VOLATILE ORGANIC COMPOUNDS DETECTED IN SURFACE-WATER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT	Surface Water 1	Surface Water 1	Surface Water 2	Surface Water 2	Surface Water 2	Surface Water 3	Surface Water 3
	Upstream	Downstream	Upstream	Downstream	Dup. Downstream	Upstream	Downstream
DATE	07/18/88	07/19/88	07/19/88	07/20/88	07/20/88	07/20/88	07/20/88
Total Petroleum Hydrocarbons (mg/L)					2.1	2	2
Chloroform (ug/L)				2	2		
1,1,1-Trichloroethane (ug/L)				4	4		
Bromodichloromethane (ug/L)							
Trichloroethylene (ug/L)							
Dibromochloromethane (ug/L)							
Tetrachloroethylene (ug/L)							

Detection limits are presented in Appendix G.

TABLE 4-7. TOTAL PETROLEUM HYDROCARBONS AND VOLATILE ORGANIC COMPOUNDS DETECTED IN SEDIMENT SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE	Surface Water 1	Surface Water 1	Surface Water 2	Surface Water 2	Surface Water 2	Surface Water 3	Surface Water 3
POINT	Upstream Sediment	Downstream Sediment	Upstream Sediment	Downstream Sediment	Dup. Downstream Sediment	Upstream Sediment	Downstream Sediment
DATE	07/18/88	07/19/88	07/19/88	07/20/88	07/20/88	07/20/88	07/20/88
Total Petroleum Hydrocarbons (mg/g)							2.2
Methylene Chloride (ug/g)	32	6				30	6
Toluene (ug/g)	2					6	7
Chloroform (ug/g)	1			1		3	
Trichloroethylene (ug/g)						4	1
Total Xylenes (ug/g)	4						
1,1,1-Trichloroethane (ug/g)				1			

Detection limits are presented in Appendix G.

TABLE 4-8. TOTAL PETROLEUM HYDROCARBONS AND VOLATILE ORGANIC COMPOUNDS DETECTED IN SANITARY SEWER SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	Cayuga St. Sanitary Sewer 07/22/88	Cayuga St. Sanitary Sewer 09/12/89	Turner Place Sanitary Sewer 07/22/88	Turner Place Sanitary Sewer 08/15/88	Turner Place Sanitary Sewer 09/13/89	Turner Place Sanitary Sewer Dup. 09/13/89
Total Petroleum Hydrocarbons (mg/L)				24	19	18
Chloroform (ug/L)	19	23	62	84	42	36
1,1,1-Trichloroethane (ug/L)	32		3	5		
Bromodichloromethane (ug/L)	3		7	10	4	3
Trichloroethylene (ug/L)	2		1	1		
Dibromochloromethane (ug/L)			1	2	2	1
Tetrachloroethylene (ug/L)					8	4

Detection limits are presented in Appendix G.

TABLE 4-9. VOLATILE ORGANIC COMPOUNDS DETECTED IN SUPPLY WATER AND EQUIPMENT BLANK SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DATE	Supply Water 1 09/12/89	Supply Water 2 09/12/89	Equipment Blank 09/12/89
Chloroform (ug/L)	45	55	1
Bromodichloromethane (ug/L)		10	
Trichloroethylene (ug/L)		10	1

Detection limits are presented in Appendix G.

TABLE 4-10. TOTAL PETROLEUM HYDROCARBONS, VOLATILE ORGANIC COMPOUNDS, AND POLYCHLORINATED BIPHENYLS DETECTED IN SOIL BORING SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT	Boring 1A	Boring 1A	Boring 2A	Boring 2A	Boring 3A	Boring 3A	Boring 3A Dup	Boring 5	Boring 7
DEPTH	7-9 ft	9- 10.6 ft	4-6 ft	8-9.2 ft	6-8 ft	8-10 ft	8-10 ft	6-7.7 ft	0-1.5 ft
DATE	07/20/88	07/20/88	07/19/88	07/19/88	07/19/88	07/19/88	07/19/88	07/20/88	07/20/88
TIME									
Total Petroleum Hydrocarbons (mg/g)	9.8	9	5.1	5.1	4.6	14	5.3	0.9	
Arochlor - 1254 (ug/kg)	940	1,700	240	44	36	71 J	65 J	54 J	25 J
Tetrachloroethylene (ug/kg)						40	42		
Total Xylenes (ug/kg)						21	29		
Vinyl Chloride (ug/kg)						32	9		
Trichloroethylene (ug/kg)						3	3		
Methylene Chloride (ug/kg)						7	6		
Toluene (ug/kg)						5	5		
Chloroform (ug/kg)						5	3		
1,1-Dichloroethane (ug/kg)						9	5		
1,1-Dichloroethylene (ug/kg)									
cis-1,2-Dichloroethylene (ug/kg)						6			
Ethyl benzene (ug/kg)						2	3		
trans-1,2-Dichloroethylene (ug/kg)							2		
1,1,1-Trichloroethane (ug/kg)									

Detection limits are presented in Appendix G.

J - Estimated value.

TABLE 4-10 (Continued). TOTAL PETROLEUM HYDROCARBONS, VOLATILE ORGANIC COMPOUNDS, AND POLYCHLORINATED BIPHENYLS DETECTED IN SOIL BORING SAMPLES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

SAMPLE POINT DEPTH DATE TIME	Boring 8 2-3.8 ft 07/20/88	Boring 10 4-6 ft 07/22/88	Boring 12 0-1.7 ft 07/22/88	Boring 13A 0.5-1.5 ft 09/12/89	Boring 13B 3-5 ft 09/12/89	Boring 14A 0-2 ft 09/12/89	Boring 14B 5.5-7.5 ft 09/12/89	Boring 15A 0-2 ft 09/12/89 14:30	Boring 15A 0-2 ft 09/12/89 14:59
Total Petroleum Hydrocarbons (mg/g)		0.4	1.6	73	5.9	0.42	33	0.52	0.62
Arochlor - 1254 (ug/kg)		24 J	180	620	110	110	72	170	150
Tetrachloroethylene (ug/kg)									
Total Xylenes (ug/kg)	2			5	15	2	20	4	
Vinyl Chloride (ug/kg)									
Trichloroethylene (ug/kg)	17								
Methylene Chloride (ug/kg)	6			27	3	14		30	71
Toluene (ug/kg)	2			8	4	3		2	
Chloroform (ug/kg)	3			2	2	2		5	5
1,1-Dichloroethane (ug/kg)								18	46
1,1-Dichloroethylene (ug/kg)				13					
cis-1,2-Dichloroethylene (ug/kg)	5								
Ethyl benzene (ug/kg)					1		5		
trans-1,2-Dichloroethylene (ug/kg)									
1,1,1-Trichloroethane (ug/kg)								12	28

Detection limits are presented in Appendix G.
J - Estimated value.

TABLE 4-11. COMPARISON OF CONCENTRATIONS OF VARIOUS COMPOUNDS DETECTED AT EMERSON POWER TRANSMISSION FACILITY WITH NYSDEC TECHNICAL AND OPERATIONAL GUIDANCE SERIES (TOGS)

Sample Point	Constituent	Detected Concentration in Water (µg/L)	NYSDEC Standard (µg/L)	NYSDEC Guidance Value (µg/L)
MW-1	Trichloroethylene	60[a]	10	
	Tetrachloroethylene	50[b]		0.7
MW-2	Trichloroethylene	68,000[c]	10	
	Tetrachloroethylene	10,000[b]		0.7
MW-3-13	Trichloroethylene	1,500[c]	10	
	Iron	4,880[b]	300	
	Chromium	927	50	
	Magnesium	56,300[b]		35,000
	Manganese	1,120[b]	300	
MW-3-31	Trichloroethylene	35,500[c]	10	
	Antimony	65[c]		3
	Barium	5,210[c]	1,000	
	Magnesium	61,450[c]		35,000
	Manganese	1,450[c]	300	
MW-3-100	Trichloroethylene	25,750[c]	10	
	trans-1,2-Dichloroethylene	3,600[a]		50
	Benzene	1,550[a]		1.0
MW-3-150	Trichloroethylene	1,850[c]	10	
MW-4	Barium	1,780[b]	1,000	
	Magnesium	41,600[b]		35,000
	Manganese	937[b]	300	
MW-5-25	Vinyl chloride	155[c]	5	
	Iron	1,850[b]	300	
	Magnesium	57,100[b]		35,000
	Manganese	40,000[b]	300	
MW-5-40	Trichloroethylene	255,000[c]	10	
	Methylene chloride	3,800[a]		50
	Barium	2,155[c]	1,000	
	Iron	856[c]	300	
	Magnesium	38,850[c]		35,000
	Manganese	985[c]	300	
MW-5-100	Trichloroethylene	270,000[b]	10	
MW-6-25	1,1-Dichloroethene	2[a]		0.07
	Iron	16,000[b]	300	
	Manganese	2,410[b]	300	

[a] Stage 1 data only.
[b] Stage 2 data only.
[c] Average concentration of Stage 1 and Stage 2 data.

TABLE 4-11. COMPARISON OF CONCENTRATIONS OF VARIOUS COMPOUNDS DETECTED AT EMERSON POWER TRANSMISSION FACILITY WITH NYSDEC TECHNICAL AND OPERATIONAL GUIDANCE SERIES (TOGS) (CONTINUED)

Sample Point	Constituent	Detected Concentration in Water (µg/L)	NYSDEC Standard (µg/L)	NYSDEC Guidance Value (µg/L)
MW-6-40	Antimony	73[a]		3
	Barium	1,330[a]	1,000	
	Iron	977[a]	300	
	Manganese	1,010[a]	300	
MW-7-40	Trichloroethylene	13[a]	10	
MW-8-40	Iron	3,870[b]	300	
	Lead	56[b]	25	
MW-9-100	Iron	12,400[b]	300	
MW-13-25	Trichloroethylene	24[c]	10	
	Vinyl chloride	21[a]	5	
	Chromium	136[b]	50	
	Iron	18,900[b]	300	
	Manganese	499[b]	300	
MW-15-40	1,1-Dichloroethene	27[a]		0.07
	1,1,1-Trichloroethane	135[c]		50
	Chromium	123[b]	50	
	Iron	955[c]	300	
	Manganese	1,110[c]	300	
MW-16-100	Iron	6,620[b]	300	
Pipe 6	Trichloroethylene	65[b]	10	
Fire Reservoir 1	Iron	2,940[b]	300	
	Manganese	327[b]	300	
Fire Reservoir 2	Iron	539[b]	300	
Seep D	1,1-Dichloroethene	1[a]		0.07
Seep F	Vinyl chloride	7[a]	5	

[a] Stage 1 data only.
[b] Stage 2 data only.
[c] Average concentration of Stage 1 and Stage 2 data.

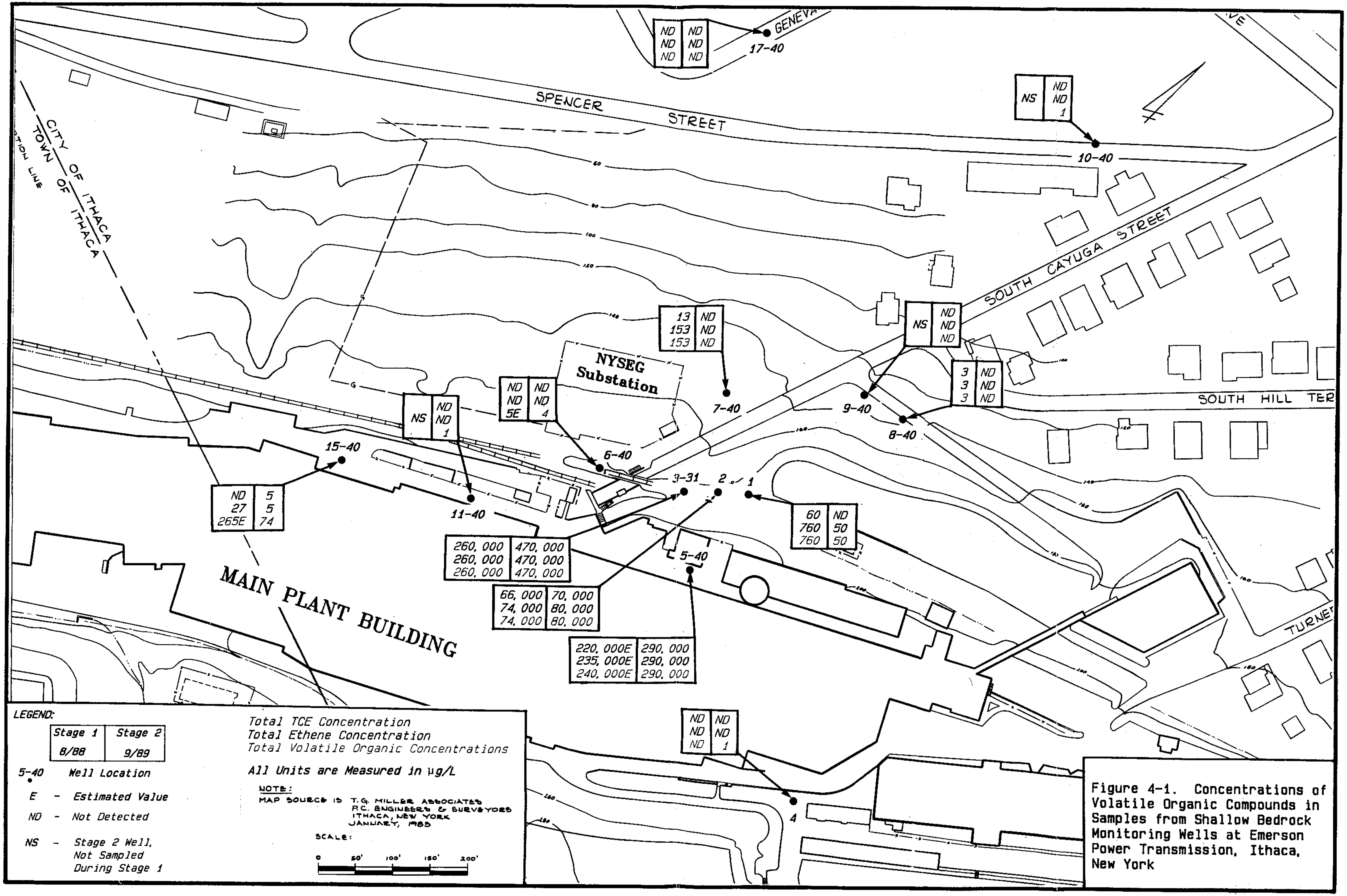

Figure 4-1. Concentrations of Volatile Organic Compounds in Samples from Shallow Bedrock Monitoring Wells at Emerson Power Transmission, Ithaca, New York

RADIAN CORPORATION

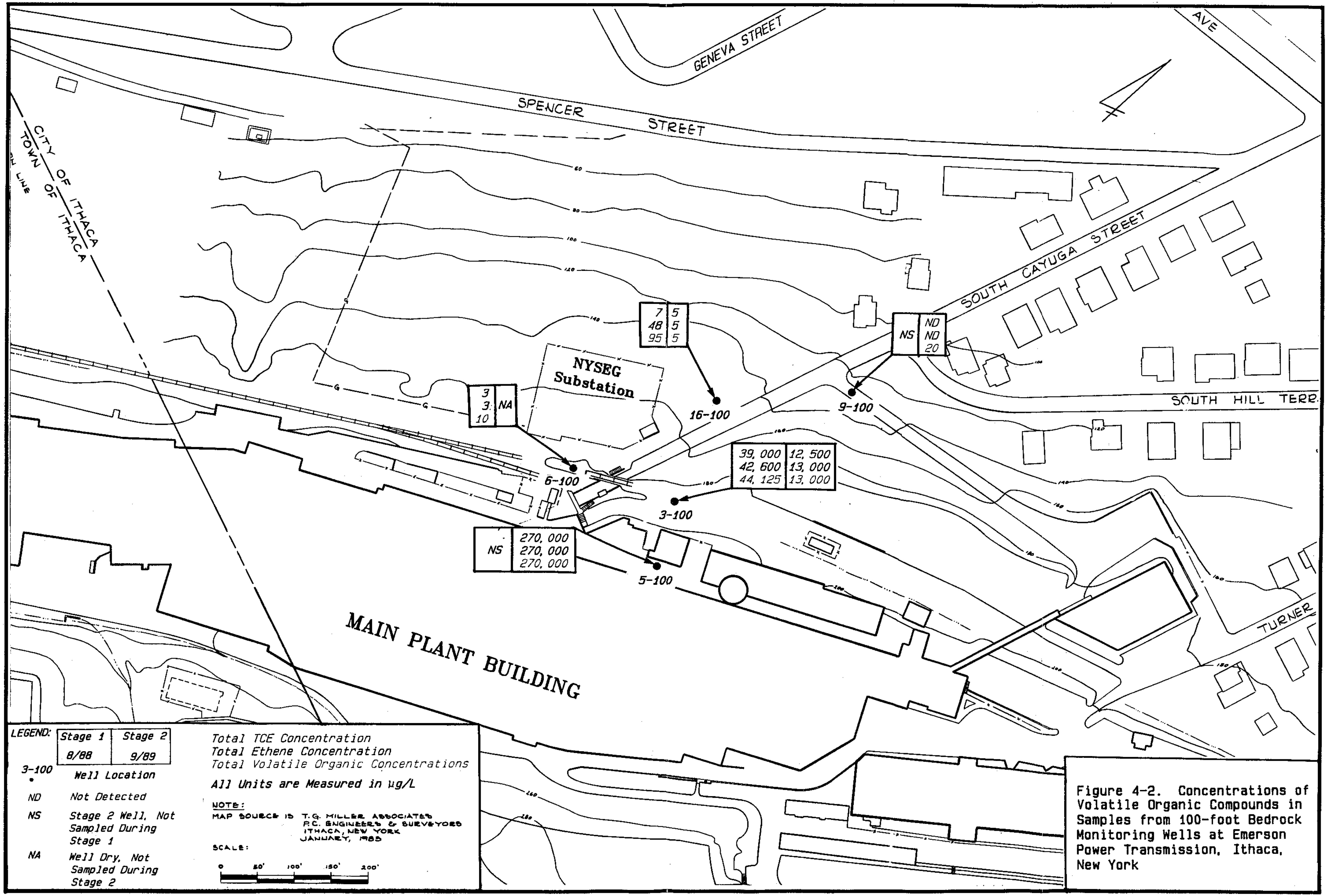

Figure 4-2. Concentrations of Volatile Organic Compounds in Samples from 100-foot Bedrock Monitoring Wells at Emerson Power Transmission, Ithaca, New York

RADIAN CORPORATION

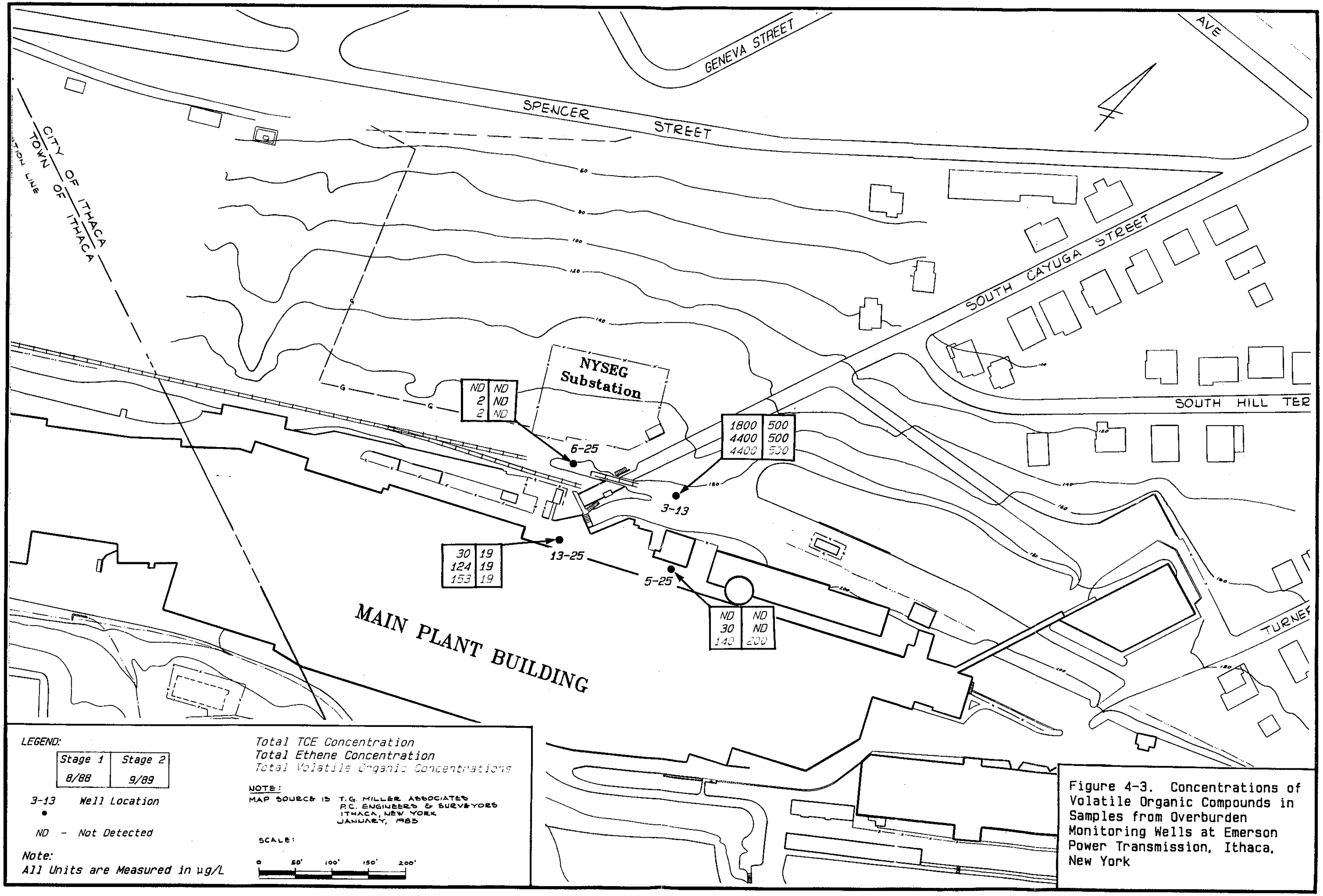

Figure 4-3. Concentrations of Volatile Organic Compounds in Samples from Overburden Monitoring Wells at Emerson Power Transmission, Ithaca, New York

RADIAN CORPORATION

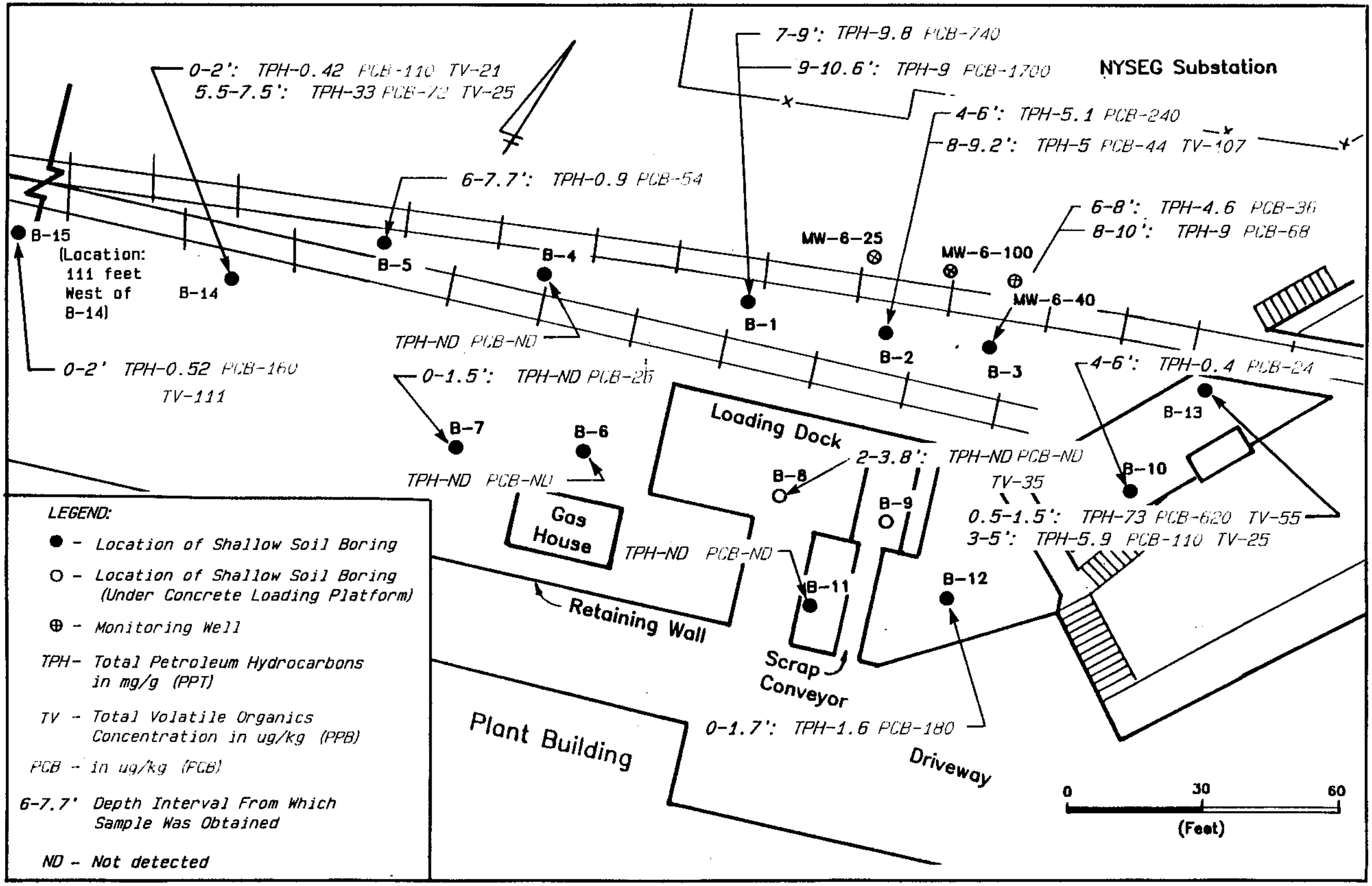

Figure 4-4. Concentrations of Total Petroleum Hydrocarbons, Total Volatile Organics, and Polychlorinated Biphenyls in Soil Samples from the Scrap Conveyor/Loading Area, Emerson Power Transmission, Ithaca, New York

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SECTION 5.0

5.0 CONCLUSIONS

5.1 Geology/Hydrogeology

The geologic and hydrogeologic characteristics of the overburden and bedrock and, to some degree, ground-water flow direction and velocity, are the major factors controlling the distribution of chemical constituents at the EPT site and their potential for migration off site. The ability of ground water or chemical constituents to move laterally and vertically in the overburden depends on the porosity of the overburden, its connection with the underlying bedrock formation, and the quantity of water flowing through this geologic unit. The potential for deeper lateral and vertical movement of chemical constituents depends primarily on fractures in the bedrock that control the movement of liquids, on the quantity of ground water in the bedrock unit, and on the physical and chemical properties of the chemical constituents themselves. The major conclusions concerning the geologic and hydrogeologic conditions at the EPT site are as follows:

(1) The plant and surrounding hillside are located in an area containing relatively thin overburden overlying fractured bedrock. Thicker overburden is present near the base of the hill. Ground water is found in both the overburden and in fractures in the bedrock.

(2) Ground water is generally flowing to the north and northwest. In the overburden, lateral ground-water flow appears to generally follow the surficial topography, with local variations resulting from manmade alterations to the site.

In the bedrock, lateral ground-water flow appears to be influenced by the frequency of occurrence and the directional trends of the fractures found in the rock. Lateral ground-water flow directions may vary with its depth below ground surface and with the type and nature of the aquifer material. Ground-water flow represents a potential migration pathway.

(3) Based on water level measurements in wells screened at different depths within the bedrock underlying the site, steep vertical hydraulic gradients exist in the aquifer. The presence of these gradients and the lack of any noticeable confining layers in the overburden or bedrock indicate that vertical movement of ground water and associated chemical constituents is common in the vicinity of the site.

In addition, the hydraulic connection between the overburden and the shallow bedrock was confirmed during limited well pumping in the area downgradient of the fire reservoir, indicating that pathways exist for movement of chemicals from shallow to deeper zones.

(4) Both the frequency of fracture occurrence and the measurements of in-situ hydraulic conductivity in the bedrock indicate that fracture porosity and associated hydraulic conductivity decrease with depth in the bedrock, down to approximately 150 feet below ground surface. Fracturing was absent in a rock core obtained from a depth of between 150 and 175 feet. This relationship suggests that the magnitude of vertical migration of ground water and associated chemical constituents decreases significantly with depth in the bedrock. Thus, ground-water movement and circulation take place primarily in the upper 150 feet of bedrock, based on available data.

(5) The total quantity of ground water flowing through the geologic units at the site, both in the overburden and in the bedrock, appears to be small. This is supported by the fact that several monitoring wells on site were easily purged dry and took considerable time to recover. Therefore, vertical migration of dense organic compounds is probably dominant over the lateral transport of chemicals in the subsurface by ground water.

5.2 Site Chemistry

5.2.1 Ground Water, Surface Water, Sediment, Sanitary Sewers, and Municipal Water Supply

The distribution of chemicals at a particular site is controlled by the location(s) of the original source(s) of the compounds of concern, and by the physical and chemical characteristics of the materials present there. The major conclusions regarding the EPT site that can be drawn from this study are as follows:

(1) The results of the soil gas surveys indicate a source of trichloroethylene (TCE) centered on the vicinity of the fire reservoir. These soil gas results do not appear to indicate the presence of other significant sources of volatile organic compounds in other areas at the EPT site.

Consistent with the results of the first soil gas survey, TCE and tetrachloroethylene (PCE) continued to be among the compounds most frequently detected in the second soil gas survey in the areas sampled downgradient of the fire reservoir and the plant. 1,1,1-trichloroethane (1,1,1-TCA) also was frequently detected in soil gas from these areas. Concentrations of these three compounds were generally detected above background concentrations in areas downgradient of the fire reservoir, in the vicinity of the NYSEG station, and at locations along South Cayuga Street.

(2) Elevated concentrations of TCE and associated degradation products were detected in soil gas in the vicinity of the fire reservoir. No other major sources of TCE were defined at the site by the soil gas surveys. No major sources of any other contaminants were defined at the site by the soil gas surveys. No plume in the vadose zone or saturated zone was defined by the soil gas surveys.

(3) Ground water from MW-4, the shallow upgradient well, did not contain detectable quantities of volatile organic compounds

(VOCs). Therefore, it is assumed that this location continues to be representative of background conditions for the property.

(4) TCE and its associated degradation products are the primary compounds of interest at the site. The highest average concentration of TCE (399,000 ppb) was detected in ground water from shallow bedrock well MW-3-31, directly downgradient of, and at the same elevation as, the fire reservoir. Based on the preliminary assessment of the fire reservoir, it was concluded that the reservoir was the original, primary source of TCE in ground water in this vicinity. Since the cleanup of the fire reservoir, it is likely that TCE-containing water that migrated from the reservoir prior to cleanup, and that is present in the subsurface vicinity of the reservoir, now serves as a secondary source for TCE in ground water. While separate-phase TCE may have been present at some point in the reservoir, no separate-phase product has been found in any of the samples from any of the wells to date.

(5) TCE concentrations decreased rapidly from the reservoir to the northeast, in the direction of ground-water flow, and in many cases TCE was not detected in off-site wells. This trend is consistent with minimal lateral dispersion of the chemical constituents in the shallow bedrock zone. At on-site well MW-1, the concentration of TCE was 60 ppb, three orders of magnitude less than TCE levels detected in the on-site area directly downgradient of the fire reservoir at MW-3-31.

The low concentrations of TCE and other organic compounds detected in ground water obtained from the on-site MW-6 well cluster to the northwest indicate that chemical constituents from the fire reservoir area have not migrated or dispersed to this location. The detected concentrations are likely associated with the handling of solvent-containing metal scrap in the scrap loading area uphill. This horizontal distribution pattern also supports the notion that dissolved chemicals are not moving in a transverse direction very far from the reservoir, but appear to be restricted to a fairly narrow path generally oriented with the fracture patterns.

(6) Concentrations of TCE and associated compounds decrease with depth in the on-site MW-3 cluster bedrock wells, consistent with the dominant vertical characteristic of the movement of ground water. The overburden well above the elevation of the reservoir in the MW-3 cluster exhibited lower TCE concentrations than levels found in wells located in the shallow bedrock just below the elevation of the reservoir. At 150 feet below ground surface, the

concentration of TCE was less than that detected in the shallow bedrock zone at the same on-site location.

TCE also was present at elevated concentrations in the on-site MW-5 cluster bedrock wells. As with the MW-3 well cluster, TCE concentrations-decreased significantly with depth. These results are consistent with the expected decrease in vertical migration of ground water and chemical constituents with decreasing fracture frequency, and with the expected decrease in hydraulic conductivity with depth in bedrock.

(7) The MW-5 cluster shallow bedrock wells that contain elevated TCE concentrations are situated on-site, immediately upgradient of the fire reservoir. Based on water levels observed in the reservoir in the past, it is likely that the elevated concentrations of VOCs detected in the sample from the MW-5 cluster are the result of past contamination in the reservoir and past radial ground-water flow from mounding on the water table under the reservoir. The history of site operations indicates that plant operations in the vicinity of the MW-5 cluster may also have contributed oils and solvents to the subsurface area at the fire reservoir.

(8) Low concentrations of TCE and associated compounds were detected in samples from well MW-13-25. This well is located in the reported former location of a solvent distillation and recovery unit. The concentrations of TCE currently being detected in ground water at this location likely resulted from spills or leaks from the former distillation unit.

(9) Low concentrations of TCE and associated compounds were detected in samples from several wells screened at different depths within bedrock and in seeps downgradient, to the northeast and northwest of the reservoir. The low concentrations of these constituents are consistent with their limited horizontal migration through fractured rock downslope from the plant.

(10) The presence of the full spectrum of degradation products of TCE at the site, generally in association with elevated levels of TCE, along with no known or reported use of the dehalogenation products of TCE at the site, indicates that TCE has aged in the subsurface environment. Aging means that there has been sufficient time for degradation to proceed to some degree at most locations sampled. At the locations of wells MW-5-25 and MW-13-25, the relative concentrations of the degradation products to

TCE may indicate that TCE has been present long enough to have completely or mostly degraded.

(11) With the exception of 1 ppb of chloroform measured in one sample, no VOCs or total petroleum hydrocarbons (TPHs) were detected in the ground water collected from wells MW-10-40 and MW-17-40, located at the base of the hill. These locations represent the furthest extent of the investigation downgradient of the plant.

(12) Current concentrations of TCE, cis-1,2-dichloroethylene (cis-1,2DCE), and TPHs in the water from the fire reservoir are several orders of magnitude lower than the concentrations detected prior to its cleanup in 1987, indicating that the majority of the contamination appears to have been removed from the reservoir during the 1987 cleanup effort. Potential sources of continued low-level contamination include contamination still present in the reservoir walls or contamination seeping in from higher concentrations in the ground-water regime in the vicinity of the reservoir. The samples from the west compartment (FR1) slightly exceed the TOGS for TCE for ground water (10 ppb) and the TOGS for polychlorinated biphenyls (PCBs) (0.1 ppb). The source of the PCBs is not known. Possible sources include past usage of PCB-containing hydraulic, cutting, or other oils at the plant, or past leaks from old PCB transformers that contaminated surface runoff entering the reservoir.

(13) Low concentrations of TPHs were detected in samples from surface drainages and storm sewers. These concentrations likely result from surface runoff from streets, parking lots, and other paved areas crossed by vehicles.

(14) The results of sampling and analysis of three surface drainages around the plant property indicate the presence of low levels (less than 10 ppb) of several organic compounds: 1,1,1-TCA, methylene chloride (CH_2Cl_2), chloroform, toluene, and total xylenes. The results of sampling and analysis of three locations along Six Mile Creek indicate the presence of TCE in a sample from a location upstream of the plant and 1 ppb of chloroform in samples upstream of and midstream relative to the plant. No other VOCs were detected in samples from these locations. These levels indicate that there was no significant migration of these compounds from EPT to the surface drainages at the time these features were sampled.

(15) The small drainage ditch that flows parallel to the plant along the lower parking lot and former railroad tracks (referred to as the railroad ditch) was sampled during the preliminary assessment. The ground water seeps downslope of the fire reservoir that contribute to the flow in the railroad ditch and the storm drain along South Cayuga Street that receives the flow from this ditch were sampled during the remedial investigation. Evaluation of this surface flow and the analytical results indicated that the majority of the flow in the railroad ditch originates from parking lot runoff, plant roof drains, and noncontact cooling water. The runoff and roof drains are likely sources for the oily sheen observed on the flow. While the hillside seeps that contribute a small portion of the flow yielded samples that contained low concentrations (10 ppb) of TCE, the sample of the storm drainage that is the discharge for this flow did not contain detectable concentrations of TCE or associated compounds. This indicates that there was no significant migration of these compounds from EPT via the railroad ditch at the time this drainage area was sampled.

(16) The results of sampling and analysis of two sanitary sewers and one storm drainage on the plant property indicated low-level contamination with 1,1,1-TCA in the first round of samples (ranging from 3 to 32 ppb). These results did not recur during analysis of the second round of samples. Chloroform (ranging from 19 to 84 ppb) was detected in all of the samples. To Radian's knowledge, chloroform is not used in the plant. However, chloroform and other trihalomethanes were present in samples of the chlorinated municipal water supply that serves the plant. 1,1,1-TCA is used at the plant; however, no additional sources of this compound in the sewer system were identified.

(14) Compounds detected in concentrations higher than the corresponding TOGS are primarily TCE and some of the associated organic compounds in samples from on-site locations. Elevated concentrations of several metals, higher than the TOGS, are primarily attributable to natural in-situ conditions not associated with EPT operations. No source of soluble chromium was reportedly used at the plant. Elevated chromium concentrations detected in three on-site wells may be attributable to imported fill materials penetrated by these wells.

5.2.2 Scrap Conveyor/Loading Area

The oils and PCBs detected in the scrap conveyor/railroad track loading area appear to be related to the metal scrap conveyor, loading operations, and railway transport formerly located there. Examination of site chemistry and potential migration pathways indicates that the chemical constituents detected at this location are generally limited to the EPT facilities and the railroad tracks in the immediate area. Significant concentrations of chemicals related to these operations are not present at this time in ground water from the locations sampled off site. The conclusions regarding the scrap conveyor/railroad track loading area at the EPT site are as follows:

(1) A thin layer of overburden (manmade fill and glacial till), ranging from 1.6 to 10.6 feet thick, overlies the bedrock in this area. Much of the surface area in the vicinity of the railroad tracks has dark, oily or rust-colored stains, and some of the surface is covered with remnant metal scrap.

(2) The majority of the overburden samples recovered at all depths from this area showed visual evidence of staining. It is likely that oil or similar substances were contributed to the area by scrap loading operations. Total petroleum hydrocarbons (TPHs) were detected in the parts-per-thousand range in samples from 11 locations. While an oily sheen was noted during drilling of the shallow well directly downgradient of this area (MW-6-25), analysis of the ground-water samples from this well and the two bedrock wells at this location did not contain concentrations of TPHs above the detectable level of 2 ppm.

(3) The overburden at the scrap conveyor/loading area showed low concentrations of PCBs (Arochlor 1254), generally less than 1 ppm. The presence of minor concentrations of PCBs appears to be primarily centered on an area downgradient of the scrap conveyor,

between the railroad track and the loading spur. Even smaller concentrations were found along the railroad tracks, west of the loading area. PCBs also were detected in a sample collected in the area uphill of the scrap conveyor/loading dock.

Samples of ground water from the well cluster directly downgradient of the scrap conveyor/loading area (MW-6) did not contain concentrations of PCBs above detectable limits; therefore, state standards for PCBs in ground water were not exceeded in any site wells. While the oils used in the scrap conveyor/loading area may have contained PCBs, no records have been found that document any use or disposal of PCBs in this area. No conclusions can be drawn about the source of PCBs here, but their low concentrations in the soils do not indicate an environmental concern. Currently, there are no state or federal standards or guidance values for PCBs in soil.

(4) A number of volatile organic compounds (VOCs) were detected in soil samples from five locations in the scrap conveyor/loading area. Total volatile organic concentrations ranged from 25 to 111 ppb at these locations. The compounds detected in the highest concentrations include tetrachloroethylene (PCE), total xylenes, trichloroethylene (TCE), and methylene chloride (CH_2Cl_2). However, concentrations of these and other volatile organic compounds detected were generally low and do not exhibit a consistent pattern of distribution across the area.

Currently, there are no state or federal standards or guidance values for these volatile organic compounds in soils. Volatile organic compounds detected in ground-water samples from the MW-6 wells downgradient of the scrap conveyer/loading area contained low concentrations of five volatile organic compounds. All concentrations were less than 10 ppb, and no TOGS were exceeded. The concentration of 1,1-dichloroethylene (1,1-DCE) in one sample slightly exceeded the guidance value for 1,1-DCE (0.07 ppb), but this compound was not detected in analysis of the Stage 2 sample from the same location.

SECTION 6.0

6.0 REFERENCES

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RADIAN CORP.
PLATE ONE

APPENDIX A

SOIL GAS SURVEYS

APPENDIX A - SOIL GAS SURVEYS

A.1 SOIL GAS SAMPLING AND ANALYSIS

Soil gas sampling and analysis is used as a screening technique to identify volatile constituents and to approximate the extent of contamination in soils and shallow ground water. This technique does not provide direct sampling of soils and ground water, and is suitable only for chemical species that will volatilize in the vadose (unsaturated) zone, such as chlorinated solvents. Moreover, there is not always a direct correlation between concentrations of such constituents in soils and ground water, and concentrations of such constituents measured in soil gas. The screening results must be confirmed by direct sampling of soils and ground water before the data generated can be used to reliably estimate the extent of subsurface contamination.

Soil gas sampling generally involves driving a small diameter probe approximately 3 feet into the ground in the soils above the ground water, and then extracting a sample of the gas that migrates through the air spaces in the soils. The gas sample is either shipped to an analytical laboratory for analysis or is injected into a portable gas chromatograph on site. The chemical species found in the gas, along with their associated concentrations, are reported. The time between sampling and reporting of results is usually about two days. Quality control samples are also collected and analyzed in the same manner.

The soil gas surveys of the EPT plant property and surrounding area required by NYSDEC were conducted in two phases. On August 10 and 11, 1987, at the request of NYSDEC, a preliminary soil gas survey of selected areas of the site was performed. The sole objective of this study was to evaluate whether any contaminants that could be leaving the EPT property could be placing the residents of houses just northeast of the plant at risk.

In the preliminary survey, 52 soil gas samples were collected at intervals along four lines labeled A, B, C, and D (Plate 1). (Plate 1 is located at the end of the report text.) Line A was located upgradient of the plant to serve as an indication of background levels for comparison with lines B, C, and D, which were located directly downgradient of the plant and the New York State Electric and Gas Corporation (NYSEG) substation (Plate 1). The samples were analyzed for vinyl chloride (VC); methylene chloride (CH_2Cl_2); trans-1,2-dichloroethylene (trans-1,2DCE); 1,1-dichloroethane (1,1-DCA); trichloroethylene (TCE); toluene; xylene; and tetrachloroethylene (PCE). The Target Environmental Services report entitled <u>Soil Gas Survey - Morse Industial Corporation</u>, dated August 1987, and the results of this preliminary survey are presented in this Appendix.

A more extensive soil gas survey was performed at the site during November 17 - December 7, 1987, as part of the Remedial Investigation. This survey was designed to provide screening data on the possible extent of subsurface contamination in the vicinity of the EPT plant. The specific objectives of this survey were to:

(1) Estimate the boundaries of the vapor plume(s), if any;

(2) Provide data to refine the siting of ground-water monitoring wells;

(3) Evaluate the extent of contaminant migration off site, if any; and

(4) Aid in the identification of subsurface contamination source(s), if any.

For this more extensive survey, 118 soil gas samples were collected at intervals along five lines and at individual locations around the plant, as approved by NYSDEC (Plate 1). One line of samples was also collected during this survey to represent background conditions. This line, also designated Line A, was located on the southeast side of the plant in the vicinity of the Line A used during the preliminary soil gas survey at the site. The remaining downgradient survey lines were labeled D, E, F, and G. Line D was located along the entire length of the main plant building, adjacent to the fire water reservoir. Line E was located perpendicular to Line D in a downgradient direction towards Six Mile Creek. Line F extended downhill from South Cayuga Street toward Spencer Street along the southwestern property boundary of the houses along South Cayuga Street. Line G was located along the western portion of South Hill Terrace. In addition, 13 soil gas samples were taken at individual locations not on the survey lines, but within the soil gas survey area. All soil gas sample locations are shown on Plate 1. All samples, including quality control samples, were analyzed for 1,1,1-trichloroethane (1,1,1-TCA); CH_2Cl_2; cis-1,2-dichloroethylene (cis-1,2-DCE); 1,1-DCA; TCE; benzene; toluene; xylene; and PCE. The results of this more extensive survey also are presented in this Appendix.

A.2 RESULTS OF SOIL GAS SURVEYS

The findings of the preliminary soil gas survey performed on August 10 and 11, 1987 were as follows:

- Vinyl chloride, methylene chloride, trans-1,2-dichloroethylene, and 1,1-dichloroethane were not detected above the detection limit of 1 ppb in any of the samples. TCE was present at a maximum of 276 ppb in the soil gas sample taken immediately adjacent to well MW-3-31, directly downgradient of the reservoir.

- TCE and PCE were present above background levels in samples from survey line D, with 6.1 ppb as the maximum for TCE and 3.4 ppb as the maximum for PCE. Concentrations of these compounds were highest at the northeastern corner of the NYSEG transformer station, showing a gradual decline to the east and west.

- TCE was detected in five of the six field blanks at concentrations ranging from 0.6 to 1.7 ppb. While these levels may indicate some cross-contamination of samples with low levels of TCE, they probably do not significantly affect those areas with the highest soil gas readings.

- PCE was detected in three of the six field blanks at concentrations ranging from 0.5 to 0.6 ppb, with a detection limit of 0.5 ppb. It does not appear that these levels in the field blanks represent any significant indication of cross-contamination of samples or data quality problems with PCE measurements.

The results of the more extensive soil gas survey performed between November 17 and December 7, 1987, are detailed below.

The compounds most frequently detected at the locations sampled were PCE, TCE, and 1,1,1-TCA. In general, the maximum concentrations of these compounds in soil gas were detected in areas downgradient of the fire reservoir. Concentrations of PCE in the background samples (Line A) ranged from 0.0001 to 0.0009 ppb. Concentrations of PCE in samples from locations downgradient of the plant ranged from 0.00002 to 2 ppb. The maximum PCE concentrations occurred in the vicinity of South Cayuga Street and South Hill Terrace along Line S (1 to 2 ppb) and along Line D, at location D-49 (0.3 ppb).

Concentrations of TCE in the background samples (Line A) ranged from 0.002 to 0.01 ppb. Concentrations of TCE in samples from locations downgradient of the plant ranged from 0.00007 to 190 ppb. The maximum TCE concentrations occurred directly downgradient of the fire reservoir at the intersection of sampling Lines D and S (12 to 190 ppb). Concentrations of 1,1,1-TCA in the background samples (Line A) ranged from 0.004 to 0.01 ppb.

Concentrations of 1,1,1-TCA in samples from locations downgradient of the plant ranged from 0.0004 to 27 ppb. The maximum 1,1,1-TCA concentrations occurred directly downgradient and northwest of the fire reservoir along South Cayuga Street (Line S, 20 to 27 ppb) and along Line D, at locations D-41 and D-42 (5 and 3 ppb, respectively).

Trans-1,2DCE and CH_2Cl_2 also were detected in samples taken across the site. The majority of detections for trans-1,2DCE were less than the 2 to 5 ppb detected in the background samples, and generally less than 1 ppb, overall. The maximum trans-1,2DCE concentration, 83 ppb, was detected in one sample (Line D, location D-49) downgradient of the plant and fire reservoir, but was not confirmed in the duplicate sample from the same location, which showed only 1 ppb. Therefore, the trans-1,2DCE concentration at this sample point is highly questionable.

Likewise, the majority of detections for CH_2Cl_2 were less than the 0.2 to 0.3 ppb detected in the background samples, and generally less than 1 ppb overall. The maximum CH_2Cl_2 concentration of 6 ppb also was detected in the sample from location D-49, with 2 ppb detected in the duplicate sample from this location.

Cis-1,2DCE was not detected in background samples (Line A), and was detected in only one sample downgradient of the plant, northwest of the fire reservoir (Line D), at 100 ppb. 1,1-DCA was detected in background samples (Line A) at 8 and 44 ppb. 1,1-DCA also was detected at five locations downgradient of the plant: at four locations clustered northwest of the fire reservoir (Line D) at concentrations ranging from 0.1 to 4 ppb, and at one location west of the fire reservoir (Line F) at 4 ppb. Benzene, toluene, and xylene were not detected in background samples (Line A), but were detected sporadically downgradient of the plant. Concentrations of benzene detected at nine locations ranged from 0.02 to 10 ppb. Concentrations of toluene detected at two locations ranged from 0.4 to 0.6 ppb.

The concentration of xylene detected at one location downgradient of the fire reservoir was 1.1 ppb.

In summary, the findings of the second soil gas survey were as follows:

- TCE and PCE, consistent with the first survey, continued to be among the compounds most frequently detected in the areas sampled downgradient of the fire reservoir and the plant.
- 1,1,1-TCA also was found to be among the compounds most frequently detected in the areas sampled downgradient of the fire reservoir and the plant.
- Concentrations of these three compounds (TCE, PCE, and 1,1,1-TCA) were generally detected above background concentrations in areas downgradient of the fire reservoir, in the vicinity of the NYSEG station, and at locations along South Cayuga Street.
- Concentrations of trans-1,2DCE and CH_2Cl_2 in samples taken from downgradient areas were less than those in samples taken upgradient of the plant. Maximum concentrations were detected for both compounds at one location downgradient of the fire reservoir.
- Several other compounds were detected at various locations across the area studied. No consistent pattern of concentration distribution emerged for these compounds. The concentrations of some of these compounds, such as benzene, toluene, and xylene, are typical of those found along urban roadsides.
- Although the soil gas survey was helpful in locating general areas where wells could be installed, the results did not delineate a subsurface plume migrating either through the vadose zone or in the ground water.

ANALYTICAL RESULTS FOR SOIL GAS SURVEY

PERFORMED

AUGUST 10 AND 11, 1987

SOIL GAS SURVEY
MORSE INDUSTRIAL CORPORATION
ITHACA, NEW YORK

TARGET ENVIRONMENTAL SERVICES

SOIL GAS SURVEY
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AUGUST 1987

EXECUTIVE SUMMARY

On August 10 and 11, 1987, **TARGET** Environmental Services, Inc. conducted a soil gas survey on and adjacent to the property of the Morse Industrial Corporation in Ithaca, New York. Samples were analyzed by GC/FID for toluene and xylene isomers, which were found to be absent in quantifiable concentrations. Analysis by GC/ECD was performed to analyze for six client-specified hydrocarbons. Vinyl chloride, methylene chloride, trans-1,2-dichloroethene, and 1,1-dichloroethane were not detected in any of the samples. Trichloroethene (TCE) was present at 276 ppb in Sample D52 and also exhibited an anomaly on Line C to the northwest. The anomaly's abrupt maximum is at Station C42 near the north corner of the NYSE&G transformer storage yard, and concentrations decline gradually to the east as would be expected considering the intervening topography. Tetrachloroethene (PCE) exhibits two slight elevations in concentration, one on Line B and one on Line C. The concentrations, however, are too low to be considered valid indicators of an anomaly.

Introduction

On August 10 and 11, 1987, **TARGET** Environmental Services, Inc. (**TARGET**), conducted a soil gas survey on and adjacent to property of the Morse Industrial Corporation, in Ithaca, New York. Monitoring wells had revealed the presence of a number of organic compounds in the groundwater on the Morse property, and government officials became concerned about the potential health threat to residents that lived down-gradient. The survey was conducted to help determine if the contaminated groundwater had migrated into the immediate vicinity of the down-slope residences.

Field Procedures

Four lines of soil gas samples were laid out in different areas of the site at the direction of the client (see Figure 1). Ten samples were collected along Line A, as shown in Figure 2, to provide "background" values. Lines B and C were each allotted twenty samples (Figure 3). The D series was comprised of two samples taken near the monitoring wells on the Morse property (Figure 3).

To collect the soil gas samples a 1/2 inch hole was produced to a depth of four feet by using a slide hammer. The entire sampling system was purged with ambient air, and a specially designed stainless steel probe was inserted to the full depth of the hole and packed off. A sample of in-situ soil gas was then withdrawn through the probe and used to purge atmospheric air from the sampling system. A second sample of soil gas was withdrawn through the probe and encapsulated in a pre-evacuated glass vial at two atmospheres of pressure (15 psig). The self-sealing vial was detached from the sampling system and stored for laboratory analysis.

Field blanks were obtained for QA/QC purposes by inserting the probe tip into a tube flushed by a 20 psi flow of ultra-zero grade nitrogen and collected in the same manner as described above. The blanks were collected at the onset of each day's field activities, after every twentieth soil gas sample, and at the end of each day's field activities to assure that carryover contamination was not occurring.

Laboratory Procedures

All of the samples collected during the field phase of the survey were subjected to dual analyses by gas chromatograph by a method similar to EPA 602, but using direct injection instead of purge and trap. One analysis was performed using an electron capture detector (ECD), and the other employed a flame ionization detector (FID). Specific analytes standardized for the ECD analysis were:

vinyl chloride
methylene chloride
trans-1,2-dichloroethene (t-12DCE)
1,1-dichloroethane (11DCA)
1,1,2-trichloroethene (TCE)
1,1,2,2-tetrachloroethene (PCE)

The chlorinated hydrocarbons in this suite were chosen by the client because of their previous detection at the site. Toluene and the xylene isomers were selected by the client for standardization in the GC/FID analysis for the same reason.

Calibration of the analytical equipment was performed on a daily basis using an instrument-response curve and injection of standards of known concentrations. Retention times of the compounds in the standards were used to identify the unknown compounds in the samples. A standard was run after every ten samples to ensure validity of the initial curve. For QA/QC purposes, one out of every ten samples was a duplicate analysis of a field sample. Laboratory blanks of carrier gas was also analyzed to assure that carryover was not occurring between analyses.

Results

The results of the GC/FID analysis for toluene and the xylene isomers are shown in Table 1. Toluene and the meta- and para-xylene isomers were not found in excess of their 1.0 ppb detection limit in any of the samples. Ortho-xylene was detected only in Sample D52, at 1.1 ppb.

Results of the GC/ECD analysis for halocarbon compounds are given in Table 2. Vinyl chloride, methylene chloride, trans-1,2-dichloroethene, and 1,1-dichloroethane were not found to be present at or above their 1.0 ppb detection limit in any of the samples. Trichloroethene (TCE) was detected (≥.05 ppb) in all but eight of the samples. In all but ten of the samples the concentrations were less than 0.5 ppb, and the highest observed concentration was 276 ppb in Sample D52. Tetrachloroethene (PCE) was similarly detected (≥.05 ppb) in all but eleven samples, but only two samples exceeded .5 ppb (C50 with .83 ppb, and D52 with 3.4 ppb).

Discussion and Interpretation

Toluene was observed as non-quantifiable traces in a few samples of the A line, a common observation for samples taken adjacent to roadways. The m- and p-xylene isomers were not seen in any of the samples, even at trace levels, while o-xylene traces were observed in Samples C50, D51, and D52. Because sample C50 was taken adjacent to South Cayuga Street, and the D Samples were collected along a former rail right-of-way, the appearance of trace levels of toluene and xylenes is not surprising. Sample C48 exhibited 1.1 ppb o-xylene, but this low value and isolated occurrence suggest that this detected o-xylene has little significance in this study.

Of the target halogenated compounds in the ECD analysis, only TCE and PCE were verified as present. Figure 4 displays the TCE values observed along Line A, which was surveyed to provide "background" levels. Concentrations are barely above the 0.5 ppb detection limit for TCE, with .09 ppb being the maximum observed. The TCE data for the remainder of the survey, shown in Figure 5, reveals similar levels on Line B. Line C exhibits a series of ten samples with obvious elevation of concentrations extending from Location C40 to Location C49.

In order to better display the variation of the TCE values along this portion of the survey, concentrations have been presented graphically along an east-west traverse from Location B17 to Location C33 (Figure 6). Concentrations increase sharply from Location 40 to Location 42, and decline sharply at Location 43. Beyond Location 43 the concentrations decline much more gradually. This pattern of concentration variation suggests possible migration along a fracture system crossing Line C near Location C42. Comparing Figure 5 with the local topography reveals that south of Line C (toward the top of the map) the ground slopes to the east (to the left). This would provide an eastward component to the groundwater flow, broadening the zone of lower concentrations eastward , as indicated by the contours.

As mentioned in the <u>**Results**</u> section of this report, PCE was widely detected in the survey, but there was little variation in the magnitude of the observed concentrations. In Figure 7 the values for Line A are shown, to establish "background". As with the TCE, concentrations are all near the .05 ppb detection limit. On Line C (Figure 8) a single point of anomalous elevation is observed at Location C50. A weaker, two-point zone of elevation is seen at B13 and B14 on Line B. For comparison with TCE in Figure 6, a graphical presentation of PCE concentrations along the same traverse has been provided in Figure 9.

Considering the two orders of magnitude decline in expressed TCE concentrations between D52 and C42, detectable anomalies of PCE would not be expected from a similar decline in concentration from the high of 3.4 ppb seen in D52. The two areas of slight elevation possibly have no relationship to the material in the vicinity of D52, especially considering the lack of correlative increases in the more abundant TCE.

Although the layout of sample points did not allow mapping of the full plume, the results indicate that the "nose" of the TCE plume has reached the "C" line in the vicinity of points C42-C44. Definition of the full extent of the plume will require additional study at the site.

TABLE 1

LABORATORY RESULTS
FLAME IONIZATION DETECTOR ANALYSIS
CONCENTRATIONS IN PARTS-PER-BILLION

SAMPLE	TOLUENE	m- & p- XYLENES	o- XYLENE
A1	<1.0	<1.0	<1.0
A2	<1.0	<1.0	<1.0
A3	<1.0	<1.0	<1.0
A4	<1.0	<1.0	<1.0
A5	<1.0	<1.0	<1.0
A6	<1.0	<1.0	<1.0
A7	<1.0	<1.0	<1.0
A8	<1.0	<1.0	<1.0
A9	<1.0	<1.0	<1.0
A10	<1.0	<1.0	<1.0
B11	<1.0	<1.0	<1.0
B12	<1.0	<1.0	<1.0
B13	<1.0	<1.0	<1.0
B14	<1.0	<1.0	<1.0
B15	<1.0	<1.0	<1.0
B16	<1.0	<1.0	<1.0
B17	<1.0	<1.0	<1.0
B18	<1.0	<1.0	<1.0
B19	<1.0	<1.0	<1.0
B20	<1.0	<1.0	<1.0
B21	<1.0	<1.0	<1.0
B22	<1.0	<1.0	<1.0
B23	<1.0	<1.0	<1.0
B24	<1.0	<1.0	<1.0
B25	<1.0	<1.0	<1.0
B26	<1.0	<1.0	<1.0
B27	<1.0	<1.0	<1.0
B28	<1.0	<1.0	<1.0
B29	<1.0	<1.0	<1.0
B30	<1.0	<1.0	<1.0
C31	<1.0	<1.0	<1.0
C32	<1.0	<1.0	<1.0
C33	<1.0	<1.0	<1.0
C34	<1.0	<1.0	<1.0
C35	<1.0	<1.0	<1.0
C36	<1.0	<1.0	<1.0
C37	<1.0	<1.0	<1.0
C38	<1.0	<1.0	<1.0
C39	<1.0	<1.0	<1.0
C40	<1.0	<1.0	<1.0
C41	<1.0	<1.0	<1.0
C42	<1.0	<1.0	<1.0
C43	<1.0	<1.0	<1.0
C44	<1.0	<1.0	<1.0
C45	<1.0	<1.0	<1.0

TABLE 1 (CONTD)

LABORATORY RESULTS
FLAME IONIZATION DETECTOR ANALYSIS
CONCENTRATIONS IN PARTS-PER-BILLION

SAMPLE	TOLUENE	m- & p- XYLENES	o- XYLENE
C46	<1.0	<1.0	<1.0
C47	<1.0	<1.0	<1.0
C48	<1.0	<1.0	1.1
C49	<1.0	<1.0	<1.0
C50	<1.0	<1.0	<1.0
D51	<1.0	<1.0	<1.0
D52	<1.0	<1.0	<1.0
FIELD BLANKS			
E62	<1.0	<1.0	<1.0
E63	<1.0	<1.0	<1.0
E64	<1.0	<1.0	<1.0
E65	<1.0	<1.0	<1.0
E66	<1.0	<1.0	<1.0
E67	<1.0	<1.0	<1.0
DUPLICATE ANALYSES			
A8	<1.0	<1.0	<1.0
A8R	<1.0	<1.0	<1.0
B18	<1.0	<1.0	<1.0
B18R	<1.0	<1.0	<1.0
B28	<1.0	<1.0	<1.0
B28R	<1.0	<1.0	<1.0
C36	<1.0	<1.0	<1.0
C36R	<1.0	<1.0	<1.0
C46	<1.0	<1.0	<1.0
C46R	<1.0	<1.0	<1.0

TABLE 2 (CONTD)

LABORATORY RESULTS
ELECTRON CAPTURE DETECTOR ANALYSIS
CONCENTRATIONS IN PARTS-PER-BILLION

SAMPLE	VINYL CHLORIDE	METHYLENE CHLORIDE	t12DCE	11DCA	TCE	PCE
C42	<1.0	<1.0	<1.0	<1.0	6.1	.08
C43	<1.0	<1.0	<1.0	<1.0	3.4	.07
C44	<1.0	<1.0	<1.0	<1.0	3.4	.11
C45	<1.0	<1.0	<1.0	<1.0	2.2	.10
C46	<1.0	<1.0	<1.0	<1.0	1.2	.11
C47	<1.0	<1.0	<1.0	<1.0	.35	<.05
C48	<1.0	<1.0	<1.0	<1.0	.59	.08
C49	<1.0	<1.0	<1.0	<1.0	.50	.13
C50	<1.0	<1.0	<1.0	<1.0	.29	.83
D51	<1.0	<1.0	<1.0	<1.0	5.3	.22
D52	<1.0	<1.0	<1.0	<1.0	276	3.4
FIELD BLANKS						
E62	<1.0	<1.0	<1.0	<1.0	.06	.06
E63	<1.0	<1.0	<1.0	<1.0	<.05	<.05
E64	<1.0	<1.0	<1.0	<1.0	.12	<.05
E65	<1.0	<1.0	<1.0	<1.0	.13	<.05
E66	<1.0	<1.0	<1.0	<1.0	.38	.05
E67	<1.0	<1.0	<1.0	<1.0	1.7	.06
DUPLICATE ANALYSES						
A8	<1.0	<1.0	<1.0	<1.0	.09	.07
A8R	<1.0	<1.0	<1.0	<1.0	.06	.07
B18	<1.0	<1.0	<1.0	<1.0	.06	.07
B18R	<1.0	<1.0	<1.0	<1.0	.07	.09
B28	<1.0	<1.0	<1.0	<1.0	<.05	<.05
B28R	<1.0	<1.0	<1.0	<1.0	<.05	<.05
C36	<1.0	<1.0	<1.0	<1.0	.19	.05
C36R	<1.0	<1.0	<1.0	<1.0	.16	.05
C46	<1.0	<1.0	<1.0	<1.0	1.2	.11
C46R	<1.0	<1.0	<1.0	<1.0	1.0	.11

t12DCE = trans-1,2-dichloroethene
11DCA = 1,1-dichloroethane
TCE = 1,1,2-trichloroethene
PCE = 1,1,2,2-tetrachloroethene

TABLE 2

LABORATORY RESULTS
ELECTRON CAPTURE DETECTOR ANALYSIS
CONCENTRATIONS IN PARTS-PER-BILLION

SAMPLE	VINYL CHLORIDE	METHYLENE CHLORIDE	t12DCE	11DCA	TCE	PCE
A1	<1.0	<1.0	<1.0	<1.0	.08	.07
A2	<1.0	<1.0	<1.0	<1.0	.08	.06
A3	<1.0	<1.0	<1.0	<1.0	<.05	<.05
A4	<1.0	<1.0	<1.0	<1.0	.07	.05
A5	<1.0	<1.0	<1.0	<1.0	.07	.07
A6	<1.0	<1.0	<1.0	<1.0	.07	.07
A7	<1.0	<1.0	<1.0	<1.0	.05	.07
A8	<1.0	<1.0	<1.0	<1.0	.09	.07
A9	<1.0	<1.0	<1.0	<1.0	.06	.07
A10	<1.0	<1.0	<1.0	<1.0	.06	.06
B11	<1.0	<1.0	<1.0	<1.0	.06	.06
B12	<1.0	<1.0	<1.0	<1.0	.06	.08
B13	<1.0	<1.0	<1.0	<1.0	.16	.29
B14	<1.0	<1.0	<1.0	<1.0	.14	.39
B15	<1.0	<1.0	<1.0	<1.0	.07	.12
B16	<1.0	<1.0	<1.0	<1.0	.06	.09
B17	<1.0	<1.0	<1.0	<1.0	.05	.05
B18	<1.0	<1.0	<1.0	<1.0	.06	.07
B19	<1.0	<1.0	<1.0	<1.0	.05	.07
B20	<1.0	<1.0	<1.0	<1.0	.05	.07
B21	<1.0	<1.0	<1.0	<1.0	<.05	.06
B22	<1.0	<1.0	<1.0	<1.0	<.05	.05
B23	<1.0	<1.0	<1.0	<1.0	.11	.08
B24	<1.0	<1.0	<1.0	<1.0	<.05	.05
B25	<1.0	<1.0	<1.0	<1.0	.05	.06
B26	<1.0	<1.0	<1.0	<1.0	.12	<.05
B27	<1.0	<1.0	<1.0	<1.0	.06	.05
B28	<1.0	<1.0	<1.0	<1.0	<.05	<.05
B29	<1.0	<1.0	<1.0	<1.0	<.05	.06
B30	<1.0	<1.0	<1.0	<1.0	<.05	.07
C31	<1.0	<1.0	<1.0	<1.0	.20	.07
C32	<1.0	<1.0	<1.0	<1.0	.05	.06
C33	<1.0	<1.0	<1.0	<1.0	.08	<.05
C34	<1.0	<1.0	<1.0	<1.0	.10	<.05
C35	<1.0	<1.0	<1.0	<1.0	.21	<.05
C36	<1.0	<1.0	<1.0	<1.0	.19	.05
C37	<1.0	<1.0	<1.0	<1.0	.11	<.05
C38	<1.0	<1.0	<1.0	<1.0	.06	<.05
C39	<1.0	<1.0	<1.0	<1.0	.09	<.05
C40	<1.0	<1.0	<1.0	<1.0	.54	.05
C41	<1.0	<1.0	<1.0	<1.0	1.3	.05

t12DCE = trans-1,2-dichloroethene
11DCA = 1,1-dichloroethane
TCE = 1,1,2-trichloroethene
PCE = 1,1,2,2-tetrachloroethene

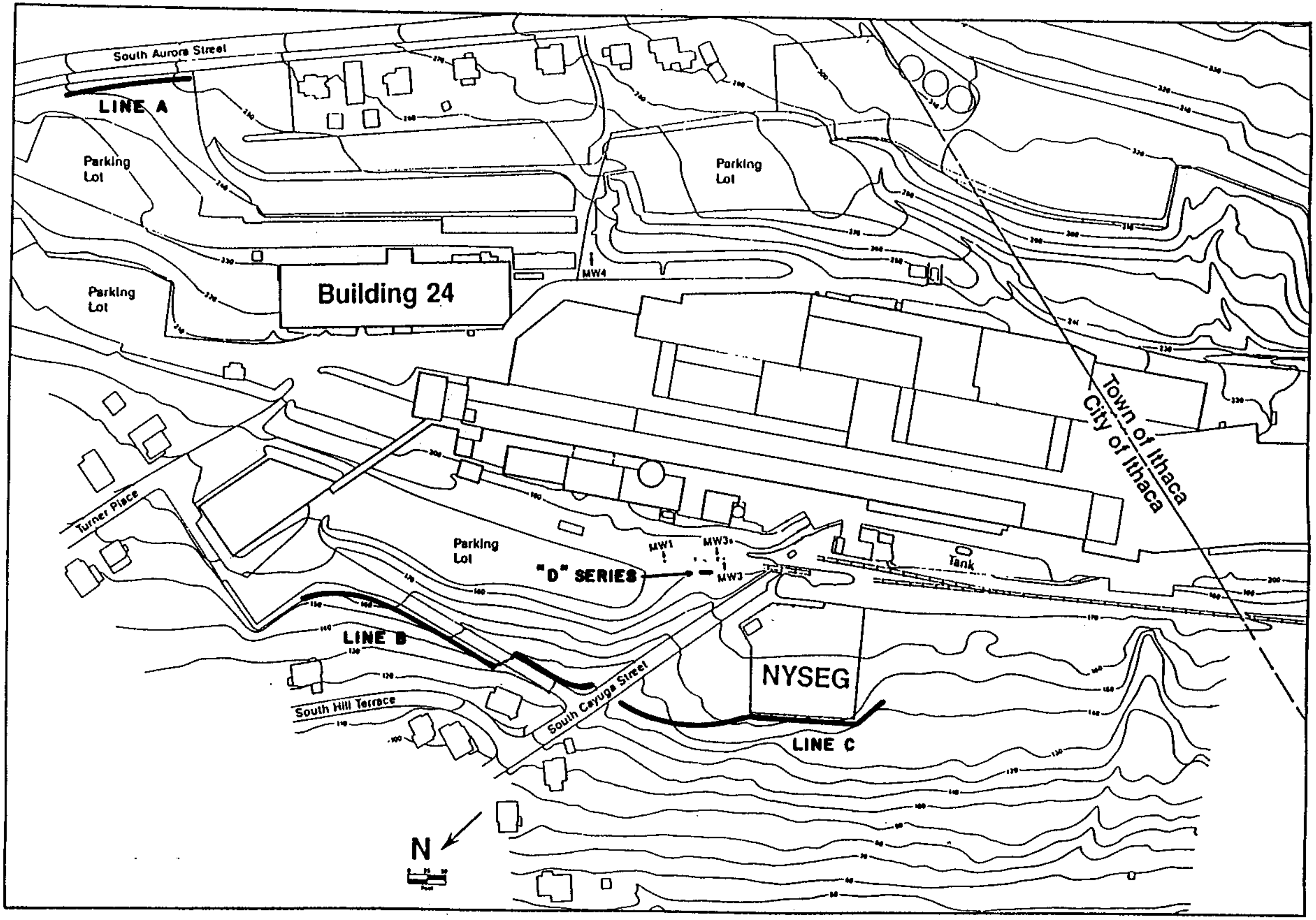


FIGURE 1. Site Plan with Locations of Soil Gas Survey Sample Lines

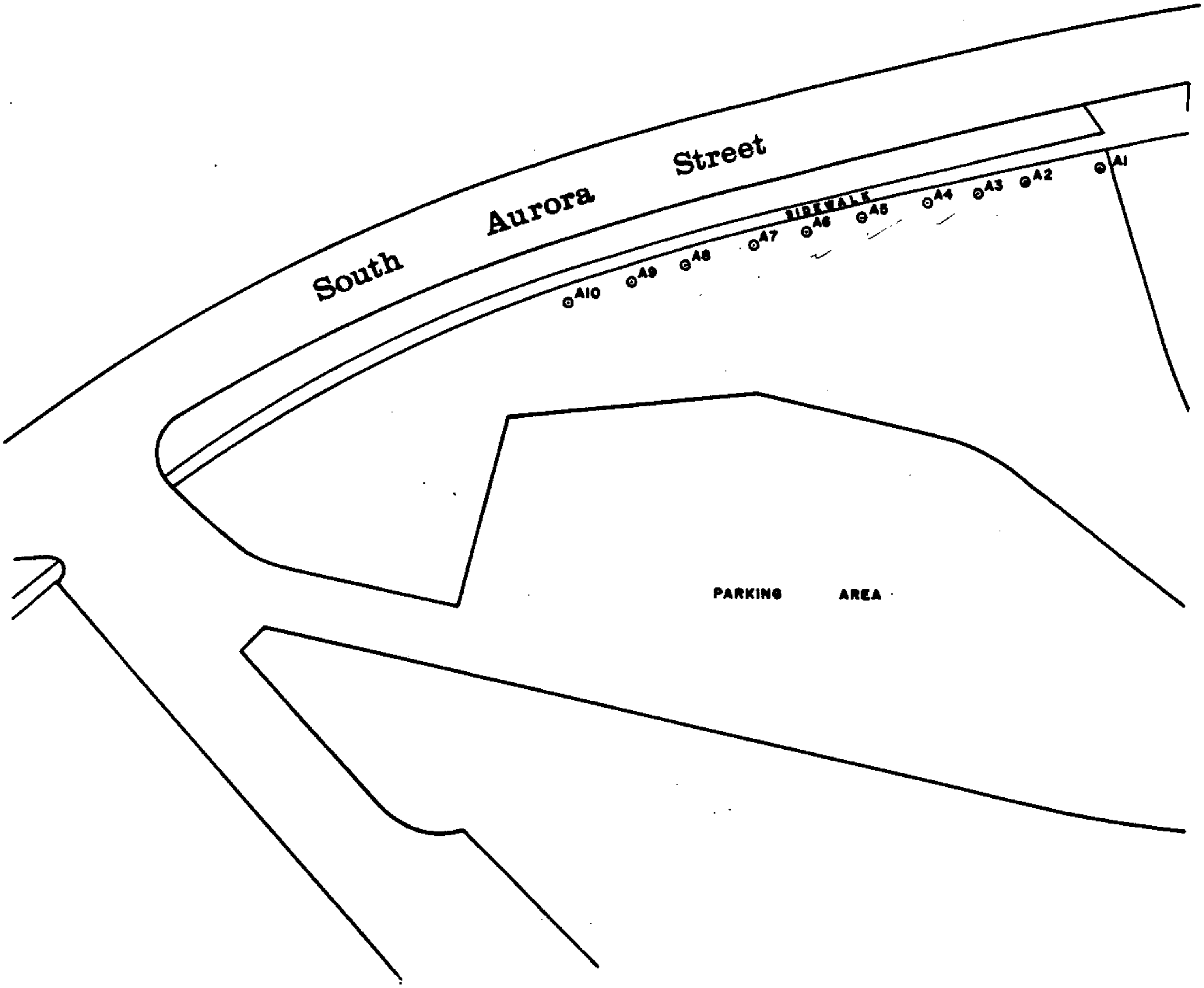


FIGURE 2. Sample Locations
LINE A

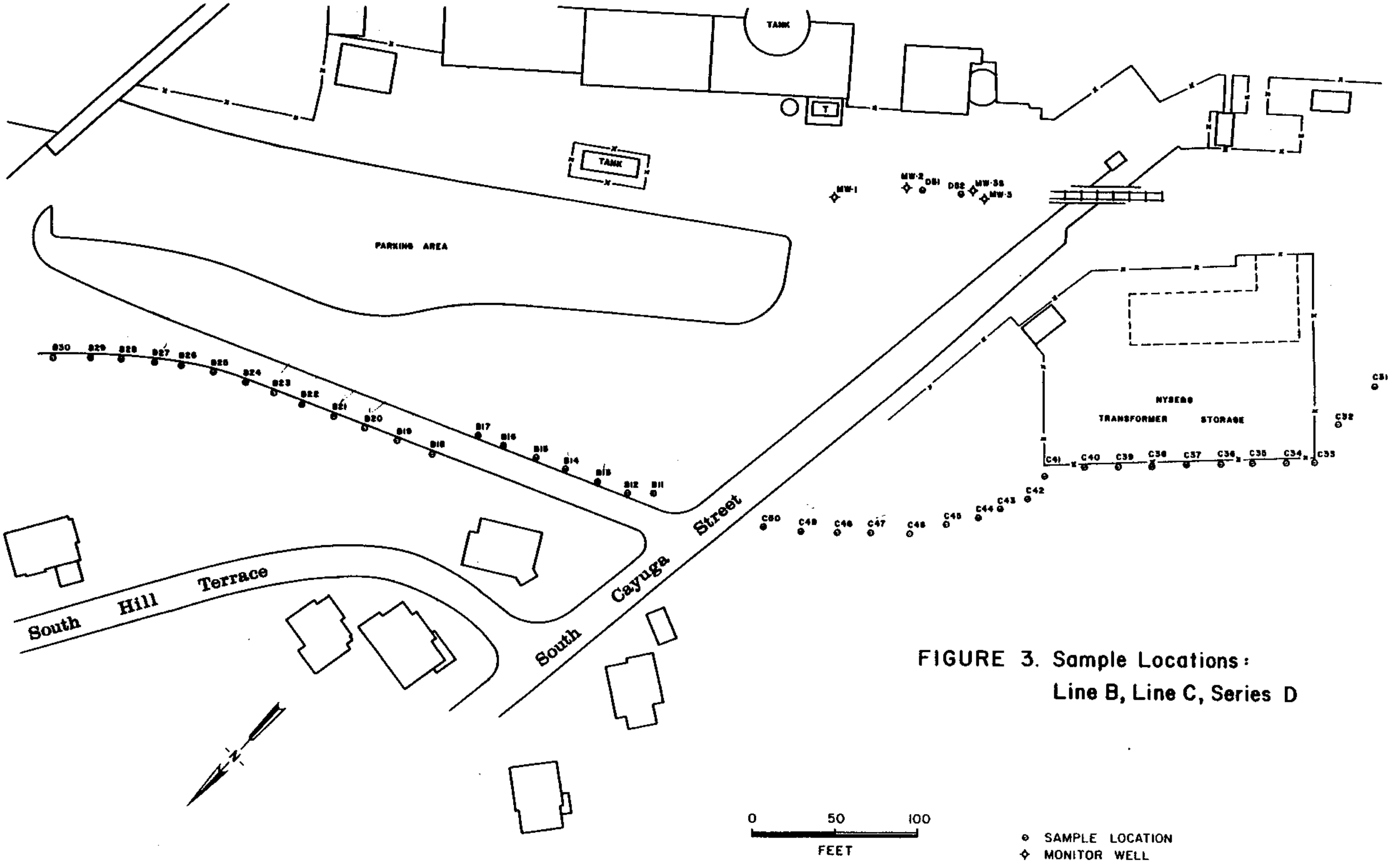


FIGURE 3. Sample Locations:
Line B, Line C, Series D

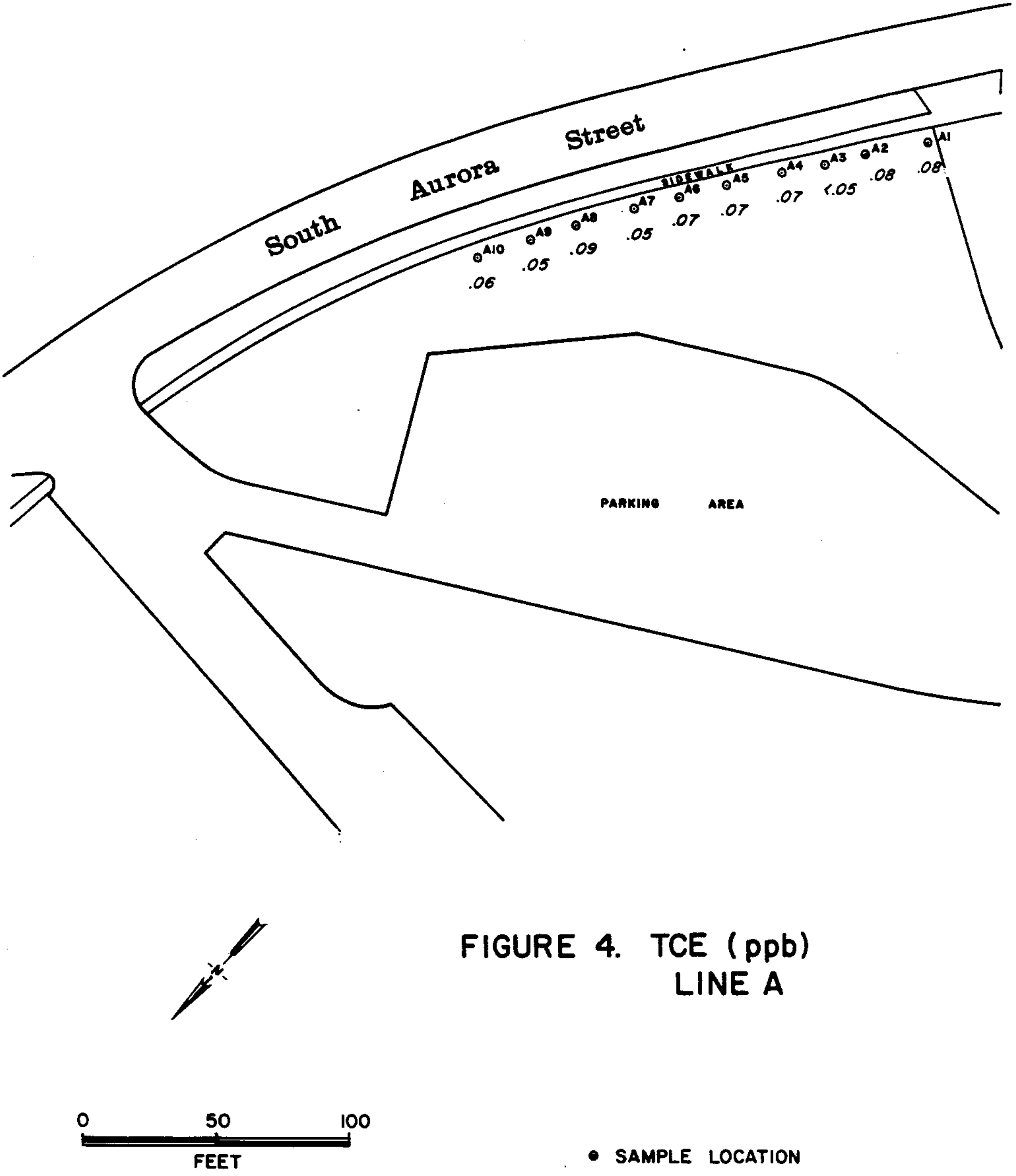


FIGURE 4. TCE (ppb)
LINE A

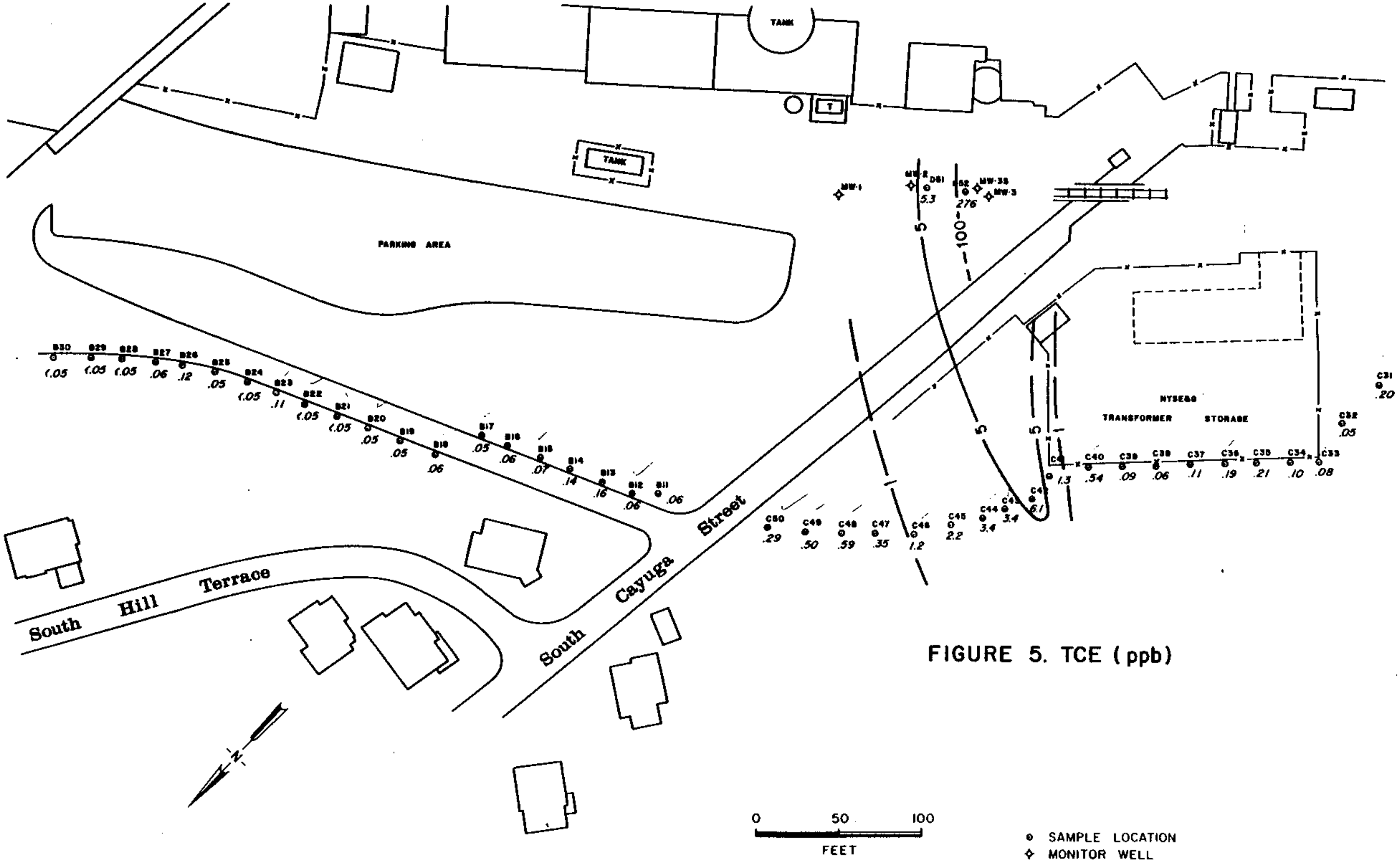


FIGURE 5. TCE (ppb)

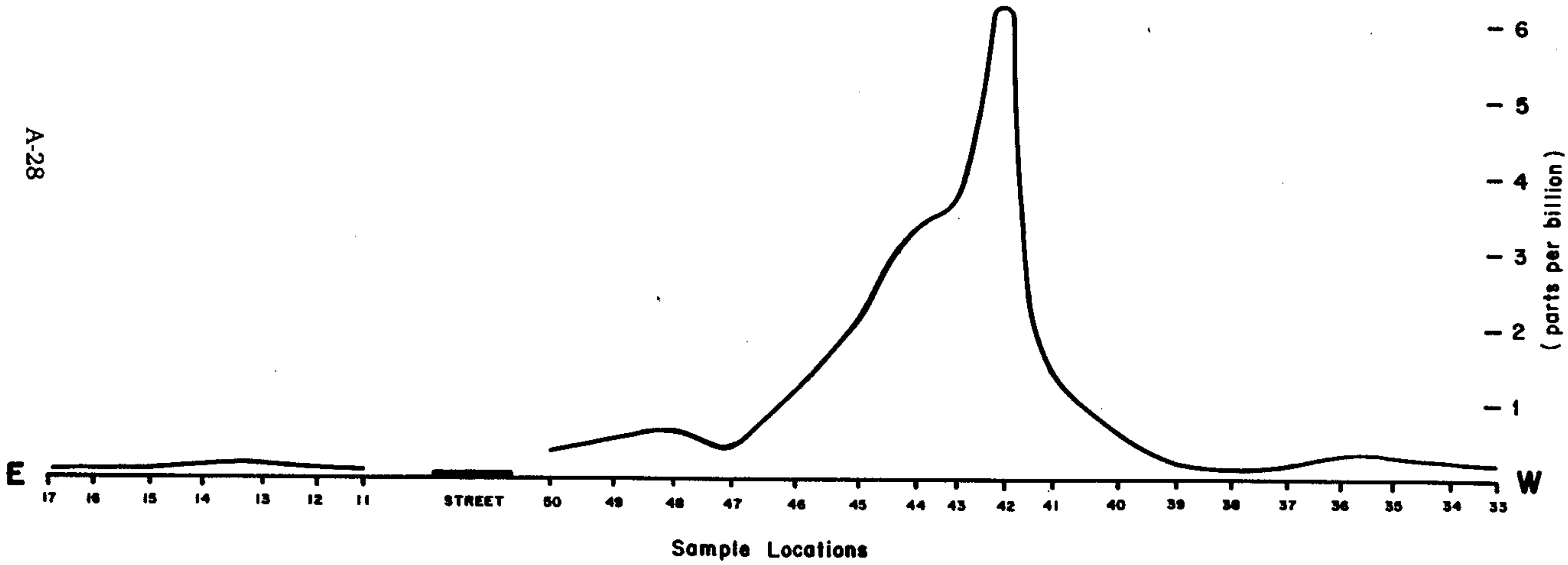


FIGURE 6. TCE Concentrations (ppb) Lines B & C

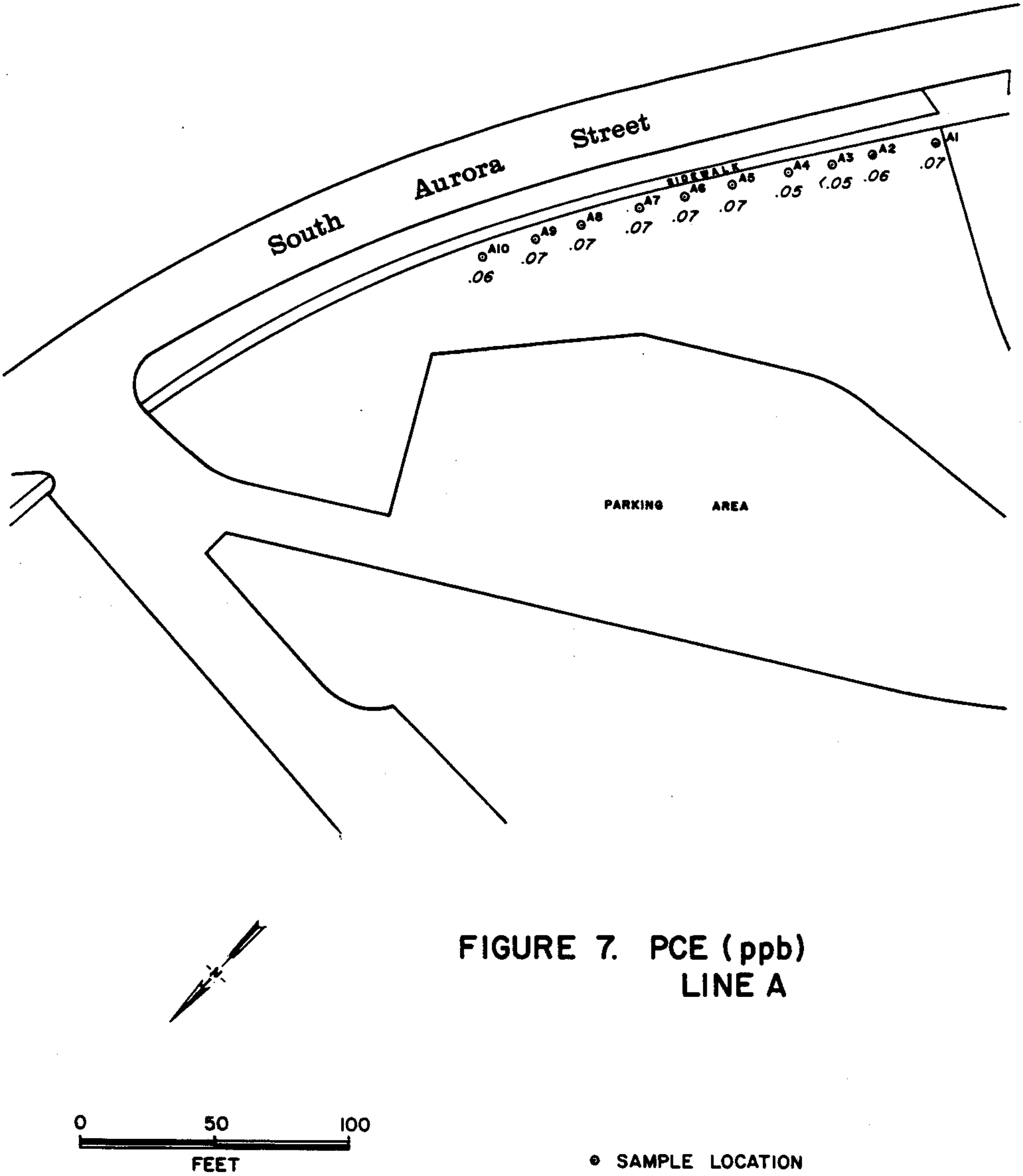


FIGURE 7. PCE (ppb)
LINE A

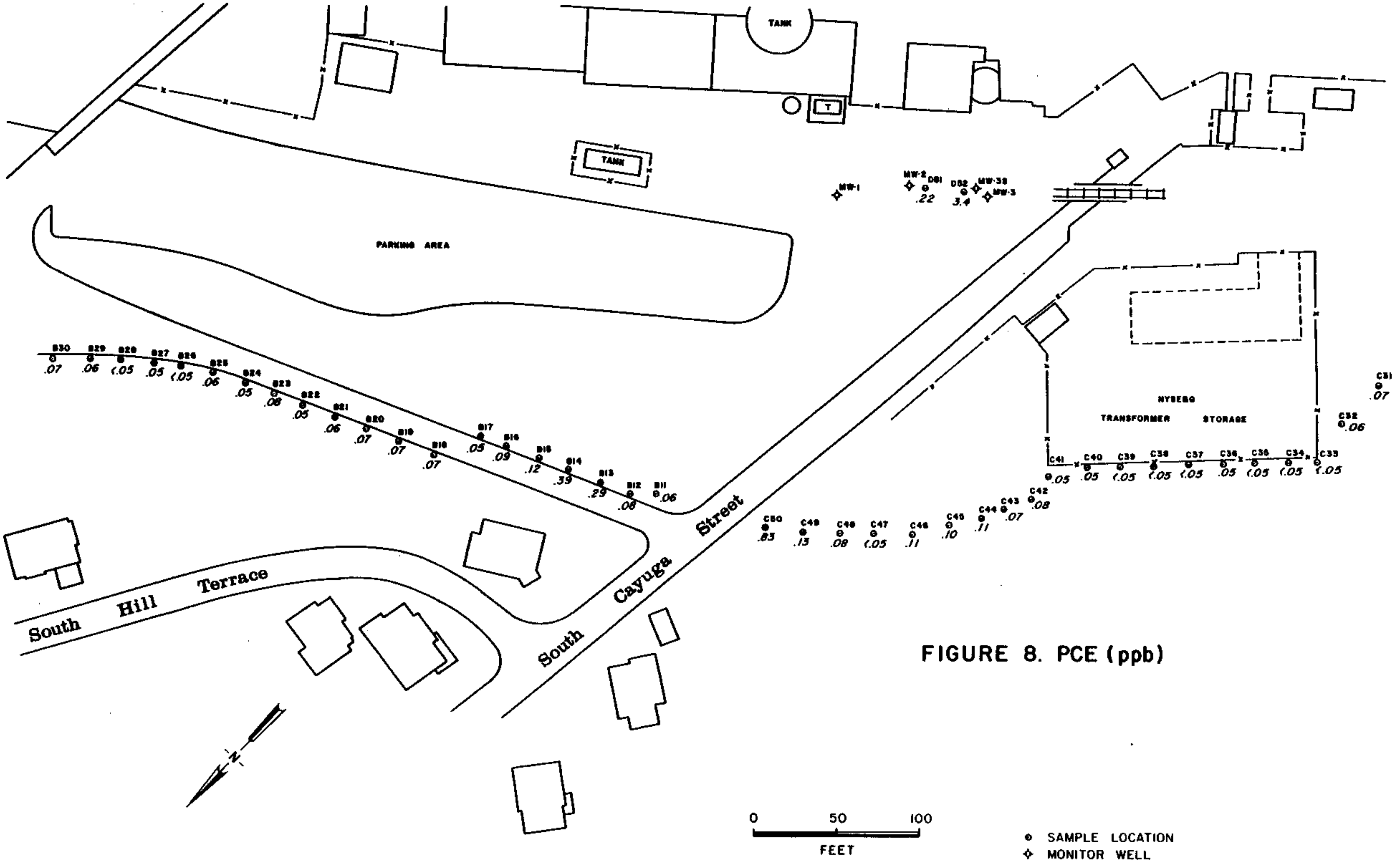


FIGURE 8. PCE (ppb)

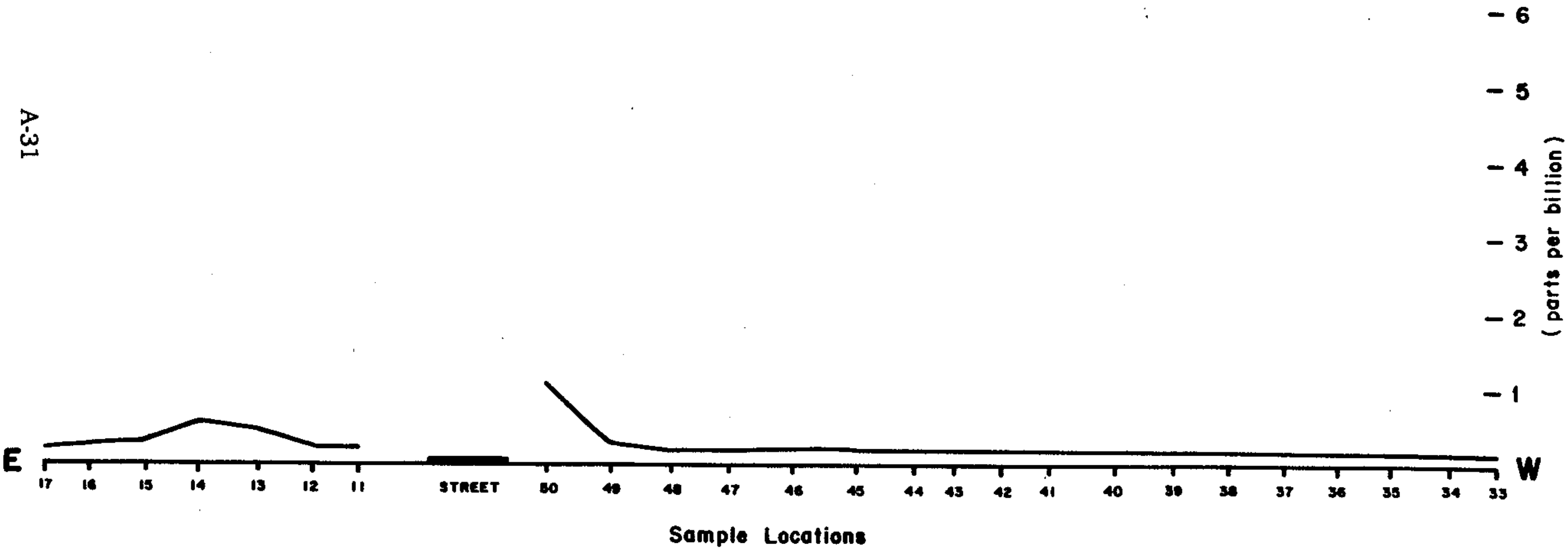


FIGURE 9. PCE Concentrations (ppb) Lines B & C

ANALYTICAL RESULTS FOR SOIL GAS SURVEY

PERFORMED

NOVEMBER 17 - DECEMBER 7, 1987

TABLE A-1

SOIL GAS CONCENTRATIONS QUANTIFIED ABOVE DETECTION LIMITS — LINE A
MORSE INDUSTRIAL CORPORATION ITHACA,NY

Sample #	Approx. Depth (feet)	Date	Methylene chloride (ug/l)	trans-1,2-DCE (ug/l)	cis-1,2-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	1,1-DCA (ug/l)	1,1,1-TCA (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Xylenes (ug/l)
A-01	3	11/17/87							0.0004			
A-01-Dup	3	12/2/87	0.2	0.3			0.0006		0.002			
A-02	3	11/17/87						8	0.006			
A-02-Dup	3	12/2/87	0.3	2		0.006	0.0009		0.007			
A-03	5	11/17/87				0.002		44	0.004			
A-03-Dup	5	11/19/87		5		0.003	0.0001		0.004			
A-04	5	11/17/87				0.01			0.01			
A-04-Dup	5	11/19/87		2		0.01	0.0004		0.01			

Notes:

1. Samples at approximately 100 foot spacings.
2. Background line.

TABLE A-2

SOIL GAS CONCENTRATIONS QUANTIFIED ABOVE DETECTION LIMITS — LINE D
MORSE INDUSTRIAL CORPORATION ITHACA,NY

Sample #	Approx. Depth (feet)	Date	Methylene chloride (ug/l)	trans-1,2-DCE (ug/l)	cis-1,2-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	1,1-DCA (ug/l)	1,1,1-TCA (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Xylenes (ug/l)
D-96	1.5	12/6/87				0.002	0.0008		0.002			
D-95	1.5	12/6/87				0.002			0.002			
D-94	1.5	12/6/87				0.002			0.002			
D-93	1.5	12/6/87				).01	0.0004		0.002			
D-92	1.5	12/6/87				0.02	0.0004		0.002			
D-30	2	11/20/87	0.3	0.8		0.3	0.01		0.004			
D-31	2	11/20/87	0.3			0.03	0.04		0.002			
D-32	2	11/20/87	0.4	0.4			0.006		0.004			
D-33	2	11/20/87	2	0.4		0.004	0.01		0.004			
D-34	2	11/20/87	0.7	0.4		0.02	0.02		0.007			
D-35	2	11/20/87	0.5	0.08		0.0008	0.06		0.002			
D-36	1	11/21/87		0.8		0.003	0.003		0.001			
D-37	2	11/21/87	0.4	0.3		0.001	0.0002		0.004			
D-38	2	11/21/87	0.4	2		0.03	0.002		0.1			
D-39	3	11/30/87		8		0.03	0.2	0.1	2			
D-40	3	11/30/87	0.4	0.08			0.01		0.008			
D-41	2	11/30/87		6		0.01	0.02	1	5	2		
D-42	2	11/30/87		2			0.08	4	3	0.6		
D-43	2	11/30/87		0.2		0.02	0.01	0.6	0.04			
D-44	2	11/30/87		0.3		0.0009	0.07		0.08			
D-45	3	11/30/87		0.2		0.008	0.1		0.02			
D-46	1	11/30/87		0.04		0.0003	0.03		0.004			
D-47	2	11/30/87	0.2	0.02		0.0002	0.03		0.005			
D-48	2	11/30/87	0.4	0.7		0.6	0.004		0.004			
D-49	3	11/30/87	2	83		132	0.3					
D-49-Dup	2.5	12/6/87	6	1	100	190	0.3		0.06			
D-50	3	11/30/87		4		3	0.02		0.002			
D-51	2	11/30/87	0.5	0.4		0.08	0.05		0.003			
D-52	3	11/30/87	0.2	0.09		0.02	0.01		0.005			
D-53	2	12/1/87	0.1	0.05		0.001	0.003		0.02			
D-54	3	12/1/87	0.1	0.1		0.002	0.002		0.01			
D-55	2	12/1/87	0.07	0.2		0.06	0.004		0.2			
D-56	2	12/1/87	0.07	0.8		0.03	0.005		0.01			
D-57	2	12/1/87	0.1			0.002	0.002		0.001			
D-58	3	12/1/87	0.2	2		0.1	0.001		0.009			
D-59	3	12/1/87	0.2	0.7		0.04	0.001		0.02	0.4	0.4	

Notes:
1. Samples D-96 through D-38 at approximately 100 foot spacings.
2. Samples D-38 through D-59 at approximately 50 foot spacings.

TABLE A-3

SOIL GAS CONCENTRATIONS QUANTIFIED ABOVE DETECTION LIMITS — LINE E

MORSE INDUSTRIAL CORPORATION ITHACA,NY

Sample #	Approx. Depth (feet)	Date	Methylene chloride (ug/l)	trans-1,2-DCE (ug/l)	cis-1,2-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	1,1-DCA (ug/l)	1,1,1-TCA (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Xylenes (ug/l)
E-60	3	12/1/87	0.2	0.2		0.02	0.001		0.004			
E-61	2	12/1/87	0.2	3		1	0.003		0.004			
E-62	2	12/1/87	0.06	0.1		0.02	0.002		0.04			
E-63	2	12/1/87	0.2	0.08		0.0004	0.002		0.002			
E-64	2	12/1/87		0.1		0.00007	0.0008		0.002			
E-65	3	12/1/87	0.2	0.05			0.0008		0.001			
E-66	3	12/1/87	0.2	0.6			0.003		0.001			
E-70	2	12/2/87	0.3	0.4			0.0005		0.001			
E-71	2	12/2/87					0.0005		0.0008			
E-72	2	12/5/87				0.02	0.001		0.004			
E-73	2.5	12/5/87				0.009	0.006		0.003			
E-74	2.5	12/5/87				0.02	0.001		0.006			
E-75	2	12/5/87				0.02			0.006			
E-76	2.5	12/5/87				0.002			0.0008			
E-77	2	12/5/87				0.001	0.0005		0.008			
E-78	2	12/5/87				0.004	0.001		0.002			
E-79	3	12/5/87				0.002	0.0001		0.002			
E-80	3	12/5/87				0.002	0.0002		0.002			

Notes:

1. Samples E-60 through E-71 at approximately 100 foot spacings along Line E.
2. Samples E-72 through E-80 were distributed along Spencer Street and among the houses.

TABLE A-4
SOIL GAS CONCENTRATIONS QUANTIFIED ABOVE DETECTION LIMITS — LINE F
MORSE INDUSTRIAL CORPORATION ITHACA,NY

Sample #	Approx. Depth (feet)	Date	Methylene chloride (ug/l)	trans-1,2-DCE (ug/l)	cis-1,2-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	1,1-DCA (ug/l)	1,1,1-TCA (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Xylenes (ug/l)
F-82	1	12/5/87				0.005			0.0009	0.6	0.6	
F-81	3	12/5/87				0.002			0.001			
F-11	1.5	11/17/87	0.9				0.01		0.002			
F-11-Dup1	2	11/19/87		0.3		0.002	0.0005		0.0006			
F-11-Dup2	2	12/2/87	0.4			0.0006	0.001		0.0008			
F-11-Dup3	2	12/5/87				0.003			0.0008			
F-05	5	11/17/87				0.03			0.001			
F-05-Dup	2	12/2/87	0.4	1		0.005	0.0007		0.001			
F-06	5	11/17/87							0.001			
F-06-Dup	2	12/2/87	0.3				0.0008		0.001			
F-07	2	11/17/87							0.0006			
F-07-Dup	2	12/2/87	0.4	0.1			0.001		0.0004	0.02		
F-08	3	11/17/87				0.002		4	0.001			
F-08-Dup	2	12/2/87	0.2	0.3			0.0008		0.0008			
F-09	2	11/17/87							0.002			
F-09-Dup	2	12/2/87	0.4				0.0005		0.001			
F-10	1	11/17/87							0.003			
F-10-Dup	2	12/2/87	0.2				0.0007		0.0007			
F-12	1	11/19/87					0.0006		0.002			
F-13	1	11/19/87	0.3	0.1		0.01	0.001		0.004			
F-14	1.5	11/19/87		0.02		0.001	0.0009		0.006			
F-15	1	11/19/87					0.0004		0.002			
F-16	1	11/19/87				0.0003	0.00002		0.001			
F-17	1	11/19/87	0.9	0.7		0.006	0.004		0.007			
F-17-Dup1	1.5	11/20/87	0.4	0.6			0.002		0.002			
F-17-Dup2	1	12/5/87				0.002			0.002			
F-18	1	11/19/87							0.001			
F-19	1	11/19/87				0.0001	0.002		0.002			
F-20	1	11/19/87	0.3			0.05			0.01			
F-21	1	11/19/87				0.01			0.001			
F-22	3	11/19/87				0.009			0.002	0.05		
F-23	3	11/19/87	0.3			0.006			0.003			
F-24	3	11/19/87	0.4			0.04	0.002		0.008			
F-25	3	11/20/87		0.2		0.009			0.007			
F-26	3	11/20/87	0.6			0.004			0.004			
F-26-Dup	3	12/1/87	0.3	0.8			0.0008		0.002			
F-27	1	11/20/87		0.1			0.002		0.003			
F-28	1	11/20/87					0.002		0.02			
F-29	1	11/20/87		0.7		0.04	0.01		4	1		
F-29-Dup	1	12/1/87	0.1	1		0.06	0.007		2			

Notes:

1. Samples F-82 through F-10 taken at approximately 100 foot spacings.
2. Samples F-10 through F-29 taken at approximately 50 foot spacings.

TABLE A-5
SOIL GAS CONCENTRATIONS QUANTIFIED ABOVE DETECTION LIMITS -- LINE G
MORSE INDUSTRIAL CORPORATION ITHACA,NY

Sample #	Approx. Depth (feet)	Date	Methylene chloride (ug/l)	trans-1,2-DCE (ug/l)	cis-1,2-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	1,1-DCA (ug/l)	1,1,1-TCA (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Xylenes (ug/l)
G-67	1.5	12/1/87	0.2				0.004		0.01			
G-68	1	12/1/87	0.2	0.5		0.0002	0.001		0.002			
G-69	1.5	12/2/87	0.3	1		0.02	0.01		0.01			

Notes:
1. Samples G-67 and G-68 at approximately 30 foot spacing.
2. Samples G-68 and G-69 at approximately 90 foot spacing.
3. Holes drilled for samples between Points 68 and 69 filled with water.

TABLE A-6

SOIL GAS CONCENTRATIONS QUANTIFIED ABOVE DETECTION LIMITS — LINE H
MORSE INDUSTRIAL CORPORATION ITHACA,NY

Sample #	Approx. Depth (feet)	Date	Methylene chloride (ug/l)	trans-1,2-DCE (ug/l)	cis-1,2-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	1,1-DCA (ug/l)	1,1,1-TCA (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Xylenes (ug/l)
H-83	2	12/5/87				0.006			0.001			
H-84	1.5	12/5/87				0.006			0.0007			

Notes:

1. Samples at approximately 100 foot spacing.
2. Samples taken in "former drum storage area".

TABLE A-7

SOIL GAS CONCENTRATIONS QUANTIFIED ABOVE DETECTION LIMITS — LINE I
MORSE INDUSTRIAL CORPORATION ITHACA,NY

Sample #	Approx. Depth (feet)	Date	Methylene chloride (ug/l)	trans-1,2-DCE (ug/l)	cis-1,2-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	1,1-DCA (ug/l)	1,1,1-TCA (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Xylenes (ug/l)
I-97	2	12/7/87				0.006	0.0009		0.04			
I-98	2	12/7/87				0.006	0.003		0.002			
I-99	2	12/7/87				0.007	0.001		0.002			

Notes:

1. Samples taken at approximately 30 foot spacings.
2. Samples taken below drums located near NYSE&G transformer station.

TABLE A-8

SOIL GAS CONCENTRATIONS QUANTIFIED ABOVE DETECTION LIMITS — POINT J

MORSE INDUSTRIAL CORPORATION ITHACA,NY

Sample #	Approx. Depth (feet)	Date	Methylene chloride (ug/l)	trans-1,2-DCE (ug/l)	cis-1,2-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	1,1-DCA (ug/l)	1,1,1-TCA (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Xylenes (ug/l)
J-100	2	12/7/87				0.002	0.006		0.002			

Notes:

1. Sample taken upgradient of NYSE&G pipeline above soil gas sample location F-18.

TABLE A-9

SOIL GAS CONCENTRATIONS QUANTIFIED ABOVE DETECTION LIMITS — SEWER LINES
MORSE INDUSTRIAL CORPORATION ITHACA,NY

Sample #	Approx. Depth (feet)	Date	Methylene chloride (ug/l)	trans-1,2-DCE (ug/l)	cis-1,2-DCE (ug/l)	TCE (ug/l)	PCE (ug/l)	1,1-DCA (ug/l)	1,1,1-TCA (ug/l)	Benzene (ug/l)	Toluene (ug/l)	Xylenes (ug/l)
S-85	1	12/6/87				0.03	0.0005		0.002			
S-86	2	12/6/87				12	0.3		4	0.2		
S-87	2	12/6/87				0.1	2		27	10		
S-88	2	12/6/87				0.06	1		20			
S-89	1.5	12/6/87				0.09	0.2		0.4			
S-90	2	12/6/87				0.06	0.8		2			
S-91	2	12/6/87				0.05	0.03		0.05			

Notes:
1. Samples taken near manhole cover locations along the streets at approximately 100 foot spacings.
2. Samples S-85 through S-88 were taken along S. Cayuga St.
3. Samples S-89 through S-91 were taken along Turner Place.

TABLE A-10

SOIL GAS CONCENTRATIONS QUANTIFIED ABOVE DETECTION LIMITS (UG/L) - AMBIENT AIR SAMPLES
MORSE INDUSTRIAL CORPORATION ITHACA, NY

Sample #	Date	CH_2CL_2	TCE	PCE	1,1,1-TCA	BENZENE	TOLUENE
A-03	11/19/87				0.01		
F-25	11/20/87				0.0006		
D-36	11/21/87				0.0006		
F-29	12/1/87	0.3		0.0003	0.001		
G-69	12/2/87			0.0003	0.0006	0.2	0.3
F-17	12/5/87(AM)		0.009		0.002		
F-17	12/5/87(PM)		0.006		0.002		
J-100	12/7/87		0.002	0.0006	0.003		

APPENDIX B

GEOLOGIC MAPPING

APPENDIX B - GEOLOGIC MAPPING

The orientation and nature of joints present in the bedrock outcrops were investigated in the field at 16 locations on EPT's property and adjacent properties (see Tables B-1 and B-2, and Figure B-1, presented at the end of this Appendix). The compass orientation of the joints was measured with a brunton compass. Joints occurring in this region have consistent orientations along a limited number of specific compass directions. Parallel joints aligned along a specific compass orientation are classified as joint sets. The spacing between parallel joints was measured at each location as an indication of the number of joints present at an outcrop. In addition, the geometry (or curvature) and the texture (fine scale surface morphology) of each individual joint face (or surface) were described. The joints of this region typically have a linear horizontal trace, even those that have a curved face. Thus, the trace generally represents vertical rather than horizontal curvature.

The joints observed in outcrops can be grouped into three sets trending north-northwest (N13-21W), east-northeast (N85-89E and N70-72E), and northeast (N45-55E). Each of these three sets of joints has slightly different morphological characteristics. All joints observed in outcrops dip within eight degrees of vertical. The orientation and nature of joints observed is similar to that reported by previous investigators (Sheldon, 1912; Parker, 1942; Podwysocki et. al., 1982; and Engelder, 1986) who investigated the regional trends of joints in New York and Pennsylvania.

The north-northwest (NNW) trending set is the dominant joint set present in the outcrops examined. These joints are well-defined, have planar and smooth faces, and are spaced from 1 to 18 inches apart. Individual joints of this set may extend vertically and horizontally through the entire exposure of the outcrops in which they occur, which in places exceed 30 feet. These vertically and horizontally extensive joints tend to be spaced about 15 to 18 inches apart. Many joints of this set display plumose markings (fine scale ridges radiating from a single point on the joint face). Plumose markings have not been reported on joints of other trends and thus are a diagnostic characteristic of the NNW trending set (Parker, 1942; Podwysocki et. al., 1982; Engelder, 1986).

The north-northeast (NNE) trending joint set is less well-defined and may actually consist of two sets ranging between N70-72E and N85-89E, respectively. These joints are generally moderately to poorly expressed, have rough irregular to curved faces (none display plumose markings), and are spaced from 10 inches to 30+ feet apart. In most outcrops where these joints are visible, individual joints do not extend vertically or horizontally beyond the extension of the outcrop. A rough surface texture and a discontinuous nature are common characteristics of these joints.

The northeast (NE) trending joint set is a very widely spaced joint set. It was not observed in outcrops with less than 20 to 30 feet of exposure. Generally, only one joint of this set is present in an outcrop. These joints generally have curved and rough faces that are vertically and horizontally extensive, and in many places form a ledge or bench several feet high.

TABLE B-1. PARAMETERS USED TO DESCRIBE JOINTS IN OUTCROPS, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

Parameter

(1) Orientation: Compass direction with respect to north

(2) Rock type: Lithology, grain size, color

(3) Bed thickness: Measure the thickness in inches or use:

VTL: Very thinly laminated:	less than 0.10 inches
TL: Thinly laminated:	0.10 to 0.50 inches
L: Laminated:	0.50 to 2.0 inches
TB: Thinly bedded:	2.0 inches to 24 inches
KB: Thickly bedded:	greater than 24 inches

(4) Joint spacing: Measure the spacing in inches or use:

VIF: Very intensely fractured:	less than 1 inch
IF: Intensely fractured:	1 to 3 inches
VF: Very fractured:	3 to 6 inches
MF: Moderately fractured:	6 to 12 inches
SF: Slightly fractured:	12 to 36 inches

(5) Trace geometry: Curvature of the joint face:

P: Planar: Flat
C: Curved: Gently curved in one direction
I: Irregular: Irregularly curved in more than one direction

(6) Face texture: Fine scale morphology of the joint face:

VR: Very rough:	Large ridges
R: Rough:	Large steps of irregularities
SP: Smooth/plumose:	Fine scale ridges radiating from a single point (appears like a feather)
S: Smooth:	Smooth to touch

TABLE B-2. JOINT MEASUREMENTS, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

Location*	Orientation	Rock Type	Bed Thickness	Joint Spacing	Trace Geometry	Face Texture	Comments
1 (Railroad Ditch)	N15W	Siltstone: grey	L-TB: 1-3"	SF: 13-15"	P	S	Extends 4+ ft. horizontally
	N87E	Siltstone: grey	L-TB: 1-3"	SF:20"	C	R	
2 (Railroad Ditch)	N13W	Siltstone: grey	L-TB: 1-6"	VF:3-6"	P	SP	Well expressed, extends 5+ ft. horizontally
	N72E	Siltstone: grey	L-TB: 1-6"	MF-SF: 10-15"	C	R	Poorly expressed
3 (Railroad Ditch)	N13W	Siltstone: grey	L-TB: 1-3"	VF:3-6"	P	S	
4 (Quarry)	N87E	Siltstone: grey	L-TB: 1-3"	SF:3-4'	C	R	
	N11-14W	Siltstone: grey	L-TB: 1-3"	VF:3-6"	P	SP	Extends 40+ ft. vertically and 20+ ft. horizontally
	N50E	Siltstone: grey	L-TB: 1-3"	SF:6'+	C	R	Extends 3+ ft. vertically
5 (Waterfalls)	N13W	Siltstone: grey	L-TB: 1-3"	VF-MF: 3-7"	P	S	Well expressed, extends 4+ ft. vertically and 30+ ft. horizontally
	N87E	Siltstone: grey	L-TB: 1-3"	SF:2-3'	C-I	R	Poorly expressed
	N45E	Siltstone: grey	L-TB: 1-3"	SF:30'+	-	-	
6 (Waterfalls)	N13W	Siltstone: grey	L-TB: 1-6"	VF:3-6"	P	SP	Extends 4+ ft. vertically and 20+ ft. horizontally
	N87E	Siltstone: grey	L-TB: 1-6"	VF-SF: 3-24"	C	R	
	N55E	Siltstone: grey	L-TB: 1-6"	SF: 10'+	C	R	Extends 4+ ft. vertically to form a ledge

* Location numbers correspond to areas shown on Figure B-1.

TABLE B-2. JOINT MEASUREMENTS, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK (CONTINUED)

Location*	Orientation	Rock Type	Bed Thickness	Joint Spacing	Trace Geometry	Face Texture	Comments
7 (Cascade)	N15W	Siltstone: grey	L-TB: 1-3"	IF:2-3"	-	-	Intersection of joints and bedding creates shattered rock extending 30 ft. vertically
	N89E	Siltstone: grey	L-TB: 1-3"	VF:3-6"	-	-	
	N52E	Siltstone: grey	L-TB: 1-3"	SF:20'+	-	-	
8 (Road Cut)	N15-18W	Siltstone: grey	VTL-TB:> 1-4"	IF:1-3"	P	SP	Well expressed, extends 5+ ft. vertically
	N88E	Siltstone: grey	VTL-TB:> 1-4"	MF-SF: 6-24"	-	-	
	N73E	Siltstone: grey	VTL-TB:> 1-4"	SF:10+	-	-	
9 (Road Cut)	N14W	Siltstone: grey	L-TB: 1-3"	VF:3-6"	P	S	Dominant
	N70E	Siltstone: grey	L-TB: 1-3"	SF:3'+	C	R	
10 (Spencer Street Drainage Ditch)	N70E	Siltstone: grey	VTL-L: >1"	-	-	-	
	N19W	Siltstone: grey	VTL-L: >1"	-	-	-	
11 (Spencer Street Drainage Ditch)	N21W	Siltstone: grey	L-TB: 1-3"	VF:4-6"	P	S	

* Location numbers correspond to areas shown on Figure B-1.

TABLE B-2. JOINT MEASUREMENTS, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK (CONTINUED)

Location*	Orientation	Rock Type	Bed Thickness	Joint Spacing	Trace Geometry	Face Texture	Comments
12 (Road Cut Geneva St.)	N87E	Siltstone: grey	VTL-TB:> 1-3"	SF:4'+	C	R	Extends 15+ ft. vertically and 5+ ft. horizontally
	N15W	Siltstone: grey	VTL-TB:> 1-3"	MF-SF: 6-20"	P	S	Extends 15+ ft. vertically and 5+ ft. horizontally
	N70E	Siltstone: grey	VTL-TB:> 1-3"	SF:30'+	P	S	
13 (Uphill Loading Dock)	N14-16W	Siltstone: grey	L-TB: 1-3"	IF-SF: 3-24"	P	SP	Extends 30+ ft. vertically
	N88E	Siltstone: grey	L-TB: 1-3"	SF:10'	C	R	Discontinuous
14 (Upper Parking Lot)	N16W	Siltstone: grey	VTL-TB:> 1-4"	IF:2-3"	P	S	Extends 4.5+ ft. vertically
	N88E	Siltstone: grey	VTL-TB:> 1-4"	SF:5+'	I	R	Poorly defined
15 (Road Cut Cayuga St.)	N13-16W	Siltstone: grey	VTL-TB:> 1-4"	MF:6-18"	P	SP	Extends 3.5+ ft. vertically
	N86E	Siltstone: grey	VTL-TB:> 1-4"	SF:2-3'	C	R	Poorly defined
16 (Road Cut Service Road)	N15-17W	Siltstone: grey	VTL-TB:> 1-4"	VF-MF: 3-18"	P	SP	Extends 14+ ft. vertically
	N85E	Siltstone: grey	VTL-TB:> 1-4"	SF:3+'	I	R	Poorly defined

* Location numbers correspond to areas shown on Figure B-1.

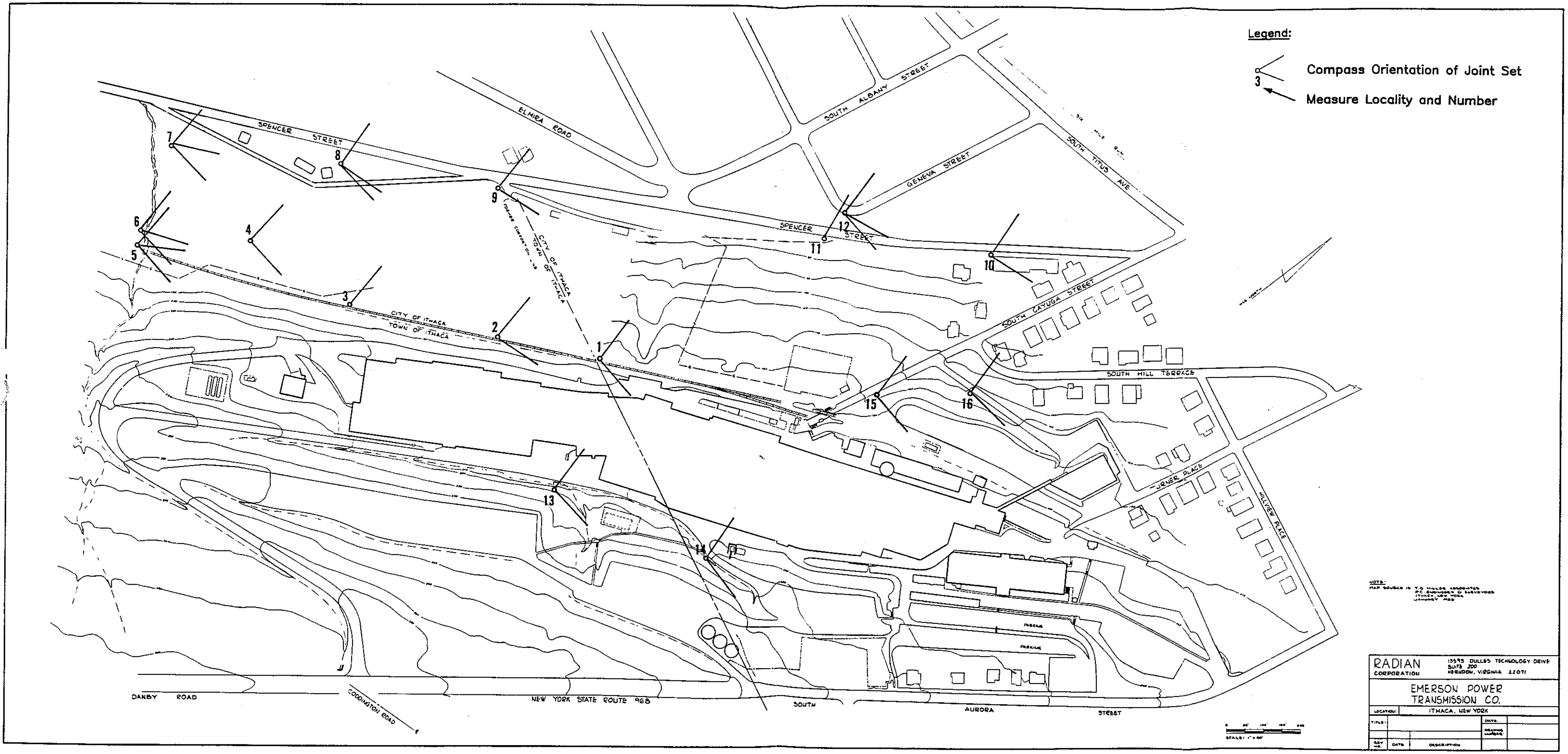


Figure B-1. Orientation of Joints Measured in Outcrops, Emerson Power Transmission, Ithaca, New York

APPENDIX C

BOREHOLE DRILLING AND ROCK CORING

APPENDIX C - BOREHOLE DRILLING AND ROCK CORING

C.1 BOREHOLE DRILLING

The first borehole drilled during the Stage 1 Investigation was for an intermediate-depth bedrock well (MW-3-100). The borehole was drilled using the air rotary technique to quickly drill and isolate the open interval, and to minimize downward migration of contaminants in the borehole. Samples of soil and bedrock could not be taken during air rotary drilling, although cuttings were inspected as they were discharged from the borehole.

For all other boreholes, drilling in the overburden (unconsolidated materials) was accomplished with 6.25-inch outside diameter hollow stem augers. Split spoon samples were taken at approximately 5-foot intervals with a 2-inch diameter, 18-inch long standard split spoon. Detailed descriptions of materials encountered were based on observations of auger cuttings and on examination of these samples. In boreholes extending into bedrock, rock was cored with 3-inch diameter core barrels. The cores were extracted, placed in sequence in labeled wooden storage boxes, logged in detail, and photographed. Where necessary for the installation of well casing materials, the corehole was reamed to a larger diameter with a 5-5/8-inch tri-cone roller bit. Cuttings from all boreholes were placed in 55-gallon containers adjacent to each drilling site, pending sample analysis and the determination of final disposition according to NYSDEC guidance.

As specified in the Health and Safety Plan, boreholes were monitored with an HNu organic vapor detector to maintain a safe working environment. The measurements obtained from unconsolidated material samples from the boreholes and from the breathing zone above the well also served to provide a qualitative measure of the presence of volatile organic compounds at these locations. These measurements were recorded on the boring logs included in this Appendix.

Boring logs were prepared by an experienced Radian field geologist during drilling of the boreholes. The boring logs provide detailed information on the lithology of the materials encountered, the depth intervals from which samples were retrieved, the blow counts from standard penetration tests, the measurements obtained during HNu screening, the total depth drilled, and other notes on conditions affecting drilling operations. Copies of the boring logs are presented at the end of this Appendix.

C.2 ROCK CORING

Detailed core logs were prepared by an experienced Radian geologist to supplement the boring logs. Continuous cores of rock obtained from boreholes drilled for some of the monitoring wells are described in detail on these core logs. Table C-1 lists the bedrock wells for which cores were logged. (All tables for Appendix C are presented at the end of this Appendix.) The core logs provide information on percent recovery, rock quality designation (RQD), fracture frequency per foot of core, orientation of fractures with respect to the long axis of the core, fracture spacing and filling, lithology, rock color, and degree of weathering. Table C-2 provides definitions of these core log parameters. Copies of the core logs also are presented at the end of this Appendix.

Radian made an effort to distinguish between naturally occurring fractures and those that were artificially induced by the coring process. Three categories of fractures were identified: naturally occurring, artificially induced, and of questionable origin. Fractures which are clearly natural can be recognized either by a mineral coating or stain on part or all of the fracture face, or by pieces of core from opposite sides of the fracture that do not fit tightly and completely together. Induced fractures are fractures created artificially by the coring process; or fractures created artificially after coring, by breaking the core with a hammer ("hammer breaks") in order to fit long pieces of core into the storage box; or fractures that form during transport of the loaded core boxes.

Induced fractures can be identified with a high degree of confidence because induced fracture faces are clean (faces lacking mineral stain or coating), and pieces of core from opposite sides of such a fracture interlock to fit tightly and completely together. Fractures created by these processes were labeled on the core as induced and were eliminated from analysis. Fractures having a morphology that was difficult to confidently characterize as either induced or natural were labeled as being of questionable origin. All fractures that did not conform to the induced fracture criteria were marked on the core logs as either natural or possibly natural fractures.

C.3 OBSERVATIONS

Observations of rock core reveal that the bedrock at the EPT site consists of at least 165 feet of gray siltstone, clayey-siltstone, and silty shale that correlate to the Genesee Formation. The rock is well-cemented and bed thickness ranges from 0.1 inch to less than 2.5 feet. Fossils generally are confined to densely packed fossil beds that range in thickness from approximately 0.5 inches to 4 inches and consist of calcite replaced fragments of Brachiopods and Crinoids. Beds are discontinuous laterally and generally do not extend more than a few feet, making stratigraphic correlation between wells difficult.

Two types of fractures are visible in cores of this rock: bedding plane fractures and joints. Bedding plane fractures (also called bedding plane partings) parallel bedding planes and split apart adjacent beds. Joints are fractures oriented at such an angle to the bedding that they do not offset the rocks on opposite sides of the fracture. The joints observed in these rocks are essentially vertical and are aligned along specific compass orientations (Appendix B).

Because the cores obtained were not oriented cores, they cannot be used to provide a compass orientation of the joints observed in the subsurface. However, based on observations of outcrops, these joints are systematically oriented and trend north-northwest (NNW), east-northeast (ENE), or northeast (NE) (see Appendix B). Observations of the morphology of joints in the outcrops reveal that the

NNW-trending joints have distinct morphologic characteristics that may be used to identify joints of this trend in rock cores.

C.3.1 Joints

Portions of joints were visible in cores obtained from 18 of the 23 boreholes drilled for monitoring wells (Table C-3). The character of the joints observed ranged from planar clean, or partially calcite-filled, to slightly rough clean joints. Joints present in core obtained from depths of less than 21 feet below the land surface were stained with ferric oxide minerals. Joints in core obtained from depths between 21 and 38 feet were either clean (not coated or stained with minerals) or were partially filled with calcite. Most joints present in core obtained from depths below 38 feet were at least partially calcite filled. Plumose markings were visible on some of the planar joint faces, indicating that these joints trend north-northwest (see Appendix B). Because joints are nearly vertical, they are essentially parallel to the long axis of the core.

No relationship is apparent between the occurrence of joints in the core and the depth from which the core is obtained, although there does appear to be a correlation between depth and the occurrence of partings. The maximum depth at which joints were observed was from 150.8 to 151.2 feet in MW-3-150, where two parallel joints spaced 1 inch apart dipped approximately 87 degrees. These two joints were partially filled with calcite, indicating open fracture porosity is present at that depth. A joint observed in core obtained from this well (from a depth of 130.0 to 130.8 feet) was partially coated with calcite crystals several millimeters long, indicating an aperture at least that wide. Investigations of similar rocks located elsewhere indicate that open fracture porosity due to the presence of joints in the subsurface may be present at depths of thousands of feet below the land surface (see Merin and Moore, 1986; Secor, 1965; Narr and Currie, 1982).

C.3.2 Bedding Plane Fractures

Bedding plane fractures were observed in core from all of the boreholes from which core was obtained. These fractures generally have slightly curved faces parallel to bedding, which is nearly perpendicular to the long axis of the core. With the exception of core obtained from wells MW-7-40 and MW-16-100, the bedding plane fractures present above a maximum depth of approximately 21 feet were stained with ferric oxide minerals. Below that depth, the faces of the bedding plane fractures were clean (not coated or stained with minerals), with the exception of the fractures located at 99.5 feet in MW-6-100, and at 129.5 and 145.5 feet in MW-3-150. These three bedding plane fractures were partially coated with calcite, indicating the existence of open bedding plane partings at these depths.

The frequency of occurrence of bedding plane fractures present in the cores appears to decrease with depth below the land surface, from a maximum fracture frequency of 27 per foot to less than one fracture per foot of core. Three depth zones (upper, middle, and lower) were defined based on the frequency of occurrence of these fractures (see Figure C-1, presented at the end of this Appendix).

The upper zone, referred to as the "stress relief" zone, extends to a depth of 15 to 22 feet below the land surface and is defined as having a bedding plane fracture frequency ranging between 27+ per foot to 5 per foot. The spacing between these fractures is generally less than 1 inch to 3 inches apart (very intensely to intensely fractured); however, there are a few zones at which the spacing is 3 to 6 inches apart (very fractured). Most of the fractures at depths of less than 21 feet were stained with ferric oxide minerals.

The middle zone, referred to as the "transitional" zone, extending from the base of the upper zone to a maximum depth of approximately 55 feet, is a transitional zone between the very intensely to intensely fractured stress relief zone and the slightly fractured to unfractured lower zone. This middle zone is defined by bedding plane fracture frequency ranging between 4 per foot to zero per 3 feet. The spacing between the bedding plane fractures in this zone ranges from 3 to 6 inches (very fractured) to 12 to 36 inches (slightly fractured), with some zones of less than 1 to 3 inches (very intensely to intensely fractured) spacing. The very to very intensely fractured zones generally display some fissility (bedding plane parting parallel to clay or mica minerals spaced a few millimeters apart) and therefore may be partially lithologically controlled. The bedding plane fractures present in this zone had clean faces.

The lower zone, referred to as the "lithologically controlled" zone, extends from the bottom of the middle zone (a maximum of approximately 55 feet) to a minimum depth of 145 feet below the land surface. The lower zone is defined as the top of the uppermost zone of zero bedding plane fractures per 3 feet to the uppermost depth below which no bedding plane fractures occur. The bedding plane fractures within this zone occur in zones spaced as far as 36 feet apart, and the individual zones are comprised of intensely fractured to very intensely fractured zones that generally display fissility. Because the bedding plane fractures are largely confined to fracture zones that display fissility, the occurrence of these fractures is probably lithologically controlled. With the exception of three partially calcite filled bedding plane fractures located at 99.5 feet in MW-6-100 and at 129.5 feet and 145.5 feet in MW-3-150, the fractures in this zone had clean faces.

Core obtained from MW-3-150 indicates that approximately 36 feet of continuously unfractured rock overlies a thin zone of bedding plane fractures at a depth of approximately 145 feet, and that approximately 30 feet of continuously unfractured rock lies below this bedding plane fracture zone. Because no other data below a depth of 100 feet was obtained, Radian cannot confidently assume that 145 feet marks the depth below which no bedding plane fractures occur. Thus, the floor of the zone of lithologically controlled bedding plane fractures may extend to depths lower than 145 feet.

TABLE C-1. BOREHOLES/MONITORING WELLS FOR WHICH CORES WERE LOGGED, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

Borehole/Monitoring Well
MW-1
MW-2
MW-3-150
MW-4
MW-5-40
MW-5-100
MW-6-40
MW-6-100
MW-7-40
MW-8-40
MW-9-40
MW-9-100
MW-10-40
MW-11-40
MW-13-25
MW-15-40
MW-16-100
MW-17-40

TABLE C-2. DEFINITIONS OF CORE LOG PARAMETERS, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

Definition

(1) Lithology and color of rock

(2) Weathering:
--Fresh rock: Unaffected by weathering
--Weathered rock: Highly, moderately, slightly
--Soil: Parent rock features unrecognizable

(3) Grain size, sorting

(4) Percent Recovery: $\frac{\text{Total recovery\%}}{\text{Solid recovery \%}}$

Total recovery = length of core recovered expressed as a percentage

Solid recovery = length of core pieces of full core diameter expressed as a percentage

(5) Fracture frequency: number of fractures per 1 foot of core recovered

(6) Rock quality designation (RQD):

$$= \frac{\text{length of pieces over 4 inches}}{\text{total length of recovered core}} \quad \text{(expressed as a \%)}$$

(7) Fracture orientation relative to long axis of core:
--Spacing:

VIF: Very intensely fractured:	less than 1 inch
IF: Intensely fractured:	1 to 3 inches
VF: Very fractured:	3 to 6 inches
MF: Moderately fractured:	6 to 12 inches
SF: Slightly fractured:	12 to 36 inches

--Fracture filling:
Clean: No material filling fracture
Stained: Rock discolored, no filling minerals
Filled: Fracture filled (or partially filled) with minerals

TABLE C-2. DEFINITIONS OF CORE LOG PARAMETERS, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK (CONTINUED)

Definition (Continued)

(8) Bed thickness:
--Very thinly laminated: less than 0.10 inches
--Thinly laminated: 0.10 to 0.5 inches
--Laminated: 0.5 to 2.0 inches
--Thinly bedded: 2.0 inches to 24 inches
--Thickly bedded: greater than 24 inches

(9) Roughness:
--Smooth: Smooth to touch
--Slightly rough: Visible surface irregularities
--Medium rough: Abrasive irregularities
--Rough: Large steps of irregularities
--Very rough: Ridges

TABLE C-3. SUMMARY OF JOINTS IN ROCK CORES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

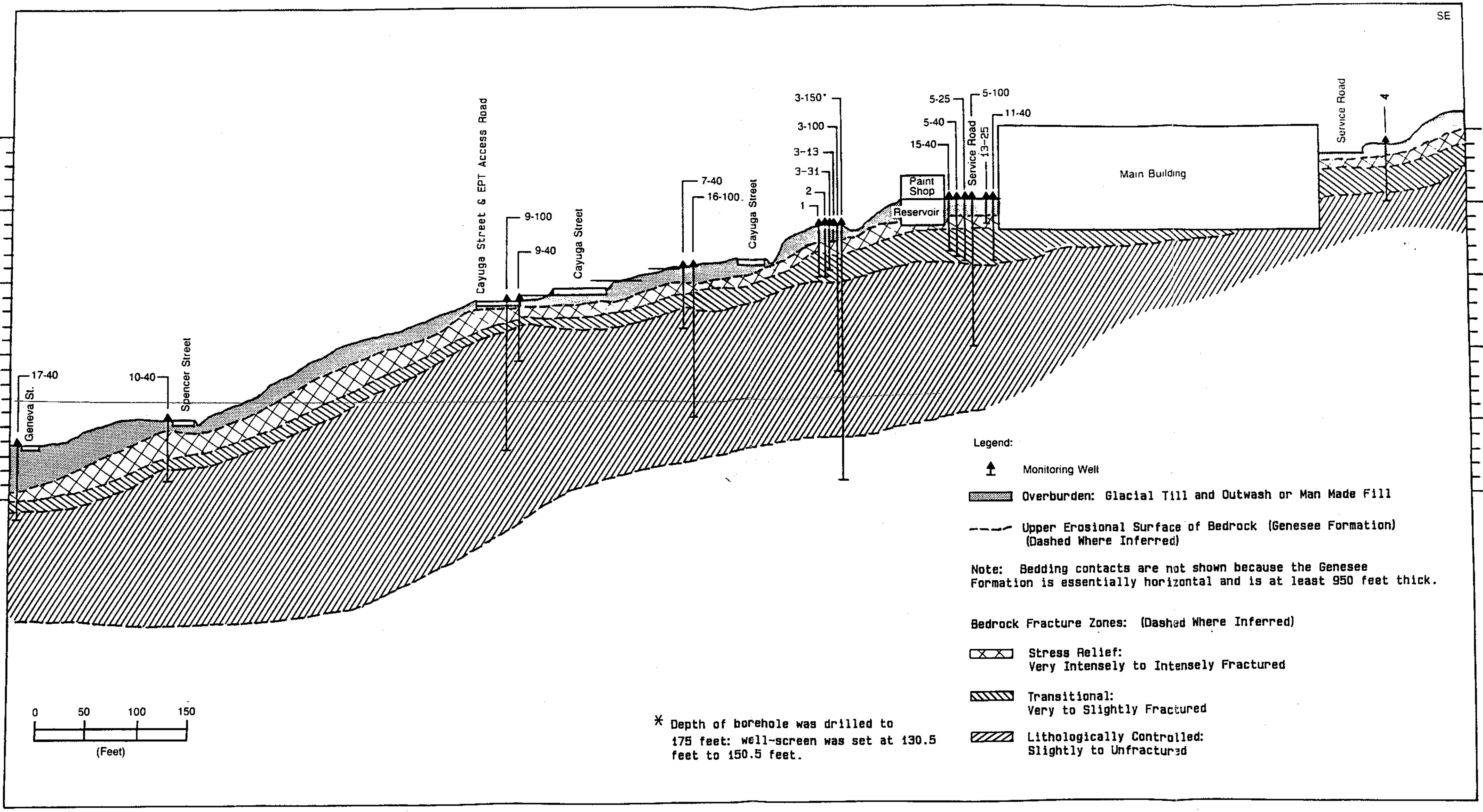
Monitoring Well	Depth of Joint	Comments
MW-1	26.2 - 26.8 ft.	Slightly rough, clean, open
	31.5 - 32.3 ft.	Plumose, clean, open
	34.6 - 35.3 ft.	Calcite closed
MW-2	12.3 - 12.8 ft.	Iron (Fe) stained, open
MW-3-150	11.7 - 11.8 ft.	Fe stained
	12.7 - 12.8 ft.	Fe stained
	14.3 - 14.4 ft.	Fe stained
	15.6 - 16.1 ft.	Smooth, clean, 80°
	17.4 - 18.0 ft.	Rough, clean, 80°
	19.3 - 19.8 ft.	Smooth calcite stain
	21.8 - 23.0 ft.	Smooth, part calcite filled
	36.5 - 37.6 ft.	Closed
	40.1 - 42.1 ft.	Rough, open
	50.0 - 52.0 ft.	Calcite closed
	82.0 - 83.1 ft.	Part calcite filled, 80°
	89.8 - 90.5 ft.	Smooth, part calcite filled, 80°
	130.0 - 130.8 ft.	Part calcite filled, 2-3 mm open
	140.8 - 141.5 ft.	Calcite closed
	146.3 - 147.5 ft.	Calcite closed
	148.3 - 148.6 ft.	Calcite closed
	150.8 - 151.2 ft.	2 parallel 1" apart, smooth, part calcite filled
MW-4	0	
MW-5-40	0	
MW-5-100	15.5 - 15.8 ft.	Smooth (plumose), clean
	17.9 - 19.0 ft.	Rough, clean
	25.4 - 28.5 ft.	Three joints spaced 1.5 inches apart, smooth, part calcite filled
	36.4 - 37.5 ft.	Smooth, part calcite filled
MW-6-40	14.1 - 14.3 ft.	Fe stained, open
	35.0 - 37.0 ft.	Calcite closed

TABLE C-3. SUMMARY OF JOINTS IN ROCK CORES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK (CONTINUED)

Monitoring Well	Depth of Joint	Comments
MW-6-100	20.8 - 22.5 ft.	Smooth, part calcite filled, 80°
	28.0 - 30.2 ft.	Smooth, part calcite filled
	81.2 - 81.8 ft.	Part calcite filled
MW-7-40	19.6 - 20.2 ft.	Calcite closed
	26.4 - 27.1 ft.	Rough, clean, open, 80°
	35.5 - 36.8 ft.	2 parallel 1" apart, plumose, part calcite filled, 85°
	37.4 - 37.9 ft.	Plumose, clean, open, 85°
MW-8-40	42.0 - 43.2 ft.	Rough, clean
MW-9-40	11.2 - 11.3 ft.	Rough, clean
	14.9 - 15.4 ft.	Rough, clean
MW-9-100	4.7 - 4.8 ft.	Fe stained, smooth
	26.2 - 27.0 ft.	Rough, clean
	40.2 - 40.8 ft.	Rough, clean
	46.6 - 46.8 ft.	Rough, clean
	60.0 - 60.5 ft.	Rough, clean
	90.0 - 90.6 ft.	Rough, clean
MW-10-40	6.6 - 6.8 ft.	Fe stained, rough
	19.6 - 19.8 ft.	Smooth, clean
	26.8 - 27.6 ft.	Rough, clean
	27.8 - 28.0 ft.	Rough, clean
	30.0 - 30.1 ft.	Rough, clean
	34.9 - 36.2 ft.	Rough, clean
MW-11-40	27.5 - 30.75 ft.	Clean
MW-13-25	17.1 - 17.3 ft.	Fe stained, 85°
MW-15-40	17.0 - 17.1 ft.	Fe stained
	19.1 - 19.2 ft.	Fe stained
	20.6 - 20.7 ft.	Fe stained
	20.8 - 20.9 ft.	Fe stained
	32.8 - 33.2 ft.	Clean, rough

TABLE C-3. SUMMARY OF JOINTS IN ROCK CORES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK (CONTINUED)

Monitoring Well	Depth of Joint	Comments
MW-16-100	15.2 - 16.9 ft.	Rough, clean, 87°
	47.0 - 47.9 ft.	Planar, closed
	57.6 - 58.8 ft.	3 parallel 1" apart, smooth, part calcite filled, 85°
	63.7 - 64.3 ft.	Plumose, part calcite filled, 85°
	71.5 - 72.5 ft.	Plumose, part calcite filled, 85°
	87.0 - 88.1 ft.	Rough, part calcite filled
	90.4 - 90.6 ft.	Calcite closed
MW-17-40	0	



Note: Bedding contacts are not shown because the Genesee Formation is essentially horizontal and is at least 950 feet thick.

* Depth of borehole was drilled to 175 feet: well-screen was set at 130.5 feet to 150.5 feet.

Figure C-1. Cross-Section Illustrating the Depth of Bedrock Fracture Zones, Emerson Power Transmission, Ithaca, New York

RADIAN CORPORATION

BORING LOGS AND CORE LOGS

BORING WELL # Boring #1 PROJECT Emerson Power Transmission

LOCATION 22 ft. N. of NW corner of loading dock DATES OF DRILLING 7/18/88 - 7/18/88

LOG RECORDED BY W. P. Sugg GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
	0.0 -		3		HNu = 0.0 ppm
0	2.0		7		sample
			16	SANDY GRAVEL:	Oil sheen (-)
-			10	brown, grey, black with	
	2.0 -		7	silty clay and metal slag	HNu = 0.0 ppm
-	4.0		11		sample
			11		Oil sheen (-)
-			11		
			23		
-			11		
	4.0 -		4	(Fill)	HNu = 0.0 ppm
5	6.0		4	- - - - - - - - - - - - - - -	sample
			4		Oil sheen (-)
-	6.0 -		3		HNu = 0.0 ppm
	8.0		44		sample
-			60		Oil sheen (+)
			2		
-	8.0 -		3	SILTY CLAY:	HNu = 0.0 ppm
	10.0		3	grey to brown, soft, wet	sample
-			7	oily sheen	Oil sheen (+)
			3		
10	10.0 -		11	(Fill_	
	11.0		100/1 in.		
-				Auger refusal at 11.0 ft.	
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #2 PROJECT Emerson Power Transmission

LOCATION 28 ft. NW of NE corner of loading dock DATES OF DRILLING 7/19/88 - 7/19/88

LOG RECORDED BY W. P. Sugg GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
	0.0 -		11		
0	2.0		14		
			13	SILTY CLAY:	HNu = 0.0 ppm
-			10	brown, stiff, with gravel	sample
	2.0 -		9	and metal slag	Oil sheen (-)
-	4.0		17		
			14		
-			13		
			6		
-			6		
	4.0 -		19	(Fill)	
5	6.0		5		
			7	GRAVELLY CLAY:	HNu = 0.0 ppm
-	6.0 -		6	black, wet, oily coating	sample
	8.0		4		Oil sheen (+)
-			16		
			17		
-	8.0 -		18	(Fill)	
	9.2		100/2 in.		
-					
				Auger Refusal at 9.2 ft.	
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #3 PROJECT Emerson Power Transmission

LOCATION 26 ft. N of NE corner of loading dock DATES OF DRILLING 7/19/88 - 7/19/88

LOG RECORDED BY W. P. Sugg GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
	0.0 -		6		
0	2.0		6	SANDY SILT:	HNu = 0.0 ppm
			6	brown with gravel, dry	sample
-			5		Oil sheen (-)
			6		
-	2.0 -		21		
	4.0		20	(Fill)	
-			6		
			14		
-	4.0 -		29		
	6.0		12		
5			7		
			12	GRAVELLY CLAY:	HNu = 0.0 - 0.5
-	6.0 -		21	grey to tan, moist, oily	ppm sample
	8.0		13	coating	Oil sheen (+)
-			29		
			21		
-	8.0 -		9	(Fill)	
	10.0		9		
-			10		
10	10.0 -		100/4 in.		
	10.4			Auger Refusal at 10.4 ft.	
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #4 PROJECT Emerson Power Transmission

LOCATION 45 ft. west of B-1 DATES OF DRILLING 7/20/88 - 7/20/88

LOG RECORDED BY W. P. Sugg GROUND SURFACE ELEV. (ft.MSL) ______

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
	0.0 -		6		
0	2.0		14		
			12		
-			19		
			48	GRAVELLY SAND:	
-	2.0 -		57	brown to black with silt	
	4.0		32	and trace clay, metal slag	
-			28		
			12	(Fill)	
-	4.0 -		13		
	6.0		5		
5			6	- - - - - - - - - - - - - - -	
			10		HNu = 0.0 ppm
-	6.0 -		58	GRAVELLY CLAY:	Oil sheen (+)
	7.4		100/4 in.	grey, stiff, wet, oily	
-				coating	
				(Fill)	
-				Auger refusal at 7.4 ft.	
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #5 PROJECT Emerson Power Transmission

LOCATION 40 ft. west of B-4 DATES OF DRILLING 7/20/88 - 7/20/88

LOG RECORDED BY W. P. Sugg GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
	0.0 -		7	GRAVELLY SAND:	Oil sheen (-)
0	2.0		9	dark brown, black, dense,	
			17	dry	
-			17		
			12		
-	2.0 -		11	(Fill)	Oil sheen (-)
	4.0		8		
-			9		
			4		
-	4.0 -		4	GRAVELLY CLAY:	Oil sheen (+)
	6.0		4	grey to tan, medium stiff,	
5			9	moist, no oily coating,	
			16	slight oily odor	
-	6.0 -		23		Oil sheen (+)
	7.7		30	(Fill)	
-			100/2 in.		
				Auger refusal at 7.7 ft.	
-					
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #6 PROJECT Emerson Power Transmission

LOCATION 15 ft. west of loading dock DATES OF DRILLING 7/20/88 - 7/20/88

LOG RECORDED BY W. P. Sugg GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
	0.0 -		17		
0	2.0		24	GRAVELLY CLAY:	
			19	dark brown to black,	Oil sheen (+)
-			12	medium stiff, oily coating	
			100/5 in.		
-	2.0 -			(Fill)	
	2.5				
-					
-				Auger refusal at 4.0 ft.	
5					
-					
-					
-					
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #7 PROJECT Emerson Power Transmission

LOCATION 45 ft. west of loading dock DATES OF DRILLING 7/20/88 - 7/20/88

LOG RECORDED BY W. P. Sugg GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
	0.0 -		5		
0	1.5		11	SILTY CLAY:	
			7	brown, medium stiff, with	HNu = 5.0 ppm
-			100/0 in.	gravel oily coating	sample
					Oil sheen (+)
-				(Fill)	
				Auger refusal at 2.5 ft.	
-					
-					
5					
-					
-					
-					
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #8 PROJECT Emerson Power Transmission

LOCATION Beneath center of loading dock DATES OF DRILLING 7/21/88 - 7/21/88

LOG RECORDED BY W. P. Sugg GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
	0.0 -		8		
0	2.0		21	GRAVELLY SILT:	Oil sheen (-)
			22	black to brown, medium	
-			16	dense, dry	
			10	(Fill)	
-	2.0 -		6		
	3.9		9	SANDY CLAY:	Oil sheen (+)
-			100/4 in.	grey to black, with	
				gravel, wet oily coating	
-					
				Auger refusal at 4.0 ft.	
5					
-					
-					
-					
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #9

PROJECT Emerson Power Transmission

LOCATION Beneath east portion of loading dock

DATES OF DRILLING 7/21/88 - 7/21/88

LOG RECORDED BY W. P. Sugg

GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-45

SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
	0.0 -		13		
0	2.0		18	GRAVEL:	Oil sheen (-)
			14	black to brown with silt	
-			100/5 in.	matrix, no oily coating	
-				Auger refusal at 2.0 ft.	
-					
-					
5					
-					
-					
-					
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #10 PROJECT Emerson Power Transmission

LOCATION Sourth of RR Bridge on Cayuga Street DATES OF DRILLING 7/21/88 - 7/21/88

LOG RECORDED BY W. P. Sugg GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-45 SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
	0.0 -		9		HNu = 1.0 ppm
0	2.0		26	GRAVELLY SAND:	sample
			34	brown to black, medium	Oil sheen (-)
-			18	dense, slight oily coating	
			15		HNu = 1.5 ppm
-	2.0 -		8	(Fill)	sample
	4.0		9		Oil sheen (+)
-			11		
			6		HNu = 1.0 ppm
-	4.0 -		6	- - - - - - - - - - - - - - - -	sample
	6.0		66	GRAVELLY CLAY:	Oil sheen (+)
5			100/4 in.	grey to brown, medium	
				stiff, wet oily coating	
-				Auger refusal a 6.0 ft.	
-					
-					
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #11 PROJECT Emerson Power Transmission

LOCATION 15 ft. south of loading dock DATES OF DRILLING 7/22/88 - 7/22/88

LOG RECORDED BY W. P. Sugg GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-45 SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
	0.0 -		6		HNu = 0.0 sample
0	1.5		11	SANDY GRAVEL:	Oil sheen (-)
			38	brown to black, dense,	
-			100/0 in.	damp	
				(Fill)	
-				Auger refusal at 1.8 ft.	
-					
-					
5					
-					
-					
-					
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #12 PROJECT Emerson Power Transmission

LOCATION 8 ft. from SE corner of loading dock DATES OF DRILLING 7/22/88 - 7/22/88

LOG RECORDED BY W. P. Sugg GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-45 SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
	0.0 -		5	SANDY GRAVEL:	HNu = 0.0 sample
0	1.7		10	dark brown, with clay,	Oil sheen (-)
			12	damp, no oily coating	
-			100/2 in.	(Fill)	
				Auger refusal at 1.7 ft.	
-					
-					
-					
5					
-					
-					
-					
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #13 PROJECT Emerson Power Transmission

LOCATION 7.5 ft. south of RR bridge DATES OF DRILLING 9/12/89 - 9/12/89

LOG RECORDED BY H. Tomich GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-45 Empire soils SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0	0.5 - 2.0		5 7 7	SAND: fine grained, light grey, some coal ash and gravel, loose, dry to moist	
-					
-					
-					
-	3.5 - 5.0			SAND: as above	
5				Bedrock at 5.0 ft. Redrill boring #13 0.85 ft. NNE of original borehole to collect sufficient sample volume	
-					
-					
-					
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #14 PROJECT Emerson Power Transmission

LOCATION 106 ft. west of loading dock DATES OF DRILLING 9/12/89 - 9/12/89

LOG RECORDED BY H. Tomich GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-45 Empire Soils SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0	0.0 - 2.0		3 5 7 13	0.0'-0.7' COAL ASH: dark grey to black, some medium gravel, loose, dry 1.7'-2.0' CLAYEY SILT: tan to brown, trace sand, stiff, dry	
-					
-					
-					
-					
5	5.0 - 7.0		1 3 3 8	SANDY CLAY: fine grained sand, dark grey, some silt, trace gravel, wet	
-					
-	7.0 - 9.0		33 100/4 in.	SANDY CLAY: as above	
-				Bedrock at 7.8 ft.	
-				Redrill boring #14 0.75 ft. NE and 2.0 ft. east of original borehole to collect sufficient sample volume.	
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # Boring #15 PROJECT Emerson Power Transmission

LOCATION 111 ft. west of B-14 DATES OF DRILLING 9/12/89 - 9/12/89

LOG RECORDED BY H. Tomich GROUND SURFACE ELEV. (ft.MSL)

TYPE OF WELL RIG CME-45 Empire Soils SAMPLING INTERVAL (ESTIMATED) Continuous

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0	0.0 - 2.0		3 4 8 25	0.0'-1.0' SILTY CLAY: dark brown, some gravel and organic material, moist	
-					
-				1.0'-2.0' GRAVELLY SAND: coarse grained, dark grey, some clay, loose, wet	
-					
-					
5					
-				Bedrock at 5.0 ft. Redrilling Boring #15 2.0 ft. west of original borehole to collect sufficient sample volume.	
-					
-					
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # MW-1 PROJECT Emerson Power Transmission

LOCATION 60 ft. NE of Fire Reservoir DATES OF DRILLING 4/13/87 - 4/16/87

LOG RECORDED BY D. Holsten GROUND SURFACE ELEV. (ft.MSL) 185.55 (USGS Datum)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) 2.5

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0 - -					
- -	2.5 - 4.5		10 3 4 10	GRAVEL: grey, some silty fine to coarse sand, moist	HNu = 0.0 ppm
5 - -	5.0 - 7.0		4 50/5 in.	GRAVEL: as above (Fill)	HNu = 0.0 ppm
- -	7.5 - 9.5		30 44 7 7	SANDY SILT: brown, some gravel, moist	HNu = 0.0 ppm
10 - -	10.0 - 12.0		15 11 7 12	No Recovery (Fill)	
-	12.5 - 14.5		54 50/3 in. 30/2 in.	SANDY SILT: brown to black, some gravel, moist.	HNu = 2.4 ppm on sample
- 15 - - - - 20				Bedrock at 14.0 ft. Bottom of boring 39.2 ft. Open hole from 19.0 ft. to 39.2 ft.	

CORE LOG

Well #: MW-1
Location: 60 ft NW Tank Corner
ig Type: CME-75
ecorded By: Merin 12 August 1988

Project: EPT
Drilling Date: 13-16 April 1987
Core Barrel Diameter: NX
Land Surface Elevation: 185.55 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
5-							
10-							
VIF 15- VF VIF 0 VIF Fe stn		#1 14.0 to 19.0	95% 85%	48" 60"	5+ 4 5 1 1	Bedding Plane: VIF to 14.6 VF-VIF 17.1; MF to 18.5; VIF to 19.0. Fe stained above 16.7 Inclined: none	SILTSTONE: grey, fresh, very intensely fractured to 14.6; very to very intensely fractured to 17.1; moderately fractured to 18.5; very intensely to 19.0. Fe stained above 16.7. No joints. No fossil beds.
0 20-20.7 0 21.9	FB	#2 19.0 to 22.5	100% 100%	60" 60"	1 0 1 0	Bedding Plane: SF Inclined: none	As above except slightly fractured. BPF @ 20.7 and 21.9. No joints. Fossil beds: 21.7-21.9 Brachiopods & Crinoids
0 24.8 25- 25.5 26.1 0 J		#3 22.5 to 27.5	100% 95%	56" 60"	0 1 1 3 0	Bedding Plane: SF Inclined: vertical clean slightly rough joint 26.2-26.8	As above except one vertical clean slightly rough open joint from 26.2-26.8. No fossil beds.
28.1 28.2 0 30-30.4 0 J		#4 27.5 to 32.2	100% 100%	60" 60"	2 0 1 1	Bedding Plane: SF Inclined: vertical smooth clean plumose open joint 31.5-32.3	As above except one vertical clean smooth plumose open joint from 31.5-32.3. No fossil beds.
32.9 33.1 33.4 34.5 35- 0 36.3 0 J		#5 32.2 to 37.2	100% 100%	100%	2 2 2 1 1 0	Bedding Plane: MF-SF Inclined: vertical calcite filled joint 34.6-35.3	As above except moderately to slightly fractured. One vertical calcite filled (apparently closed) joint from 34.6-35.3'. No fossil beds.
38.0 38.9 40-		#6 37.2 to 39.2	100% 100%	100%	2	Bedding Plane: possible BPF @ 38.0-38.9 Inclined: none	As above except no joints. No fossil beds.
							Coring Terminated @ 39.2

BORING WELL # MW-2 PROJECT Emerson Power Transmission

LOCATION 50 ft. NE of Fire Reservoir DATES OF DRILLING 4/15/87 -4/16/87

LOG RECORDED BY D. Holsten GROUND SURFACE ELEV. (ft.MSL) 183.48 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) 5.0

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					
-					
-					
-	2.5 - 4.5		5 4 5 4	GRAVEL: grey, with black silty, fine to coarse sand, moist	HNu = 1.7 ppm on sample
-					
5				(Fill)	
-					
-					
-	7.5 - 9.5		50/5 in.	CRUSHED BEDROCK:	HNu = 30 ppm at wellhead
-				Bedrock at 8.5 ft. Bottom of boring 38.3 ft. Open hole from 13.5 ft. to 38.3 ft.	
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

CORE LOG

Well #: MW-2
Location: 30 ft NW Tank Corner
ig Type: CME-75
.ecorded By: Merin 12 August 1988

Project: EPT
Drilling Date: 15 April 1987
Core Barrel Diameter: NX
Land Surface Elevation: 183.48 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
-							
-							
-							
-							
5-							
-							
-							
-							
-		#1			12		
10- VIF		8.5	100%		10	Bedding Plane: VIF-VF;	SILTSTONE: grey, fresh, very intensely to intensely
- VF		to	100%		11	Fe stained.	fractured. Vertical Fe stained joint from 12.3-
- Fe stained		13.5			7	Inclined: vertical Fe	12.8. BPF Fe stained to 14.0'. No fossil beds.
-					5	stained joint 12.3-12.8	
-		#2			8		
15-		13.5	100%		9	Bedding Plane: VF	As above except very fractured. No joints. No fossil
- VF		to	100%		8	Inclined: none	beds.
-		18.5			5		
-					6		
-		#3			5		
20-		18.5	100%		0	Bedding Plane: VF-SF	As above except very fractured to 19.0', and
-		to	100%		0	Inclined: none	unfractured below.
-		23.3			1		
-					0		
- 23.9		#4			3		
25- 24.8		23.3	100%		3	Bedding Plane: MF	As above except moderately fractured.
- 25.9		to	100%		2	Inclined: none	
- 26.5 - 27.3		28.3			1		
- 27.6 - 28.9					3		
-		#5			1		
30-		28.3	100%		2	Bedding Plane: MF	As above.
-		to	100%		2	Inclined: none	
-		33.3			3		
-					2		
- 33.8		#6			2		
35- 34.7		33.3	100%		1	Bedding Plane: SF	As above except slightly fractured.
- 35.6		to	100%		1	Inclined: none	
- 36.7 - 37.3		37.3			1		
-							Coring terminated @ 37.3
-							
40-							
-							
-							
-							
-							

BORING WELL # MW-3-13 PROJECT Emerson Power Transmission

LOCATION 40 ft. N of Fire Reservoir DATES OF DRILLING 4/20/87 -4/20/87

LOG RECORDED BY K. Makeig GROUND SURFACE ELEV. (ft.MSL) 183.92 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) 5.0

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					No samples taken from soils. Stratigraphy is from MW-3-31 located 5 ft. away. HNu = 4.2 ppm on cuttings
-					
-					
-				CLAYEY SILT: brown, some sand and gravel, medium stiff, moist to wet (Fill)	
-					
5					
-					
-					
-					
-					
10					
-					
-					
-				Bedrock at 12.7 ft. Bottom of boring at 12.7 ft. Screen from 4.0 ft. to 12.0 ft.	
-					
15					
-					
-					
-					
-					
20					

BORING WELL # MW-3-31 PROJECT Emerson Power Transmission

LOCATION 40 ft. N of Fire Reservoir DATES OF DRILLING 4/17/87 -4/20/87

LOG RECORDED BY D. Holsten GROUND SURFACE ELEV. (ft.MSL) 183.33 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) 5.0

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					
-					
-					
	2.5 -		4	2.5'-3.5' SAND:	HNu = 0.5 ppm on
-	4.5		5	brown, fine to medium	sample
			5	grained, some silt,	
-			6	moist, loose.	
				3.5'-4.0' SLAG	
5				4.0'-4.5' SILT:	
				brown, some sand and	
-				gravel, stiff, moist	
-				(Fill)	
	7.5 -		4	CLAYEY SILT:	HNu = 0.1 ppm at
-	9.5		3	brown, some sand and	sample
			3	gravel, medium stiff,	
-			3	wet	
10				(Fill)	
-					
-					
	12.5 -		5	CLAYEY SILT:	HNu = 0.0 ppm
-	14.5		9	as above	Oil sheen on
			7		split spoon
-			4		
15				(Fill)	
-					
				Bedrock at 16.0 ft.	
-				Bottom of boring at	
				31.0 ft.	
-				Open hole from 21.0 ft. to	
				31.0 ft.	
-					
20					

CORE LOG FOR MW-3-31

SEE LOG FOR MW-3-175

BORING WELL # MW-3-100 PROJECT Emerson Power Transmission

LOCATION 40 ft. N of Fire Reservoir DATES OF DRILLING 7/6/88 -7/8/88

LOG RECORDED BY R. T. Church GROUND SURFACE ELEV. (ft.MSL) 183.83 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) 5.0

1 of 5

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					Samples taken with 2" standard split spoon.
-					
-					
-					
-					
5	5.0 - 6.5		4 5 5	CLAYEY SAND: brown, fine grained, trace angular gravel, loose, moist.	HNu = 8.0 ppm on sample HNu = 0.0 ppm in breathing zone
-					
-					
-				(Fill)	
-					
10	10.0 - 11.5		35 100/4 in.	CLAYEY SAND: brown, fine grained, some angular gravel, medium dense, moist to wet.	HNu = 10 ppm at wellhead HNu = 30 ppm on sample
-					
-					
-				Bedrock at 12.0 ft.	Air rotary
-					
15					
-				12.0-22.0 ft. SILTSTONE: black, medium hard	HNu = 0.0 ppm on sample Rotary is averaging 5 ft./30 min.
-					
-					
-					
20					

BORING WELL # MW-3-100 PROJECT Emerson Power Transmission

LOCATION 40 ft. N of Fire Reservoir DATES OF DRILLING 7/6/88 -7/8/88

LOG RECORDED BY R. T. Church GROUND SURFACE ELEV. (ft.MSL) 183.83 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) 5.0

2 of 5

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
-					
-					
-					
-					
25					
-					
-				22.0'-32.0' SILTSTONE: black, medium hard	HNu = 0.0 ppm on sample 10 ft./60 min.
-					
-					
30					
-					
-				32.0'-42.0' SILTSTONE: black, medium hard	HNu = 0.0 ppm on sample 10 ft./59 min.
-					
-					
35					
-					
-					
-					
-					
40					
-					
-					

BORING WELL # MW-3-100 PROJECT Emerson Power Transmission

LOCATION 40 ft. N of Fire Reservoir DATES OF DRILLING 7/6/88 -7/8/88

LOG RECORDED BY R. T. Church GROUND SURFACE ELEV. (ft.MSL) 183.83 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) 5.0

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
-					
-					
45					
-					
-				42.0'-52.0' SILTSTONE: black, medium hard	HNu = 0.0 ppm on sample 10 ft./58 min.
-					
-					
50					
-					
-				52.0'-62.0' SILTSTONE: black, medium hard	HNu = 0.0 ppm on sample 10 ft./52 min.
-					
-					
55					
-					
-					
-					
-					
60					From 61.0' to 63.0', loss of air pressure in borehole. Much faster drilling with average of 5 in./min.
-					
-					
-					

BORING WELL # MW-3-100 PROJECT Emerson Power Transmission

LOCATION 40 ft. N of Fire Reservoir DATES OF DRILLING 7/6/88 -7/8/88

LOG RECORDED BY R. T. Church GROUND SURFACE ELEV. (ft.MSL) 183.83 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) 5.0

4 of 5

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
-				62.0'-72.0' SILTSTONE: black, medium hard	HNu = 0.0 ppm on sample
65					10 ft./37 min.
-					
-					
-					
-					
70					
-					
-				72.0'-82.0' SILTSTONE: black, medium hard	HNu = 0.0 ppm on sample
-					10 ft./33 min.
-					
75					
-					
-					
-					
-					
80					
-					
-					
-					
-					

BORING WELL # MW-3-100 PROJECT Emerson Power Transmission

LOCATION 40 ft. N of Fire Reservoir DATES OF DRILLING 7/6/88 -7/8/88

LOG RECORDED BY R. T. Church GROUND SURFACE ELEV. (ft.MSL) 183.83 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) 5.0

5 of 5

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
85					
-					
-				82.0'-92.0' SILTSTONE: black, medium hard	HNu = 0.0 ppm on sample 10 ft./40 min.
-					
-					
90					
-					
-				92.0'-100.0' SILTSTONE:	HNu = 0.0 ppm on sample 8 ft./28 min.
-					
-					
95					
-					
-					
-					
-					
100					
-				Bottom of borings 100.0 ft. Screen from 80.0 ft. to 100.0 ft.	
-					
-					
-					

BORING WELL # MW-3-150 PROJECT Emerson Power Transmission

LOCATION 40 ft. N of Fire Reservoir DATES OF DRILLING 8/3/88 -8/12/88

LOG RECORDED BY R. T. Church GROUND SURFACE ELEV. (ft.MSL) 183.87 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) ______

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					No samples taken from soils. Stratigraphy is from MW-3-100 located 6 ft. away.
-					
-					
-					
-					
5				CLAYEY SAND: brown, fine grained,	
-				trace angular gravel, loose to medium dense,	
-				moist	
-				(Fill)	
-				Bedrock at 9.0 ft. Bottom of boring 175.0 ft.	
10				Screen from 150.5 ft. to 130.5.	
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

CORE LOG

Well #: MW-3-175 (MW-3-150)
Location:
ig Type: CME-75
ecorded By: Merin 8 August 1988

Project: EPT
Drilling Date: 3-12 August 1988
Core Barrel Diameter: NX
Land Surface Elevation: 183.87 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
5-							
VIF 10- 9.5 IF 12.8 VF 14.3 Fe stain J J J	#1	#1 9.0 to 14.0	100% 90%	10" 60"	16+ 7 8 7 6	Bedding Plane: VIF-VF Fe stained to 14.7' Inclined: 1" long vert Fe stained @ 11.7; 12.7; 14.3	SILTSTONE grey, fresh, intensely to very fractured. Fe stained to 14.7'. Two inch long vertical joints @ 11.7; 12.6 & 14.3'. No fossil beds.
15- 14.7 0 16.5 IF VF 19.8 20- VF 21.8 IF J J J J	#1	#2 14.0 to 22.7	90% 80%	26" 96"	3 5 6 7 9 9 3 4 6	Bedding Plane: IF - VF Fe stained to 14.7' Inclined: @ 15.6 - 16.1 smooth 80° @ 17.4 - 18.1 rough 80° @ 19.3 - 19.8 smooth vert @ 21.8 - 21.8 smooth vert	As above except joints occur @: 15.6 - 16.0: clean smooth 80° dip 17.4 - 18.0: clean rough 80° dip 19.3 - 19.8: calcite stain smooth vertical 21.8 - 22.8: calcite stain smooth vertical Fossil beds: @ 20.5 - 20.6: Brachiopods & Crinoids @ 21.2 - 21.3: ditto
23.0 25- 0 0 27.1 0 28.1	#1+2	#3 22.7 to 29.0	100% 100%	76" 76"	0 0 1 0 1 1	Bedding Plane: none except possible @ 27.7; 28.1' Inclined: 21.8-23.0 part calcite filled vert smooth	As above except unfractured except for possible BPF @ 27.7 & 28.1' and vertical joint from 21.8 to 23.0' No fossil beds.
29.5 30- 0 30.0 32.1 33.3 34.3 35- 0 36.0 0 J	#2	#4 29.0 to 39.0	100% 100%	120" 120"	1 1 0 1 2 1 0 2 2 0	Bedding Plane: SF; all clean. Inclined: 36.5-37.6' vert, calcite closed	As above except slightly fractured. One vertical joint from 36.5 - 37.6' calcite filled closed. No fossil beds.
40- 5-	#2+3	#5 39.0 to 49.0	100% 90%	114" 120"	0 1 1 1 0 0 0 0	Bedding Plane: none to 48.5 VIF btw 48.5 - 48.8' Inclined: 40.1-42.1' rough open irregular trace	As above except unfractured to 48.5; very intensely fractured between 48.5 - 48.8'; one joint from 40.1 to 42.1'. The joint has an irregular trace & rough open face. No fossil beds.

CORE LOG

Well #: MW-3-175 (MW-3-150)
Location:
Rig Type: CME-75
Recorded By: Merin 9 August 1988

Project: EPT
Drilling Date: 3-12 August 1988
Core Barrel Diameter: NX
Land Surface Elevation: 183.87 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
VIF					0 7		
50- J 55- 55.4 FB	#3	#6 49.0 to 59.0	100% 100%	119" 120"	0 1 1 0 0 0 1 2 0 0	Bedding Plane: none except 55.4; 56.6; 56.7'. All clean. Inclined: 50.0 - 52.0 vert calcite closed	As above unfractured except for BPF @ 55.4; 56.6; & 56.7' and one vertical calcite filled closed joint from 50.0 to 52.0'. Fossil beds: @ 56.5 - 56.6: Crinoids
60- FB 55- 67.3	#4	#7 59.0 to 69.0	100% 100%	120" 120"	0 0 0 0 0 0 0 0 1 0	Bedding Plane: none except possible @ 67.3' Inclined: none	As above unfractured except 1 possible BPF @ 67.3' and no joints. Fossil beds: @ 62.3 - 62.4: borrows
70- 74.4 75- VIF 78.1	#4 + 5	#8 69.0 to 79.0	100% 100%	120" 120"	0 0 0 0 0 1 0 4 4 2	Bedding Plane: none except possible @ 74.4; 78.1; 78.2'; and VIF btw 76.9 to 77.5' Inclined: none	As above unfractured except possible BPF @ 74.4;78.1; 78.2' and very intensely fractured between 76.9 & 77.5'. No joints. No fossils beds.
80- J FB 85-	# 5	#9 79.0 to 89.0	100% 100%	120" 120"	0 0 0 1 1 0 0 0 0 0	Bedding Plane: none Inclined: part calcite fill 80°dip planar	As above unfractured except for one partially calcite filled joint dipping 80°from 82.0 to 83.1'. Fossil beds: 84.8 - 85.0 borrows

CORE LOG

Well #: MW-3-175 (MW-3-150)
Location:
ig Type: CME-75
ecorded By: Merin 9 August 1988

Project: EPT
Drilling Date: 3-12 August 1988
Core Barrel Diameter: NX
Land Surface Elevation: 183.87 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
90- 0	FB	#10			|		
- 90.7 J		89.0	100%	120"	|	Bedding Plane: none except	As above unfractured except for BPF @ 90.8 & 94.9' &
-	#6	to	100%	120"	0	@ 90.7; 94.9	one 80° dipping joint from 89.8 - 90.5'. The joint
- 0		99.0			0	Inclined:	has a partially calcite filled smooth face & planar
-					0	89.8 - 90.5: part calcite	trace.
95- 94.9					/	filled planar smooth	Fossil beds:
-					0		89.1 - 89.3 Crinoids
- 0					0		
-					0 0		
100-		#11			0 0		
-		99.0	100%	120"	0	Bedding Plane: none	As above except unfractured. No fossil beds
- 0	#7	to	100%	120"	0	Induced: none	
-		109.0			0		
-					0		
105-					0		
-					0		
-					0		
-					0 0		
110-		#12			0		
-	#8	109.0	100%	120"	0 0	Bedding Plane: none	As above
- o		to	100%	120"	0	Inclined: none	
-		119.0			0		
-					0		
115-					0		
-					0		
-					0		
-					0		
120-		#13			0		
- o	#8	119.0	100%	60"	0	Bedding Plane: none	As above
-		to	100%	60"	0	Inclined: none	
-		125.0			0		
-					0 0		
125-							
- o		#14			0		
-	#9	125.0	100%	120"	0	Bedding Plane: none except	
-		to	100%	120"	0	@ 129.5 part calcite fill	
-		135.0			0	@ 131.0 - 131.1 VIF	

CORE LOG

Well #: MW-3-175 (MW-3-150)
Location:
Rig Type: CME-75
Recorded By: Merin 10 August 1988

Project: EPT
Drilling Date: 5 August 1988
Core Barrel Diameter: NX
Land Surface Elevation: 183.87 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
130 (129.5 J) VIF					1 1 2 0 0 0	Inclined: 130.0 - 130.8 vert part calcite fill, open	As above unfractured except BPF at 129.5; very intensely BPF fractured between 131.0 - 131.1 and one partially calcite filled joint from 130.0 - 130.8'. The BPF @ 129.5 is partially calcite filled with open porosity. The joint 2 -3 mm open porosity. No fossil beds.
135 140 J	#9	#15 135.0 to 145.0	100% 100%	120" 120"	0 0 0 0 0 1 1 0 0 0	Bedding Plane: none Inclined: 140.8 - 141.5 vert calcite closed	As above unfractured except one vertical calcite filled closed joint from 140.8 - 141.5'. No fossil beds.
145 (145.5 J) J 150 JJ	#10	#16 145.0 to 155.0	100% 100%	120" 120	1 1 1 1 0 2 2 0 0 0	Bedding Plane: one part calcite filled @ 145.5' Inclined: 146.3 - 147.5 148.3 - 148.6 150.8 - 151.1	As above unfractured except one partially calcite filled BPF @ 145.5' and three parallel joints dipping at 87 . No fossil beds. Joints: 146.3 - 147.5: calcite filled closed, linear trace 148.3 - 148.6: ditto 150.8 - 151.2: two parallel joints 1 " apart, each has smooth planar partially calcite filled face
155 160	#11	#17 155.0 to 165.0	100% 100%	120" 120	0 0 0 0 0 0 0 0 0 0	Bedding Plane: none Inclined: none	As above except unfractured

CORE LOG

Well #: MW-3-175 (MW-3-15C)
Location:
ig Type: CME-75
ecorded By: Merin 11 August 1988

Project: EPT
Drilling Date: 3-12 August 1988
Core Barrel Diameter: NX
Land Surface Elevation: 183.87 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
165							
					0		
	#11				0		
	+						
	12	#18			0		
		165.0	100%	120"	0	Bedding Plane: none	As above
170		to	100%	120"	0	Inclined: none	
		175.0			0		
					0		
					0		
					0		
					0		
175							
							Coring Terminated @ 175.0

BORING WELL # MW-4 PROJECT Emerson Power Transmission

LOCATION Upgradient of facility DATES OF DRILLING 4/21/87-4/22/87

LOG RECORDED BY K. Makeig GROUND SURFACE ELEV. (ft.MSL) 240.62 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) ________

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					
-					
-					
	2.5 -		25	SAND:	HNu = 0.0 ppm
-	4.5		37	brown, fine to medium	
			33	grained, some coarse	
-			23	gravel, some silt, some	
				silt, dense, dry	
5					
				(Fill)	
-				Bedrock at 6.0 ft.	
				Augered 1.0 ft. into	
-				bedrock.	
				Bottom of boring 42.0 ft.	
-				Open hole from 12.0 ft. to	
				42.0 ft.	
-					
				Deepened to 47.0 ft. on	
10				8/10/89	
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

CORE LOG

Well #: MW-4
Location: Upgradient
ig Type: CME-75
ecorded By: Merin 19 July 1988

Project: EPT
Drilling Date: 21 April 1987
Core Barrel Diameter: NX
Land Surface Elevation: 240.62 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
5-							
Fe Stn 10- IF		#1 7.0 to 12.0	100% 85%	4" 60"	12 13 5 7 5	Bedding Plane: IF, medium rough, slight Fe stain to 8.2' Inclined: none	SILTSTONE: grey, fresh, intensely fractured. Slight Fe stain to 8.2'. No joints. Fossil beds: 9.2-9.3' Brachiopods & Crinoids 11.8-11.9 ditto
FB 15- VF FB		#2 12.0 to 17.0	100% 100%	19" 60"	5 6 2 3 2	Bedding Plane: IF above 14.0 and VF below Inclined: none	As above except intensely fractured above 14.0 and very fractured below. No joints. Fossil beds: 14.8-15.0 Brachiopods & Crinoids 16.2-16.3 ditto
17.6 18.7 20- 19.8 20.1 21.2 21.6		#3 17.0 to 22.0	100% 95%	49" 60"	1 2 1 2 2	Bedding Plane: MF Inclined: none	As above except moderately fractured. Fossil beds: none
FB 0 24.8 25- 0 26.5		#4 22.0 to 27.0	100% 100%	60" 60"	0 0 1 0 1	Bedding Plane: SF; 24.8, 26.5 Inclined: none	As above except slightly fractured. No joints. Fossil beds: 22.0-22.2 Brachiopods & Crinoids
27.5 28.8 0 29.7 30- 29.8 FB 0		#5 27.0 to 32.0	100% 100%	60" 60"	2 1 2 0 0	Bedding Plane: SF to 29.8 none below Inclined: none	As above except slightly fractured to 29.8 and unfractured below. No joints. Fossil beds: 29.7-29.8 Brachiopods & Crinoids
33.5 35- 0		#6 32.0 to 37.0	100% 100%	60" 60"	0 1 0 0 0	Bedding Plane: none except possible BPF @ 33.5 Inclined: none	As above one possible BPF @ 33.5. No joints. Fossil beds: none
40-		#7 37.0 to 42.0	100% 100%	60" 60"	0 0 0 0 0	Bedding Plane: none Inclined: none	As above except unfractured. Fossil beds: none
							Coring Terminated @ 42.0

BORING WELL # MW-5-25 PROJECT Emerson Power Transmission

LOCATION Upgradient of fire reservoir DATES OF DRILLING 7/18/88-7/18/88

LOG RECORDED BY W.P. Sugg GROUND SURFACE ELEV. (ft.MSL) 205.87 (USGS DATUM)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) 4.5

Depth	Sample Depth (feet)	Sampl^ Number	Blow Counts	Description	Remarks
				10-inch concrete pad	
0					
-	1.0 -		2	SILTY CLAY:	HNu = 0.0 ppm
	2.5		3	grey to brown, stiff	
-			4	angular gravel, moist	
-					
-	4.5 -		3	GRAVEL:	HNu = 0.0 ppm
	6.0		7	grey, loose with silty	
5			3	clay matrix	
-					
				(Fill)	
-					
-					
-					
	9.5 -		5	SILTY CLAY:	
10	11.0		7	brown, very stiff with	
			10	angular gravel, moist	
-					
				Bedrock at 11.5 ft.	
-				Bottom of boring 11.9 ft.	
				Screen from 11.6 ft. to	
-				36.0 ft.	
-				36.0 ft.	
15					
-					
-					
-					
-					
20					

BORING WELL # MW-5-40 PROJECT Emerson Power Transmission

LOCATION Upgradient of fire reservoir DATES OF DRILLING 7/12/88-7/14/88

LOG RECORDED BY W.P. Sugg GROUND SURFACE ELEV. (ft.MSL) 205.86 (USGS DATUM)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) 4.5

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
				10-inch Concrete Pad	
0					
-	1.0 -		2	SILTY CLAY:	HNu = 0.0 ppm on
	2.5		3	grey to brown, stiff,	sample
-			12	some angular gravel,	HNu = 0.0 ppm at
				moist	wellhead
-					
				(Fill)	
-					
	4.5 -		3	GRAVEL:	
5	6.0		3	grey, loose with silty	HNu = 0.0 ppm on
			5	clay matrix	sample
-					HNu = 0.0 ppm at
					wellhead
-					
				(Fill)	
-					
-					
	9.5 -		4	SILTY CLAY:	HNu = 0.0 at
10	11.0		6	brown, very stiff, with	wellhead
			11	subangular gravel,	HNu = 1.0 on
-				moist	sample
-					
				Bedrock at 12.3 ft.	
-				Bottom of boring 40.3 ft.	
				Open hole from 17.3 ft. to	
-				40.3 ft.	
15					
-					
-					
-					
-					
20					

CORE LOG

Well #: MW-5-40
Location: Uphill from Fire Reservoir
Rig Type: CME-55 and CME-75
Recorded By: Merin 18 July 1988

Project: EPT
Drilling Date: 13-14 July 1988
Core Barrel Diameter: NX
Land Surface Elevation: 205.86 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
5- 10-							
15- Fe stain FB=		#1 12.3 to 17.3	100% 95%	11" 60"	6 10 8 11 11 11	Bedding Plane: VF-VIF, some Fe stained Inclined: none	SILTSTONE: grey, fresh, very to very intensely fractured. BPF have rough faces, and slight Fe stain. No joints. Fossil bed @ 15.5' to 15.6': dissolved brachiopods.
20-VIF to VF FB FB 25- FB 26.2		#2 17.3 to 27.3	100% 100%	33" 120"	4 8 5 6 4 6 4 5 2 3	Bedding Plane: as above, Fe staining extends to 18.3' Inclined: none	As above except: BPF faces are rough to slightly rough, Fe stained to 18.3'. Fossil beds @ : 22.3' to 22.6' Brachiopods + Crinoids 23.3' to 23.6' Brachiopods 25.0' to 25.2' Brachiopods
VF MF 30- 30.3 MF 35-		#3 27.3 to 37.3	100% 100%	77" 120"	2 5 3 3 6 2 1 1 2 1	Bedding Plane: VF-MF, clean Inclined: none	As above except: 27.3 to 30.3' very to moderately fractured 30.0' to 37.3' moderately fractured BPF slightly rough faces Fossil beds: none
VF MF 40-		#4 37.3 to 40.3	100% 100%	33" 36"	2 1	Bedding Plane: VF-MF Inclined: none	As above except:

BORING WELL # MW-5-100 PROJECT Emerson Power Transmission

LOCATION Upgradient Fire Reservoir DATES OF DRILLING 8/7/89 - 8/13/89

LOG RECORDED BY R. T. Church GROUND SURFACE ELEV. (ft.MSL) 587.42 ft. (USGS)

TYPE OF WELL RIG CME-75 Empire Soils

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0				12 inch concrete pad (Fill)	Grab samples
-				SILTY CLAY: grey to brown, some	HNu = 0.0 ppm on sample
-				angular coarse gravel, moist.	
-					
-					Silty clay to approx. 4.0 ft.
5				GRAVEL: grey, loose with clayey	HNu = 0.0 ppm
-				matrix.	on sample
-				(Fill)	
-					
-				(Fill)	Gravel to approx. 9.0 ft.
10				SILTY CLAY: brown, some angular	HNu = 1.5 ppm
-				coarse gravel, moist	on sample
-				Bedrock at 12.0 ft.	
-				Bottom of boring 100.0 ft. Screen from 79.0 ft. to	
-				99.0 ft.	
15					
-					
-					
-					

CORE LOG

Well #: MW-5-100
Location: Upgradient of Reservoir
ig Type: CME-75
ecorded By: Merin

Project: EPT
Drilling Date: 8 August 1989
Core Barrel Diameter: NX
Land Surface Elevation: 587.42 ft. MSL
1 of 3

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
5- 10-							Rock @12.0 ft.
VIF to VF J J 15-	#1	#1 12.0 to 14.5	100% 86%	0.0 3.0	10 9 8	BPF: VIF-IF Joints: 2 parallel, smooth, plumose 13.2-14.2, less inch spaced.	SILTSTONE: grey, fresh; very intensely to intensely fractured; 2 parallel joints 13.7-14.2: smooth plumose;
J J IF J J 20- BPF — BPF — BPF	#1	#2 14.5 to 23.0	100% 100%	13 102	8 6 6 4 5 1 1	BPF: VIF-IF to 15.3 IF to 20.2 BPF @ 21.6, 22.5 Joints 15.5-15.8, rough, clean 17.9-19.0 plumose, clean	As above except intensely fractured to 20.2; moderately fractured below. Joints @ 15.5-15.8, plumose clean and 17.9-19.0 rough clean.
— BPF 25- J NO BPF J 30- BPF BPF BPF BPF	#1 + #2	#3 23.0 to 33.0	100% 100%	70 120	0 1 3 3 2 2 2 2 1 2	BPF: VF to MF Joints: 4 parallel joints 25.4-28.5 smooth, partially filled each spaced 1-2 inches.	As above except very to moderately fractured; with 4 parallel joints spaced 1-2 inches, smooth, partially calcite filled.
BPF BPF 35- BPF J J BPF 40- NONE	#2 + #3	#4 33.0 to 43.0	100% 100%	120 120	3 3 1 1 1 1 0 0 0	BPF: mostly induced except for possibly 33.2, 34.6, 35.2, 36.7, 37.8, 38.6. Joints: 36.4 to 37.5 part calcite filled, smooth.	As above except moderately fractured.

Coring Log EPT
0928-03.bjg.2

CORE LOG

Well #: MW-5-100
Location: Upgradient of Reservoir
Rig Type: CME-75
Recorded By: Merin

Project: EPT
Drilling Date: 8 August 1989
Core Barrel Diameter: NX
Land Surface Elevation: 587.42 ft. MSL
2 of 3

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
-					0		
					0		
- NONE	#3	#5	100%	120	0	BPF:	As above except unfractured except for two fissil
45- Fissil		43.0	100%	120	/	Fissil zone	zones @ 45.4 and 46.8. No joints.
-		to			/	@ 45.5 @ 46.8	
- Fissil		53.0			0		
-					0	Joints: None	
-					0		
50- NONE					0		
-					0		
-					0		
					0		
-	#4	#6			0	BPF: None	As above except unfractured.
55-		53.0	100%	120	0		
-		to	100%	120	0	Joints: None	
-		63.0			0		
-					0		
-					0		
60-					0		
-					0		
-					0		
					0		
-	#4	#7	100%	120	0	BPF: all induced except	As above: unfractured except for possible bedding
65- NONE	+	63.0	100%	120	0	possible @ 72.1, 72.5.	plane fractures at 72.1, 72.5; no joints.
-	#5	to			0		
-		73.0			0		
-					0	Joints: None.	
-					0		
70-					0		
-					0		
- =BPF?					2		
-					0		
-	#5	#8	100%	120	0	BPF: all induced except	As above: unfractured except for possible bedding
75- NONE	+	73.0	100%	120	0	fissil zone @ 79.26.	plane fractures (fissil zone) @ 79.2; no joints.
-	#6	to			0		
-		83.0			0		
-					0	Joints: None.	
- =Fissil					2		
80-					0		
-					0		
-					0		
- NONE					0		

CORE LOG

Well #: MW-5-100
Location: Upgradient of Reservoir
`ig Type: CME-75
.ecorded By: Merin

Project: EPT
Drilling Date: 8 August 1989
Core Barrel Diameter: NX
Land Surface Elevation: 587.42 ft. MSL

3 of 3

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
85- ^					0		
-					0		
-	#6	#9	100%	120	0	BPF: all induced except	As above: unfractured except possible BPF @ 91.3
- NONE		83.0	100%	120	0	possible BPF @ 91.3 and	and 91.6.
-		to			0	91.6.	
90- v =BPF		93.0			0		
- ^					0	Joints: None	
- NONE					2		
					0		
-					0		
95- v =BPF					0		
-BPF ^					3		
-	#7	#9	100%	120	1	BPF: possible @ 95.1,	As above: unfractured except possible bedding
- NONE		93.0	100%	120	0	95.3, 95.6, 96.8	plane fractured 95.1, 95.3, 95.6, and 96.8; no
-		to			0		joints.
100- v		100			0	Joints: None	
-							
-							
-							
-							Coring terminated @ 100.0 ft.
105-							
-							
-							
-							
-							
110-							
-							
-							
-							
-							
115-							
-							
-							
-							
-							
120-							
-							
-							
-							
-							
125-							
-							

BORING WELL # MW-6-25 PROJECT Emerson Power Transmission

LOCATION 20 ft. North of loading dock DATES OF DRILLING 7/13/88-7/14/88

LOG RECORDED BY R.T. Church GROUND SURFACE ELEV. (ft.MSL) 178.91 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) 4.5

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					Samples taken with 2" standard split spoon.
-					
-					
-					
-					
5	4.5 - 6.0		4 4 9	SANDY SILT: brown to black with iron stains, some angular coarse gravel, dry	HNu = 0.0 ppm wellhead HNu = 0.0 ppm breathing zone HNu = 0.6 ppm sample
-					
-					
-				(Fill)	
-	9.0 - 10.5		2 3 100/2 in.	GRAVEL: fine grained, angular, wet, black, tar-like coating	HNu = 4.0 ppm sample HNu = 0.0 ppm wellhead
10					
-				Bedrock at 11.0 ft. Bottom of boring 11.0 ft. Screen from 4.0 ft. to 11.0 ft.	
-					
-					
-					
15					
-					
-					
-					
-					
20					

BORING WELL # MW-6-40 PROJECT Emerson Power Transmission

LOCATION 20 ft. North of loading dock DATES OF DRILLING 7/6/88-7/11/88

LOG RECORDED BY W.P. Sugg GROUND SURFACE ELEV. (ft.MSL) 180.44 (USGS DATUM)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) 5.0

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					Samples taken with 2" standard split spoon
-					
-					
-					
-					
5	5.0 - 6.5		5 3 8	SANDY SILT: tan to grey, some gravel, stiff, dry	HNu = 0.0 ppm wellhead HNu = 0.5 ppm sample
-					
-				(Fill)	
-					
-					
10	10.0 - 11.5		3 5 8	SILTY CLAY: tan to grey, some fine gravel, stiff, moist	HNu = 0.5 ppm sample HNu = 6.0 ppm wellhead
-					
-					
-					
-				Bedrock at 13.2 ft. Bottom of boring 38.9 ft. Open hole from 18.9 ft. to 38.9 ft.	
15					
-					
-					
-					
-					
20					

CORE LOG

Well #: MW-6-40
Location: West of RR Bridge
ig Type: CME-55
ecorded By: Merin 19 July 1988

Project: EPT
Drilling Date: 6-11 July 1988
Core Barrel Diameter: NX
Land Surface Elevation: 180.44 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
-							
-							
-							
-							
5-							
-							
-							
-							
-							
10-							
-							
-							
-							
VIF Fe Stn FB							
15- VF		#1			7	Bedding Plane: VIF-VF:	SILTSTONE: grey, fresh, very intensely to very
-		13.9	100%	29"	6	13.9-16.2 VIF	fractured. BPF slight rough. One joint from 14.0-
- IF		to	100%	60"	6	16.2-18.9 IF-VF	14.3'. Fe stain to 14.4'. Fossil bed 14.4-14.5:
- VF		18.9			4	Fe stained to 14.4'	dissolved Brachiopods.
FB FB FB					2	Inclined: vertical Fe	
20-		#2			2	stained 14.0-14.3	
-		18.9	100%	26"	5	Bedding Plane: IF-VF	As above except: intensely to very fractured.
-		to	100%	60"	4	Inclined: none	Fossil beds: 19.0-19.3 Brachiopods
- IF		23.9			2		19.4-19.5 Crinoids
-					2		19.7-19.9 Brachiopods
25-		#3			3		
- VF IF		23.9	100%	24"	3	Bedding Plane: as above	As above
-		to	100%	60"	3	Inclined: none	Fossil beds: none
- IF		28.9			3		
-					1		
-					2		
30- VF		#4			2		
-		28.9	100%	38"	2	Bedding Plane: VF-MF	As above except very to moderately fractured.
-		to	100%	60"	2	Inclined: none	Fossil beds: none
- MF		33.9			1		
-					3		
35- VF J		#5			3		
-		33.9	100%	54"	3	Bedding Plane: as above	As above except one vertical joint from 35.0-37.0
- MF		to	100%	60"	1	Inclined: vertical 35.0-	apparently closed by calcite fill.
- VF		38.9			2	37.0, calcite filled	Fossil beds: none
40-							Coring Terminated @ 38.9
-							
-							
-							
-							

BORING WELL # MW-6-100 PROJECT Emerson Power Transmission

LOCATION 20 ft. North of loading dock DATES OF DRILLING 7/18/88-7/22/88

LOG RECORDED BY R.T. Church GROUND SURFACE ELEV. (ft.MSL) 179.74 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) 5.0

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					
-					
-					
-					
-					
5	5.0 - 6.0		8 14 12	SILTY SAND: brown, medium grained, medium dense to dense, some fine angular gravel, wet (Fill)	HNu = 0.0 ppm sample HNu = 0.0 ppm breathing zone
-					
-					
-					
-					
10	10.0 - 11.5		7 8 15	CLAYEY SAND: greyish-black, fine grained, medium dense to dense, trace angular gravel, wet	HNu = 0.0 ppm sample HNu = 0.0 ppm
-					
-					
-				Bedrock at 11.5 ft. Bottom of boring 100.0 ft. Screen from 79.5 ft. to 99.5 ft.	
-					
15					
-					
-					
-					
-					
20					

CORE LOG

Well #: MW-6-100
Location: West of RR Bridge
ig Type: CME-75
ecorded By: Merin 19 July 1988

Project: EPT
Drilling Date: 18-22 July 1988
Core Barrel Diameter: NX
Land Surface Elevation: 179.74 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
-							
-							
-							
-							
5-							
-							
-							
-							
-							
10-							
-							
- Fe Stain —12.9					8		
-		#1			8		
- IF	#1	11.5	100%	57"	11	Bedding Plane: IF to 15.3;	SILTSTONE grey, fresh, intensely fractured to 15.3;
15-		to	95%	120"	8	VF - MF to 21.5;	very to moderately fractured to 21.5. Fe stained
-		21.5			2	Fe stained to 12.9	BPF to 12.9'. One 80°dipping slight calcite coated
- VF					5	Inclined: 80 dipping,	smooth joint from 20.8 - 22.5'. No fossil beds.
- MF					1	slight calcite coated,	
-					4	smooth joint 20.8-22.5	
20- J					3		
-					1		
-					6		
-	#1	#2			2		
- VF		21.5	87%	45"	3	Bedding Plane: VF - MF	As above except very to moderately fractured. One
25- MF		to	70%	103"	2	VF (probably induced)	vertical joint slight calcite coated smooth face
-		30.2			2	from 29.0 - 30.3	from 28.0 to 30.2. BPF are clean. No fossil beds.
-					4	All BPF are clean	
- J					4	Inclined: Vertical slight	
- VF					8	calcite coated, smooth	
30-					6	joint 28.0 to 30.2	
-					2		
-		#3			2		
- MF	#2	30.2	100%	68"	1	Bedding Plane: MF	As above except MF. No joints. No fossil beds.
-		to	100%	76"	2	clean.	
35-		36.5			1	Inclined: none	
-					1		
-					1		
-		4			1		
- VF	#2	36.5	100%	97"	2	Bedding Plane: VF to 42.0;	As above except very fractured to 42.0; moderately
40-		to	99%	120"	3	MF to 44.8; VF to 46.5'.	fractured to 44.8; very fractured to 46.5'. No
-		46.5			3	Clean.	joints. No fossil beds.
-					2	Inclined: none	
- MF —43.2					1		
-					0		

CORE LOG

Well #: MW-6-100
Location: West of RR Bridge
ig Type: CME-75
ecorded By: Merin 20 July 1988

Project: EPT
Drilling Date:
Core Barrel Diameter: NX
Land Surface Elevation: 179.74 (USGS)

			%		FRACTURE	ORIENTATION SPACING	
DEPTH	BOX	RUN	RECOVERY	RQD	FREQUENCY	FILLING	LITHOLOGY COLOR WEATHERING
45- VF					4		
-					3		
- 47.2					1		
- 47.6	#2	#5			1		
- 49.2	+	46.5	100%	102"	1	Bedding Plane: MF - SF to	As above except moderately to slightly fractured to
50- 49.7 50.1 FB	3	to	100%	120"	2	51.4; IF to 52.4; MF to	51.4; very fractured to 52.4; moderately fractured
-		56.5			3	55.6'. Clean	to 55.6'; unfractured below. All BPF clean. No
- IF					5	Inclined: none	joints. Fossil beds:
- o FB					0		49.0 - 49.1
- 54.3 FB					1		52.5 - 52.6
55- 54.7 54.6					2		53.5 - 53.6
- 55.6					1		
- o					0		
-		#6			0		
- 58.5		56.5	100%	111"	1	Bedding Plane: none to 58.6	As above except slightly to unfractured to 63.9';
60-	#3	to	100%	120"	0	none to 63.9; VF to 64.9;	very fractured between 63.9 and 64.9; unfractured
- o		66.5			0	none below.	below. No joints. No fossil beds.
-					0	Inclined: none	
-					0		
- 63.9 VF					2		
65- 64.9					2		
- o					0		
-					0		
-		#7			0		
- o	#4	66.5	100%	117"	0	Bedding Plane: none except	As above except unfractured except for BPF @ 72.3 &
70-		to	100%	120"	0	possible BPF @ 72.3; 72.5	72.5'. No joints.
-		76.5			0	Both are clean.	Fossil beds @ 72.3 - 72.4 Brachiopods & Crinoids.
- 72.3					0	Inclined: none	
- 72.5 FB					2		
-					0		
75- o					0		
-					0		
-					0		
-	#4	#8			0		
-	+	76.5	100%	76"	4	Bedding Plane: none to 78.8	As above except unfractured to 78.8'; very intensely
80- VIF	5	to	100%	120"	3	VIF to 80.3;none to 81.2;	fractured to 80.3'; unfractured to 81.2'; very
- o J		86.5			0	VF to 84.3; none below.	fractured to 84.3'; unfractured below. BPF are
-					6	All BPF are clean.	clean. One partially calcite filled joint from 81.2
- VF					4	Inclined: partially calcite	to 81.8'. No fossil beds.
-					3	filled vertical joint 81.2	
85- o					0	to 81.8'.	

CORE LOG

Well #: MW-6-100
Location: West of RR Bridge
ig Type: CME-75
ecorded By: Merin 20 July 1988

Project: EPT
Drilling Date: 18-22 July 1988
Core Barrel Diameter: NX
Land Surface Elevation: 179.74 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
0					0		
		#9			0		
FB		86.5	100%	120"	0	Bedding Plane: none except	As above except unfractured except for clean BPF @
90	#5	to	99%	120"	0	@ 91.3'; 91.4'; 95.3';	91.3'; 91.4'; 95.3' 95.4'. No Joints.
91.3 91.4		96.5			0	95.4'	
					2	Inclined: none	
					0		Fossil beds:
0 FB					0		88.7 - 88.8' Brachiopods & Crinoids
95 95.3					2		94.2 - 94.4' ditto
95.4		#10			0		
0	#5	96.5	100%	42"	0	Bedding Plane: none except	As above: unfractured except for slightly calcite
		to	97%	42"	0	99.4; 99.5. Slightly	stained BPF at 95.4 & 95.5'. No joints. No fossil
99.4 99.5		100.			0	calcite stained.	beds.
100					2	Inclined: none	
							Coring Terminated at 100.0 ft

BORING WELL # MW-7-40 PROJECT Emerson Power Transmission

LOCATION NYSEG property DATES OF DRILLING 7/28/88-7/29/88

LOG RECORDED BY R.T. Church GROUND SURFACE ELEV. (ft.MSL) 150.01 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) 5.0

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					
-					
-					
-					
-					
5	5.0 - 6.5		6 9 9	SILTY SAND: black, medium grained, trace fine angular gravel, medium dense, dry	HNu = 0.0 ppm sample
-					
-					
-				(Fill)	
-					
10	10.0 - 11.5		20 17 17	SILT: brown, some fine to coarse gravel, dry	HNu = 0.0 ppm sample
-					
-					
-					
-				Bedrock at 13.0 ft. Bottom of boring 38.0 ft. Open hole from 18.0 ft. to 38.0 ft.	
15					
-					
-					
-					
-					
20					

CORE LOG

Well #: MW-7-40
Location: NYSGE
ig Type: CME-75
ecorded By: Merin 10 August 1988

Project: EPT
Drilling Date: 28-29 July 1988
Core Barrel Diameter: NX
Land Surface Elevation: 150.01 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
5- 10-							
VIF 15- IF VF IF		#1 13.0 to 18.0	100% 92%	19" 60"	6 12+ 3 4 7	Bedding Plane: VIF-IF to 15.1'; VF to 16.75'; IF below. All are clean. Inclined: none	SILTSTONE: grey, fresh, very intensely to intensely fractured to 15.1'; very fractured to 16.75'; intensely fractured below. All BPF are clean. No joints. No fossil beds.
18.1 18.2 J 20- 20.3 21.3 22.4 22.6		#2 18.0 to 23.0	100% 100%	50" 60"	2 1 2 1 2	Bedding Plane: MF Inclined: vertical calcite closed joint 19.6-20.2'	As above except moderately fractured. One vertical calcite filled (closed) joint from 19.6-20.2'. No fossil beds.
0 25- 24.9 25.4 25.4 J 26.5		#3 23.0 to 28.0	100% 100%	60" 60"	1 0 2 2 2	Bedding Plane: MF Inclined: 80°, clean, rough open face joint 26.4-27.1	As above except one 80° dipping clean, rough, open joint from 26.4-27.1. No fossil beds.
30- 0 32.2		#4 28.0 to 33.0	100% 100%	60" 60"	0 0 0 0 1	Bedding Plane: none except @ 32.2 Inclined: none	As above except unfractured except one clean BPF at 32.2'. No joints. No fossil beds.
0 34.3 35- J J		#5 33.0 to 38.0	100% 83%	40"+ 60"	0 1 1 1 1	Bedding Plane: none except @ 34.3 Inclined: 35.5-36.8 37.4-37.9	As above: unfractured except one clean BPF at 34.2'. Two parallel smooth, plumose partially calcite filled joints 1 inch apart dipping at 85° from 35.5 to 36.8. One smooth clean open joint from 37.4-37.9 parallel to joints above. No fossil beds
40-							Coring Terminated @ 38.0

BORING WELL # MW-8-40 PROJECT Emerson Power Transmission

LOCATION Facility Access Road DATES OF DRILLING 7/13/88-7/15/88

LOG RECORDED BY R.T. Church GROUND SURFACE ELEV. (ft.MSL) 137.27 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) ________

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					
-					
-					
-					
-					
5	5.0 - 6.5		5 7 18	GRAVELLY CLAY: brown to grey, medium stiff, dry	HNu = 0.0 ppm sample
-					
-					
-				(Fill)	
-					
10	10.0 - 11.5		5 9 11	CLAY: brown, some angular medium stiff to stiff, damp	HNu = 0.0 ppm sample
-					
-					
-				Bedrock at 12.1 ft. Bottom of boring 43.2 ft. Open hole from 17.1 ft. 43.2 ft.	
-					
15					
-					
-					
-					
-					
20					

CORE LOG

Well #: MW-8-40
Location: Downhill Service Road
ig Type: CME-75
ecorded By: Merin 19 July 1988

Project: EPT
Drilling Date: 11-13 July 1988
Core Barrel Diameter: NX
Land Surface Elevation: 137.27 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
5- 10-							
Fe Stn 15- IF		#1 12.1 to 17.1	100% 100%	0" 60"	9 6 6 6 5	Bedding Plane: IF, slight Fe stain above 14.1, clean below Inclined: none	SILTSTONE: grey, fresh, intensely fractured. Medium rough, Fe stained faces above 14.1 and clean below. No joints. No fossil beds.
MF		#2	100% 100%	14.5" 18.0"	2 3	Bedding Plane: MF Inclined: none	As above except: moderately fractured, slightly rough faces.
20- VF MF		#3 18.6 to 23.6	99% 95%	44" 58"	3 2 2 1	Bedding Plane: MF to VF, clean Inclined: none	As above except: moderate to very fractured, slightly rough faces.
25- VF FB MF 26.3 0		#4 23.6 to 28.6	100% 99%	53" 60"	6 0 1 0 0	Bedding Plane: MF to SF, clean Inclined: none	As above except: moderate to slightly fractured. Fossil bed: @ 25.0-25.1 Brachiopods.
30- 0		#5 28.6 to 33.5	100% 100%	58" 58"	0 0 0 0 0	Bedding Plane: none Inclined: none	As above except: unfractured.
35- 36.0 0 37.3 0 38.1		#6 33.5 to 38.2	100% 100%	56" 56"	0 0 1 0 2	Bedding Plane: fractures @ 36.0', 37.3', 38.1' Inclined: none	As above except: unfractured to 36.0, slightly fractured to 38.1'. No joints. Fossil beds: none.
FB 40- 0 42.0 J		#7 38.2 to 43.2	100% 100%	38" 60"	0 0 0 2 1	Bedding Plane: @ 42.0' Inclined: vertical joint from 42.0-43.2, medium rough, clean	As above except unfractured to 42.0. One vertical joint from 42.0-43.2. One natural BPF @ 42.0. Fossil bed @ 38.4-38.5 Brachiopods & Crinoids.

Coring Terminated @ 43.2

BORING WELL # MW-9-40 PROJECT Emerson Power Transmission

LOCATION Cayuga St. and Access Rd. DATES OF DRILLING 8/21/89 - 8/22/89

LOG RECORDED BY P. T. LeClair GROUND SURFACE ELEV. (ft.MSL) 507.76 ft. (USGS)

TYPE OF WELL RIG CME-75 Empire Soils

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
				6 inches Asphalt	
0					
				SILTY CLAY:	
-				black, trace fine to	HNu = 0.0 ppm
				coarse gravel, moist	
-					
-				Bedrock at 2.5 ft.	
				Bottom of boring 40.0 ft.	
-				Open hole from 7.5 ft. to	
				40.0 ft.	
5					
-					
-					
-					
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

CORE LOG

Well #: 9-40
Location: Cayuga Street and Access Rd.
Rig Type: CME-75
Recorded By: I.S. Merin

Project: EPT
Drilling Date: 22 August 1989
Core Barrel Diameter: NX
Land Surface Elevation: 507.76 ft. MSL

Well inclined about 8° to SSW

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
-							
-							
-							
-							
5-							
-							
-							
-					3		
- IF	#1	#1	100%		2	BPF:IF	SILTSTONE, grey, fresh
10-		7.5	98%		5		Intensely fractured to 11.8 ft. and very
- J		to		58	2		fractured below and two rough clean joints
-		16.5		108	2	Joints:	(one @ 11.2 to 11.3 and other @ 14.9 to 15.4)
- VF					3	11.2 to 11.3, 14.9 to	
-					1	15.4, rough, clean	
15- J					2		
-					1		
-					0		
-					0		
-		#2			0	BPF	As above except unfractured.
20-	#1	16.5	100%	120	0	NONE	
-		to	100%	120	0		
- NONE		26.5			0		
-					0		
-					0	Joints: None	
25-					0		
-					0		
-		#3			0	BPF: possible BPF 30.6,	As above: possible BPF @
-	#2	26.5	100%	120	0	33.2, 34.0	30.6, 33.2, 34.0; no joints.
-		to	100%	120	0	Joints: None	
30- BPF		36.5			1		
- NONE					0		
-					0		
- BPF					1		
- BPF					1		
35- NONE					0		
-					0		
- BPF		#4			1	BPF: possible @ 38.4.	As above except possible bedding plane fracture
- NONE	#2	36.5	100%	42	0		@ 38.4; no joints
-		to	100%	42	0	Joints: None	
40-		40.0					
-							Coring terminated @ 40.0 ft.
-							
-							
-							

Coring Log EPT
0928-03.bjg.1

BORING WELL # MW-9-100 PROJECT Emerson Power Transmission

LOCATION Cayuga St. and Access Road DATES OF DRILLING 8/15/89 - 8/18/89

LOG RECORDED BY R. T. Church GROUND SURFACE ELEV. (ft.MSL) 507.35 ft. (USGS)

TYPE OF WELL RIG CME-75 Empire Soils

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
				6 inches Asphalt	
0				SILTY CLAY:	HNu = 0.0 ppm
				black, trace fine to	
-				coarse gravel, moist	
-					
-				Bedrock at 2.5 ft.	
-					
5				Note: Reamed bedrock to	
				4.0 ft. in order to fit	
-				core barrel between	
				drive head and bottom of	
-				borehole.	
-				Bottom of boring 101.0 ft.	
				Screen from 80.0 ft. to	
-				100.0 ft.	
10					
-					
-					
-					
-					
15					
-					
-					
-					

CORE LOG

Well #: MW-9-100
Location: Cayuga Street and Access Rd.
ig Type: CME-75
ecorded By: Merin

Project: EPT
Drilling Date: August 15-August 16, 1989
Core Barrel Diameter: NX
Land Surface Elevation: 507.35 ft. MSL

1 of 3

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
							Rock at 2.5 ft.; first core @ 4.0 ft.
5- Fe stained J J VIF to VF	#1	#1 4.0 to 10.0	100% 85%	14 72	8 12 2 4 3 6	BPF: VIF to IF Joints: 4.7 to 4.8, Fe stained, smooth.	SILTSTONE: grey, fresh, very intensely to intensely fractured; Fe stained to 6.0 ft.; one joint 4.7 to 4.8 smooth face.
10 15- VF to MF	#1 and #2	#2 10.0 to 20.0	100% 98%	94 120	4 3 7 0 3 3 1 1 2 0	BPF: VIF to IF to 12.9 then VF to MF. Joints: none	As above except very intensely to intensely fractured to 12.9 ft. and very to moderately fractured below, no joints.
20 NONE 25- J J BPF?	#2	#3 20.0 to 30.0	100% 100%	120 120	0 0 0 0 0 0 1 1 0 0	BPF: all induced except possible BPF @ 27.4 ft. Joints: one from 26.2 ft. to 27.0 ft., rough, clean.	As above except: unfractured except for one possible BPF @ 27.4 ft. and one rough clean joint from 26.2 to 27.0.
30 NONE Fissil NONE 35- BPF NONE Fissil	#3	#4 30.0 to 40.0	100% 100%	118 120	0 0 0 5+ 0 1 0 0 2+ 0	BPF: unfractured except possible BPF @ 35.7 and fissil zones @ 33.4 to 33.5 and 38.7 to 38.8. Joints: none	As above: unfractured except for fissil zones from 33.4 to 33.5 and 38.7 to 38.8 and possible BPF @ 35.7; no joints.
40 NONE J J Fissil Fissil	#3 + #4	#5 40.0 to 50.0	100% 100%	59 120	1 0 6+ 9+ 0	BPF: unfractured except fissil @ 42.2, 42.5 to 42.6, 43.6 to 43.9, 45.6 to 45.8, 47.3 to 47.4, 48.1 to 48.5.	As above: except numerous fissil zones and for joints from 40.2 to 40.8 and 46.6 to 46.8.

CORE LOG

Well #: MW-9-100
Location: Cayuga Street and Access Road
Rig Type: CME-75
Recorded By: Merin

Project: EPT
Drilling Date: 15-16 August 1989
Core Barrel Diameter: NX
Land Surface Elevation: 507.35 ft. MSL
2 of 3

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
45- Fissil Fissil Fissil ↑					0 4+ 2 3+ 5+ 0	Joints: rough clean from 40.2 to 40.8 rough clean 46.6 to 46.8	
50- 55- NONE ↓ 1J	#4 + #5	#6 50.0 to 60.0	100% 100%	120 120	0 0 0 0 0 0 0 0 0 0	BPF: None Joints: None	As above except unfractured.
60- ↓ BPF 65-BPF BPF BPF ↑ NONE	#5	#7 60.0 to 70.0	100% 100%	120 120	0 0 1 0 1 2 0 0 0 0	BPF: induced except possible BPF @ 62.1, 64.8, 65.1, 65.9. Joints: rough clean @ 60.0 to 60.5.	As above: unfractured except for possible BPF @ 62.1, 64.8, 65.1, 65.9, and one rough clean joint @ 60.0 to 60.5.
70- ↓ BPF BPF BPF 75-BPF BPF ↑ NONE ↓	#5 + #6	#8 70.0 to 80.0	100% 100%	120 120	0 1 0 1 1 1 1 1 0 0 0	BPF: possible BPF @ 71.6, 73.4, 74.5, 75.5, 76.5. Joints: none	As above: unfractured except possible bedding plane fractures @ 71.6, 73.4, 74.5, 75.5, and 76.5.
80- BPF ↑ NONE ↓ 85-BPF BPF ↑ NONE ↓ Fissil	#6	#9 80.0 to 90.0	100% 100%	120 120	0 0 0 0 1 1 0 0 2+	BPF: induced except possible BPF @ 80.2, 84.8, 85.3, and one fissil zone from 88.8 to 88.9.	As above: unfractured except for possible bedding plane fractures @ 80.2, 84.8, and 85.3 and one fissil zone from 88.8 to 88.9; no joints.

CORE LOG

Well #: MW-9-100
Location: Cayuga Street and Access Road
ig Type: CME-75
ecorded By: Merin

Project: EPT
Drilling Date: 15-16 August 1989
Core Barrel Diameter: NX
Land Surface Elevation: 507.35 ft. MSL
3 of 3

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
-					0		
90- 13							
-		#10	100%	120	1	Joints: none	As above: unfractured except one possible bedding plane fracture @ 96.6 and one rough clean joint from 90.0 to 90.6.
-	#7	90.0	100%	120	0		
-		to			0	BPF: induced except for possible BPF @ 96.6.	
- NONE		100			0		
95-					0		
-					0	Joints:	
- BPF					1	rough clean @ 90.0 to 90.6.	
- NONE					0		
-					0		
100-					0		
-							Coring terminated @ 100.0 ft.
-							
-							
-							
105-							
-							
-							
-							
-							
110-							
-							
-							
-							
-							
115-							
-							
-							
-							
-							
120-							
-							
-							
-							
-							
125-							
-							
-							
-							
-							
130-							

BORING WELL # MW-10-40 PROJECT Emerson Power Transmission

LOCATION Spencer Street DATES OF DRILLING 8/23/89 - 8/24/89

LOG RECORDED BY P. T. LeClair GROUND SURFACE ELEV. (ft.MSL) 417.22 ft. (USGS)

TYPE OF WELL RIG CME-75 Empire Soils

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					
-					
-				SILTY CLAY: brown, trace fine to coarse gravel, moist to wet.	HNu = 0.0 ppm
-					
-					
5					
-				Bedrock at 6.0 ft. Bottom of boring 40.0 ft. Open hole from 11.0 ft. to 40.0 ft.	
-					
-					
-					
10					
-					
-					
-					
-					
15					
-					
-					
-					
-					
20					

CORE LOG

Well #: 10-40
Location: Spencer Street
Rig Type: CME-75
ecorded By: Merin

Project: EPT
Drilling Date: 23 August 1989
Core Barrel Diameter: NX
Land Surface Elevation: 417.22 ft. MSL

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
5							Bedrock @ 6.0 ft.
VIF to IF IF Fe stain J 10	#1	#1 6.0 to 11.0	100% 85%	0 60	10+ 17 11 17 8	BPF: VIF to IF to 8.5; IF below. Joints: 6.6 to 6.8 rough, Fe stain	SILTSTONE, grey, fresh; very intensely to intensely fractured; Ferric and Manganese Oxide to 9.8 ft.; One rough ferric oxide stained joint from 6.6 to 6.8 ft.
15 IF to VF J J 20	#1	#2 11.0 to 20.0	100% 90%	28 108	4 3 2 3 6 5 4 9 7	BPF: IF to VF Joints: Planar smooth 19.6 to 19.8	As above except: intensely to very fractured; one planar smooth joint 19.6 to 19.8 ft.
25 Fissil Fissil J J J NONE BPF 30	#2	#3 20.0 to 30.0	100% 100%	52 120	11 10 10 7 7 3+ 3+ 3 1 1	BPF: IF to VF to 28.1 with fissil zone @ 25.6 and 26.4 and a possible BPF @ 29.1 Joints: 26.8 to 27.6 and 27.8 to 28.0 same joint, rough, clean	As above except: intensely to very fractured to 28.1 ft., with fissil zones @ 25.6 and 26.4 and a possible BPF @ 29.1. The fissil zone 25.6 is ferric oxide stained. One joint from 26.8 to 27.6 and 27.8 to 28.0, rough, clean.
J NONE J J 35 40	#2 + #3	#4 30.0 to 40.0	100% 100%	120 120	1 0 0 0 1 1 1 0 0 0	BPF - None Joints: 1) rough clean 30.0 to 30.1 2) rough planes, clear, 34.9 to 36.2	As above except: unfractured, except for 2 joints, both are rough and clean from 30.0 to 30.1 and 34.9 to 36.2
							Coring terminated @ 40.0 ft.

Coring Log EPT
0928-03.bjg.1.1

BORING WELL # MW-11-40 PROJECT Emerson Power Transmission

LOCATION Midpoint of MW-13-40 and MW-15-40 DATES OF DRILLING 8/15/89 - 8/18/89

LOG RECORDED BY R. T. Church GROUND SURFACE ELEV. (ft.MSL) 585.61 ft. (USGS)

TYPE OF WELL RIG CME-75 Empire Soils

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
				6 inches Asphalt	
0					
-					
-					
	2.5 -		5	SILTY CLAY:	HNu = 0.0 ppm
-	4.0		3	black, trace medium	on sample
			4	grained sand, damp	
-					
5				(Fill)	Boulder at
					6.0 ft.
-					
-				- - - - - - - - - - - - - - -	Silty Clay to
					approx. 7.0 ft.
-	8.0 -		6	SAND SILT:	
	10.0		7	black, medium grained,	HNu = 0.0 ppm
-			6	traced coarse gravel,	on sample
				medium dense, moist	
10					
-				(Fill)	
-					
-					
	13.5 -		7	SAND SILT:	HNu = 0.0 ppm
-	15.0		5	black, medium grained,	on sample
			7	trace coarse gravel,	
15				medium dense, moist	
-					
-					
-					
				Bedrock at 18.0 ft.	
-				Bottom of boring 40.0 ft.	
				Open hole from 23.0 ft. to	
20				40.0 ft.	

CORE LOG

Well #: MW-11-40
Location: Mid pt. 6tw MW 13-25 and MW 15-40
ig Type: CME-75
ecorded By: Merin

Project: EPT
Drilling Date: 14 August 1988
Core Barrel Diameter: NX
Land Surface Elevation: 585.61 ft. MSL

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
15							Rock @ 18.0 ft.
Fe		#1	100%	4	8	BPF: VIF to VF	SILTSTONE: grey, fresh, very intensely to intensely fractured, ferric oxide stained to 19.4 ft. No joints.
Stained	#1	18.0		60	9		
20 VIF		to			8		
to VF		23.0			7	Joints: none	
					6		
					4		
					4		
25					3		
	#1	#2			2	BPF: VF	As above: except very fractured
VF			100%		3		
J		23.0		12	2		
		to		120	2		
30 J		33.0			3	Joints: no filling or staining.	One joint from 27.6 to 30.8.
					4		
					3		
					2		
					0		
35 MF					1		
					0		
		#3			1	BPF: MF	As above: except moderately fractured.
		33.0	100%		0		
	#2	to		7	0		
40		40.0		84		Joints: none	No joints.
							coring terminated @ 40ft

BORING WELL # MW-13-40 (MW-13-25) PROJECT Emerson Power Transmission

LOCATION Facility driveway DATES OF DRILLING 7/14/88-7/15/88

LOG RECORDED BY W.P. Sugg GROUND SURFACE ELEV. (ft.MSL) 206.13 (USGS DATUM)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) 4.5

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0				10-inch concrete pad	
-	1.0 -		3	SILTY CLAY:	HNu = 0.0 ppm
	2.5		5	brown, with sub-angular	sample
-			7	gravel, stiff, moist	
-				(Fill)	
-					
5	4.5 -		7	SANDY SILT:	
	6.0		6	brown, with gravel,	HNu = 0.0 ppm
-			6	medium dense, moist	sample
-					
-				(Fill)	
-					
	9.5 -		7	SANDY SILT:	HNu = 0.0 ppm
10	11.0		5	as above	sample
			5		
-				(Fill)	
-					
-					
-				Bedrock at 13.3 ft.	
				Bottom of boring 18.3 ft.	
				Screen from 8.3 ft. to	
15				18.3 ft.	
-					
-					
-					
-					
20					

CORE LOG

Well #: MW-13-40 (MW-13-25)
Location: TCE Still
ig Type: CME-55 CME-75
ecorded By: Merin 18 July 1988

Project: EPT
Drilling Date: 14-15 July 1988
Core Barrel Diameter: NX
Land Surface Elevation: 206.13 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
5-							
10-							
- VIF		#1			9+		
15-		13.3	85%	5"	10	Bedding Plane Fracture:	SILTSTONE: grey, fresh, very to very intensely
- VF Fe stn		to	56%	50"	6+	VF-VIF, Fe stained	fractured. BPF medium rough Fe stained faces.
- IF J		18.3			6+	Inclined: one joint 17.1'	One joint dipping 85°, Fe stained slight rough
-					6+	to 17.3', Fe stained	face.
20-							Coring Terminated @ 18.3
25-							
30-							
35-							
40-							

0817-01.nrj.1

BORING WELL # MW-15-40 PROJECT Emerson Power Transmission

LOCATION Facility driveway DATES OF DRILLING 7/11/88-7/14/88

LOG RECORDED BY W.P. Sugg GROUND SURFACE ELEV. (ft.MSL) 203.01 (USGS DATUM)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) 3.5

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0				Asphalt	
-					
-					
-					
-					
5					
-	6.0 - 7.5		6 6 6	GRAVEL: grey with brown, fine sandy silt matrix, dry	HNu = 0.0 ppm sample
-					
-				(Fill)	
-					
10	9.5 - 11.0		7 5 5	GRAVEL: as above	HNu = 0.0 ppm sample
-					
-				(Fill)	
-					
-				Bedrock at 13.3 ft. Bottom of boring 38.2 ft. Open hole from 18.7 ft. to 38.2 ft.	
15					
-					
-					
-					
-					
20					

CORE LOG

Well #: MW-15-40
Location: West of Fire Reservoir
ig Type: CME-55
ecorded By: Merin 19 July 1988

Project: EPT
Drilling Date: 11-14 July 1988
Core Barrel Diameter: NX
Land Surface Elevation: 203.01 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
-							
-							
-							
-							
5-							
-							
-							
-							
-							
10-							
-							
-							
-							
- VIF					7		
15-		#1			11		
-		13.7	100%	5"	9	Bedding Plane: IF, Fe	SILTSTONE: grey, fresh, intensely fractured, slight
- stained	FB	to	90%	60"	7	stained	Fe stained. BPF slightly rough faces. Two vertical
-		18.7			3	Inclined: vertical, Fe	1-inch long, slight Fe stained joints @ 17.0'.
-					11	stained	Fossil bed @ 17.1 to 17.2: dissolved brachiopods.
20- Fe		#2			11	Bedding Plane: IF, Fe	As above except: Fossil beds @
-	FB	18.7	100%	0"	8	stained to 21.5'.	21.9-22.0 Brachiopods & Crinoids
- IF	FB	to	79%	54"	7	Inclined: 1" long vertical	22.2-22.5 ditto
-		23.7			4	joints, Fe stained @	
-					6	19.1, 20.6, & 20.8	
25-		#3			5		
-		23.7	100%	4"	5	Bedding Plane: IF-VF,	As above except: intensely fractured to 25.3 & very
-		to	100%	60"	4	clean	to intensely fractured below. BPF are clean. No
-		28.2			4	Inclined: none	joints. No fossil beds.
-					5		
30-		#4			4		
-		28.2	100%	6.5"	6	Bedding Plane: IF-VF	As above except: VF-IF to 29.0' and VF below.
-	J	to	98%	60"	3	Inclined: vertical joint	All fractures are clean. Vertical joint from 32.8-
-		33.2			2	32.8-33.2, clean	33.2, rough face. No fossil beds.
-		#5			4		
35- VF		33.2	100%	29"	5	Bedding Plane: VF, clean	As above
-		to	99%	60"	4	Inclined: none	
-		38.2			3		
-					4		
-							
40-							
-							
-							
-							
-							

BORING WELL # MW-16-100 PROJECT Emerson Power Transmission

LOCATION NYSEG property DATES OF DRILLING 7/27/88-8/2/88

LOG RECORDED BY W.P. Sugg GROUND SURFACE ELEV. (ft.MSL) 149.72 (USGS DATUM)

TYPE OF WELL RIG CME-75 SAMPLING INTERVAL (ESTIMATED) ____________

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0					No split spoon samples taken. Stratigraphy taken from MW-7-40 located 6 ft. away.
-				SANDY SILT: black to brown with gravel	
-					
-				(Fill)	
-					
5					
-				SANDY SILT: black to brown with gravel	HNu = 0.0 ppm wellhead
-					
-				(Fill)	
-					
10					
-					
-					
-				Bedrock at 10.8 ft. Bottom of boring 100.0 ft. Screen from 80.0 ft. to 100.0 ft.	
-					
15					
-					
-					
-					
-					
20					

CORE LOG

Well #: MW-16-100
Location: NYSGE
ig Type:
ecorded By: Merin 10 August 1988

Project: EPT
Drilling Date: 27 July-2 August 1988
Core Barrel Diameter: NX
Land Surface Elevation: 149.72 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
5- 10-							
VIF IF VF J 15-	#1	#1 10.8 to 13.3	100% 95%	0" 30"	15 8 5	Bedding Plane: VIF-IF; clean Inclined: none	SILTSTONE: grey, fresh, very intensely to intensely fractured. BPF are all clean. No joints. No fossil beds.
0 18.0 18.1 0 19.2 20- 19.3	#1	#2 13.3 to 23.3	100% 100%	117" 120"	6 1 1 2 2 0 0 0 0	Bedding Plane: IF-VF to 15.2'; SF to 19.3'; none below except 18.0-.1 + 19.2-.3 Inclined: 87° dipping, clean slightly rough face 15.2-16.9'	As above except intensely to very fractured to 15.2' slightly fractured to 19.3'; unfractured below. One clean, slightly rough face joint dipping 87° from 15.2-16.9'. No fossil beds.
0 25- 25.3 0 26.8 0 30- 30.8 31.2 0 FB 32.6	# 1 + 2	#3 23.3 to 33.3	100% 100%	120" 120"	0 0 1 1 0 0 0 2 0 1	Bedding Plane: SF to none Inclined: none	As above except slightly to unfractured. No joints. fossil beds: 32.0 - 32.3 Brachiopod;
35- 0 37.3 0 38.8 40- IF VF FB	# 3	#4 33.3 to 43.3	100% 100%	97" 120"	0 0 0 0 1 1 1 4 5 5 0	Bedding Plane: none to 37.3; SF to 39.8'; IF-VF to 41.8; none below Inclined: none	As above except unfractured to 37.3'; slightly fractured to 39.8'; intensely to very fractured to 41.8'; unfractured below. No joints. Fossil beds: 41.7-42.1 Brachiopods & Crinoids
0 5- IF VF J 0 50-	# 3	#5 43.3 to 53.3	100% 90%	109" 120"	0 0 1 3 3 1 0	Bedding Plane: none except IF-VF @ 46.2-48.2'; BPF @ 50.6 & 50.8' Inclined: vertical closed planar joint 47.0-47.9	As above except unfractured to 46.2; IF-VF from 46.2-48.2'; unfractured below except BPF @ 50.6 & 50.8'. One vertical planar closed joint from 47.0-47.9'. Fossil bed: 53.0-53.3': Brachiopods & Crinoids

CORE LOG

Well #:	MW-16-100	Project:	EPT
Location:	NYSGE	Drilling Date:	28 July-2 August 1988
`ig Type:		Core Barrel Diameter:	NX
ecorded By:	Merin 10 August 1988	Land Surface Elevation:	149.72 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
52.6 52.8 0 FB 53.6 54.5 55 0 VIF 60 FB FB	#3	[illegible] 53.3 to 63.3	100% 94%	112" 120"	2 0 1 1 0 0 8 4 0 0 0 0	Bedding Plane: none except: @ 53.6'; 54.5'; VIF 57.7-58.8'. All are clean. (VIF 57.7 - 58.8 may be induced) Inclined: Three parallel 85° dipping partially calcite filled planar joints spaced 1" apart.	As above except slightly fractured to 57.7'; very intensely fractured from 57.6 to 58.8'; unfractured below. All BPF are clean. Three parallel joints from 57.6 - 58.8 partially calcite filled, planar & spaced 1 inch apart. Fossil beds: @ 60.3 - 60.4: Crinoids & Brachiopods @ 61.8 - 61.9: Brachiopods & Crinoids
0 J 65 0 J 72.8	#4	#7 63.3 to 73.3	100% 100%	120" 120"	1 0 0 0 0 0 0 0 1 2	Bedding Plane: none except @ 72.8 Inclined: @ 63.7 - 64.3 @ 71.5 - 72.5	As above except unfractured except for one BPF @ 72.8' and two parallel joints @ 63.7-64.3 & 71.5-72.8'. The joints dip 85° have partially calcite filled, smooth faces & planar trace & are spaced about 20" apart. The upper has plumose markings and slight pyrite stain. No fossil beds.
73.8 75 80 0	#4	#8 73.3 to 83.3	100% 100%	120" 120"	1 0 0 0 0 0 0 0 0 0	Bedding Plane: none except possible BPF @ 73.3' Inclined: none	As above except unfractured except for possible BPF @ 73.3'. No joints. No fossil beds.
83.8 85 0 VF J 0 90 VF J 0 VIF 93.8	#5	#9 83.3 to 93.3	100% 100%	112" 120"	1 0 0 3 1 0 1 1 0 10 1	Bedding Plane: none except @ 83.8; VF btw 86.4 - 86.7 and 89.9 - 90.5; VIF btw 92.6 - 93.0'. All clean. Inclined: @ 87.0 - 88.1: vert, part calcite fill, slt rough @ 90.4 - 90.6: vert calcite closed	As above unfractured except BPF @ 83.8; VF between 86.4 - 88.1' & 89.9 - 90.5'; VIF from 92.6-93.0'. Vertical partially calcite filled, slightly rough open face joint from 87.0-88.1'. Vertical calcite filled closed joint from 90.4-90.6'. No fossil beds.

CORE LOG

Well #: MW-16-100
Location: NYSGE
`ig Type:
.ecorded By: Merin 10 August 1988

Project: EPT
Drilling Date: 28 July-2 August 1988
Core Barrel Diameter: NX
Land Surface Elevation: 149.72 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING
95-		10			0		
- 0		93.3	100%	86"	0	Bedding Plane: possible	As above unfractured except possible BPF @ 93.8;
-		to	100%	86"	0	BPF @ 93.8; 97.5; 97.9;	97.5; & 97.9'. No joints. No fossil beds.
- 97.5		100.5			2	no others	
- 97.9					0	Inclined: none	
100-					0		
-							
-							Coring Terminated @ 100.5 ft

BORING WELL # MW-17-40 PROJECT Emerson Power Transmission

LOCATION Geneva Street DATES OF DRILLING 7/25/88-7/26/88

LOG RECORDED BY W.P. Sugg GROUND SURFACE ELEV. (ft.MSL) 145.90 (USGS DATUM)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) 5.0

1 of 2

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
0	0.0 -		2	SILTY SAND:	HNu = 0.5 ppm
	1.5		1	brown, fine grained,	sample
-			1	some clay, moist	
-				(Topsoil)	
-					
-					
	4.5 -		1	SANDY CLAYEY SILT:	HNu = 0.5 ppm
5	6.0		1	greyish-brown, trace	sample
			1	gravel, moist	
-					
-					
				(Lacustrine Deposits)	
-					
-					
	9.5 -		2	SILTY CLAY:	HNu = 0.0 ppm
10	11.0		1	grey, very soft, moist	sample
			2		
-					
-				(Lacustrine Deposits)	
-					
-					
	14.5 -		2	SILTY CLAY:	HNu = 0.0 PPM
15	16.0		1	as above	sample
			1		
-					
-					
				(Lacustrine Deposits)	
-					

BORING WELL # MW-17-40 PROJECT Emerson Power Transmission

LOCATION Geneva Street DATES OF DRILLING 7/25/88-7/26/88

LOG RECORDED BY W.P. Sugg GROUND SURFACE ELEV. (ft.MSL) 145.90 (USGS DATUM)

TYPE OF WELL RIG CME-55 SAMPLING INTERVAL (ESTIMATED) 5.0

2 of 2

Depth	Sample Depth (feet)	Sample Number	Blow Counts	Description	Remarks
-	19.5 -		2	CLAY:	HNu = 0.0 ppm
	21.0		2	grey, plant material	sample
20			3	(roots), soft, moist	
-					
-				(Lacustrine Deposits)	
-					
-					
	24.5 -		2	SILTY CLAY:	HNu = 0.0 ppm
25	26.0		2	grey, peat lenses, soft,	sample
			2	moist to wet	
-					
-					
-				(Lacustrine Deposits)	
-					
	29.5 -		5	29.5'-30.9' SILTY CLAY:	HNu = 0.0 ppm
30	31.0		7	grey, peat lenses, soft,	sample
			10	wet	
-				30.9'-31.0' GRAVEL:	
				black bedrock fragments	
-					
				Bedrock at 32.9 ft.	
-				Bottom of boring 47.9 ft.	
				Open hole from 37.9 ft. to	
-				47.9 ft.	
35					
-					
-					
-					
-					

CORE LOG

Well #: MW-17-40
Location: Geneva Street
ig Type: CME-75 and CME-55
ecorded By: Merin 8 August 1988

Project: EPT
Drilling Date: 25-26 July 1988
Core Barrel Diameter: NX
Land Surface Elevation: 14.59 (USGS)

DEPTH	BOX	RUN	% RECOVERY	RQD	FRACTURE FREQUENCY	ORIENTATION SPACING FILLING	LITHOLOGY COLOR WEATHERING GRAIN SIZE
-							
-							
-							
-							
5-							
-							
-							
-							
-							
10-							
-							
-							
-							
-							
15-							
-							
-							
-							
-							
20-							
-							
-							
-							
-							
25-							
-							
-							
-							
-							
30-							
-							
-							
-					21+		
- VIF		#1			27+		
35-		32.9	90%	0"	11	Bedding Plane: VIF to 34.9	SILTSTONE: grey, fresh, VIF to 34.9 and IF below.
- IF		to	80%	54"	9	IF to 38.1, clean	All fractures are clean. No joints.
-		37.9			2	Inclined: none	Fossil beds: none
-							
- IF		#2			4		
40- VIF		37.9	100%	81"	2	Bedding Plane: IF-VIF to	As above except intensely to very fractured to 41.9;
-		to	100%	120"	1	41.9; MF to 45.0; none	moderately fractured to 45.0; unfractured below.
- o		47.9			0	below; all BPF clean	No joints.
- 43.1					1	Inclined: none	Fossil beds: none
- o					0		
5- IF					5 0		
- o					0		
-					0		Coring Terminated @ 47.9

APPENDIX D

WELL INSTALLATION AND DEVELOPMENT

APPENDIX D - WELL INSTALLATION AND DEVELOPMENT

Eighteen monitoring wells were installed in boreholes drilled to three depth ranges. Three shallow monitoring wells, ranging in depth from approximately 11 to 18 feet, were installed in the overburden. Nine shallow bedrock monitoring wells, ranging in depth from approximately 38 to 48 feet, were installed in the top of the bedrock. Six intermediate depth monitoring wells were installed in the bedrock, five to a depth of 100 feet and one to a depth of 150 feet. Table D-1 (at the end of this Appendix) presents a summary of the borehole and monitoring well dimensions for these wells. Well completion logs for these monitoring wells also are presented at the end of this Appendix.

Three different configurations of well construction were used to address differing considerations at each depth range. A typical well construction for overburden monitoring wells installed at the EPT site is shown in Figure D-1. (All figures for Appendix D are presented at the end of this Appendix.) These wells were constructed of 2-inch diameter stainless steel casing with a maximum of 10 feet of 0.010-inch slotted stainless steel screen. The screened section was placed to intercept the water table. The annulus around the screen was sand-packed up to one foot above the top of the screen. The interval above was sealed with approximately 1 foot of hydrated, pelleted bentonite. The remaining annular space was filled with a grout-bentonite slurry. All wells were installed with locking, protective steel casings.

A typical well construction for shallow bedrock wells installed at the EPT site is shown in Figure D-2. To isolate the overburden, these wells were constructed of 4-inch diameter stainless steel casing grouted into the top 5 feet of bedrock. A 3-inch diameter open rock corehole was left below the casing to serve as the open interval in lieu of a screened casing section.

A typical well construction for intermediate depth bedrock wells installed at the EPT site is shown in Figure D-3. These wells were constructed of 2-inch diameter stainless steel casing with 20 feet of 0.010-inch slotted stainless steel screen placed inside a corehole reamed to approximately 6 inches. The annulus around the screen was sand-packed up to 1 foot above the top of the screen. The interval above was sealed with approximately 1 foot of hydrated, pelleted bentonite. The remaining annular space was filled with a grout-bentonite slurry.

All wells were developed using a 2-inch diameter stainless steel air displacement pump. The pump also was equipped with a flexible rubber wiper that created a surge-block action in cased wells to increase development effectiveness. Many of the on-site wells were pumped dry during development. Water extracted during this process was placed in 55-gallon drums adjacent to the wellhead for storage, until a decision could be made on final disposition based on the results of sample analysis.

TABLE D-1. SUMMARY OF BOREHOLE AND MONITORING WELL DIMENSIONS, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK
(feet from ground surface, except where otherwise noted)

	MW-1	MW-2	MW-3-13	MW-3-31	MW-3-100
Wellhead Elevation (USGS Datum)	569.63	567.66	568.01	567.42	567.94
Ground Elevation (USGS Datum)	567.11	565.04	565.48	564.89	565.39
Completed Well Depth	39.2	38.3	12.7	31.0	100.0
6-5/8" Borehole Interval	0.0-14.0	0.0-8.5	0.0-12.7	0.0-16.0	0.0-12.0
5-5/8" Borehole Interval	14.0-19.0	8.5-13.5	N/A	16.0-21.0	12.0-100.0
3-7/8" Borehole Interval	N/A	N/A	N/A	N/A	N/A
3" Open Borehole Interval*	19.0-39.2	13.5-38.3	N/A	21.0-31.0	N/A
PVC Casing Depth	19.0	13.5	4.0	21.0	N/A
Stainless Steel Casing Depth	N/A	N/A	N/A	N/A	80.0
Casing Stick-up	2.52	2.62	2.53	2.53	2.55
Screened Interval	N/A	N/A	4.0-12.0	N/A	80.0-100.0
Sand Pack Interval	N/A	N/A	3.0-12.3	N/A	77.0-100.0
Bentonite Seal Interval	N/A	N/A	2.0-3.0 12.3-12.7	N/A	74.0-77.0
Grout Seal Interval	0.0-19.0	0.0-13.5	0.0-2.0	0.0-21.0	0.0-74.0

*Open corehole served as the open interval for sample collection in shallow bedrock wells constructed without slotted screens.

BJG-13
1012-07.bjg.1

Table D-1 (Continued). SUMMARY OF BOREHOLE AND MONITORING WELL DIMENSIONS, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK (feet from ground surface, except where otherwise noted)

	MW-3-150	MW-4	MW-5-25	MW-5-40	MW-5-100	MW-6-25
Wellhead Elevation (USGS Datum)	565.43	625.81	587.43	587.42	587.42	563.89
Ground Elevation (USGS Datum)	565.43	622.18	587.43	587.42	587.42	560.47
Completed Well Depth	150.5	42.0	11.8	40.3	99.0	11.0
6-5/8" Borehole Interval	0.0-9.0	0.0-7.0	0.0-11.8	0.0-12.3	0. -12.0	0.0-11.0
5-5/8" Borehole Interval	9.0-125.0	7.0-12.0	N/A	12.3-17.3	12.0-100.0	N/A
3-7/8" Borehole Interval	125.0-151.5	N/A	N/A	N/A	N/A	N/A
3" Open Borehole Interval*	151.5-175.0	12.0-42.0	N/A	17.3-40.3	N/A	N/A
PVC Casing Depth	125.0	12.0	N/A	N/A	N/A	N/A
Stainless Steel Casing Depth	130.5	N/A	3.6	17.3	79.0	4.0
Casing Stick-up	0.0	3.63	0.0	0.0	0.0	3.42
Screened Interval	130.5-150.5	N/A	3.6-11.6	N/A	79.0-99.0	4.0-11.0
Sand Pack Interval	128.5-150.5 152.0-175.0	N/A	3.0-11.8	N/A	76.0-99.0	3.5-11.0
Bentonite Seal Interval	126.5-128.5 150.5-152.0	N/A	1.7-3.0	N/A	73.0-76.0	1.5-3.5
Grout Seal Interval	0.0-126.5	0.0-12.0	0.0-1.7	0.0-17.3	0.8-73.0	0.0-1.5

*Open corehole served as the open interval for sample collection in shallow bedrock wells constructed without slotted screens.

BJG-13
1012-07.bjg.1.1

Table D-1 (Continued). SUMMARY OF BOREHOLE AND MONITORING WELL DIMENSIONS, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK (feet from ground surface, except where otherwise noted)

	MW-6-40	MW-6-100	MW-7-40	MW-8-40	MW-9-40	MW-9-100	MW-10-40	MW-11-40
Wellhead Elevation (USGS Datum)	564.42	564.73	534.39	518.83	507.76	507.35	417.22	585.61
Ground Elevation (USGS Datum)	562.00	561.30	531.57	518.83	507.76	507.35	417.22	585.61
Completed Well Depth	38.9	99.5	38.0	43.2	40.0	100.0	40.0	40.0
6-5/8" Borehole Interval	0.0-13.3	0.0-11.5	0.0-13.0	0.0-12.1	0.0-2.5	0.0-2.5	0.0-6.0	0.0-18.0
5-5/8" Borehole Interval	13.3-18.9	11.5-100.0	13.0-18.0	12.1-17.1	2.5-7.5	2.5-101.0	6.0-11.0	18.0-23.0
3-7/8" Borehole Interval	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3" Open Borehole Interval*	18.9-38.9	N/A	18.0-38.0	17.1-43.2	7.5-40.0	N/A	11.0-40.0	23.0-40.0
PVC Casing Depth	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stainless Steel Casing Depth	18.9	79.5	18.0	17.1	7.5	80.0	11.0	18.0
Casing Stick-up	2.42	3.43	2.82	0.0	0.0	0.0	0.0	0.0
Screened Interval	N/A	79.5-99.5	N/A	N/A	N/A	80.0-100.0	N/A	N/A
Sand Pack Interval	N/A	76.5-99.5	N/A	N/A	N/A	76.5-100.0	N/A	N/A
Bentonite Seal Interval	N/A	73.0-76.5	N/A	N/A	N/A	73.0-76.5	N/A	N/A
Grout Seal Interval	0.0 - 18.9	0.0-73.0	0.0-18.0	0.0-17.1	0.0-7.5	0.9-73.0	0.0-11.0	0.0-23.0

*Open corehole served as the open interval for sample collection in shallow bedrock wells constructed without slotted screens.

BJG-13
1012-07.bjg.2

Table D-1 (Continued). SUMMARY OF BOREHOLE AND MONITORING WELL DIMENSIONS, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK (feet from ground surface, except where otherwise noted)

	MW-13-25	MW-15-40	MW-16-100	MW-17-40
Wellhead Elevation (USGS Datum)	587.69	584.57	534.83	396.15
Ground Elevation (USGS Datum)	587.69	584.57	531.28	396.15
Completed Well Depth	18.3	38.2	100.0	47.9
6-5/8" Borehole Interval	0.0-13.0	0.0-13.3	0.0-10.0	0.0-32.9
5-5/8" Borehole Interval	13.0-18.3	13.3-18.7	10.0-100.0	32.9-37.9
3-7/8" Borehole Interval	N/A	N/A	N/A	N/A
3" Open Borehole Interval*	N/A	18.7-38.2	N/A	37.9-47.9
PVC Casing Depth	N/A	N/A	N/A	N/A
Stainless Steel Casing Depth	8.3	18.7	80.0	37.9
Casing Stick-up	0.0	0.0	3.55	0.0
Screened Interval	8.3-18.3	N/A	80.0-100.0	N/A
Sand Pack Interval	6.0-18.3	N/A	78.0-100.0	N/A
Bentonite Seal Interval	4.0-6.0	N/A	75.0-78.0	N/A
Grout Seal Interval	0.0-4.0	0.0-18.7	0.0-75.0	0.0-37.9

*Open corehole served as the open interval for sample collection in shallow bedrock wells constructed without slotted screens.

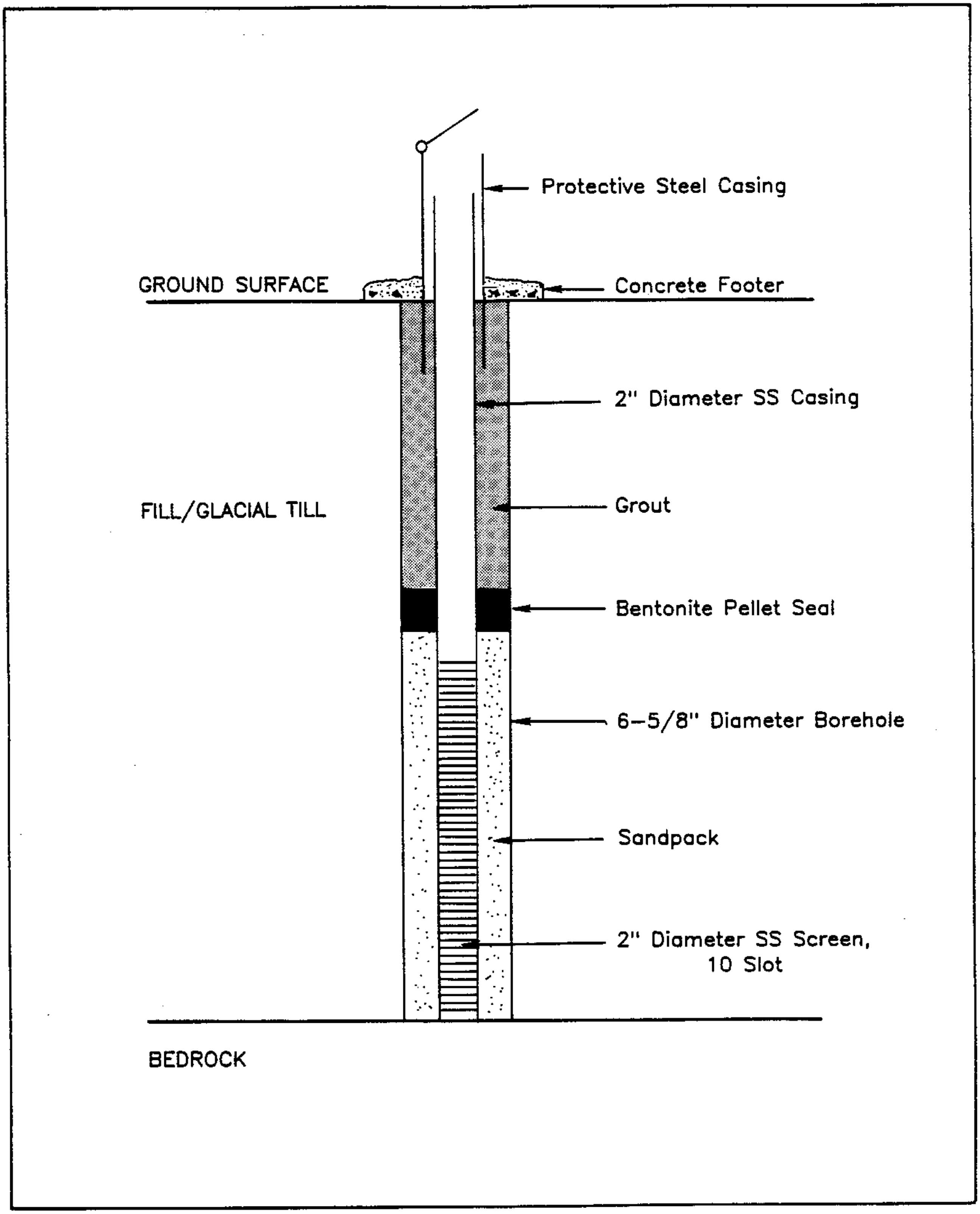


Figure D-1. Typical Well Construction for Overburden Wells Installed at Emerson Power Transmission, Ithaca, New York

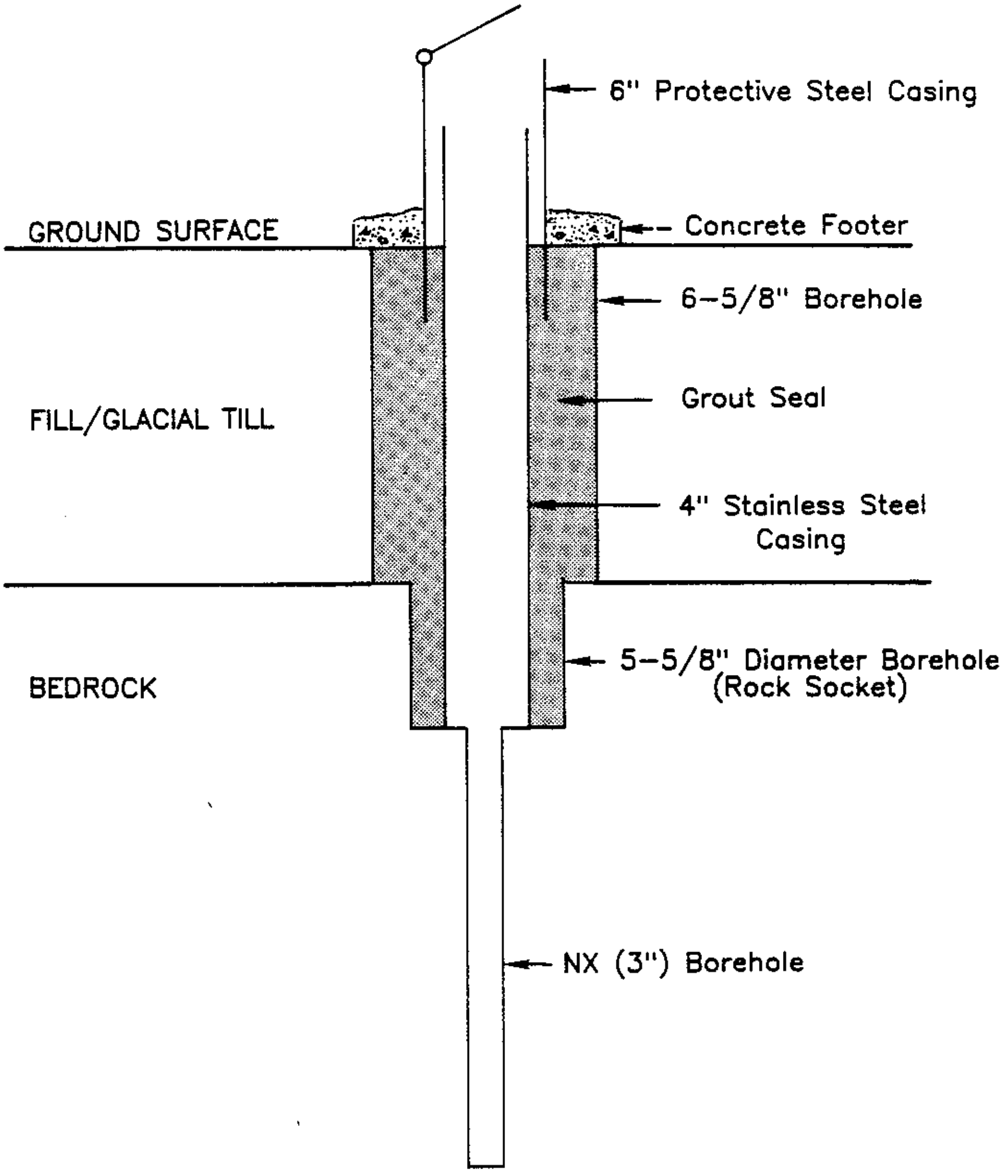


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Figure D-2. Typical Well Construction for Shallow Bedrock Wells Installed at Emerson Power Transmission, Ithaca, New York

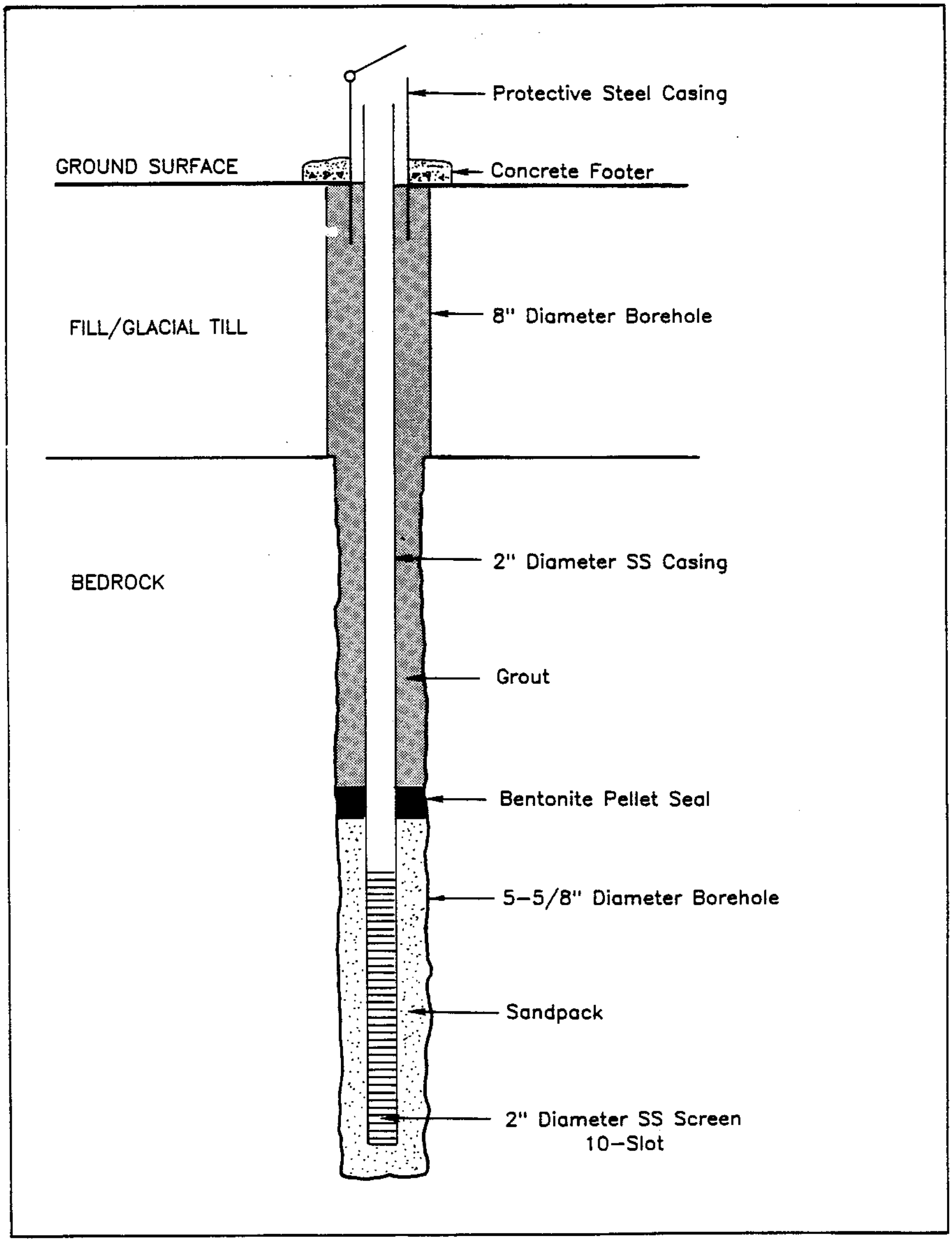

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Figure D-3. Typical Well Construction for Intermediate Depth Bedrock Wells Installed at Emerson Power Transmission, Ithaca, New York

WELL COMPLETION LOGS

WELL COMPLETION LOG

Project Name: Morse Industries
Project Number: 265-003-06-01

Well No. MW-1
Log Recorded By D. Holsten
Location ~60' NW of Tank
Completion Date 4/16/87

Drilling Method HSA and NX Core
Borehole Depth 39.2 ft.
Borehole Diameter 6 3/4 " - 5 5/8" - 3"

Materials:

Casing Diameter/Type Sch. 40 PVC/Flush Threaded
Screen Diameter/Type/Slot Size No Screen
Sand/Gravel No Pack
Bentonite Seal No Bentonite
Grout 0-19'

Intervals:

Screen Interval N/A
Casing Interval 0-19'
Sand/Gravel Pack Interval N/A
Bentonite Seal Interval N/A
Grout Interval 0-19'

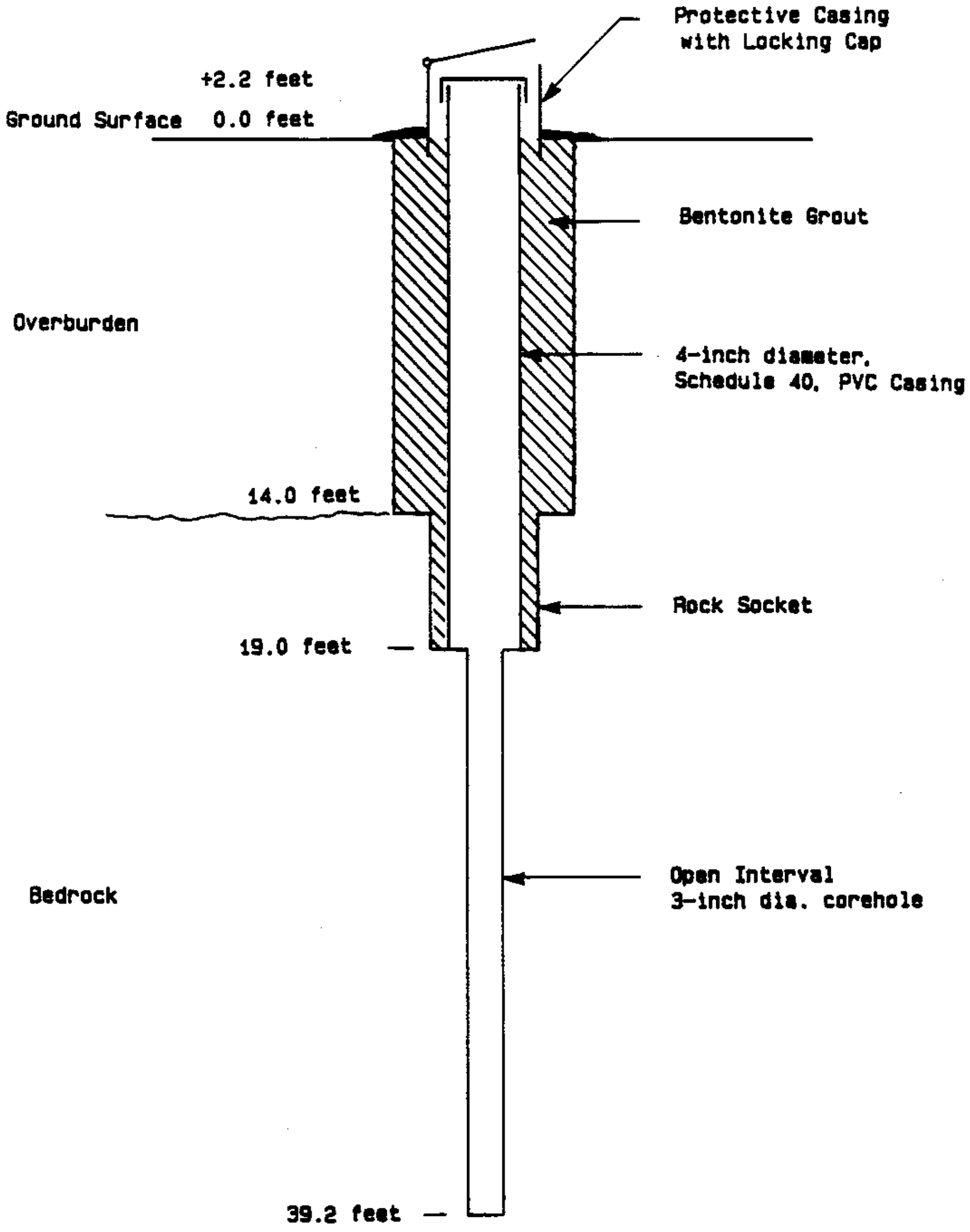
Type of Surface Completion Above Ground - 6" 0 Steel Security Casing

NOTES:

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number: MW-1



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WELL COMPLETION LOG

Project Name: Morse Industrial
Project Number: 265-003-06-01

Well No. MW-2 Log Recorded By D. Holsten
Location ~60' West of Tank Completion Date 4/16/87

Drilling Method HSA and NX Coring
Borehole Depth 38.3 ft. Borehole Diameter 6 3/4" - 5 5/8" - 3"

Materials:

Casing Diameter/Type Sch. 40 PVC/Flush Threaded
Screen Diameter/Type/Slot Size No Screen
Sand/Gravel No Pack
Bentonite Seal No Bentonite
Grout 0-13.5'

Intervals:

Screen Interval N/A
Casing Interval 0-13.5'
Sand/Gravel Pack Interval N/A
Bentonite Seal Interval N/A
Grout Interval 0-13.5'

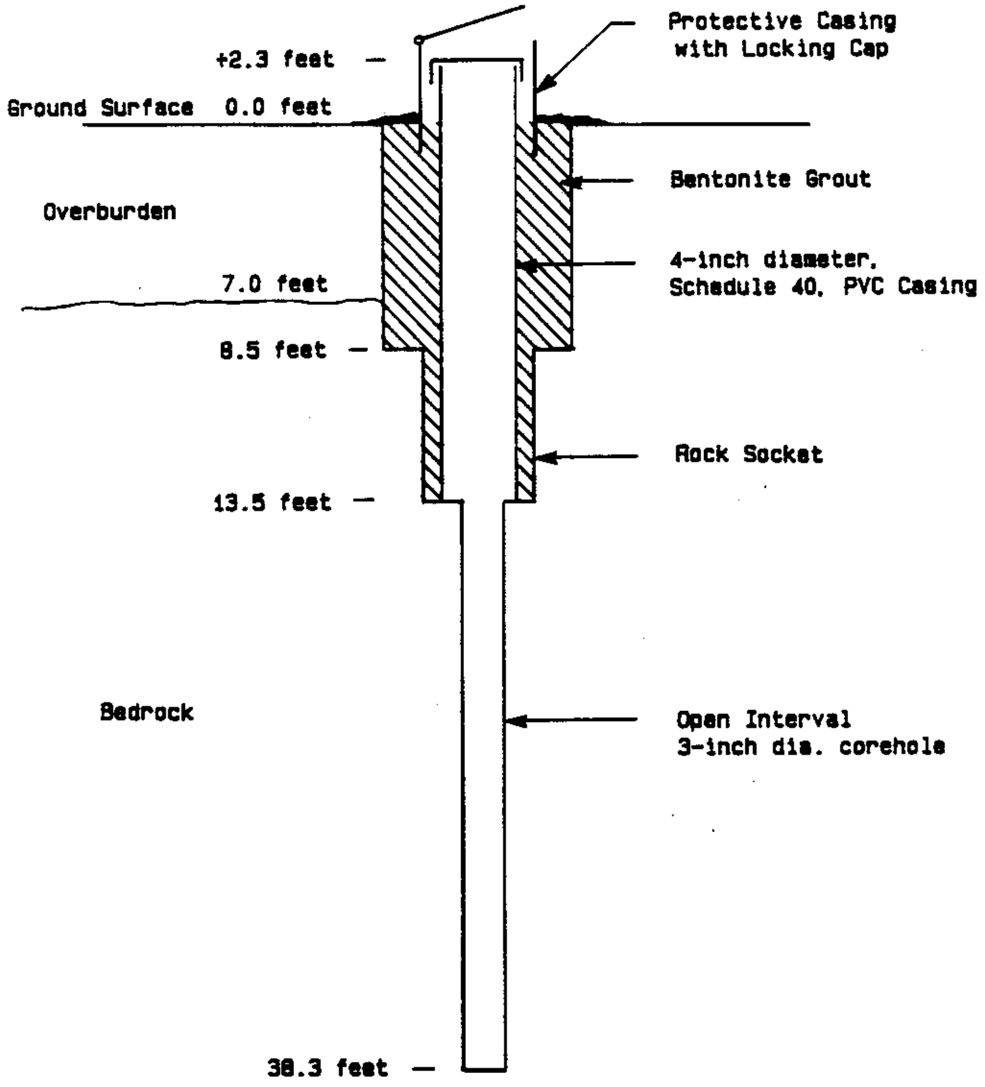
Type of Surface Completion Above ground 6" 0 steel security casing

NOTES:

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number: MW-2



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WELL COMPLETION LOG

Project Name: Emerson Power Transmission
Project Number: 215-004-36

Well No. MW-3s
Log Recorded By K. Makeig
Location
Completion Date 4/21/87

Drilling Method 6-inch O.D. Hollow Stem Auger

Borehole Depth 12.7 ft
Borehole Diameter 6-inch

Materials:

Casing Diameter/Type 4-inch sch. 40 PVC
Screen Diameter/Type/Slot Size 4-inch sch. 40 PVC
Sand/Gravel coarse sand
Bentonite Seal pellets
Grout Type I Portland cement/bentonite powder 6:1

Intervals:

Screen Interval 12.0 ft. to 4.0 ft.
Casing Interval 4.0 ft. to surface plus 2.5 ft. stick-up
Sand/Gravel Pack Interval 12.3 ft. to 3.0 ft.
Bentonite Seal Interval 12.7 ft. to 12.3 ft. and 3.0 ft. to 2.0 ft.
Grout Interval 2.0 ft. to surface

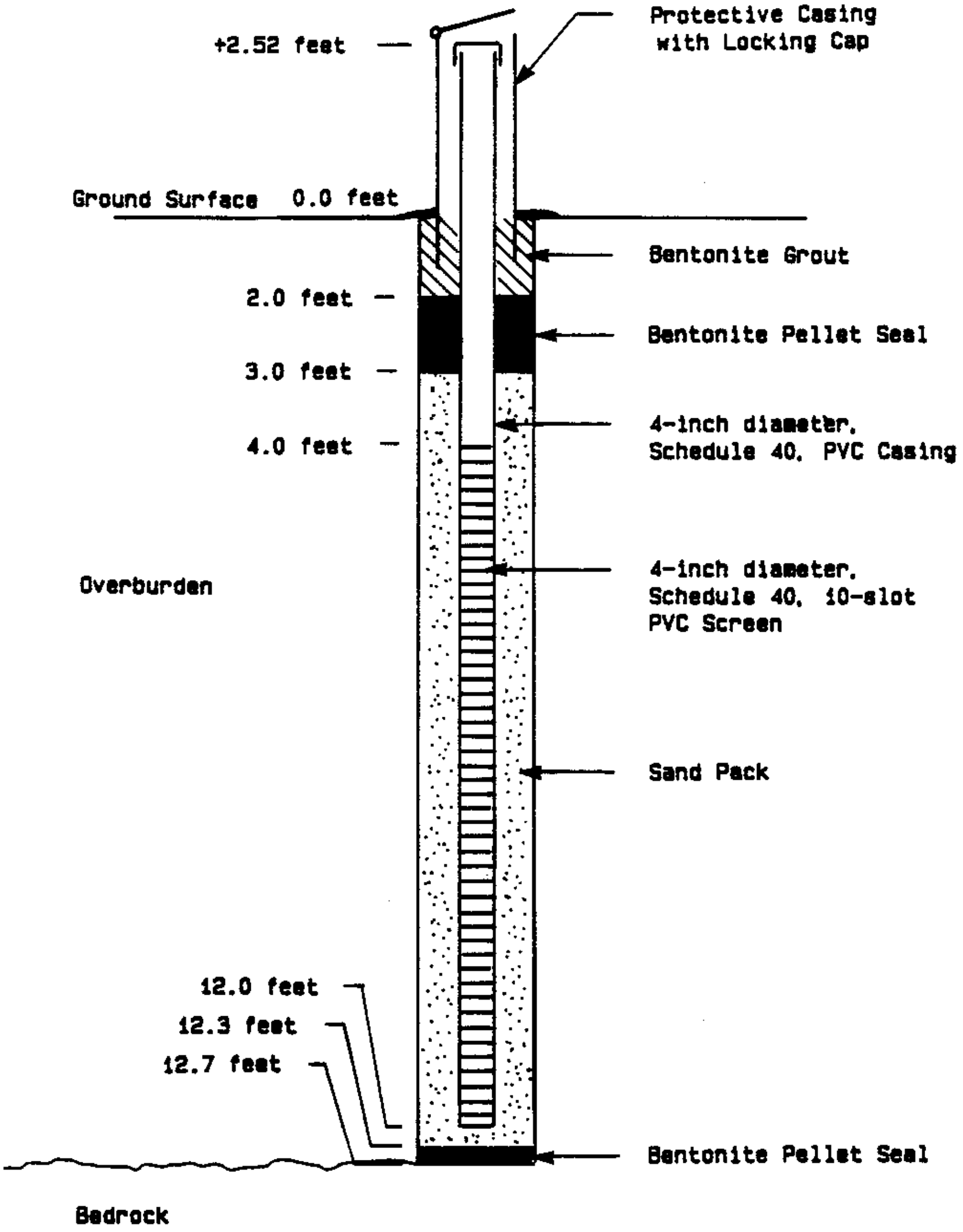
Type of Surface Completion Above ground 6-inch diameter steal guard pipe

NOTES:

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number: MW-3-13



WELL COMPLETION LOG

Project Name: Morse Industrial
Project Number: 265-003-06-01

Well No. MW-3
Log Recorded By D. Holsten
Location 60' SW of Tank
Completion Date 4/20/87

Drilling Method Auger and NX Coring
Borehole Depth 31 ft.
Borehole Diameter 5 5/8'

Materials:
Casing Diameter/Type 4" Sch. 40 PVC, Flush Threaded
Screen Diameter/Type/Slot Size N/A
Sand/Gravel N/A
Bentonite Seal N/A
Grout Type I Portland Cement With 3% Powdered Bentonite

Intervals:
Screen Interval N/A
Casing Interval 0-21'
Sand/Gravel Pack Interval N/A
Bentonite Seal Interval N/A
Grout Interval 0-21'

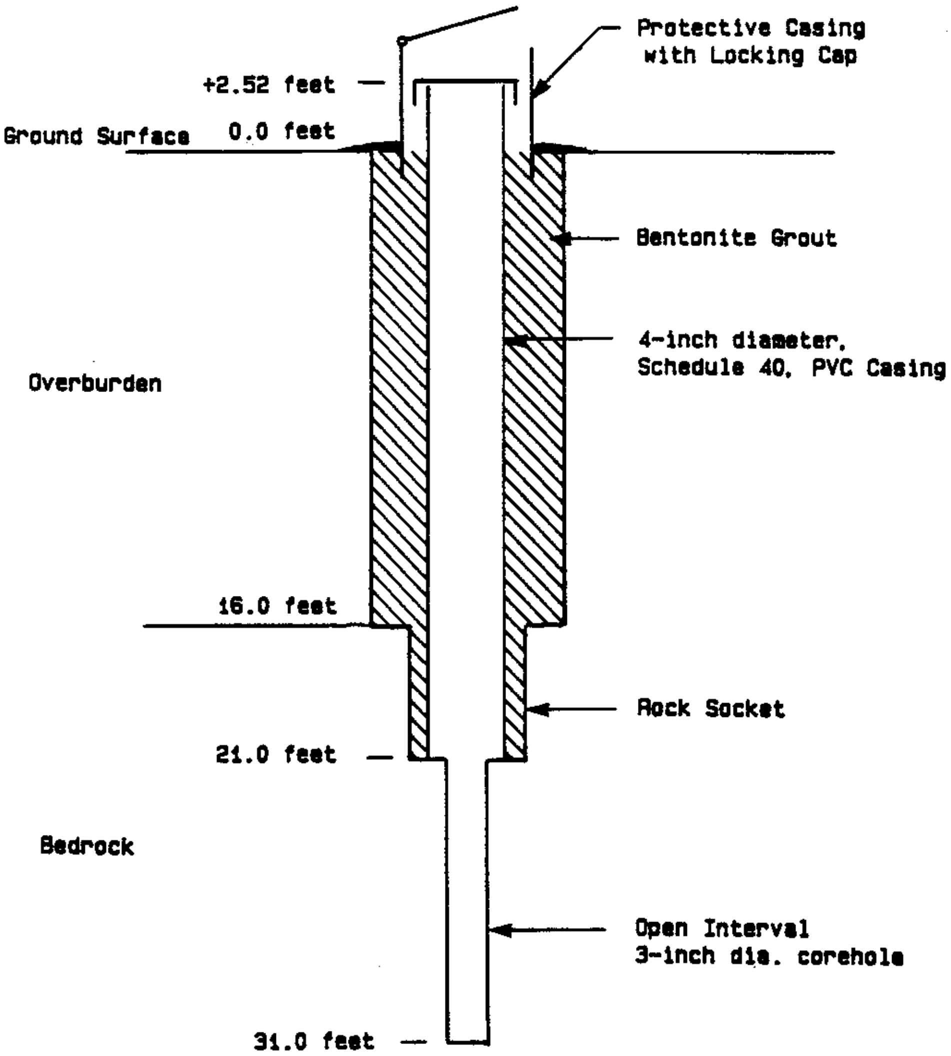
Type of Surface Completion Above Ground

NOTES:

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number: MW-3-31



WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project,Number: 215-004-01

Well No. MW-3-100
Log Recorded By R.T. Church
Location EPT
Completion Date 7/8/88
Drilling Method air rotary thru bedrock, hollow stem auger thru soil
Borehole Depth 100.0 ft
Borehole Diameter 5 5/8 inches

Materials:

Casing Diameter/Type 2-inch 304 stainless steel
Screen Diameter/Type/Slot Size 2-inch 304 stainless 0.010 slot
Sand/Gravel med size sand
Bentonite Seal pellets
Grout type I Portland Cement and Bentonite Powder 6:1

Intervals:

Screen Interval 100 ft to 80 ft
Casing interval 80 ft to surface + 2.5 ft stickup
Sand/Gravel Pack Interval 100 ft to 77 ft
Bentonite Seal Interval 77 ft to 74 ft
Grout Interval 74 ft to surface

Type of Surface Completion protective casing with locking cap and footer

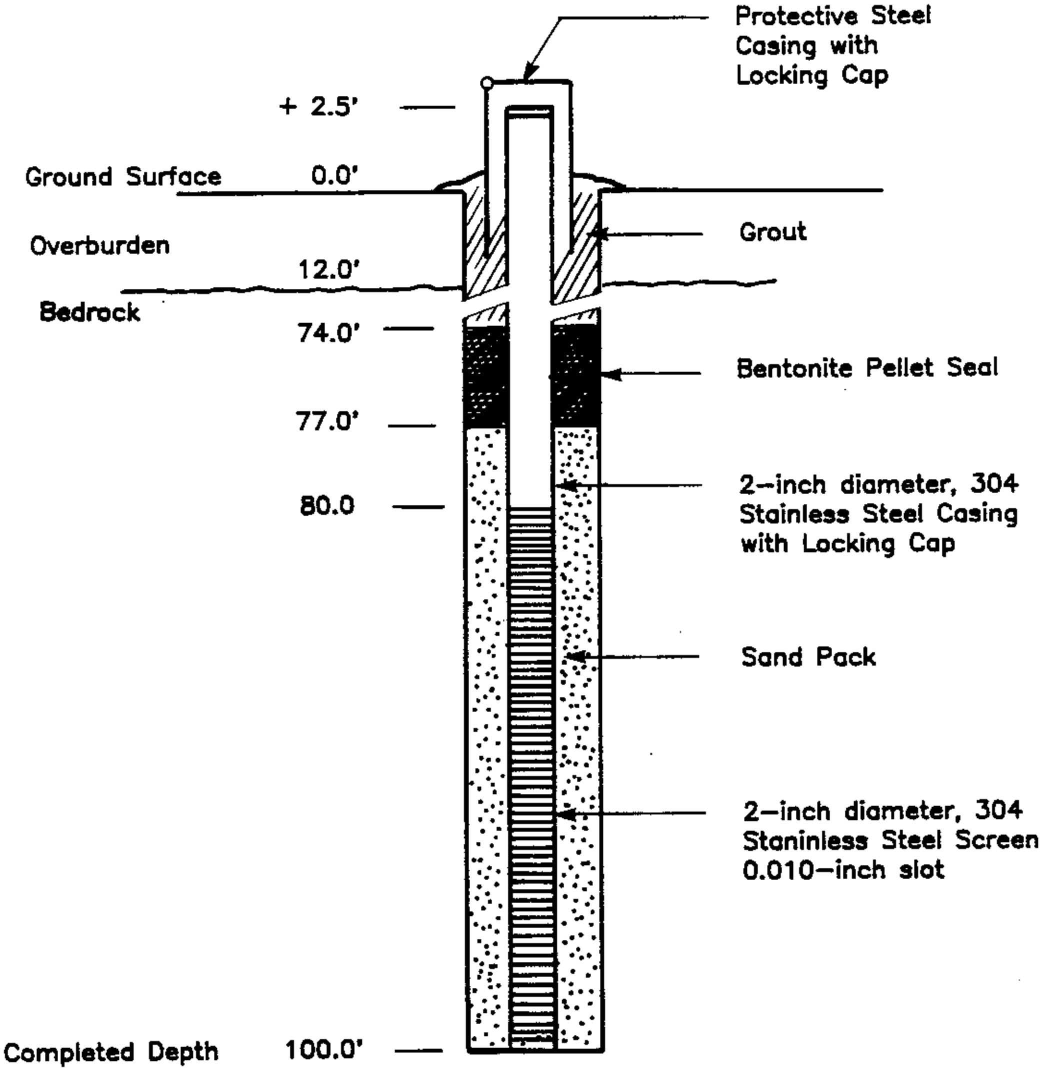
NOTES:

Rev. 8/86

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number MW–3–100



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WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project,Number: 215-004-01

Well No. MW-3-150 (MW-3-175)
Log Recorded By R.T. Church
Location EPT
Completion Date 8/12/88
Drilling Method see notes
Borehole Depth see note
Borehole Diameter 5 5/8 inches

Materials:

Casing Diameter/Type 2-inch 304 stainless steel
Screen Diameter/Type/Slot Size 2-inch 304 stainless 0.010 slot
Sand/Gravel med size sand
Bentonite Seal pellets
Grout type I Portland Cement and Bentonite Powder 6:1

Intervals:

Screen Interval 150.0 ft to 130.5 ft
Casing interval 130.5 ft to surface (stainless) 125.0 to surface (PVC)
Sand/Gravel Pack Interval 175.0 ft to 152.0 ft + 150.0 ft to 128.5 ft
Bentonite Seal Interval 152.0 ft to 150.0 ft + 128.5 ft to 126.5 ft
Grout Interval 126.5 ft to surface

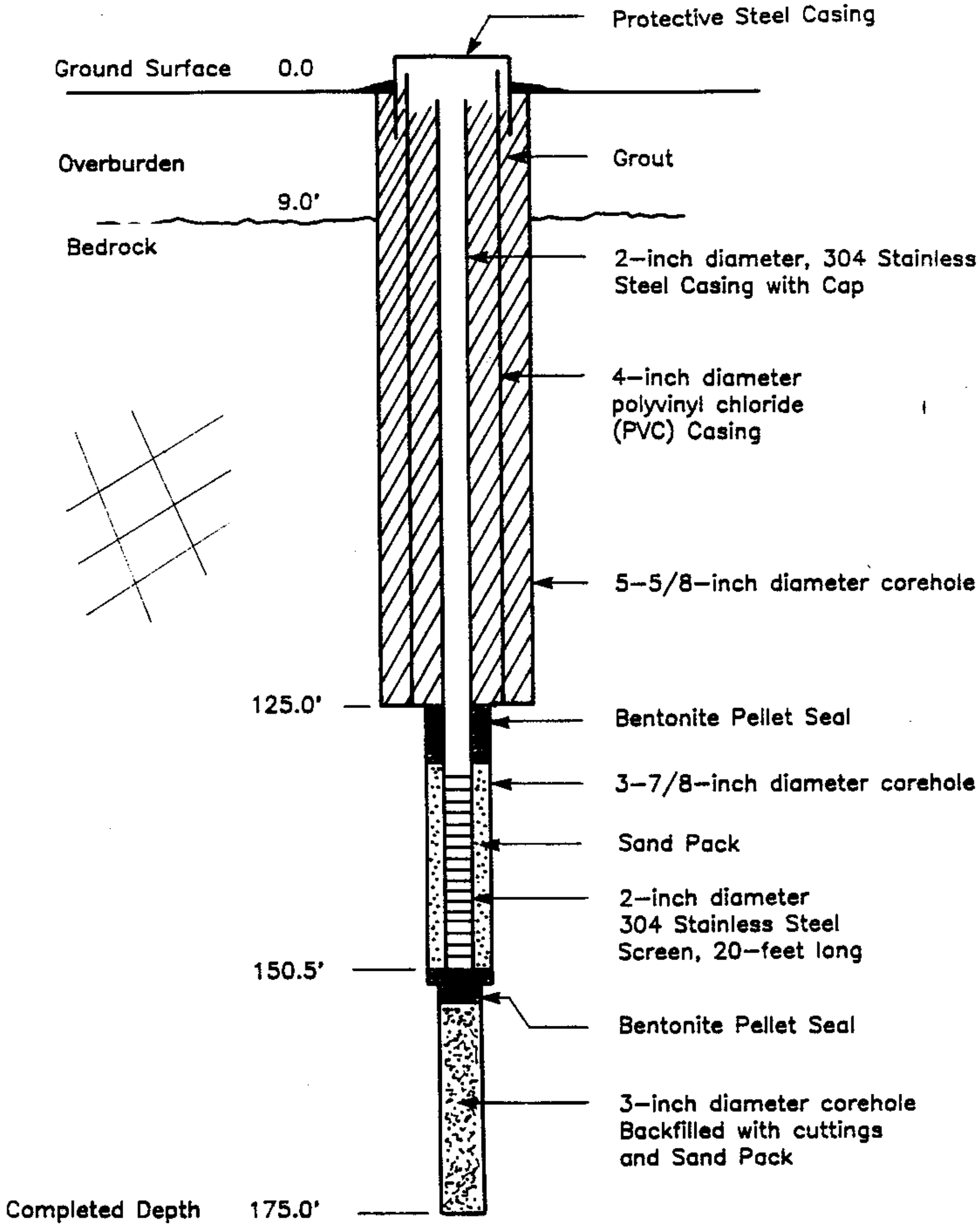
Type of Surface Completion protective casing with curb box

NOTES: Drilling method:
1. 6-inch ID temporary casing to top of bedrock
2. NX (3-inch) core of bedrock to 125 ft
3. Ream to 5 5/8-inch with tricone roller bit

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number: MW-3-150



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Page 1 of 2
Well No. MW-4

WELL COMPLETION LOG

Project Name: Morse Industrial
Project Number: 265-003-06-01

Well No. MW-4 Log Recorded By K. Makeig
Location Upgradient Completion Date 4/22/87

Drilling Method Auger and NX Coring
Borehole Depth 42 ft. Borehole Diameter 3'

Materials:
Casing Diameter/Type 4" Sch. 40 PVC, Flush Threaded
Screen Diameter/Type/Slot Size N/A
Sand/Gravel N/A
Bentonite Seal N/A
Grout Type I Portland Cement With Powdered Bentonite 6:1

Intervals:
Screen Interval N/A
Casing Interval 0-12'
Sand/Gravel Pack Interval N/A
Bentonite Seal Interval N/A
Grout Interval 0-12'

Type of Surface Completion Above ground 6" steel guard pipe

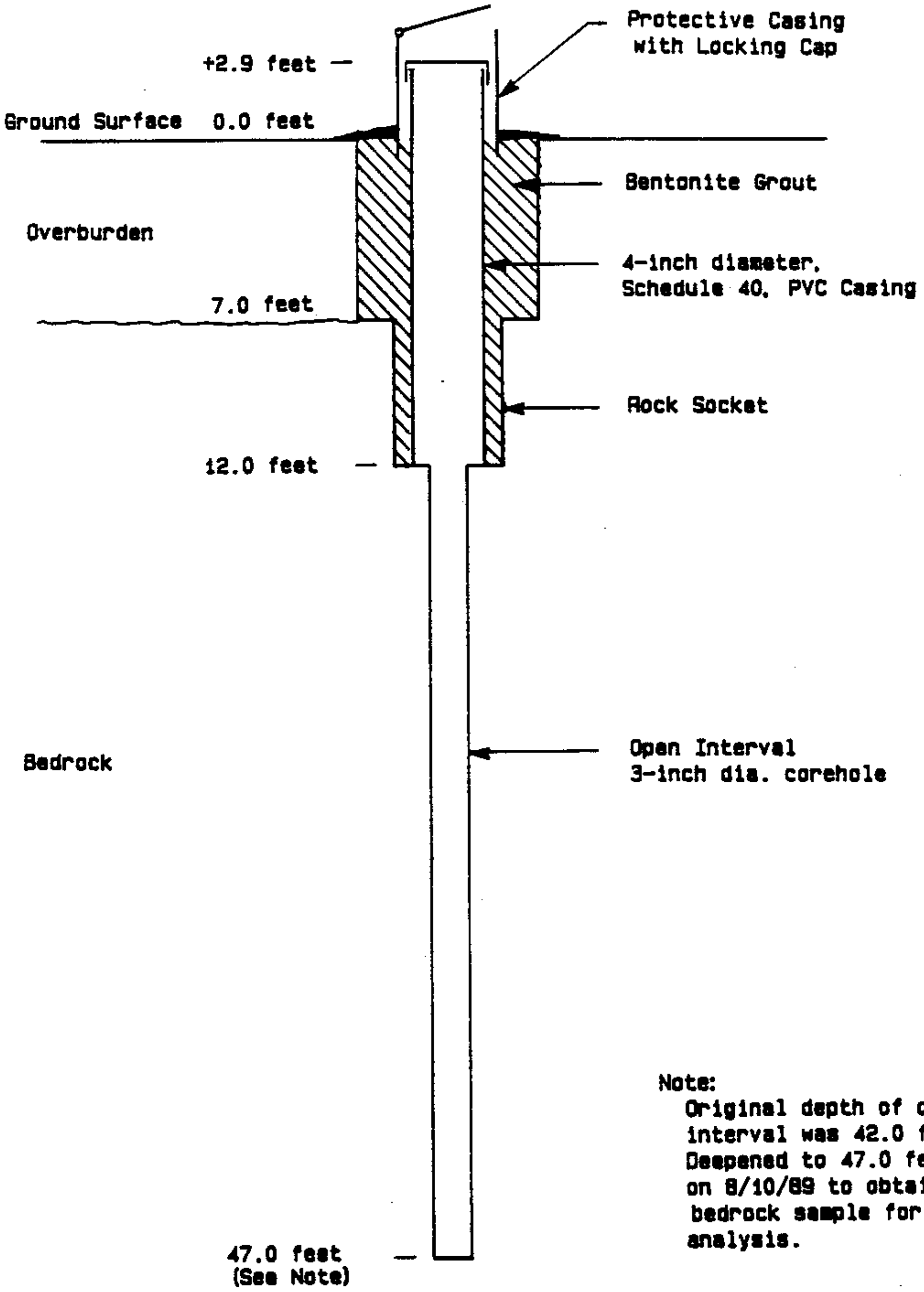
NOTES: *Borehole deepened to 47 ft. during Stage 2

BJG-15
1031-02.bjg.5

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number: MW-4



Note:
Original depth of open interval was 42.0 feet. Deepened to 47.0 feet on 8/10/89 to obtain bedrock sample for chemical analysis.

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Page 1 of 2
Well No. MW-5-25

WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project Number: 215-004-01

Well No. MW-5-25

Log Recorded By W.P. Suggs

Location EPT

Completion Date 7/18/88

Drilling Method hollow stem auger

Borehole Depth 11.8 ft

Borehole Diameter 8 1/4 to 11.8 inches

Materials:

Casing Diameter/Type 2-inch stainless steel 304

Screen Diameter/Type/Slot Size 2-inch 304 stainless 0.010 slot

Sand/Gravel coarse sand

Bentonite Seal pellets

Grout type I Portland Cement and Bentonite Powder 6:1

Intervals:

Screen Interval 3.5 ft to 11.6 ft

Casing interval 0.3 ft to 3.5 ft

Sand/Gravel Pack Interval 3.0 ft to 11.8 ft

Bentonite Seal Interval 1.7 ft to 3.0 ft

Grout Interval 1.7 ft to 0.7 ft

Type of Surface Completion 8-inch flush mount steel protective manhole w/cap

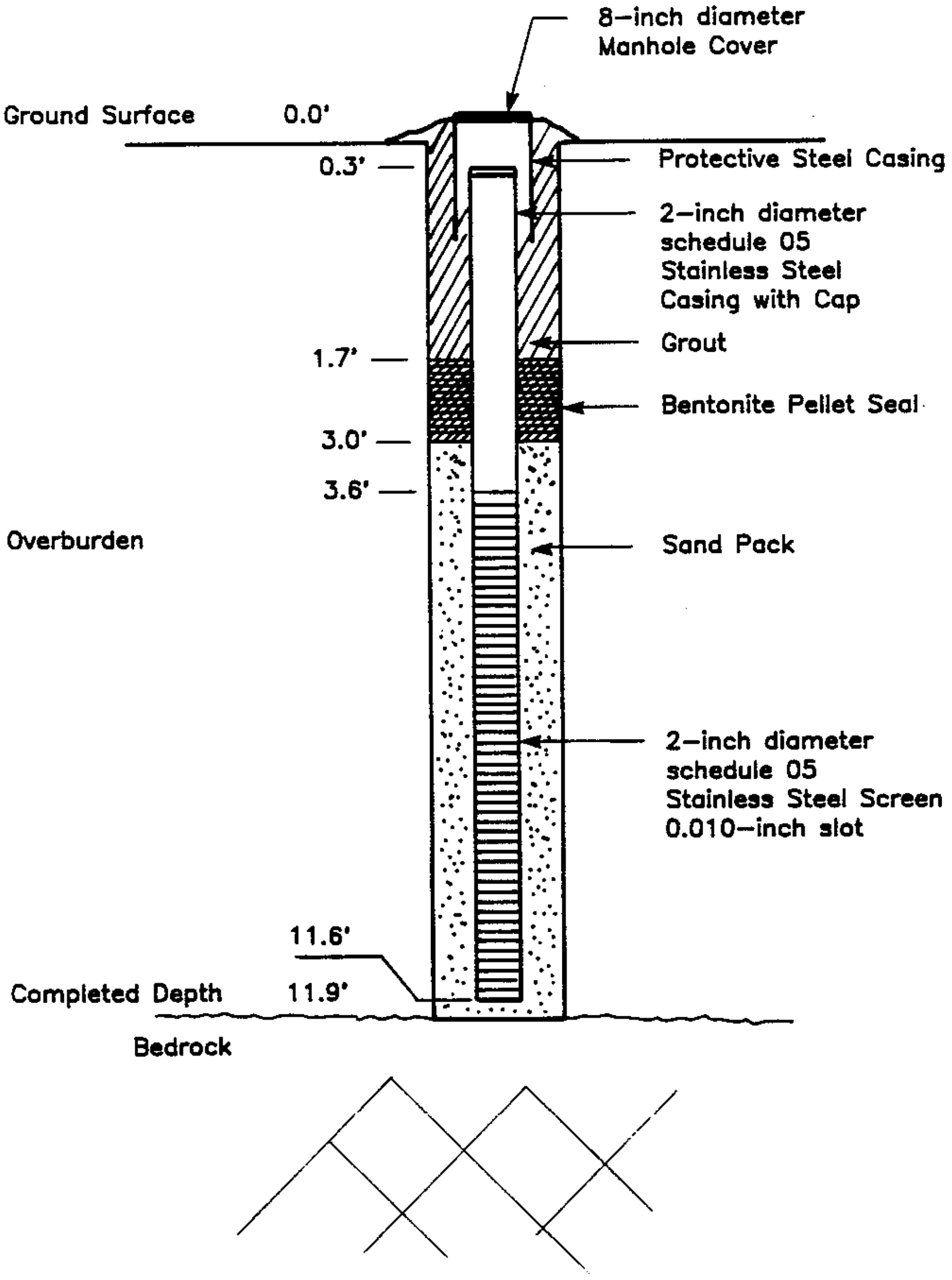
NOTES:

Rev. 8/86

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number MW-5-25



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WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project Number: 215-004-01

Well No. MW-5-40 **Log Recorded By** R.T. Church
Location EPT **Completion Date** 5/14/88
Drilling Method air rotary thru bedrock, hollow stem auger thru soil
Borehole Depth 40.3 ft **Borehole Diameter** 3 inches

Materials:

Casing Diameter/Type 4-inch 304 stainless steel
Screen Diameter/Type/Slot Size open hole
Sand/Gravel
Bentonite Seal
Grout type I Portland Cement and Bentonite Powder 6:1

Intervals:

Screen Interval open hole 40.3 ft to 17.3 ft
Casing interval 17.3 ft to 0.4 ft
Sand/Gravel Pack Interval
Bentonite Seal Interval
Grout Interval 17.3 ft to 0.4 ft

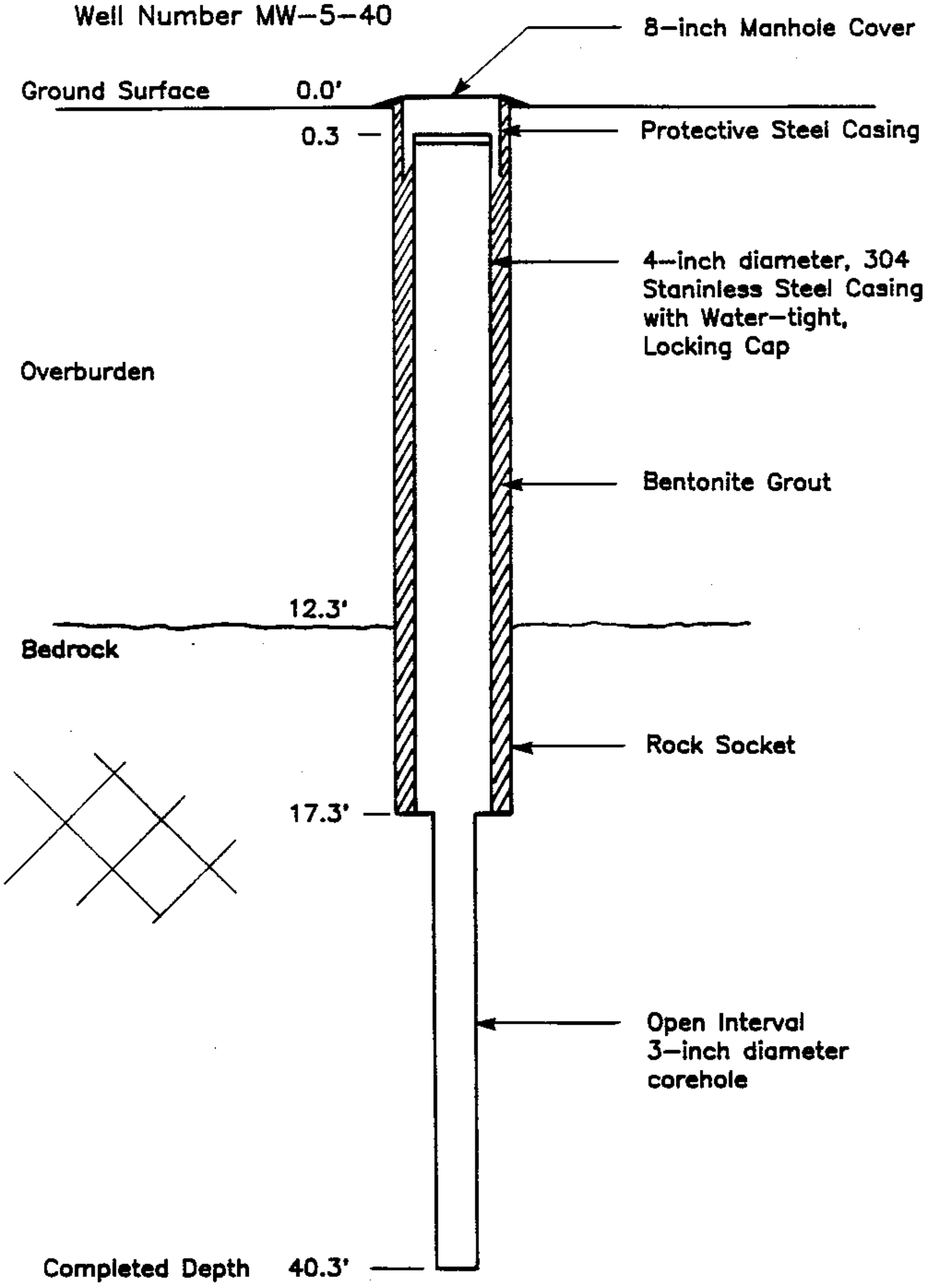
Type of Surface Completion protective, curb box with 2-inch stickup

NOTES:

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number MW–5–40



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WELL COMPLETION LOG

Project Name· Emerson Power Transmission
Project Number: 215-004-36

Well No. MW-5-100
Log Recorded By R.T. Church
Location Upgradient of fire reservoir
Completion Date 8/11/89

Drilling Method NX core and 5 5/8" tri-cone roller
Borehole Depth 100.0 ft.
Borehole Diameter 5 5/8 inches

Materials:

Casing Diameter/Type 2-inch stainless steel type 304
Screen Diameter/Type/Slot Size 2-inch type 304 stainless steel, 10 slot
Sand/Gravel Coarse sand
Bentonite Seal Pellets
Grout Type I Portland cement/bentonite powder 6/1

Intervals:

Screen Interval 99.0' to 79.0'
Casing Interval 79.0' to 0.8'
Sand/Gravel Pack Interval 99.0' to 76.0'
Bentonite Seal Interval 76.0' to 73.0'
Grout Interval 73.0' to 1.0 ft.

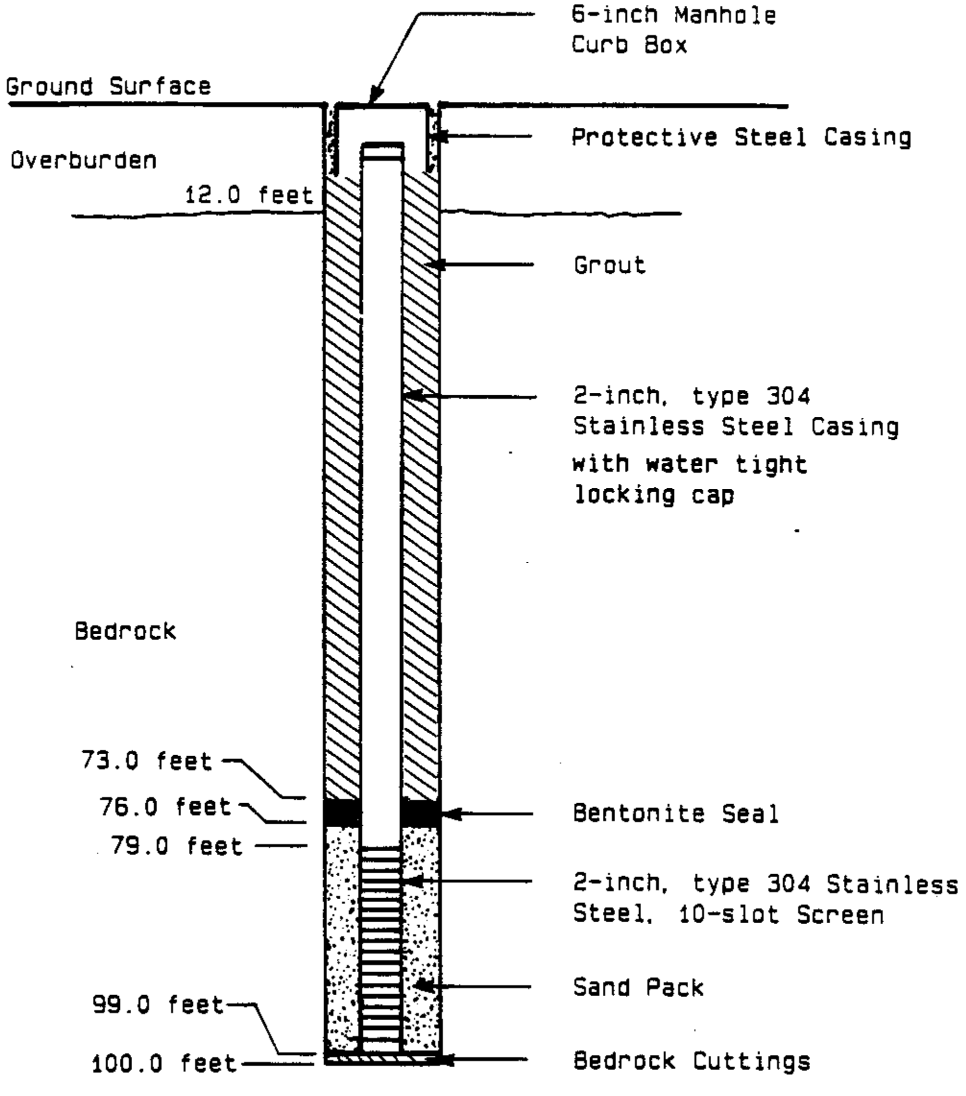
Type of Surface Completion 6-inch manhole over locking expandable plug

NOTES: 1 foot of rock cuttings settled in bottom of hole before installing well.

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number: MW-5-100



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RADIAN CORPORATION

WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project Number: 215-004-01

Well No. MW-6-25

Log Recorded By R.T.Church

Location EPT

Completion Date 7/14/88

Drilling Method hollow stem auger

Borehole Depth 11.0 ft

Borehole Diameter 6 1/4 inch

Materials:

Casing Diameter/Type 2-inch 304 stainless steel schedule 5

Screen Diameter/Type/Slot Size 2-inch 304 stainless 0.010 slot

Sand/Gravel coarse sand

Bentonite Seal pellets

Grout type I Portland Cement and Bentonite Powder 6:1

Intervals:

Screen Interval 11.0 ft to 4.0 ft

Casing interval 4.0 ft to surface

Sand/Gravel Pack Interval 11.0 ft to 3.5 ft

Bentonite Seal Interval 3.5 ft to 1.5 ft

Grout Interval 1.5 ft to surface

Type of Surface Completion 2.5 ft stickup, protective casing with locking cap

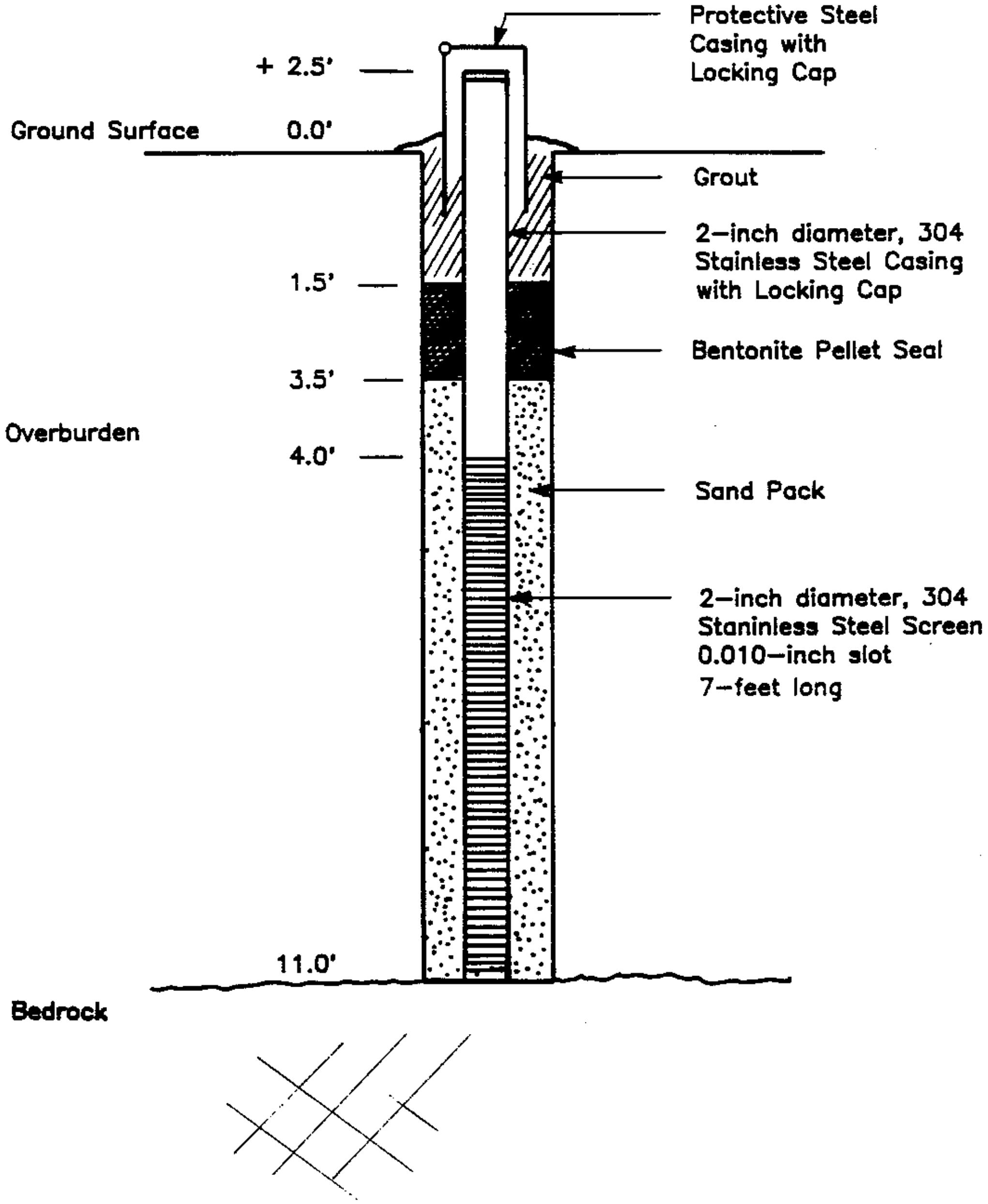
NOTES:

Rev. 8/86

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number MW–6–25



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WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project Number: 215-004-01

Well No. MW-6-40

Log Recorded By W.P. Sugg

Location EPT

Completion Date 7/11/88

Drilling Method tri-cone roller thru bedrock, hollow stem auger thru soil

Borehole Depth 38.9 ft

Borehole Diameter 3 inches to 38.9 ft

Materials:

Casing Diameter/Type 4-inch 304 stainless steel to 13.9 ft

Screen Diameter/Type/Slot Size open hole

Sand/Gravel

Bentonite Seal

Grout Type I Portland Cement and Bentonite Powder 6:1

Intervals:

Screen Interval

Casing interval +1.1 ft to 18.9 ft

Sand/Gravel Pack Interval

Bentonite Seal Interval

Grout Interval 0.0 ft to 18.9 ft

Type of Surface Completion protective casing and locking cap with footer

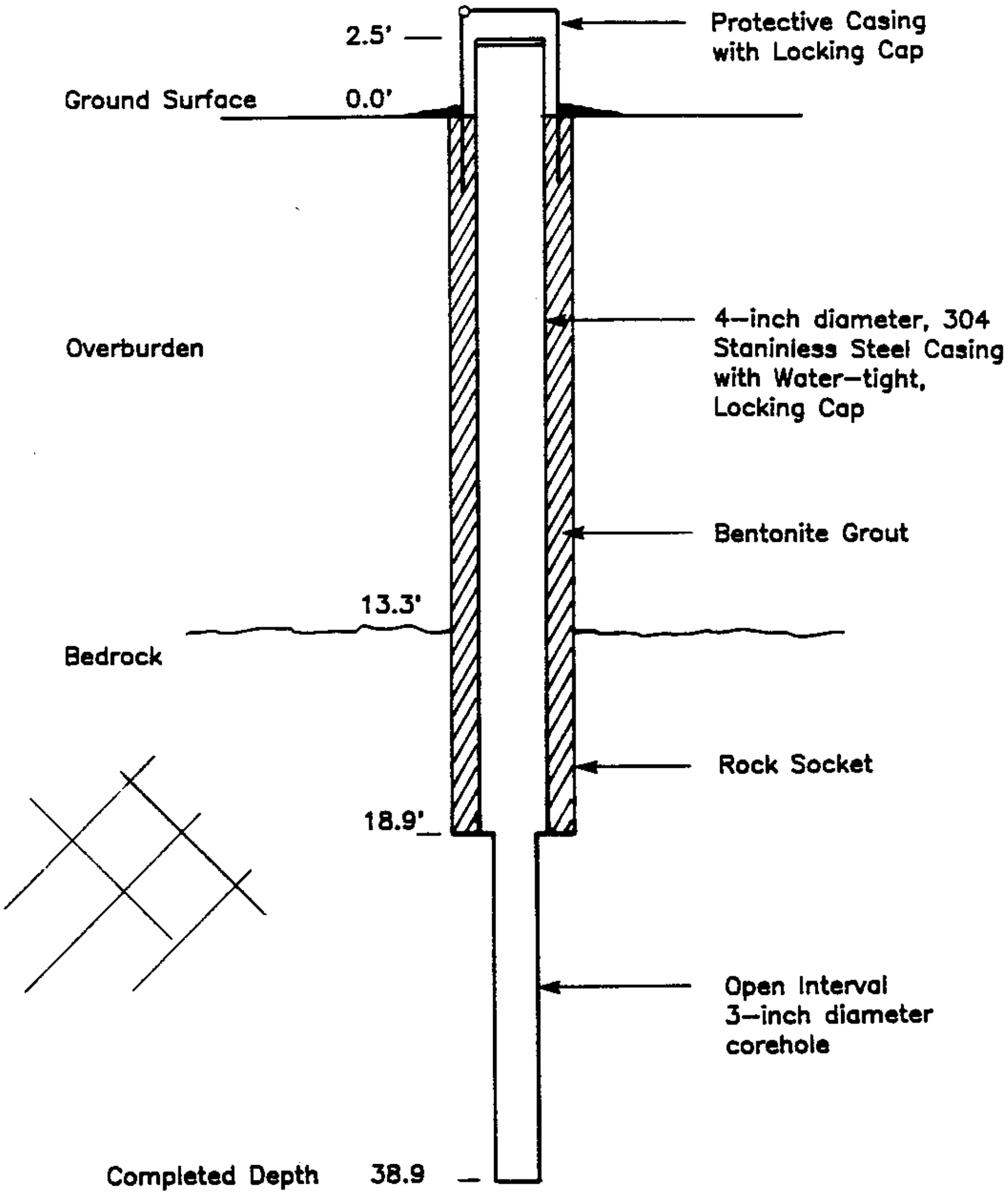
NOTES:

Rev. 8/86

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number MW-6-40



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Page 1 of 2
Well No. MW- 6-100

WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project, Number: 215-004-01

Well No. MW-6-100 **Log Recorded By** R.T. Church

Location EPT **Completion Date** 7/25/88

Drilling Method air rotary thru bedrock, hollow stem auger thru soil

Borehole Depth 100 ft **Borehole Diameter** 5 5/8 inches

Materials:

Casing Diameter/Type 2-inch 304 stainless steel

Screen Diameter/Type/Slot Size 2-inch 304 stainless 0.010 slot

Sand/Gravel coarse sand

Bentonite Seal pellets

Grout type I Portland Cement and Bentonite Powder 6:1

Intervals:

Screen Interval 99.5 ft tp 79.5 ft

Casing interval 79.5 ft to surface + 2.5 ft stickup

Sand/Gravel Pack Interval 99.5 ft to 76.5 ft

Bentonite Seal Interval 76.5 ft to 73.0 ft

Grout Interval 73.0 ft to surface

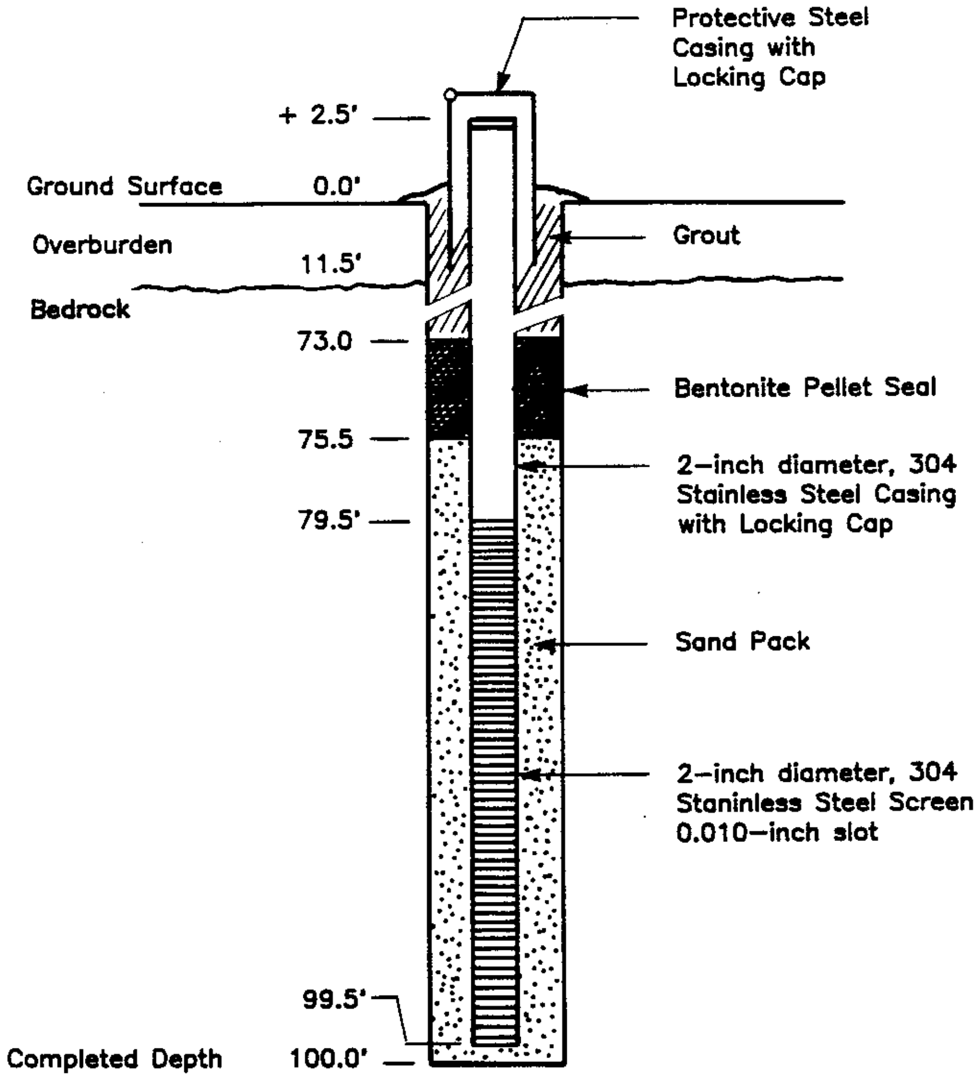
Type of Surface Completion protective casing with locking cap and footer

NOTES:

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number MW–6–100



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Page 1 of 2
Well No. MW- 7-40

WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project,Number: 215-004-01

Well No. MW-7-40 **Log Recorded By** R.T. Church

Location EPT **Completion Date** 7/29/88

Drilling Method air rotary thru bedrock, hollow stem auger thru soil

Borehole Depth 38.0 ft **Borehole Diameter** 3 inches

Materials:

Casing Diameter/Type 4`-inch 304 stainless steel

Screen Diameter/Type/Slot Size open hole

Sand/Gravel

Bentonite Seal

Grout type I Portland Cement and Bentonite Powder 6:1

Intervals:

Screen Interval open hole from 38.0 ft to 18.0 ft

Casing interval 18.0 ft to surface + 2.0 ft stickup

Sand/Gravel Pack Interval

Bentonite Seal Interval

Grout Interval 18.0 ft to surface

Type of Surface Completion protective casing with locking cap and footer

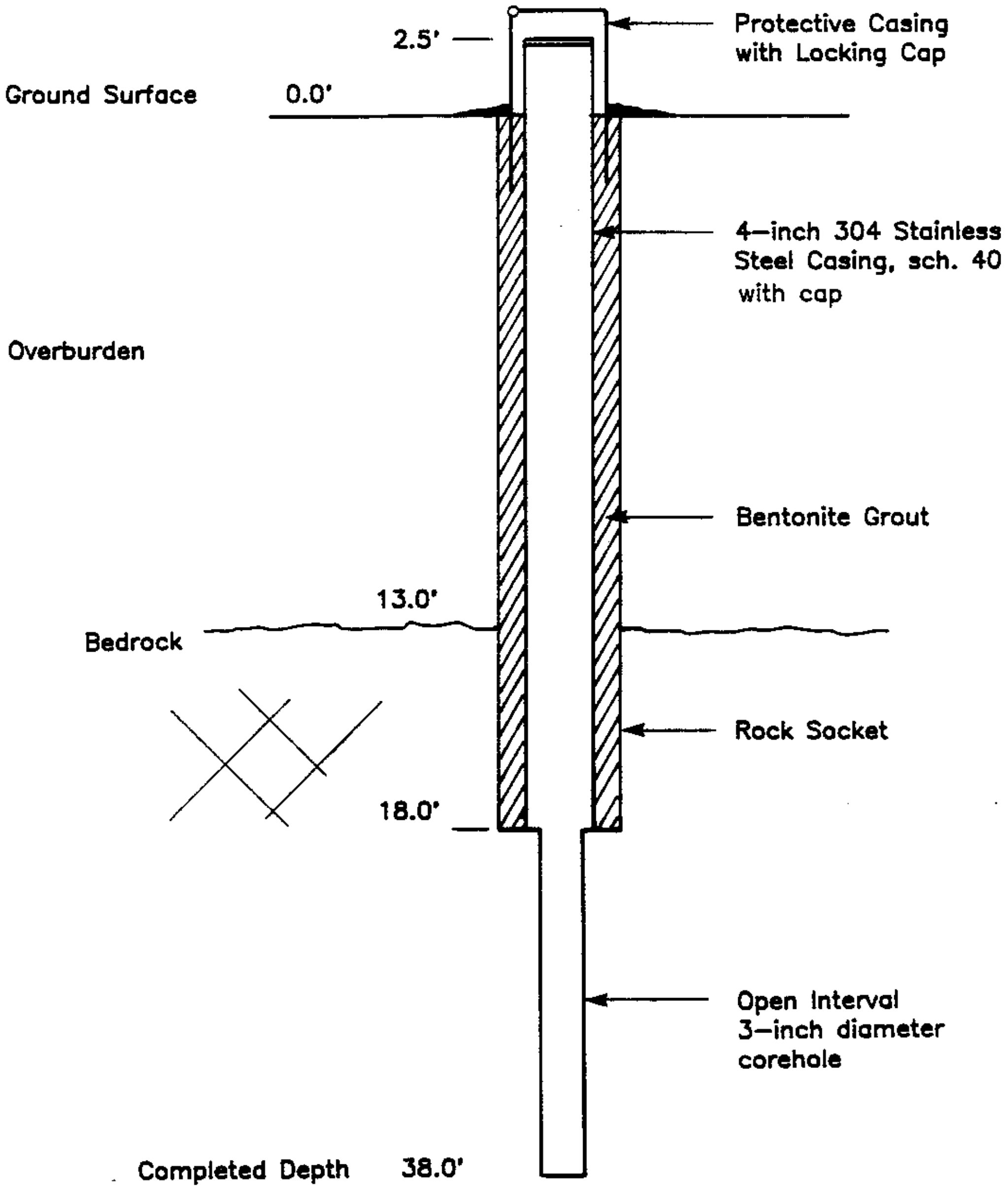
NOTES:

Rev. 8/86

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number MW-7-40



NOT TO SCALE

WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project Number: 215-004-01

Well No. MW-8-40

Log Recorded By Church/Sugg

Location EPT

Completion Date 7/13/88

Drilling Method Tricone roller thru bedrock, hollow stem auger thru soil

Borehole Depth 43.2 ft

Borehole Diameter 3 inches to 43.2 ft

Materials:

Casing Diameter/Type 4-inch 304 stainless steel

Screen Diameter/Type/Slot Size open hole

Sand/Gravel

Bentonite Seal

Grout type I Portland Cement and Bentonite Powder 6:1

Intervals:

Screen Interval

Casing interval 0.2 ft to 17.1 ft

Sand/Gravel Pack Interval

Bentonite Seal Interval

Grout Interval 0.5 ft to 17.1 ft

Type of Surface Completion 8-inch flush mount manhole w/water tight lid

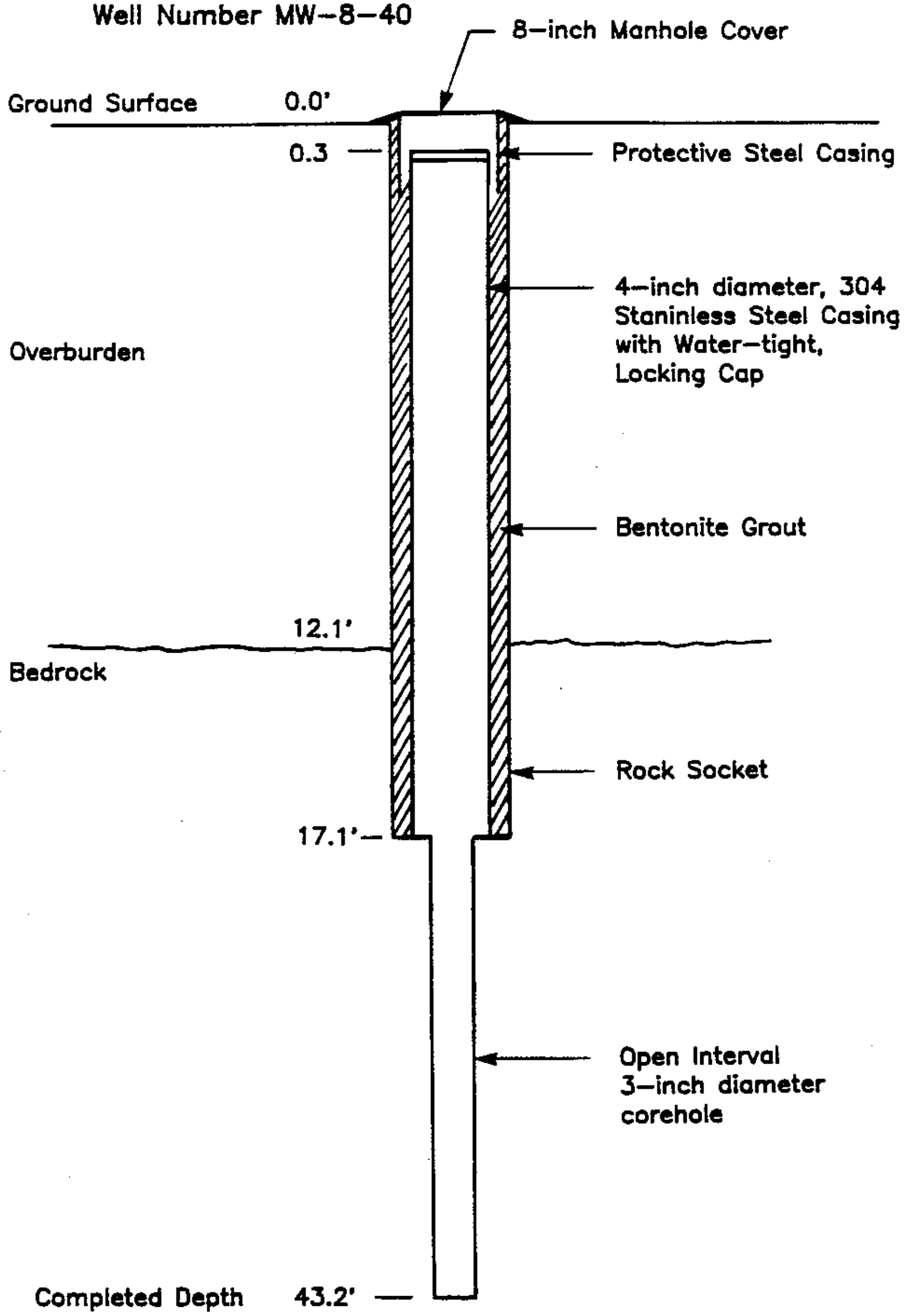
NOTES:

Rev. 8/86

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number MW-8-40



WELL COMPLETION LOG

Project Name: Copeland

Project Number: 215-004-36

Well No. MW-9-40

Log Recorded By P.T. LeClair

Location EPT

Completion Date 8/22/89

Drilling Method NX core barrel and tri-cone holler thru bedrock, hollow stem auger thru soil

Borehole Depth 40.0 ft

Borehole Diameter 3-inch

Materials:

Casing Diameter/Type 4-inch 304 stainless steel

Screen Diameter/Type/Slot Size 3-inch open hole

Sand/Gravel

Bentonite Seal

Grout Type I Portland cement/bentonite powder 6:1

Intervals:

Screen Interval Open hole 7.5 ft. to 40.0 ft.

Casing Interval 0.5 ft. to 7.5 ft.

Sand/Gravel Pack Interval

Bentonite Seal Interval

Grout Interval 0.5 ft. to 7.5 ft.

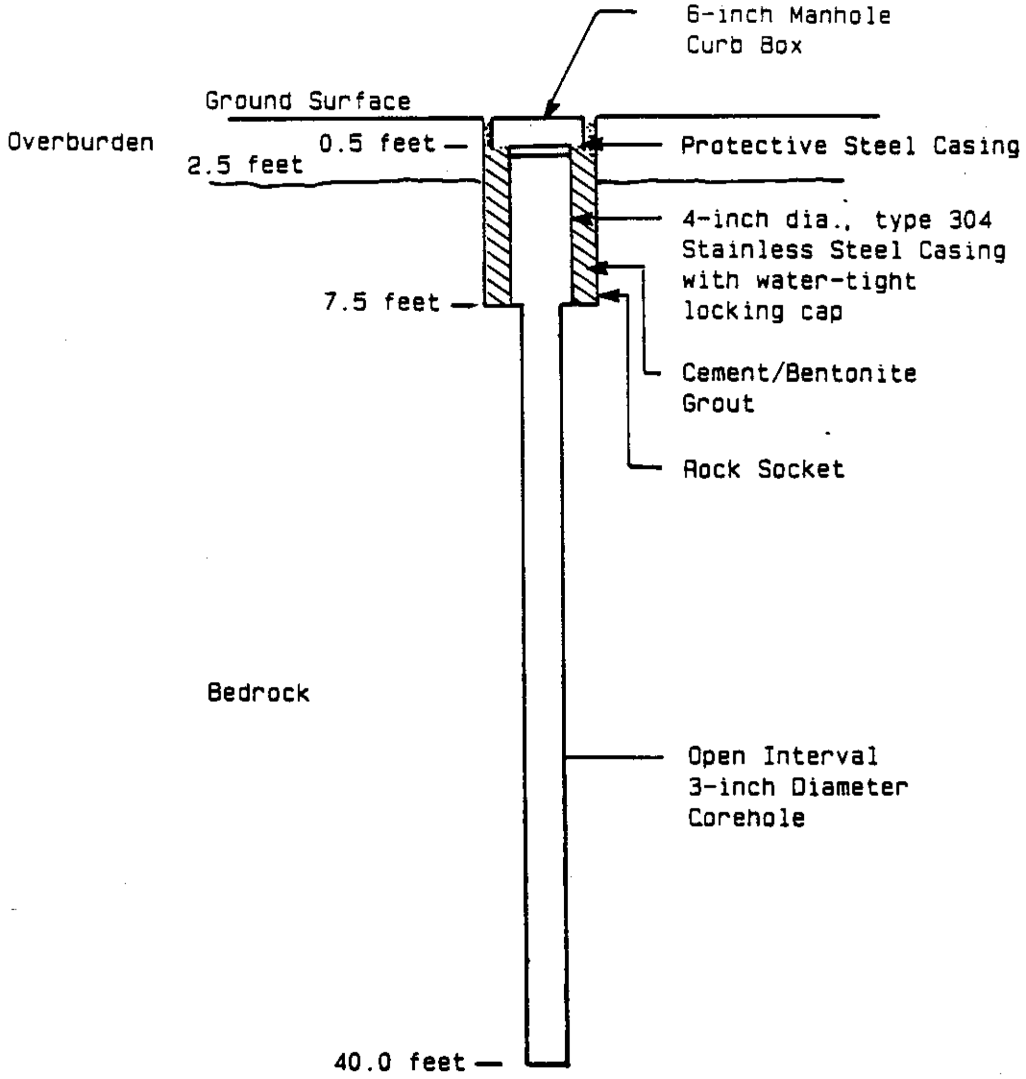
Type of Surface Completion flush mounted protective curb box

NOTES:

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number: MW-9-40



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WELL COMPLETION LOG

Project Name: Emerson Power Transmission
Project Number: 215-004-36

Well No. MW-9-100 Log Recorded By R.T. Church
Location Cayuga Street and access road Completion Date 8/18/89

Drilling Method Size NX core barrel and 5 5/8" tri-cone roller
Borehole Depth 101.0 ft Borehole Diameter 5 5/8'

Materials:

Casing Diameter/Type 2-inch type 304 stainless steel
Screen Diameter/Type/Slot Size 2-inch, 304 stainless steel, 10-slot
Sand/Gravel Coarse sand
Bentonite Seal Pellets
Grout Type I Portland cement/powder bentonite 6:1

Intervals:

Screen Interval 100.0' to 80.0'
Casing Interval 80.0' to 0.8'
Sand/Gravel Pack Interval 100.0' to 76.5'
Bentonite Seal Interval 76.5' to 73.0'
Grout Interval 73.0' to 0.9'

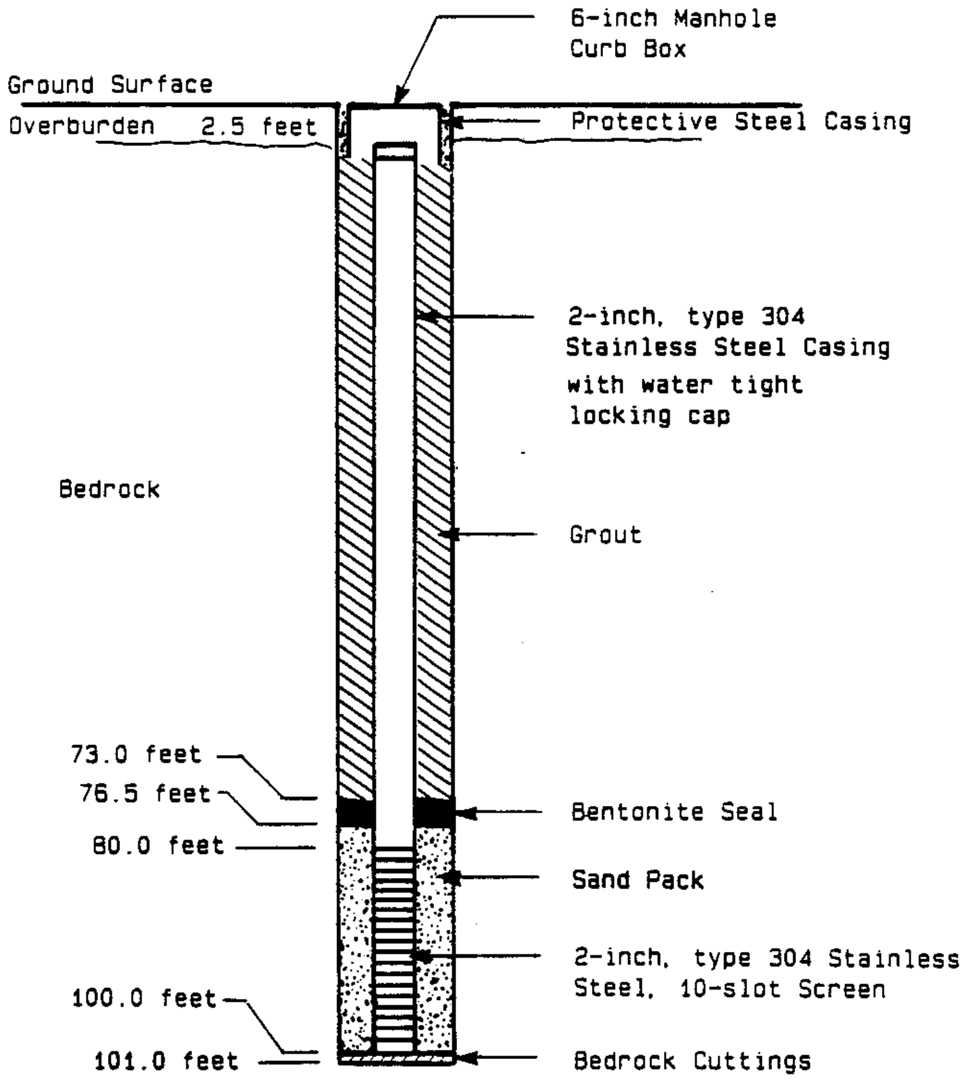
Type of Surface Completion 6-inch manhole over locking expandable plug

NOTES: 1 ft. of rock cuttings settled to bottom of borehole before installing well

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number: MW-9-100



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RADIAN

WELL COMPLETION LOG

Project Name: Emerson Power Transmission
Project Number: 215-004-36

Well No. MW-10-40
Log Recorded By P.T. LeClair
Location EPT
Completion Date 8/24/89

Drilling Method NX core barrel and tri-cone roller thru bedrock, hollow stem auger thru soil
Borehole Depth 40.0 ft
Borehole Diameter 3-inch

Materials:

Casing Diameter/Type 4-inch type 304 stainless steel
Screen Diameter/Type/Slot Size 3-inch open hole
Sand/Gravel
Bentonite Seal
Grout Type I Portland cement/bentonite powder 6:1

Intervals:

Screen Interval Open hole 11.0 ft to 40.0 ft
Casing Interval 0.5 ft. to 11.0 ft.
Sand/Gravel Pack Interval
Bentonite Seal Interval
Grout Interval 0.5 ft. to 11.0 ft.

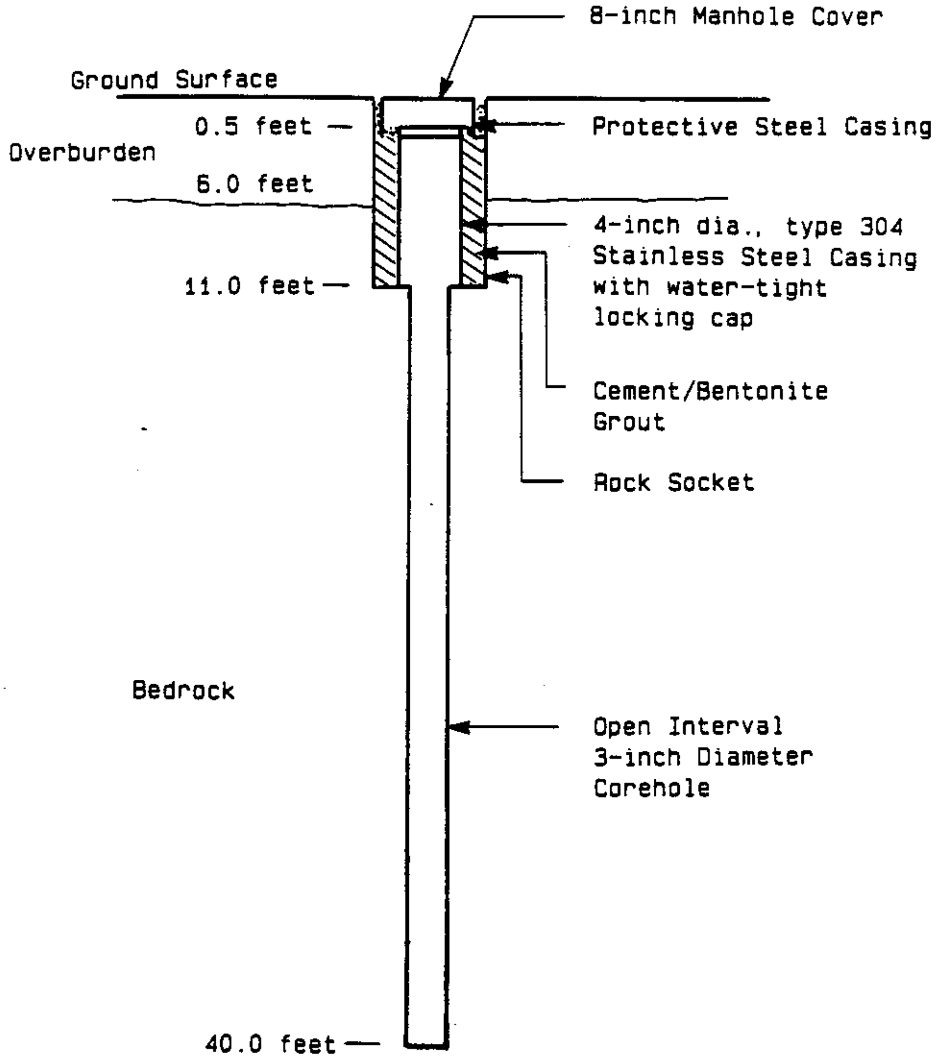
Type of Surface Completion flush mounted protective curb box

NOTES:

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number: MW-10-40



NOT TO SCALE

RADIAN CORPORATION

WELL COMPLETION LOG

Project Name: Emerson Power Transmission
Project Number: 215-004-36

Well No. MW-11-40
Log Recorded By P.T. LeClair
Location EPT
Completion Date 8/25/89

Drilling Method ND4X core barrel and tri-cone roller thru bedrock, hollow stem auger thru soil
Borehole Depth 40.0 ft
Borehole Diameter 3-inch

Materials:

Casing Diameter/Type 4-inch type 304 stainless steel
Screen Diameter/Type/Slot Size 3-inch open hole
Sand/Gravel
Bentonite Seal
Grout Type I Portland cement/bentonite powder 6:1

Intervals:

Screen Interval Open hole 23.0 ft. to 40.0 ft.
Casing Interval 0.9 ft to 23.0 ft.
Sand/Gravel Pack Interval
Bentonite Seal Interval
Grout Interval 0.9 ft to 23.0 ft.

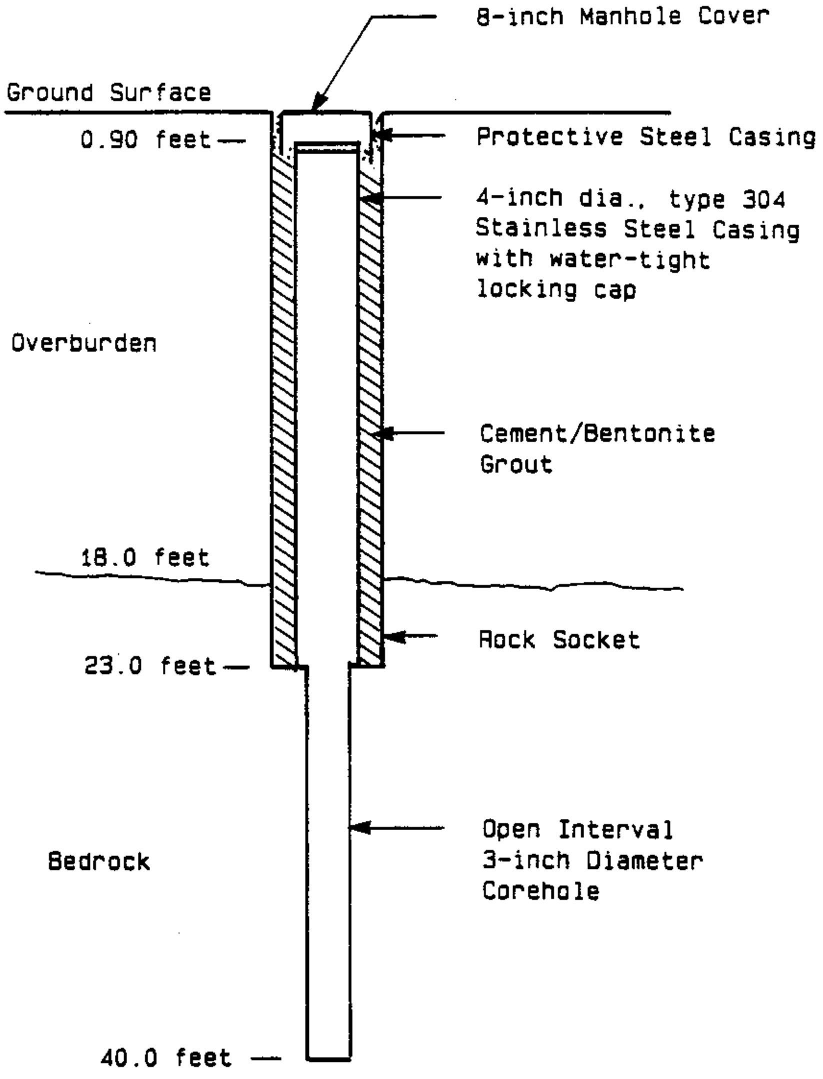
Type of Surface Completion flush mounted protective curb box

NOTES:

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number: MW-11-40



NOT TO SCALE

RADIAN CORPORATION

RADIAN CORPORATION

WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project,Number: 215-004-01

Well No. MW-13-25 **Log Recorded By** R.T. Church

Location EPT **Completion Date** 7/15/88

Drilling Method tricone thru bedrock, hollow stem auger thru soil

Borehole Depth 18.3 ft **Borehole Diameter** 5 5/8 inches

Materials:

Casing Diameter/Type 2-inch 304 stainless steel

Screen Diameter/Type/Slot Size 2-inch 304 stainless 0.010 slot

Sand/Gravel coarse sand

Bentonite Seal pellets

Grout type I Portland Cement and Bentonite Powder 6:1

Intervals:

Screen Interval 18 ft to 8 ft

Casing interval 8 ft to 0.5 ft

Sand/Gravel Pack Interval 18 ft to 6 ft

Bentonite Seal Interval 6 ft to 4 ft

Grout Interval 4 ft to 0.75 ft

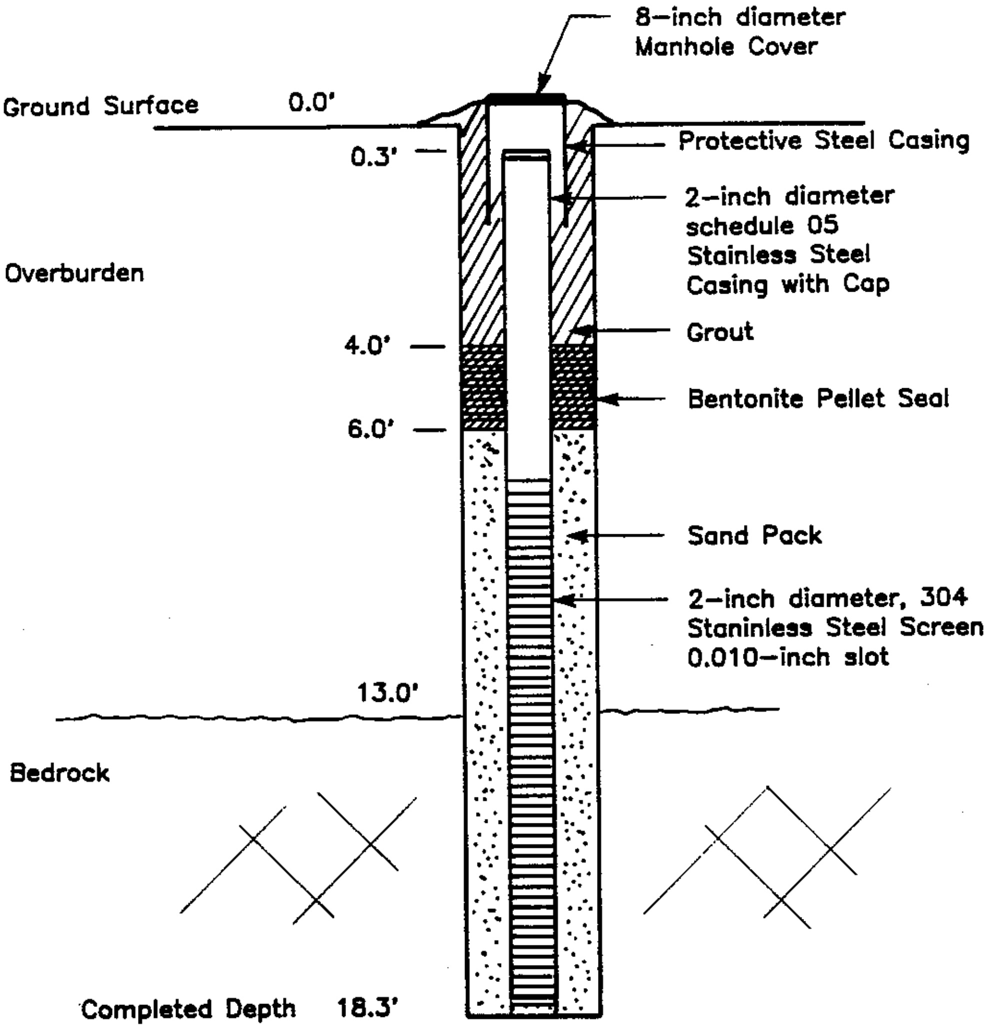
Type of Surface Completion curb box

NOTES:

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number MW-13-25



NOT TO SCALE

WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project Number: 215-004-01

Well No. MW-15-40

Log Recorded By W.P.Sugg

Location EPT

Completion Date 7/14/88

Drilling Method tricone roller thru bedrock, hollow stem auger thru soil

Borehole Depth 38.2 ft

Borehole Diameter 3 inches to 38.2 ft

Materials:

Casing Diameter/Type 4-inch 304 stainless steel

Screen Diameter/Type/Slot Size open hole

Sand/Gravel

Bentonite Seal

Grout type I Portland Cement and BentonitePowder 6:1

Intervals:

Screen Interval

Casing interval 0.3 ft to 18.7 ft

Sand/Gravel Pack Interval

Bentonite Seal Interval

Grout Interval 0.5 ft to 18.7 ft

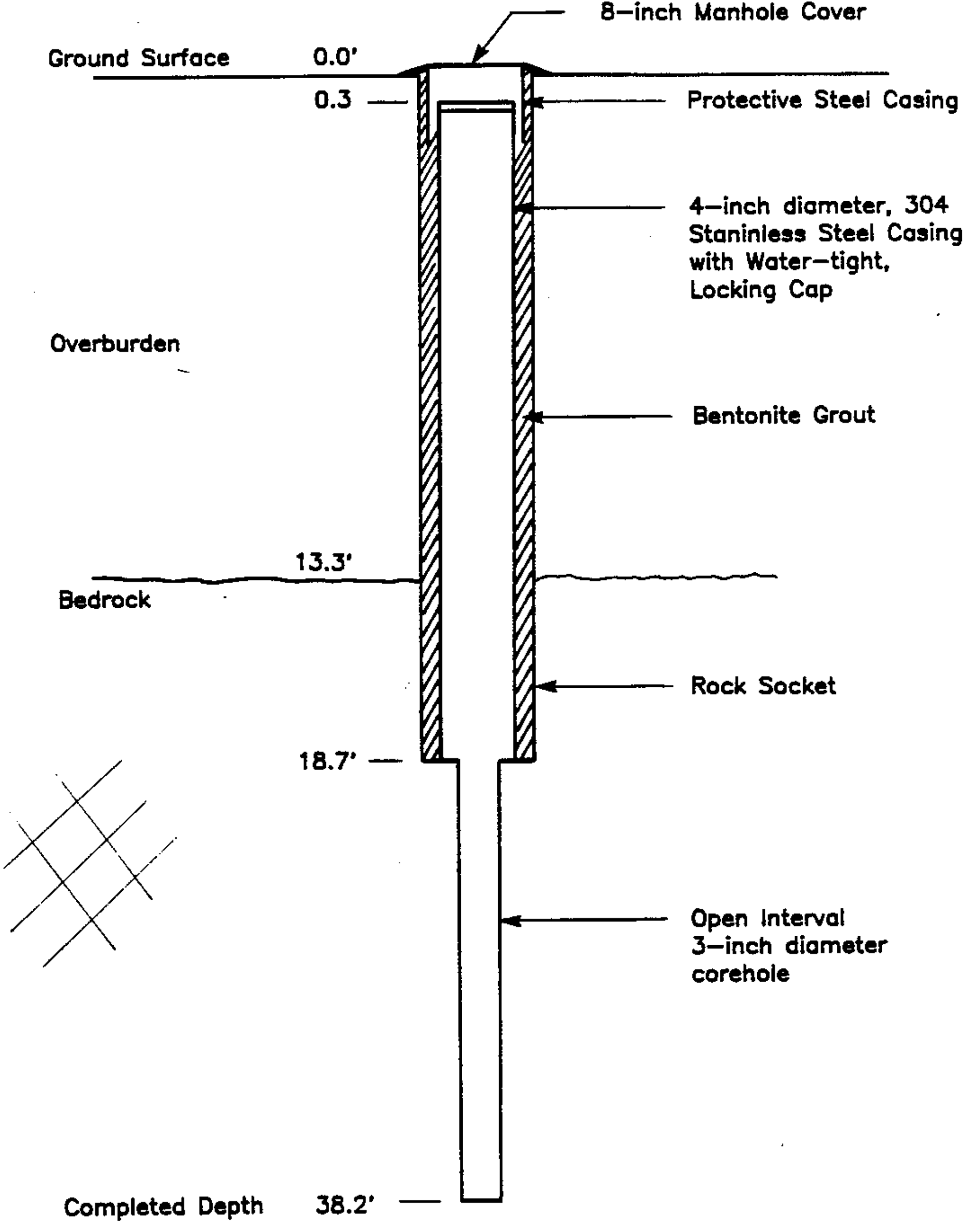
Type of Surface Completion 8-inch flush mount manhole w/ water tight seal

NOTES:

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number MW-15-40



NOT TO SCALE

RADIAN CORPORATION

WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project Number: 215-004-01

Well No. MW-16-100 **Log Recorded By** R.T. Church

Location EPT **Completion Date** 8/2/88

Drilling Method tricone roller thru bedrock, hollow stem auger thru soil

Borehole Depth 100 ft **Borehole Diameter** 5 5/8 inches

Materials:

Casing Diameter/Type 2-inch 304 stainless steel schedule 5

Screen Diameter/Type/Slot Size 2-inch 304 stainless steel 0 .01 slot

Sand/Gravel coarse sand

Bentonite Seal pellets

Grout type I Portland Cement and Bentonite Powder 6:1

Intervals:

Screen Interval 100 ft to 80 ft

Casing interval 80 ft to surface + 2.5 ft stickup

Sand/Gravel Pack Interval 100 ft to 78 ft

Bentonite Seal Interval 78 ft to 75 ft

Grout Interval 75 ft to surface

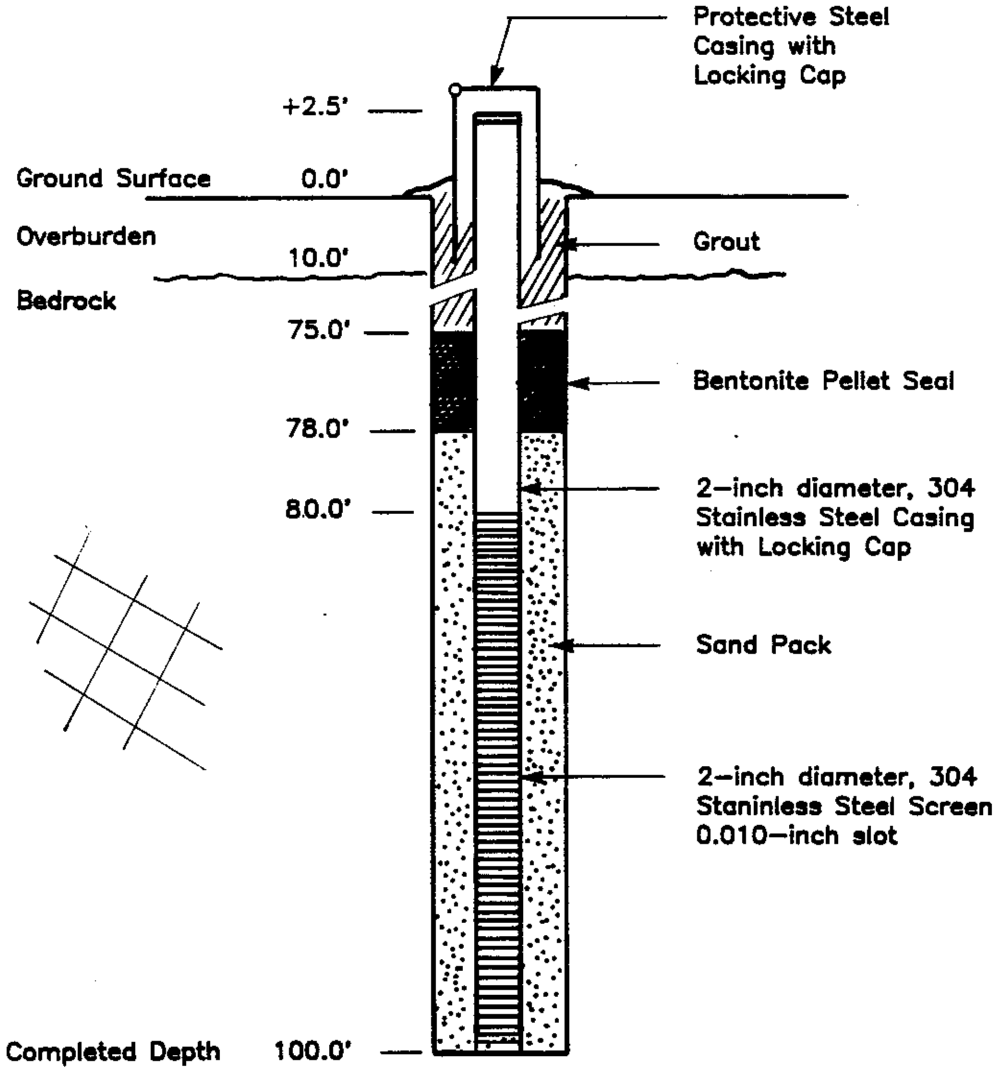
Type of Surface Completion protective casing with locking cap

NOTES:

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number MW-16-100



NOT TO SCALE

WELL COMPLETION LOG

Project Name: Emerson Power Transmission

Project Number: 215-004-01

Well No. MW-17-40

Log Recorded By R.T. Church

Location EPT

Completion Date 7/27/88

Drilling Method tricone roller thru bedrock, hollow stem auger thru soil

Borehole Depth 47.9 ft

Borehole Diameter 3 inches

Materials:

Casing Diameter/Type 4-inch 304 stainless steel schedule 40

Screen Diameter/Type/Slot Size

Sand/Gravel

Bentonite Seal

Grout type I Portland Cement and Bentonite Powder 6:1

Intervals:

Screen Interval

Casing interval 37.9 ft tp 0.5 ft

Sand/Gravel Pack Interval

Bentonite Seal Interval

Grout Interval 37.9 ft to 0.5 ft

Type of Surface Completion curb box

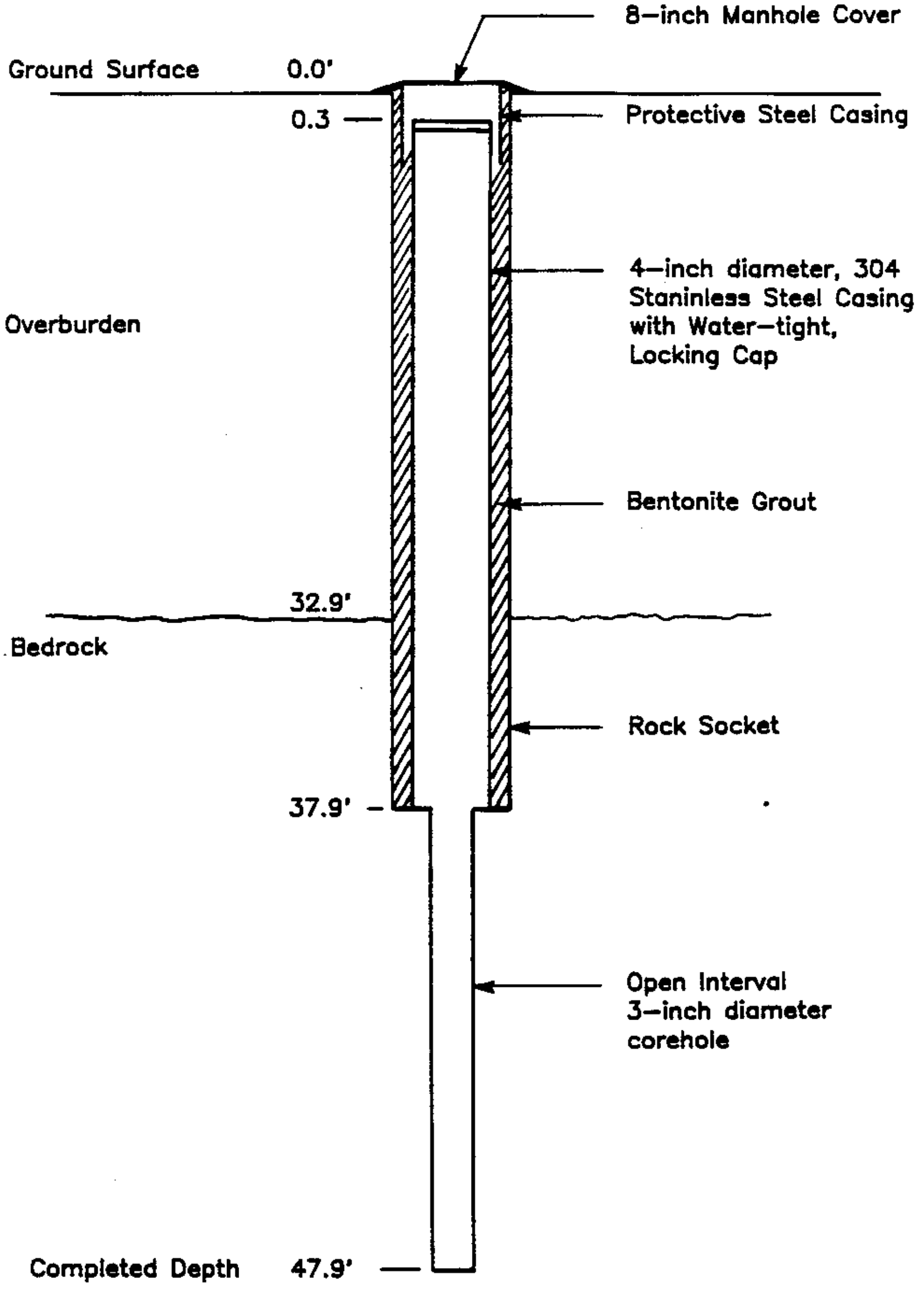
NOTES:

Rev. 8/86

WELL CONSTRUCTION DIAGRAM

Location: Emerson Power Transmission
Ithaca, New York

Well Number MW-17-40



NOT TO SCALE

APPENDIX E

GEOPHYSICAL BOREHOLE LOGGING

APPENDIX E - GEOPHYSICAL BOREHOLE LOGGING

Borehole geophysical logs are used to investigate subsurface lithology, bedrock porosity, and fluid chemistry. Borehole geophysical logs were acquired for most of the EPT monitoring wells that penetrated bedrock. For monitoring wells where bedrock was not cased, the logs acquired consisted of caliper logs, gamma logs, neutron logs, density logs, temperature logs, fluid conductivity logs, resistivity logs, resistance logs, and spontaneous potential logs. Gamma and neutron logs were acquired in monitoring wells where bedrock was cased and screened (MW-6-100 and MW-16-100).

A brief description of the general characteristics of each type of geophysical log acquired during this program is given in Section E.1 of this Appendix. Additional details regarding geophysical log information are available in standard texts, such as Keys and MacCary (1971).[1] Copies of the logs acquired during Stage 1 are provided at the end of this Appendix. A discussion of the results and an analysis of the logs acquired during the Stage 1 Investigation are presented in Section E.2 of this Appendix.

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[1] Keys, W. Scott and L.M. MacCary. 1971. Chapter E1 - Application of Borehole Geophysics to Water-Resources Investigations. Book 2: Techniques of Water-Resources Investigations of the United States Geological Survey. Arlington, Virginia: United States Geological Survey.

E.1 BOREHOLE LOG DESCRIPTION

E.1.1 Caliper Log

The caliper log is a record of the measurement of the diameter of the borehole. Most caliper devices include one to four arms that act as points of contact inside the borehole to provide a measure of the average borehole diameter. A 3-arm caliper device with an 0.1 inch resolution was used to measure borehole diameters for this investigation. This device detects any changes in borehole diameter greater than 0.1 inch. Because each arm of this device is 0.375 inches in diameter, porosity parameters (e.g., fractures) that do not produce a borehole change in excess of 0.1 inch will only be detected if they span a vertical distance exceeding 0.375 inches.

Borehole diameter is generally interpreted as an indication of rock hardness (an index to rock types) or as an indication of fractures or other macroscopic porosity. The log is usually plotted to show borehole diameter increasing to the right. Softer rock is generally indicated by an enlarged borehole relative to the borehole diameter of harder rock; thus, soft rock will appear as a line plotted to the right approximately equal to the vertical thickness of the soft rock. Fractures or other macroscopic porosity are generally indicated as an abrupt enlargement of the borehole; thus, fractures will appear as abrupt "kicks" to the right on the caliper logs.

E.1.2 Gamma Log

The gamma log is a record of the natural gamma photon radiation emitted by the subsurface materials. An increase in radiation response is plotted to the right. The source of natural gamma radiation in rocks and soils is radioactive decay of potassium, uranium, and thorium. Because these elements preferentially concentrate in specific minerals such as clay minerals and feldspars, the gamma log is a record of the concentration of such minerals. In sedimentary rocks and soils, the gamma log is generally interpreted as an indicator of the amount of clay minerals present or as an index of "shale." Thus, shale beds will appear as "kicks" to the right and non-shale (e.g., sand or limestone) beds as "kicks" to the left on the gamma logs.

E.1.3 Neutron Log

The neutron log is a record of the hydrogen ion content of the rocks, soils, and fluids in the subsurface. The log is produced using an active device that radiates short-lived neutrons into the borehole and then records the borehole response using a detector that records, or counts, neutrons per second. Because hydrogen ions absorb neutrons, the greater the hydrogen ion content of the borehole, the more neutrons that are absorbed, and the lower the count rate recorded on the neutron logs. Hydrogen ions may occur in the borehole environment either as free water, in which case the neutron log indicates the amount of water-filled porosity; or as mineral-bound water present in clay minerals or gypsum, in which case the neutron log indicates the concentrations of these minerals.

Proper interpretation of neutron logs requires simultaneous analysis of the corresponding gamma logs. High natural gamma response correlated with low neutron counts per second (apparently high neutron porosity) indicates shale. Low natural gamma response correlated with low neutron counts per second indicates water-saturated, porous, non-clayey rock, such as sandstone, siltstone, or limestone.

E.1.4 Density Log

The density log (also known as the gamma-gamma log) is a record of the electron density of the subsurface. It provides a record of the variation in subsurface bulk density in grams per cubic centimeter (g/cc). The log is produced by using an active device that radiates gamma photons into the borehole environment and senses the response as gamma counts per second. Because gamma photons are absorbed by electrons, an increase in the electron density results in greater gamma photon absorption and lower counts per second. Lower counts imply higher bulk density and higher bulk density implies lower porosity.

A high resolution density device was used during the EPT investigation. This device detects the average density of a cylinder of rock approximately 0.5 inches high and 1 inch in diameter, providing a resolution of approximately 0.01 g/cc. Identification of a fracture would require a change in density of at least 0.05 g/cc. This is essentially equivalent to an ideal planar fracture cutting through the borehole, having an aperture of approximately 0.6mm.

The density log is plotted directly as density in grams per cubic centimeter (g/cc), which increases to the left. In the logs prepared for this investigation, more porous rocks are indicated as "kicks" to the right. A standard formula is used to calculate subsurface porosity based on the log-derived density.

E.1.5 Temperature Log

The temperature log is a record of the variation in temperature of the borehole fluids. Temperature logs may be acquired in cased boreholes to investigate various attributes of well construction. In uncased boreholes, temperature logs are used to investigate the depths at which fluids may be entering or leaving the borehole. Such locations generally correspond to fractures; hence, temperature logs may be used to identify water-transmitting fractures in the borehole.

E.1.6 Fluid Conductivity Log

The fluid conductivity log is a record of the variations in subsurface fluid conductivity with depth in the borehole. For this investigation, fluid conductivity was measured using a device that records resistivity in ohms per meter. Fluid resistivity and conductivity are inversely related, and the logs produced can be interpreted as either conductivity (which increases to the left) or resistivity (which increases to the right).

Fluid conductivity logs may be used to investigate ground-water chemistry. Conductivity is directly related to dissolved ion content; thus, fresher ground water is less conductive than salty ground water. Additionally, various non-aqueous phase liquids, such as oils or chlorinated solvents, may have a conductivity substantially different from ground water, which allows identification of the phase interface.

E.1.7 Electrical Log

The three electrical logs that may be used include spontaneous potential (SP) logs, resistance logs, and resistivity logs. The spontaneous potential instrument records the natural electrical potential of the borehole environment. It is generally not usable in environments in which subsurface fluids consist of fresh water (as in this investigation) (Keys and MacCary, 1971). Resistance and resistivity logs are acquired using active instruments that transmit an electrical current into the borehole and then record the electrical response. These two devices measure similar parameters, but the resistance device generally produces a log with a greater vertical resolution than that produced by the resistivity device. Both of these logs provide information on the borehole fluids as well as on the mineralogy of the rock; thus, proper interpretation of these logs requires simultaneous analysis of other logs, such as the gamma logs. Generally, clay minerals have characteristically low resistivity and low resistance signatures. Thus, shales may be recognized by high natural gamma response and low resistivity or resistance.

E.2 BOREHOLE LOG ANALYSIS

The borehole geophysical logs obtained during the Stage 1 Investigation were analyzed by the same Radian geologist who analyzed the rock cores obtained from boreholes, providing a context within which to interpret the logs, as well as providing direct correlations with observations (or "ground truth") regarding the subsurface environment that the borehole logs represent. The log suite from each borehole was annotated with information obtained from the core logs, such as data related to the position and nature of fractures. This core log information was compared to each borehole geophysical log to allow accurate interpretation of a log response or recognition of a log signature of a particular borehole feature. A discussion of this analysis is provided in the following sections.

E.2.1 Lithology

Observations of the core reveal that the bedrock is a homogenous, thin-bedded, gray, well-cemented siltstone that lacks macroscopic matrix (intergranular) porosity and that has abundant macroscopic fracture porosity. Variations in grain size can be seen in samples of core, but are generally only apparent by the fissile character displayed by certain beds (See Appendix C).

The gamma logs acquired for the various monitoring wells confirm the observations made of the cores. These logs also reveal a record of subtle lithologic variations in the rock more detailed than that which can be obtained from core analysis alone. The gamma logs of MW-3-150 and MW-6-100 reveal that a clay-poor siltstone bed approximately 3 feet thick can be correlated between the boreholes. Correlations of this nature cannot be made based on the core logs.

E.2.2 Porosity

Analysis of borehole geophysics provides an alternative to core observations in evaluating the porosity of bedrock. The most useful logs for investigating porosity are the gamma, neutron, and density logs. A combination of gamma and neutron logs are used to indicate which portions of the rock contain water-saturated porosity, while the density logs are used to calculate a theoretical average porosity value for the rock.

Gamma logs acquired in MW-17-40 were used to examine differences in porosity between the overburden and the bedrock. The gamma response of the overburden (around MW-17-40) was substantially less than that of the bedrock, indicating that the overburden contains substantially greater porosity than the bedrock.

E.2.3 Fractures

The presence of fractures may be indicated by anomalously low density values in the density log, a sudden increase in borehole diameter indicated by the caliper log, or an abrupt variation in the temperature log. Comparison of these logs with fractures observed in the core can provide information on the nature of the fractures that is not available by core observation alone. Caliper logs provide data on the size of the opening created by the fracture. Density logs provide data on the volume of porosity provided by the fracture. Temperature and neutron logs can provide information on the nature of any fluid that may be within the fracture.

Fractures may appear on the caliper log as an increase in borehole diameter if the fractures have an aperture large enough to be detected by the caliper tool. None of the caliper logs acquired for any of the boreholes were able to sense any of the fractures observed in the cores, indicating that the fractures have apertures less than the resolution of the caliper instrument (between 0.1 and 0.375 inches).

In general, open fractures should appear on density logs as low density anomalies. Comparison with core data indicates that the majority of the bedding plane fractures are evident on density logs. The magnitude of these "kicks" on the logs shows a decrease in density of less than 10%, indicating a maximum increase in porosity of 10%. Thus, the individual fractures are hairline fractures that have a very small volume (aperture of less than 0.6mm, as noted in Section E.1.4 above). Correlation of temperature variations in caliper or density logs that are characteristic of fractures is an indication of fractures transmitting ground water. These correlations occur in many of the log suites acquired for the EPT investigation. The best example is seen at a depth of 44 feet in MW-17-40.

E.2.4 Fluid Chemistry

The best geophysical indicator of ground-water chemistry is the conductivity log. Conductivity logs obtained during the investigation reveal that the vertical distribution of the conductivity of ground water is relatively constant with depth in individual wells. Logs of the upper few feet of ground water in some of the wells (e.g., MW-5-40 and MW-15-40) indicate that the fluid at this depth is generally of low conductivity (high resistivity). In MW-5-40, the log indicates an abrupt transition between a low conductivity fluid above and a higher conductivity fluid below, probably indicating an oil layer floating on the ground water.

For mineral-filled fractures, the log character will be a function of the average of the density of the rock and the minerals filling the fracture. Most of the joints are poorly expressed on the density logs, possibly because most of these fractures are partially filled with a mineral, calcite, with a density of 2.72, in contrast to the dominant minerals comprising the rock, quartz and feldspar, with densities of 2.65 and 2.56, respectively.

Water-saturated fractures may be present if a fracture indicated on the caliper or density logs is correlated with both low natural gamma response and low neutron counts per second (CPS). The correlation of low neutron CPS with low natural gamma response indicates that the low neutron CPS is sensing liquid water, rather than mineral-bound water. In several boreholes, the neutron log indicates water-filled porosity correlating with very intensely fractured intervals less than 1-1/2 feet thick and several feet apart. In MW-3-150, these fractures occur at approximately 53 and 80 feet in depth, implying that these fractures are transmitting ground water.

Water flow into or out of the borehole may be indicated by variations on the temperature log. For this investigation, temperatures ranged between 50 and 60 degrees Fahrenheit.

While the conductivity of borehole fluid within a given borehole was relatively constant, varying primarily with temperature, conductivity varied from borehole to borehole. The values ranged from approximately 2.5 umhos per cm (4 ohm meters) in borehole MW-5-40 to approximately 0.2 umhos per cm (50 ohm meters) in MW-4.

DOWNHOLE GEOPHYSICAL LOGS

P.O. Box 17203
Pittsburgh, PA 15235
Telephone (412) 243-3030

APPALACHIAN COAL SURVEYS

LOG HEADING
HOLE NO.
MW-1-40

COMPANY RADIAN CORPORATION	LOCATION	UNIT 41 OFFICE Pgh
PROJECT [illegible] HOLE NO. MW-1-40		OPERATOR CBC
CLIENT REPRESENTATIVE I. Merin	COUNTY Tompkins STATE NY	DATE 09-Aug-88
DRILLED DEPTH 40 FT. ELEVATION FT.	CASING DEPTH 22 FT.	DRILLING FLUID WATER
HOLE DIAMETER 3.0 IN. WATER LEVEL 22 FT.	DIAMETER6.0 IN. FACTOR WALL THICKNESS IN.	DRILLING CO. EMPIRE DRILLER

RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
1	CALIPER	22 - 41	1 in/in			
2	NATURAL γ	0 - 35	100 CPS	2 SEC	NATURAL	
2	H.R. DENSITY	22 - 41	1k CPS	1 SEC	Am 241	0.5 in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
3	NEUTRON	6 - 41	1k CPS	1 SEC	Am-Be	12.0 in.
1, 4	RESISTIVITY	22 - 41	20 Ω			
4	SPONTANEOUS POTENTIAL	22 - 39	200 MV			
4	TEMPERATURE	22 - 41	5 °F			
4	FLUID CONDUCTIVITY	22 - 41	50 Ω M			
	SONIC	-	us/ft			2.0 FT.
	OTHER	-				

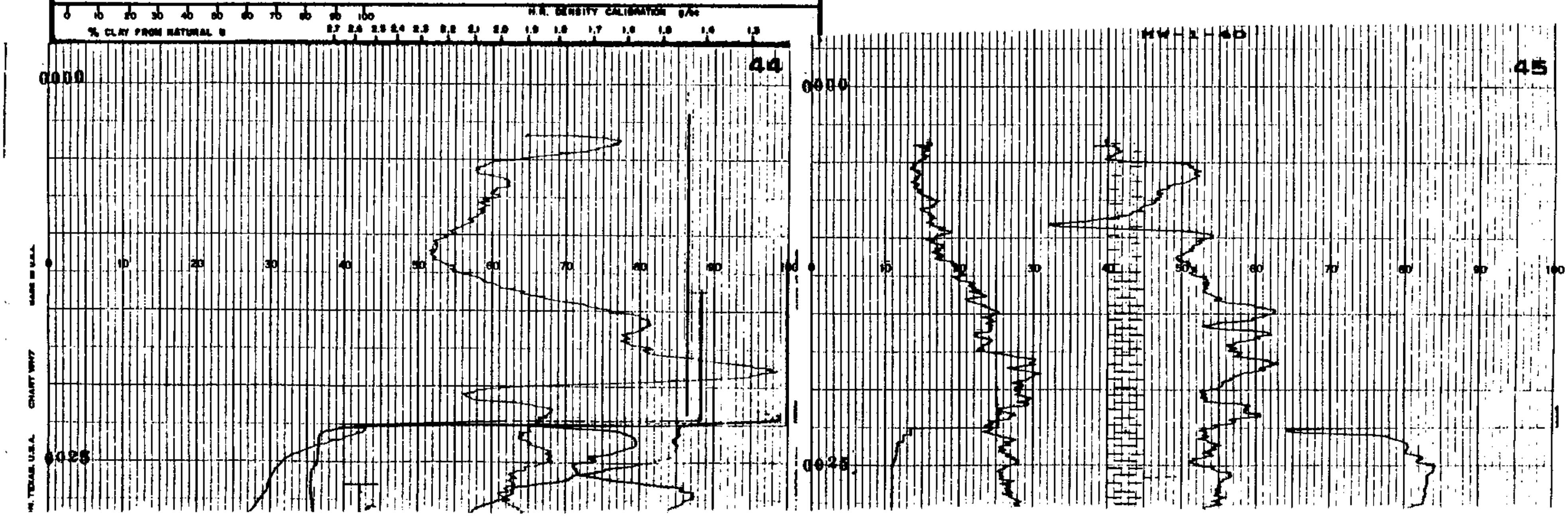
INTERPRETATION

- ■ COAL < 10% ASH
- ▥ COAL > 10% ASH
- ▤ BONE/CARBONACEOUS SHALE > 50% ASH
- ▤ FIRECLAY/HOT SHALE
- ▦ LIMESTONE/OTHER CARBONATE
- ▨ SANDSTONE
- ▨ SILTY SANDSTONE
- ▤ SHALE/CLAYSTONE
- ▤ SANDY SHALE/SILTSTONE
- GROUNDWATER INFLOW
- GROUNDWATER OUTFLOW

RUNS

RUN #	INTERVAL (DEPTH) FT.	SCALE FT./IN.	LOGGING SPEED FT./MIN.
1	SUR - 41	5	20
2	SUR - 41	5	20
3	SUR - 41	5	20
4	SUR - 41	5	20
	-		
	-		
	-		
	-		

NOTES: DATUM IS TOP OF CASING

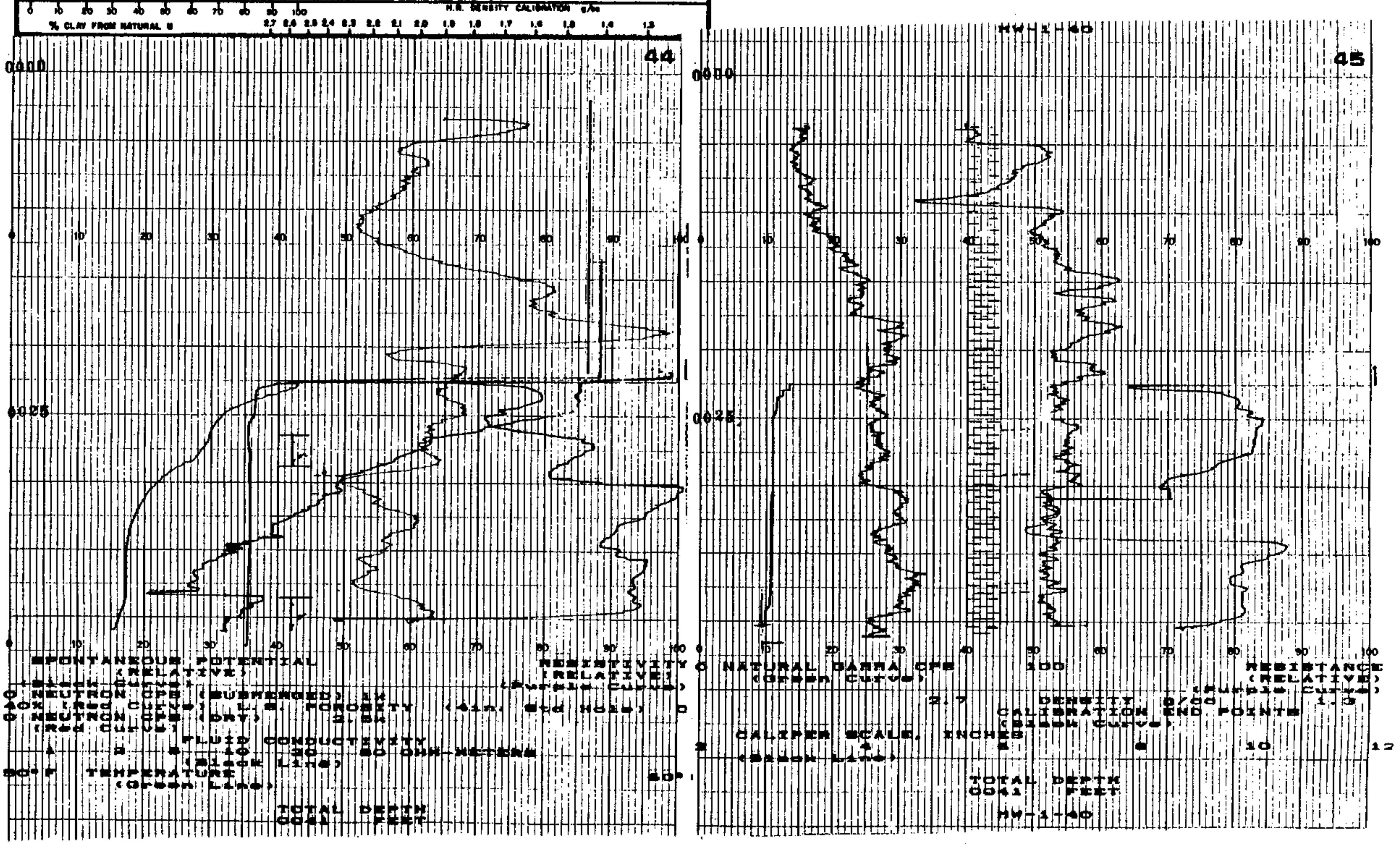


2	HR DENSITY	22 - 41	1k CPS	1 SEC	Am 241	0.5 in.
	DENSITY	-	CPS	SEC	Ra 226	in.
3	NEUTRON	6 - 41	1k CPS	1 SEC	Am-Be	12.0 in.
1,4	RESISTIVITY	22 - 41	20 Ω			
4	SPONTANEOUS POTENTIAL	22 - 39	200 MV			
4	TEMPERATURE	22 - 41	5 °F			
4	FLUID CONDUCTIVITY	22 - 41	50 Ω M			
	SONIC	-	μs/ft			2.0 FT.
	OTHER	-				

- BONE/CARBONACEOUS SHALE > 50% ASH
- FIRECLAY/HOT SHALE
- LIMESTONE/OTHER CARBONATE
- SANDSTONE
- SILTY SANDSTONE
- SHALE/CLAYSTONE
- SANDY SHALE/SILTSTONE
- GROUNDWATER INFLOW
- GROUNDWATER OUTFLOW

1	SUR -		5	20
2	SUR -	41	5	20
3	SUR -	41	5	20
4	SUR -	41	5	20
	-			
	-			
	-			
	-			

NOTES: DATUM IS TOP OF CASING



P.O Box 17203
Pittsburgh, PA 15235
Telephone (412) 243-3030

APPALACHIAN COAL SURVEYS

LOG HEADING
HOLE NO.
MW-2-40

COMPANY RADIAN CORPORATION	LOCATION	UNIT 61 OFFICE Pgh
PROJECT EMERSON HOLE NO. MW-2-40		OPERATOR CSC
CLIENT REPRESENTATIVE I. Morin	COUNTY Tompkins STATE NY	DATE 08-Aug-88
DRILLED DEPTH 40 FT. ELEVATION FT.	CASING DEPTH 16 FT.	DRILLING FLUID WATER
HOLE DIAMETER 3.0 IN. WATER LEVEL 13 FT.	DIAMETER 6.0 IN. FACTOR WALL THICKNESS IN.	DRILLING CO. EMPIRE DRILLER

RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
1	CALIPER	16 - 40	1 in/in			
2	NATURAL γ	0 - 34	100 CPS	2 SEC	NATURAL	
2	H.R. DENSITY	16 - 40	1k CPS	1 SEC	Am 241	0.5 in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
3	NEUTRON	6 - 40	1k CPS	1 SEC	Am-Be	2.0 in.
1, 4	RESISTIVITY	16 - 40	20 Ω			
4	SPONTANEOUS POTENTIAL	16 - 38	200 MV			
4	TEMPERATURE	16 - 40	5 °F			
4	FLUID CONDUCTIVITY	16 - 40	50 Ω M			
	SONIC	-	us/ft			2.0 FT.
	OTHER	-				

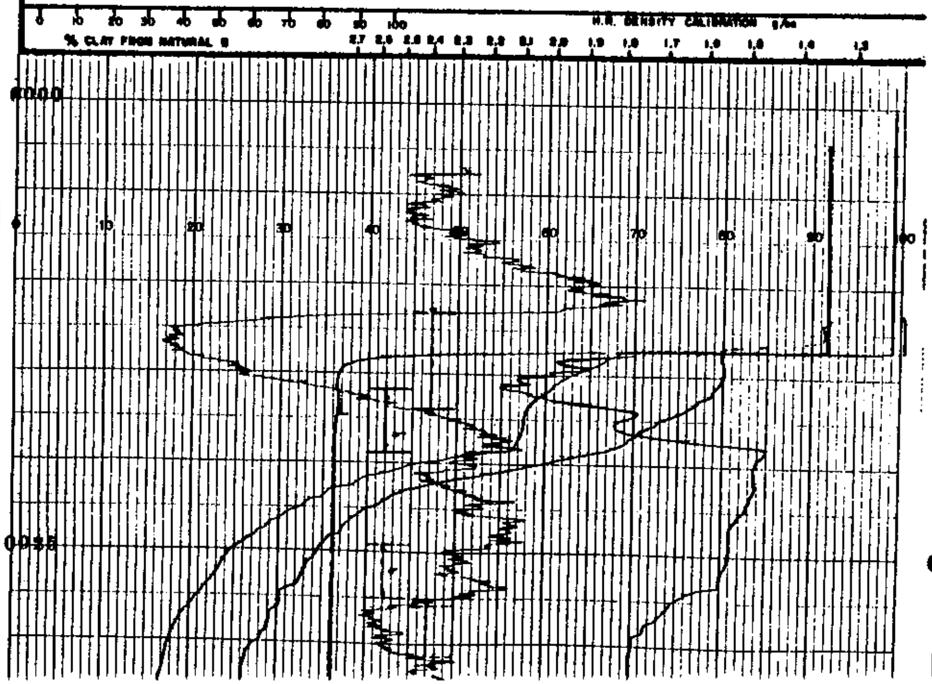
INTERPRETATION

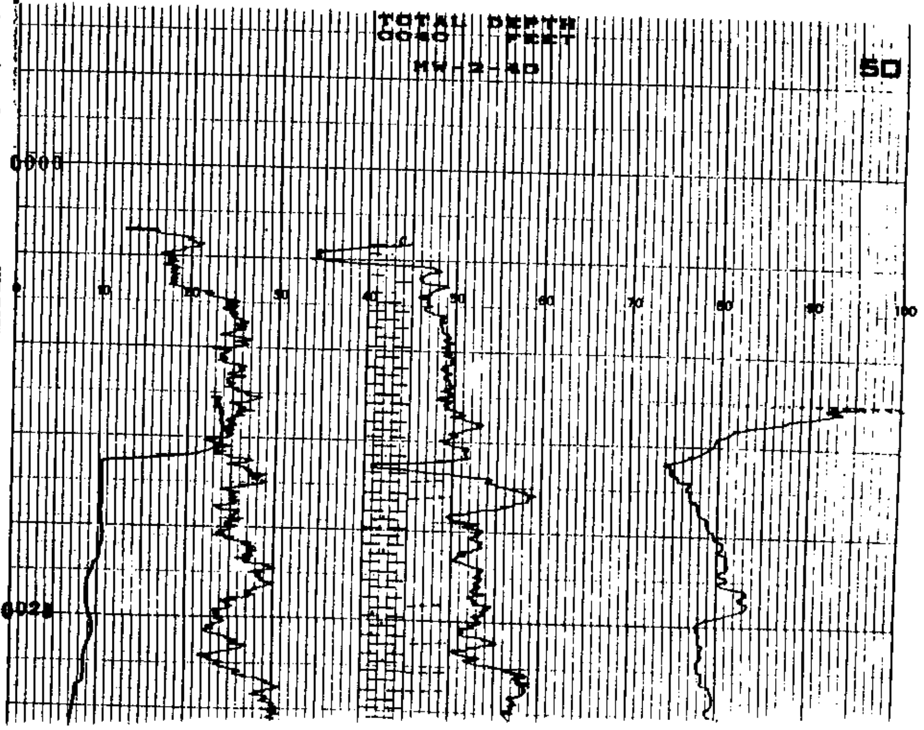
- ■ COAL < 10% ASH
- ▥ COAL > 10% ASH
- ▤ BONE/CARBONACEOUS SHALE > 50% ASH
- ▤ FIRECLAY/HOT SHALE
- ▦ LIMESTONE/OTHER CARBONATE
- ▒ SANDSTONE
- ▒ SILTY SANDSTONE
- ▤ SHALE/CLAYSTONE
- ▤ SANDY SHALE/SILTSTONE
- GROUNDWATER INFLOW
- GROUNDWATER OUTFLOW

RUNS

RUN #	INTERVAL (DEPTH) FT.	SCALE FT/IN	LOGGING SPEED FT/MIN
1	SUR - 40	5	20
2	SUR - 40	5	20
3	SUR - 40	5	20
4	SUR - 40	5	20
	-		
	-		
	-		
	-		

NOTES: DATUM IS TOP OF CASING



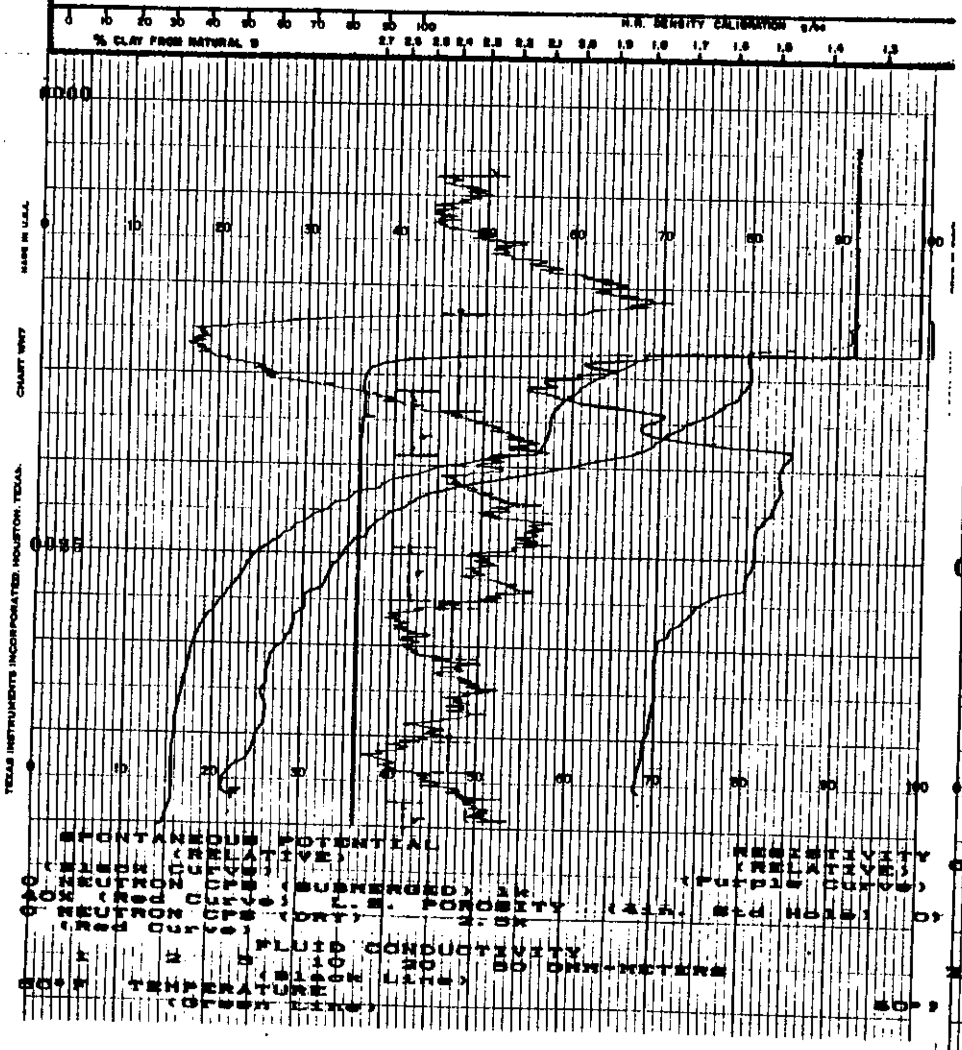


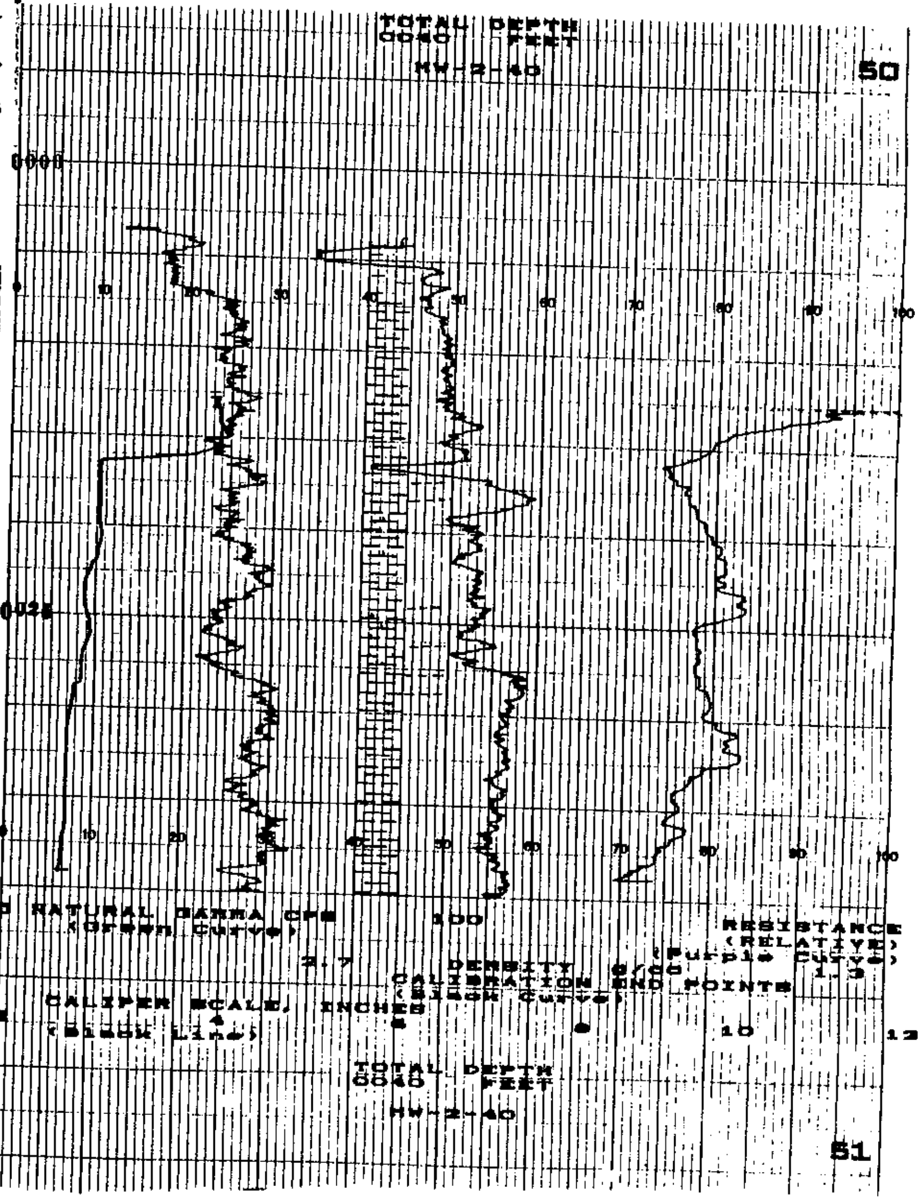
2	DENSITY	16 - 40	1k CPS	1 SEC	Am 241	0.5 in.
	DENSITY	-	CPS	SEC	Ra 226	in.
3	NEUTRON	6 - 40	1k CPS	1 SEC	Am-Be	2.0 in.
1, 4	RESISTIVITY	16 - 40	20 Ω			
4	SPONTANEOUS POTENTIAL	16 - 38	200 MV			
4	TEMPERATURE	16 - 40	5 °F			
4	FLUID CONDUCTIVITY	16 - 40	50 Ω M			
	SONIC	-	m/ft			2.0 FT.
	OTHER	-				

- BONE / CARBONACEOUS SHALE > 50% ASH
- FIRECLAY/ HOT SHALE
- LIMESTONE/ OTHER CARBONATE
- SANDSTONE
- SILTY SANDSTONE
- SHALE/CLAYSTONE
- SANDY SHALE/ SILTSTONE
- GROUNDWATER INFLOW
- GROUNDWATER OUTFLOW

RU	INTE	SCALE	LOGGI SPEED
1	SUR -	5	20
2	SUR - 40	5	20
3	SUR - 40	5	20
4	SUR - 40	5	20
	-		
	-		
	-		
	-		

NOTES: DATUM IS TOP OF CASING





P O B. ..203
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Telephone (412) 243-3030

APPALACHIAN COAL SURVEYS

LOG H.. .ING
HOLE NO.
MW-3-175

(150)

COMPANY RADIAN CORPORATION
PROJECT EMERSON HOLE NO. MW-3-175
CLIENT REPRESENTATIVE I. Morin
DRILLED DEPTH 125 FT. ELEVATION FT.
HOLE DIAMETER 3.0 IN. WATER LEVEL 33 FT.

LOCATION
COUNTY Tompkins STATE NY
CASING DEPTH 9 FT.
DIAMETER 6.0 IN. FACTOR
WALL THICKNESS IN.

UNIT 61 OFFICE Pgh
OPERATOR CBC
DATE 08-Aug-88
DRILLING FLUID WATER
DRILLING CO. EMPIRE DRILLER

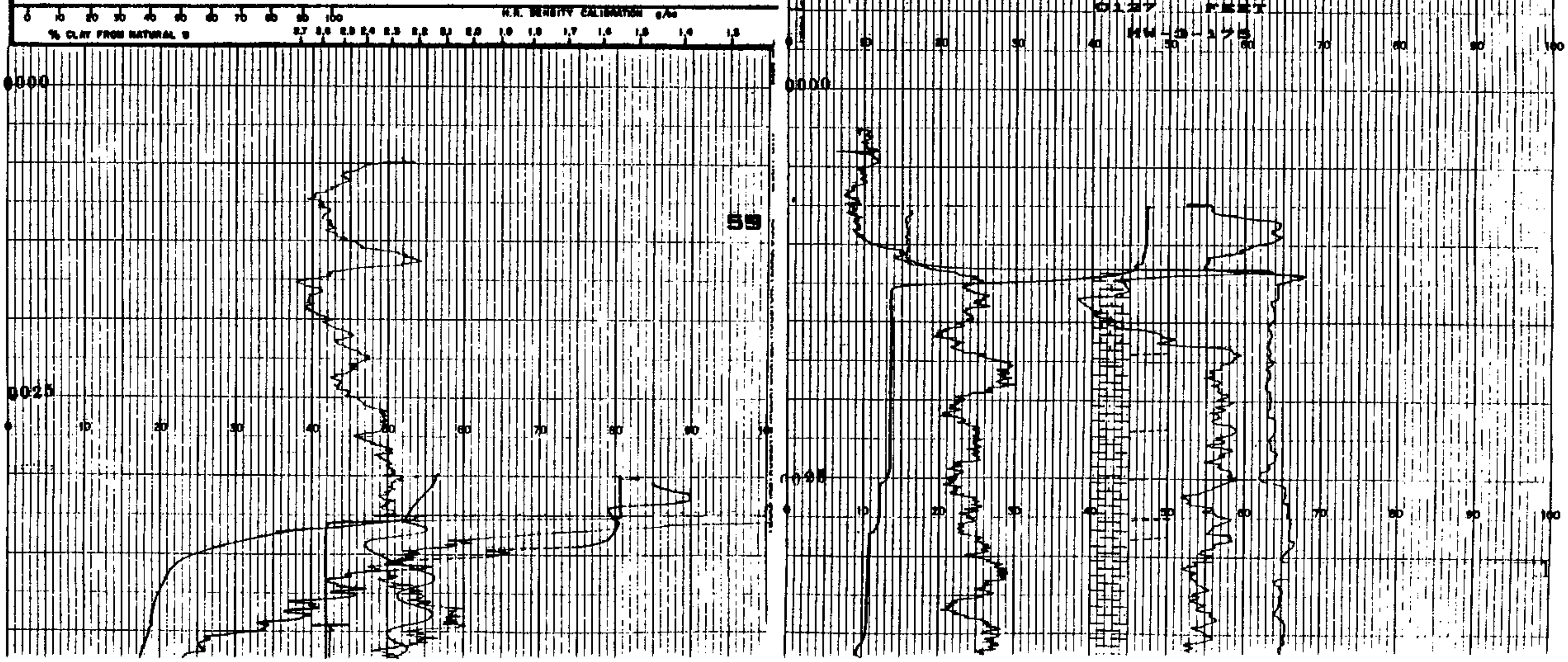
RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
1	CALIPER	9 - 127	1 in/in			
2	NATURAL γ	0 - 121	100 CPS	2 SEC	NATURAL	
2	H.R. DENSITY	9 - 127	1k CPS	1 SEC	Am 241	0.3 in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
3	NEUTRON	6 - 127	1k CPS	1 SEC	Am-Be	12.0 in.
1, 4	RESISTIVITY	9 - 127	20 Ω			
4	SPONTANEOUS POTENTIAL	33 - 125	200 MV			
4	TEMPERATURE	33 - 127	5 °F			
4	FLUID CONDUCTIVITY	33 - 127	30 Ω.M			
	SONIC	-	μs/ft			2.0 FT.
	OTHER	-				

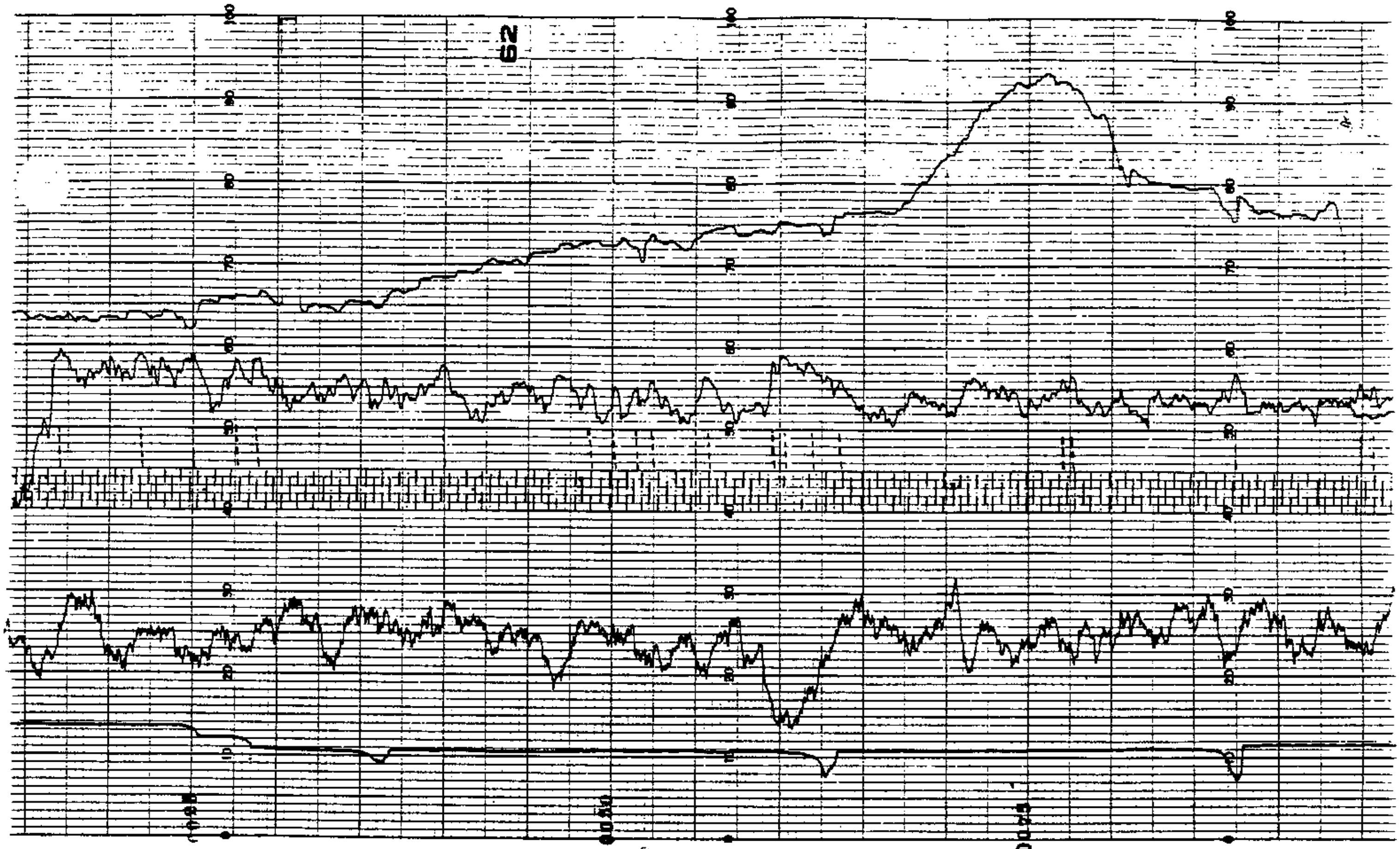
INTERPRETATION
- ▆ COAL < 10% ASH
- ▥ COAL > 10% ASH
- ▤ BONE/CARBONACEOUS SHALE > 60% ASH
- ▤ FIRECLAY/HOT SHALE
- ▦ LIMESTONE/OTHER CARBONATE
- ░ SANDSTONE
- ░ SILTY SANDSTONE
- ▤ SHALE/CLAYSTONE
- ▤ SANDY SHALE/SILTSTONE
- GROUNDWATER INFLOW
- GROUNDWATER OUTFLOW

RUNS

RUN #	INTERVAL (DEPTH) FT.	SCALE FT/IN	LOGGING SPEED FT/MIN
1	SUR - 127	5	20
2	SUR - 127	5	20
3	SUR - 127	5	20
4	SUR - 127	5	20
	-		
	-		
	-		
	-		

NOTES: DATUM IS TOP OF CASING

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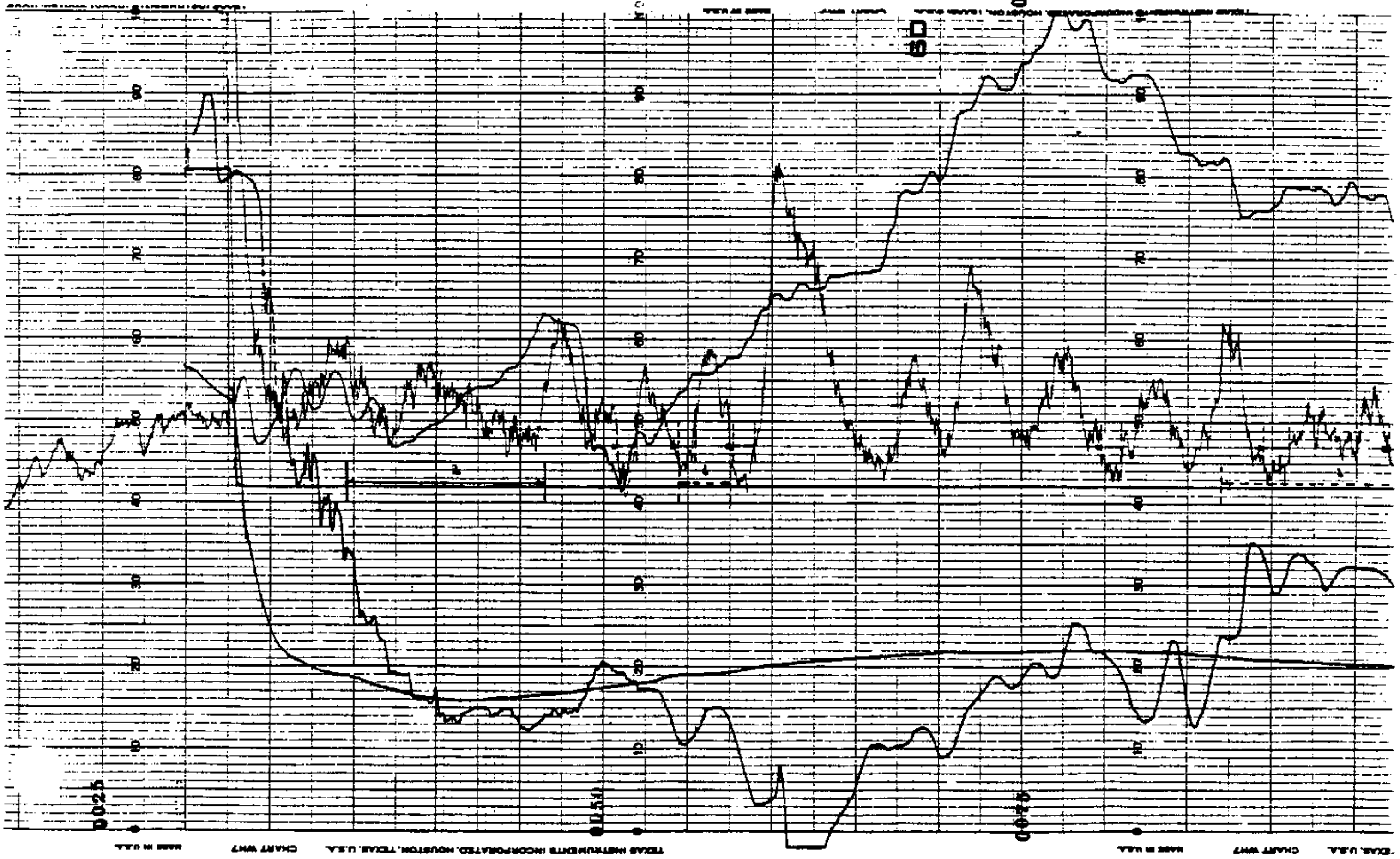
60
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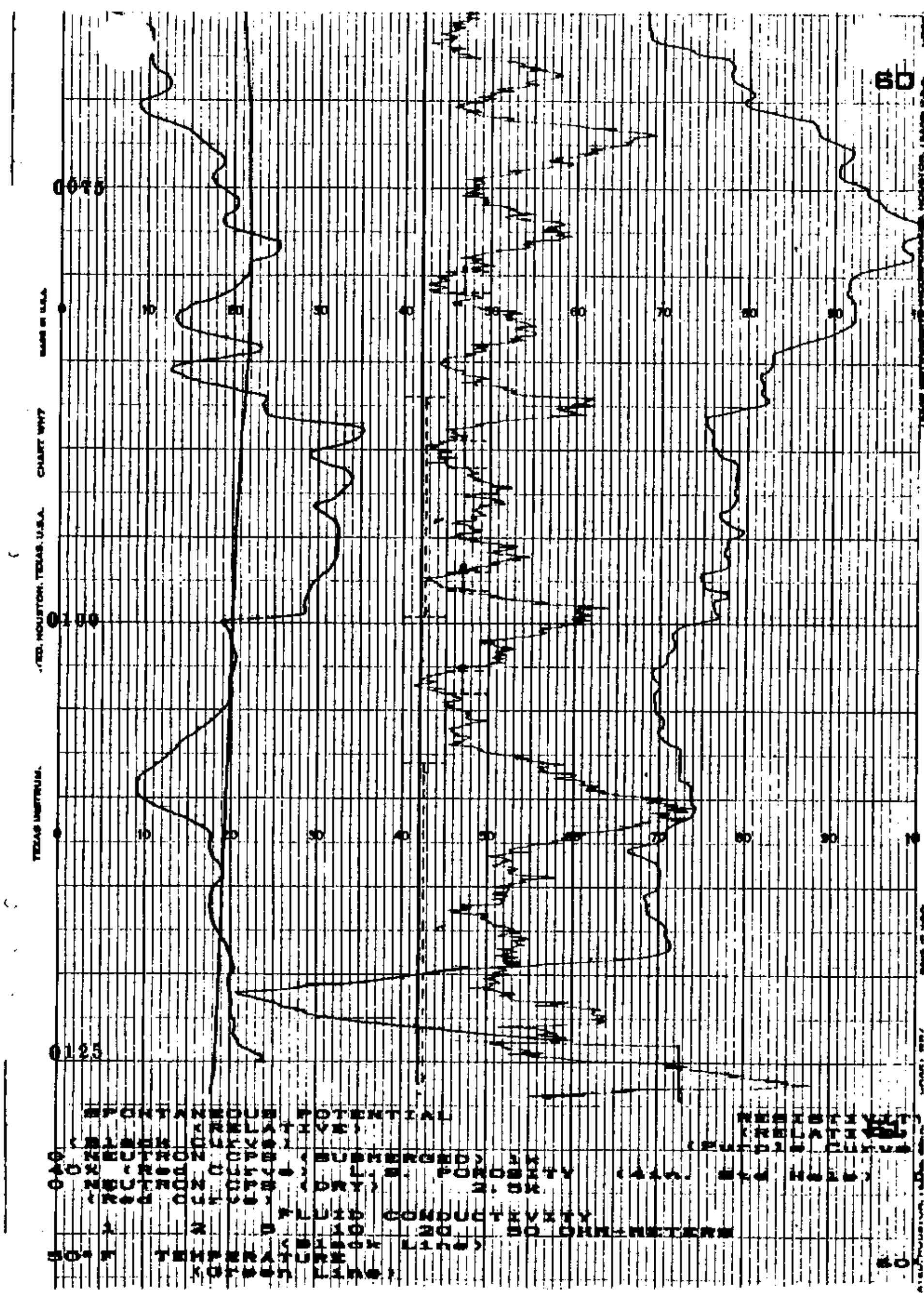
MADE IN U.S.A.
CHART WH7
TEXAS INSTRUMENTS INCORPORATED, HOUSTON, TEXAS, U.S.A.



6D
0075
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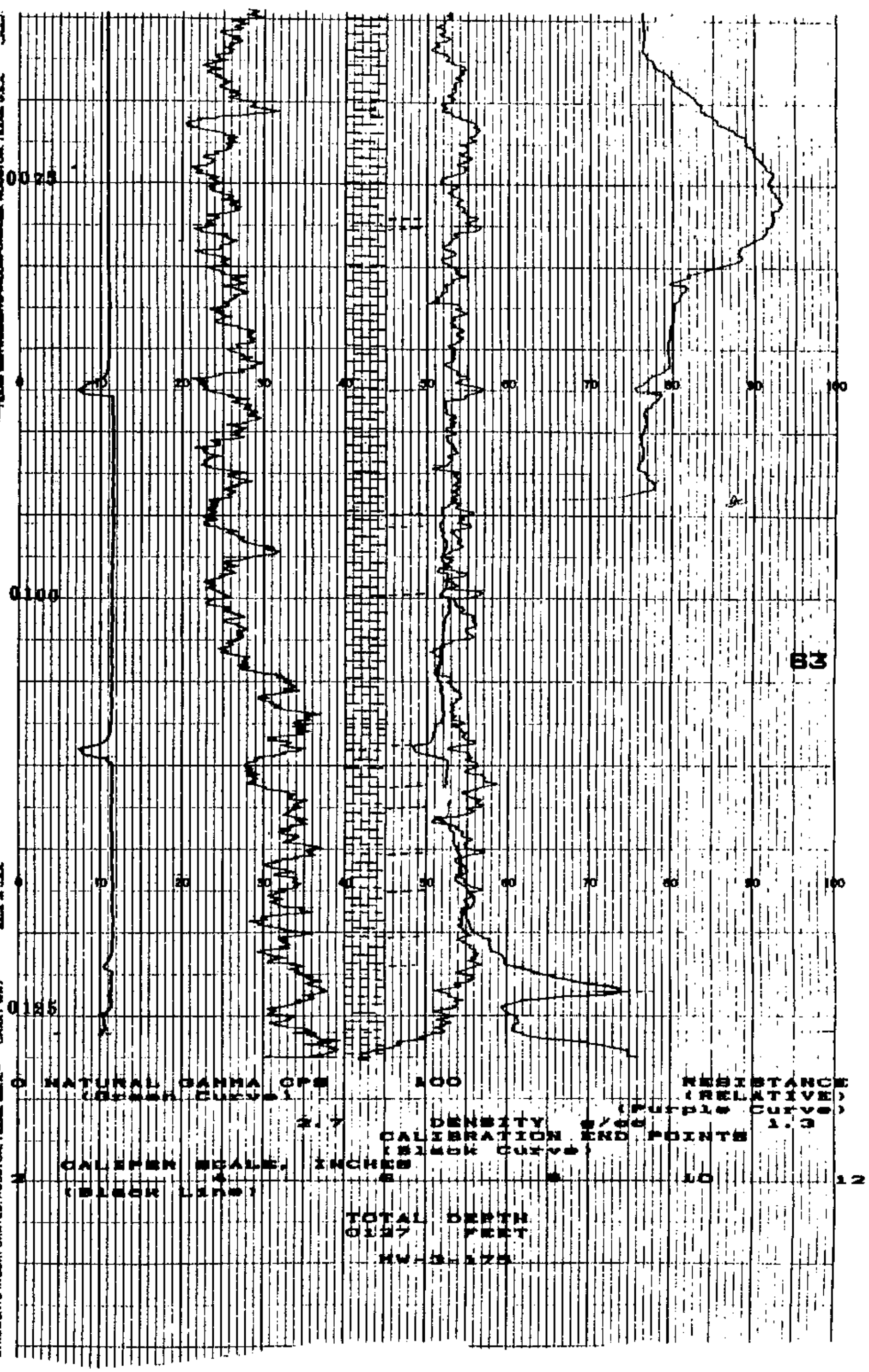
80
90
SPONTANEOUS POTENTIAL
(RELATIVE)
(Black Curve)
0 NEUTRON CPS (SUBMERGED) 1K
40% (Red Curve) L.S. POROSITY (4in. Std Hole) 0
0 NEUTRON CPS (DRY) 2.5K
(Red Curve)
FLUID CONDUCTIVITY
1 2 5 10 20 50 OHM-METERS
(Black Line)
50° F TEMPERATURE 60
(Green Line)
RESISTIVITY
(RELATIVE)
(Purple Curve)
TEXAS INSTRUM.
TED. HOUSTON, TEXAS, U.S.A.
CHART WH7
MADE IN U.S.A.



B3
0025
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10
20
30
40
50
60
70
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90
100
0 NATURAL GAMMA CPS 100
(Green Curve)
RESISTANCE
(RELATIVE)
(Purple Curve)
2.7 DENSITY g/cc 1.3
CALIBRATION END POINTS
(Black Curve)
2 CALIPER SCALE, INCHES 4 6 8 10 12
(Black Line)
TOTAL DEPTH
0127 FEET
MW-3-175

P.O. Box 17203
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Telephone (412) 243-3039

APPALACHIA COAL SURVEYS

LOG HEADING
HOLE NO.
MW-3-175 re (150)

COMPANY RADIAN CORPORATION	LOCATION	UNIT 61 OFFICE Pgh
PROJECT [illegible] HOLE NO. MW-3-175 relog		OPERATOR CBC
CLIENT REPRESENTATIVE I. Morin	COUNTY Tompkins STATE NY	DATE 11-Aug-88
DRILLED DEPTH 175 FT. ELEVATION FT.	CASING DEPTH 125 FT.	DRILLING FLUID WATER
HOLE DIAMETER 3.0 IN. WATER LEVEL 33 FT.	DIAMETER 4.0 IN. FACTOR WALL THICKNESS IN.	DRILLING CO. EMPIRE DRILLER

RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
1	CALIPER	153 - 177	1 in/in			
	NATURAL γ	-	CPS	SEC	NATURAL	
	H.R. DENSITY	-	CPS	SEC	Am 241	in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
	NEUTRON	-	CPS	SEC	Am-Be	in.
1	RESISTIVITY	153 - 177	20 Ω			
	SPONTANEOUS POTENTIAL	-	MV			
	TEMPERATURE	-	°F			
	FLUID CONDUCTIVITY	-	Ω M			
	SONIC	-	us/ft			2.0 FT.
	OTHER	-				

INTERPRETATION

■	COAL < 10% ASH
▥	COAL > 10% ASH
▤	BONE/CARBONACEOUS SHALE > 60% ASH
▤	FIRECLAY/HOT SHALE
▦	LIMESTONE/OTHER CARBONATE
▨	SANDSTONE
▨	SILTY SANDSTONE
▤	SHALE/CLAYSTONE
▨	SANDY SHALE/SILTSTONE
	GROUNDWATER INFLOW
	GROUNDWATER OUTFLOW

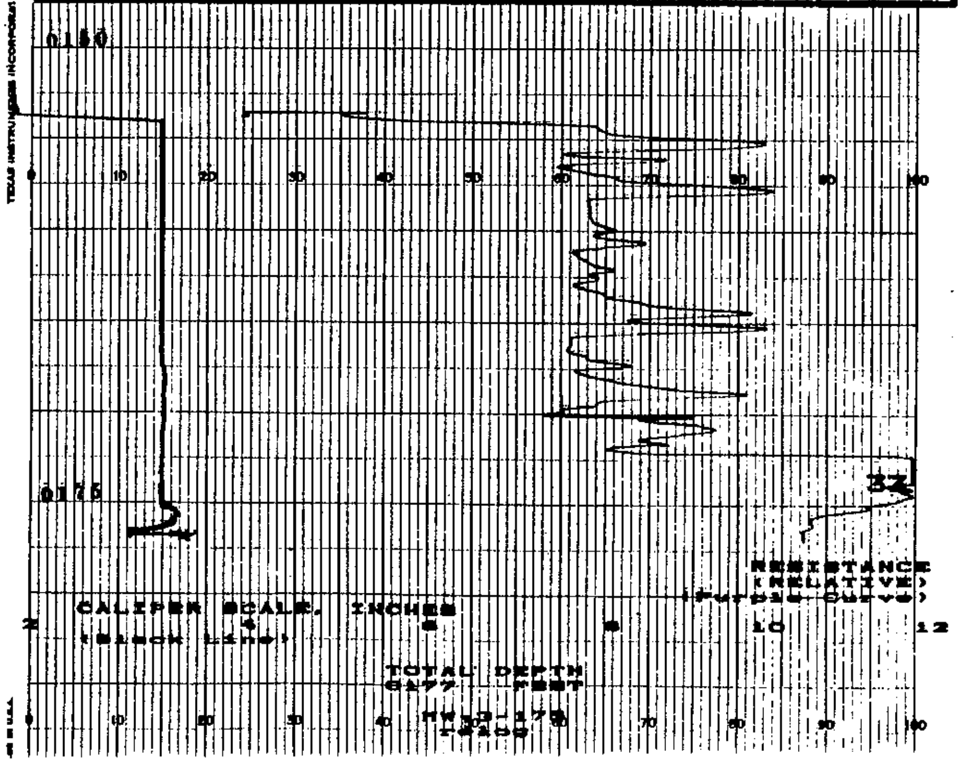
RUNS

RUN #	INTERVAL (DEPTH) FT.	SCALE FT/IN	LOGGING SPEED FT/MIN
1	153 - 177	5	20
	-		
	-		
	-		
	-		
	-		
	-		
	-		

NOTES: DATUM IS TOP OF CASING. HOLE COLLAPSED @ 153 FT OF INITIAL RUN. CALIPER TOOL STUCK FOUR HOURS DOWNHOLE!

0 10 20 30 40 50 60 70 80 90 100
% CLAY FROM NATURAL γ

H.R. DENSITY CALIBRATION g/cc
2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9 1.8 1.7 1.6 1.5 1.4 1.3



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APPALACHIAN COAL SURVEYS

LOG HEADING
HOLE NO.
MW - 4

COMPANY RADIAN CORPORATION	LOCATION	UNIT 41 OFFICE Pgh
PROJECT EMERSON HOLE NO. MW-4		OPERATOR CBC
CLIENT REPRESENTATIVE I. Morin	COUNTY Tompkins STATE NY	DATE 09-Aug-88
DRILLED DEPTH 43 FT. ELEVATION FT.	CASING DEPTH 16 FT.	DRILLING FLUID WATER
HOLE DIAMETER 3.0 IN. WATER LEVEL 18 FT.	DIAMETER 6.0 IN. FACTOR WALL THICKNESS IN.	DRILLING CO. EMPIRE DRILLER

RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
1	CALIPER	16 - 45	1 in/in			
2	NATURAL γ	0 - 39	100 CPS	2 SEC	NATURAL	
2	H.R. DENSITY	16 - 45	1k CPS	1 SEC	Am 241	0.5 in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
3	NEUTRON	6 - 45	1k CPS	1 SEC	Am-Be	12.0 in.
1,4	RESISTIVITY	16 - 45	20 Ω			
4	SPONTANEOUS POTENTIAL	16 - 43	200 MV			
4	TEMPERATURE	16 - 43	5 °F			
4	FLUID CONDUCTIVITY	16 - 45	50 Ω M			
	SONIC	-	us/ft			2.0 FT.
	OTHER	-				

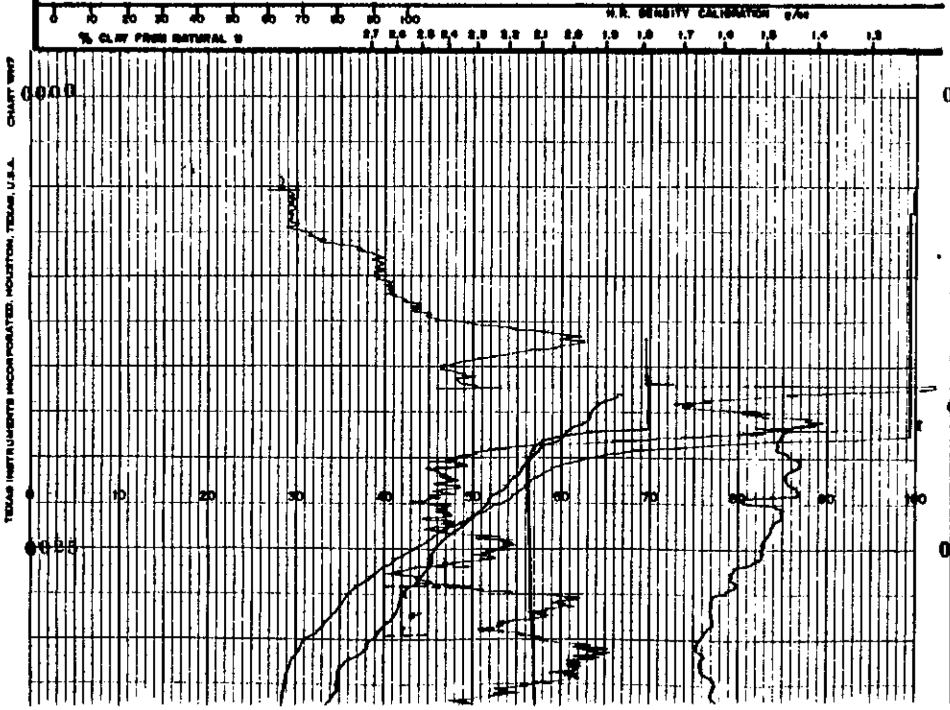
INTERPRETATION

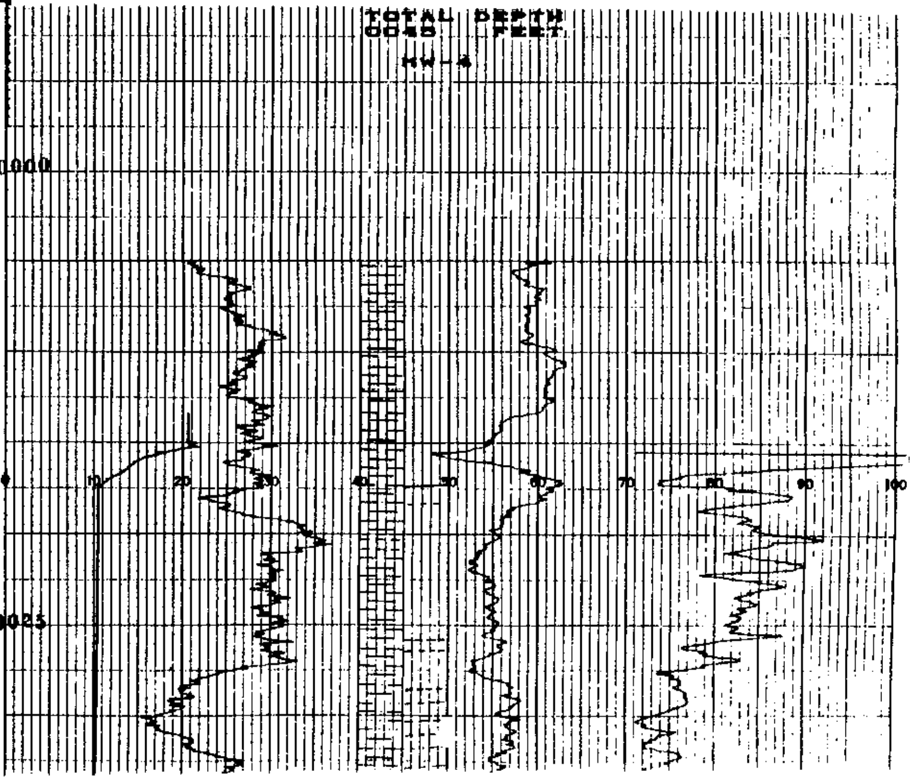
- ■ COAL < 10% ASH
- ▥ COAL > 10% ASH
- ▤ BONE/CARBONACEOUS SHALE > 50% ASH
- ▤ FIRECLAY/HOT SHALE
- ▦ LIMESTONE/OTHER CARBONATE
- ▒ SANDSTONE
- ▒ SILTY SANDSTONE
- ▤ SHALE/CLAYSTONE
- ▤ SANDY SHALE/SILTSTONE
- GROUNDWATER INFLOW
- GROUNDWATER OUTFLOW

RUNS

RUN #	INTERVAL (DEPTH) FT.	SCALE FT/IN	LOGGING SPEED FT/MIN
1	SUR - 45	5	20
2	SUR - 45	5	20
3	SUR - 45	5	20
4	SUR - 45	5	20
	-		
	-		
	-		
	-		

NOTES: DATUM IS TOP OF CASING



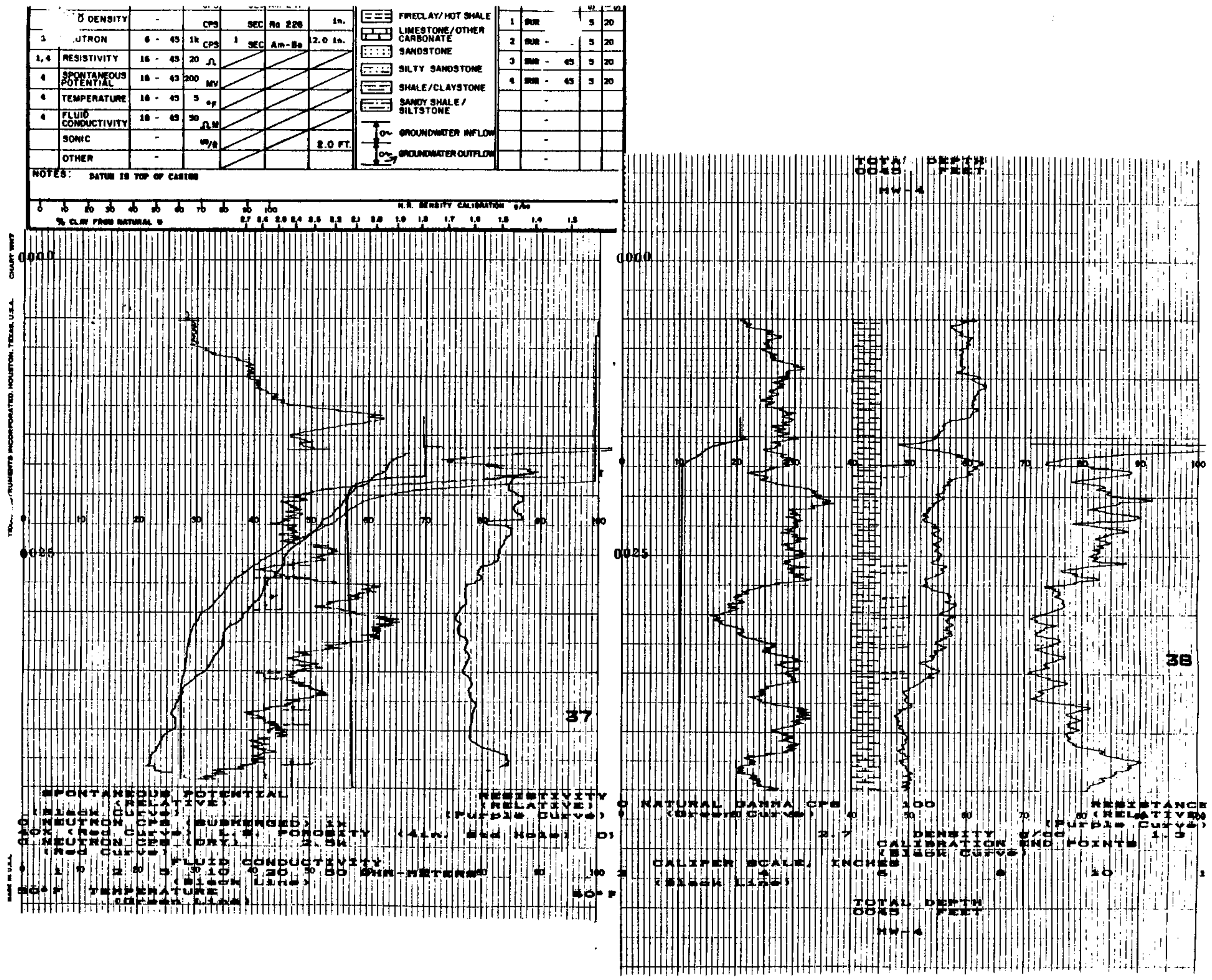


	Ŏ DENSITY	-		CPS		SEC	Ra 226	in.
3	UTRON	6 - 45	1k	CPS	1	SEC	Am-Be	12.0 in.
1,4	RESISTIVITY	16 - 45	20	Ω				
4	SPONTANEOUS POTENTIAL	18 - 43	200	MV				
4	TEMPERATURE	16 - 45	5	°F				
4	FLUID CONDUCTIVITY	18 - 45	30	Ω M				
	SONIC	-		μs/ft				2.0 FT.
	OTHER	-						

- FIRECLAY/HOT SHALE
- LIMESTONE/OTHER CARBONATE
- SANDSTONE
- SILTY SANDSTONE
- SHALE/CLAYSTONE
- SANDY SHALE / SILTSTONE
- GROUNDWATER INFLOW
- GROUNDWATER OUTFLOW

1	SUR		5	20
2	SUR -	-	5	20
3	SUR -	45	5	20
4	SUR -	45	5	20
	-			
	-			
	-			
	-			

NOTES: DATUM IS TOP OF CASING



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APPALACHIAN COAL SURVEYS

LOG HEADING
HOLE NO.
MW-5-40

COMPANY RADIAN CORPORATION
PROJECT EMERSON HOLE NO. MW-5-40
CLIENT REPRESENTATIVE J. Morin
DRILLED DEPTH 40 FT. ELEVATION FT.
HOLE DIAMETER 3.0 IN. WATER LEVEL 31 FT.

LOCATION
COUNTY Tompkins STATE NY
CASING DEPTH 23 FT.
DIAMETER 5.0 IN. FACTOR
WALL THICKNESS IN.

UNIT 61 OFFICE Pgh
OPERATOR CBC
DATE 09-Aug-88
DRILLING FLUID WATER
DRILLING CO. EMPIRE DRILLER

RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
1	CALIPER	23 - 40	1 in/in			
2	NATURAL γ	0 - 34	100 CPS	2 SEC	NATURAL	
2	H.R. DENSITY	23 - 40	1k CPS	1 SEC	Am 241	0.5 in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
3	NEUTRON	6 - 40	1k CPS	1 SEC	Am-Be	2.0 in.
1, 4	RESISTIVITY	23 - 40	20 Ω			
4	SPONTANEOUS POTENTIAL	31 - 38	200 MV			
4	TEMPERATURE	31 - 40	5 °F			
4	FLUID CONDUCTIVITY	31 - 40	50 Ω.M			
	SONIC	-	μs/ft			2.0 FT.
	OTHER	-				

INTERPRETATION
- ■ COAL < 10% ASH
- ▥ COAL > 10% ASH
- ▤ BONE/CARBONACEOUS SHALE > 60% ASH
- ▤ FIRECLAY/HOT SHALE
- ▦ LIMESTONE/OTHER CARBONATE
- ▒ SANDSTONE
- ▒ SILTY SANDSTONE
- ▤ SHALE/CLAYSTONE
- ▒ SANDY SHALE/SILTSTONE
- GROUNDWATER INFLOW
- GROUNDWATER OUTFLOW

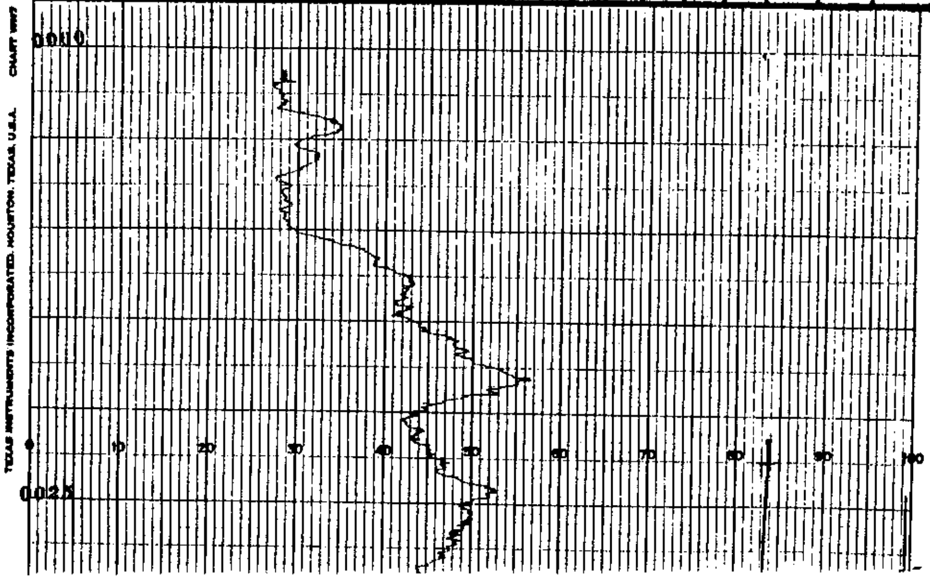
RUNS

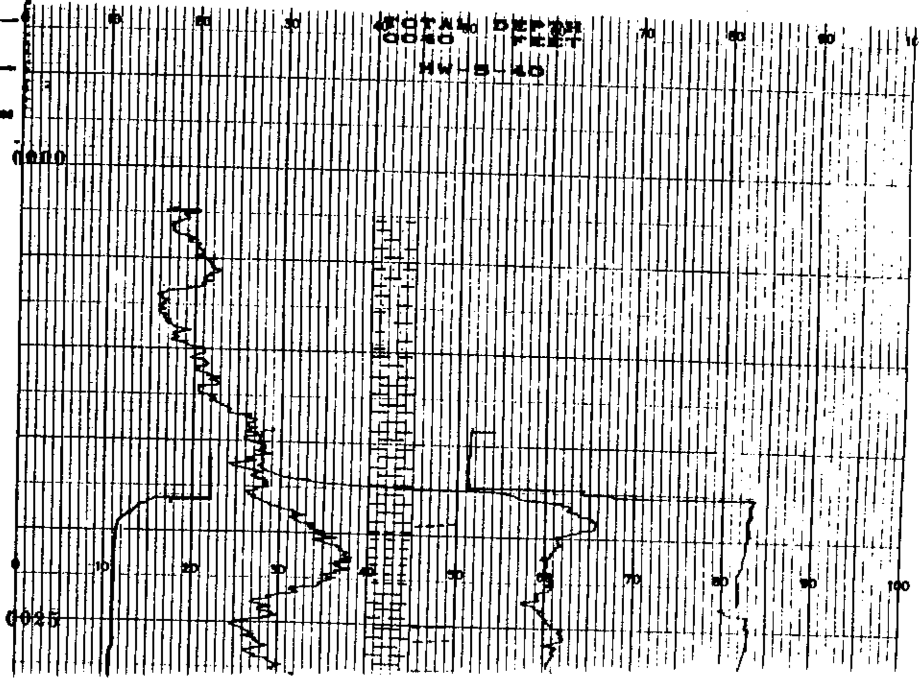
RUN #	INTERVAL (DEPTH) FT.	SCALE FT./IN.	LOGGING SPEED FT./MIN.
1	SUR - 40	5	20
2	SUR - 40	5	20
3	SUR - 40	5	20
4	SUR - 40	5	20
	-		
	-		
	-		
	-		

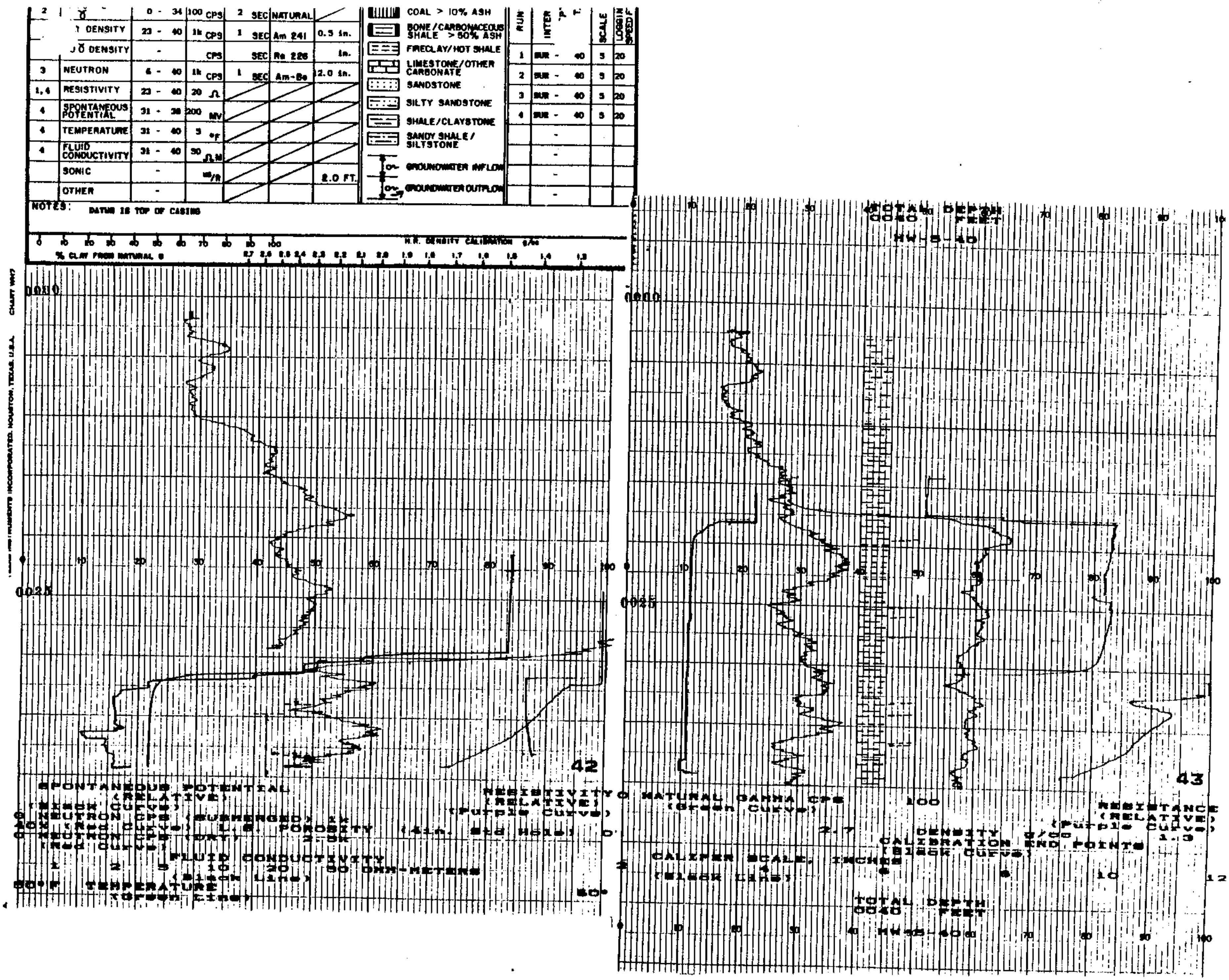
NOTES: DATUM IS TOP OF CASING

0 10 20 30 40 50 60 70 80 90 100
% CLAY FROM NATURAL γ

H.R. DENSITY CALIBRATION g/cc
2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9 1.8 1.7 1.6 1.5 1.4 1.3







2	Ŏ	0 - 34	100	CPS	2	SEC	NATURAL	
	DENSITY	23 - 40	1k	CPS	1	SEC	Am 241	0.5 in.
	Ŏ DENSITY	-		CPS		SEC	Ra 226	in.
3	NEUTRON	6 - 40	1k	CPS	1	SEC	Am-Be	2.0 in.
1, 4	RESISTIVITY	23 - 40	20	Ω				
4	SPONTANEOUS POTENTIAL	31 - 38	200	MV				
4	TEMPERATURE	31 - 40	5	°F				
4	FLUID CONDUCTIVITY	31 - 40	50	Ω.M				
	SONIC	-		µs/ft				2.0 FT.
	OTHER	-						

▥	COAL > 10% ASH
▤	BONE / CARBONACEOUS SHALE > 50% ASH
▤	FIRECLAY/HOT SHALE
▦	LIMESTONE/OTHER CARBONATE
░	SANDSTONE
░	SILTY SANDSTONE
▤	SHALE/CLAYSTONE
▤	SANDY SHALE / SILTSTONE
	GROUNDWATER INFLOW
	GROUNDWATER OUTFLOW

RUN	INTER		SCALE	LOGGING SPEED
1	SUR -	40	5	20
2	SUR -	40	5	20
3	SUR -	40	5	20
4	SUR -	40	5	20
	-			
	-			
	-			
	-			

NOTES: DATUM IS TOP OF CASING

0 10 20 30 40 50 60 70 80 90 100

% CLAY FROM NATURAL G

H.R. DENSITY CALIBRATION g/cc

2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9 1.8 1.7 1.6 1.5 1.4 1.3

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APPALACHIAN
COAL SURVEYS

LOG HEADING
HOLE NO.
MW-6-40

COMPANY RADIAN CORPORATION	LOCATION	UNIT 61 OFFICE Pgh
PROJECT [illegible] HOLE NO. MW-6-40		OPERATOR CBC
CLIENT REPRESENTATIVE I. Morin	COUNTY Tompkins STATE NY	DATE 11-Aug-88
DRILLED DEPTH 40 FT. ELEVATION FT.	CASING DEPTH 21 FT.	DRILLING FLUID WATER
HOLE DIAMETER 3.0 IN. WATER LEVEL 19 FT.	DIAMETER 4.0 IN. FACTOR WALL THICKNESS IN.	DRILLING CO. EMPIRE DRILLER

RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
1	CALIPER	21 - 40	1 in/in			
2	NATURAL γ	0 - 34	100 CPS	2 SEC	NATURAL	
2	H.R. DENSITY	21 - 40	1k CPS	1 SEC	Am 241	0.5 in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
3	NEUTRON	6 - 40	1k CPS	1 SEC	Am-Be	12.0 in.
1, 4	RESISTIVITY	21 - 40	20 Ω			
4	SPONTANEOUS POTENTIAL	21 - 38	200 MV			
4	TEMPERATURE	21 - 40	5 °F			
4	FLUID CONDUCTIVITY	21 - 40	50 Ω.M			
	SONIC	-	us/ft			2.0 FT.
	OTHER	-				

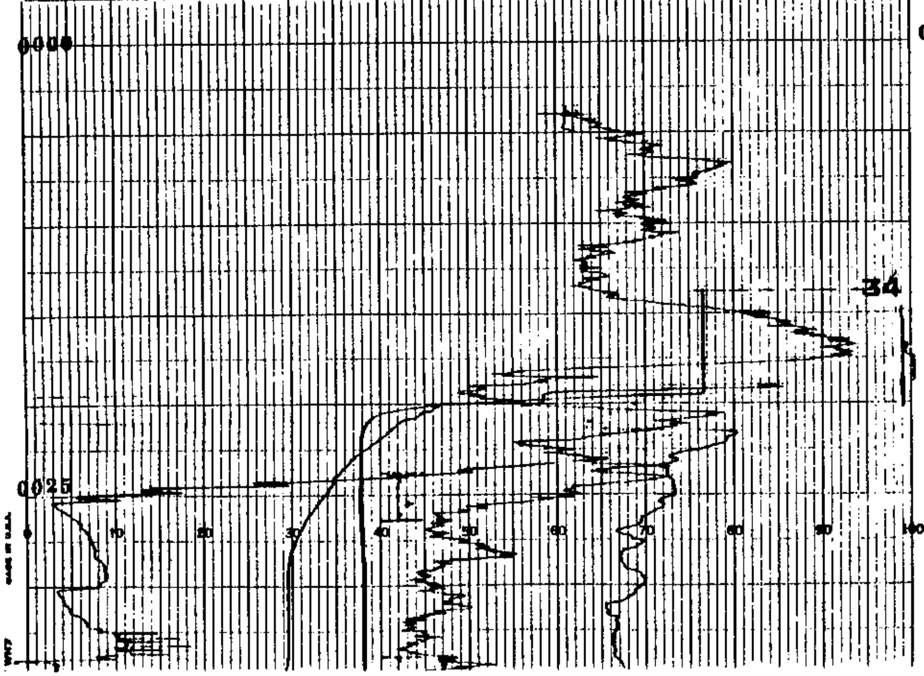
INTERPRETATION	
■	COAL < 10% ASH
▥	COAL > 10% ASH
▤	BONE/CARBONACEOUS SHALE > 50% ASH
▤	FIRECLAY/HOT SHALE
▦	LIMESTONE/OTHER CARBONATE
⁙	SANDSTONE
▤	SILTY SANDSTONE
▤	SHALE/CLAYSTONE
▤	SANDY SHALE/SILTSTONE
⊢	GROUNDWATER INFLOW
⊢	GROUNDWATER OUTFLOW

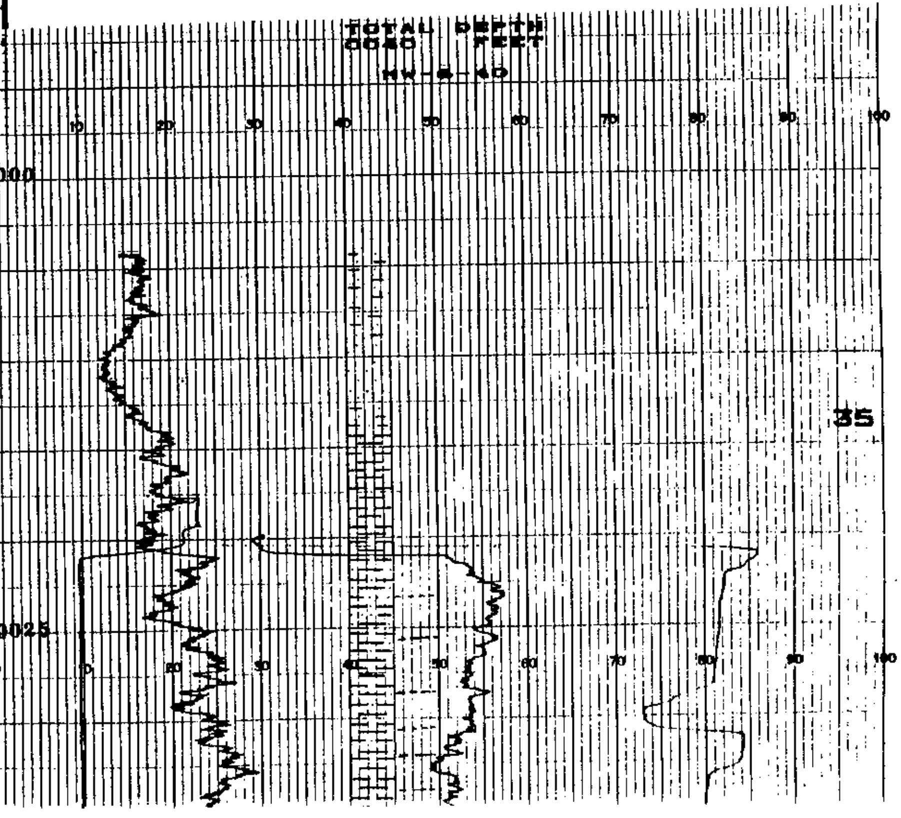
RUNS			
RUN #	INTERVAL (DEPTH) FT.	SCALE FT/IN	LOGGING SPEED FT/MIN
1	SUR - 40	5	20
2	SUR - 40	5	20
3	SUR - 40	5	20
4	SUR - 40	5	20
	-		
	-		
	-		
	-		

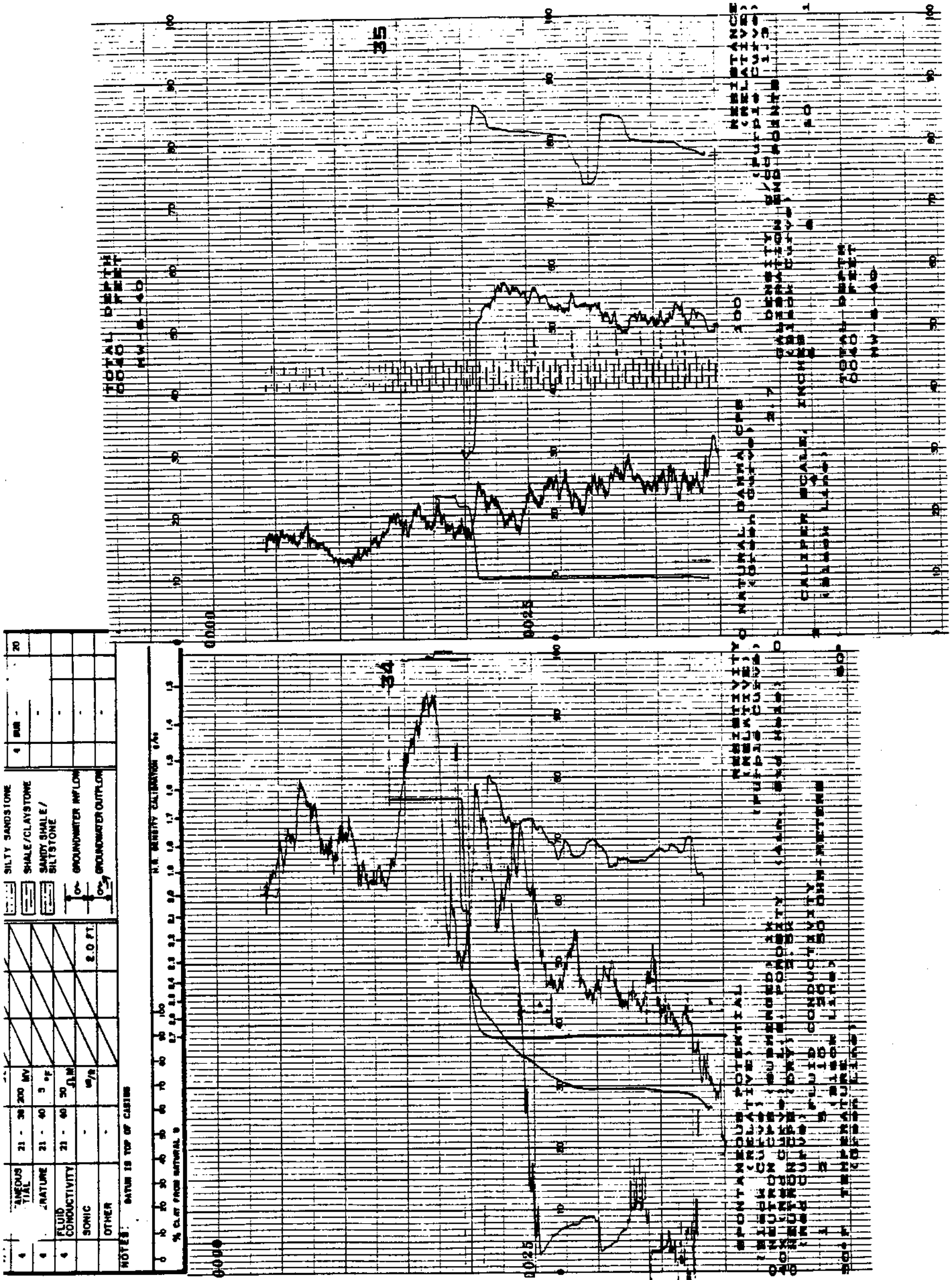
NOTES: DATUM IS TOP OF CASING

0 10 20 30 40 50 60 70 80 90 100
% CLAY FROM NATURAL γ

H.R. DENSITY CALIBRATION g/cc
2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9 1.8 1.7 1.6 1.5 1.4 1.3





35
34
0000
0025
TOTAL DEPTH FEET
MW-8-40
NATURAL GAMMA, CPS
RESISTANCE
CALIPER SCALE, INCHES
SPONTANEOUS POTENTIAL
FLUID CONDUCTIVITY
TEMPERATURE
SILTY SANDSTONE
SHALE/CLAYSTONE
SANDY SHALE/SILTSTONE
GROUNDWATER INFLOW
GROUNDWATER OUTFLOW
FLUID CONDUCTIVITY
SONIC
OTHER
2.0 FT.
NOTES: DATUM IS TOP OF CASING
H.R. DENSITY CALIBRATION G/CC
% CLAY FROM NATURAL G
INCORPORATED, HOUSTON, TEXAS, U.S.A.

P O Box 17203
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Telephone (412) 243-3030

APPALACHIAN COAL SURVEYS

LOG HEADING

HOLE NO.
MW-9-100
6

COMPANY RADIAN CORPORATION	LOCATION	UNIT 61 OFFICE Pgh
PROJECT EMERSON HOLE NO. MW-9-100		OPERATOR CBC
CLIENT REPRESENTATIVE I. Borin	COUNTY Tompkins STATE NY	DATE 11-Aug-88
DRILLED DEPTH 100 FT. ELEVATION FT.	CASING DEPTH 101 FT.	DRILLING FLUID WATER
HOLE DIAMETER 3.0 IN. WATER LEVEL 93 FT.	DIAMETER 2.0 IN. FACTOR WALL THICKNESS IN.	DRILLING CO. EMPIRE DRILLER

RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
	CALIPER	-	in/in			.
1	NATURAL γ	4 - 101	100 CPS	SEC	NATURAL	
	H.R. DENSITY	-	CPS	SEC	Am 241	in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
2	NEUTRON	4 - 101	1k CPS	1 SEC	Am-Be	12.0 in.
	RESISTIVITY	-	Ω			
	SPONTANEOUS POTENTIAL	-	MV			
	TEMPERATURE	-	°F			
	FLUID CONDUCTIVITY	-	Ω M			
	SONIC	-	us/ft			2.0 FT.
	OTHER	-				

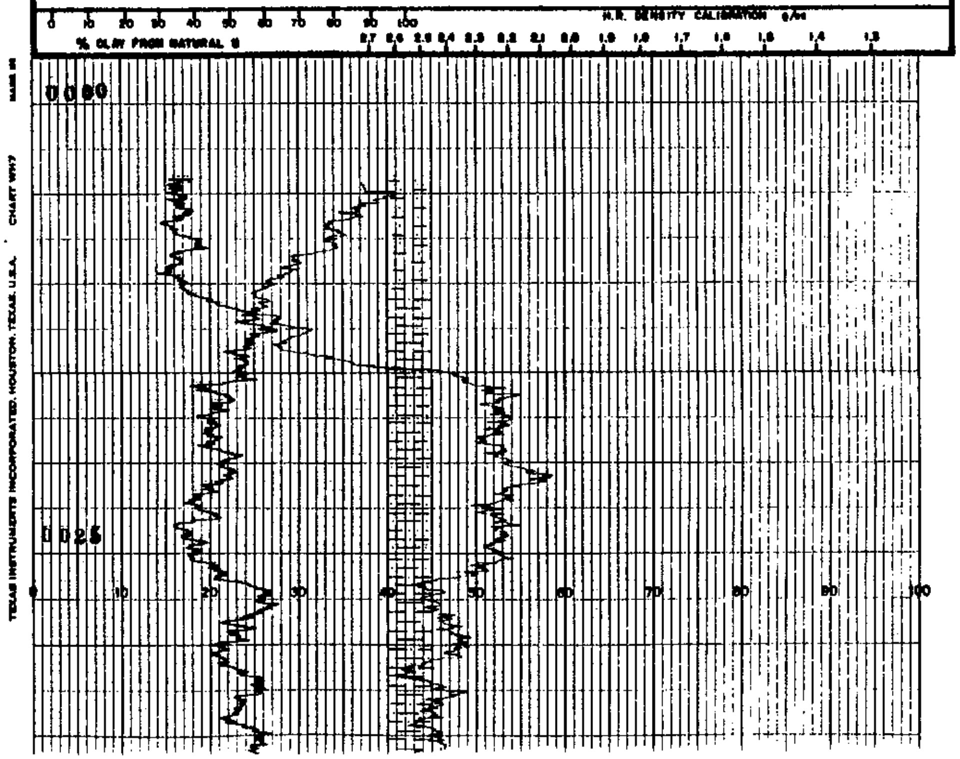
INTERPRETATION

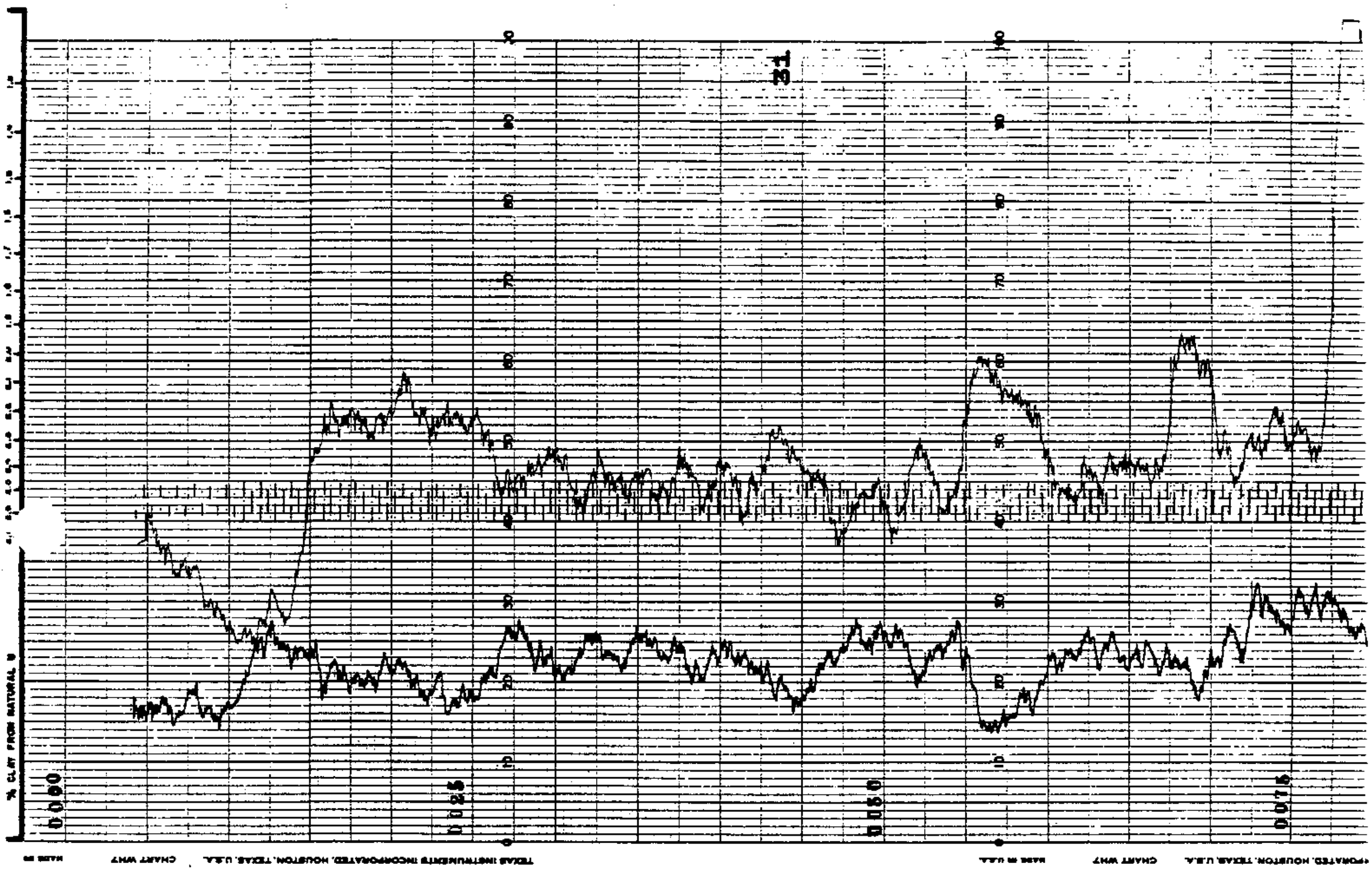
■	COAL < 10% ASH
▥	COAL > 10% ASH
▤	BONE/CARBONACEOUS SHALE > 50% ASH
▤	FIRECLAY/HOT SHALE
▦	LIMESTONE/OTHER CARBONATE
▨	SANDSTONE
▨	SILTY SANDSTONE
▤	SHALE/CLAYSTONE
▨	SANDY SHALE/SILTSTONE
	GROUNDWATER INFLOW
	GROUNDWATER OUTFLOW

RUNS

RUN #	INTERVAL (DEPTH) FT.	SCALE FT/IN	LOGGING SPEED FT/MIN
1	SUR - 101	5	20
2	SUR - 101	5	20
	-		
	-		
	-		
	-		
	-		
	-		

NOTES: DATUM IS TOP OF CASING




% CLAY FROM NATURAL
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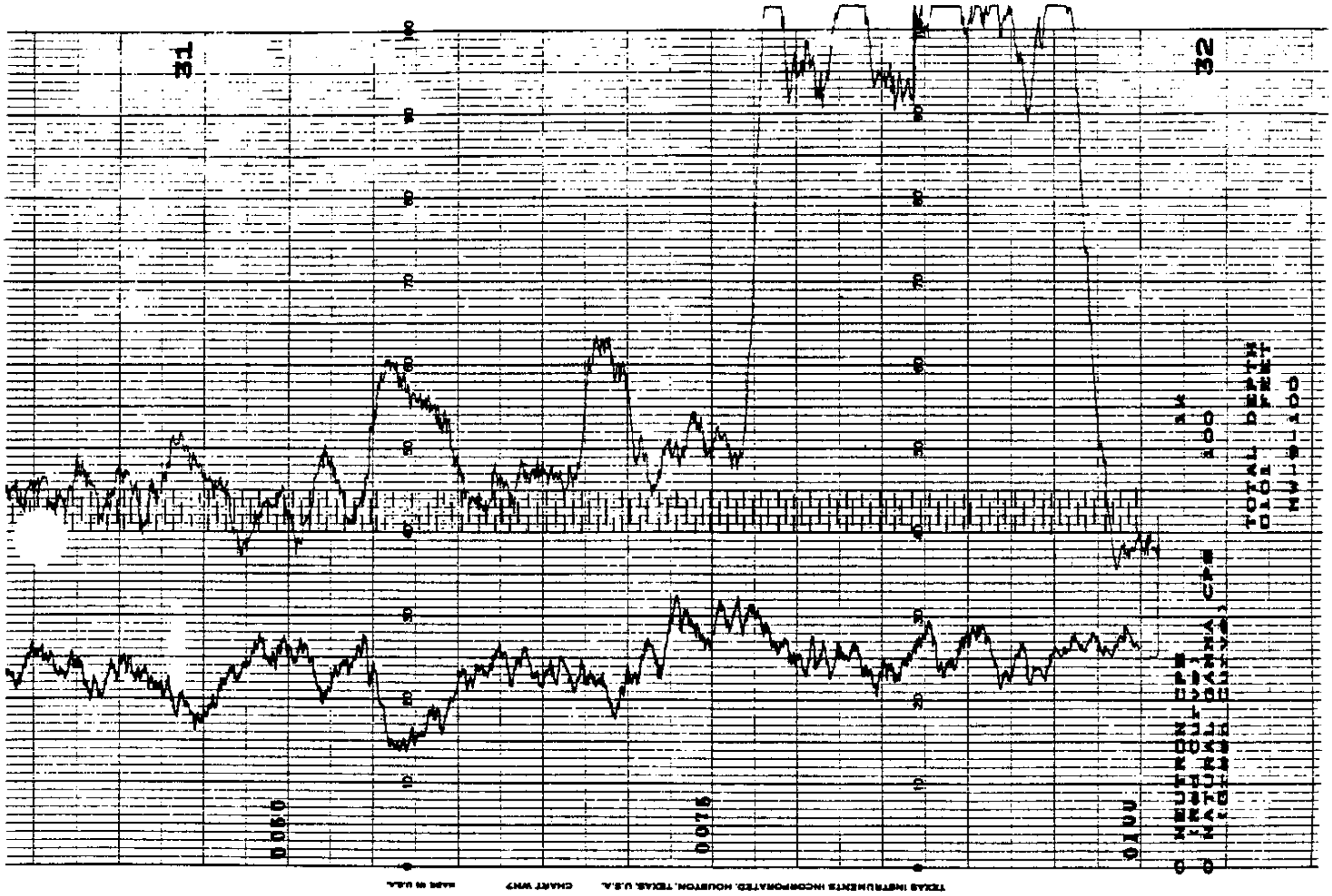
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20
10
0
NEUTRON CPS
NATURAL GAMMA CPS
1K
100
TOTAL DEPTH
FEET
TEXAS INSTRUMENTS INCORPORATED, HOUSTON, TEXAS, U.S.A.
CHART WH7
MADE IN U.S.A.

P.O Box 17203
Pittsburgh, PA 15235
Telephone (412) 243-3030

APPALACHIAN COAL SURVEYS

LOG HEADING
HOLE NO.
MW-7-40

COMPANY RADIAN CORPORATION	LOCATION	UNIT 41 OFFICE Pgh
PROJECT EMERSON HOLE NO. MW-7-40		OPERATOR CBC
CLIENT REPRESENTATIVE I. Morin	COUNTY Tompkins STATE NY	DATE 08-Aug-88
DRILLED DEPTH 40 FT. ELEVATION FT.	CASING DEPTH 20 FT.	DRILLING FLUID WATER
HOLE DIAMETER 3.0 IN. WATER LEVEL 30 FT.	DIAMETER 6.0 IN. FACTOR WALL THICKNESS IN.	DRILLING CO. EMPIRE DRILLER

RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
1	CALIPER	20 - 41	1 in/in			
2	NATURAL γ	0 - 35	100 CPS	2 SEC	NATURAL	
2	H.R. DENSITY	20 - 41	1k CPS	1 SEC	Am 241	0.3 in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
3	NEUTRON	6 - 41	1k CPS	1 SEC	Am-Be	12.0 in.
1, 4	RESISTIVITY	20 - 41	20 Ω			
4	SPONTANEOUS POTENTIAL	36 - 39	200 MV			
4	TEMPERATURE	30 - 41	5 °F			
4	FLUID CONDUCTIVITY	30 - 41	50 Ω M			
	SONIC	-	μs/ft			2.0 FT.
	OTHER	-				

INTERPRETATION

■	COAL < 10% ASH
▥	COAL > 10% ASH
▤	BONE/CARBONACEOUS SHALE > 50% ASH
▤	FIRECLAY/HOT SHALE
▦	LIMESTONE/OTHER CARBONATE
▒	SANDSTONE
▒	SILTY SANDSTONE
▤	SHALE/CLAYSTONE
▤	SANDY SHALE/ SILTSTONE
	GROUNDWATER INFLOW
	GROUNDWATER OUTFLOW

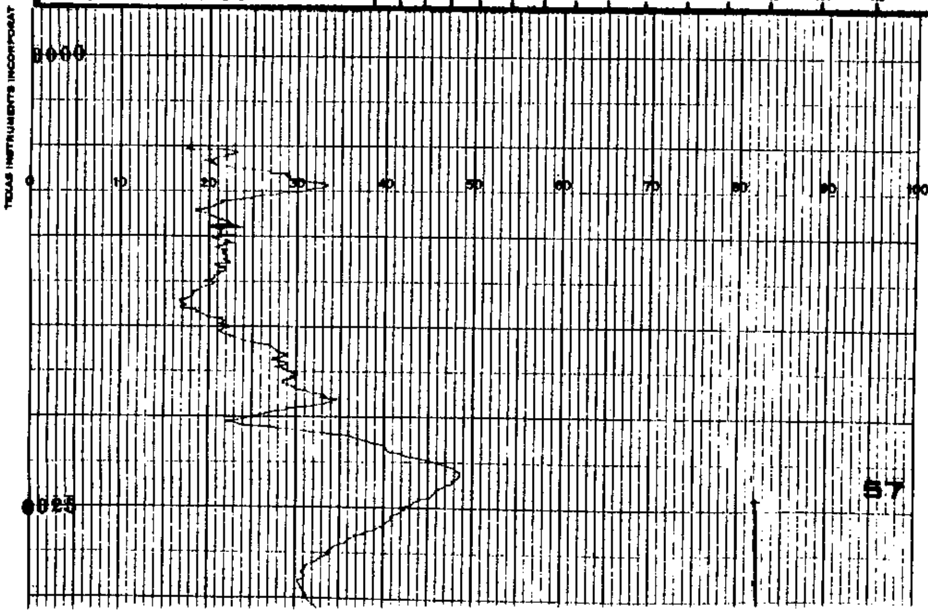
RUNS

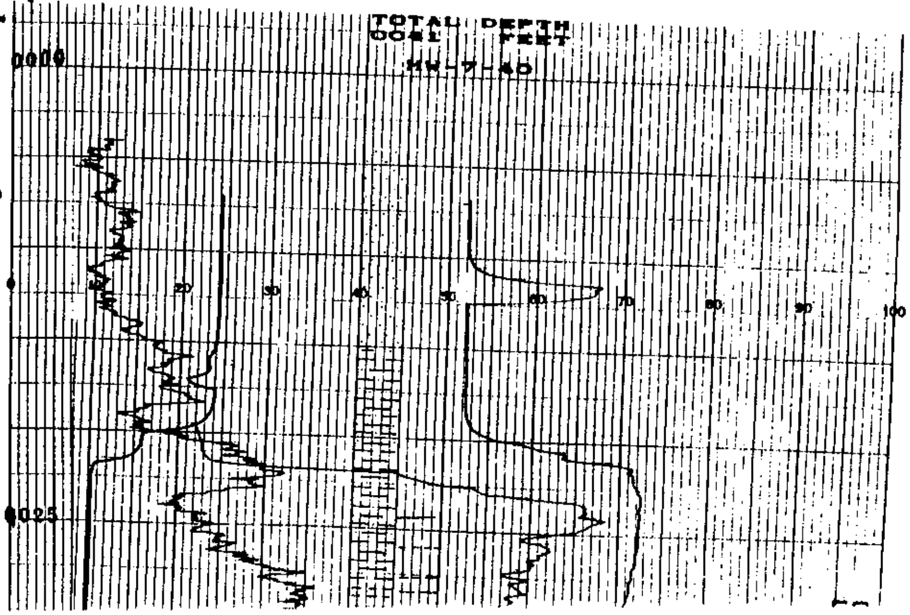
RUN #	INTERVAL (DEPTH) FT.	SCALE FT/IN	LOGGING SPEED FT/MIN
1	SUR - 41	5	20
2	SUR - 41	5	20
3	SUR - 41	5	20
4	SUR - 41	5	20
	-		
	-		
	-		
	-		

NOTES: DATUM IS TOP OF CASING

0 10 20 30 40 50 60 70 80 90 100
% CLAY FROM NATURAL γ

H.R. DENSITY CALIBRATION g/cc
2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9 1.8 1.7 1.6 1.5 1.4 1.3



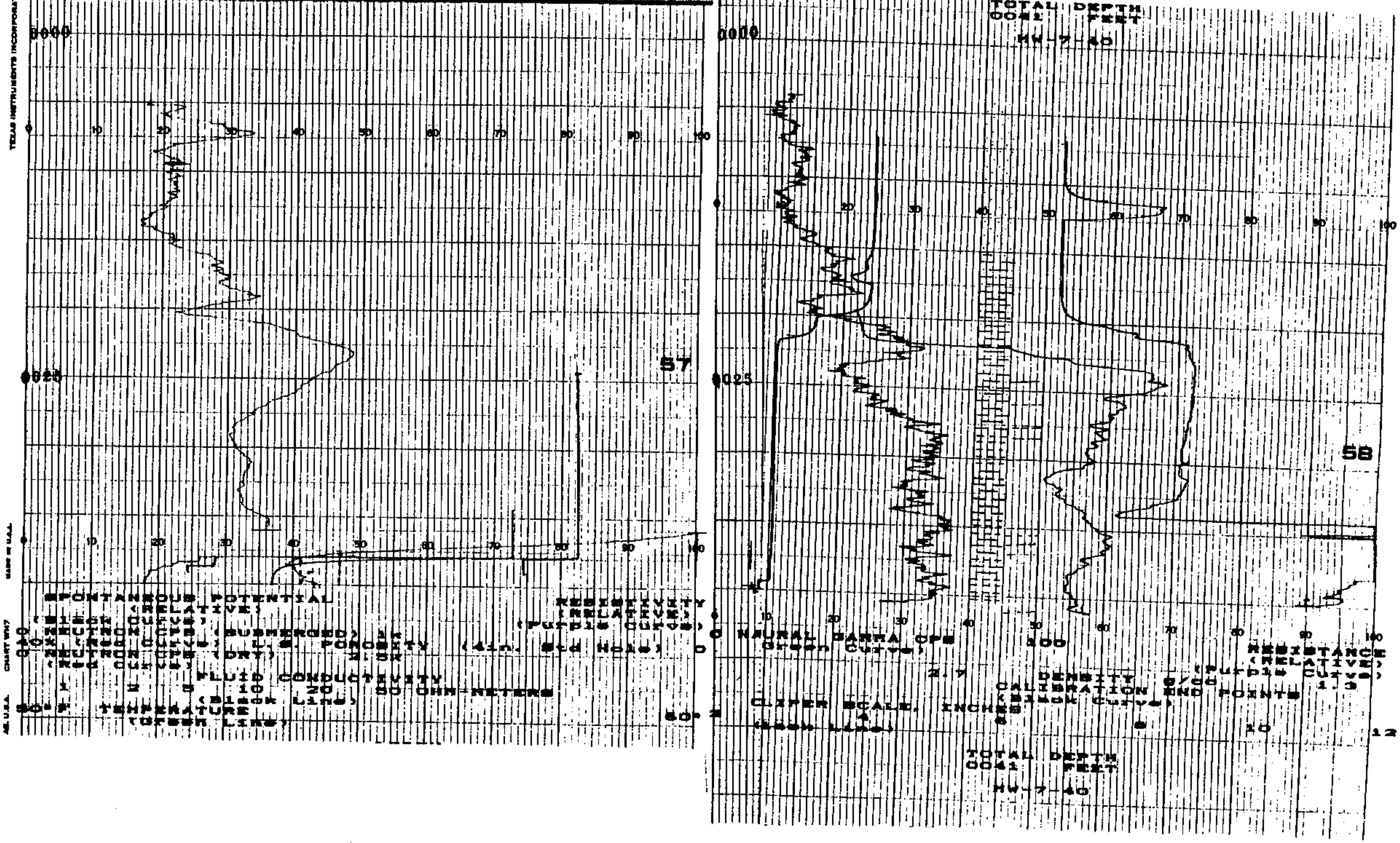


	'UTRON	6 - 41	1k CPS	1 SEC	Am-Be	12.0 in.	LIMESTONE/OTHER CARBONATE	2	SUR		5	20
1.	ISTIVITY	30 - 41	20 Ω				SANDSTONE	3	SUR -		5	20
4	SPONTANEOUS POTENTIAL	38 - 39	200 MV				SILTY SANDSTONE	4	SUR -	41	5	20
4	TEMPERATURE	38 - 41	5 °F				SHALE/CLAYSTONE		-			
4	FLUID CONDUCTIVITY	38 - 41	50 Ω.M				SANDY SHALE / SILTSTONE		-			
	SONIC	-	us/ft			2.0 FT.	GROUNDWATER INFLOW		-			
	OTHER	-					GROUNDWATER OUTFLOW		-			

NOTES: DATUM IS TOP OF CASING

0 10 20 30 40 50 60 70 80 90 100
% CLAY FROM NATURAL U

N.R. DENSITY CALIBRATION g/cc
2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9 1.8 1.7 1.6 1.5 1.4 1.3



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APPALACHIAN COAL SURVEYS

LOG HEADING
HOLE NO.
MW-8-40

COMPANY RADIAN CORPORATION
PROJECT EMERSON HOLE NO. MW-8-40
CLIENT REPRESENTATIVE I. Morin
DRILLED DEPTH 40 FT. ELEVATION FT.
HOLE DIAMETER 3.0 IN. WATER LEVEL 37 FT.

LOCATION
COUNTY Tompkins STATE NY
CASING DEPTH FT.
DIAMETER 6.0 IN. FACTOR 18
WALL THICKNESS IN.

UNIT 61 OFFICE Pgh
OPERATOR CRC
DATE 09-Aug-90
DRILLING FLUID WATER
DRILLING CO. EMPIRE DRILLER

RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
1	CALIPER	18 - 43	1 in/in			
2	NATURAL γ	0 - 37	100 CPS	2 SEC	NATURAL	
2	H.R. DENSITY	18 - 43	1k CPS	1 SEC	Am 241	0.5 in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
3	NEUTRON	6 - 43	1k CPS	1 SEC	Am-Be	2.0 in.
1, 4	RESISTIVITY	18 - 43	20 Ω			
4	SPONTANEOUS POTENTIAL	37 - 41	200 MV			
4	TEMPERATURE	37 - 43	5 °F			
4	FLUID CONDUCTIVITY	37 - 43	50 Ω M			
	SONIC	-	us/ft			2.0 FT.
	OTHER	-				

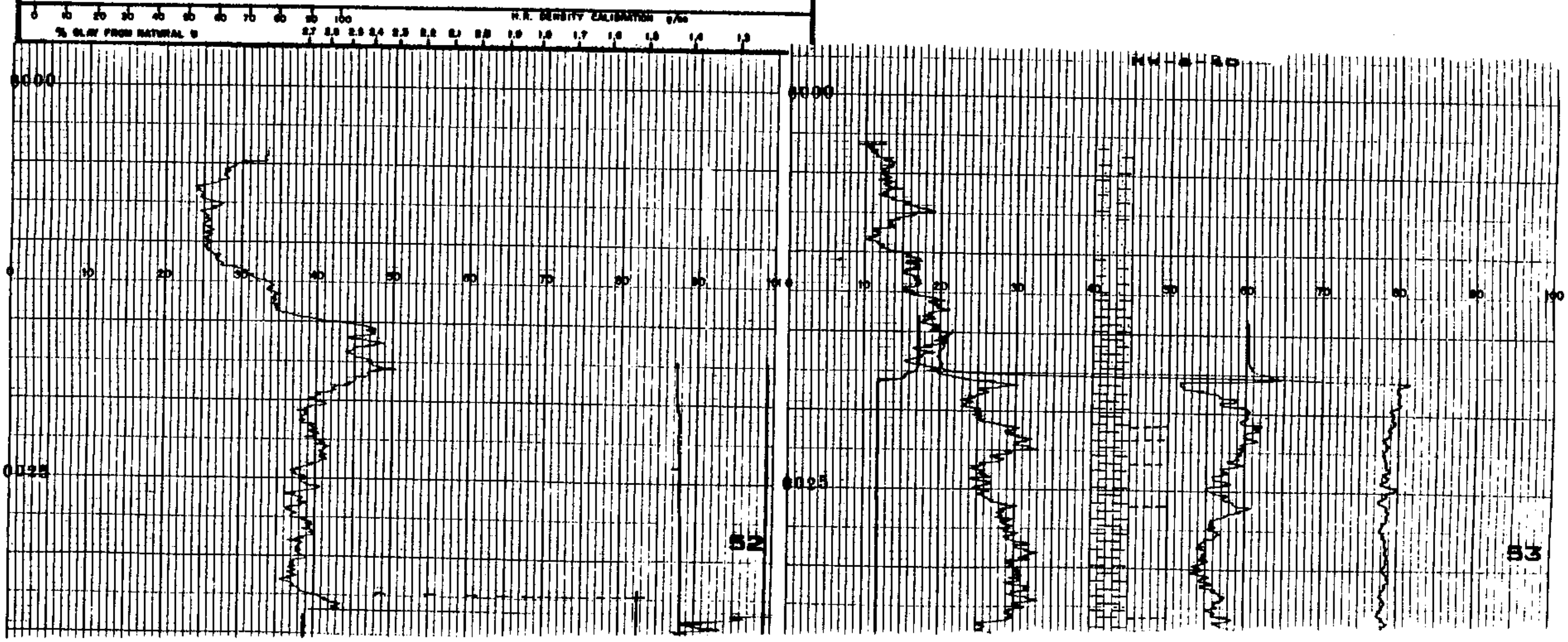
INTERPRETATION

- ▇ COAL < 10% ASH
- ▥ COAL > 10% ASH
- ▤ BONE/CARBONACEOUS SHALE > 50% ASH
- ▤ FIRECLAY/HOT SHALE
- ▦ LIMESTONE/OTHER CARBONATE
- ▒ SANDSTONE
- ▒ SILTY SANDSTONE
- ▤ SHALE/CLAYSTONE
- ▤ SANDY SHALE/SILTSTONE
- GROUNDWATER INFLOW
- GROUNDWATER OUTFLOW

RUNS

RUN #	INTERVAL (DEPTH) FT.	SCALE FT./IN.	LOGGING SPEED FT./MIN.
1	SUR - 43	5	20
2	SUR - 43	5	20
3	SUR - 43	5	20
4	SUR - 43	5	20
	-		
	-		
	-		
	-		

NOTES: DATUM IS TOP OF CASING



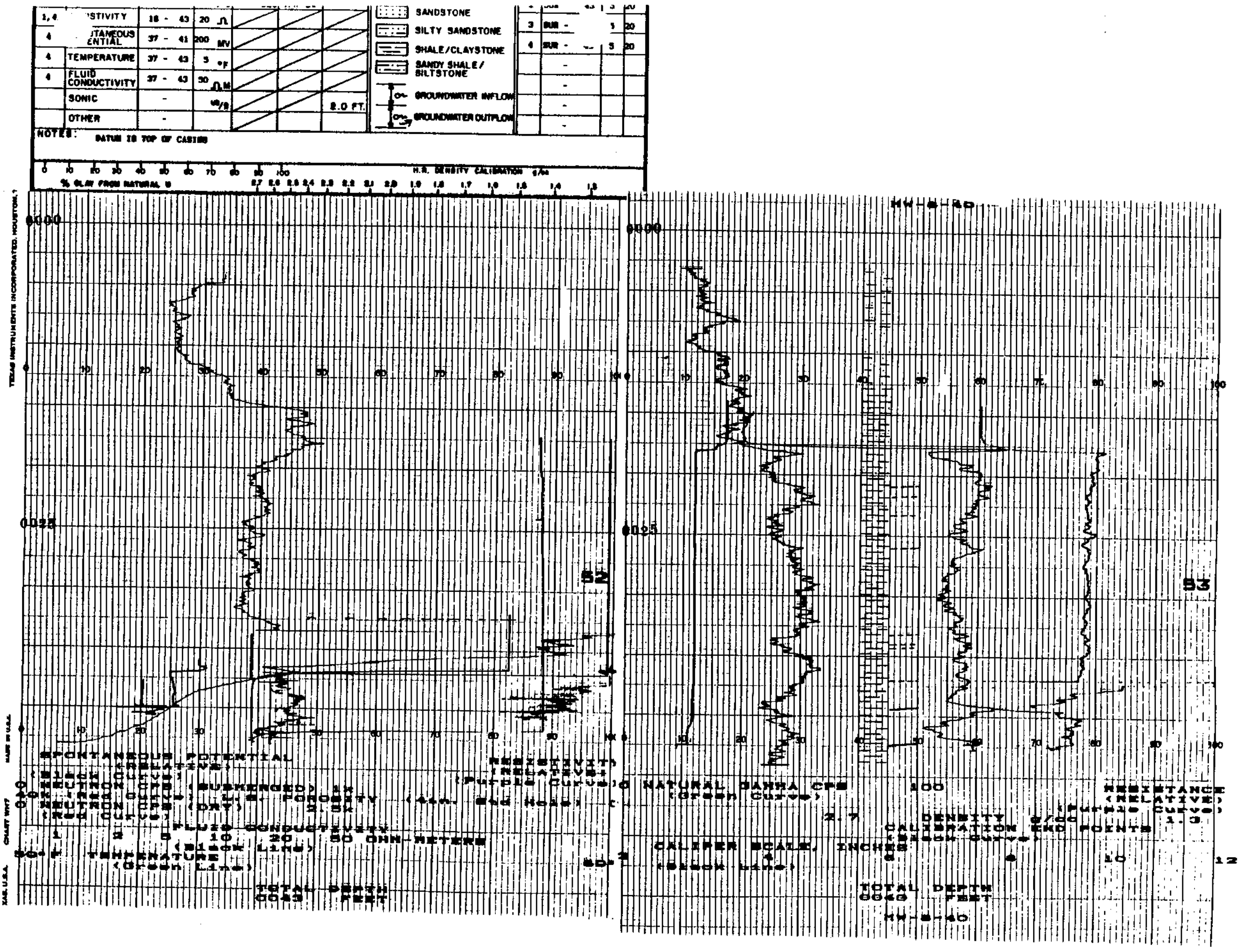

1, 4
STIVITY
18 - 43
20 Ω
4
TANEOUS ENTIAL
37 - 41
200 MV
4
TEMPERATURE
37 - 43
5 °F
4
FLUID CONDUCTIVITY
37 - 43
30 Ω.M
SONIC
OTHER
8.0 FT.
SANDSTONE
SILTY SANDSTONE
SHALE/CLAYSTONE
SANDY SHALE / SILTSTONE
GROUNDWATER INFLOW
GROUNDWATER OUTFLOW
3 SUR - 5 20
4 SUR - 5 20
NOTES: DATUM IS TOP OF CASING
% CLAY FROM NATURAL G
H.R. DENSITY CALIBRATION g/cc
TEXAS INSTRUMENTS INCORPORATED, HOUSTON, T
0000
0025
S2
S3
MW-8-40
SPONTANEOUS POTENTIAL (RELATIVE) (Black Curve)
0 NEUTRON CPS (SUBMERGED) 1K
40K (Red Curve) L.S. POROSITY (4in. Bad Hole) C
0 NEUTRON CPS (DRY) 2.5K (Red Curve)
RESISTIVITY (RELATIVE) (Purple Curve)
FLUID CONDUCTIVITY
1 2 5 10 20 50 OHM-METERS (Black Line)
50°F TEMPERATURE (Green Line)
60°F
TOTAL DEPTH 0043 FEET
0 NATURAL GAMMA CPS 100 (Green Curve)
2.7 DENSITY g/cc 1.3
CALIBRATION END POINTS (Black Curve)
RESISTANCE (RELATIVE) (Purple Curve)
2 CALIPER SCALE, INCHES 4 6 8 10 12 (Black Line)
TOTAL DEPTH 0040 FEET
MW-8-40
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CHART WHT
KAS. U.S.A.

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APPALACHIAN COAL SURVEYS

LOG HEADING
HOLE NO.
MW-15-40

COMPANY RADIAN CORPORATION

PROJECT [illegible] HOLE NO. MW-15-40

CLIENT REPRESENTATIVE I. Morin

DRILLED DEPTH 38 FT. ELEVATION FT.

HOLE DIAMETER 3.0 IN. WATER LEVEL 19 FT.

LOCATION

COUNTY Tompkins STATE NY

CASING DEPTH 19 FT

DIAMETER 6.0 IN. FACTOR

WALL THICKNESS IN.

UNIT 61 OFFICE Pgh

OPERATOR CBC

DATE 09-Aug-88

DRILLING FLUID WATER

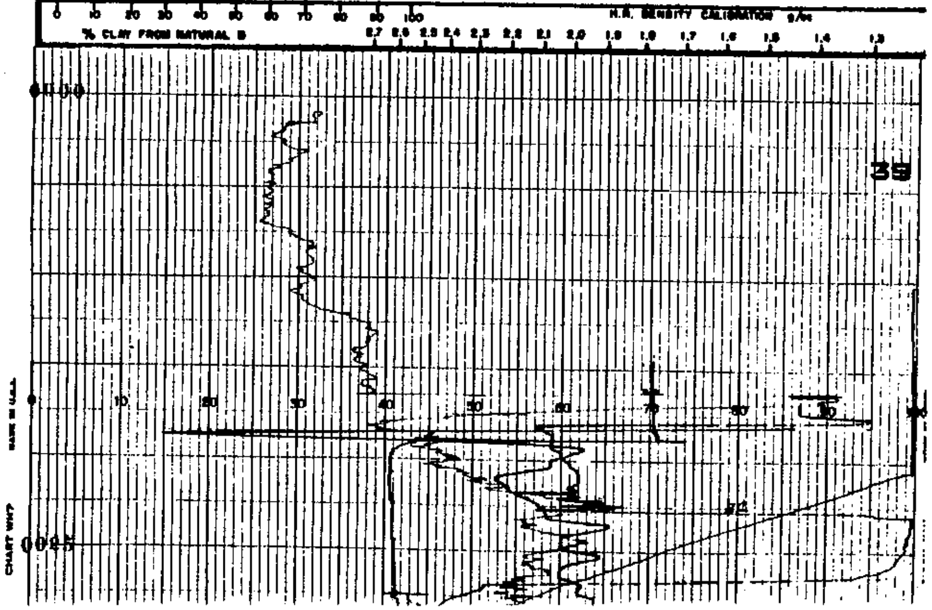
DRILLING CO. EMPIRE DRILLER

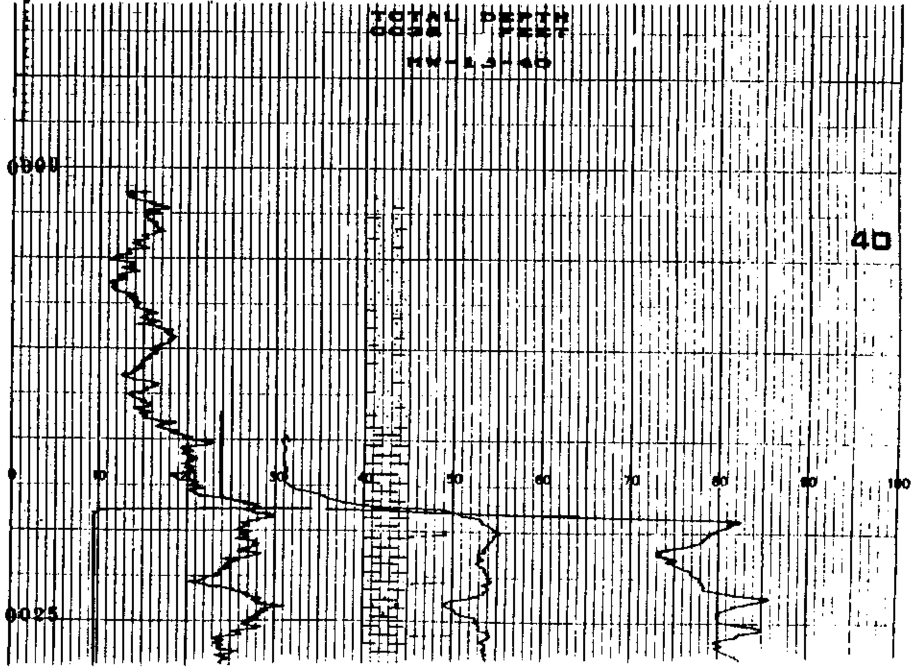
RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
1	CALIPER	19 - 38	1 in/in			
2	NATURAL γ	0 - 32	100 CPS	2 SEC	NATURAL	
2	H.R. DENSITY	19 - 38	1k CPS	1 SEC	Am 241	0.5 in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
3	NEUTRON	6 - 38	1k CPS	1 SEC	Am-Be	12.0 in.
1,4	RESISTIVITY	19 - 38	20 Ω			
4	SPONTANEOUS POTENTIAL	19 - 36	200 MV			
4	TEMPERATURE	19 - 38	5 °F			
4	FLUID CONDUCTIVITY	19 - 38	50 Ω M			
	SONIC	-	μs/ft			2.0 FT.
	OTHER	-				

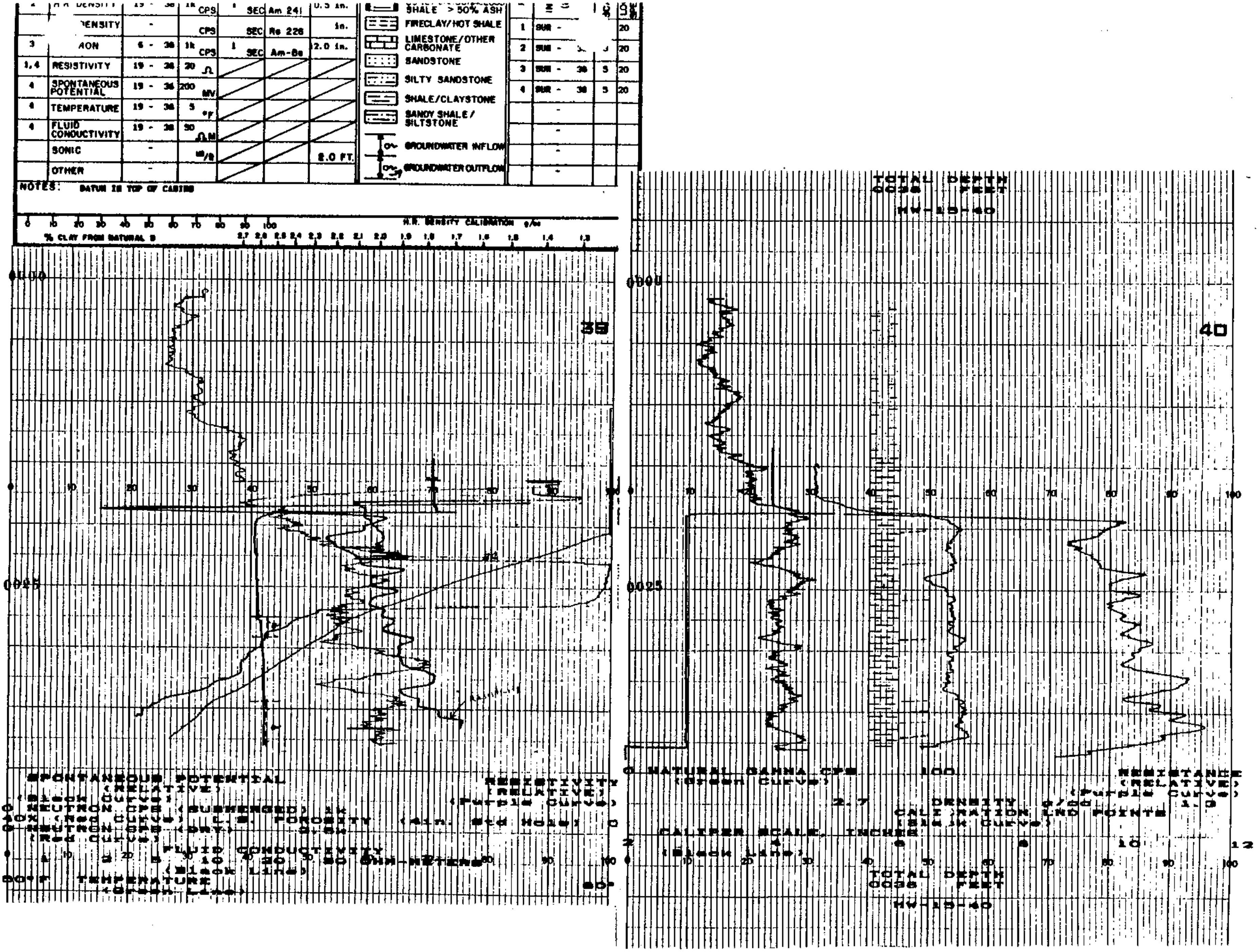
INTERPRETATION	
■	COAL < 10% ASH
▥	COAL > 10% ASH
▤	BONE/CARBONACEOUS SHALE > 50% ASH
▤	FIRECLAY/HOT SHALE
▦	LIMESTONE/OTHER CARBONATE
▨	SANDSTONE
▨	SILTY SANDSTONE
▤	SHALE/CLAYSTONE
▤	SANDY SHALE/SILTSTONE
┬	GROUNDWATER INFLOW
┴	GROUNDWATER OUTFLOW

RUNS			
RUN #	INTERVAL (DEPTH) FT.	SCALE FT/IN	LOGGING SPEED FT/MIN
1	SUR - 38	5	20
2	SUR - 38	5	20
3	SUR - 38	5	20
4	SUR - 38	5	20
	-		
	-		
	-		
	-		

NOTES: DATUM IS TOP OF CASING







4	DENSITY	19 - 38	1k	CPS	1	SEC Am 241	0.5 in.
	DENSITY	-		CPS		SEC Ra 226	in.
3	AON	6 - 38	1k	CPS	1	SEC Am-Be	2.0 in.
1,4	RESISTIVITY	19 - 38	20	Ω			
4	SPONTANEOUS POTENTIAL	19 - 38	200	MV			
4	TEMPERATURE	19 - 38	5	°F			
4	FLUID CONDUCTIVITY	19 - 38	50	Ω M			
	SONIC	-		m/s			2.0 FT.
	OTHER	-					

SHALE > 50% ASH
FIRECLAY/HOT SHALE
LIMESTONE/OTHER CARBONATE
SANDSTONE
SILTY SANDSTONE
SHALE/CLAYSTONE
SANDY SHALE / SILTSTONE
GROUNDWATER INFLOW
GROUNDWATER OUTFLOW

1	SUR -			20
2	SUR -	3.	3	20
3	SUR -	38	5	20
4	SUR -	38	5	20
	-			
	-			
	-			
	-			

NOTES: DATUM IS TOP OF CASING

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APPALACHIAN COAL SURVEYS

LOG HEADING
HOLE NO.
MW-16-100

COMPANY RADIAN CORPORATION
PROJECT [illegible] HOLE NO. MW-16-100
CLIENT REPRESENTATIVE I. Morin
DRILLED DEPTH 100 FT. ELEVATION FT.
HOLE DIAMETER 3.0 IN. WATER LEVEL 69 FT.

LOCATION
COUNTY Tompkins STATE NY
CASING DEPTH 102 FT.
DIAMETER 2.0 IN. FACTOR
WALL THICKNESS IN.

UNIT 61 OFFICE Pgh
OPERATOR CBC
DATE 08-Aug-86
DRILLING FLUID WATER
DRILLING CO. EMPIRE DRILLER

RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
	CALIPER	-	in/in			
1	NATURAL γ	5 - 102	100 CPS	SEC	NATURAL	
3	H.R. DENSITY	6 - 102	1k CPS	1 SEC	Am 241	0.5 in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
2	NEUTRON	6 - 102	1k CPS	1 SEC	Am-Be	12.0 in.
	RESISTIVITY	-	Ω			
	SPONTANEOUS POTENTIAL	-	MV			
	TEMPERATURE	-	°F			
	FLUID CONDUCTIVITY	-	Ω M			
	SONIC	-	us/ft			2.0 FT.
	OTHER	-				

INTERPRETATION
- ■ COAL < 10% ASH
- ▥ COAL > 10% ASH
- ▤ BONE/CARBONACEOUS SHALE > 50% ASH
- ▤ FIRECLAY/HOT SHALE
- ▦ LIMESTONE/OTHER CARBONATE
- ▒ SANDSTONE
- ▒ SILTY SANDSTONE
- ▤ SHALE/CLAYSTONE
- ▒ SANDY SHALE/SILTSTONE
- GROUNDWATER INFLOW
- GROUNDWATER OUTFLOW

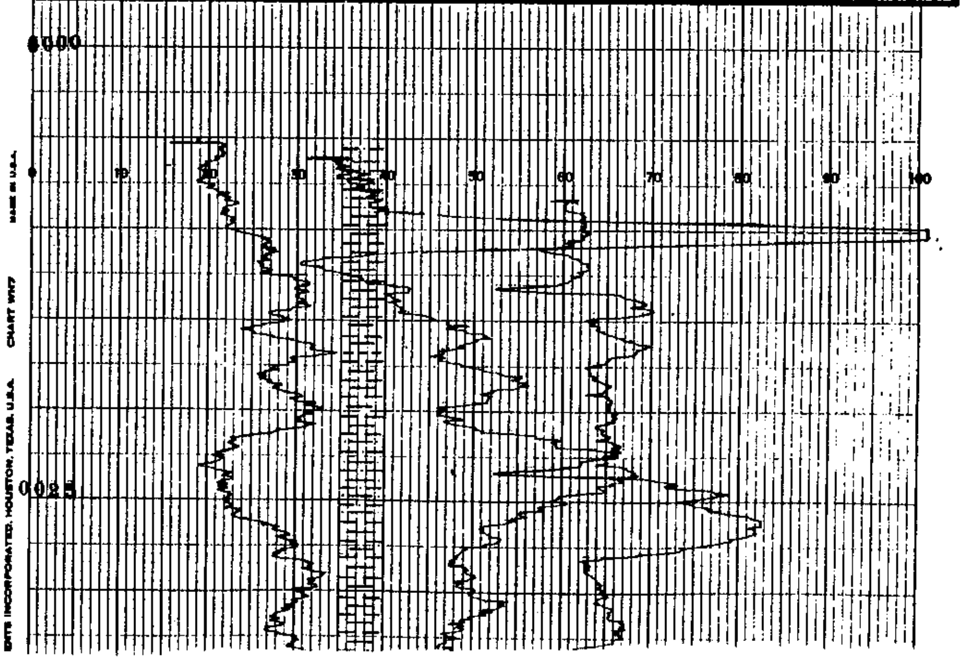
RUNS

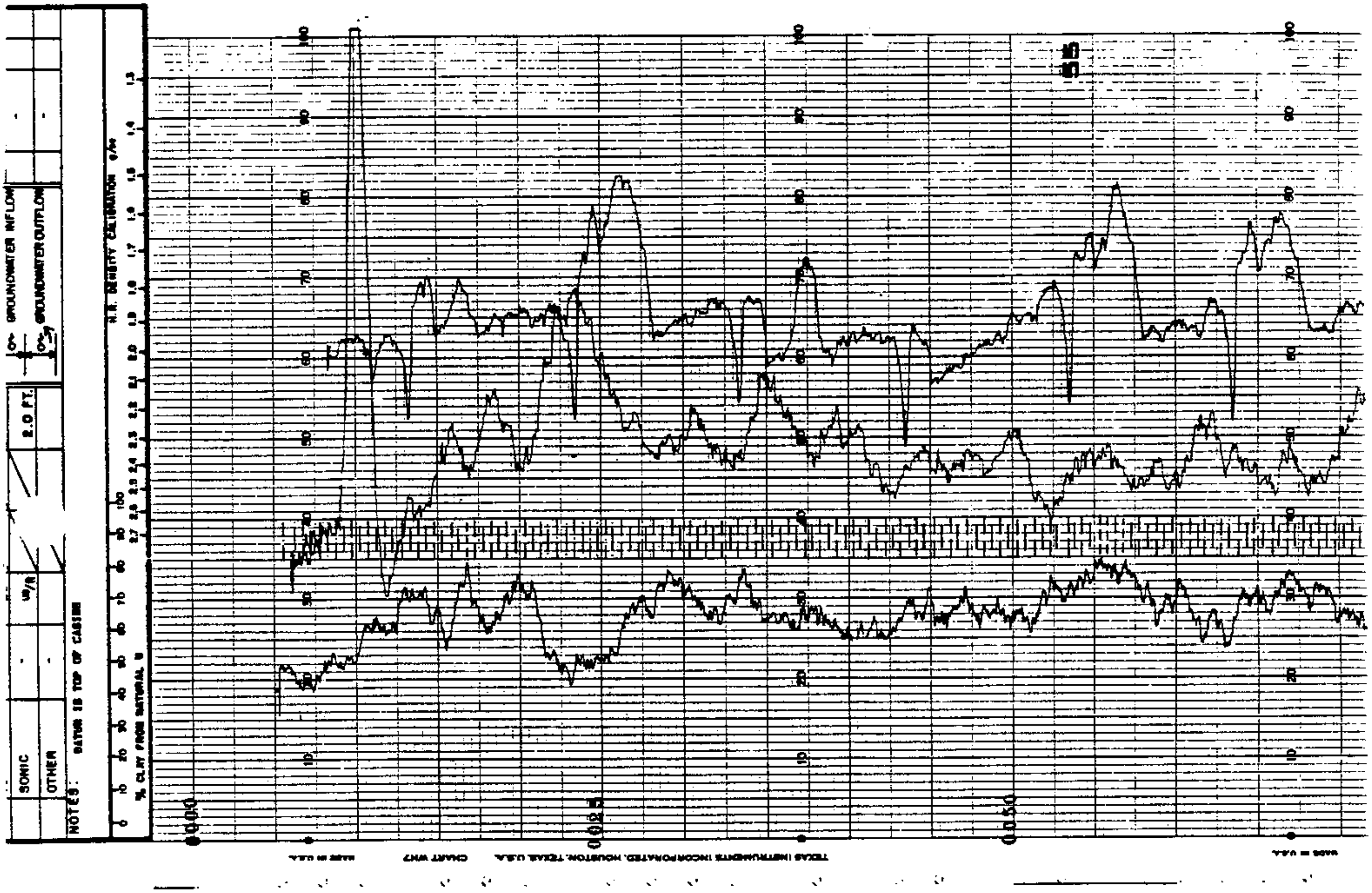
RUN #	INTERVAL (DEPTH) FT.	SCALE FT/IN	LOGGING SPEED FT/MIN
1	SUB - 102	5	20
2	SUB - 102	5	20
3	SUB - 102	5	20
	-		
	-		
	-		
	-		
	-		

NOTES: DATUM IS TOP OF CASING

0 10 20 30 40 50 60 70 80 90 100
% CLAY FROM NATURAL γ

H.R. DENSITY CALIBRATION g/cc
2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9 1.8 1.7 1.6 1.5 1.4 1.3




GROUNDWATER INFLOW
GROUNDWATER OUTFLOW
2.0 FT.
SONIC
OTHER
NOTES: DATUM IS TOP OF CASING
N.R. DENSITY CALIBRATION g/cc
% CLAY FROM NATURAL U
0.00
0.25
0.50
TEXAS INSTRUMENTS INCORPORATED, HOUSTON, TEXAS U.S.A.
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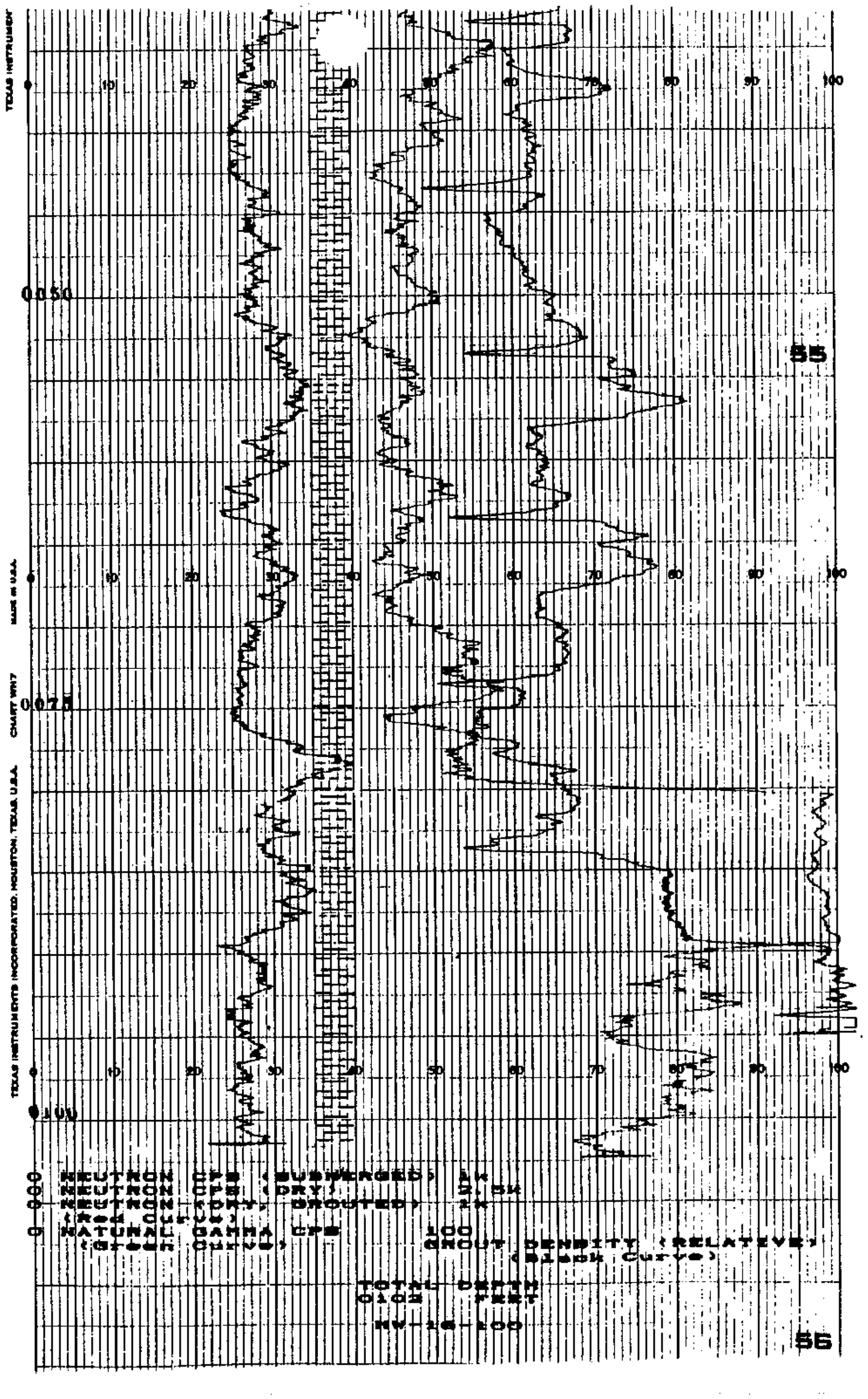
0 10 20 30 40 50 60 70 80 90 100
0050
0075
0100
55
56
0 NEUTRON CPS (SUBMERGED) 1K
0 NEUTRON CPS (DRY) 2.5K
0 NEUTRON (DRY, GROUTED) 1K
(Red Curve)
0 NATURAL GAMMA CPS 100
(Green Curve)
GROUT DENSITY (RELATIVE)
(Black Curve)
TOTAL DEPTH
0102 FEET
MV-16-100
TEXAS INSTRUMENTS INCORPORATED, HOUSTON, TEXAS, U.S.A.
CHART WN7
MADE IN U.S.A.
TEXAS INSTRUMEN

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Pittsburgh, PA 15235
Telephone (412) 243-3030

APPALACHIAN
COAL SURVEYS

LOG HEADING
HOLE NO.
MW-17-40

COMPANY RADIAN CORPORATION
PROJECT EMERSON HOLE NO. MW-17-40
CLIENT REPRESENTATIVE I. Morin
DRILLED DEPTH 46 FT. ELEVATION FT.
HOLE DIAMETER 3.0 IN. WATER LEVEL 5 FT.

LOCATION
COUNTY Tompkins STATE NY
CASING DEPTH 30 FT.
DIAMETER 6.0 IN. FACTOR
WALL THICKNESS IN.

UNIT 61 OFFICE Pgh
OPERATOR CRC
DATE 09-Aug-88
DRILLING FLUID WATER
DRILLING CO. EMPIRE DRILLER

RUN #	LOG	INTERVAL (DEPTH) FT.	RANGE	TIME CONSTANT	SOURCE	SPACING
1	CALIPER	30 - 46	1 in/in			
2	NATURAL γ	0 - 40	100 CPS	2 SEC	NATURAL	
2	H.R. DENSITY	30 - 46	1k CPS	1 SEC	Am 241	0.3 in.
	γγ DENSITY	-	CPS	SEC	Ra 226	in.
3	NEUTRON	6 - 46	1k CPS	1 SEC	Am-Be	12.0 in.
1, 4	RESISTIVITY	30 - 46	20 Ω			
4	SPONTANEOUS POTENTIAL	30 - 44	200 MV			
4	TEMPERATURE	30 - 46	5 °F			
4	FLUID CONDUCTIVITY	30 - 46	50 Ω M			
	SONIC	-	us/ft			2.0 FT.
	OTHER	-				

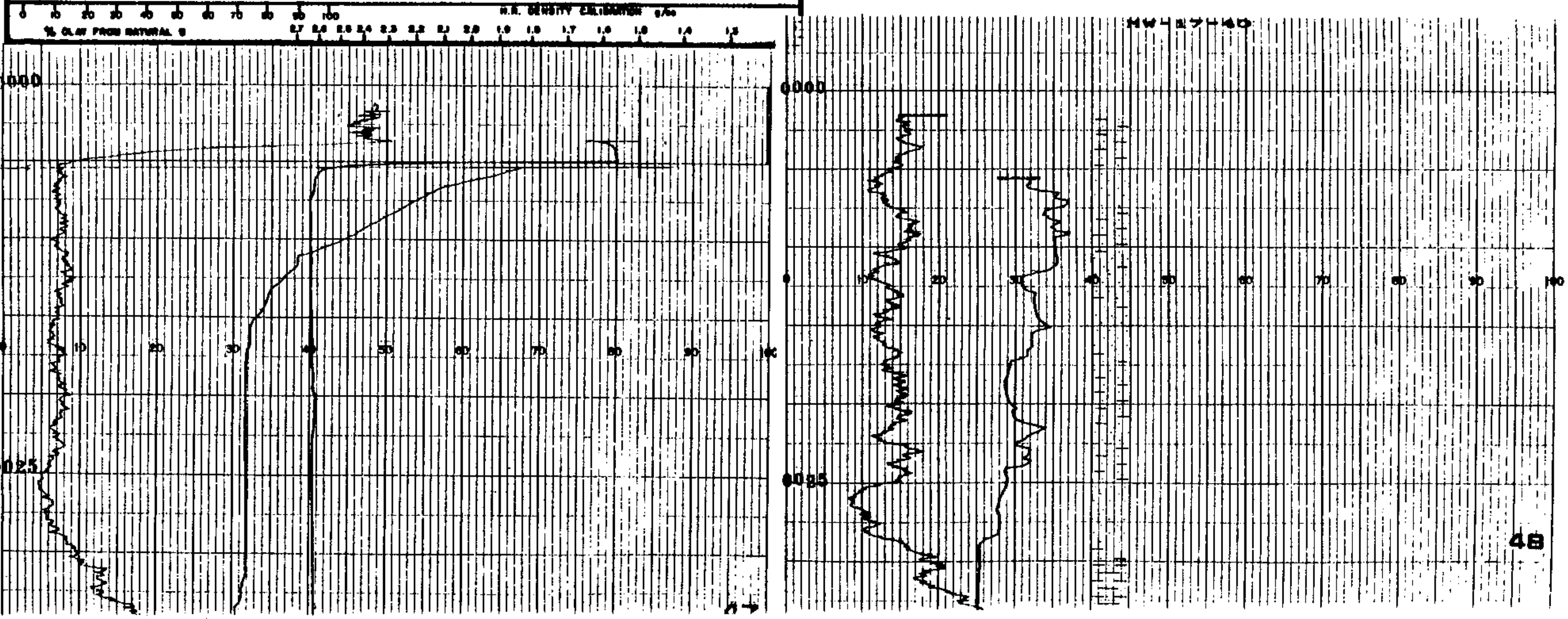
INTERPRETATION

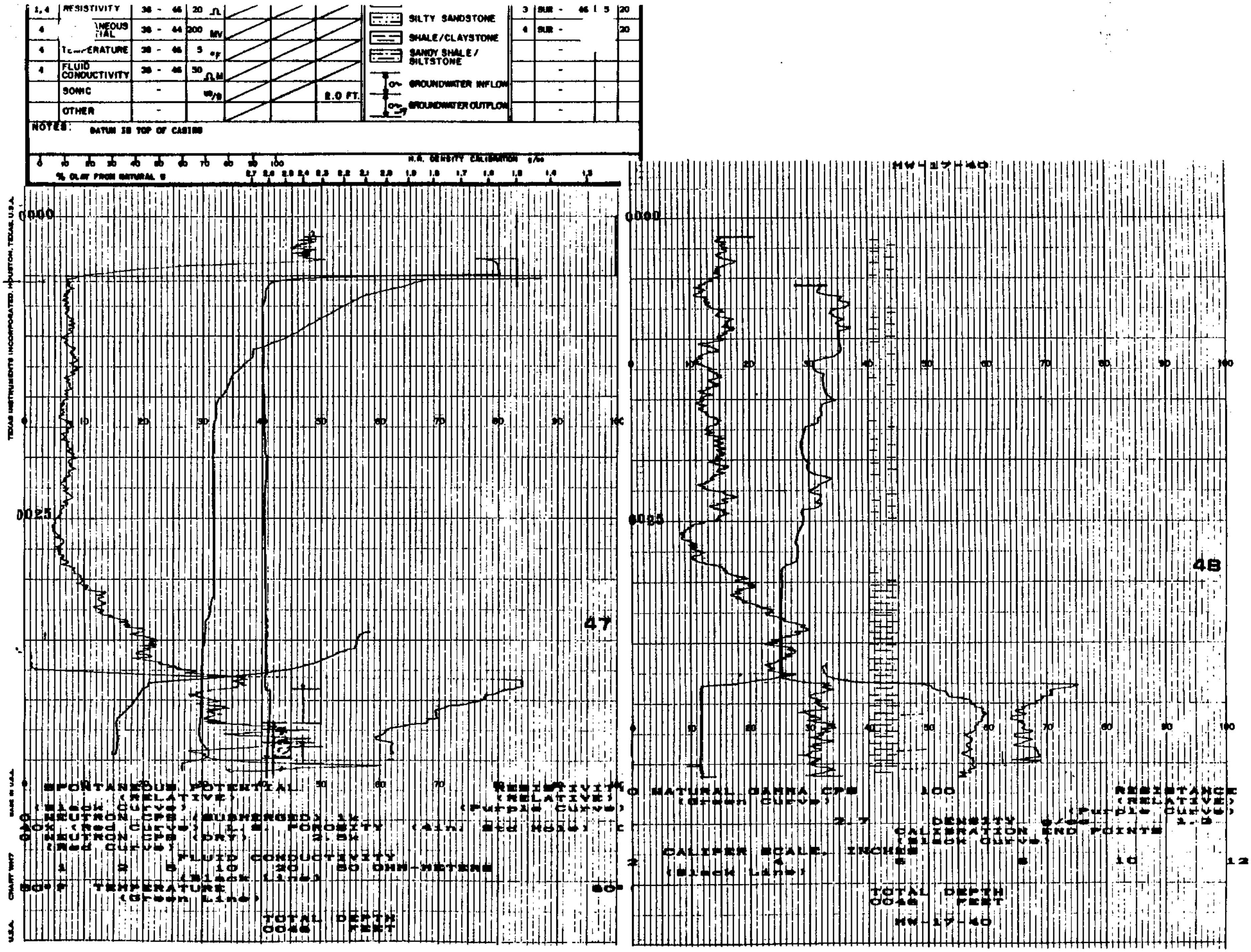
- ■ COAL < 10% ASH
- ▥ COAL > 10% ASH
- ▤ BONE/CARBONACEOUS SHALE > 50% ASH
- ▤ FIRECLAY/HOT SHALE
- ▦ LIMESTONE/OTHER CARBONATE
- ▨ SANDSTONE
- ▨ SILTY SANDSTONE
- ▤ SHALE/CLAYSTONE
- ▤ SANDY SHALE/SILTSTONE
- GROUNDWATER INFLOW
- GROUNDWATER OUTFLOW

RUNS

RUN #	INTERVAL (DEPTH) FT.	SCALE FT/IN	LOGGING SPEED FT/MIN
1	SUR - 46	5	20
2	SUR - 46	5	20
3	SUR - 46	5	20
4	SUR - 46	5	20
	-		
	-		
	-		
	-		

NOTES: DATUM IS TOP OF CASING




1, 4 | RESISTIVITY | 38 - 46 | 20 Ω
4 | [illegible]ANEOUS [illegible]TIAL | 38 - 44 | 200 MV
4 | TEMPERATURE | 38 - 46 | 5 °F
4 | FLUID CONDUCTIVITY | 38 - 46 | 50 Ω M
SONIC | - | µs/ft
OTHER | -
2.0 FT.
SILTY SANDSTONE
SHALE/CLAYSTONE
SANDY SHALE / SILTSTONE
GROUNDWATER INFLOW
GROUNDWATER OUTFLOW
3 | SUR - 46 | 5 | 20
4 | SUR - | 20
NOTES: DATUM IS TOP OF CASING
0 10 20 30 40 50 60 70 80 90 100
% CLAY FROM NATURAL G
N.G. DENSITY CALIBRATION g/cc
2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9 1.8 1.7 1.6 1.5 1.4 1.3
0000
0025
47
48
MW-17-40
0 10 20 30 40 50 60 70 80 90 100
SPONTANEOUS POTENTIAL
(RELATIVE)
(Black Curve)
RESISTIVITY
(RELATIVE)
(Purple Curve)
0 NEUTRON CPS (SUBMERGED) 1K
40% (Red Curve) 1.2 POROSITY (4in. Std Hole)
0 NEUTRON CPS (DRY) 2.5K
(Red Curve)
FLUID CONDUCTIVITY
1 2 5 10 20 50 OHM-METERS
(Black Line)
50°F TEMPERATURE 60°
(Green Line)
TOTAL DEPTH
0046 FEET
0 NATURAL GAMMA CPS 100
(Green Curve)
RESISTANCE
(RELATIVE)
(Purple Curve)
2.7 DENSITY g/cc 1.3
CALIBRATION END POINTS
(Black Curve)
CALIPER SCALE, INCHES
2 4 6 8 10 12
(Black Line)
TOTAL DEPTH
0046 FEET
MW-17-40
TEXAS INSTRUMENTS INCORPORATED, HOUSTON, TEXAS, U.S.A.
MADE IN U.S.A.
CHART 9007
U.S.A.

APPENDIX F

AQUIFER TESTING

APPENDIX F - AQUIFER TESTING

F.1 HYDRAULIC CONDUCTIVITY TESTS

Hydraulic conductivity of the bedrock underlying the EPT property and its vicinity was estimated using in situ permeability tests. Falling head tests were conducted between October 18 and 20, 1988, in eight monitoring wells (Table F-1), using procedures outlined by Hvorslev (1951). (All tables for Appendix F are presented at the end of this Appendix.) Approximately 1 to 3 gallons of deionized water, HPLC (High Performance Liquid Chromatography)-grade, were rapidly poured into each well to create an "instantaneous" rise in the hydraulic head. Rising head tests were conducted between September 26 and 27, 1989, in four monitoring wells (Table F-1) using procedures outlined by Bouwer (1989). Approximately 2 to 4 gallons of water were removed (pumped) out of each well to create an "instantaneous" fall in the hydraulic head. The depth to water in each well tested was periodically measured with either a fiberglass tape measure or an electronic water level indicator and recorded to the nearest hundredth of a foot to monitor the rate of head recovery.

Field data were reduced in the office and hydraulic conductivity estimates were computed for each well with the aid of Lotus 1-2-3_R computer software. Values from the falling head tests were computed for both the time lag and the two-point methods (Hvorslev, 1951) using the following formulas:

Time lag method:

$$K=\frac{d^2\ln(\frac{2mL}{D})}{8LT}$$

Two-Point method:

$$K=\frac{d^2in(\frac{2mL}{D})}{8L(t_2-t_1)}\ln(\frac{H_1}{H_2})$$

where
d = diameter of well casing
D = diameter of test interval
L = length of test interval
m = ratio of horizontal to vertical hydraulic conductivity, which is assumed to be equal to 1
K = hydraulic conductivity
T = time elapsed since start of test where head ratio = 0.37
t_1 = time at head ratio of H_1
t_2 = time at head ratio of H_2

Values from the rising head tests were computed using the following formula from Bouwer (1989):

$$K = \frac{r_c^2 \ln(Re/r_w)}{2L} \frac{1}{t} \ln \frac{Y_o}{Y_t}$$

and

$$\ln(Re/r_w) = \frac{1.10}{\ln(H/r_w)} + \frac{A+B \ln[(D-H)/r_w]}{L/r_w}^{-1}$$

where A and B = dimensionless coefficients that are a function of L/r_w

D = saturated aquifer thickness

H = distance from water table to the bottom of intake section

K = hydraulic conductivity

L = length of intake section

r_c = casing radius

r_w = radial distance between undisturbed aquifer and well center

Re = effective radius of well

Y_o = initial drawdown

Y_t = vertical distance between water level in well at time t and equilibrium level

Data sheets and graphs of water levels versus time are presented at the end of this Appendix.

F.2 PUMP TEST

Well MW-3-31 was pumped using a dedicated bladder pump installed in the well, while water levels were monitored in nearby monitoring wells MW-1, MW-2, MW-3-13, MW-3-100, and MW-3-150. Approximately 5 gallons of water were pumped from well MW-3-31 in about 25 minutes before the well went dry and pumping was discontinued. The depth to water was measured in each of the wells mentioned above at periodic intervals using a calibrated fiberglass tape measure or an electronic water level indicator. Water level measurements (recorded to the nearest hundredth of a foot) and measurements of time since the start of pumping (recorded using a stopwatch) are presented in Table F-2.

Because of the limitations of this test (its short duration and its inability to achieve a steady flow rate from the pumped well), the data is limited and serve only to provide a qualitative measure of the degree of interconnection between the overburden and the shallow bedrock at the location tested. The pumping was probably too short in duration to produce measurable effects in the deeper bedrock wells.

TABLE F-1. HYDRAULIC CONDUCTIVITY ESTIMATES, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

HVORSLEV (1951) FALLING HEAD TESTS

		Hydraulic Conductivity		
Well Number	Well Type	Time Lag (cm/sec)	2-Point (cm/sec)	Mean (cm/sec)
MW-1	SB	1.48×10^{-5}	1.28×10^{-5}	1.38×10^{-5}
MW-2	SB	1.20×10^{-5}	1.14×10^{-5}	1.17×10^{-5}
MW-3-31	SB	1.26×10^{-5}	1.19×10^{-5}	1.23×10^{-5}
MW-3-150	IB	1.45×10^{-6}	1.54×10^{-6}	1.50×10^{-6}
MW-6-40	SB	2.42×10^{-5}	1.77×10^{-5}	2.10×10^{-5}
MW-15-40	SB	4.38×10^{-5}	3.96×10^{-5}	4.17×10^{-5}
MW-16-100	IB	4.19×10^{-7}	4.03×10^{-7}	4.11×10^{-7}
MW-17-40	SB	1.68×10^{-4}	1.45×10^{-4}	1.57×10^{-4}

BOUWER (1989) RISING HEAD TESTS

Well Number	Well Type	Hydraulic Conductivity (cm/sec)
MW-9-40	SB	4.36×10^{-7}
MW-9-100	IB	1.88×10^{-7}
MW-10-40	SB	5.27×10^{-6}
MW-11-40	SB	5.22×10^{-5}

SB - Shallow Bedrock.
IB - Intermediate Bedrock.

TABLE F-2. PUMP TEST DATA, EMERSON POWER TRANSMISSION, ITHACA, NEW YORK

PUMPING WELL		OBSERVATION WELLS									
MW-3-31 (10/19/88)		MW-1 (10/19/88)		MW-2 (10/19/88)		MW-3-13 (10/19/88)		MW-3-100 (10/19/88)		MW-3-150 (10/19/88)	
Time[a]	Depth[b]	Time[a]	Depth[b]	Time[a]	Depth[b]	Time[a]	Depth[b]	Time[a]	Depth[b]	Time[a]	Depth[b]
0.00	22.90	0.00	21.28	0.00	14.40	0.00	8.73	0.00	86.45	0.00	98.30
0.75	23.20	20.00	21.28	20.50	14.40	5.50	8.82	16.50	86.45	13.00	98.35
1.33	23.60					6.50	8.84				
2.00	24.15					9.26	8.85				
2.50	25.20					10.50	8.93				
3.33	25.80					11.50	8.97				
3.67	26.20					13.50	9.18				
4.00	26.70					16.58	9.82				
4.75	27.45					19.33	9.81				
5.75	28.10										
7.75	29.50										
9.50	30.45										
24.00	31.48										
- - -[c]	- - -[c]	- - -[c]	- - -[c]	- - -[c]	- - -[c]	- - -[c]	- - -[c]	- - -[c]	- - -[c]	- - -[c]	- - -[c]
41.50	30.82	34.00	21.28	32.00	14.40	26.67	8.88				
44.15	30.65	57.00	21.28	56.00	14.40	36.25	8.87	29.50	86.50	33.00	98.15
50.50	30.50					44.25	8.86				
58.50	30.10					52.00	8.85				
70.00	30.05					78.50	8.82				
82.33	29.90					108.17	8.81				
106.33	29.10					121.50	8.81				
120.50	29.00					137.67	8.80				
135.00	28.70					148.75	8.80				
146.00	28.37										
156.33	28.15										
211.30	27.10										

[a] Time measured in minutes from start of pumping.

[b] Depth to water measured in feet below ground surface.

[c] Pumping discontinued, start of recovery.

FALLING HEAT TESTS

FIELD DATA TABLES AND PLOTS

Site Name:	EPT
Well #:	MW-1
Casing Type:	Stainless Steel

Falling Head Test

static head [H]	20.38
casing diameter [d	0.33
test diamter [D]	0.25
test length [L]	20.2

Time Lag

time@.37	118
time lag ft/min	2.90E-05
time lag cm/sec	1.47E-05

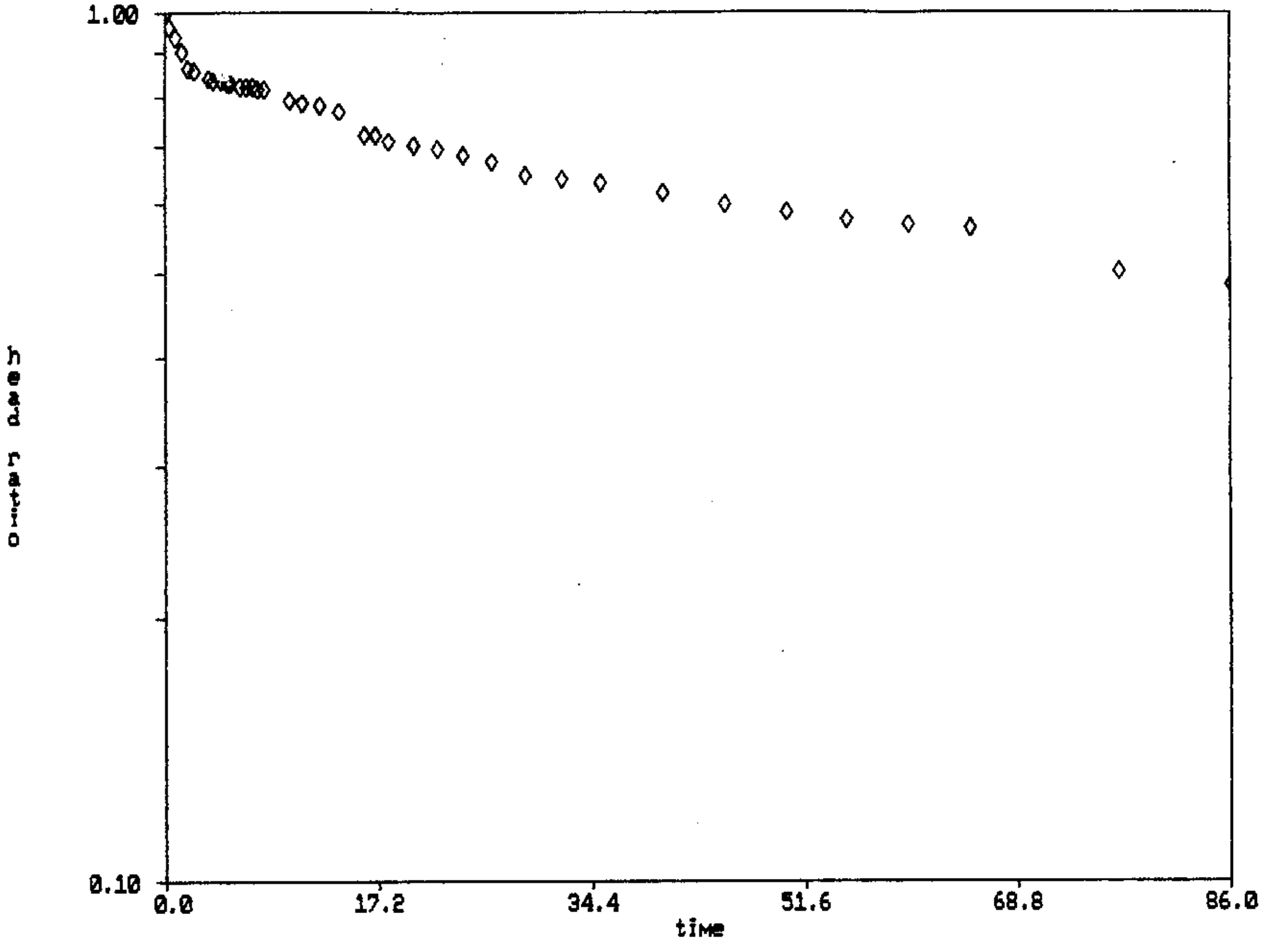
h = water level (head)
ratio = ratio of initial h-H to h-H at any time

Two Point

time1	3.5
time2	50
head ratio 1	0.8482
head ratio 2	0.5879
variablehead ft/min	2.51E-05
variablehead cm/sec	1.28E-05

minutes	h	h-H	ratio
0	18.73	1.65	1.0000
0.25	18.79	1.59	0.9636
0.75	18.83	1.55	0.9394
1.33	18.89	1.49	0.9030
1.83	18.95	1.43	0.8667
2.33	18.96	1.42	0.8606
3.5	18.99	1.39	0.8424
3.83	19	1.38	0.8364
4.5	19	1.38	0.8364
5	19.01	1.37	0.8303
5.3	19.01	1.37	0.8303
6	19.02	1.36	0.8242
6.5	19.02	1.36	0.8242
7	19.02	1.36	0.8242
7.5	19.03	1.35	0.8182
8	19.03	1.35	0.8182
10	19.07	1.31	0.7939
11	19.08	1.3	0.7879
12.5	19.09	1.29	0.7818
14	19.11	1.27	0.7697
16	19.19	1.19	0.7212
17	19.19	1.19	0.7212
18	19.21	1.17	0.7091
20	19.22	1.16	0.7030
22	19.23	1.15	0.6970
24	19.25	1.13	0.6848
26.25	19.27	1.11	0.6727
29	19.31	1.07	0.6485
32	19.32	1.06	0.6424
35	19.33	1.05	0.6364
40	19.36	1.02	0.6182
45	19.39	0.99	0.6000
50	19.41	0.97	0.5879
55	19.43	0.95	0.5758
60	19.44	0.94	0.5697
65	19.45	0.93	0.5636
77	19.55	0.83	0.5030
86	19.58	0.8	0.4848

MW-1



Site Name:	EPT
Well #:	MW-2
Casing Type:	Stainless Steel

Falling Head Test

static head [H]	15.64
casing diameter [d	0.33
test diamter [D]	0.25
test length [L]	10

Time Lag

time@.37	252
time lag ft/min	2.37E-05
time lag cm/sec	1.20E-05

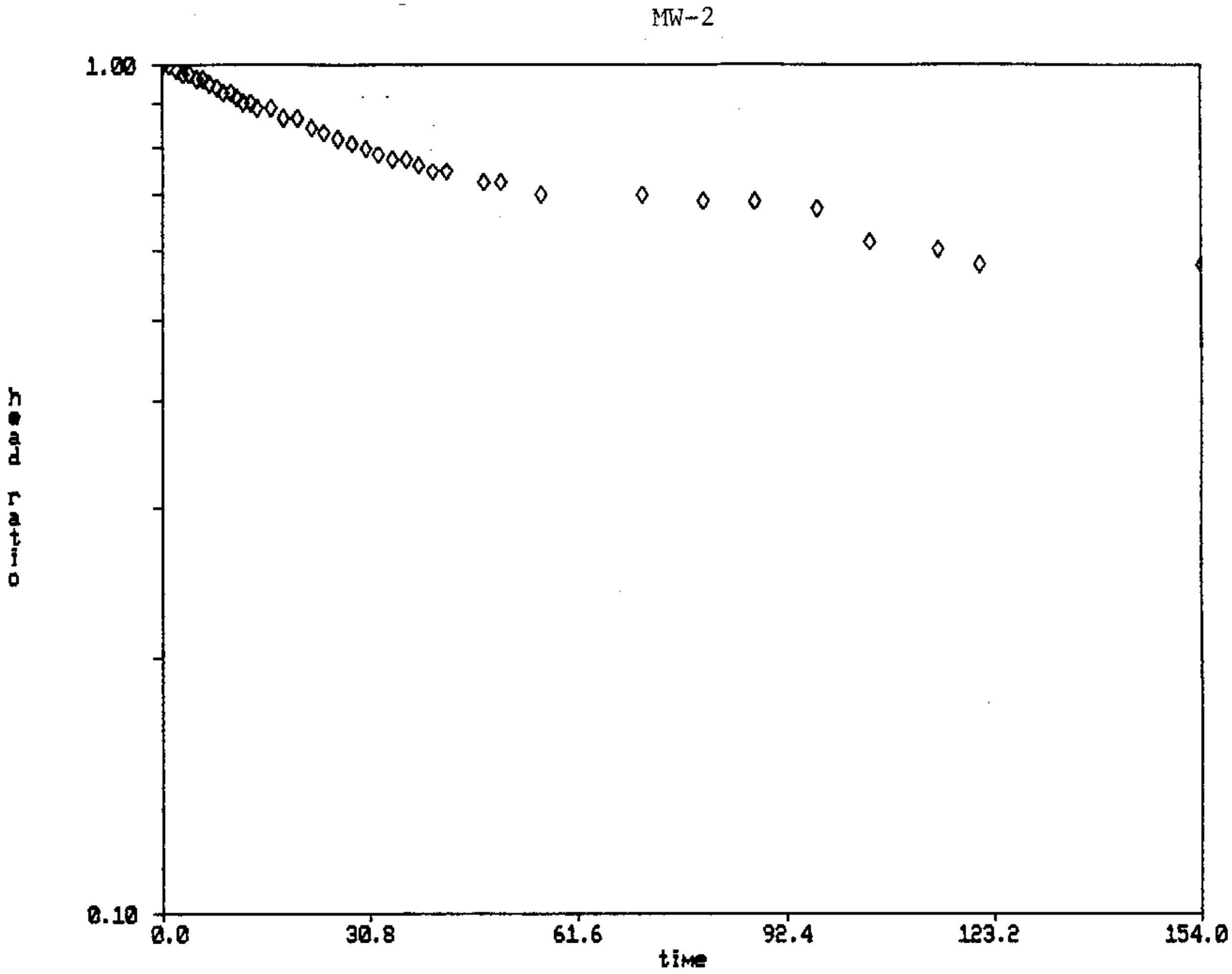
Two Point

time1	20
time2	80
head ratio 1	0.869
head ratio 2	0.6905
variablehead ft/min	2.28E-05
variablehead cm/sec	1.14E-05

h = water level (head)

ratio = ratio of initial h-H to h-H at any time

minutes	h	h-H	ratio
0	14.8	0.84	1.0000
1	14.8	0.84	1.0000
2	14.81	0.83	0.9881
3	14.82	0.82	0.9762
4	14.82	0.82	0.9762
5	14.83	0.81	0.9643
6	14.83	0.81	0.9643
7	14.84	0.8	0.9524
8	14.85	0.79	0.9405
9	14.86	0.78	0.9286
10	14.86	0.78	0.9286
11	14.87	0.77	0.9167
12	14.88	0.76	0.9048
13	14.88	0.76	0.9048
14	14.89	0.75	0.8929
16	14.89	0.75	0.8929
18	14.91	0.73	0.8690
20	14.91	0.73	0.8690
22	14.93	0.71	0.8452
24	14.94	0.7	0.8333
26	14.95	0.69	0.8214
28	14.96	0.68	0.8095
30	14.97	0.67	0.7976
32	14.98	0.66	0.7857
34	14.99	0.65	0.7738
36	14.99	0.65	0.7738
38	15	0.64	0.7619
40	15.01	0.63	0.7500
42	15.01	0.63	0.7500
47.5	15.03	0.61	0.7262
50	15.03	0.61	0.7262
56	15.05	0.59	0.7024
71	15.05	0.59	0.7024
80	15.06	0.58	0.6905
87.5	15.06	0.58	0.6905
96.75	15.07	0.57	0.6786
104.5	15.12	0.52	0.6190
114.75	15.13	0.51	0.6071
121	15.15	0.49	0.5833
154	15.15	0.49	0.5833


MW-2
1.00
0.10
head ratio
0.0
30.8
61.6
92.4
123.2
154.0
time

Site Name:	EPT
Well #:	MW-3
Casing Type:	Stainless Steel

Falling Head Test

static head [H]	20.65
casing diameter [d	0.33
test diamter [D]	0.25
test length [L]	10

minutes	h	h-H	ratio
0	19.02	1.63	1.0000
0.25	19.04	1.61	0.9877
0.5	19.05	1.6	0.9816
0.75	19.06	1.59	0.9755
1	19.07	1.58	0.9693
1.25	19.08	1.57	0.9632
1.5	19.1	1.55	0.9509
2	19.13	1.52	0.9325
2.5	19.14	1.51	0.9264
3	19.14	1.51	0.9264
3.5	19.15	1.5	0.9202
4	19.17	1.48	0.9080
5	19.18	1.47	0.9018
6	19.19	1.46	0.8957
7	19.22	1.43	0.8773
8	19.23	1.42	0.8712
10	19.23	1.42	0.8712
13	19.24	1.41	0.8650
15	19.25	1.4	0.8589
17	19.27	1.38	0.8466
20	19.28	1.37	0.8405
23	19.29	1.36	0.8344
26	19.31	1.34	0.8221
34	19.35	1.3	0.7975
47	19.44	1.21	0.7423
57	19.46	1.19	0.7301
67	19.49	1.16	0.7117
80	19.51	1.14	0.6994
90	19.53	1.12	0.6871

Time Lag

time@.37	240
time lag ft/min	2.49E-05
time lag cm/sec	1.26E-05

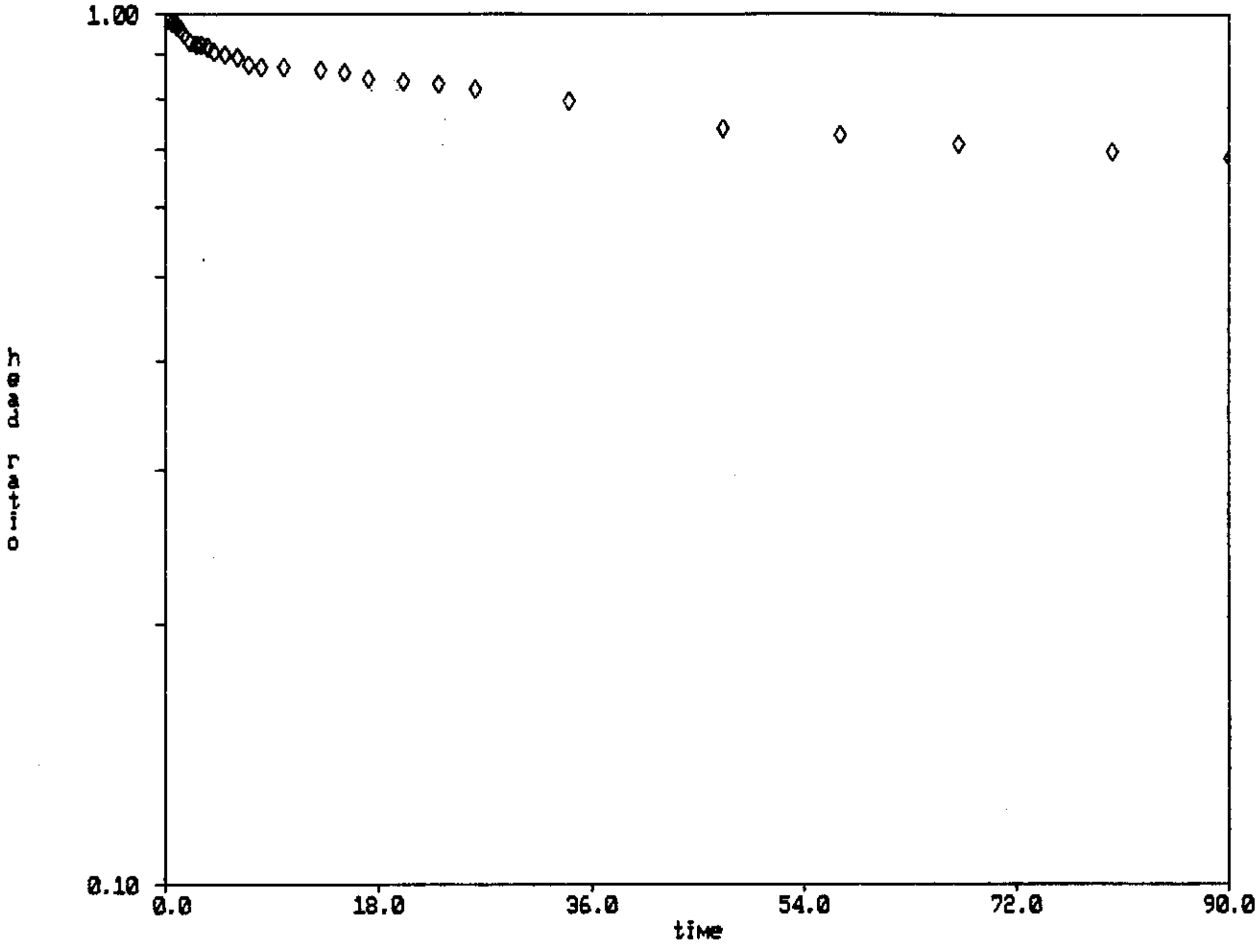
h = water level (head)

ratio = ratio of initial h-H to h-H at any time

Two Point

time1	3
time2	67
head ratio 1	0.9264
head ratio 2	0.7117
variablehead ft/min	2.35E-05
variablehead cm/sec	1.19E-05

MW-3



Site Name:	EPT
Well #:	MW-3-175 (MW-3-150)
Casing Type:	Stainless Steel

Falling Head Test

static head [H]	98.32
casing diameter [d	0.17
test diamter [D]	0.32
test length [L]	22

Time Lag

time@.37	283
time lag ft/min	2.86E-06
time lag cm/sec	1.45E-06

Two Point

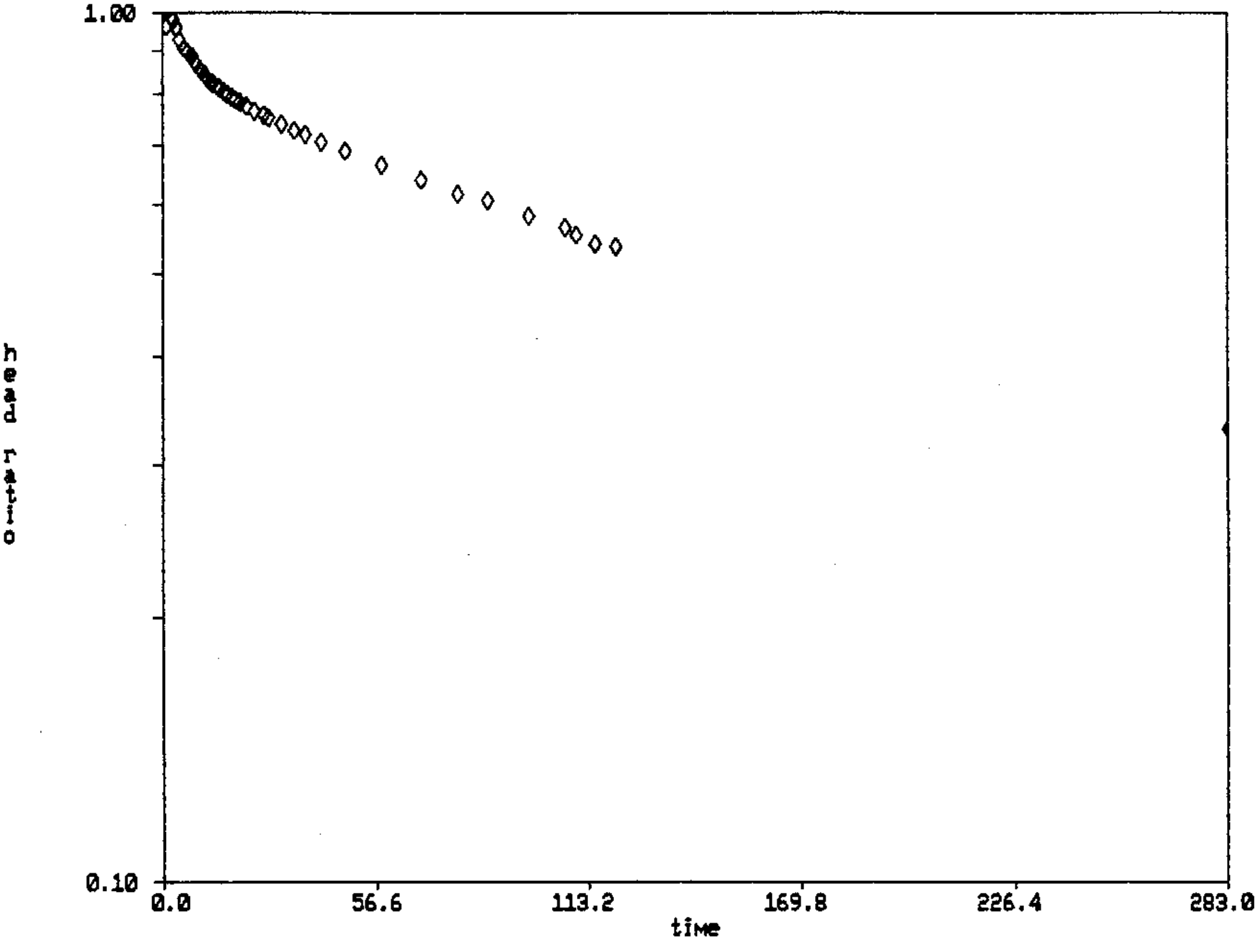
time1	11.08
time2	120.43
head ratio 1	0.8443
head ratio 2	0.537
variablehead ft/min	3.04E-06
variablehead cm/sec	1.54E-06

h = water level (head)

ratio = ratio of initial h-H to h-H at any time

minutes	h	H-h	ratio
0	84	14.32	1.0000
0.77	84.5	13.82	0.9651
2.16	84.15	14.17	0.9895
2.5	84.3	14.02	0.9791
3.18	84.55	13.77	0.9616
4.12	85	13.32	0.9302
5.67	85.32	13	0.9078
6.35	85.45	12.87	0.8987
7.08	85.58	12.74	0.8897
7.5	85.58	12.74	0.8897
8.5	85.86	12.46	0.8701
9.58	86.05	12.27	0.8568
10.25	86.13	12.19	0.8513
11.08	86.23	12.09	0.8443
11.92	86.36	11.96	0.8352
12.5	86.46	11.86	0.8282
13.25	86.5	11.82	0.8254
14.83	86.66	11.66	0.8142
16.16	86.78	11.54	0.8059
16.83	86.83	11.49	0.8024
18	86.93	11.39	0.7954
19.17	86.99	11.33	0.7912
20.08	87.07	11.25	0.7856
21.93	87.2	11.12	0.7765
24.22	87.32	11	0.7682
26.55	87.46	10.86	0.7584
28	87.53	10.79	0.7535
31.42	87.69	10.63	0.7423
34.7	87.87	10.45	0.7297
37.63	87.98	10.34	0.7221
41.75	88.18	10.14	0.7081
48.08	88.43	9.89	0.6906
57.97	88.79	9.53	0.6655
68.3	89.15	9.17	0.6404
78.17	89.48	8.84	0.6173
86.22	89.63	8.69	0.6068
97.07	89.98	8.34	0.5824
106.76	90.24	8.08	0.5642
110.02	90.38	7.94	0.5545
114.95	90.58	7.74	0.5405
120.43	90.63	7.69	0.5370
283	93.57	4.75	0.3317

MW-3-150



Site Name: EPT

Well #: MW-6-40

Casing Type: Stainless Steel

Falling Head Test

static head [H]	17.35
casing diameter [d	0.33
test diamter [D]	0.25
test length [L]	10

0	14.35	3	1.0000
0.83	14.39	2.96	0.9867
1.5	14.4	2.95	0.9833
2.67	14.46	2.89	0.9633
3.5	14.5	2.85	0.9500
4.5	14.53	2.82	0.9400
5.67	14.57	2.78	0.9267
6.75	14.58	2.77	0.9233
7.67	14.61	2.74	0.9133
8.58	14.65	2.7	0.9000
9.5	14.67	2.68	0.8933
10.5	14.7	2.65	0.8833
11.5	14.73	2.62	0.8733
13	14.8	2.55	0.8500
15	14.84	2.51	0.8367
17	14.89	2.46	0.8200
19	14.95	2.4	0.8000
22.25	14.98	2.37	0.7900
25	15.05	2.3	0.7667
30	15.15	2.2	0.7333
35	15.24	2.11	0.7033
40	15.3	2.05	0.6833
46	15.42	1.93	0.6433
50	15.45	1.9	0.6333
60	15.6	1.75	0.5833
115	16.1	1.25	0.4167

Time Lag

time@.37	125
time lag ft/min	4.77E-05
time lag cm/sec	2.42E-05

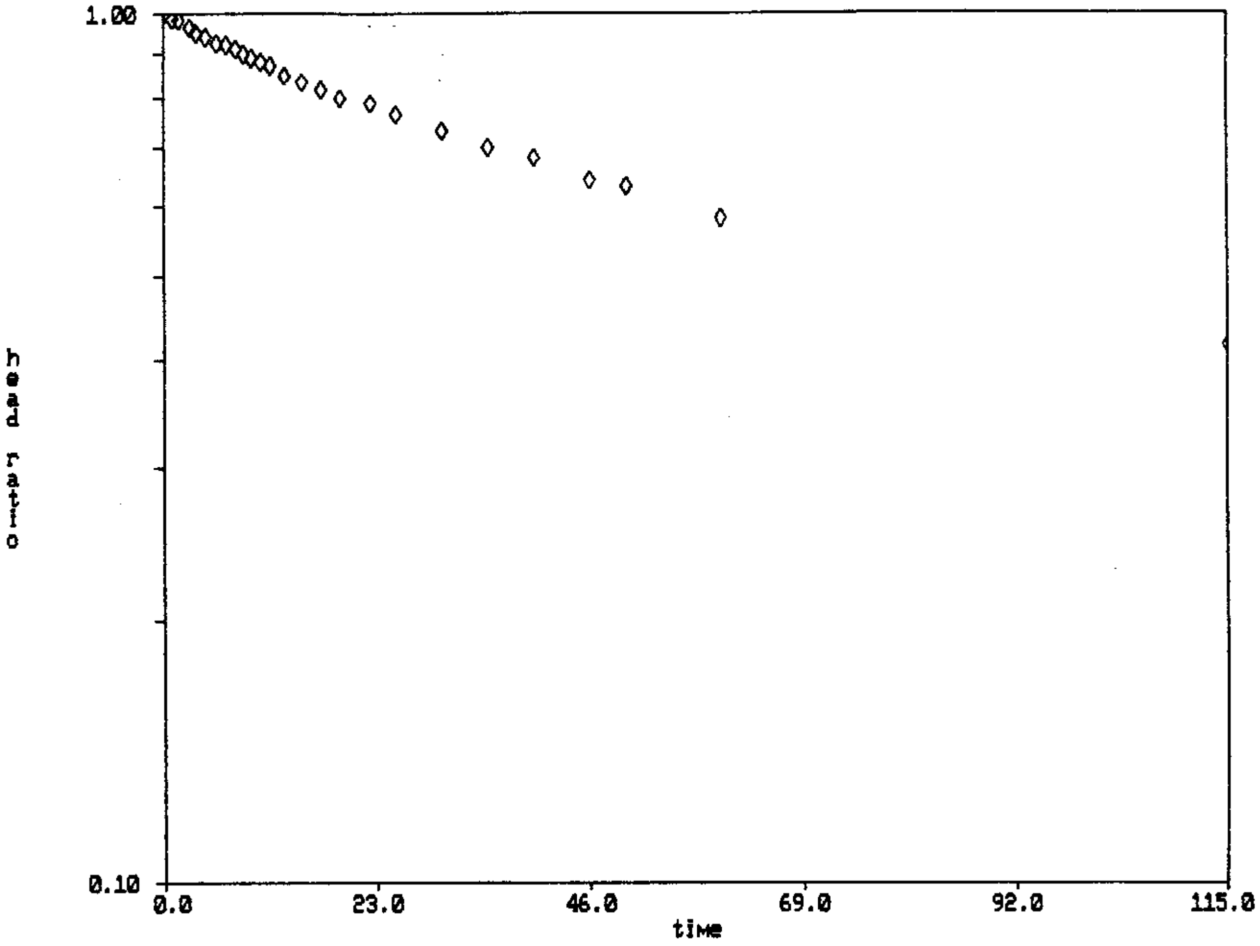
h = water level [head]

ratio = ratio of initial h-H to h-H at any time

Two Point

time1	11.5
time2	30
head ratio 1	0.8733
head ratio 2	0.7333
variablehead ft/min	3.49E-05
variablehead cm/sec	1.77E-05

MW-6-40



Site Name: EPT

Well #: MW-15-40

Casing Type: Stainless Steel

Falling Head Test

static head [H]	16.78
casing diameter [d	0.33
test diamter [D]	0.278
test length [L]	19.5

minutes	h	h-H	ratio
0	13.62	3.16	1.0000
0.93	13.7	3.08	0.9747
1.38	13.72	3.06	0.9684
2.07	13.8	2.98	0.9430
2.6	13.83	2.95	0.9335
3	13.89	2.89	0.9146
3.55	13.98	2.8	0.8861
4.12	14.04	2.74	0.8671
4.63	14.04	2.74	0.8671
4.28	14.13	2.65	0.8386
6.58	14.2	2.58	0.8165
7.43	14.23	2.55	0.8070
8.33	14.29	2.49	0.7880
9.6	14.34	2.44	0.7722
10.68	14.4	2.38	0.7532
11.67	14.49	2.29	0.7247
12.77	14.56	2.22	0.7025
14.07	14.64	2.14	0.6772
15.13	14.7	2.08	0.6582
16.18	14.76	2.02	0.6392
17.27	14.8	1.98	0.6266
19.25	14.85	1.93	0.6108
21.52	15.04	1.74	0.5506
23.95	15.14	1.64	0.5190
26.22	15.26	1.52	0.4810
28.78	15.31	1.47	0.4652
31.75	15.37	1.41	0.4462
33.8	15.44	1.34	0.4241
35.77	15.52	1.26	0.3987
38.05	15.59	1.19	0.3766
40.03	15.63	1.15	0.3639
43.33	15.72	1.06	0.3354
46.18	15.8	0.98	0.3101
48.88	15.85	0.93	0.2943
52.55	15.96	0.82	0.2595
56.03	16.02	0.76	0.2405
60.47	16.08	0.7	0.2215
64.22	16.16	0.62	0.1962
67.55	16.2	0.58	0.1835
71.93	16.23	0.55	0.1741
81.3	16.35	0.43	0.1361

Time Lag

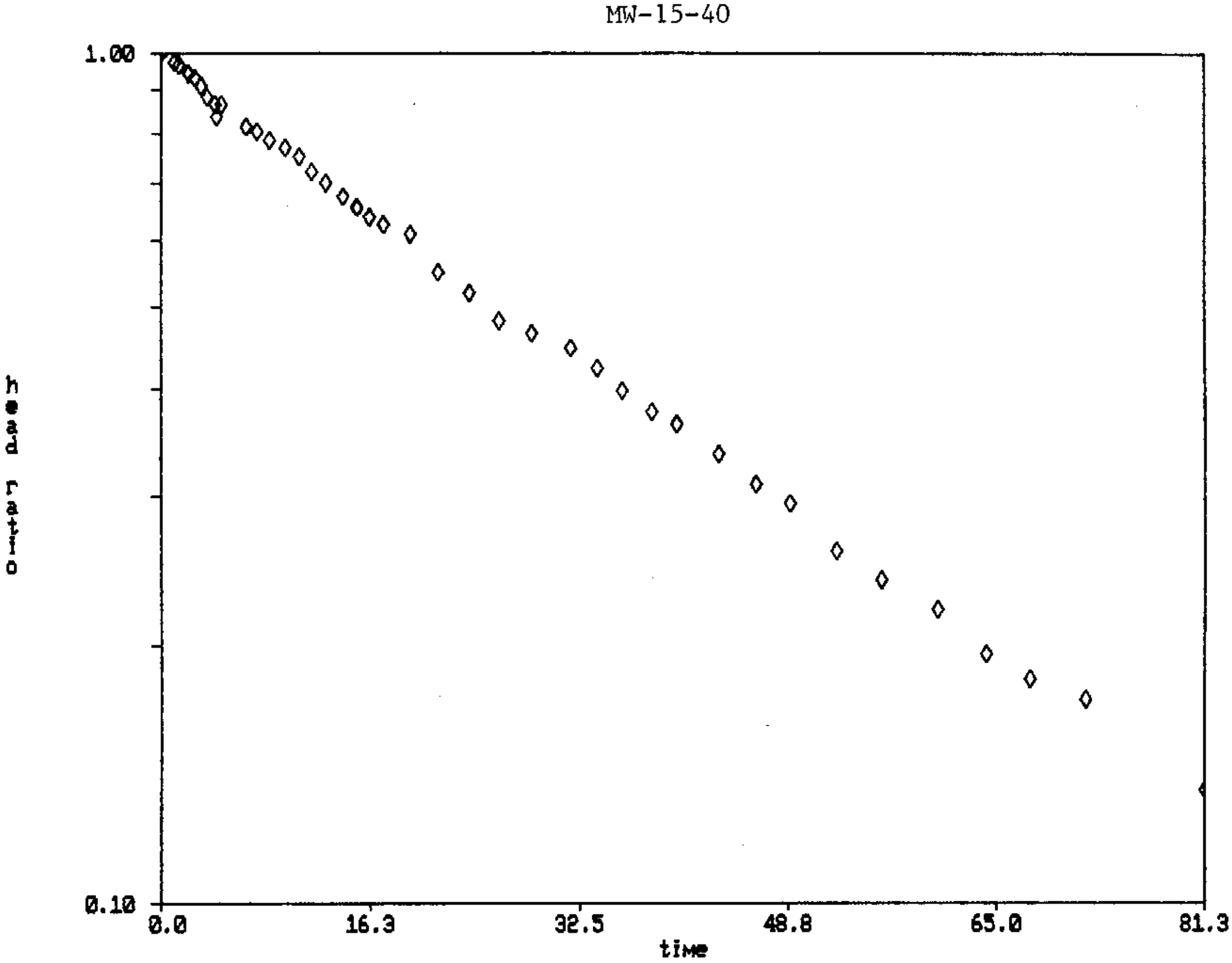
time@.37	40
time lag ft/min	8.63E-05
time lag cm/sec	4.38E-05

h = water level [head]

ratio = ratio of initial h-H to h-H at any time

Two Point

time1	3.55
time2	48.88
head ratio 1	0.8861
head ratio 2	0.2943
variablehead ft/min	7.79E-05
variablehead cm/sec	3.96E-05


MW-15-40
1.00
0.10
head ratio
0.0
16.3
32.5
48.8
65.0
81.3
time

Site Name: EPT

Well #: MW-16-100

Casing Type: Stainless Steel

Falling Head Test

static head [H]	73.28
casing diameter [d	0.167
test diamter [D]	0.167
test length [L]	22

minutes	h		ratio
0	62	11.28	1.0000
0.84	62.08	11.2	0.9929
2.84	62.08	11.2	0.9929
3.67	62.14	11.14	0.9876
4.34	62.14	11.14	0.9876
6.84	62.17	11.11	0.9849
13.09	62.28	11	0.9752
22.09	62.44	10.84	0.9610
28.59	62.49	10.79	0.9566
38.59	62.66	10.62	0.9415
48.76	62.75	10.53	0.9335
58.84	62.9	10.38	0.9202
68.84	63.03	10.25	0.9087
132.09	63.57	9.71	0.8608
259.34	64.35	8.93	0.7917

Time Lag

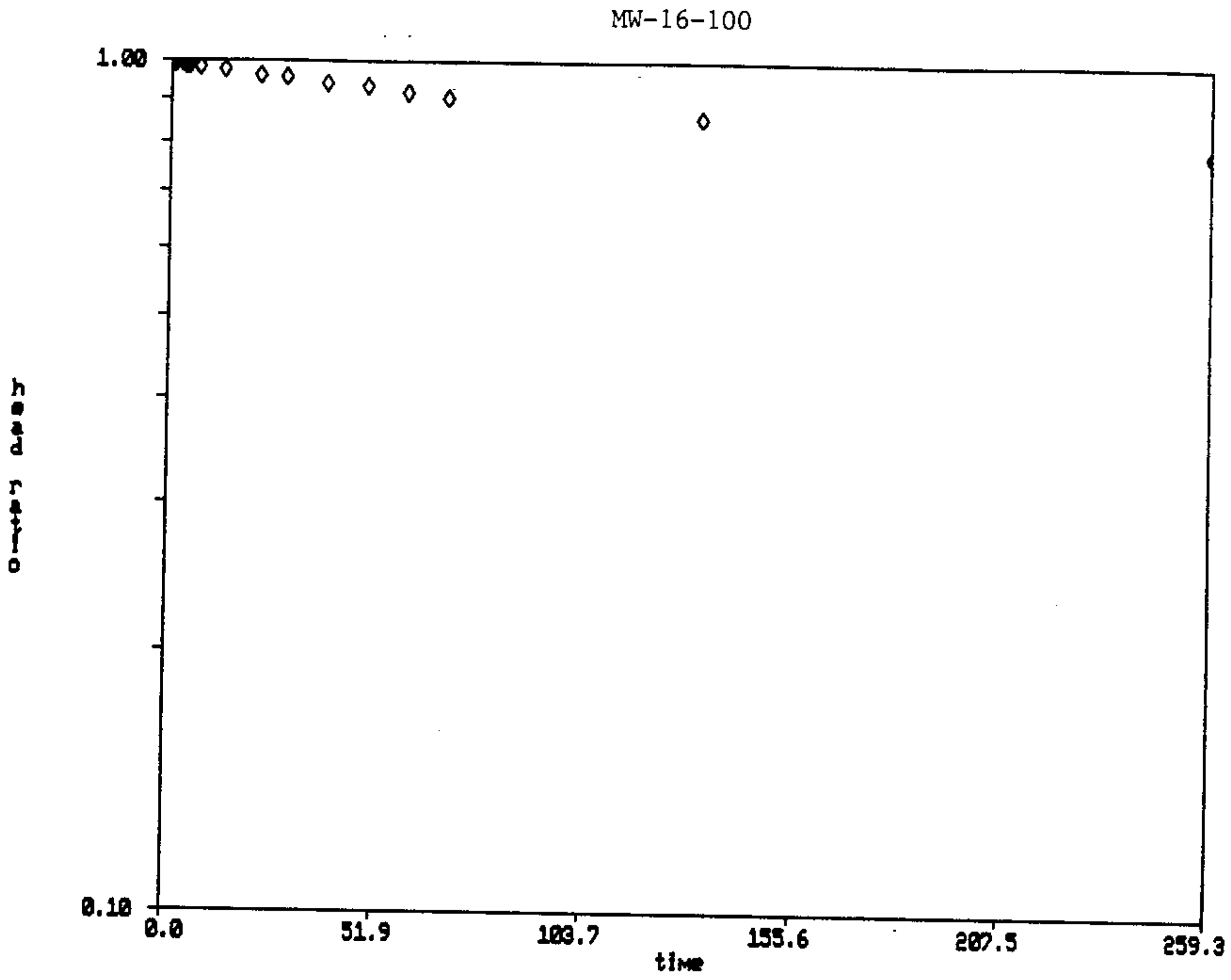
time@.37	1071
time lag ft/min	8.25E-07
time lag cm/sec	4.19E-07

h = water level (head)

ratio = ratio of initial h-H to h-H at any time

Two Point

time1	13.09
time2	48.76
head ratio 1	0.9752
head ratio 2	0.9335
variablehead ft/min	7.93E-07
variablehead cm/sec	4.03E-07


MW-16-100
1.00
0.10
head ratio
0.0
51.9
103.7
155.6
207.5
259.3
time

Site Name: EPT

Well #: MW-17-40

Casing Type: Stainless Steel

Falling Head Test

static head [H]	3.61
casing diameter [d	0.33
test diamter [D]	0.25
test length [L]	10

minutes	h	h-H	ratio
0	0.79	2.82	1.0000
0.25	0.92	2.69	0.9539
0.5	1.01	2.6	0.9220
0.75	1.1	2.51	0.8901
1.25	1.24	2.37	0.8404
1.5	1.3	2.31	0.8191
2	1.39	2.22	0.7872
2.5	1.5	2.11	0.7482
3	1.61	2	0.7092
3.75	1.7	1.91	0.6773
4.5	1.82	1.79	0.6348
5	1.92	1.69	0.5993
6	2.05	1.56	0.5532
6.5	2.17	1.44	0.5106
7	2.19	1.42	0.5035
8	2.26	1.35	0.4787
9	2.38	1.23	0.4362
10.67	2.5	1.11	0.3936
10.75	2.53	1.08	0.3830
11.5	2.56	1.05	0.3723
12.45	2.5	1.11	0.3936
13.5	2.68	0.93	0.3298
14.75	2.74	0.87	0.3085
16.25	2.83	0.78	0.2766
18	2.88	0.73	0.2589
19	2.91	0.7	0.2482
20.75	2.96	0.65	0.2305
21.45	3	0.61	0.2163
23.25	3.02	0.59	0.2092
24.33	3.08	0.53	0.1879
26.15	3.12	0.49	0.1738
27.5	3.16	0.45	0.1596
28.75	3.18	0.43	0.1525
30	3.2	0.41	0.1454
32.75	3.25	0.36	0.1277
34.5	3.27	0.34	0.1206
36.5	3.31	0.3	0.1064
38.5	3.34	0.27	0.0957
40.5	3.36	0.25	0.0887
42.5	3.37	0.24	0.0851
44.5	3.39	0.22	0.0780
46.5	3.41	0.2	0.0709
49.5	3.44	0.17	0.0603
60	3.51	0.1	0.0355

Time Lag

time@.37	18
time lag ft/min	3.31E-04
time lag cm/sec	1.68E-04

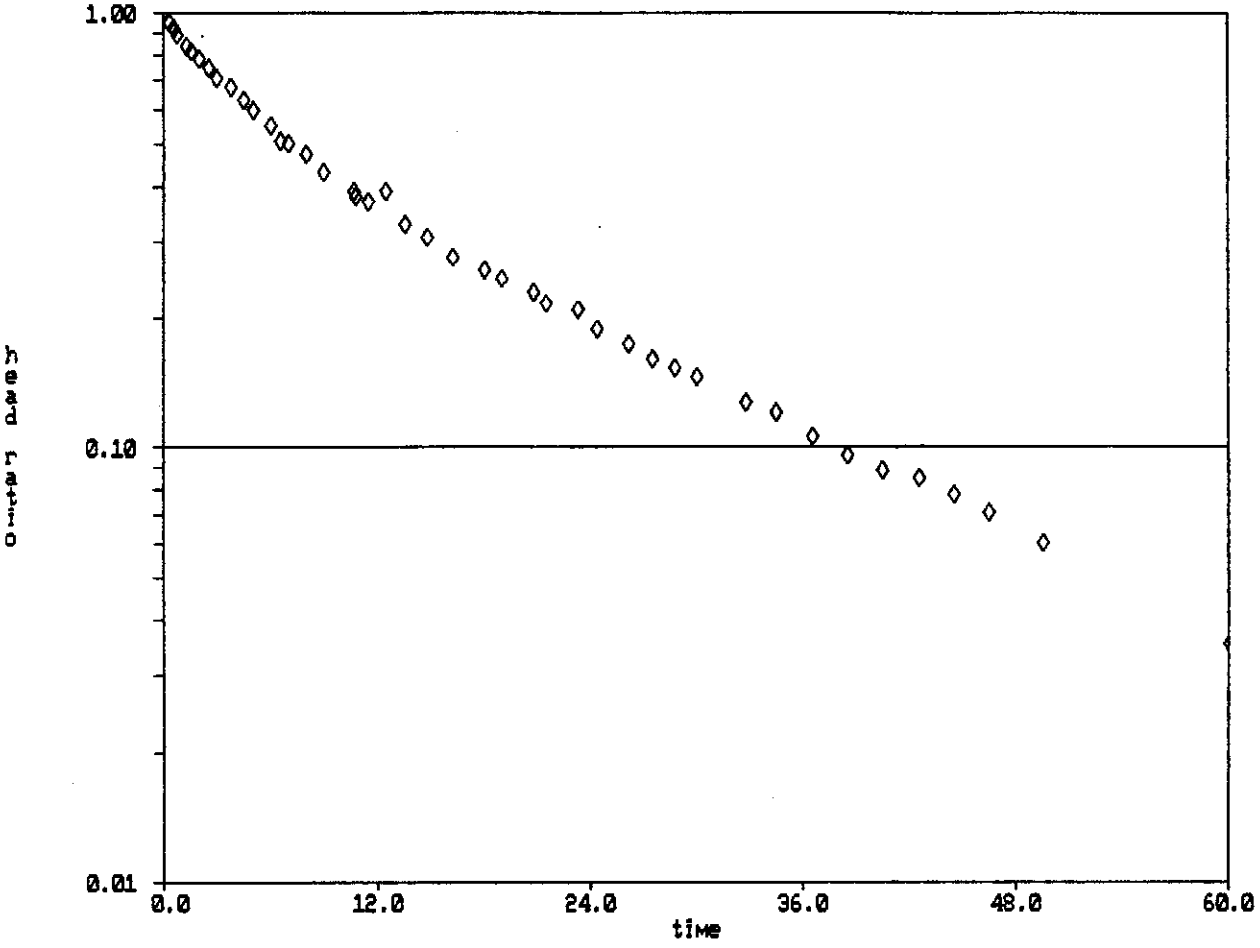
Two Point

time1	5
time2	38.5
head ratio 1	0.5993
head ratio 2	0.0957
variablehead ft/min	2.85E-04
variablehead cm/sec	1.45E-04

h = water level (head)

ratio = ratio of initial h-H to h-H at any time

MW-17-40



RISING HEAD TESTS

FIELD DATA TABLES AND PLOTS

RADIAN
CORPORATION

CALCULATION SHEET

CALC. NO. ______

SIGNATURE RTC DATE 10/4/89 CHECKED ______ DATE ______

PROJECT EPT JOB NO. ______

SUBJECT Permeability MW-9-40 SHEET 1 OF 5 SHEETS

$r_c = 0.125$ ft

$L = 27.7$ ft

$H = 27.7$ ft

$r_w = 0.125$ ft

$Y_o = 18.41$ ft (graph)

$Y_t = 17.22$ ft (graph)

$D = 200$ ft

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \frac{1}{t} \ln \frac{Y_o}{Y_t}$$

where $\ln(R_e/r_w) = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B\ln\left(\frac{D-H}{r_w}\right)}{L/r_w}\right]^{-1}$

$$\ln(R_e/r_w) = \left[\frac{1.1}{\ln\left(\frac{27.7}{.125}\right)} + \frac{6.5 + (1.25)\ln\left(\frac{200-27.7}{.125}\right)}{27.7/.125}\right]^{-1}$$

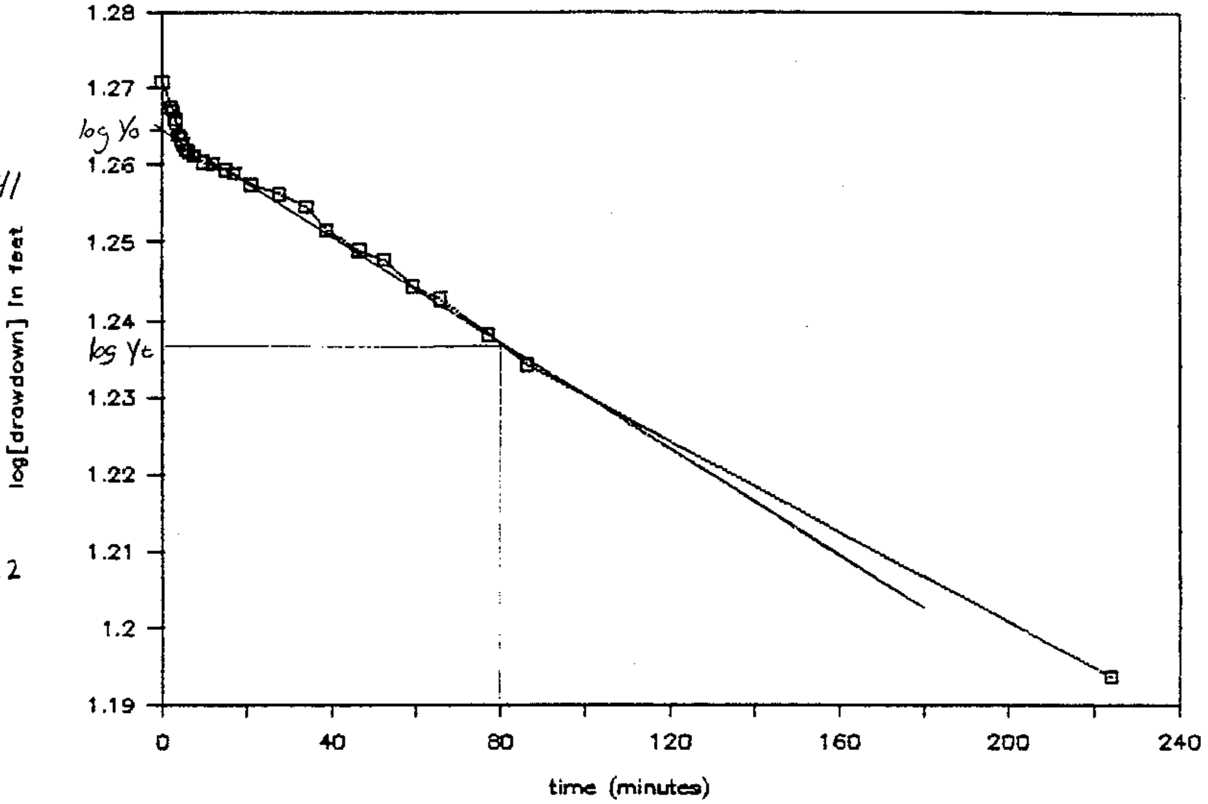
$$\ln(R_e/r_w) = 3.65$$

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \frac{1}{t} \ln \frac{Y_o}{Y_t}$$

$$K = \frac{(.125)^2 (3.65)}{2(27.7)} \frac{1}{(80)} \ln\left(\frac{18.41}{17.22}\right)$$

$$K = 8.59 \times 10^{-7} \text{ ft/min} \times .508 = 4.36 \times 10^{-7} \text{ cm/sec}$$

MW-9-40



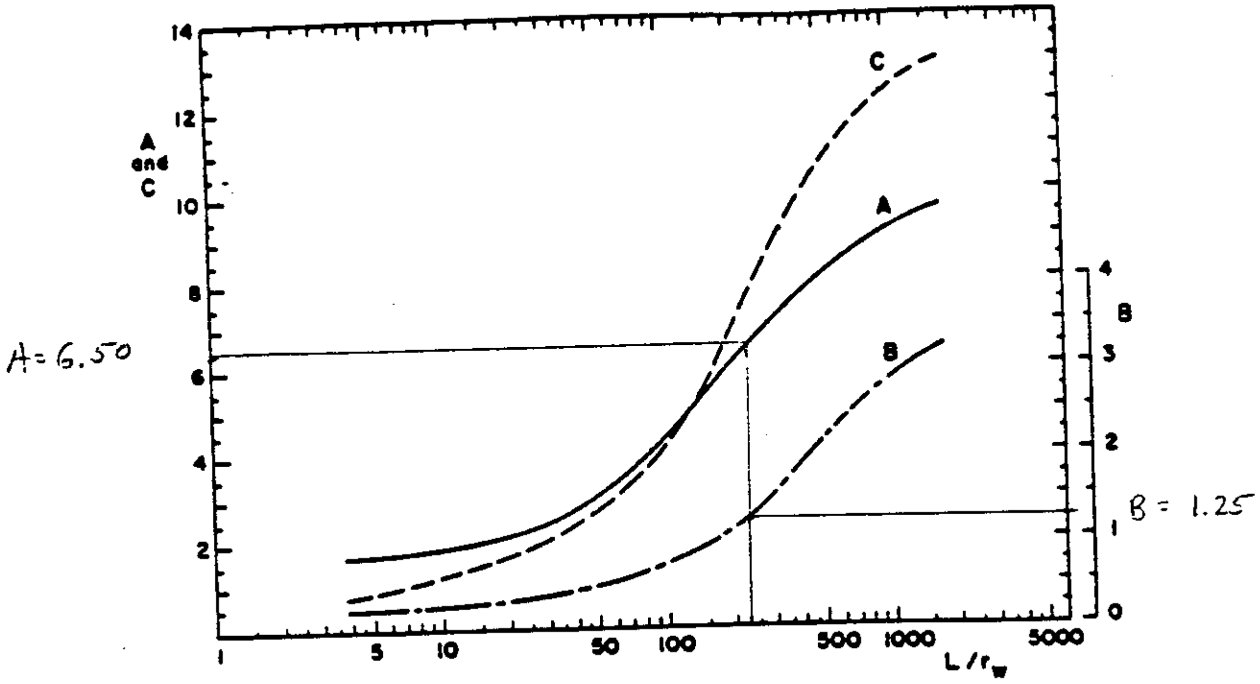
$y_o = 18.41$

$y_t = 17.22$

$t = 80$ min

mw-9-40

BOUWER AND RICE: GROUNDWATER HYDRAULICS



Curves relating coefficients *A*, *B*, and *C* to L/r_w.

$L/r_w = 221.6$

Use C if Fully penetrating

Use A + B if partially penetrating

VARIABLE HEAD PERMEABILITY TEST Pg 1 of 2

Site Name Emerson Power Transmission Well MW-9-40 Date 9/27/89

Static Water Level (TOC) 12.30 ft = H

Depth to Water at Start of Test (TOC) 30.46 ft = Ho H-Ho = -18.66 ft

Clock Time (min)	t Elapsed Time (min)	h Depth of Water Below TOC (ft)	H-h (ft)	H-h / H-Ho
11:28:00 AM	0.00	30.96	-18.66	
	0.33	30.69 *	-18.39	
	0.83	30.59 *	-18.29	
	1.75	30.77 *	-18.47	
	2.25	30.82	-18.52	
	2.58	30.80	-18.50	
	3.00	30.75	-18.45	
	3.33	30.73	-18.43	
	3.92	30.66	-18.36	
	4.33	30.64	-18.34	
	4.83	30.61	-18.31	
	5.75	30.58	-18.28	
	6.50	30.57	-18.27	
	7.50	30.55	-18.25	
	9.75	30.51	-18.21	
	12.00	30.50	-18.20	
	15.00	30.47	-18.17	

PM/003
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VARIABLE HEAD PERMEABILITY TEST MW-9-40
(Continued)
pg 2 of 2

Clock Time (min)	t Elapsed Time (min)	h Depth of Water Below TOC (ft)	H-h (ft)	$\frac{H-h}{H-Ho}$
	17.00	30.45	-18.15	
	21.00	30.39	-18.09	
	27.67	30.34	-18.04	
	34.00	30.27	-17.97	
	38.83	30.15	-17.85	
	46.50	30.04	-17.74	
	52.50	29.99	-17.69	
	57.40	29.85	-17.55	
	65.75	29.79	-17.49	
	77.25	29.61	-17.31	
	86.50	29.45	-17.15	
3:12:00 pm	224 00	27.92	-15.62	

CALCULATION SHEET

CALC. NO.

SIGNATURE Merin DATE ~~30~~ Oct 89 CHECKED DATE

PROJECT EPT permeability Calculations JOB NO. MW-9-100

SUBJECT Using Bower + Rice SHEET 1 OF 5 SHEETS

$r_{eq} = \overset{0.17}{\cancel{0.25}}$ ft

L = 12.89 ft

H = 12.89 ft

r_w = 0.25 ft

Y_0 = 8.28 ft (from graph)

Y_t = 8.17 ft for t = 100 minutes (from graph)

D = 200

$$K = \frac{r_{eq}^2 \ln\left(\frac{R_e}{r_w}\right)}{2L} \frac{1}{t} \ln \frac{Y_0}{Y_t}$$

$$\text{where } \ln\left(\frac{R_e}{r_w}\right) = \left[\frac{1.1}{\ln\left(\frac{H}{r_w}\right)} + \frac{A + B\ln\left(\frac{D-H}{r_w}\right)}{L/r_w}\right]^{-1}$$

$$\ln\frac{R_e}{r_w} = \left[\frac{1.1}{\ln\frac{12.89}{0.25}} + \frac{3.2 + 0.5\ln\left(\frac{200-12.89}{0.25}\right)}{\frac{12.89}{0.25}}\right]^{-1}$$

$$= \left[\frac{1.1}{3.94} + \frac{3.2 + (0.5)(6.62)}{51.56}\right]^{-1}$$

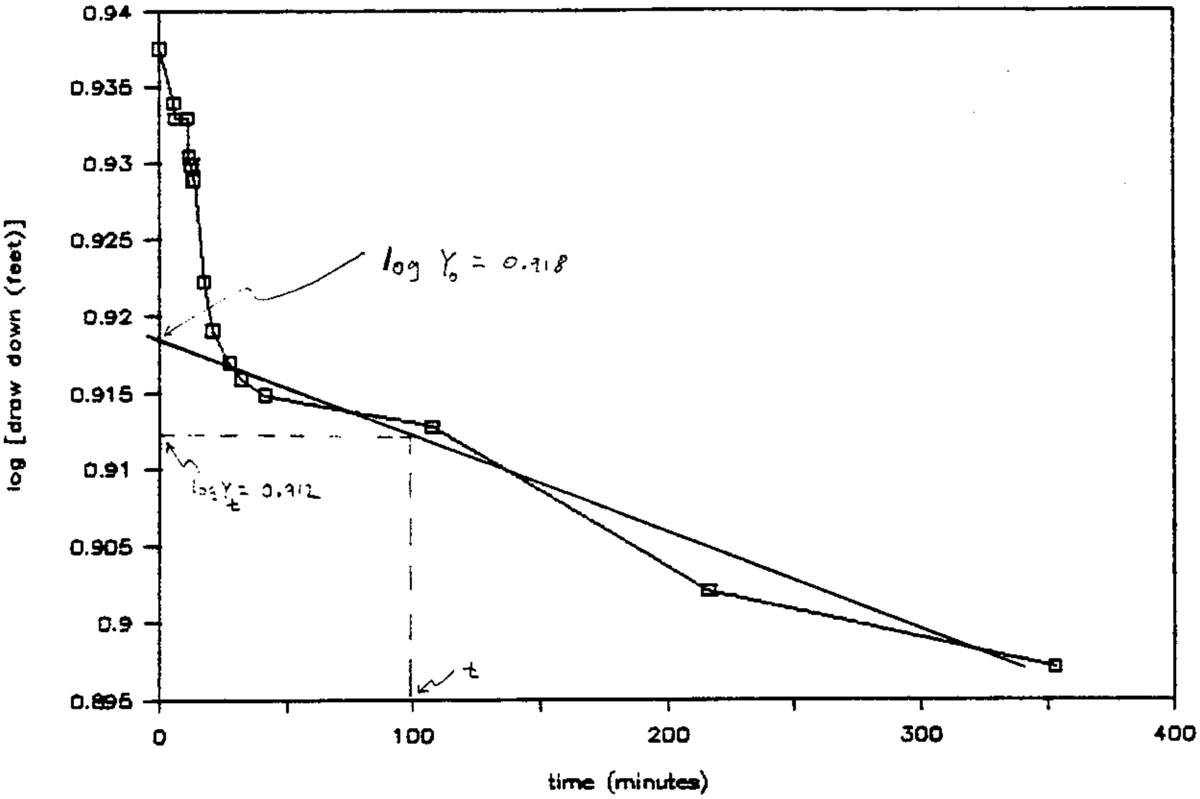
$$= \left[0.279 + 0.126\right]^{-1}$$

$$\ln\frac{R_e}{r_w} = 2.47$$

$$K = \frac{(0.17)^2(2.47)}{2(12.89)} \frac{1}{100} \ln\frac{8.28}{8.17} = 3.7\times10^{-7} \text{ ft/min} \times .508 = \boxed{1.88\times10^{-7} \text{ cm/sec}}$$

2 oF 5

MW-9-100



log Y_o = 0.918

Y_o = 2.28 Ft

log Y_t = 0.912

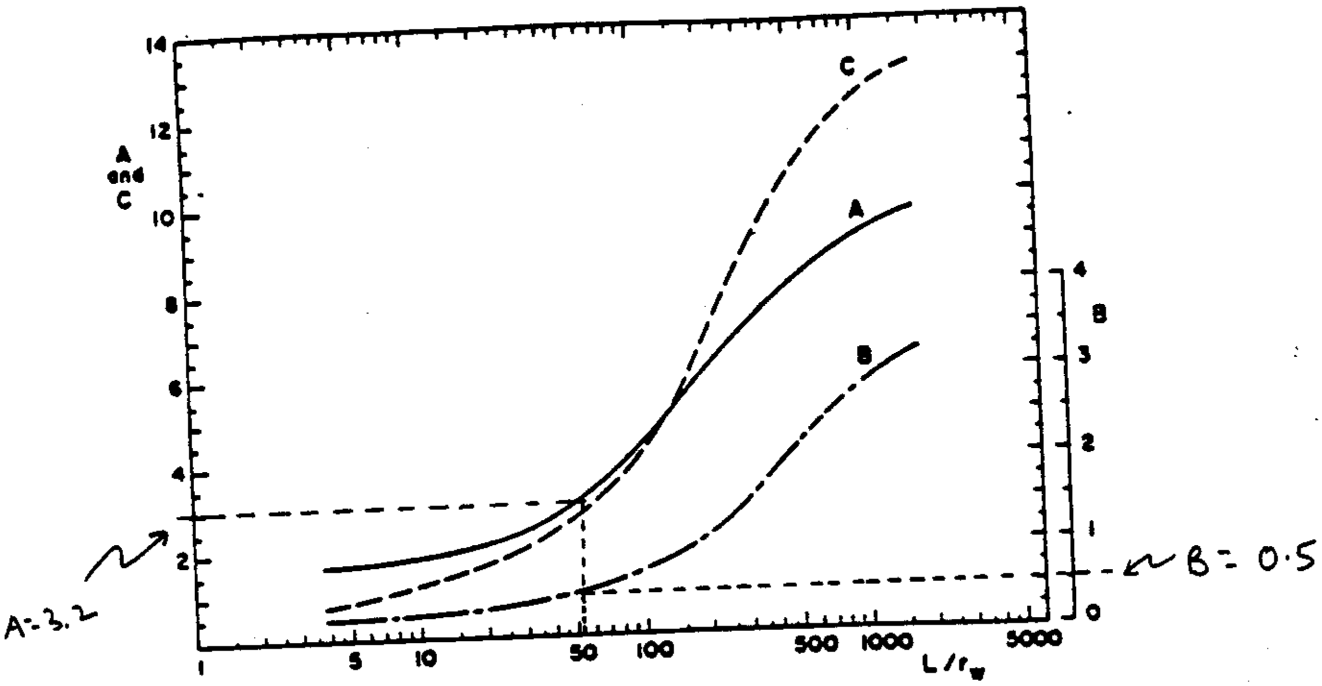
Y_t = 8.17 Ft

for t = 100 minutes

3 of 5

MW-9-100

BOUWER AND RICE: GROUNDWATER HYDRAULICS



Curves relating coefficients *A*, *B*, and *C* to *L*/r_w.

Use C if Fully penetrating

use A + B if partially penetrating

L= 12.89

r_w= 0.25

L/r_w= 51.56

F_C = 2 inches

H = L =

4 of 5

VARIABLE HEAD PERMEABILITY TEST

Site Name Emerson Power Transmission Well mw-9-100 Date 9/27/89

Static Water Level (TOC) 87.11 ft = H

Depth to Water at Start of Test (TOC) 95.97 ft = Ho H-Ho = -8.86 ft

Clock Time (min)	t Elapsed Time (min)	h Depth of Water Below TOC (ft)	H-h (ft)	$\frac{H-h}{H-Ho}$
9:15:00 Am	0.00	95.97		
	0.75	95.74 *		
	4.00	95.75 *		
	5.83	95.90		
	6.33	95.88		
	6.75	95.78 *		
	7.42	95.75 *		
	8.00	95.72 *		
	11.33	95.88		
	11.67	95.83		
	12.25	95.82		
	12.83	95.82		
	13.33	95.80		
	13.83	95.80		
	17.67	95.67		
	21.00	95.61		
	27.50	95.57		
	32.25	95.55		

* pump body and hoses are interfering with E-line. Readings inaccurate

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VARIABLE HEAD PERMEABILITY TEST
(Continued)

MW-9-100
pg 2 of 2

Clock Time (min)	t Elapsed Time (min)	h Depth of Water Below TOC (ft)	H-h (ft)	$\frac{H-h}{H-Ho}$
	41.50	95.53		
	50.00	95.49		
	52.33	95.54		
	54.33	95.54		
	63.33	95.54		
	72.33	95.54		
	80;67	95.53		
	87.75	95.53		
	98.50	95.53		
	107.33	95.49		
12:51:00 pm	216.00	95.29		
3:08:00 pm	353.00	95.20		

RADIAN
CORPORATION

CALCULATION SHEET

CALC. NO. ____

SIGNATURE Merin DATE 3 Oct 89 CHECKED ____ DATE ____

PROJECT EPT JOB NO. MW-10-40

SUBJECT Permeability Calculation SHEET 1 OF 5 SHEETS

$r_c = 0.125$

$L = 20.08$

$H = 20.08$

$r_w = 0.125$

$Y_0 = 8.51$ ft

$Y_t = 5.17$

$t = 40$

$D = 200$

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \frac{1}{t} \ln\left(\frac{Y_0}{Y_t}\right)$$

where
$$\ln(R_e/r_w) = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B \ln\left(\frac{D-H}{r_w}\right)}{L/r_w}\right]^{-1}$$

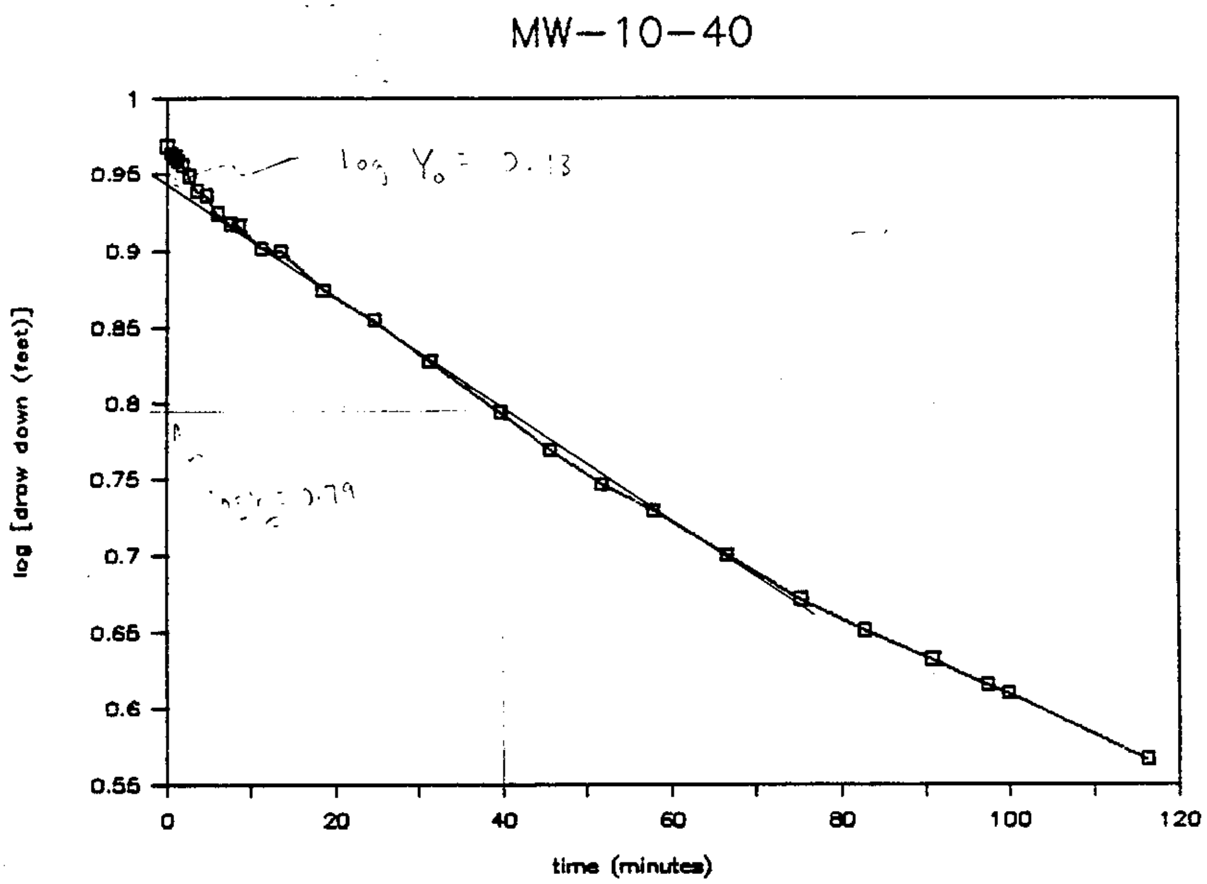
$$\ln(R_e/r_w) = \left[\frac{1.1}{\ln\left(\frac{20.08}{.125}\right)} + \frac{5.6 + (1.1) \ln\left(\frac{200 - 20.08}{.125}\right)}{20.08/.125}\right]^{-1}$$

$$\ln(R_e/r_w) = 3.32$$

$$K = \frac{(.125)^2 (3.32)}{2(20.08)} \frac{1}{40} \ln \frac{8.51}{6.17}$$

$K = 1.04 \times 10^{-5}$ ft/min $\times .508 = 5.27 \times 10^{-6}$ cm/sec

2 of 5



$\log Y_0 = 0.93$

$Y_0 = 8.51$ Ft

$\log Y_t = 0.79$

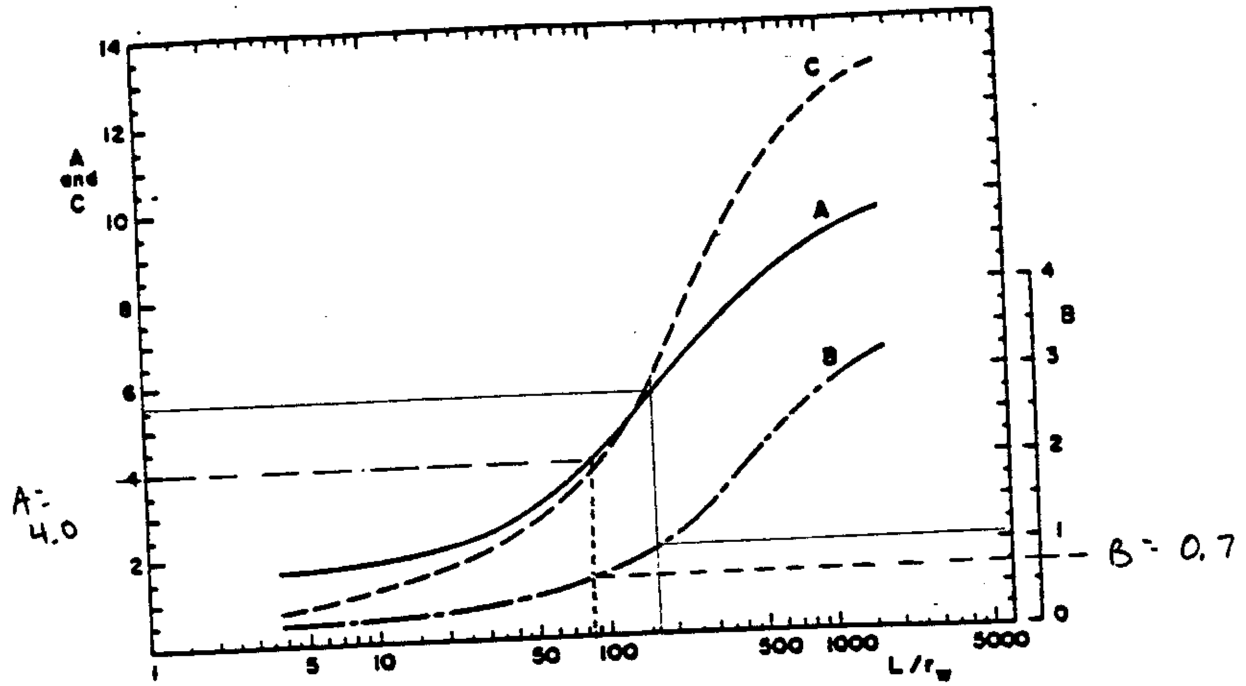
$Y_t = 6.17$ Ft

For time = 40 minutes.

3 of 5

MW-10-40

Bouwer and Rice: Groundwater Hydraulics



Curves relating coefficients A, B, and C to L/r_w.

Use C if Fully penetrating

Use A + B if partially penetrating

L = 20.08

r_w = .125

L/r_w = 160.64

B = 1.10
A = 5.60

VARIABLE HEAD PERMEABILITY TEST pg 1 of 2

Site Name Emerson Power Transmission Well MW-10-40 Date 9/27/89

Static Water Level (TOC) 19.92 ft = H

Depth to Water at Start of Test (TOC) 29.21 ft = Ho H-Ho = -9.29 ft

Clock Time (min)	t Elapsed Time (min)	h Depth of Water Below TOC (ft)	H-h (ft)	$\frac{H-h}{H-Ho}$
1:20:00 pm	0.00	29.21		
	0.50	29.11		
	0.83	29.06		
	1.25	29.01		
	1.83	28.95		
	2.58	28.81		
	3.50	28.62		
	4.67	28.55		
	6.00	28.33		
	7.50	28.20		
	8.50	28.18		
	11.16	27.90		
	13.50	27.86		
	18.50	27.41		
	24.67	27.08		
	31.30	26.64		
	39.67	26.14		
	45.67	25.79		

5 of 5

VARIABLE HEAD PERMEABILITY TEST
(Continued)

mw-10-40
pg 2 of 2

Clock Time (min)	t Elapsed Time (min)	h Depth of Water Below TOC (ft)	H-h (ft)	$\frac{H-h}{H-Ho}$
	51.83	25.49		
	57.83	25.28		
	66.58	24.93		
	75.33	24.61		
	82.83	24.39		
	90.75	24.20		
	97.25	24.04		
3:00:00 pm	99.75	23.99		
	116.33	23.60		

RADIAN CORPORATION

CALCULATION SHEET

CALC. NO.

SIGNATURE RTC DATE 10/2/89 CHECKED DATE

PROJECT Permeability MW-11-40 JOB NO.

SUBJECT EPT SHEET 1 OF 5 SHEETS

$r_c = 0.125$ ft

$L = 9.22$ ft

$H = 9.22$ ft

$r_w = 0.125$ ft

$Y_o = 4.80$

$Y_t = 2.75$ for $t = 12.5$

$D = 200$ ft

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \frac{1}{t} \ln\left(\frac{Y_o}{Y_t}\right)$$

$$\text{where } \ln(R_e/r_w) = \left[\frac{1.1}{\ln(H/r_w)} + \frac{A + B\ln\left(\frac{D-H}{r_w}\right)}{L/r_w}\right]^{-1}$$

$$\ln(R_e/r_w) = \left[\frac{1.1}{\ln\left(\frac{9.22}{.125}\right)} + \frac{(\overset{3.[illegible]}{3.90}) + (.60)\ln\left(\frac{200-9.22}{.125}\right)}{9.22/.125}\right]^{-1}$$

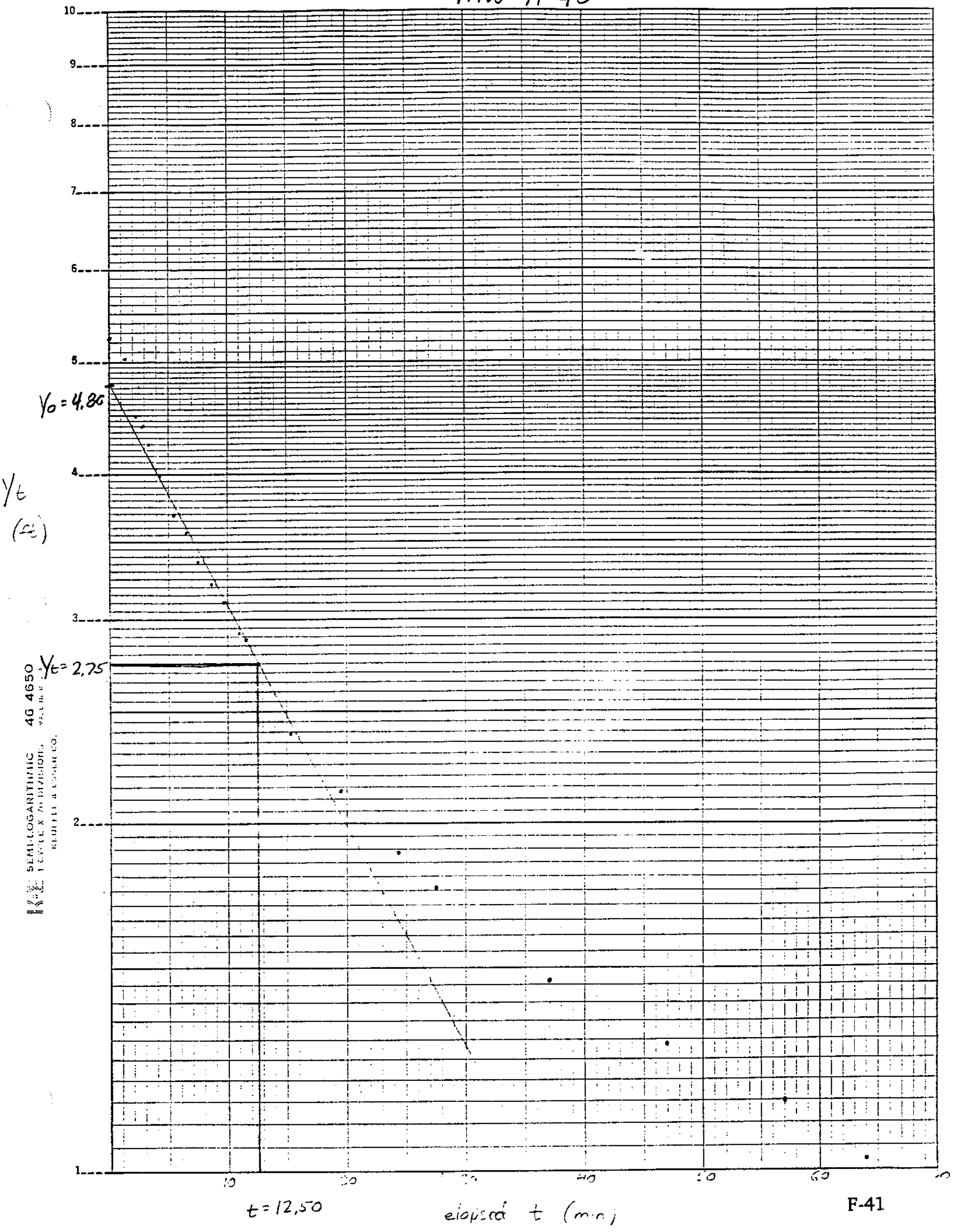
$$\ln(R_e/r_w) = 2.74$$

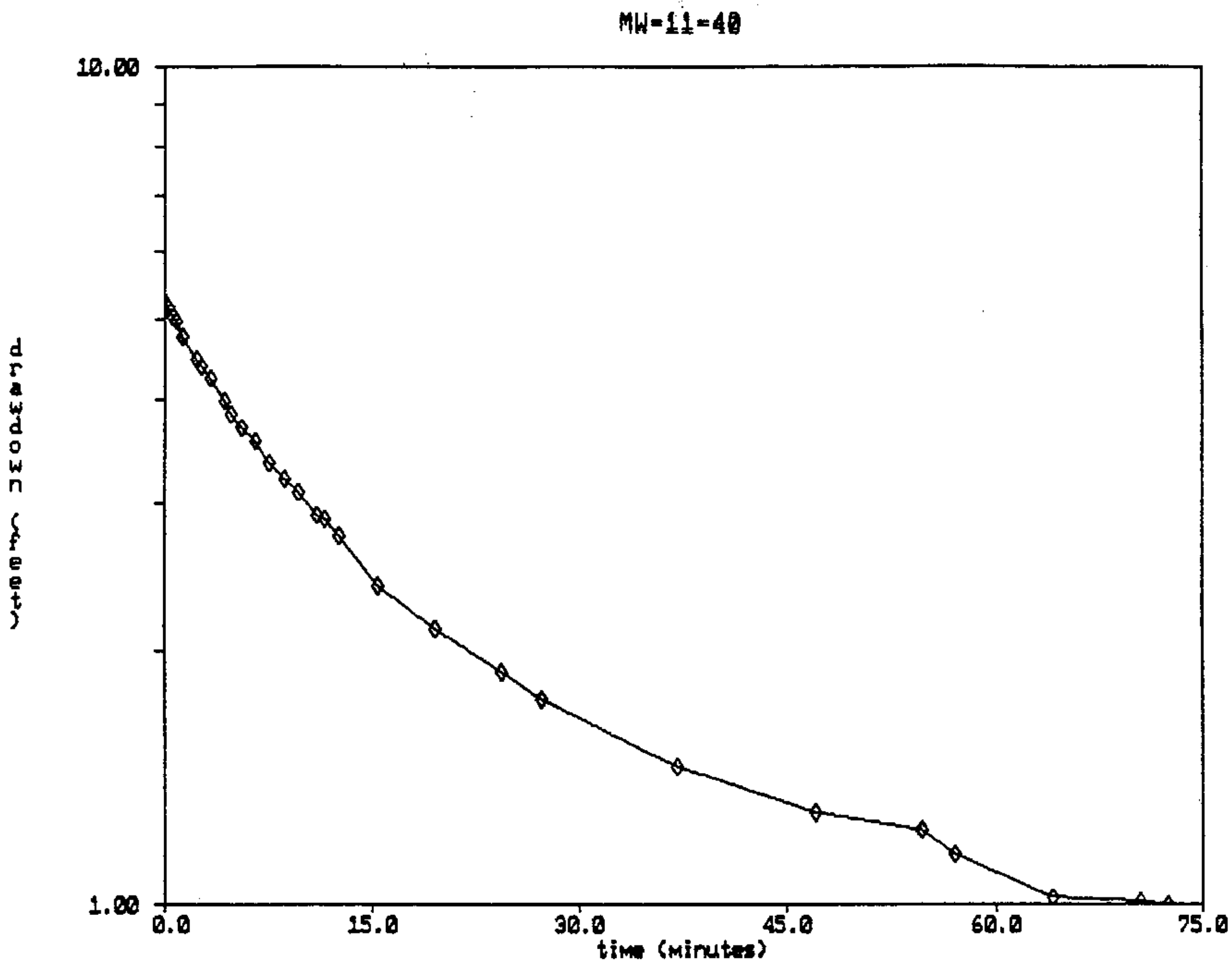
$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \frac{1}{t} \ln\left(\frac{Y_o}{Y_t}\right)$$

$$K = \frac{(.125)^2(2.72)}{2(9.22)} \frac{1}{(12.50)} \ln\left(\frac{4.80}{2.75}\right)$$

$K = 1.03 \times 10^{-4}$ ft/min $\times .508 = 5.22 \times 10^{-5}$ cm/sec

MW-11-40


10
9
8
7
6
5
4
3
2
1
$Y_0 = 4.80$
$Y_t = 2.25$
Y_t (ft)
10
20
30
40
50
60
70
t = 12,50
elapsed t (min)
SEMI-LOGARITHMIC 1 CYCLE X 70 DIVISIONS
KEUFFEL & ESSER CO.
4G 4650
MADE IN U.S.A.

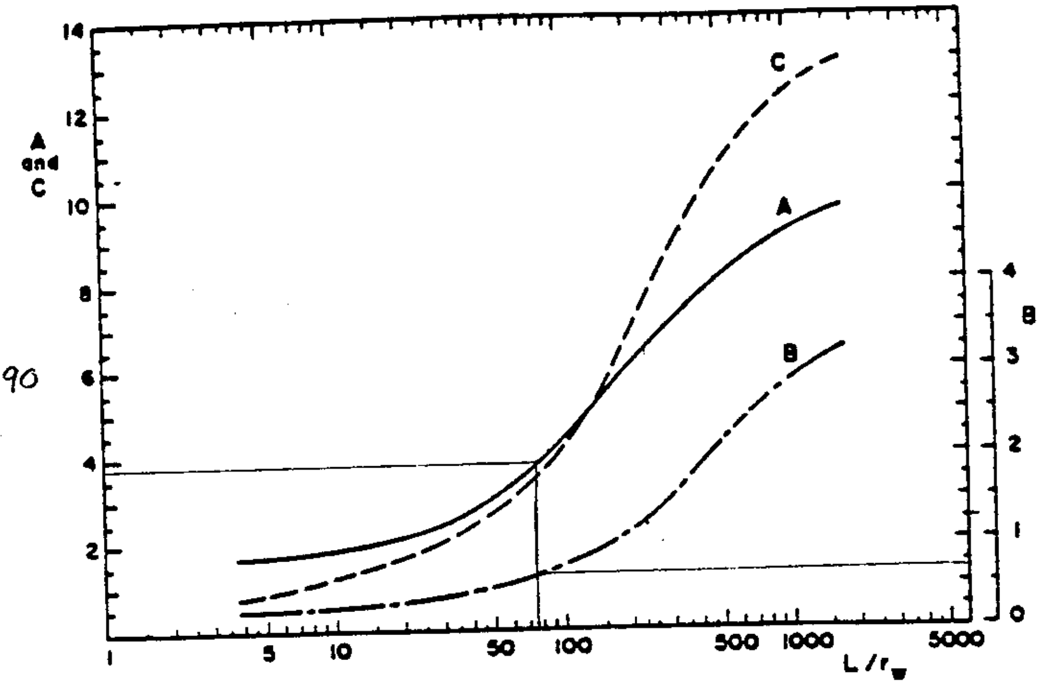


MW-11-40

MW-11-40

BOUWER AND RICE: GROUNDWATER HYDRAULICS

A=3.90



B= .60

Curves relating coefficients *A*, *B*, and *C* to *L*/r_w.

$L/r_w = 73.76$

Use C if Fully penetrating

use A+B if partially penetrating

VARIABLE HEAD PERMEABILITY TEST pg 1 of 2

Site Name Emerson Power Transmission Well MW-11-40 Date 9/26/89

Static Water Level (TOC) 30.78 ft = H

Depth to Water at Start of Test (TOC) 36.02 ft = Ho H-Ho = -5.24 ft

Clock Time (min)	t Elapsed Time (min)	h Depth of Water Below TOC (ft)	H-h (ft)	$\frac{H-h}{H-Ho}$
2:16:00 pm	0.00	36.02	-5.24	
	0.20	35.94	-5.16	
	0.60	35.81	-5.03	
	0.83	35.76	-4.98	
	1.25	35.54	-4.76	
	2.26	35.26	-4.48	
	2.60	35.18	-4.40	
	3.25	35.03	-4.25	
	4.25	34.77	-3.99	
	4.75	34.62	-3.84	
	5.50	34.48	-3.70	
	6.50	34.35	-3.57	
	7.50	34.14	-3.36	
	8.67	34.00	-3.22	
	9.67	33.88	-3.10	
	11.00	33.69	-2.91	
	11.50	33.66	-2.88	
	12.50	33.53	-2.75	

VARIABLE HEAD PERMEABILITY TEST
(Continued)

MW-11-40
Pg. 2 of 2

Clock Time (min)	t Elapsed Time (min)	h Depth of Water Below TOC (ft)	H-h (ft)	$\frac{H-h}{H-Ho}$
	15.33	33.17	-2.39	
	19.50	32.91	-2.13	
	24.25	32.67	-1.89	
	27.25	32.54	-1.76	
	37.00	32.24	-1.46	
	47.00	32.07	-1.29	
	54.67	32.01	-1.23	
	57.00	31.93	-1.15	
	64.08	31.80	-1.02	
	70.43	31.79	-1.01	
	72.38	31.78	-1.00	