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EVALUATION OF OFF-SITE BEDROCK HYDROGEOLOGY FOR THE CIBA-GEIGY GLENS FALLS FACILITY GLENS FALLS, NEW YORK

Prepared for:

Ciba-Geigy Corporation
Lower Warren Street
Glens Falls, New York

AWARE Incorporated
1200 MacArthur Boulevard
Mahwah, New Jersey 07430

January 1989

AWARE
INCORPORATED
consultants in environmental management

January 23, 1989 6966
6993

Mrs. LaVerne Fagel
CIBA-GEIGY Corporation
Lower Warren Street
Glens Falls, New York 12801

RE: Glens Falls Main Plant Site

Dear Mrs. Fagel:

AWARE is pleased to submit the following reports for your review:

- o Evaluation Of Off-Site Bedrock Hydrogeology
- o Groundwater Monitoring Task

As requested, we have also forwarded copies to the appropriate offices at NYSDEC.

Should you have any questions, please feel free to contact us at (201) 529-0800.

Very truly yours,

AWARE Incorporated

William G. Soukup

William G. Soukup
Senior Hydrogeologist

WGS:kl
enclosures

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1.0 INTRODUCTION

During the past several years, the Ciba-Geigy Glens Falls site has been the subject of several hydrogeologic investigations. The two principal studies have been conducted by Dunn Geoscience Corporation in 1980 and Malcolm Pirnie in 1987. Both of these investigations included activities focused on the Main Plant site itself, and have produced a sizable amount of subsurface information. These studies provided 15 overburden wells, 13 shallow rock wells, 9 deeper rock wells, and 11 wells screened over more than one interval. In addition, 78 soil borings were installed in the overburden materials. This current evaluation by AWARE has added two on site wells and three off site wells, plus another round of water quality information.

These investigations provide a thorough understanding of the area's geology, groundwater movement, and water quality both on site as well as across the Hudson River. These studies have identified areas requiring additional work which is proposed in the work plan for the Groundwater Monitoring Task prepared by AWARE (January 1989).

1.1 OBJECTIVES AND SCOPE

The overall goal of this off site bedrock evaluation is to determine the ultimate discharge point or fate of groundwater in the bedrock originating in the western portion of the Ciba-Geigy Main Plant site. (It has been shown in the Malcolm Pirnie report that groundwater in the overburden discharges into the Hudson River.) In order to accomplish this goal, four specific objectives have been identified as follows:

- Define the stratigraphy and structural relationships which exist between the Main Plant site and the limestone quarry located south of the Hudson River.
- Define all relevant stratigraphic horizons which act as groundwater flow zones.
- Define the direction of groundwater flow within each zone.
- Define the groundwater quality within each zone.

The scope of this investigation includes the western portion of the Main Plant site from Lower Warren Street to the Hudson River. Across the river, the area includes the entire active quarry as well as the quarry property to the south as shown on Figure 1-1. Since the focus of this evaluation is on the regional hydrogeologic conditions, this report does not attempt to provide a complete historic account of groundwater quality on the Main Plant site. Although groundwater quality data collected during this study as well as previous studies were used to aid in the interpretation of regional impacts, (if any) it was not specifically evaluated relative to potential source areas or existing soil quality data. This type of detailed on site evaluation will be conducted as part of the proposed Groundwater Monitoring Plan and will have the benefit of the additional soils data collected during the Soil Sampling Plan.

1.2 TECHNICAL APPROACH

The approach used to achieve the objectives stated above was to first develop a conceptual model of the geologic framework and groundwater flow conditions within the study area. This model was developed during the preparation of the work plan and will not be repeated in this report. In order to test this model, the following investigative tasks were implemented:

- Exploratory coring at five regional locations to depths well below the lowest (western) quarry floor elevation of 116 feet (mean sea level).

- Downhole geophysics in each of these wells plus the two available plant production wells. Geophysics included spontaneous potential (SP), resistivity, natural gamma, temperature, and caliper.

- Packer pressure testing in each of the five exploratory wells.

- Installation of monitoring wells in each of the five exploratory holes.

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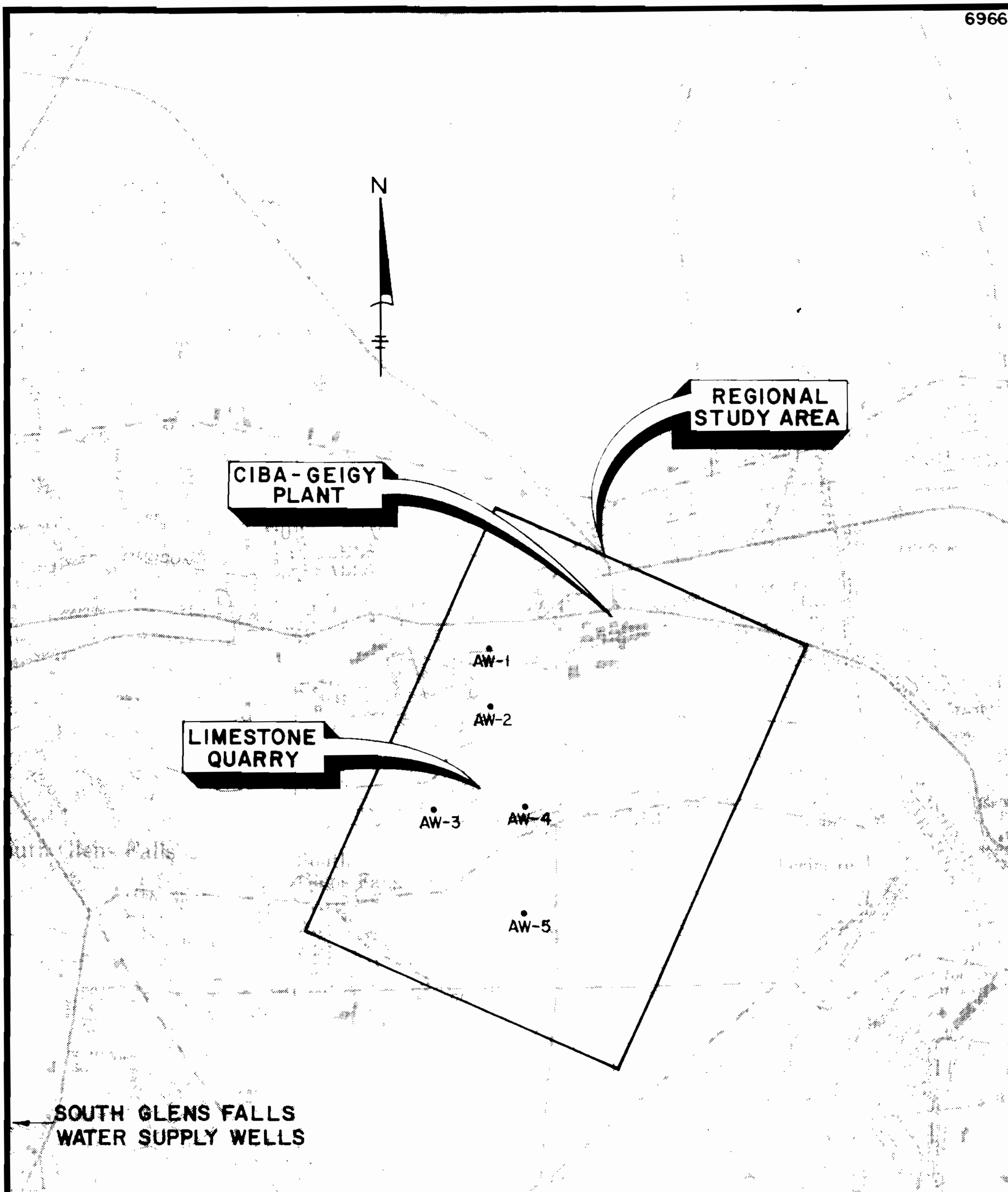


AW • APPROXIMATE LOCATION OF AWARE WELL.

SOURCE: GLENS FALLS, N.Y. (1966)
HUDSON FALLS, N.Y. (1966)
N.Y. 7.5' QUADRANGLE

2000 0 2000

scale feet

MAP LOCATION

FIGURE 1-1

SITE LOCATION MAP

CIBA - GEIGY CORPORATION
GLENS FALLS PLANT

AWARE INCORPORATED

NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY

- Groundwater sample collection and analysis for major ions, volatile organics, selected semi-volatile organics, metals, and selected indicator parameters.

- Water sample collection from within the limestone quarry including two flowing coreholes in the western floor, a seep in the northern wall, and the quarry pond prior to discharge to the Hudson River. Four monthly rounds of these samples were collected.

- Water level monitoring in new and existing wells.

1.3 SITE CHARACTERISTICS

The study area of this regional bedrock evaluation is shown on the USGS quadrangle of Figure 1-1 and can be divided into three principal portions. The northern section consists of the Main Plant site which encompasses approximately 75 acres. The central portion is the active limestone quarry operated by Glens Falls Cement Co., Inc. The southern portion consists of the lands owned by Glens Falls Cement Co. throughout which a number of exploratory borings (drill holes) have been conducted by the cement company. The data from these borings have been provided to AWARE.

The Main Plant site has been described in a number of previous documents and thus its characteristics will not be repeated herein. The other two portions of the study area warrant a brief summary of their important features.

The limestone quarry occupies approximately 50 acres and can be generally divided into two portions. The eastern portion has a floor elevation of approximately 160 feet above mean sea level and is not currently being mined. The walls surrounding this portion are nearly vertical with no significant observable seeps. According to quarry personnel, this area does not require dewatering and only receives water from incipient precipitation.

The western portion is much deeper with a floor elevation of approximately 116 feet above mean sea level and is currently being mined along its southern face.

The walls are benched as a result of the mining of individual limestone members within the Glens Falls formation. Several seeps can be observed with the predominant one located in the north wall. This seep is observed to occur directly over a horizontally continuous clay layer. This layer ranges in thickness from one to six inches and has been interpreted to represent the top of the Isle La Motte formation (refer to Section 3.2.3).

Another prominent feature of the western quarry is the open coreholes which have been drilled into the floor by the cement company. According to the data received from the cement company, there are 13 coreholes ranging in depth from 10 to 40 feet and located as shown on Sheet 6966-1. A number of the coreholes are actively discharging groundwater to the quarry floor. This water drains into a number of quarry floor ponds and is ultimately discharged via pumps to the Hudson River.

The lands to the south of the quarry contain a number of drill holes conducted by the cement company in order to map the geology down dip ahead of their operation. The cement company has provided AWARE with the geologic logs of 11 of these drill holes. Six were drilled in 1974 (dh74-1 through dh74-6) and five were drilled in 1979 (dh79-1 through dh79-5). The locations of these borings are shown on Sheet 6966-1.

To properly map the data collected during this study, a single base map of the entire study area was needed. For this report, AWARE joined a reduced version of the Main Plant site topographic map and a map of the quarry provided by Glens Falls Cement Co. The maps which were used are referenced on Sheet 6966-1. Certain inaccuracies may be present due to this process and thus AWARE assumes no responsibility for its accuracy.

2.0 FIELD INVESTIGATION

2.1 DRILLING AND WELL CONSTRUCTION

In order to identify the nature of the bedrock present beneath the site and to allow for the installation of monitoring wells, exploratory bedrock borings were drilled at five locations. These locations are identified by an "AW" (AWARE Well) prefix in the various maps, tables, and appendices that accompany this report. Identification numbers were assigned to the five locations at the beginning of the investigation, and are numbered consecutively (AW-1 through AW-5). The geologic logs and well completion data for each boring are contained in Appendix B.

Drilling services were provided by Empire Soils of Latham, New York, using a truck-mounted Failing F-10 rotary drill rig. Fresh potable water was used as the drilling fluid. At four of the five locations, the bedrock was continuously cored with an NX (3-inch diameter) boring bit using a wireline system. The three-inch coreholes were then reamed to six inches with a rollerbit prior to well installation. Well AW-5 was not cored due to its excessive depth (over 400 feet), distance from the Main Plant site and the predominance of nearby drill hole data from the cement company borings.

All drilling, testing, and well construction activities were performed under the direct observation of AWARE Incorporated. The core was visually inspected and placed in clearly marked core boxes, which are currently in storage at the Ciba-Geigy Main Plant site in Glens Falls, New York, for reference.

Initially, the regional bedrock evaluation was designed to examine the bedrock to an elevation of 60 feet above mean sea level, approximately 50 feet below the quarry's western floor. The borings, as described in the Regional Bedrock Evaluation Work Plan (AWARE, 1988), were all targeted to intercept this elevation. However, after completion of AW-1 and AW-2 on the Main Plant site, the presence of a deep, laterally continuous, south dipping water-bearing fracture (Horizon C) was identified. The exploratory program was consequently modified in order to reach this deeper fracture horizon. The following changes were made relative to well depth.

Well Number	Anticipated Depth	Actual Depth	Screen Depth
AW-1	220	220	133-143
AW-2	175	206	156-166
AW-3	51	151	89-99
AW-4	100	206	180-190
AW-5	260	407	394-406

Well construction consisted of a two-inch diameter PVC well screen installed on a two-inch PVC riser. Where the corehole depth exceeded the desired screen depth, grout and/or bentonite pellets were used as backfill to minimize potential hydraulic communication with the deeper cored section. The NX (nominal three-inch diameter) corehole was enlarged to six inches in diameter to the desired screen depth with a rollerbit reaming assembly. The screens placed in the borehole were ten feet in length. Clean, coarse sand was placed in the annular space around the well screen and riser from the base of the reamed corehole to approximately two feet above the screen. A layer of bentonite pellets at least three feet in thickness was placed above the sand pack. The annular space above the bentonite seal was grouted with Volclay by the "tremie" method. An outer protective casing with locking cap was set into the grout to a minimum depth of three feet.

One well (AW-2) included the installation of a permanent outside casing through the overburden soils. The double-casing consisted of a six-inch diameter black-steel casing within an eight-inch diameter borehole. Installation of the casing was conducted by augering to competent bedrock. The augers were filled with cement grout and then removed leaving an open eight-inch borehole filled with the grout slurry. The six-inch casing was fitted with a bottom plug and inserted into the cement-filled borehole. The cement was allowed to cure for 18 hours before resumption of the coring operation.

2.2 DOWNHOLE GEOPHYSICAL PROGRAM

Borehole geophysics, or downhole logging, involves lowering sensing devices into a borehole to record physical parameters that may be interpreted as specific rock characteristics. The basic system involves a generator-powered unit which controls the tool output, receives data detected by the tool, and records the data on a chart. The unit contains a synchronized winch which raises and lowers tools into the borehole in time with the advancing chart recorder. Thus, the resulting logs furnish continuous records of subsurface conditions which may be compared or correlated from one well to another. The charted log data allowed rapid field interpretation and comparison with pre-existing logs, permitting immediate well screen depth selection. The geophysical logs are reproduced in Attachment A.

A Mineral Logging System (MLS) Model 1502 Downhole Logging Unit was used to conduct the borehole logging program described herein. The system consists of a modular control panel, a pen recorder, a motorized winch, and, in this case, four individual downhole tools. Initial system calibration was performed at the site in order to establish general guidelines to optimize the performance of each tool relative to site conditions. The initial calibration effort included multiple tool runs in AW-1, with comparison of the logs to the core samples from that borehole. Subsequent logs were obtained using these established guidelines. Prior to each logging run, each tool was individually calibrated using detailed instructions supplied by the manufacturer.

2.2.1 Natural Gamma Logging

Rocks contain traces of naturally occurring radioactive materials which emit gamma rays. The natural gamma tool detects the rate of gamma ray emissions. An electrical signal which is proportional to the number of gamma rays counted per unit time is sent continuously uphole from the tool to the logging unit. Whereas carbonates emit comparatively low to moderate natural radioactivity, shales are typically among the most radioactive sedimentary rocks. The noted increase in the natural radioactivity as shale content increases has been attributed to both the depositional environment of shales and to selective concentration of radioactive ions through cation exchange and adsorption

(Norris, 1972). The gamma response is, therefore, a useful indicator of the shaliness of the formations within the borehole. Thin, individual shale beds are useful marker beds which correlate nicely between boreholes. Natural gamma logs may be obtained through steel or PVC casing, permitting logging inside cased holes or wells, and are not dependent upon a fluid-filled borehole. The natural gamma log has proven to be the most reliable tool for stratigraphic correlation for the conditions encountered during this investigation.

The natural gamma tool is a 1-11/16 inch diameter probe that is eighty-four inches in length. The probe registers gamma ray emissions using a scintillation counter. The control module for this probe allows the selection of variable scales, measured in counts per second (cps). During the initial calibration period, variable scales and logging speeds were evaluated and compared to available core samples. A scale of 0 to 500 cps at a logging speed of twenty-five feet per minute was selected as most appropriate for site conditions. Running the tool at slower logging speeds results in excessive background noise; higher speeds risk the loss of stratigraphic detail.

2.2.2 Caliper Logging

The caliper log is a mechanical device which continuously measure the diameter of a borehole with depth. It is a useful tool for identifying less consolidated formations which have produced larger diameter borehole sections. It is also useful in identifying horizontal fractures; however, vertical fractures are generally not detected by the caliper. The caliper tool used during this investigation is three-armed, without wall contact pads. The arms are coupled and thus react to the borehole shape simultaneously. This tool is run uphole only.

The caliper was used on both NX boreholes (nominal diameter three inches) and reamed boreholes (nominal diameter six inches). Before each run, the tool was calibrated to known diameters on a calibration board.

2.2.3 Temperature Logging

Temperature logging can be useful to locate and track sections in the borehole where fluids enter or exit. Two temperature devices, gradient and differential (included in the same tool), were used during the investigation. Whereas the gradient device measures the actual temperature of borehole fluid, the differential device measures relative changes in borehole fluid temperature. While both logs typically respond to temperature changes of the magnitude encountered during the investigation, the differential tool exhibits a much higher sensitivity to both fluid migration and variable thermal conductivity (Basham and Macune, 1952).

The temperature tool is run in uncased boreholes, preferably after the fluid has equilibrated to natural temperature conditions. Even in the absence of complete equilibrium, the temperature logs are useful for identifying zones of drilling fluid loss that are indicative of increased hydraulic conductivity (Nelson, 1982). This tool is logged downhole to avoid fluid mixing induced by the probe itself. The temperature tool has been extremely helpful in delineating discrete water-bearing zones which exhibit anomalous temperatures relative to the fluid within the borehole.

The temperature tool is a 1-7/16 inch diameter probe that is 37 inches in length. As noted above, the tool provides both temperature gradient and differential temperature measurements. The temperature tool utilizes high resistance semiconductor sensing elements (resistors) that rapidly respond to changes in temperature with a proportional change in resistance. The change in resistance is calibrated to degrees Fahrenheit. The gradient temperature log is provided by a sensing element located at the bottom of the tool. The differential log is provided by comparing the bottom sensing element to a second sensing element located 30 inches above the lower element. The temperature tool was calibrated to a range of 20°F based upon site conditions encountered during the initial calibration period. A logging speed of thirty feet per minute, based on the manufacturer's recommendations, was used throughout the program.

2.2.4 Spontaneous Potential and Single-Point Resistivity Logging

Spontaneous potential (SP) and single-point resistivity logging measure the natural electrical properties of lithologic formations in the subsurface. Both techniques are combined in a single logging tool. In general, an electrode is placed within a borehole, electric currents are generated by the logging system, and the resulting electrical potential distribution is measured and printed on the log form. The potential distribution is dependent on the magnitude of the electrical resistivities encountered in the borehole. Resistivity is the inverse of conductivity.

Conventional resistivity logging involves the passing of currents of known intensity through the formation. Resistivity logging conducted during this investigation employed the use of a "normal" resistivity device in which a constant current was passed between two electrodes on the surface and two electrodes on the downhole tool. The distance between electrodes on the tool is called the spacing, and the point midway between is termed the point of inscription. The spacing of the normal device is 16 inches. Geologic measurements of the tool are taken at the point of inscription, accordingly, the tool is termed a single-point resistivity device. The fact that different rocks have different resistivities provides a means of establishing stratigraphic correlations from borehole to borehole. The single-point resistivity tool measures the response of a relatively small volume of rock immediately adjacent to the borehole. As a consequence of the short electrode spacing, stratigraphic detail is enhanced, minimizing the depth-averaging effect of larger electrode arrays. Resistivity logging was not instrumental in the hydrogeological aspect of this investigation, but proved helpful in interpreting lithology.

Spontaneous Potential (SP) logs are generated by lowering an insulated cable, with an electrode ground at the surface, into the well. As the electrode is moved, an electrical potential is measured between differing rock types and varies with lithology. A well-defined baseline, termed the "shale line", is often recognized on the SP log. Deflections from this baseline typically correspond to more permeable horizons, such as sand intervals.

Both resistivity and SP logging require an uncased, water-filled borehole. The resistivity/SP tool is a 1.5-inch diameter probe that is 27.5 inches in length. During the initial calibration period variable scales and logging speeds were evaluated. A scale of 0 to 800 ohms per chart division at a logging speed of 30 feet per minute was selected for the resistivity function. The SP scale was calibrated to record 100 millivolts per chart division.

2.3 HYDRAULIC CONDUCTIVITY DETERMINATIONS

The measure of hydraulic conductivity in the subsurface describes the ability of a rock or soil deposit to transmit water. Hydraulic conductivities present beneath the site represent perhaps the most critical parameter in characterizing fluid interaction with the subsurface system. Given sufficient continuity of the strata and known hydraulic gradients, it is the hydraulic conductivity that will control the migration pathways for fluids as well as the volumetric rates of groundwater flow.

In this section, several hydraulic conductivity testing methods used in the investigation are described. These methods include two methods of direct, in situ, field testing; packer (pressure) testing of the open bedrock corehole and variable head recovery tests of individual wells. The data generated from each test are presented in Appendix C.

2.3.1 In Situ Variable Head Recovery Tests

To determine the in-place lateral hydraulic conductivity of the saturated materials, variable head recovery tests were performed on three of the five AWARE wells. The field tests involve rapidly lowering the water level in the well and measuring the change in head with respect to time as the well is allowed to recover.

The field methodology utilized an In Situ, Inc. Hermit model automatic data logger and pressure transducer system to measure water level changes. The Hermit data logger permitted measurement of water levels at frequent time intervals, much more frequently than could have been achieved manually. The recovery tests were conducted as follows:

- The static water level in the monitoring well was measured and recorded.

- The pressure transducer was placed in the well, followed by a standard PVC bailer. Water level measurements were continued until the water level had returned to static conditions following introduction of the transducer and bailer.

- Once static conditions were re-established, the bailer was rapidly removed from the water column, thus creating a virtually instantaneous decline of the water level in the well. Coincident with the withdrawal of the bailer, automatic logging of the water levels was initiated using the Hermit data logger.

- The water level measurements were typically continued until water levels had recovered to within 10 percent of the original static level (90 percent recovery).

It is assumed that the rate of inflow to the well screen after pumping, at any time, is proportional to the hydraulic conductivity (k) and to the unrecovered head distance. A semi-log plot of the unrecovered head distance or head ratio (h_t/h_o) versus time (t) typically indicates an exponential decline in the recovery rate over time.

The following equation is used to calculate the in situ hydraulic conductivity of the saturated materials at the screened interval of the piezometer (Cedergren, 1977).

$$k = \frac{r^2}{2L(t_2 - t_1)} \quad \ln(L/R) \times \ln(h_1/h_2)$$

Where:

L = Screen length, in cm

r = Screen radius, in cm

R = Gravel pack radius, in cm

t_1 = Time interval corresponding to h_1, in sec

t_2 = Time interval corresponding to h_2, in sec

h_1 = Head ratio at time t_1, dimensionless

h_2 = Head ratio at time t_2, dimensionless

k = Hydraulic conductivity, in cm/sec

The results of the in situ recovery tests are provided in Appendix C of this report.

2.3.2 Packer Testing

Packer testing (permeability pressure testing) is a method of determining the hydraulic conductivity of isolated bedrock zones within a borehole. The test apparatus consists of a perforated pipe enclosed within two inflatable rubber packers spaced at a specified interval. Non-perforated pipe is connected to the perforated pipe isolated in the borehole. The packers are inflated with compressed nitrogen to seal off the test zone from the remainder of the borehole. Clean, potable water from the surface is pumped at a constant, known pressure into the isolated packer test section. The water volume pumped is calculated through time, and the water volume which enters the bedrock under the specified pressure is a function of the hydraulic conductivity. An assembly of gauges at the ground surface control water pressure and record volume pumped. Values observed are related to hydraulic conductivity k, by the equation:

$$k = Cp \frac{Q}{H}$$

Where k is calculated in cm/sec, Cp is the packer coefficient (a shape factor that accounts for test section length and borehole diameter), Q is the constant rate of flow, and H is the differential pressure head.

In boreholes AW-1 through AW-4 packer tests were performed in 11.2 foot test sections at ten-foot continuous intervals. In well AW-5 packer tests were performed in 10.6 foot test sections (due to a slightly different packer requirements for the six-inch diameter borehole) at ten-foot continuous intervals. However, the upper 240 feet of this well were not packer tested as it contains formations which are not present on or near the Main Plant site. An untested zone approximately three feet in length exists at the base of each hole due to the length of the lower packer. The packer test results were used in conjunction with the geophysical logging data in selecting well screen depths. Results of the packer testing program are discussed in Section 4.3.1.

2.4 Monitoring Well Sampling and Analysis

Each of the five AWARE wells and 17 selected existing wells were purged and sampled by Aquatec Inc. of Burlington, Vermont. The wells were chosen based on their location in the western portion of the Main Plant site and on the fact that they were twice previously sampled. The first round was during the Malcolm Pirnie investigation, and the second was during a supplemental groundwater sampling program in December of 1987.

Each well was sampled in accordance with the protocols described in Attachment B for the parameters listed in Section 3. The results are contained in Attachment C and are summarized and discussed in section 4.5.

2.5 Quarry Sampling Program

In an effort to evaluate the quality of water entering the quarry, four sampling locations were chosen in the western floor. This area was selected since it represents the regional discharge area of groundwater in the bedrock and contains active seeps and flowing coreholes which can be readily sampled. These locations are coreholes 2 and 5, the seep on the north wall, and the ponded water east of corehole 5. Coreholes 2 and 5 represent discharge from Horizon B; the seep represents discharge from Horizon A and the quarry pond represents the quality of water prior to discharge to the Hudson River.

In order to broaden the data base, each location was sampled monthly for a period of four months (August through November, 1988). The results are contained in Attachment C and further discussed in section 3.5.

2.6 Water Level Monitoring

A complete round of water levels were obtained by AWARE on October 6, 1988. Unfortunately, access to several of the wells was not possible due to a variety of physical reasons (obstruction, rusted caps, etc.). To include the newly installed AWARE wells, the ground surface and top of PVC casing was surveyed for elevation by Vermont Survey Consultants, Inc. Water level and related data are summarized on Table 2-1.

Table 2-1

SUMMARY OF WATER LEVEL DATA
(October 6, 1988)

WELL	REF. ELEV. (ft.,msl)	DEPTH WATER (ft)	ELEV. WATER (ft.,msl)	NOTES	WELL	REF. ELEV. (ft.,msl)	DEPTH WATER (ft)	ELEV. WATER (ft.,msl)	NOTES
----	-----	-----	-----	-----	----	-----	-----	-----	-----
MW-1	240.18	27.4	212.78		MW-27S	241.64	31.48	210.16	
MW-2	240.14	11.3	228.84		MW-27D	242.53	37.71	204.82	
MW-4	241.11	31.83	209.28		MW-28	241	11.78	229.22	
MW-5	241.03	27.9	213.13		MW-29S	236.82	33.03	203.79	
MW-6	236.99			NA	MW-30S	216.44	12.5	203.94	
MW-7	236.66			dry	MW-30D	216.78	12.88	203.9	
MW-8	242.66	14.65	228.01		MW-31	217.44	8.06	209.38	
MW-9	242.35	6.47	235.88		MW-33S	254.11	19.34	234.77	
MW-10	257.41	26.54	230.87		MW-33D	254.34	41.51	212.83	
MW-13	234.32	25.83	208.49		MW-34	239.61	19.09	220.52	
MW-14	234.32	15.48	218.84		MW-35S	240.32			NA
MW-15	282.6	42	240.6	quest.	MW-35D	239.93	36.51	203.42	
MW-16	283.12			dry	MW-36S	261.96	27.62	234.34	
MW-17S	285.98			NA	MW-36D	262.94	44.48	218.46	
MW-17D	286.18			NA	MW-37S	266.08	8.25	257.83	
MW-18	286.73			NA	MW-40S	281.5	16.65	264.85	
MW-19	245.58			NA	MW-40D	281.39	48.66	232.73	
MW-20S	262.27	19.94	242.33		MW-45	249.74	13.45	236.29	
MW-20D	263.15	41.83	221.32		P-46	277.89	8.3	269.59	
MW-21	239.75	26.83	212.92		P-53	242.98			NA
MW-22	241.13	8.9	232.23		P-71	244.29			NA
MW-23S	282.91	17.41	265.5						
MW-23D	283.64	25.59	258.05		AW-1	282.78	74.5	208.28	
MW-24	283.33	8.54	274.79		AW-2	237.97	59.58	178.39	
MW-25S	238.74	25.97	212.77		AW-3	131.03	2.54	128.49	
MW-25D	237.91			plugged	AW-4	160.11	6.26	153.85	
MW-26	238.57	7.98	230.59		AW-5	315.72			NA
					PW-1	265	63.57	201.43	
					PW-2	265			NA
					PW-7				NA

3.0 ANALYTICAL CHEMISTRY

3.1 Certification

Aquatec, Inc., located in Burlington, Vermont, provided analytical chemistry services for this project. Aquatec's analytical laboratory is currently certified for analysis by both the New York State Department of Environmental Conservation and the New York State Department of Health. These certifications are the result of Aquatec's satisfactory participation in performance evaluations issued by these agencies.

3.2 Analytical Methods, References and Reporting Limits

Presented in Table 3.1 is the method number, method reference, and reporting limit for each parameter analyzed during this investigation. The method references are as follows:

1: Test Methods for the Evaluation of Solid Waste: SW-846. USEPA Office of Solid Waste and Emergency Response, Washington, DC 20460. Third Edition, November 1986.

2: Methods for Chemical Analysis of Water and Wastes: EPA-600/4-79-020. USEPA Office of Research and Development, Cincinnati, OH 45268. March 1983.

3: Standard Methods for the Examination of Water and Wastewater: Sixteenth Edition. American Public Health Association, Washington, DC 20005. 1987.

Reporting limits are given for each parameter in Table 3-1. The reporting limit is the lowest concentration at which a parameter can be identified and

Table 3.1 Analytical methods, references, and reporting.

	Reference	Method Number	Reporting Limit (mg/l)
I. Inorganics			
A. Metallics			
1. Antimony	1	3010/7041	0.06
2. Arsenic	1	3020/7060	0.01
3. Beryllium	1	3010/6010	0.01
4. Cadmium	1	3010/6010	0.01
5. Calcium	1	3010/6010	1.0
6. Chromium, Total	1	3010/6010	0.01
7. Chromium, Hexavalent	1	7196	0.005
8. Copper	1	3010/6010	0.025
9. Lead	1	3020/7421	0.005
10. Magnesium	1	3010/6010	1.0
11. Manganese	1	3010/6010	0.015
12. Mercury	1	7470	0.0005
13. Nickel	1	3010/6010	0.04
14. Potassium	1	3010/6010	1.0
15. Selenium	1	3020/7740	0.005
16. Sodium	1	3010/6010	1.0
17. Thallium	1	3020/7841	0.01
18. Zinc	1	3010/6010	0.02
B. Complex Ions and Chloride			
1. Bicarbonate	3	406C	1.0
2. Carbonate	3	406C	1.0
3. Chloride	3	407A	0.5
4. Cyanide	1	9010	0.01
5. Sulfate	1	9038	1.0
C. pH	1	9040	
D. Total Dissolved Solids	2	160.1	2.0
II. Organics			
A. Total Organic Halogens	1	9020	0.020
B. Volatile Organics			
1. Methylene Chloride	1	8240	.005
2. Chloromethane	1	8240	.01
3. Bromomethane	1	8240	.01
4. Bromoform	1	8240	.005
5. Bromodichloro-methane	1	8240	.005
6. Dibromochloro-methane	1	8240	.005
7. Tetrachloroethene	1	8240	.005
8. Toluene	1	8240	.005
9. Trichloroethene	1	8240	.005

Table 3.1. (continued).

	Reference	Method Number	Reporting Limit (mg/l)
10. Vinyl Chloride	1	8240	.01
11. Acetone	1	8240	.01
12. 2-Butanone	1	8240	.01
13. Carbon Disulfide	1	8240	.005
14. 2-Hexanone	1	8240	.01
15. 4-Methyl-2-pentanone	1	8240	.01
16. Styrene	1	8240	.005
17. Vinyl Acetate	1	8240	.01
18. Total Xylenes	1	8240	.005
19. Benzene	1	8240	.005
20. Carbon Tetra-chloride	1	8240	.005
21. Chlorobenzene	1	8240	.005
22. 1,2-Dichloro-ethane	1	8240	.005
23. 1,1,1-Trichloro-ethane	1	8240	.005
24. 1,1-Dichloroethane	1	8240	.005
25. 1,1,2-Trichloro-ethane	1	8240	.005
26. 1,1,2,2-Tetrachloro-ethane	1	8240	.005
27. Chloroethane	1	8240	.01
28. 2-Chloroethyl Vinyl Ether	1	8240	.01
29. Chloroform	1	8240	.005
30. 1,1-Dichloroethene	1	8240	.005
31. 1,2-Dichloroethene	1	8240	.005
32. 1,2-Dichloropropane	1	8240	.005
33. Trans-1,3-Dichloro-propene	1	8240	.005
34. cis-1,3-Dichloro-propene	1	8240	.005
35. Ethylbenzene	1	8240	.005
36. o-Dichlorobenzene	1	8240	.005

quantified by a given method. The reporting limit for a parameter on a sample specific basis may vary and can be increased. An increase would be due to analysis related dilution of the sample to reduce sample related interferences.

3.3 Quality Assurance/Quality Control

The quality assurance/quality control (QA/QC) program for this investigation was designed to provide data regarding the accuracy and precision of the analytical results.

Three types of QA/QC samples were analyzed: blanks, duplicates, and matrix spikes. Two types of blanks were analyzed and reported: trip blanks and laboratory reagent blanks. The trip blank represents the possible contamination a sample could receive upon transportation from the laboratory to the site and back to the laboratory. Laboratory reagent blanks represent the possible contamination a sample could receive by handling in the laboratory.

Duplicate analyses are a measure of analytical precision. Two types of duplicates were utilized in this study, they are field and laboratory duplicates. Field duplicates permit the estimation of the overall sampling and analysis program precision, while laboratory duplicates only point to the precision of the laboratory measurements.

The accuracy of sample analyses was monitored through the use of matrix spike analyses. A matrix spike analysis is a separate analysis on a sample aliquot to which the parameters of interest are added in known amounts. These spiked samples are then analyzed and percent recoveries are computed. Additional information regarding accuracy have also been included in the form of surrogate spike recoveries and calibration check standards results. Three surrogate spikes used for organic analysis were toluene-D_8, BFB (bromofluorobenzene), and 1,2-dichloroethane-D_4.

The QA/QC analyses types discussed above have been reported on Aquatec's original Analytical Reports which are included in Attachment C.

3.4 Analytical Results

Samples were collected over a four-month period, August-November 1988, as listed in Table 3-2. In each month, samples were collected from the seep in the limestone quarry (Seep), from a pond in the quarry (Q-Pond), and from two coreholes (CH-2 and CH-5). Note that on Aquatec's Analytical Reports which are contained in Attachment C, sample stations CH-2 and CH-5 are labeled CH-1 and CH-2, respectively.

From 13 to 15 September 1988, 17 on site wells were sampled in addition to the monthly samples in the limestone quarry. Well MW-40D had slow recovery and was sampled on 29 September 1988. The new AWARE wells (AW-1, AW-2, AW-3, AW-4, and AW-5) were sampled from 22 September to 25 October 1988; AW-2 was sampled twice.

Three samples were collected and analyzed in duplicate: CH-2, Q-Pond and MW-9. Three samples were selected for volatile organic matrix spike and matrix spike duplicate analysis, MW-27D, CH-5, and Q-Pond. Inorganic replicate and matrix spike analyses were conducted on MW-27D, Seep (twice), CH-2, CH-5, AW-1, AW-2 and AW-4. These samples and quality control analyses are indicated in Table 3-2.

Summary tables of Analytical Report sheets are contained in Appendix A of this report. Four summary tables in Appendix A contain the inorganic, organic, and field measurement results. Table A-1 has metals only; Table A-2 has hexavalent chromium and four major ions. Additional major ions, TDS, total cyanide, and laboratory pH are in Table A-3. Table A-3 also has field measurements. Organic results are in Table A-4 including TOX. Results of the two samples analyzed for base/neutral acid extractable compounds are in Attachment C.

Table 3.2. Summary of samples and quality assurance samples.

Date:	8/15/88	9/13/88	9/13-14/88	9/14-15/88	9/22/88	9/29/88	10/3/88	10/24-25/88	11/22/88
ETR No.:	14617	14962	14980	15008	15094	15175	15216	15452	15711
Level (1):	II	III	III	III	III	III	III	III	III
Samples:	TB	TB	TB	TB	--	TB	TB	TB	TB
	CH-2(d)	MW-25S	CH-2	MW-8	AW-3	AW-2	AW-1(r)	AW-2(r)	CH-2
	CH-5	MW-26	CH-5(r,o)	MW-9(d)		MW-40D	AW-4(r)	AW-5	CH-5
	Q-Pond(d)	MW-27D(r,o)	Q-Pond	MW-19				CH-2(r)	Q-Pond
	Seep	MW-27S	Seep(r)	MW-36D				CH-5	Seep
		MW-28	MW-20D	MW-36S				Q-Pond(o)	
			MW-20S	MW-40S				Seep(r)	
			MW-34(b)	P-53(b)					
			MW-35D						
			MW-35S						

Notes:

Samples (unfiltered) were analyzed for parameters listed in Table 3.1. Field filtered samples collected for all samples except TB (trip blank) and MW-27S; field filtered samples were analyzed for priority pollutant metals plus calcium, potassium, magnesium, and sodium.

d = Field duplicate collected and analyzed.

b = Sample analyzed for base/neutral and acid extractable semivolatile organic compounds.

r = Replicate and matrix spike analyzed for various combinations of TOX, metals, and other inorganics.

o = Matrix spike and matrix spike duplicate analyzed for volatile organic compounds.

1 = Level of analysis III means internal laboratory quality assurance reported for each sample. Level II indicates internal QA not reported, see Addendum E for results.

4.0 HYDROGEOLOGIC CONDITIONS

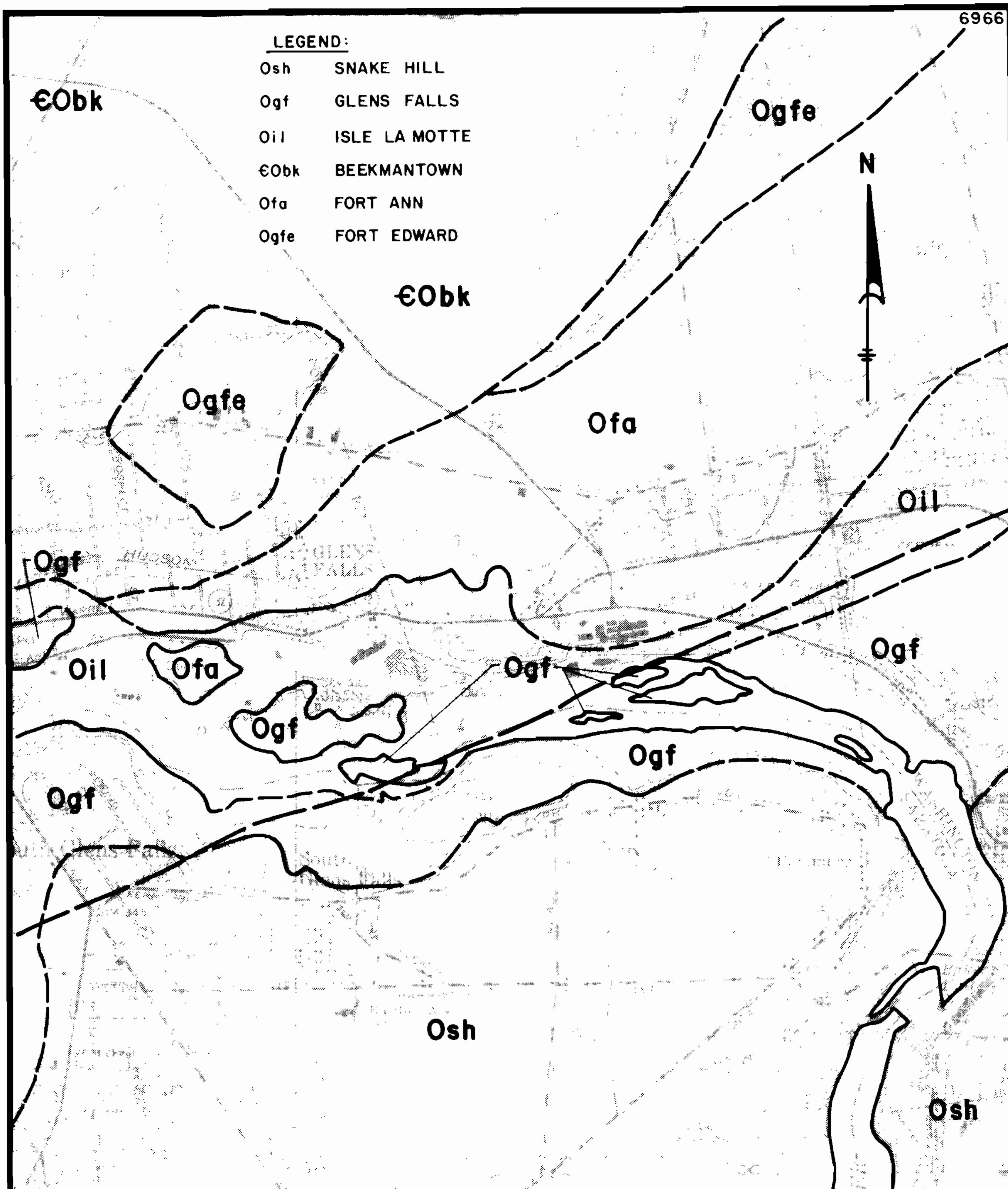
4.1 REGIONAL GEOLOGIC SETTING

The study area is situated over middle and lower Ordovician Age bedrock. The history of Ordovician sedimentation in northern New York was influenced by the Taconic orogeny (Cisne et al, 1982), which uplifted the Appalachian mountains to the east, and subtly warped continental crust within central New York State. This orogeny may be subdivided into three phases, the later two being the Vermontian and Hudson Valley phases. The tectonic disturbance resulted in crustal subsidence accompanied by a westward marine invasion of transgressing seas. The early Ordovician shallow marine environment led to a maximum carbonate production in the Upper Beekmantown Group. The pure carbonates are interrupted by occasional thin shale beds, as clay was still a very small component of oceanic shelf sediments to the east (Fisher, 1984).

During the middle Ordovician, compressional stresses from the Vermontian phase of the Taconic orogeny initiated block faulting and elevation of the North American plate creating a major marine recession. This resulted in a sedimentation break and exposure of the Beekmantown Group to the forces of erosion. The eroded Beekmantown surface is called the Knox Unconformity. Further tectonic disturbance led to interior crustal subsidence and a late middle Ordovian marine transgression. Limestone deposited on the subsiding planar surface initiated formation of a carbonate platform, which in turn led to accumulation of the Black River and Trenton Group limestones.

These strata represent marine sedimentary deposits that have subsequently been solidified, slightly deformed, and uplifted to near their present position. The uplift and deformation have resulted in a slight tilting of the deposits to the south and southwest, away from the Adirondacks, at a dip of approximately three degrees.

The most recent publication regarding the regional geology has been the "Bedrock Geology of the Glens Falls - Whitehall Region, New York" by Fisher (1984). Figure 4-1 illustrates the interpretation of bedrock geology contained in this report.



SOURCE: GLENS FALLS, N.Y. (1966)
HUDSON FALLS, N.Y. (1966)
N.Y. 7.5' QUADRANGLE

MAP LOCATION

2000 0 2000
scale feet

FIGURE 4-1

REGIONAL BEDROCK GEOLOGY

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GLENS FALLS PLANT

AWARE INCORPORATED
NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY

4.2 SITE STRATIGRAPHY

The bedrock stratigraphy underlying the study area has been well defined during this investigation. Information obtained from the geophysical logging of well AW-5 and Ciba-Geigy Production Well No. 2 provides over 600 feet of continuous sedimentary record. The 406 feet of geophysical log from well AW-5 provides data beginning 85 feet within the Snake Hill formation down into the middle of the Fort Ann formation. The 365 feet of geophysical log from Production Well No. 2 (located up dip from AW-5) provides data from the top of the Fort Ann down into the Skene member of the Whitehall formation. The two logs contain approximately 100 feet of overlapping section from which a nearly identical gamma trace can be observed.

The complete stratigraphic sequence is depicted on Figure 4-2 and was developed from Fisher's interpretation of the core from Production Well No. 2 (as published in his report) and from the logs provided by the Glens Falls Cement Co. The individual formations were measured to be of generally uniform thickness across the study area and dip to the south at approximately three degrees. Locally, there are likely to be gentle undulations in the beds such as the slight anticlinal structure observed in the north wall of the western quarry area. However, as shown on Sheets 6966-2 and 6966-3 individual stratigraphic horizons can be mapped for a horizontal distance of over 4,800 feet and are regionally quite uniform. These two maps depict hydrostratigraphic horizons B and C and are further discussed in Section 4.3.

Each of the bedrock formations are further discussed below in ascending order and are depicted on the cross-sections of Sheets 6966-4, 6966-5 and 6966-6.

4.2.1. White Hall Formation

The oldest bedrock formation encountered in the investigation is the Skene member of the White Hall formation. This formation was observed in the last 15 feet of the geophysical log of Production Well No. 2. According to Fisher (1984), this formation is a crystalline, tan to light gray, medium to coarse grained, vuggy dolostone.

6966

AGE	GROUP	FORMATION	LITHOLOGY	THK. (ft.)	SUB UNITS	REMARKS
MIDDLE ORDOVICIAN		SNAKE HILL	MUDSTONE	0-100	DOLGE-VILLE	CAPROCK
	TRENTON	GLENS FALLS	LIMESTONE	130	UPPER SUGAR RIVER	ACTIVELY MINED BY GLENS FALLS CEMENT CO. - INC.
					LOWER SUGAR RIVER	
					LARRABEE	
	BLACK RIVER	ISLE LA MOTTE	LIMESTONE	20		CLAY MARKER BED
LOWER ORDOVICIAN	BEEKMAN-TOWN	FORT ANN	CALCITIC DOLOSTONE AND DOLOMITIC LIMESTONE	140		
		GREAT MEADOWS	DOLOSTONE	150	FORT EDWARD	
			SANDSTONE SILTSTONE SHALE	70	WINCHELL CREEK	
		WHITEHALL	DOLOSTONE	20 +	SKENE	

FIGURE 4-2

GENERALIZED GEOLOGIC SECTION

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MAHWAH, NEW JERSEY

4.2.2. Great Meadows Formation

The Great Meadows formation consists of two members, the Winchell Creek overlain by the Fort Edwards. The Winchell Creek member was only identified in the geophysical log of Production Well No. 2 as shown on Sheet 6966-6. The upper portion of the Great Meadows formation (Fort Edwards Member) was encountered in two of the AWARE wells, AW-1 and AW-3, as well as Production Well No. 2. According to Fisher, the Fort Edwards consists of a light gray vuggy dolostone with variable amounts of quartz crystals, dolomite rhombs and chert. The Winchell Creek is a clastic member consisting of interbedded sandstone, siltstone, and gray shale with pyrite, and dolomitic and calcite cement.

4.2.3. Fort Ann Formation

The Fort Ann formation is approximately 140 feet thick across the study area and directly overlies the Great Meadows formation. The rock is generally described as undifferentiated dolostones and limestones (Fisher 1984). Testing of the extracted drill core with a 5 percent HCL solution has confirmed this. The rock is predominantly high in magnesium carbonate (dolostone) with thin (up to two-feet thick) isolated zones of pure calcium carbonate (limestone). Simple visual inspection of the core does not reveal the magnesium content.

The Fort Ann may be described as a predominately medium light gray (N6) to medium dark gray (N4) nodular, sometimes stylolitic or fossiliferous dolomite with intercalated, undulating thin seams of brownish black (5 YR 2/1) shale. The fauna of the Beekmantown includes nautiloid cephalopods, high- and low-spired gastropods, abundant trilobites, scarce articulate brachiopods, and the earliest ostracods (Fisher, 1984). Although bioclastic zones were observed in the drill core, most fossils were not recognizable as definite paleo-environmental indicators.

4.2.4. Isle La Motte Formation

The contact between the Fort Ann formation dolomite and the overlying Isle La Motte limestone has been identified in the literature as an erosional surface

(Knox Unconformity). However, inspection of the core retrieved during this study and discussions with Mr. Robert Olgilby, geologist for Glens Falls Cement Co., does not provide direct evidence of such a contact.

The Isle La Motte is described as massive, fine-grained, dark gray to black, conchoidally fractured limestone (weathers to light gray). Reported fossils, which are scarce, include bracheopods, gastropods, and corals (Fisher, 1984).

The upper surface of the Isle La Motte consists of a prominent but thin semi-consolidated clay layer. This layer varies in thickness from one to six inches and in competence from soft plastic clay to soft shale. In outcrop along the northern wall of the western quarry area, the unit can easily be traced for hundreds of feet. It is strikingly apparent since it serves to impede infiltrating groundwater and in doing so creates a long prominent seep.

The core from this interval often contained loose broken pieces of the soft shale, but the clay had apparently washed out of the sample by the coring action. The clay serves as an excellent marker bed in the gamma logs. It was present in four of the five AWARE wells but had been mined in the AW-3 location where it was observed in outcrop.

4.2.5. Glens Falls Formation

The Glens Falls limestone is approximately 130 feet thick and is actively mined in the quarry. The drill hole logs provided by the cement company indicate that they have subdivided this formation into three sub-members: the Larrabee, Lower Sugar River and Upper Sugar River. This division is apparently based on the quality of the limestone (i.e., calcium carbonate content) for cement manufacturing. The data indicates that the percent of calcium carbonate increases with depth in each successive layer. The three sub-members are reflected by the different "bench" elevations of the active quarry face. As shown on the cross-sections, only a thin portion of the Glens Falls formation is present north of the Hudson River on the Main Plant site.

The Glens Falls formation is classified within the Trenton Group Limestone and is described by Reudemann (1912) as thin-bedded, fine to medium grained, dark gray to black limestone (upper) and thin to medium-bedded, medium to coarse grained, light to medium gray limestone (lower). The two sections are equally fossiliferous with bracheopods, gastropods, and trilobites predominating.

4.2.6 Snake Hill Formation

The Snake Hill formation is the uppermost bedrock unit in the study area. The formation consists of shale and thus is the "cap rock" which must be removed by quarry operations. Since the quarry operation is progressing down dip (south), an increasing thickness of shale is encountered. The shale is described by Reudemann (1912) as dark gray to black shale and mudstone with a few siltstone beds. The lower 45 feet consist of harder, calcareous argillite and contain pyritized trilobites, graptolites, and bracheopod faunas.

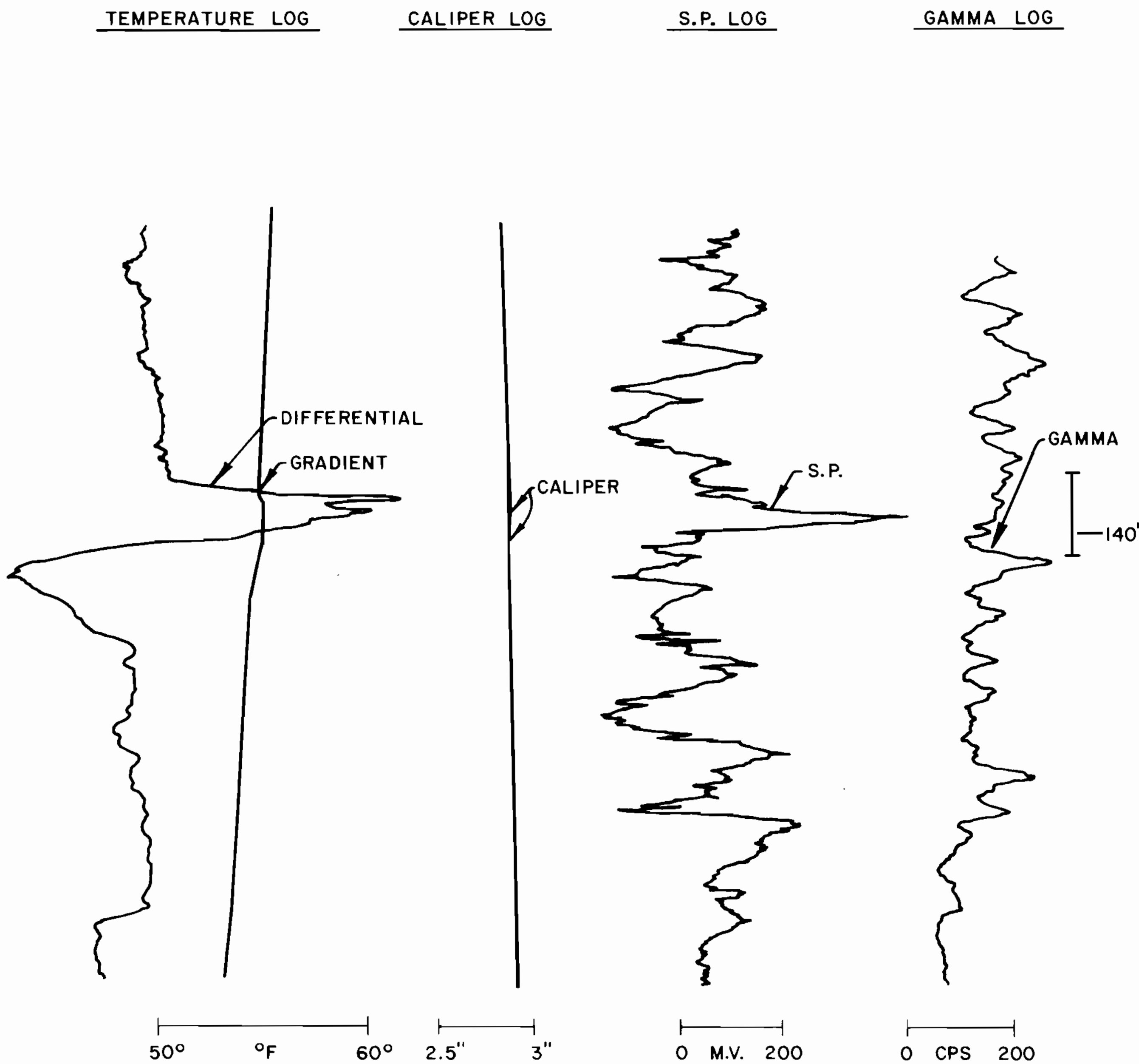
4.3 IDENTIFICATION OF HYDROSTRATIGRAPHIC HORIZONS

Groundwater flow through bedrock will be generally controlled by the size, frequency, and orientation of openings or fractures within the rock. In relatively flat-lying sedimentary bedrock formations such as within the study area, fractures can be divided into two types; horizontal fractures oriented parallel or sub-parallel to bedding and vertical fractures resulting from jointing and/or high angle faulting. Using this same system of classification, groundwater flow and hydraulic conductivity of the bedrock can be defined in terms of their horizontal and vertical components. It has been demonstrated during this study that the horizontal fractures predominate as the controlling factors of groundwater flow.

4.3.1. Horizontal Fractures

The existence of identifiable, areally extensive fractures occurring within the same stratigraphic position has been accomplished primarily by the downhole geophysical program. Interpretations involving borehole geophysical methods rely on integrating all the data obtained from the four logging tools and comparing it with the extracted drill core. Figure 4-3 provides a comparison of a portion of the geophysical logs for AW-1 and illustrates the conjunctive use of each log to identify the presence of a water-bearing fracture.

AW - I



LEGEND:

- ANOMALY AT DEEP FRACTURE
- SCREENED INTERVAL
- —140' ELEVATION (ABOVE MEAN SEA LEVEL)

FIGURE 4-3

COMPARISON OF TEMPERATURE, CALIPER, S.P. AND GAMMA LOGS FOR AW - I

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GLENS FALLS PLANT

AWARE INCORPORATED
WEST MILFORD, NEW JERSEY
NASHVILLE, TENNESSEE

Pilot geophysical logging data obtained at the onset of this investigation contributed substantially to development of an exploration strategy for delineation of water-bearing zones. Although the drill core aided in the detection of zones of fracture permeability, horizontal bedding plane fractures are not easily differentiated from drilling-induced bedding plane breaks. Furthermore, examination of the core alone does not provide an indication that the fracture is open and actively transmitting water.

The principal logging devices used to identify water-bearing fractures was the caliper and temperature tools. Logging several coreholes with these instruments revealed the presence of a caliper anomaly (fracture) existing at a particular stratigraphic horizon. The corresponding temperature anomaly indicated that this fracture was in fact open and providing a temperature contrast with the water standing in the hole. Further review of the other logging data (primarily gamma) reveals that this fracture also occurs at a relatively consistent stratigraphic position. This is perhaps best illustrated in boring AW-1 at an approximate elevation of 140 feet (msl).

In order to supplement the downhole geophysical interpretations, packer pressure test data from discrete (10-feet) intervals was compiled and reviewed. This information is summarized on Table 4-1 and presented graphically on Figure 4-4. The hydraulic conductivity profiles clearly illustrate the B and C horizons as well as other intermediate zones of moderate permeability. These intermediate zones however, do not occur at consistent stratigraphic horizons, nor do they provide a caliper or temperature anomaly.

Using these methods, three laterally extensive hydrostratigraphic horizons have been identified as having the potential to impact groundwater flow. These are illustrated on the cross-sections and have been termed the A, B, and C horizons in order of their depth. The deepest horizon (C) was chosen as the target zone for the AWARE well screen settings in this investigation. As discussed in Section 4.2, the structural configuration of the two prominent horizons (B and C) was also mapped in plan view on Sheets 6966-2 and 6966-3 respectively. A summary of the data used to produce these maps is provided on Table 4-2.

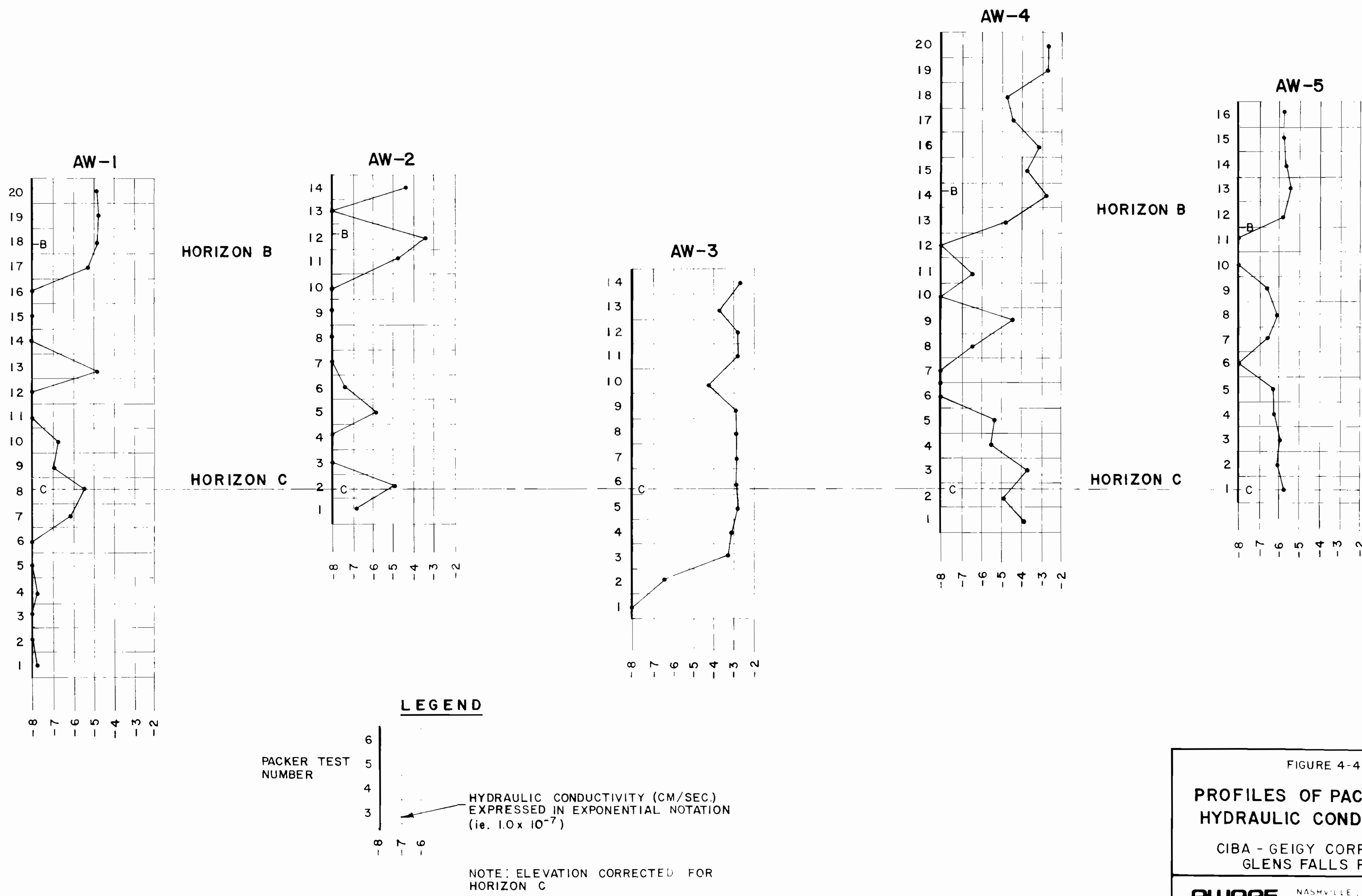

FIGURE 4-4

PROFILES OF PACKER TES[T] HYDRAULIC CONDUCTIVITY

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GLENS FALLS PLANT

AWARE INCORPORATED NASHVILLE, TENNESSEE MAHWAH, NEW JERSEY

TABLE 4-1

SUMMARY OF PACKER TEST DATA

WELL # AW-1			WELL # AW-2		
TEST #	TEST INTERVAL (FEET BELOW) (GROUND SURFACE)	HYDRAULIC CONDUCTIVITY (CM/SEC)	TEST #	TEST INTERVAL (FEET BELOW) (GROUND SURFACE)	HYDRAULIC CONDUCTIVITY (CM/SEC)
20	21.3 - 32.5	1.2 X 10-5	14	29.8 - 41.0	6.4 X 10-5
19	26.3 - 37.5	2.8 X 10-5	13	39.8 - 51.0	< 1 X 10-8
18	36.3 - 47.5	1.5 X 10-5	12	49.8 - 61.0	7.7 X 10-4
17	46.3 - 57.5	8.4 X 10-6	11	59.8 - 71.0	2.5 X 10-5
16	56.3 - 67.5	< 1 X 10-8	10	69.8 - 81.0	< 1 X 10-8
15	66.3 - 77.5	< 1 X 10-8	9	79.8 - 91.0	< 1 X 10-8
14	76.3 - 87.5	< 1 X 10-8	8	89.8 - 101.0	< 1 X 10-8
13	86.3 - 97.5	1.1 X 10-5	7	99.8 - 111.0	< 1 X 10-8
12	96.3 - 107.5	< 1 X 10-8	6	109.8 - 121.0	6.6 X 10-8
11	106.3 - 117.5	< 1 X 10-8	5	119.8 - 131.0	1.3 X 10-6
10	116.3 - 127.5	2.0 X 10-7	4	129.8 - 141.0	< 1 X 10-8
9	126.3 - 137.5	1.0 X 10-7	3	139.8 - 151.0	< 1 X 10-8
8	136.3 - 147.5	4.8 X 10-6	2	149.8 - 161.0	1.5 X 10-5
7	146.3 - 157.5	9.0 X 10-7	1	159.8 - 171.0	3.0 X 10-7
6	156.3 - 167.5	< 1 X 10-8			
5	166.3 - 177.5	< 1 X 10-8			
4	176.3 - 187.5	2.0 X 10-8			
3	186.3 - 197.5	< 1 X 10-8			
2	196.3 - 207.5	< 1 X 10-8			
1	206.3 - 217.5	3.2 X 10-8			

TABLE 4-1

SUMMARY OF PACKER TEST DATA

WELL # AW-3			WELL # AW-4		
TEST #	TEST INTERVAL (FEET BELOW) (GROUND SURFACE)	HYDRAULIC CONDUCTIVITY (CM/SEC)	TEST #	TEST INTERVAL (FEET BELOW) (GROUND SURFACE)	HYDRAULIC CONDUCTIVITY (CM/SEC)
14	7.3 - 18.5	3.5 X 10-3	20	7.3 - 18.5	3.5 X 10-3
13	17.3 - 28.5	3.2 X 10-4	19	12.3 - 23.5	2.4 X 10-3
12	27.3 - 38.5	1.9 X 10-3	18	22.3 - 33.5	2.5 X 10-5
11	37.3 - 48.5	1.9 X 10-3	17	32.3 - 43.5	5.0 X 10-5
10	47.3 - 58.5	8.3 X 10-5	16	42.3 - 53.5	9.7 X 10-4
9	57.3 - 68.5	1.2 X 10-3	15	52.3 - 63.5	3.6 X 10-4
8	67.3 - 78.5	1.3 X 10-3	14	62.3 - 73.5	1.7 X 10-3
7	77.3 - 88.5	1.3 X 10-3	13	72.3 - 83.5	2.7 X 10-5
6	87.3 - 98.5	1.1 X 10-3	12	82.3 - 93.5	< 1 X 10-8
5	97.3 - 108.5	1.1 X 10-3	11	92.3 - 103.5	6.0 X 10-7
4	107.3 - 118.5	9.9 X 10-4	10	102.3 - 113.5	< 1 X 10-8
3	117.3 - 128.5	8.3 X 10-4	9	112.3 - 123.5	5.5 X 10-5
2	127.3 - 138.5	6.0 X 10-7	8	122.3 - 133.5	6.0 X 10-7
1	137.3 - 148.5	< 1 X 10-8	7	132.3 - 143.5	< 1 X 10-8
			6	142.3 - 153.5	< 1 X 10-8
			5	152.3 - 163.5	7.1 X 10-6
			4	162.3 - 173.5	5.5 X 10-6
			3	172.3 - 183.5	1.9 X 10-4
			2	182.3 - 193.5	2.8 X 10-5
			1	192.3 - 203.5	1.3 X 10-4

TABLE 4-1

SUMMARY OF PACKER TEST DATA

WELL # AW-5				WELL #		
TEST #	TEST INTERVAL (FEET BELOW) (GROUND SURFACE)	HYDRAULIC CONDUCTIVITY (CM/SEC)	¦	TEST #	TEST INTERVAL (FEET BELOW) (GROUND SURFACE)	HYDRAULIC CONDUCTIVITY (CM/SEC)
16	242.2 - 252.8	3.0 X 10-6	¦			
15	252.2 - 262.8	3.0 X 10-6	¦			
14	262.2 - 272.8	4.7 X 10-6	¦			
13	272.2 - 282.8	6.0 X 10-6	¦			
12	282.2 - 292.8	2.7 X 10-6	¦			
11	292.2 - 302.8	< 1 X 10-8	¦			
10	302.2 - 312.8	< 1 X 10-8	¦			
9	312.2 - 322.8	5.0 X 10-7	¦			
8	322.2 - 332.8	1.0 X 10-6	¦			
7	332.2 - 342.8	5.0 X 10-7	¦			
6	342.2 - 352.8	< 1 X 10-8	¦			
5	352.2 - 362.8	8.0 X 10-7	¦			
4	362.2 - 372.8	8.0 X 10-7	¦			
3	372.2 - 382.8	1.3 X 10-6	¦			
2	382.2 - 392.8	1.0 X 10-6	¦			
1	392.2 - 402.8	4.3 X 10-6	¦			

TABLE 4-2
STRATIGRAPHIC ELEVATION DATA

DATA LOCATION	REFERENCE ELEVATION: ground surface	REFERENCE ELEVATION: top of casing	BEDROCK SURFACE: depth from ground	BEDROCK SURFACE: elevation (msl)	MONITORING INTERVAL: bottom elev.	MONITORING INTERVAL: top elev.	MONITORING INTERVAL: thickness (ft)	ELEVATION OF FRACTURE HORIZONS: horizon A	ELEVATION OF FRACTURE HORIZONS: horizon B	ELEVATION OF FRACTURE HORIZONS: horizon C
MW-1	238.1	240.18	26.0	212.1	198	212	14	NP i	NP i	142 i
MW-2	238.1	240.14	26.0	212.1	212	217	5	NP i	NP i	142 i
MW-4	239.2	241.11	25.4	213.8	199	211	12	NP i	NP i	125 i
MW-5	239.0	241.03	15.0	213.6	211	216	5	NP i	NP i	125 i
MW-6	235.1	236.99	15.0	220.1	195	215	20	208 i	185 i	82 i
MW-7	235.2	236.66	18.5	220.2	225	230	5	208 i	185 i	82 i
MW-8	241.6	242.66	18.5	223.1	197	221	24	301 i	188 i	90 i
MW-9	240.4	242.35	12.1	221.9	230	235	5	301 i	188 i	90 i
MW-10	256.1	257.41	12.1	244.0	203	240	37	251 i	228 i	123 i
MW-13	233.0	234.32	36.3	196.7	196	199	3	NP i	NP i	92 i
MW-14	232.7	234.32	36.3	196.4	216	221	5	NP i	NP i	92 i
MW-15	280.5	282.6	24.0	256.9	221	254	34	252 i	229 g	140 i
MW-16	281.2	283.12	24.0	257.2	268	273	5	252 i	229 i	140 i
MW-17S	284.5	285.98	11.0	273.5	258	268	10	NP i	NP i	175 i
MW-17	284.6	286.18	10.0	274.6	205	273	69	NP i	NP i	175 i
MW-18	284.8	286.73	10.0	274.8	274	279	5	NP i	NP i	175 i
MW-19	243.3	245.58	10.5	232.8	201	232	31	218 i	195 i	98 i
MW-20S	260.9	262.27	16.0	244.9	230	240	10	235 i	212 i	115 i
MW-20D	260.8	263.15	15.0	245.8	206	216	10	235 i	212 g	115 i
MW-21	238.5	239.75	18.6	219.9	194	219	26	NP i	NP i	115 i
MW-22	238.8	241.13	8.0	230.8	194	229	36	254 i	213 g	110 i
MW-23S	281.3	282.91	11.5	269.8	255	265	10	273 i	250 i	152 i
MW-23D	281.4	283.64	11.6	269.8	234	244	10	273 i	250 g	152 i
MW-24	281.5	283.33			270	275	5	273 i	250 i	152 i
MW-25S	236.1	238.74	24.5	211.6	197	207	10	201 i	178 i	75 i
MW-25D	236.3	237.91	23.2	213.1	176	186	10	201 i	178 i	75 i
MW-26	236.7	238.57			229	234	5	199 i	176 g	75 i
MW-27S	240.4	241.64	28.0	212.4	198	207	10	203 i	180 i	78 i
MW-27D	241.0	242.53	27.1	213.9	175	185	10	203 i	180 g	78 i
MW-28	240.2	241	27.3	212.9	213	218	5	203 i	180 i	78 i
MW-29S	235.1	236.82	25.0	210.1	196	203	7	213 i	190 i	90 i

TABLE 4-2
STRATIGRAPHIC ELEVATION DATA

DATA LOCATION	REFERENCE ELEVATION ground surface	top of casing	BEDROCK SURFACE depth from ground	elevation (msl)	MONITORING INTERVAL bottom elev.	top elev.	thickness (ft)	ELEVATION OF FRACTURE HORIZONS horizon A	horizon B	horizon C
MW-30S	214.8	216.44	16.5	198.3	183	193	10	NP i	NP i	99 i
MW-30D	215.1	216.78	16.8	198.3	164	173	10	NP i	NP i	99 i
MW-31	215.0	217.44	16.0	199.0	199	204	5	NP i	NP i	99 i
MW-33S	251.9	254.11	16.0	235.9	220	230	10	NP i	NP i	175 i
MW-33D	252.2	254.34	16.0	236.2	200	209	10	NP i	NP i	175 i
MW-34	238.0	239.61	30.0	208.0	202	207	5	198 i	175 i	79 i
MW-35S	238.5	240.32	32.5	206.0	190	199	9	198 i	176 i	79 i
MW-35D	238.7	239.93	34.5	204.2	172	182	10	198 i	176 i	79 i
MW-36S	260.7	261.96	18.1	242.6	228	237	9	231 i	205 i	115 i
MW-36D	260.9	262.94	18.6	242.3	204	214	10	231 i	205 i	115 i
MW-37S	263.8	266.08	6.0	257.8	244	253	9	NP i	NP i	165 i
MW-40S	279.6	281.5	18.0	261.6	246	256	10	259 i	236 i	145 i
MW-40D	279.6	281.39	18.0	261.6	227	237	10	259 i	236 i	145 i
MW-45	247.7	249.74			234	239	5	NP i	NP i	175 i
P-46	276.8	277.89	21.4	255.4	255	262	7	na	230 i	138 i
P-53	240.2	242.98			226	236	10	na	185 i	82 i
P-71	242.5	244.29			234	244	10	na	193 i	95 i
AW-1	280.8	282.78	16.0	264.8	137	147	10	257 g	237 g	144 g
AW-2	235.8	237.97	24.5	211.3	70	80	10	202 g	182 g	78 g
AW-3	116.7	131.03	0.0	116.7	15	25	10	NP g	118 g	27 g
AW-4	158.9	160.11	0.0	158.9	-31	-21	10	115 g	91 g	-23 g
AW-5	313.8	315.72	42.0	271.8	-92	-82	10	49 g	22 g	-82 g
PW-1	266.0		20.0	246.0	113	246	133	NP g	246 g	140 g
PW-2	265.0		9.0	256.0	-101	256	357	NP g	NP g	168 g

"g" indicates elevation obtained from geologic data (logs).
"i" indicates data interpolated from structural contour maps.
"NP" indicates contact not present.
All elevations are in feet above mean sea level.

Horizon A represents the top of the Isle La Motte formation and is identified by the distinctive gamma response (signature) to the thin clay layer discussed in Section 4.2.3. This horizon is considered significant since it exists close to the bedrock surface beneath the Main Plant site and intersects a number of existing monitoring wells. As observed in quarry outcrop, the horizon has the ability to significantly restrict the vertical percolation of water into lower portions of the rock. There are some indications that it may also be significant as a horizontal fracture horizon. In some instances, this layer (probably just above the clay) produces a temperature anomaly as well as a relatively high horizontal hydraulic conductivity from the packer pressure tests. On the Main Plant site many of the western "shallow" (S-designated) monitoring wells are completed in this horizon.

Sheet 6966-2 depicts the structural surface of the Fort Ann dolomite (Horizon B) which has been intersected by each of the cement company drill holes. A summary of these logs is presented on Table 4-3. This is the surface reported to be the Knox Unconformity and has been shown to correspond to a water bearing horizontal fracture. Caliper and temperature anomalies, as well as strong packer test hydraulic conductivities, have been identified. This horizon exists directly beneath the western quarry floor and is penetrated by a number of the flowing core holes. On the Main Plant site, this horizon "outcrops" along a north-south trace just east of Buildings 41, 43, and 8 (refer to Sheet 6966-2). This "outcrop", of course, exists at the bedrock surface and is covered by the unconsolidated soil. Thus, west of this outcrop, Isle La Motte limestone overlies the Fort Ann dolomite, whereas east of this trace, the Fort Ann is the uppermost bedrock unit.

It is of interest to note that the quarry "outcrop" of Horizon B also traces parallel to and possibly beneath the Hudson River. If this horizon was in good communication with the river, significant quantities of water could be induced into this fracture and may explain the prolific nature of the coreholes. Large quantities of river water would also serve to dilute any contaminants in this horizon as they move downgradient toward their discharge area.

Horizon C exists approximately 100 feet below Horizon B, two-thirds of the way down into Fort Ann formation. Again, temperature and caliper anomalies were

Table 4-3

Elevation of Geologic Formations from Glens Falls Cement Co., Inc.

Data Location	Ground Surface	Top of Rock (Shale)	Upper Sugar R.	Lower Sugar R.	Top of Larrabee	Top of Isle La Motte	Top of Fort Ann
	(All values represent elevation in feet above mean sea level)						
dh74-1	326.8	262	157	118	63	23	-1
dh74-2	301.8	276	179	142	82	42	18
dh74-3	298.2	242	219	178	124	88	63
dh74-4	307.6	265	208	168	115	75	54
dh74-5	326.2	276	179	136	84	44	21
dh74-6	326.0	280	187	146	93	53	28
dh79-1	285.6	238*	--	--	156	--	98
dh79-2	276.9	252	247	208	152	--	93
dh79-3	280.7	275	221	181	129	--	68
dh79-4	288.3	276	195	153	98	--	39
dh79-5	293.5	261	213	178	116	--	56
CH-2							127
CH-3							99
CH-4							89
CH-5							111
CH-6							123
CH-7							123
CH-8							98
CH-9							107
CH-10							97
CH-11							88
CH-12							107
CH-13							98

* Top of rock is Upper Sugar River
\- Top of this formation not differentiated

strong indications of an open fracture at this stratigraphic position. These observations were true for the AWARE wells and the two production wells. In fact, the packer test evaluation conducted by Malcolm Pirnie identified one particular zone in each of these wells which was contributing the most flow. These zones correspond directly to Horizon C as shown on cross-section C-C' on Sheet 6966-6.

Horizon C, being the deepest of the encountered horizontal fracture zones, was chosen as the target horizon for the AWARE wells. In well AW-5, Horizon C was encountered at a depth of approximately 400 feet. At this depth, the overburden pressures are such that the existence of caliper and temperature anomalies were speculative at best. These data in conjunction with the extremely poor recovery from a subsequent bail-down test suggests the fracture is nearly or completely closed. In order to maintain continuity, however, this stratigraphic horizon was screened using an extra long sand pack.

4.3.2. Vertical Fractures

The ability of the bedrock to transmit water vertically is a function of the openness and frequency of joints and/or high angle faults. Since these structures are oriented parallel to the exploratory drilling efforts, it is difficult to obtain direct measurements of their influence. Although the existence of the limestone quarry provides a unique opportunity to view these structures in outcrop, this information is limited to the formations above the Fort Ann dolomite.

The Glens Falls and Isle La Motte formations appear to contain a primary joint set oriented N70°E with a nearly vertical dip. The distance between joints ranges between 10 and 60 feet. With very few exceptions, the joints do not appear to function as active groundwater flow zones as they were filled with secondary mineralization. Nearly all of the active seeps observed in the walls were oriented horizontally. No vertical faults were observed.

The relatively small influence of vertical fractures can also be qualitatively assessed in the lower formations by observations of water levels. On the Main Plant site very large vertical gradients (downward) are observed over relatively short screened intervals. This suggests that vertical communication is small relative to the horizontal communication within a hydrostratigraphic horizon. A similar observation is made in the western quarry floor. The coreholes represent man-made vertical fractures and flow naturally, producing large quantities of water from underlying horizontal fractures.. If vertical communication existed in joints, one would expect numerous seeps throughout the floor area. Yet no "natural" seeps have been observed despite the strong upward (discharge) gradient which exists.

The foregoing discussion is not intended to imply that the vertical hydraulic conductivity of the bedrock is zero. The joint system likely induces a "regional" vertical hydraulic conductivity to the bedrock which may be orders of magnitude less than the horizontal conductivity in the fracture zones. However, from a contaminant transport standpoint, man-made vertical conduits, such as open rock wells, are likely to have a greater local impact. The "outcrop" of horizontal fracture horizons is also likely to provide a direct conduit to near surface contamination.

4.4 GROUNDWATER FLOW

In order to evaluate the fate of groundwater movement in the bedrock environment, the horizontal and vertical components of flow must be identified. Furthermore, the horizontal components must be discussed in terms of their discrete fracture zones or hydrostratigraphic horizons. Only wells representing the same horizon should be considered for comparison. The first task, therefore, is to identify or categorize each of the existing monitoring wells based upon the elevation of their open intervals relative to the three hydrostratigraphic horizons. This categorization is presented on Table 4-4 and is considered preliminary since a certain amount of extrapolation (of structural contours) was necessary. Field confirmation of these categories is recommended in Section 5.

Table 4-4 illustrates that the majority of the wells do intersect only one horizon and thus can be used in this fashion. There are a number of wells however, which are either open over two horizons or do not intersect any of the three. Most of the latter type are located on the eastern portion of the

Table 4-4

Preliminary Well Categorization by Hydrostratigraphic Horizon

Overburden	Weathered Bedrock	Hydrostratigraphic Horizon A	B	C	Undefined
2	1	6	10	AW-1	17
7	4	8	15*	AW-2	17S
9	5	15*	20D	AW-3	21
14	13	19	22*	AW-4	29S
16	34	22*	23D	AW-5	30S
18		20S	25D		30D
24		23S	27D		33S
26		25S	35D		33D
28		27S	36D		37S
31		35S			40D
45		36S			40S
P-46					
P-53					
P-71					

*Well may represent two horizons.

site where the A and B horizons are absent and the C horizon is well beneath their bottom elevations.

A fourth category has also been created which includes four wells screened in the very uppermost portion of the bedrock surface. This zone often consists of fractures resulting from the movement of glacial ice and subsequent weathering. This weathered zone, unlike the hydrostratigraphic horizons is independent of stratigraphic position. In situ recovery tests are recommended in order to confirm the existence of this zone and its relative importance to groundwater flow.

It should be noted that although this list is preliminary, certain observations reported during prior sampling events appear to support these interpretations. For example, well MW-40D is shown not to intersect any of the three horizons (cross-section A-A) and is unable to sustain a yield during sampling. Furthermore, two of the wells (MW-27S and MW-40S) which are open across the clay layer (Horizon A) report to have "bentonite" accumulations in the bottom of their open rock boreholes. This may be due to the deterioration of this layer into the open rock well bore.

Water level data collected on October 6, 1988, from monitoring representing Horizons A, B and C were used to develop the piezometric contour maps on Sheets 6966-7, 6966-8 and 6966-9 respectively. Each map contains a number of data points on the Main Plant site and thus this area has been contoured with solid lines indicating a good degree of certainty. In each case groundwater flow is generally from north to south and generally supports the results presented in the Malcolm Pirnie report. With the exception of Horizon C, water level data south of the Hudson River consists only of observations made in the quarry and thus cannot be contoured with the same degree of confidence. Contour lines in this area have therefore been identified as "conceptual" and are shown as dashed lines. It is the intent of these maps to portray this conceptual scenario of groundwater flow based on the following observations and interpretations.

4.4.1 Horizon A

Horizon A is limited in its areal extent both on the Main Plant site and in the western quarry area. As discussed in Section 4.2.4, this horizon outcrops in a seep in the north wall of the western quarry at an elevation of approximately 140 feet (msl). The piezometric head at any location is equal to the pressure head plus the elevation head. Since the pressure head is zero (atmospheric) at the seep, the piezometric head is equal to the elevation of the seep or approximately 140 feet (msl). Plotting this value on Sheet 6966-7 and interpolating the contours has defined a conceptual piezometric surface from the Main Plant site to the seep.

4.4.2 Horizon B

Horizon B can be thought of as an aquifer that is actively being pumped by a number of open rock wells in close proximity to one another. Collectively, these wells comprise a "pumping center" which creates a cone of depression in the piezometric surface of Horizon B. These wells are the coreholes drilled into Horizon B in the western quarry floor and "pump" continuously by virtue of their low elevation. (Actually, the "pump" can be thought of as the quarry's sump pump which periodically keeps the quarry dewatered).

Although the precise shape of this depression in the piezometric surface cannot be defined without additional wells, the "pumping level" or lowest level in the system can. This level is the elevation of the quarry floor adjacent to the flowing coreholes and is approximately 116 feet (msl). Using this information and the hydrologic principles which govern groundwater flow to wells, a conceptual depiction of the piezometric surface south of the Hudson River was developed and is shown on Sheet 6966-8. It should be noted that the pumping level is over 100 feet below the elevation of the Hudson River and thus its "drawdown" is quite sufficient to induce water beneath the river to the quarry. The impact of this cone of influence can be seen in the Horizon B wells directly adjacent to the river. Piezometric elevations in these wells (i.e., MW-25D) are also below the Hudson River level.

The other indirect observation which tends to support this flow model is that the eastern quarry does not receive groundwater discharge. With a floor elevation (158 feet msl) approximately 60 feet below the Hudson River, the only feasible explanation for this is that the cone of depression from the corehole pumping center has lowered the piezometric surface below the floor elevation.

4.4.3 Horizon C

Horizon C has been screened by each of the five AWARE wells as shown on Sheet 6966-9. However, due to the low hydraulic conductivity associated with this Horizon at AW-5, a static water level in this well could not be obtained for this report. Thus, the data consists of two locations on the Main Plant site and two in the quarry. Although the "pumping" associated with the quarry is not directly from Horizon C, its impact has been observed in wells AW-3 and AW-4. Well AW-3 has a piezometric surface elevation of 128.49 feet (msl) or approximately 12 feet above the head in Horizon B. This strong upward gradient is to be expected from a lower semi-confined aquifer adjacent to a pumping center. Well AW-4 has a piezometric surface elevation of 153.85 feet (msl) or about seven feet below the floor of the quarry. Thus, for the same reasons described for Horizon B, the "drawdown" in Horizon C is sufficient to "dewater" the eastern quarry area.

Although the actual volume of discharge from Horizon C to Horizon B in the vicinity of the pumping center is not known, the fact that discharge does occur is supported by the packer test data. Figure 4-4 illustrates that the hydraulic conductivity throughout the Fort Ann formation between Horizons C and B is generally greater than 1.0×10^{-3} cm/sec. This is much different than the other four wells and likely reflects the unloading or "pop-up" effect of mining the overlying rock. Thus, with vertical communication enhanced, the corehole pumping center has also produced a cone of depression in Horizon C (although less pronounced) as conceptually depicted on Sheet 6966-9.

Another way of evaluating the flow scenarios presented above is through the process of elimination. The approach consists of trying to identify any other scenario or mechanism which would produce similar data measurements and observations. In order for the western quarry area not to be the local (within the study area) discharge point, some other nearby sink would need to exist and be maintained at an even lower elevation. Such a sink would almost have to be a pumping well in close proximity to the quarry.

The only known active pumping wells completed in bedrock are the South Glens Falls water supply wells located approximately 1.7 miles southwest of the quarry. According to the report, "Quantity and Quality of Water from Public Supply Wells and Springs in the Village of South Glens Falls, New York" (Appendix to USEPA "Moreau Site" Record of Decision; 7-13-87), there are two wells at this location. Each well is 210 feet deep and is completed in the shale of the Snake Hill formation. The wells are used only during the summer months and pump approximately 450 gpm each. Considering the distance and stratigraphic position of the wells relative to the quarry and their intermittent use, it is extremely unlikely they would have any discernible impact on piezometric elevations.

4.5 Water Quality

For the purposes of this discussion, groundwater quality has been divided into three categories; indicators related to the major ion evaluation, inorganics (metals) and organics.

4.5.1 Inorganics

Laboratory analyses results for metals total cyanide and pH have been summarized on Table 4-5. Of the inorganic parameters, only five exceeded these standards during the study. Of these hexavalent chromium and total cyanide were the most prevalent and exceeded the standards by the largest amount. As a result, these two parameters were chosen to provide an overview of their distribution within the study area and are plotted on Sheet 6966-10. The reader is referred to Table 4-5 and Attachment C for information regarding the other parameters.

These data illustrate that hexavalent chromium is found predominantly in the overburden wells and in one case (MW-19) in the A horizon. This is no surprise since many of these wells are completed directly in the chrome ore

TABLE 4-5

Summary of Water Quality Data: Metals and Total Cyanide

Lab ID Number	Date Sampled	Location	Filtered	arsenic mg/l	beryllium mg/l	cadmium mg/l	chromium mg/l	copper mg/l	lead mg/l	mercury mg/l	nickel mg/l	silver mg/l	zinc mg/l	hexavalent chromium mg/l	total cyanide mg/l
Overburden															
88998	13-Sep-88	MW-26		0.017	--	--	13.6	--	--	--	--	--	--	13.2	6.7
88999	13-Sep-88	MW-26	F	0.016	--	--	14.1	--	--	--	--	--	--		
89003	13-Sep-88	MW-28		0.025	--	--	1.58	0.039	0.088	--	--	0.03	0.04	1.39	0.43
89004	13-Sep-88	MW-28	F	0.042	--	--	1.61	0.031	0.038	--	--	0.03	0.02		
89079	14-Sep-88	MW-34		<0.1	--	--	4.5	--	--	--	--	--	--	4.7	0.19
89080	14-Sep-88	MW-34	F	<0.04	--	--	4.8	--	--	--	--	--	--		
89175	15-Sep-88	MW-9		0.010	--	--	42	--	--	--	--	--	--	41	1.19
89176	15-Sep-88	MW-9	F	0.015	--	--	40	--	--	--	--	--	--		
89177	15-Sep-88	MW-9		0.011	--	--	42	--	--	--	--	--	0.02	42	0.97
89178	15-Sep-88	MW-9	F	0.018	--	--	37	--	--	--	--	--	--		
89187	15-Sep-88	P-53		--	--	--	0.60	--	0.007	--	--	--	0.07	0.81	5.0
89188	15-Sep-88	P-53	F	--	--	--	0.59	--	--	--	--	--	0.03		
Horizon A															
89179	15-Sep-88	MW-19		--	--	--	2.3	--	--	--	--	0.06	--	2.4	0.86
89180	15-Sep-88	MW-19	F	--	--	--	2.5	--	--	--	--	--	--		
89077	14-Sep-88	MW-20S		0.047	--	--	--	--	--	0.0012	0.13	--	--	--	1.49
89078	14-Sep-88	MW-20S	F	0.024	--	--	--	--	--	--	0.11	--	--		
88996	13-Sep-88	MW-25S		--	--	--	--	--	--	--	--	--	--	--	0.23
88997	13-Sep-88	MW-25S	F	--	--	--	--	--	<0.1	--	--	--	--		
89002	13-Sep-88	MW-27S		0.041	0.02	0.02	2.3	0.046	0.48	--	0.09	0.10	0.80	--	0.37
89083	14-Sep-88	MW-35S		<0.02	--	--	1.36	--	--	--	--	--	0.06	1.32	0.16
89084	14-Sep-88	MW-35S	F	<0.02	--	--	1.17	--	--	--	--	--	0.03		
89183	15-Sep-88	MW-36S		--	--	--	--	--	--	--	0.06	0.04	0.03	--	0.32
89184	15-Sep-88	MW-36S	F	--	--	--	--	--	--	--	0.05	--	--		
89173	15-Sep-88	MW-8		0.010	--	--	0.08	--	--	--	--	--	0.03	0.018	0.27
89174	15-Sep-88	MW-8	F	--	--	--	0.04	--	--	--	--	--	--		
87409	15-Aug-88	SEEP		--	--	--	--	--	--	--	--	--	--	--	--
87410	15-Aug-88	SEEP	F	--	--	--	--	--	--	--	--	--	--		
89087	14-Sep-88	SEEP		--	--	--	--	--	--	--	--	--	0.03	--	--
89088	14-Sep-88	SEEP	F	--	--	--	--	--	--	--	--	--	--		
91302	24-Oct-88	SEEP		--	--	--	--	--	--	--	--	--	--	--	--
91303	24-Oct-88	SEEP	F	--	--	--	--	--	--	--	--	--	--		
92342	22-Nov-88	SEEP		--	--	--	--	--	--	--	--	--	--	--	--
92343	22-Nov-88	SEEP	F	--	--	--	--	--	--	--	--	--	--		
Horizon B															
87399	15-Aug-88	CH-2		--	--	--	--	--	--	--	--	--	--	--	--
87400	15-Aug-88	CH-2	F	--	--	--	--	--	--	--	--	--	--		
87401	15-Aug-88	CH-2		--	--	--	--	--	--	--	--	--	--	--	--
87402	15-Aug-88	CH-2	F	--	--	--	--	--	--	--	--	--	--		
89071	14-Sep-88	CH-2		--	--	--	--	--	--	--	--	--	--	--	--
89072	14-Sep-88	CH-2	F	--	--	--	--	--	--	--	--	--	--		
91296	24-Oct-88	CH-2		--	--	--	--	--	--	--	--	--	0.26	--	--
91297	24-Oct-88	CH-2	F	--	--	--	--	--	--	--	--	--	--		
92336	22-Nov-88	CH-2		--	--	--	--	--	--	--	--	--	--	--	--
92337	22-Nov-88	CH-2	F	--	--	--	--	--	--	--	--	--	--		
87403	15-Aug-88	CH-5		--	--	--	--	--	--	--	--	--	--	--	--
87404	15-Aug-88	CH-5	F	--	--	--	--	--	--	--	--	--	--		
89073	14-Sep-88	CH-5		--	--	--	--	--	--	--	--	--	--	--	--
89074	14-Sep-88	CH-5	F	--	--	--	--	--	--	--	--	--	--		
91298	24-Oct-88	CH-5		--	--	--	--	--	--	--	--	--	0.02	--	--
91299	24-Oct-88	CH-5	F	--	--	--	--	--	--	--	--	--	--		
92338	22-Nov-88	CH-5		--	--	--	--	--	--	--	--	--	--	--	--
92339	22-Nov-88	CH-5	F	--	--	--	--	--	--	--	--	--	--		
89075	14-Sep-88	MW-20D		0.013	--	--	--	0.027	0.147	--	--	--	--	--	0.03
89076	14-Sep-88	MW-20D	F	--	--	--	--	--	--	--	--	--	--		

TABLE 4-5

Summary of Water Quality Data: Metals and Total Cyanide

Lab ID Number	Date Sampled	Location	Filtered	arsenic mg/l	beryllium mg/l	cadmium mg/l	chromium mg/l	copper mg/l	lead mg/l	mercury mg/l	nickel mg/l	silver mg/l	zinc mg/l	hexavalent chromium mg/l	total cyanide mg/l
89000	13-Sep-88	MW-27D		0.011	--	--	--	--	--	--	--	--	0.03	--	0.23
89001	13-Sep-88	MW-27D	F	--	--	--	--	--	--	--	--	--	0.02		
89081	14-Sep-88	MW-35D		--	--	--	--	--	0.018	--	--	--	0.04	--	0.12
89082	14-Sep-88	MW-35D	F	--	--	--	--	--	--		--	--	--		
89181	15-Sep-88	MW-36D		0.052	--	--	0.07	--	--	--	0.07	0.04	0.02	<0.05	0.043
89182	15-Sep-88	MW-36D	F	0.059	--	--	--	--	--	--	0.05	0.02	0.02		
Horizon C															
90245	03-Oct-88	AW-1		0.042	--	--	--	--	--	--	--	--	0.05	0.005	--
90246	03-Oct-88	AW-1	F	0.046	--	--	--	--	--	--	--	--	--		
90042	29-Sep-88	AW-2		--	--	--	46	--	--	--	--	--	0.03	47	0.87
90043	29-Sep-88	AW-2	F	--	--	--	44	--	--	--	--	--	0.03		
91292	25-Oct-88	AW-2		--	--	--	52	--	--	--	--	--	--	46	0.72
91293	25-Oct-88	AW-2	F	--	--	--	52	--	--	--	--	--	--		
89604	22-Sep-88	AW-3		--	--	--	--	--	--	--	--	--	--	--	--
89605	22-Sep-88	AW-3	F	--	--	--	--	--	--	--	--	--	--		
90247	04-Oct-88	AW-4		--	--	--	--	--	--	--	--	--	--	--	--
90248	04-Oct-88	AW-4	F	--	--	--	--	--	--	--	--	--	--		
91294	25-Oct-88	AW-5		--	--	--	--	--	0.010	--	--	--	0.69	--	--
91295	25-Oct-88	AW-5	F	--	--	--	--	--	--	--	--	--	0.41		
Surface															
87405	15-Aug-88	Q POND		--	--	--	--	--	--	--	--	--	--	--	--
87406	15-Aug-88	Q POND	F	--	--	--	--	--	--	--	--	--	--		
87407	15-Aug-88	Q POND		--	--	--	--	--	--	--	--	--	--	--	--
87408	15-Aug-88	Q POND	F	--	--	--	--	--	--	--	--	--	--		
89085	14-Sep-88	Q POND		--	--	--	--	--	--	--	--	--	--	--	--
89086	14-Sep-88	Q POND	F	--	--	--	--	--	--	--	--	--	--		
91300	24-Oct-88	Q POND		--	--	--	--	--	--	--	--	--	--	--	--
91301	24-Oct-88	Q POND	F	--	--	--	--	--	--	--	--	--	--		
92340	22-Nov-88	Q POND		--	--	--	--	--	--	--	--	--	--	--	--
92341	22-Nov-88	Q POND	F	--	--	--	--	--	--	--	--	--	--		
Undefined															
89185	15-Sep-88	MW-40S		0.018	--	--	0.06	--	0.20	--	--	--	0.32	--	--
89186	15-Sep-88	MW-40S	F	--	--	--	--	--	--		--	--	--		
90044	29-Sep-88	MW-40D		--	--	--	--	--	--	--	--	--	0.05	--	--
90045	29-Sep-88	MW-40D	F	--	--	--	--	--	--	--	--	--	0.04		
Trip Blanks															
88995	13-Sep-88	TB		--	--	--	--	--	--	--	--	--	--	--	--
89070	13-Sep-88	TB		--	--	--	--	--	--	--	--	--	--	--	--
89170	14-Sep-88	TB		--	--	--	--	--	--	--	--	--	--	--	--
90041	28-Sep-88	TB		--	--	--	--	--	--	--	--	--	--	--	--
90244	03-Oct-88	TB		--	--	--	--	--	--	--	--	--	--	--	--
91291	24-Oct-88	TB		--	--	--	--	--	--	--	--	--	--	--	--
92335	22-Nov-88	TB		--	--	--	--	--	--	--	--	--	--	--	--

blank indicates no analysis conducted
-- indicates not detected above reporting limit
F in the fourth column indicates a field filtered sample

tailings. These data also show that none of the B horizon wells contains hexavalent chromium above the 0.05 ppm standard. This would indicate that the chromium is not being transported vertically from these shallow zones to the lower bedrock horizons.

Well AW-2 contained 46 ppm of hexavalent chromium and would appear to undermine this scenario. However, the water quality results obtained during the Malcolm Pirnie study showed that the central portion of the Main Plant site in the vicinity of Production Well No. 1 contained hexavalent chromium in the groundwater. Wells 21 and 22, for example, contained 50 and 15.5 ppm hexavalent chromium respectively. Furthermore, Production Well No. 1 was shown to contain over 30 ppm and the time-series sampling concluded that the source of chromium in this well was near its surface.

As shown on Sheet 6966-6, cross-section C-C', Horizon C is in direct hydraulic communication with Production Well No. 1 and thus this reported source of chromium. Furthermore, there are at least three other production wells (Nos. 3, 4 and 6) in this immediate vicinity which undoubtedly have open rock coreholes intersecting the C Horizon. The reason that the B Horizon does not also reflect this potential source is not known. It may be, as it is in the case of Production Well No. 1, that the B Horizon intersects the wells above their static water levels.

Whatever the source, none of the inorganic parameters was found off site in the samples collected in the quarry. In the western quarry area, the seep represents Horizon A, the corehole water represents Horizon B and of course AW-3 is screened in Horizon C. Thus, no off site impact from the inorganic metals or cyanide was observed.

4.5.2 Organics

A similar overview of the organic parameters indicates that there are only two compounds which are reported above the detection limit. These are chlorobenzene and o-dichlorobenzene. Benzene and toluene were also reported but only in one well, MW-20S. The reader is referred to Table 4-6 and Appendix A for the complete organic data summary.

TABLE 4-6

Summary of Water Quality Data: Organics

Lab ID Number	Date Sampled	Location	TOX mg/l	chloro-benzene ug/l	o-dichloro-benzene ug/l	benzene ug/l	toluene ug/l	total xylenes ug/l	1,1,1-trichloro-ethane ug/l	tri-chloro-ethene ug/l
Overburden										
88998	13-Sep-88	MW-26	7.7	--	37000	--	--	--	--	--
89003	13-Sep-88	MW-28	0.102	--	190	--	--	--	--	--
89079	14-Sep-88	MW-34	0.105	--	--	2J	2J	2J	--	--
89175	15-Sep-88	MW-9	0.20	--	--	--	--	--	--	--
89177	15-Sep-88	MW-9	0.21	--	--	--	--	--	--	--
89187	15-Sep-88	P-53	0.032	--	8J	--	--	--	--	--
Horizon A										
89179	15-Sep-88	MW-19	1.37	--	--	--	--	--	--	--
89077	14-Sep-88	MW-20S	0.72	860	--	48	50	--	--	16J
88996	13-Sep-88	MW-25S	11.3	--	--	--	--	--	--	--
89002	13-Sep-88	MW-27S	0.97	--	--	--	--	--	--	--
89083	14-Sep-88	MW-35S	0.060	--	--	--	--	--	2J	--
89183	15-Sep-88	MW-36S	35	2000	66J	--	--	--	--	--
89173	15-Sep-88	MW-8	12.1	--	--	--	--	--	--	--
87409	15-Aug-88	SEEP	--	--	--	--	--	--	--	--
89087	14-Sep-88	SEEP	--	--	--	--	--	--	--	--
91302	24-Oct-88	SEEP	--	--	--	--	--	--	--	--
92342	22-Nov-88	SEEP	--	--	--	--	--	--	--	--
Horizon B										
87399	15-Aug-88	CH-2	0.146	--	--	--	--	--	--	--
87401	15-Aug-88	CH-2	0.140	--	--	--	--	--	--	--
89071	14-Sep-88	CH-2	0.049	--	--	--	--	--	--	--
91296	24-Oct-88	CH-2	0.080	--	--	--	--	--	--	--
92336	22-Nov-88	CH-2	0.037	--	--	--	--	--	--	--
87403	15-Aug-88	CH-5	0.152	--	--	--	--	--	--	--
89073	14-Sep-88	CH-5	0.051	--	--	--	--	--	--	--
91298	24-Oct-88	CH-5	0.071	--	--	--	--	--	--	--
92338	22-Nov-88	CH-5	0.041	--	--	--	--	--	--	--
89075	14-Sep-88	MW-20D	0.061	92	--	--	--	--	--	--
89000	13-Sep-88	MW-27D	9.2	3400	410	--	--	--	--	--
89081	14-Sep-88	MW-35D	0.21	41	--	--	--	--	--	--
89181	15-Sep-88	MW-36D	7.4	1300	--	--	--	--	--	--
Horizon C										
90245	03-Oct-88	AW-1	0.34	--	--	1J	3J	--	--	--
90042	29-Sep-88	AW-2	0.30	--	18	--	--	--	--	7
91292	25-Oct-88	AW-2	0.26	--	21	--	--	--	--	5
89604	22-Sep-88	AW-3	0.036	--	--	--	--	--	--	--
90247	04-Oct-88	AW-4	--	--	--	--	--	--	--	--
91294	25-Oct-88	AW-5	0.051	--	--	--	1J	--	--	--
Surface										
87405	15-Aug-88	Q POND	0.082	--	--	--	--	--	--	--
87407	15-Aug-88	Q POND	0.066	--	--	--	--	--	--	--
89085	14-Sep-88	Q POND	0.037	--	--	--	--	--	--	--
91300	24-Oct-88	Q POND	0.050	--	--	--	--	--	--	--
92340	22-Nov-88	Q POND	0.029	--	--	--	--	--	--	--
Undefined										
89185	15-Sep-88	MW-40S	--	--	--	--	--	--	--	--
90044	29-Sep-88	MW-40D	--	--	--	--	--	--	--	--
Trip Blanks										
88995	13-Sep-88	TB	--	--	--	--	--	--	--	--
89070	13-Sep-88	TB	--	--	--	--	--	--	--	--
89170	14-Sep-88	TB	--	--	--	--	--	--	--	--
90041	28-Sep-88	TB	--	--	--	--	--	--	--	--
90244	03-Oct-88	TB	--	--	--	--	--	--	--	--
91291	24-Oct-88	TB	--	--	--	--	--	--	--	--
92335	22-Nov-88	TB	--	--	--	--	--	--	--	--

-- indicates not detected above reporting limit

J an estimated value which is below the reliable detection limit

The results for the two organic compounds listed above have been plotted on Sheet 6966-11. The data appear to indicate that for chlorobenzene, the source may be associated with the south waste pile as this was the only area in which chlorobenzene was found above the B Horizon. Down gradient of this area (on site) chlorobenzene is consistently found in, and only in, Horizon B. O-dichlorobenzene was found in only two locations, both at the on site down gradient edge of the Main Plant site. The overburden well MW-26 contained the highest concentration of all organics (37,000 ug/l) and may indicate a source in the overburden.

None of the organic parameters which were sampled was detected off site. This includes the A, B and C Horizons at the AW-3 location and the three other C Horizon wells.

4.5.3 Major Ion Analysis

To provide yet another tool to aid in the evaluation of groundwater slow through the bedrock, a major ion analysis was conducted on groundwater samples collected from selected wells. In theory, groundwater collected from two wells which represent similar flow regimes would possess similar distributions of the major cations and anions. Conversely, groundwater originating in different environments or flowing in different regimes would exhibit a dissimilar major ion characteristic. Since it is quite possible to have exceptions to these relationships, the major ion analysis is considered a qualitative tool to be used along with other information sources.

The major ion data have been analyzed using computer software marketed by Hall Groundwater Consultants, Inc. of St. Albert, Alberta, Canada, under the name "Groundwater Chemistry Programs, Version 7.0". The software allows efficient calculation of the ionic balance and generates Piper trilinear and Stiff diagrams. These diagrams are particularly useful for assessing the similarities and differences in water quality between wells and between water-bearing zones. The Stiff diagram, in particular, often possesses a distinctive shape that is characteristic of the water in a given water-bearing zone or a portion thereof. The Piper trilinear diagram permits the plotting of all of the analyses on a single diagram. In constructing a Piper trilinear diagram, the relative percentages of cations (calcium, magnesium, and sodium plus potassium) are plotted on the lower left cation triangle, while the relative percentages of anions (chloride, sulfate, and carbonate plus bicarbonate) are plotted on the anion triangle, located on the lower right side of the diagram. A central plotting position is then established for each point in the central plotting rhomb by projecting the intersection of rays of the plotting positions from the cation and anion triangles. Water from distinct water-bearing zones will typically plot within separate, reasonably well-defined fields on the central "diamond" in the trilinear diagram. This technique theoretically provides the ability to distinguish between groundwater which originates from geochemically distinct water-bearing zones and to identify groundwater which may represent a mixture of differing groundwater types as discussed above (Davis and DeWiest, 1966; Hem, 1970).

The major ion data for wells screened in the overburden are presented in graphical form on the figures in Appendix D. The Piper trilinear diagram indicates that wells MW-9, MW-26, and MW-28 plot within the same half of the diamond (alkali). Well P-53 plots in a separate field and may reflect a difference in well construction for the piezometer. The three overburden wells which plot close within the trilinear diagram also exhibit somewhat similar Stiff diagram "patterns". The similar pattern is marked by dominant sodium plus potassium with an absence of calcium and magnesium. Carbonate comprises a dominant anion with variable sulfate. The concentrations of dominant ions in equivalent per million (EPM) is between 20 and 40. Overburden well P-53 exhibits a dissimilar Stiff diagram "pattern" and is characterized by a much lower concentration of less than 10 EPM for its dominant ions.

The majority of wells sampled within Horizon A exhibit clear similarities in chemical composition. Monitoring wells MW-8, MW-20S, MW-27S, MW-34, MW-35S, and MW-36S all contain sodium plus potassium as the predominant cation, sulfate as the predominant anion, and plot towards the extreme right of the central plotting rhomb (non-carbonate alkali) typically representing ocean waters and brines (Walton, 1984). The predominant groundwater type encountered in Horizon A may thus be classified as a sodium-sulfate type (Davis and DeWiest, 1966).

Horizon A wells MW-19 and MW-25S plot towards the center of the rhomb classifying them as a somewhat "neutral" chemistry where no cation-anion pair exceeds 50 percent of the total dissolved solids. This characteristic is also seen in the Stiff diagram "patterns" in which the aforementioned "brine" wells exhibit somewhat similar patterns and EPM concentrations between 30 and 100. Wells MW-19 and MW-27S exhibit dissimilar Stiff "patterns" with EPM concentrations of less than 20. The "brine" Stiff patterns are marked by dominant sodium plus potassium and sulfate with variable calcium magnesium and bicarbonate. The apparently anomalous major ion characteristics for these two wells may again be due to their construction. Well MW-19 contains a long (35 foot) open interval which starts at the top of the bedrock surface. Well MW-27S is located within several feet of the new well AW-2 and may have been impacted by drilling fluid during construction.

Of the four wells screened within Horizon B (MW-20D, MW-27D, MW-35D, and MW-36D), three exhibit similar chemical properties. For reasons unknown at this time, well MW-35D exhibits dissimilar chemical properties. The majority of these B wells contain sodium plus potassium, and sulfate as their dominant cations and anions, respectively. These wells also plot within the extreme right of the plotting rhomb, characterizing them as a sodium sulfate type water. The Stiff "patterns" of these wells are marked by similar values of predominant sodium plus potassium and sulfate which exceed concentrations of 35 EPM (predominantly greater than 50).

Of the five wells (AW-1 through AW-5) screened within Horizon C, few similarities in the major ion data can be observed. It should be noted that the water quality database for these wells consist of analytical results from sampling episodes conducted shortly after the wells were completed.

A major ion evaluation of water from the two quarry coreholes was also conducted. It is noteworthy that both coreholes plot close together on the trilinear diagram, towards the center of the plotting rhomb. This area corresponds to the "neutral" field in which no one cation-anion pair exceeds fifty percent of the total ions. Comparison of the similar Stiff diagram "patterns" suggest equally similar water chemistry between the coreholes (as would be expected). Perhaps the most significant characteristic inherent of the corehole Stiff graph involves the extremely weak ion strength (less than 3 EPM) which is not usually characteristic of groundwater. This property may suggest that groundwater discharging from the coreholes is being recharged by the Hudson River as discussed in Section 4.4.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions have been drawn from the data and interpretations presented in this report.

- o Over 600 feet of bedrock stratigraphy have been identified beneath the study area. The formations consist of shale, limestone and dolomite of Ordovician Age and dip to the south at approximately three degrees.

- o Three hydrostratigraphic horizons (fractures) have been identified and correlated for over 4,800 feet across the study area. At least two of these horizons (B and C) have been shown to significantly control the horizontal movement of groundwater flow.

- o Groundwater flow in each of the three horizons has been conceptually shown to discharge to the western area of the limestone quarry, south of the Hudson River. These flow scenarios were developed using direct water level measurements from wells, indirect observations of seeps and flowing rock coreholes and the application of standard principles for converging flow to a discharge area.

- o Groundwater in the overburden soils flows south discharging into the Hudson River.

- o The quality of groundwater determined in selected wells on the Main Plant site generally confirms previously collected data. Several organic and inorganic constituents were present in concentrations exceeding drinking water standards.

- o None of the organics which were analyzed was reported south of the Hudson River, in or near the limestone quarry. Furthermore, none of the inorganic constituents was reported above or even close to drinking water standards off site. These results were repeated for four consecutive months of testing.

- The Main Plant site is not having a detectable impact on groundwater (or surface water in the seep) at its discharge point in the limestone quarry.

The following recommendations are offered and have been addressed in the Groundwater Monitoring Plan.

- Horizon A is only present over a limited area on the Main Plant site and is represented by ten existing wells. Across the river, Horizon A outcrops in a seep in the northern wall of the western quarry area. This seep has been sampled four times and was found not to contain detectable concentrations of contaminants. As a consequence, no additional A horizon wells are necessary.

- B Horizon wells are needed south of the Hudson River. These wells should be located east and south of the discharge area. This approach would not only provide a definition of the B Horizon but would provide vertical gradients.

- Two Additional C Horizon wells on the eastern portion of the Main Plant site are necessary to evaluate groundwater quality in this horizon.

- Further attempts should be made to locate the remaining production wells on the Main Plant site. They should be geophysically logged and then sealed to prevent continued vertical connection between horizons.

- The water quality in the quarry should be monitored on a quarterly basis.

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APPENDIX A

ANALYTICAL DATA SUMMARY TABLES

TABLE A-1: Metals

Lab ID	Date	Location **		antimony	arsenic	beryllium	cadmium	chromium	copper	lead	mercury	nickel	selenium	silver	thallium	zinc	hexavalent chromium
				Concentrations in Milligrams per Liter													
Overburden																	
88998	13-Sep-88	MW-26		<0.06	0.017	<0.01	<0.01	13.6	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	13.2
88999	13-Sep-88	MW-26	F	<0.06	0.016	<0.01	<0.01	14.1	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
89003	13-Sep-88	MW-28		<0.06	0.025	<0.01	<0.01	1.58	0.039	0.088	<0.0005	<0.04	<0.005	0.03	<0.01	0.04	1.39
89004	13-Sep-88	MW-28	F	<0.06	0.042	<0.01	<0.01	1.61	0.031	0.038	<0.0005	<0.04	<0.005	0.03	<0.01	0.02	
89079	14-Sep-88	MW-34		<0.06	<0.1	<0.01	<0.01	4.5	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.1	<0.02	4.7
89080	14-Sep-88	MW-34	F	<0.06	<0.04	<0.01	<0.01	4.8	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
89175	15-Sep-88	MW-9		<0.06	0.010	<0.01	<0.01	42	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	41
89176	15-Sep-88	MW-9	F	<0.06	0.015	<0.01	<0.01	40	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
89177	15-Sep-88	MW-9		<0.06	0.011	<0.01	<0.01	42	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	0.02	42
89178	15-Sep-88	MW-9	F	<0.06	0.018	<0.01	<0.01	37	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
89187	15-Sep-88	P-53		<0.06	<0.01	<0.01	<0.01	0.60	<0.025	0.007	<0.0005	<0.04	<0.005	<0.02	<0.01	0.07	0.81
89188	15-Sep-88	P-53	F	<0.06	<0.01	<0.01	<0.01	0.59	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	0.03	
Horizon A																	
89179	15-Sep-88	MW-19		<0.06	<0.01	<0.01	<0.01	2.3	<0.025	<0.005	<0.0005	<0.04	<0.005	0.06	<0.01	<0.02	2.4
89180	15-Sep-88	MW-19	F	<0.06	<0.01	<0.01	<0.01	2.5	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
89077	14-Sep-88	MW-20S		<0.06	0.047	<0.01	<0.01	<0.02	<0.025	<0.01	0.0012	0.13	<0.1	<0.02	<0.01	<0.02	<0.005
89078	14-Sep-88	MW-20S	F	<0.06	0.024	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	0.11	<0.05	<0.02	<0.01	<0.02	
88996	13-Sep-88	MW-25S		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.1	<0.02	<0.005
88997	13-Sep-88	MW-25S	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.1	<0.0005	<0.04	<0.005	<0.02	<0.1	<0.02	
89002	13-Sep-88	MW-27S		<0.06	0.041	0.02	0.02	2.3	0.046	0.48	<0.0005	0.09	<0.1	0.10	<0.01	0.80	<0.005
89083	14-Sep-88	MW-35S		<0.06	<0.02	<0.01	<0.01	1.36	<0.025	<0.005	<0.0005	<0.04	<0.05	<0.02	<0.01	0.06	1.32
89084	14-Sep-88	MW-35S	F	<0.06	<0.02	<0.01	<0.01	1.17	<0.025	<0.005	<0.0005	<0.04	<0.05	<0.02	<0.1	0.03	
89183	15-Sep-88	MW-36S		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	0.06	<0.1	0.04	<0.01	0.03	<0.005
89184	15-Sep-88	MW-36S	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	0.05	<0.005	<0.02	<0.01	<0.02	
89173	15-Sep-88	MW-8		<0.06	0.010	<0.01	<0.01	0.08	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.2	0.03	0.018
89174	15-Sep-88	MW-8	F	<0.06	<0.01	<0.01	<0.01	0.04	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.1	<0.02	
87409	15-Aug-88	SEEP		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.002
87410	15-Aug-88	SEEP	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
89087	14-Sep-88	SEEP		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	0.03	<0.005
89088	14-Sep-88	SEEP	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
91302	24-Oct-88	SEEP		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
91303	24-Oct-88	SEEP	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
92342	22-Nov-88	SEEP		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
92343	22-Nov-88	SEEP	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
Horizon B																	
87399	15-Aug-88	CH-2		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.002
87400	15-Aug-88	CH-2	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
87401	15-Aug-88	CH-2		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.002
87402	15-Aug-88	CH-2	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
89071	14-Sep-88	CH-2		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
89072	14-Sep-88	CH-2	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
91296	24-Oct-88	CH-2		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	0.26	<0.005
91297	24-Oct-88	CH-2	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
92336	22-Nov-88	CH-2		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
92337	22-Nov-88	CH-2	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
87403	15-Aug-88	CH-5		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.002
87404	15-Aug-88	CH-5	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
89073	14-Sep-88	CH-5		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
89074	14-Sep-88	CH-5	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
91298	24-Oct-88	CH-5		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	0.02	<0.005
91299	24-Oct-88	CH-5	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
92338	22-Nov-88	CH-5		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
92339	22-Nov-88	CH-5	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
89075	14-Sep-88	MW-20D		<0.06	0.013	<0.01	<0.01	<0.02	0.027	0.147	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005

TABLE A-1: Metals

Lab ID	Date	Location	**	antimony	arsenic	beryllium	cadmium	chromium	copper	lead	mercury	nickel	selenium	silver	thallium	zinc	hexavalent chromium
				Concentrations in Milligrams per Liter													
89076	14-Sep-88	MW-20D	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
89000	13-Sep-88	MW-27D		<0.06	0.011	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.1	<0.02	<0.01	0.03	<0.005
89001	13-Sep-88	MW-27D	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.1	0.02	
89081	14-Sep-88	MW-35D		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	0.018	<0.0005	<0.04	<0.1	<0.02	<0.01	0.04	<0.005
89082	14-Sep-88	MW-35D	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005		<0.04	<0.1	<0.02	<0.01	<0.02	
89181	15-Sep-88	MW-36D		<0.06	0.052	<0.01	<0.01	0.07	<0.025	<0.005	<0.0005	0.07	<0.1	0.04	<0.01	0.02	<0.05
89182	15-Sep-88	MW-36D	F	<0.06	0.059	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	0.05	<0.1	0.02	<0.01	0.02	
Horizon C																	
90245	03-Oct-88	AW-1		<0.06	0.042	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	0.05	0.005
90246	03-Oct-88	AW-1	F	<0.06	0.046	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
90042	29-Sep-88	AW-2		<0.06	<0.01	<0.01	<0.01	46	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	0.03	47
90043	29-Sep-88	AW-2	F	<0.06	<0.01	<0.01	<0.01	44	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	0.03	
91292	25-Oct-88	AW-2		<0.06	<0.01	<0.01	<0.01	52	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	46
91293	25-Oct-88	AW-2	F	<0.06	<0.01	<0.01	<0.01	52	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
89604	22-Sep-88	AW-3		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
89605	22-Sep-88	AW-3	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
90247	04-Oct-88	AW-4		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
90248	04-Oct-88	AW-4	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
91294	25-Oct-88	AW-5		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	0.010	<0.0005	<0.04	<0.005	<0.02	<0.01	0.69	<0.005
91295	25-Oct-88	AW-5	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	0.41	
Surface																	
87405	15-Aug-88	Q POND		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.002
87406	15-Aug-88	Q POND	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
87407	15-Aug-88	Q POND		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.002
87408	15-Aug-88	Q POND	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
89085	14-Sep-88	Q POND		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
89086	14-Sep-88	Q POND	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
91300	24-Oct-88	Q POND		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
91301	24-Oct-88	Q POND	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
92340	22-Nov-88	Q POND		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
92341	22-Nov-88	Q POND	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	
Undefined																	
89185	15-Sep-88	MW-40S		<0.06	0.018	<0.01	<0.01	0.06	<0.025	0.20	<0.0005	<0.04	<0.005	<0.02	<0.01	0.32	<0.005
89186	15-Sep-88	MW-40S	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005		<0.04	<0.005	<0.02	<0.2	<0.02	
90044	29-Sep-88	MW-40D		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	0.05	<0.005
90045	29-Sep-88	MW-40D	F	<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	0.04	
Trip Blanks																	
88995	13-Sep-88	TB		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
89070	13-Sep-88	TB		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
89170	14-Sep-88	TB		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
90041	28-Sep-88	TB		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
90244	03-Oct-88	TB		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
91291	24-Oct-88	TB		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005
92335	22-Nov-88	TB		<0.06	<0.01	<0.01	<0.01	<0.02	<0.025	<0.005	<0.0005	<0.04	<0.005	<0.02	<0.01	<0.02	<0.005

** F indicates sample filtered

TABLE A-2: Major Ions

Concentrations in Milligrams per Liter

Lab ID	Date	Location	**	calcium	potassium	magnesium	sodium
Overburden							
88998	13-Sep-88	MW-26		13.8	4.4	1.97	700
88999	13-Sep-88	MW-26	F	13.1	4.6	2.0	690
89003	13-Sep-88	MW-28		1.0	<1	<1	470
89004	13-Sep-88	MW-28	F	1.12	<1	<1	500
89079	14-Sep-88	MW-34		9.0	12.0	10.2	2220
89080	14-Sep-88	MW-34	F	9.2	11.1	6.6	1650
89175	15-Sep-88	MW-9		12.5	2.4	8.7	790
89176	15-Sep-88	MW-9	F	10.9	2.2	6.7	790
89177	15-Sep-88	MW-9		15.6	2.4	12.6	770
89178	15-Sep-88	MW-9	F	10.7	2.4	7.2	770
89187	15-Sep-88	P-53		67	2.9	58	135
89188	15-Sep-88	P-53	F	63	3.1	55	120
Horizon A							
89179	15-Sep-88	MW-19		196	4.7	28	81
89180	15-Sep-88	MW-19	F	148	4.6	26	82
89077	14-Sep-88	MW-20S		160	47	93	1110
89078	14-Sep-88	MW-20S	F	150	48	110	960
88996	13-Sep-88	MW-25S		60	330	36	380
88997	13-Sep-88	MW-25S	F	68	360	38	400
89002	13-Sep-88	MW-27S		250	13.2	68	350
89083	14-Sep-88	MW-35S		35	12.3	19.8	1790
89084	14-Sep-88	MW-35S	F	31	11.5	18.3	1280
89183	15-Sep-88	MW-36S		148	300	53	340
89184	15-Sep-88	MW-36S	F	191	300	51	340
89173	15-Sep-88	MW-8		9.6	820	7.4	350
89174	15-Sep-88	MW-8	F	3.3	830	7.6	340
87409	15-Aug-88	SEEP		96	40	29	13.1
87410	15-Aug-88	SEEP	F	90	42	28	13.1
89087	14-Sep-88	SEEP		106	48	32	15.6
89088	14-Sep-88	SEEP	F	105	44	33	14.2
91302	24-Oct-88	SEEP		85	107	22	26
91303	24-Oct-88	SEEP	F	152	146	39	36
92342	22-Nov-88	SEEP		128	34	50	9.7
92343	22-Nov-88	SEEP	F	128	33	49	9.6
Horizon B							
87399	15-Aug-88	CH-2		36	27	7.0	27
87400	15-Aug-88	CH-2	F	35	27	7.1	26
87401	15-Aug-88	CH-2		35	27	6.9	27
87402	15-Aug-88	CH-2	F	38	28	7.5	28
89071	14-Sep-88	CH-2		19.5	11.7	3.2	10.7
89072	14-Sep-88	CH-2	F	21	11.6	3.3	10.8
91296	24-Oct-88	CH-2		30	30	6.1	23
91297	24-Oct-88	CH-2	F	30	30	6.3	23
92336	22-Nov-88	CH-2		30	34	6.6	24
92337	22-Nov-88	CH-2	F	29	34	6.4	23
87403	15-Aug-88	CH-5		38	25	7.5	27
87404	15-Aug-88	CH-5	F	40	26	7.9	28
89073	14-Sep-88	CH-5		50	20	9.7	29
89074	14-Sep-88	CH-5	F	48	20	9.3	29
91298	24-Oct-88	CH-5		32	28	6.7	25
91299	24-Oct-88	CH-5	F	34	31	7.1	28
92338	22-Nov-88	CH-5		41	34	7.8	27
92339	22-Nov-88	CH-5	F	33	33	7.3	26
89075	14-Sep-88	MW-20D		110	30	82	90

TABLE A-2: Major Ions

Concentrations in Milligrams per Liter

Lab ID	Date	Location	**	calcium	potassium	magnesium	sodium
89076	14-Sep-88	MW-20D	F	53	24	33	80
89000	13-Sep-88	MW-27D		260	470	66	330
89001	13-Sep-88	MW-27D	F	280	520	68	370
89081	14-Sep-88	MW-35D		190	21	82	1110
89082	14-Sep-88	MW-35D	F	177	16.4	61	1090
89181	15-Sep-88	MW-36D		200	2000	40	470
89182	15-Sep-88	MW-36D	F	197	2100	40	480
Horizon C							
90245	03-Oct-88	AW-1		5.4	4.6	1.29	560
90246	03-Oct-88	AW-1	F	4.5	4.4	<1	540
90042	29-Sep-88	AW-2		74	5.9	16.5	280
90043	29-Sep-88	AW-2	F	73	6.1	15.9	270
91292	25-Oct-88	AW-2		83	3.0	18	330
91293	25-Oct-88	AW-2	F	85	3.1	18.4	330
89604	22-Sep-88	AW-3		81	5.0	14.0	39
89605	22-Sep-88	AW-3	F	80	5.1	14.3	39
90247	04-Oct-88	AW-4		83	3.0	18.1	32
90248	04-Oct-88	AW-4	F	81	2.9	18.3	31
91294	25-Oct-88	AW-5		62	5.9	7.2	91
91295	25-Oct-88	AW-5	F	53	6.0	6.6	88
Surface							
87405	15-Aug-88	Q POND		58	14.5	15.7	18.5
87406	15-Aug-88	Q POND	F	58	14.9	16.1	19.2
87407	15-Aug-88	Q POND		57	14.5	15.5	18.8
87408	15-Aug-88	Q POND	F	58	14.8	16.2	19.1
89085	14-Sep-88	Q POND		57	13.8	13.3	18.4
89086	14-Sep-88	Q POND	F	58	13.3	12.7	18.1
91300	24-Oct-88	Q POND		48	17.8	12.5	19.4
91301	24-Oct-88	Q POND	F	51	17.8	13.3	21
92340	22-Nov-88	Q POND		45	32	10.8	29
92341	22-Nov-88	Q POND	F	44	30	11.5	29
Undefined							
89185	15-Sep-88	MW-40S		168	8.5	30	29
89186	15-Sep-88	MW-40S	F	58	3.8	6.0	19.0
90044	29-Sep-88	MW-40D		210	24	84	13.3
90045	29-Sep-88	MW-40D	F	195	21	76	10.9
Trip Blanks							
88995	13-Sep-88	TB		<1	<1	<1	<1
89070	13-Sep-88	TB		<1	<1	<1	<1
89170	14-Sep-88	TB		<1	<1	<1	<1
90041	28-Sep-88	TB		<1	<1	<1	<1
90244	03-Oct-88	TB		<1	<1	<1	<1
91291	24-Oct-88	TB		<1	<1	<1	<1
92335	22-Nov-88	TB		<1	<1	<1	<1

** F indicates sample filtered

TABLE A-3: Major ions, TDS, pH, field measurements

Lab ID	Date	Location	**	chloride mg/l	sulfate mg/l	TDS mg/l	total cyanide mg/l	lab pH	carbonate (as CaCO3) mg/l	bicarbonate (as CaCO3) mg/l	total hardness mg/l as CaCO3	Date	field pH	conduc-tivity mmho/cm.	temp. deg C	depth to water feet	purge volume gallons
Overburden																	
88998	13-Sep-88	MW-26		21	710	2000	6.7		411	337	43	13-Sep-88	10.1	2.82	15.3	7.55	1.2
88999	13-Sep-88	MW-26	F								41						
89003	13-Sep-88	MW-28		3.9	230	1160	0.43		655	18	2.5	13-Sep-88	10.9	1.5/1.8	14.4/12.9	10.89	3.0
89004	13-Sep-88	MW-28	F								2.8						
89079	14-Sep-88	MW-34		550	2500	4420	0.19		408	250	64	14-Sep-88	-	6.20	23.6	18.19	5.9
89080	14-Sep-88	MW-34	F								50						
89175	15-Sep-88	MW-9		16.3	950	2320	1.19	10.4	708	159	67	15-Sep-88	-	3.18/3.30	14.3/15.0	5.43	3.0
89176	15-Sep-88	MW-9	F								55						
89177	15-Sep-88	MW-9		15.6	860	2320	0.97	10.5	745	139	91						
89178	15-Sep-88	MW-9	F								56						
89187	15-Sep-88	P-53		52	69	730	5.0	7.4	<1	620	406	15-Sep-88	-	1.24	19.2	11.01	2.4
89188	15-Sep-88	P-53	F								384						
Horizon A																	
89179	15-Sep-88	MW-19		1.9	280	790	0.86	7.1	<1	386	605	15-Sep-88	-	1.07	10	7.80	18.0
89180	15-Sep-88	MW-19	F								477						
89077	14-Sep-88	MW-20S		35	2200	3890	1.49		<1	880	782	14-Sep-88	-	4.93/5.0	10.7/11.4	17.37	10
89078	14-Sep-88	MW-20S	F								827						
88996	13-Sep-88	MW-25S		58	1290	2400	0.23		45	189	298	13-Sep-88	8.3	2.90	10.4	25.53	8.7
88997	13-Sep-88	MW-25S	F								326						
89002	13-Sep-88	MW-27S		16.4	360	960	0.37		80	264	904	13-Sep-88	9.5	1.49	10.7	30.90	9.5
89083	14-Sep-88	MW-35S		340	3000	4380	0.16		146	71	169	14-Sep-88	-	4.94	18.5	31.05	9.0
89084	14-Sep-88	MW-35S	F								153						
89183	15-Sep-88	MW-36S		88	1530	2760	0.32	9.3	226	285	588	15-Sep-88	-	3.55	10.9	26.53	7.0
89184	15-Sep-88	MW-36S	F								687						
89173	15-Sep-88	MW-8		69	1490	2970	0.27	8.4	114	205	54	15-Sep-88	-	3.98/4.15	10.5	14.04	15.3
89174	15-Sep-88	MW-8	F								40						
87409	15-Aug-88	SEEP		3.6	330	597	<0.01		<1	84	360	15-Aug-88	8.03	.729	21.6	-	-
87410	15-Aug-88	SEEP	F														
89087	14-Sep-88	SEEP		5.7	390	610	<0.01		7.0	81	396	14-Sep-88	-	.85	21.4	-	-
89088	14-Sep-88	SEEP	F								398						
91302	24-Oct-88	SEEP		4.2	570	908	<0.01		<1	109	303	24-Oct-88	-	1.068	9.8	-	-
91303	24-Oct-88	SEEP	F								540						
92342	22-Nov-88	SEEP		3.7	490	790	<0.010		<1	97	525						
92343	22-Nov-88	SEEP	F								521						
Horizon B																	
87399	15-Aug-88	CH-2		33	48	279	<0.01		<1	120	119	15-Aug-88	7.66	.205	12.9	-	-
87400	15-Aug-88	CH-2	F														
87401	15-Aug-88	CH-2		33	50	272	<0.01		<1	119	116						
87402	15-Aug-88	CH-2	F														
89071	14-Sep-88	CH-2		13.4	25	165	<0.01		3.4	58	62						
89072	14-Sep-88	CH-2	F								66						
91296	24-Oct-88	CH-2		27	43	210	<0.01		<1	106	100	24-Oct-88	-	.186	12.7	-	-
91297	24-Oct-88	CH-2	F								101						
92336	22-Nov-88	CH-2		2.8	48	262	<0.010		0.80	108	102						
92337	22-Nov-88	CH-2	F								99						
87403	15-Aug-88	CH-5		34	53	274	<0.01		<1	125	126	15-Aug-88	7.33	.275	12.2	-	-
87404	15-Aug-88	CH-5	F														
89073	14-Sep-88	CH-5		37	55	320	<0.01		<1	150	165						
89074	14-Sep-88	CH-5	F								158						
91298	24-Oct-88	CH-5		31	48	244	<0.01		<1	124	107	24-Oct-88	-	.152	12.5	-	-
91299	24-Oct-88	CH-5	F								114						
92338	22-Nov-88	CH-5		31	50	278	<0.010		<1	126	134						
92339	22-Nov-88	CH-5	F								112						
89075	14-Sep-88	MW-200		99	45	470	0.03		88	246	612	14-Sep-88	-	.854	11.1	41.28	30

TABLE A-3: Major ions, TDS, pH, field measurements

Lab ID	Date	Location	**	chloride mg/l	sulfate mg/l	TDS mg/l	total cyanide mg/l	lab pH	carbonate (as CaCO3) mg/l	bicarbonate (as CaCO3) mg/l	total hardness mg/l as CaCO3	Date	field pH	conduc-tivity mmho/cm.	temp. deg C	depth to water feet	purge volume gallons
89076	14-Sep-88	MW-20D	F								268						
89000	13-Sep-88	MW-27D		96	1880	3330	0.23		<1	342	921	13-Sep-88	6.9	4.4	10.7	36.72	57.3
89001	13-Sep-88	MW-27D	F								979						
89081	14-Sep-88	MW-35D		121	2800	3890	0.12		<1	240	812	14-Sep-88	8.32	6.46	15.3	35.88	20.3
89082	14-Sep-88	MW-35D	F								693						
89181	15-Sep-88	MW-36D		112	4700	7190	0.043	7.8	<1	255	664	15-Sep-88	-	13.4	10.9	43.83	25
89182	15-Sep-88	MW-36D	F								657						
Horizon C																	
90245	03-Oct-88	AW-1		72	260	1440	<0.01	11.5	360	<1	18.8	03-Oct-88	-	2.91	11.2	70.53	36
90246	03-Oct-88	AW-1	F								11.2						
90042	29-Sep-88	AW-2		126	350	1130	0.87	7.4	<1	350	253	29-Sep-88	-	1.78	10.1	59.29	-
90043	29-Sep-88	AW-2	F														
91292	25-Oct-88	AW-2		129	350	1130	0.72		<1	340	281	25-Oct-88	-	3.10/3.14	10.9	59.88	36
91293	25-Oct-88	AW-2	F								288						
89604	22-Sep-88	AW-3		45	52	390	<0.01	7.3	<1	230	260	22-Sep-88	-	.66	10.5	2.58	-
89605	22-Sep-88	AW-3	F														
90247	04-Oct-88	AW-4		73	33	424	<0.01	7.7	<1	250	282	04-Oct-88	7.3	.761	10.8	5.83	90
90248	04-Oct-88	AW-4	F								278						
91294	25-Oct-88	AW-5		154	53	432	<0.01		<1	82	184	25-Oct-88	-	.16	11.1	-	2.0
91295	25-Oct-88	AW-5									160	22-Nov-88	-	-	-	387.1	-
Surface																	
87405	15-Aug-88	Q POND		21	118	333	<0.01		<1	116	210	15-Aug-88	8.07	.477	21.7	-	-
87406	15-Aug-88	Q POND	F														
87407	15-Aug-88	Q POND		22	110	325	<0.01		<1	116	210						
87408	15-Aug-88	Q POND	F														
89085	14-Sep-88	Q POND		23	104	340	<0.01		8.0	108	197	14-Sep-88	-	.48	18.0	-	-
89086	14-Sep-88	Q POND	F								197						
91300	24-Oct-88	Q POND		22	89	257	<0.01		<1	114	171	24-Oct-88	-	.505	11.3	-	-
91301	24-Oct-88	Q POND	F								182						
92340	22-Nov-88	Q POND		30	89	335	<0.010		<1	140	157						
92341	22-Nov-88	Q POND	F								157						
89185	15-Sep-88	MW-40S		36	66	290	<0.01	7.9	<1	157	543	15-Sep-88	-	.411	16.6	16.63	12
89186	15-Sep-88	MW-40S	F								170						
90044	29-Sep-88	MW-40D		62	510	1210	<0.01	7.2	<1	310	870	29-Sep-88	-	1.54/1.66	11.1	48.66	4.0
90045	29-Sep-88	MW-40D	F					9.3									
Trip Blanks																	
88995	13-Sep-88	TB		<0.5	<1	50	<0.01		<1	2.5	<7						
89070	13-Sep-88	TB		<0.5	<1	52	<0.01		<1	3.2	<7						
89170	14-Sep-88	TB		<0.05	<1	10	<0.01	6.1	<1	3.1	<7						
90041	28-Sep-88	TB		0.5	<1	5.0	<0.01	6.8	<1	3.5	<7						
90244	03-Oct-88	TB		<0.5	<1	9.0	<0.01	6.8	<1	13.0	<7						
91291	24-Oct-88	TB		<0.5	<1	<2	<0.01		<1	3.5	<7						
92335	22-Nov-88	TB		1.0	<1	30	<0.010		<1	2.8	<7						

** F indicates sample filtered

TABLE A-4: Organics

Lab ID	Date	Location	TOX	benzene	carbon tetra-chloride	chloro-benzene	1,2-dichloro-ethane	1,1,1-trichloro-ethane	1,1-dichloro-ethane	1,1,2-trichloro-ethane	1,1,2,2-tetrachloro-ethane	chloro-ethane	2-chloroethyl vinyl ether	chloro-form
			Concentrations in micrograms per liter											
Overburden														
88998	13-Sep-88	MW-26	7.7	1250U	1250U	1250U	1250U	1250U	1250U	1250U	1250U	2500U	2500U	1250U
89003	13-Sep-88	MW-28	0.102	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89079	14-Sep-88	MW-34	0.105	2J	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89175	15-Sep-88	MW-9	0.20	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89177	15-Sep-88	MW-9	0.21	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89187	15-Sep-88	P-53	0.032	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
Horizon A														
89179	15-Sep-88	MW-19	1.37	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89077	14-Sep-88	MW-20S	0.72	48	30U	860	30U	30U	30U	30U	30U	60U	60U	30U
88996	13-Sep-88	MW-25S	11.3	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89002	13-Sep-88	MW-27S	0.97	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89083	14-Sep-88	MW-35S	0.060	5U	5U	5U	5U	2J	5U	5U	5U	10U	10U	5U
89183	15-Sep-88	MW-36S	35	70U	70U	2000	70U	70U	70U	70U	70U	140U	140U	70U
89173	15-Sep-88	MW-8	12.1	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
87409	15-Aug-88	SEEP	<0.020	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89087	14-Sep-88	SEEP	<0.020	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
91302	24-Oct-88	SEEP	<0.020	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
92342	22-Nov-88	SEEP	<0.02	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
Horizon B														
87399	15-Aug-88	CH-2	0.146	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
87401	15-Aug-88	CH-2	0.140	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89071	14-Sep-88	CH-2	0.049	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
91296	24-Oct-88	CH-2	0.080	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
92336	22-Nov-88	CH-2	0.037	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
87403	15-Aug-88	CH-5	0.152	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89073	14-Sep-88	CH-5	0.051	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
91298	24-Oct-88	CH-5	0.071	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
92338	22-Nov-88	CH-5	0.041	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89075	14-Sep-88	MW-20D	0.061	5U	5U	92	5U	5U	5U	5U	5U	10U	10U	5U
89000	13-Sep-88	MW-27D	9.2	125U	125U	3400	125U	125U	125U	125U	125U	250U	250U	125U
89081	14-Sep-88	MW-35D	0.21	5U	5U	41	5U	5U	5U	5U	5U	10U	10U	5U
89181	15-Sep-88	MW-36D	7.4	55U	55U	1300	55U	55U	55U	55U	55U	110U	110U	55U
Horizon C														
90245	03-Oct-88	AW-1	0.34	1J	5U	5U	5U	5U	5U	5U	5U	10U	10U	12
90042	29-Sep-88	AW-2	0.30	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
91292	25-Oct-88	AW-2	0.26	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89604	22-Sep-88	AW-3	0.036	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
90247	04-Oct-88	AW-4	<0.020	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
91294	25-Oct-88	AW-5	0.051	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	4J
Surface														
87405	15-Aug-88	Q POND	0.082	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
87407	15-Aug-88	Q POND	0.066	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89085	14-Sep-88	Q POND	0.037	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
91300	24-Oct-88	Q POND	0.050	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
92340	22-Nov-88	Q POND	0.029	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
Undefined														
89185	15-Sep-88	MW-40S	<0.020	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U

TABLE A-4: Organics

Lab ID	Date	Location	1,1-dichloro-ethene	1,2-dichloro-ethene	1,2-dichloro-propane	trans-1,3-dichloro-propene	cis-1,3-dichloro-propene	ethyl-benzene	o-dichloro-benzene	methylene chloride	chloro-methane	bromo-methane	bromoform	bromodi-chloro-methane
			Concentrations in micrograms per liter											
Overburden														
88998	13-Sep-88	MW-26	1250U	1250U	1250U	1250U	1250U	1250U	37000	LCB	2500U	2500U	1250U	1250U
89003	13-Sep-88	MW-28	5U	5U	5U	5U	5U	5U	190	LCB	10U	10U	5U	5U
89079	14-Sep-88	MW-34	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89175	15-Sep-88	MW-9	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89177	15-Sep-88	MW-9	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89187	15-Sep-88	P-53	5U	5U	5U	5U	5U	5U		5U	10U	10U	5U	5U
Horizon A														
89179	15-Sep-88	MW-19	5U	5U	5U	5U	5U	5U		5U	10U	10U	5U	5U
89077	14-Sep-88	MW-20S	30U	30U	30U	30U	30U	30U		LCB	60U	60U	30U	30U
88996	13-Sep-88	MW-25S	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89002	13-Sep-88	MW-27S	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89083	14-Sep-88	MW-35S	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89183	15-Sep-88	MW-36S	70U	70U	70U	70U	70U	70U	66J	70U	140U	140U	70U	70U
89173	15-Sep-88	MW-8	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
87409	15-Aug-88	SEEP	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89087	14-Sep-88	SEEP	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
91302	24-Oct-88	SEEP	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
92342	22-Nov-88	SEEP	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
Horizon B														
87399	15-Aug-88	CH-2	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
87401	15-Aug-88	CH-2	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89071	14-Sep-88	CH-2	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
91296	24-Oct-88	CH-2	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
92336	22-Nov-88	CH-2	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
87403	15-Aug-88	CH-5	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89073	14-Sep-88	CH-5	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
91298	24-Oct-88	CH-5	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
92338	22-Nov-88	CH-5	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89075	14-Sep-88	MW-20D	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89000	13-Sep-88	MW-27D	125U	125U	125U	125U	125U	125U	410	LCB	250U	250U	125U	125U
89081	14-Sep-88	MW-35D	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89181	15-Sep-88	MW-36D	55U	55U	55U	55U	55U	55U		55U	110U	110U	55U	55U
Horizon C														
90245	03-Oct-88	AW-1	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
90042	29-Sep-88	AW-2	5U	2J	5U	5U	5U	5U	18	6	10U	10U	5U	5U
91292	25-Oct-88	AW-2	5U	2J	5U	5U	5U	5U	21	LCB	10U	10U	5U	5U
89604	22-Sep-88	AW-3	5U	5U	5U	5U	5U	5U		5U	10U	10U	5U	5U
90247	04-Oct-88	AW-4	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
91294	25-Oct-88	AW-5	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
Surface														
87405	15-Aug-88	Q POND	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
87407	15-Aug-88	Q POND	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89085	14-Sep-88	Q POND	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
91300	24-Oct-88	Q POND	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
92340	22-Nov-88	Q POND	5U	5U	5U	5U	5U	5U		5U	10U	10U	5U	5U
Undefined														
89185	15-Sep-88	MW-40S	5U	5U	5U	5U	5U	5U		5U	10U	10U	5U	5U

TABLE A-4: Organics

Lab ID	Date	Location	1,1-dichloroethene	1,2-dichloroethene	1,2-dichloropropane	trans-1,3-dichloropropene	cis-1,3-dichloropropene	ethylbenzene	o-dichlorobenzene	methylene chloride	chloromethane	bromomethane	bromoform	bromodichloromethane
			Concentrations in micrograms per liter											
90044	29-Sep-88	MW-40D	5U	5U	5U	5U	5U	5U		5U	10U	10U	5U	5U
Trip Blanks														
88995	13-Sep-88	TB	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89070	13-Sep-88	TB	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
89170	14-Sep-88	TB	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
90041	28-Sep-88	TB	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
90244	03-Oct-88	TB	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
91291	24-Oct-88	TB	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U
92335	22-Nov-88	TB	5U	5U	5U	5U	5U	5U		LCB	10U	10U	5U	5U

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LCD - Compound detected, but at low concentration, comparable to that in the blank
C - Number has been corrected for the presence in the blank
J - An estimated value which is below the reliable detection limit

TABLE A-4: Organics

Lab ID	Date	Location	dibromo-chloro-methane	tetra-chloro-ethene	toluene	tri-chloro-ethene	vinyl chloride	acetone	2-butanone	carbon disulfide	2-hexanone	4-methyl-2-pentanone	styrene	vinyl acetate	total xylenes
			Concentrations in micrograms per liter												
Overburden															
88998	13-Sep-88	MW-26	1250U	1250U	1250U	1250U	2500U	LCB	LCB	1250U	2500U	2500U	1250U	2500U	1250U
89003	13-Sep-88	MW-28	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
89079	14-Sep-88	MW-34	5U	5U	2J	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	2J
89175	15-Sep-88	MW-9	5U	5U	5U	5U	10U	26C	LCB	5U	10U	10U	5U	10U	5U
89177	15-Sep-88	MW-9	5U	5U	5U	5U	10U	45C	10U	5U	10U	10U	5U	10U	5U
89187	15-Sep-88	P-53	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
Horizon A															
89179	15-Sep-88	MW-19	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
89077	14-Sep-88	MW-20S	30U	30U	50	16J	60U	LCB	60U	30U	60U	60U	30U	60U	30U
88996	13-Sep-88	MW-25S	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
89002	13-Sep-88	MW-27S	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
89083	14-Sep-88	MW-35S	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
89183	15-Sep-88	MW-36S	70U	70U	70U	70U	140U	LCB	140U	70U	140U	140U	70U	140U	70U
89173	15-Sep-88	MW-8	5U	5U	5U	5U	10U	12C	10U	5U	10U	10U	5U	10U	5U
87409	15-Aug-88	SEEP	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
89087	14-Sep-88	SEEP	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
91302	24-Oct-88	SEEP	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
92342	22-Nov-88	SEEP	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
Horizon B															
87399	15-Aug-88	CH-2	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
87401	15-Aug-88	CH-2	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
89071	14-Sep-88	CH-2	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
91296	24-Oct-88	CH-2	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
92336	22-Nov-88	CH-2	5U	5U	5U	5U	10U	10U	10U	5U	10U	10U	5U	10U	5U
87403	15-Aug-88	CH-5	5U	5U	5U	5U	10U	10U	LCB	5U	10U	10U	5U	10U	5U
89073	14-Sep-88	CH-5	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
91298	24-Oct-88	CH-5	5U	5U	5U	5U	10U	10U	10U	5U	10U	10U	5U	10U	5U
92338	22-Nov-88	CH-5	5U	5U	5U	5U	10U	10U	10U	5U	10U	10U	5U	10U	5U
89075	14-Sep-88	MW-20D	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
89000	13-Sep-88	MW-27D	125U	125U	125U	125U	250U	LCB	250U	125U	250U	250U	125U	250U	125U
89081	14-Sep-88	MW-35D	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
89181	15-Sep-88	MW-36D	55U	55U	55U	55U	110U	LCB	LCB	55U	110U	110U	55U	110U	55U
Horizon C															
90245	03-Oct-88	AW-1	5U	5U	3J	5U	10U	24C	LCB	5U	10U	10U	5U	10U	5U
90042	29-Sep-88	AW-2	5U	5U	5U	7	10U	LCB	10U	5U	10U	10U	5U	10U	5U
91292	25-Oct-88	AW-2	5U	5U	5U	5	10U	LCB	10U	5U	10U	10U	5U	10U	5U
89604	22-Sep-88	AW-3	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
90247	04-Oct-88	AW-4	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
91294	25-Oct-88	AW-5	5U	5U	1J	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
Surface															
87405	15-Aug-88	Q POND	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
87407	15-Aug-88	Q POND	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
89085	14-Sep-88	Q POND	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
91300	24-Oct-88	Q POND	5U	5U	5U	5U	10U	10U	10U	5U	10U	10U	5U	10U	5U
92340	22-Nov-88	Q POND	5U	5U	5U	5U	10U	10U	10U	5U	10U	10U	5U	10U	5U
Undefined															
89185	15-Sep-88	MW-40S	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U

TABLE A-4: Organics

Lab ID	Date	Location	dibromo-chloro-methane	tetra-chloro-ethene	toluene	tri-chloro-ethene	vinyl chloride	acetone	2-butanone	carbon disulfide	2-hexanone	4-methyl-2-pentanone	styrene	vinyl acetate	total xylenes
			Concentrations in micrograms per liter												
90044	29-Sep-88	MW-40D	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
Trip Blanks															
88995	13-Sep-88	TB	5U	5U	5U	5U	10U	15C	10U	5U	10U	10U	5U	10U	5U
89070	13-Sep-88	TB	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
89170	14-Sep-88	TB	5U	5U	5U	5U	10U	24C	10U	5U	10U	10U	5U	10U	5U
90041	28-Sep-88	TB	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
90244	03-Oct-88	TB	5U	5U	5U	5U	10U	LCB	LCB	5U	10U	10U	5U	10U	5U
91291	24-Oct-88	TB	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U
92335	22-Nov-88	TB	5U	5U	5U	5U	10U	LCB	10U	5U	10U	10U	5U	10U	5U

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LCD - Compound detected, but at low concentration, comparable to that in the blank
C - Number has been corrected for the presence in the blank
J - An estimated value which is below the reliable detection limit

TABLE A-4: Organics

Lab ID	Date	Location	TOX	benzene	carbon tetra-chloride	chloro-benzene	1,2-dichloro-ethane	1,1,1-trichloro-ethane	1,1-dichloro-ethane	1,1,2-trichloro-ethane	1,1,2,2-tetrachloro-ethane	chloro-ethane	2-chloroethyl vinyl ether	chloro-form
			Concentrations in micrograms per liter											
90044	29-Sep-88	MW-40D	<0.020	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
Trip Blanks														
88995	13-Sep-88	TB	<0.020	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89070	13-Sep-88	TB	<0.020	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
89170	14-Sep-88	TB	<0.020	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
90041	28-Sep-88	TB	<0.020	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
90244	03-Oct-88	TB	<0.020	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
91291	24-Oct-88	TB	<0.020	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U
92335	22-Nov-88	TB	<0.02	5U	5U	5U	5U	5U	5U	5U	5U	10U	10U	5U

U - Compound analysed for but not detected; the number shows the detection level for the compound
LCD - Compound detected, but at low concentration, comparable to that in the blank
C - Number has been corrected for the presence in the blank
J - An estimated value which is below the reliable detection limit

APPENDIX B

EXPLORATORY BORING LOGS

AWARE INCORPORATED — TEST BORING LOG

NO. AW-1

PROJECT:	Regional Bedrock Evaluation	SHEET NO. 1 of 5	
CLIENT:	Ciba-Geigy Corp.	PROJECT NO.	6966

DRILLING DATA

CONTRACTOR:	Empire Soils
DRILLER:	Ed Cole
EQUIPMENT:	Failing F-10
METHOD:	Water Rotary

SAMPLING METHODS

	SAMPLER	TUBE	CORE
TYPE			NX
DIAMETER			3"
OTHER	REAM TO 6"		

WELL CONSTRUCTION

	RISER	INTAKE
MATERIAL	PVC	PVC
DIAMETER	2"	2"
COUPLING	flush	flush

WELL DEVELOPMENT

METHOD:	Compressed Air
DURATION:	2 hours
YIELD:	
OTHER:	

	GROUND	WELL	PROT CSG.
ELEV	280.81	282.78	

DATE STARTED: 7/25/88
DATE COMPLETED: 8/3/88
INSPECTOR: Robinson

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
VOLCLAY GROUT; 2" Sch. 40 PVC; 6"	0–16.0				OVERBURDEN 16.0'		
	16.0–23.0				LARRABEE LIMESTONE V Dk Gray, v f-grained fossiliferous LIMESTONE, includes wavy beds (possible stylolites) 23.0'	0.4' FRACTURE @ 17.5' "HORIZON A" Oxidation @ 23.8'	59%
	23.0–42				ISLE LA MOTTE FORMATION V. Dk Gray, v.f-grained fossiliferous LIMESTONE with wavy beds and a few thin argillaceous beds 2.1' BENTONITE SEAM @ ≈ 26.0' Argillaceous beds become thicker and more frequent		85% 62%

AWARE INCORPORATED

TEST BORING LOG

NO. AW-1

PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 2 of 5

PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
VOLCLAY GROUT; 2" PVC	40						
	45				FORT ANN FORMATION	"HORIZON B"	87%
					Lt. Gray DOLOMITE w/ hairlike, wavy beds which thicken with depth; siltite — 48.0'	slickenside @ 47.1	
	50				V. Lt. Gray DOLOSTONE w/ diffusely bedded darker zones, predominantly siltite — 53.3'	calcite-filled en-echelon vertical joints 49.5-51.8'	
	55				MASSIVE MODERATE Gray DOLOSTONE, SILTITE — 55.0'	bedding plane pyrite crystals	90%
	60				NODULAR DOLOSTONE w/ thin argillaceous stringers; SHALE beds to 3.0" thick — 60.5'	pyrite @ 60.5'	
	65				MASSIVE CALCISILTITE, variable Mg content, mottled Lt and dk gray, rare calcite-filled vugs — 72.5'	vertical, calcite-filled fracture 61-66.0'	81%
	70						
	75				Nodular DOLOSTONE w/ argillaceous stringers		100%
	80				MOTTLED Lt and medium gray. - Shale beds @ 80.5' — 81.0'	pyrite @ 81.0'	
	85				V. Lt Gray, Stylolitic, phase-parallel bedded dolostone SILTITE w/ irregular Shale beds, Variable Mg content	fissile 88.8-89.1'	94%
	90						

AWARE INCORPORATED

TEST BORING LOG

NO. AW-1

PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 3 of 5

PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
2" PVC; VOLCLAY GROUT	90				Lt Gray, plane-parallel bedded, nodular and mottled LIMESTONE		
	95						98%
	100						
	105						100%
	110				112.6'		
	115				Wavy bedded to bedded nodular DOLOSTONE w/ thin shale stringers interbedded w/ plane-parallel bedded SILTITE.		100%
Bentonite Pellet Seal	120				Includes isolated bioclast zones.		
	125						100%
	130						
SAND PACK	135				0.2' SHALE bed w/ trace slickensides	WEATHERED - Breaks along SHALE; Breaks in "poker chips"	97%
	140				Thin SHALE interbeds	"HORIZON C"	

AWARE INCORPORATED

TEST BORING LOG

NO. AW-1

PROJECT: Regional Bedrock Evaluation — SHEET NO. 4 of 5

CLIENT: Ciba-Geigy Corp. — PROJECT NO. 6966

Well Construction	Depth (feet)	Sample No.	Type	Blows per 6 inches	Classification (after Burmister, 1959)	Remarks	RQD
NX CORE HOLE Filled w/ Bentonite-Cement Grout	140						
	145				Wavy bedded to bedded nodular calcisiltite DOLOSTONE w/ thin shale stringers, interbedded w/ plane-parallel SILTITE	Calcite-filled hairline fractures	100%
	150				151.0'		
	155				Vugular, plane-parallel bedded DOLOSTONE	vugs are calcite-filled	98%
	160				160.9'		
					Wavy bedded / bedded nodular DOLOSTONE		
					164.1'		98%
	165				Plane-parallel bedded DOLOSTONE	vertical, hairline fracture network w/	
	170					pyrite bed	
	175					vertical, calcite-filled fractures	98%
					177.5'		
					Breccia, calcite filling btwn angular clasts		
	180				180.5'		
					Mottled and stylolitic DOLOSTONE w/ irregular beds		
	185				186.0'		100%
					GREAT MEADOWS FORMATION		
	190				Lt Gray, sucrosic, vugular calcarenitic DOLOSTONE	vugs are calcite-filled	

AWARE INCORPORATED

TEST BORING LOG

NO. AW-1

PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 5 of 5

PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
NX CORE HOLE - Filled with Bentonite Cement Grout	190				GREAT MEADOWS FORMATION		
					Lt Gray, sucrosic, vugular, calcarenite DOLOSTONE		
	195						91%
	200				Plane-parallel bedding @ 201.5-202.9'		
	205				Lt. Gray and Med Lt. Gray, mottled, vugular, sucrosic DOLOSTONE		100%
	210				Possible clast @ 209.9'		
	215						100%
	220				220.0'		
					END OF CORING		
	225						

AWARE INCORPORATED

TEST BORING LOG

NO. AW-2

PROJECT:	Regional Bedrock Evaluation	SHEET NO.	1 of 4
CLIENT:	Ciba-Geigy Corp.	PROJECT NO.	6966

DRILLING DATA		SAMPLING METHODS	SAMPLER	TUBE	CORE
CONTRACTOR:	Empire Soils				
DRILLER:	Ed Cole	TYPE			NX
EQUIPMENT:	Failing F-10	DIAMETER			3"
METHOD:	Water Rotary	OTHER	REAMED TO 6"		

WELL CONSTRUCTION	RISER	INTAKE	WELL DEVELOPMENT			GROUND	WELL	PROT CSG.
MATERIAL	PVC	PVC	METHOD:	Compressed Air	ELEV	235.78	237.97	
DIAMETER	2"	2"	DURATION:	2 hours	DATE STARTED:	8/4/88		
COUPLING	flush	flush	YIELD:		DATE COMPLETED:	8/12/88		
			OTHER:		INSPECTOR:	Robinson		

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
6" outer Casing; Bentonite - Cement Grout; 2' sch. 40 PVC	0–24.5				OVERBURDEN 24.5'		
Volclay Grout	24.5–33.0				LARRABEE LIMESTONE MED DK Gray, v. fine-grained (CALSISILTITE), faintly bedded LIMESTONE w/ faint stylolites 33.0'	Abundant bedding plane fractures VERTICAL Fracture 31-32.0' "HORIZON A"	43%
	33.0–				ISLE LA MOTTE FM. MED DK Gray, wavy bedded, bioclastic LIMESTONE		55%

AWARE INCORPORATED

TEST BORING LOG

NO. AW-2

PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 2 of 4

PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
VOLCLAY GROUT; 2" PVC; 6"	40						
	45						91%
					Argillaceous. wavy beds become thicker w/ depth.		
	50						
					Rounded limestone clasts and possible dewatering structures. 54.8'	"HORIZON B"	63%
	55				FORT ANN FORMATION		
					Lt Gray DOLOSTONE w/ hairlike, wavy beds (shale partings) 59.0'	Pyrite btwn. shale partings	
	60				Very Lt. Gray and faint darker mottling, w/ faint bedded nodular texture.	Variable reactions to 5% HCl soln.	100%
	65						
	70						100%
	75				77.0'		94%
					Predominantly plane-parallel bedded calcisiltite DOLOSTONE, few vugs	Vugs calcite-filled Calcite-filled hairline fractures	
	80						
	85						89%
					shale bed @ 88.5'		
	90				90.8'		

AWARE INCORPORATED

TEST BORING LOG

NO. AW-2

PROJECT: Regional Bedrock Evaluation
CLIENT: Ciba-Geigy Corp.
SHEET NO. 3 of 4
PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
VOLCLAY GROUT; 2" PVC	90						
	95				MOTTLED Lt and MED Gray DOLOSTONE SILTITE w/ wavy beds – bedded, nodular texture. 94.0'		98%
	100				MED Gray plane-parallel bedded DOLOSTONE SILTITE w/ few intervals of stylolites and nodules	Calcite-filled vertical fracture	
	105				@ 102' Calcite-filled vugs		88%
	110				Mottled w/ bedded nodules		98%
					113.5'		
	115				Plane-parallel, mottled and wavy bedded DOLOSTONE w/ shale stringer		
	120						100%
					123.5'		
	125				Vugular, plane-parallel bedded and wavy bedded calcisiltite DOLOSTONE		100%
	130						
	135						100%
	140						100%

AWARE INCORPORATED

TEST BORING LOG

NO. AW-2

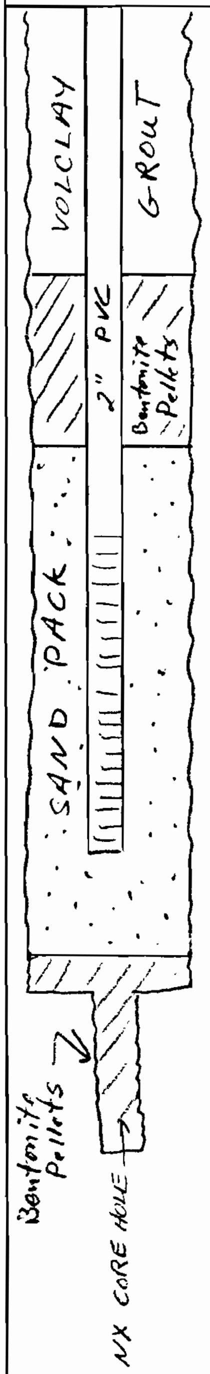
PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 4 of 4

PROJECT NO. 6966

WELL CONSTRUCTION



DEPTH (FEET)	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
140				FORT ANN FORMATION		
				DOLOSTONE		100%
145						
150				Thin SHALE interbeds		99%
155						
160					"HORIZON C"	100%
165				wavy bedded to bedded nodular calcisiltite DOLOSTONE w/ thin shale stringers interbedded w/ plane-parallel SILTITE		
170						100%
175				175.0'		
				END OF CORING		
180						
185						
190						

AWARE INCORPORATED

TEST BORING LOG

NO. AW-3

PROJECT:	Regional Bedrock Evaluation	SHEET NO. 1 of 4	
CLIENT:	Ciba-Geigy Corp.	PROJECT NO.	6966

DRILLING DATA		SAMPLING METHODS	SAMPLER	TUBE	CORE
CONTRACTOR:	Empire Soils				
DRILLER:	Ed Cole	TYPE			NX
EQUIPMENT:	Failing F-10	DIAMETER			3"
METHOD:	Water Rotary	OTHER	REAM TO 6"		

WELL CONSTRUCTION	RISER	INTAKE	WELL DEVELOPMENT			GROUND	WELL	PROT CSG.
MATERIAL	PVC	PVC	METHOD:	Compressed Air	ELEV	116.72	131.03	
DIAMETER	2"	2"	DURATION:	2 hours	DATE STARTED:	9/9/88		
COUPLING	flush	flush	YIELD:		DATE COMPLETED:	9/22/88		
			OTHER:		INSPECTOR:	Robinson		

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
VOLCLAY GROUT; 2" sch. 40 PVC; 4" pvc CASING (upper portion removed)	0				FORT ANN FORMATION		
					CRUSHED ROCK TO 5.5'		
	5						
					Lt. to MED Gray DOLOSTONE w/ wavy beds, alternating w/ zones of plane-parallel beds.		
	10						
	15					Calcite-filled, vertical fracture	49%
	20						
	25						87%
VOLCLAY GROUT; VOLCLAY GROUT	30				Some bedded nodular 29-31.0'		
	35						96%
	40						

AWARE INCORPORATED

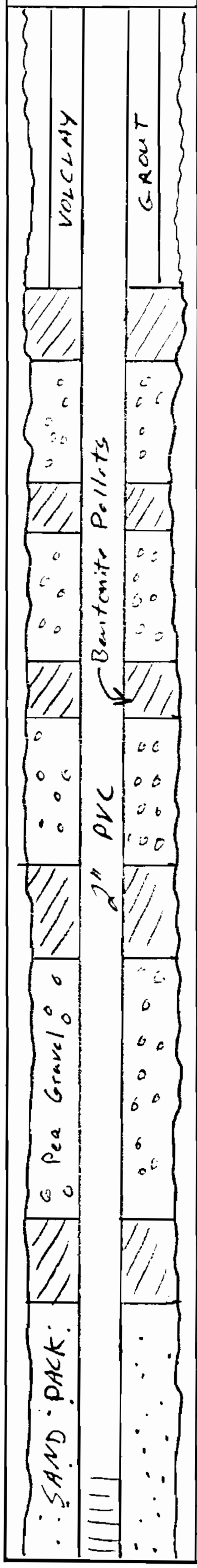
TEST BORING LOG

NO. AW-3

PROJECT: Regional Bedrock Evaluation — SHEET NO. 2 of 4

CLIENT: Ciba-Geigy Corp. — PROJECT NO. 6966

WELL CONSTRUCTION



DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
40–50				Lt to MED GRAY DOLOSTONE w/ wavy beds alternating w/ zones of plane-parallel beds	Calcite-filled fractures	91%
50–60				60.0'		99%
60–66.5				MED DK vugular DOLOSTONE faintly mottled — 66.5'	Calcite-filled vugs	100%
66.5–75				Lt to MED Gray DOLOSTONE w/ wavy beds alternating w/ zones of plane-parallel beds. — 75.0'		98%
75–77.5				Wavy bedded and bedded nodular DOLOSTONE w/ brecciated clasts. — 77.5'		93%
77.5–92				Lt to MED GRAY DOLOSTONE w/ wavy beds alternating w/ zones of plane-parallel beds		93%

AWARE INCORPORATED

TEST BORING LOG

NO. AW-3

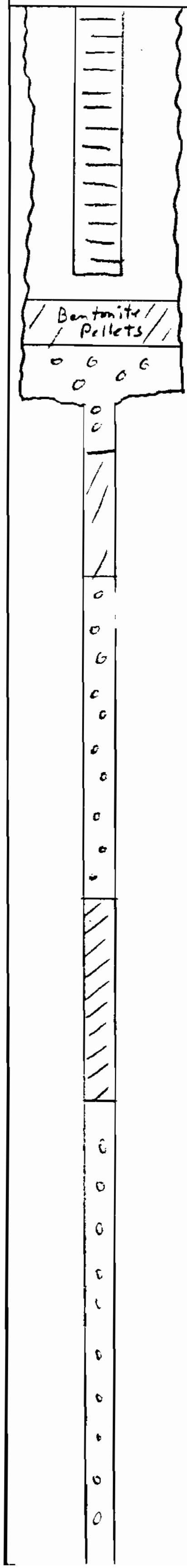
PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 3 of 4

PROJECT NO. 6966

WELL CONSTRUCTION:



DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
90–95				Alternating wavy bedded and zones of plane-parallel bedding	"HORIZON C"	93%
95–100				1/4" fissile SHALE @ 98.9'		97%
106.5'						
106.5–109.0				Darker vugular DOLOSTONE w/ plane-parallel bedding		82%
109.0'						
115–120				Alternating wavy bedding and zones of plane-parallel bedding.	Open vertical joint	
120–126.5				Thin SHALE beds w/ pyrite		96%
126.5'						
126.5–136.0				Plane-parallel beds, some disrupted by calcite-filled fractures into breccia.	crackle breccia	95%
136.0'						
136.0–139.5				Brecciated DOLOSTONE	45° fracture w/slickenside slickenside 45° Fracture	
139.5'						96%
139.5–				GREAT MEADOWS FORMATION Med Gray, med-grained, sucrosic DOLOSTONE		

AWARE INCORPORATED

TEST BORING LOG

NO. AW-3

PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 4 of 4

PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
	140				GREAT MEADOWS FM.		96%
	145				MED Gray, med-grained sucrosic DOLOSTONE		91%
	150				151.0'	Open vertical joint Open vug	
					END OF CORING		
	155						
	160						
	165						

AWARE INCORPORATED

TEST BORING LOG

NO. AW-4

PROJECT:	Regional Bedrock Evaluation	SHEET NO. 1 of 5	
CLIENT:	Ciba-Geigy Corp.	PROJECT NO.	6966

DRILLING DATA		SAMPLING METHODS	SAMPLER	TUBE	CORE
CONTRACTOR:	Empire Soils				
DRILLER:	Ed Cole	TYPE			NX
EQUIPMENT:	Failing F-10	DIAMETER			3"
METHOD:	Water Rotary	OTHER	REAM TO 6"		

WELL CONSTRUCTION	RISER	INTAKE	WELL DEVELOPMENT			GROUND	WELL	PROT CSG.
MATERIAL	PVC	PVC	METHOD:	Compressed Air	ELEV	158.87	160.11	
DIAMETER	2"	2"	DURATION:	2 hours	DATE STARTED:	8/30/88		
COUPLING	flush	flush	YIELD:		DATE COMPLETED:	9/8/88		
			OTHER:		INSPECTOR:	Robinson		

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
2" Sch. 40 PVC; VOLCLAY GROUT	0				GLENNS FALLS FORMATION LOWER SUGAR RIVER LIMESTONE		
	5				MED TO DK Gray, med to fine grained LIMESTONE w/ argillaceous beds — 8.0'	VERTICAL FRACTURE 6-6.5'	48%
	10				LARRABEE LIMESTONE DK Gray fine-grained LIMESTONE		
	15				— 16.5'		74%
	20				MED DK Gray, fine-grained LIMESTONE w/ abundant thin Shale stringers and nodules and a few coarser (calcarenite) beds		
	25						87%
	28.5				— 28.5'		
	30				MED Gray, fine-grained, faintly plane-parallel bedded LIMESTONE w/ trace paper-thin Shale stringers and a few zones of coarser (calcarenite and calcirudite LIMESTONE). Rare stylolites		
	35						81%
	40				— 39.3'		
					MED DK Gray, f grained, LIMESTONE w/ diffuse shale partings		

AWARE INCORPORATED

TEST BORING LOG

NO. AW-4

PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 2 of 5

PROJECT NO. 6966

WELL CONSTRUCTION: 2" PVC; VOLCLAY GROUT

DEPTH (FEET)	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
40				LARRABEE LIMESTONE Fine-grained, plane-parallel bedded LIMESTONE w/ DK argillaceous beds at base. 44.5	"HORIZON A"	70%
45				ISLE LA MOTTE FORMATION Lt Gray, f-grained, plane-parallel bedded LIMESTONE 48.0'		
50				Med Lt Gray, f-grained, bioclastic, bedded nodular LIMESTONE. Nodules formed by abundant hairline shale partings and stylolites 57.5'		89%
60				Lt gray, f-grained, nodular LIMESTONE w/ frequent, thicker shale partings (to 1") 65.2'		48%
65				V. lt. Gray, f-grained LIMESTONE w/ paper-thin shale partings and stylolites 69.5'	Core broken in zones 65.7-68.5'	
70				FORT ANN FORMATION Med Gray and Lt Gray mottled, medium-grained, massive DOLOSTONE	"HORIZON B" High angle, en-echelon fractures	98%
80				Abundant shale partings		99%
90				91.3'		

AWARE INCORPORATED

TEST BORING LOG

NO. AW-4

PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 3 of 5

PROJECT NO. 6966

WELL CONSTRUCTION: 2" PVC; VOLCLAY GROUT

DEPTH (FEET)	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
90–91.3'				91.3'		
91.3'–101.0'				Plane-parallel and wavy bedded and nodular-textured DOLOSTONE. Rare calcite-filled vugs; occasional shale beds 101.0'		100%
101.0'–119.5'				Variable textures, including bedded nodular, plane-parallel, and isolated clasts. 119.5'	pyrite	94%; 100%
119.5'–126.0'				Mottled Lt and Dk Gray, bedded nodular DOLOSTONE w/ calcite-filled vugs and shale partings. 126.0'		100%
126.0'–131.3'				Very Lt Gray, mottled and stylolitic DOLOSTONE w/ few shale stringers. 131.3'		93%
131.3'–135.3'				Plane-parallel bedded DOLOSTONE 135.3'		
135.3'–138.4'				Lighter Gray, bedded nodular and stylolitic DOLOSTONE. 138.4'		98%
138.4'–				Lt Gray, wavy bedded DOLOSTONE w/ zones of darker gray, plane-parallel beds		

AWARE INCORPORATED

TEST BORING LOG

NO. AW-4

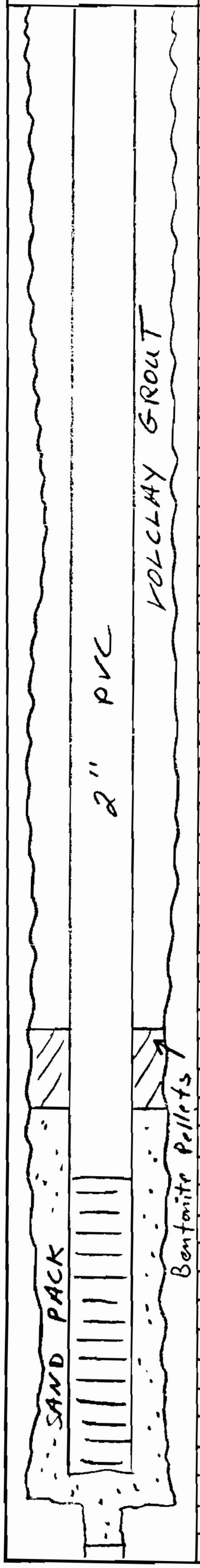
PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 4 of 5

PROJECT NO. 6966

WELL CONSTRUCTION



Depth (feet)	Sample No.	Type	Blows per 6 inches	Classification (after Burmister, 1959)	Remarks	RQD
140–145				Lt Gray, wavy bedded DOLOSTONE w/ zones of darker gray, plane-parallel beds		98%
150				Vugular w/ calcite filling 148.5 - 151.4'		
155						100%
160				Clasts and Shell frags. 160 - 161.0'		100%
164.8'				Bedded Nodular and wavy bedded DOLOSTONE		
170						100%
175						
180.5'				MED DK Gray, vugular DOLOSTONE	vugs calcite-filled	91%
183.2'				Plane-parallel, wavy bedded w/ shale partings	"HORIZON C"	
185–190						96%

AWARE INCORPORATED

TEST BORING LOG

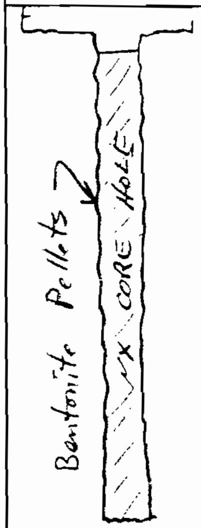
NO. AW-4

PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 5 of 5

PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS	RQD
	190						
	195				Plane-parallel, wavy bedded DOLOSTONE w/ shale partings — 197.9'	VERTICAL CALCITE-FILLED joint	96%
	200				Plane-parallel and wavy bedded DOLOSTONE		95%
	205				206.0'		
					END OF CORING		
	210						

AWARE INCORPORATED

TEST BORING LOG

NO. AW-5

PROJECT:	Regional Bedrock Evaluation	SHEET NO. 1 of 9	
CLIENT:	Ciba-Geigy Corp.	PROJECT NO.	6966

DRILLING DATA		SAMPLING METHODS	SAMPLER	TUBE	CORE
CONTRACTOR:	Empire Soils				
DRILLER:	Ed Cole	TYPE			NX
EQUIPMENT:	Failing F-10	DIAMETER			3"
METHOD:	Water Rotary	OTHER	REAM TO 6"		

WELL CONSTRUCTION	RISER	INTAKE	WELL DEVELOPMENT	
MATERIAL	PVC	PVC	METHOD:	Compressed Air
DIAMETER	2"	2"	DURATION:	2 hours
COUPLING	flush	flush	YIELD:	
			OTHER:	

	GROUND	WELL	PROT CSG.
ELEV	313.84	315.72	

DATE STARTED: 9/27/88

DATE COMPLETED: 10/10/88

INSPECTOR: Robinson

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS
VOLCLAY GROUT; 2" Sch. 40 PVC	0–42.0				OVERBURDEN 42.0'	NOT SAMPLED OR CORED. FORMATION CONTACTS DETERMINED FROM GAMMA LOG.

AWARE INCORPORATED

TEST BORING LOG

NO. AW-9

PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 2 of 9

PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS
	40				42.0'	
					SNAKE HILL FORMATION	
	45				Black SHALE	
	50					
	55					
	60					
2" PVC	65					
VOLCLAY GROUT	70					
	75					
	80					
	85					
	90					

AWARE INCORPORATED

TEST BORING LOG

NO. AW-5

PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 3 of 9

PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS
VOLCLAY GROUT; 2" PVC	90				SNAKE HILL FORMATION	
	95				Black SHALE	
	100					
	105					
	110					
	115					
	120					
	125					
	130					
	135				135.0'	
					GLENNS FALLS FORMATION UPPER SUGAR RIVER LIMESTONE LIMESTONE	
	140					

AWARE INCORPORATED

TEST BORING LOG

NO. AW-5

PROJECT:	Regional Bedrock Evaluation	SHEET NO. 4 of 9	
CLIENT:	Ciba-Geigy Corp.	PROJECT NO. 6966	

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS
Volclay Grout; 2" PVC	140				UPPER SUGAR RIVER LIMESTONE	
	145				LIMESTONE	
	150					
	155					
	160					
	165					
	170				171.0'	
					LOWER SUGAR RIVER LIMESTONE	
	175				LIMESTONE	
	180					
	185					
	190					

AWARE INCORPORATED

TEST BORING LOG

NO. AW-5

PROJECT: Regional Bedrock Evaluation	SHEET NO. 5 of 9
CLIENT: Ciba-Geigy Corp.	PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS
VOLCLAY GROUT; 2" PVC	190				LOWER SUGAR RIVER LIMESTONE	
	195					
	200				LIMESTONE	
	205					
	210					
	215					
	220					
	225					
					229.0'	
	230				LARRABEE LIMESTONE	
	235				LIMESTONE	
	240					

AWARE INCORPORATED

TEST BORING LOG

NO. AW-5

PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 6 of 9

PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS
VOLCLAY GROUT; 2" PVC	240				LARRABEE LIMESTONE	
	245				LIMESTONE	
	250					
	255					
	260					
	265				265.0'	"HORIZON A"
					ISLE LA MOTTE FORMATION	
	270					
	275				LIMESTONE	
	280					
	285					
					288.0'	"HORIZON B"
					FORT ANN FORMATION	
	290				DOLOSTONE	

AWARE INCORPORATED

TEST BORING LOG

NO. AW-5

PROJECT: Regional Bedrock Evaluation	SHEET NO. 7 of 9
CLIENT: Ciba-Geigy Corp.	PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS
	290				FORT ANN FORMATION	
	295				DOLOSTONE	
	300					
VOLCLAY GROUT	305					
	310					
	315					
2" PVC	320					
	325					
	330					
	335					
	340					

AWARE INCORPORATED

TEST BORING LOG

NO. AW-5

PROJECT:	Regional Bedrock Evaluation	SHEET NO.	8 of 9
CLIENT:	Ciba-Geigy Corp.	PROJECT NO.	6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS
VOLCLAY; 2" PVC	340					
	345				FORT ANN FORMATION	
	350				DOLOSTONE	
	355					
	360					
	365					
	370					
	375					
Bentonite Pellets	380					
SAND-PACK	385					
	390					

AWARE INCORPORATED

TEST BORING LOG

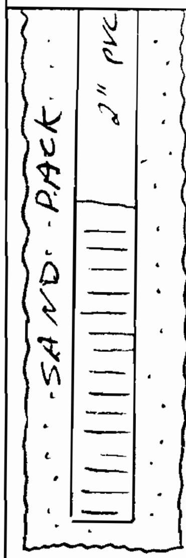
NO. AW-5

PROJECT: Regional Bedrock Evaluation

CLIENT: Ciba-Geigy Corp.

SHEET NO. 9 of 9

PROJECT NO. 6966

WELL CONSTRUCTION	DEPTH (FEET)	SAMPLE NO.	SAMPLE TYPE	SAMPLE BLOWS PER 6 INCHES	CLASSIFICATION (AFTER BURMISTER, 1959)	REMARKS
	390				FORT ANN FORMATION	
	395				DOLOSTONE	
	400					
	405				407.0'	"HORIZON C"
	410				END OF CORING	

APPENDIX C

HYDRAULIC CONDUCTIVITY DETERMINATIONS

AWARE, INC.
IN SITU VARIABLE HEAD
HYDRAULIC CONDUCTIVITY TEST

PIEZOMETER NO. AW-1
TEST NO. 1

PROJECT NO: 6966

CLIENT: CIBA GEIGY

GEOLOGIC UNIT: Beekmantown

SOIL CLASSIFICATION: Dolomite

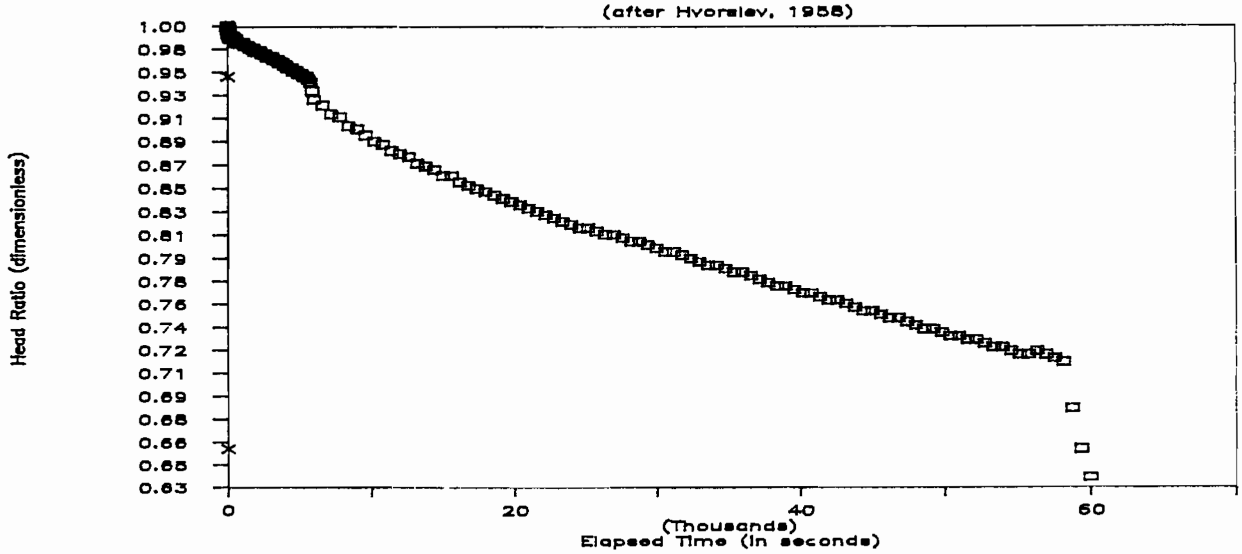
TESTED BY: JQR

DATE OF TEST: October 3, 1988

TEST DATA (PARTIAL LIST)

ELAPSED TIME	HEAD RATIO
0.0	1.000
5.2	1.000
19.2	1.000
85.2	0.995
330.2	0.989
1200.2	0.981
2880.2	0.970
4560.2	0.957
7200.2	0.916
15600.2	0.862
24000.2	0.822
32400.2	0.795
40800.2	0.768
49200.2	0.741

GRAPHICAL ANALYSIS
(after Hvorslev, 1958)



METHOD:

$$k = \frac{r^2}{2L(t_2 - t_1)} \ln(L/R) \ln(H_1/H_2)$$

k = hydraulic conductivity in cm/sec

k = 2.3E-07 cm/sec

r = well radius in cm 2.54
R = bore radius in cm 7.62
L = effective length in cm 381

H1 = head ratio at t1 0.951
t1 = elapsed time at H1 5520.2 sec
H2 = head ratio at t2 0.657
t2 = elapsed time at H2 59400.2 sec

AWARE, INC.

IN SITU VARIABLE HEAD
HYDRAULIC CONDUCTIVITY TEST

PIEZOMETER NO. AW-2
TEST NO. 1

PROJECT NO: 6966

CLIENT: Ciba-Geigy

GEOLOGIC UNIT: Beekmantown

SOIL CLASSIFICATION: Dolomite

TESTED BY: JQR

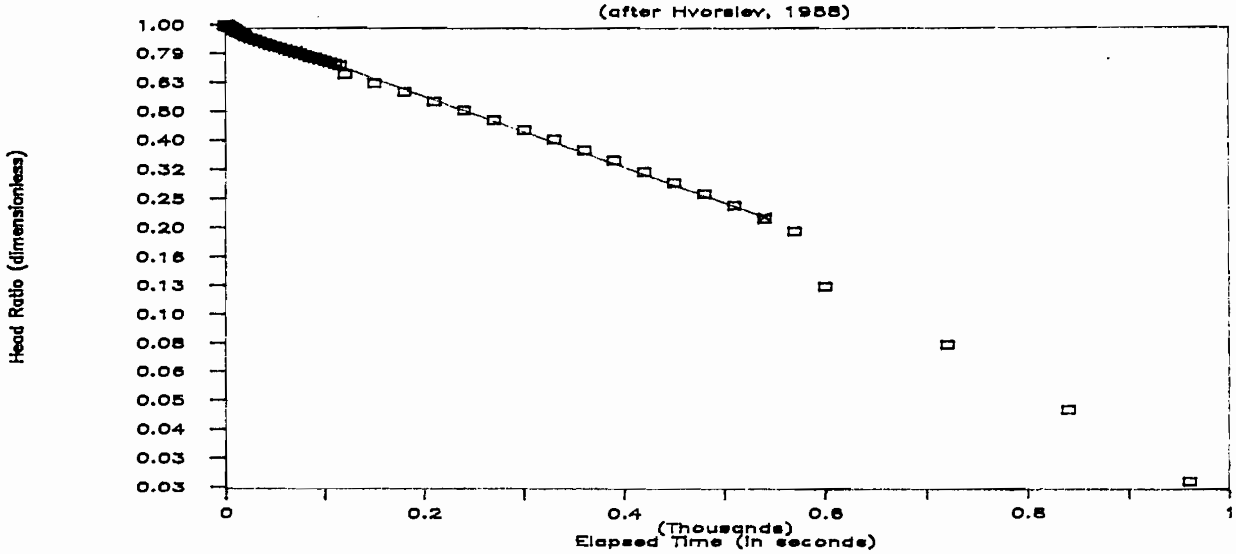
DATE OF TEST: October 3, 1988

TEST DATA (PARTIAL LIST)

ELAPSED TIME	HEAD RATIO
0.0	1.000
0.8	0.997
1.6	1.000
3.2	0.997
7.2	0.980
11.2	0.953
15.2	0.942
19.2	0.927
35.2	0.878
55.2	0.834
75.2	0.796
95.2	0.761
115.2	0.726
210.2	0.545

GRAPHICAL ANALYSIS

(after Hvorslev, 1988)



METHOD:

$$k = \frac{r^2}{2L(t_2 - t_1)} \ln(L/R) \ln(H_1/H_2)$$

k = hydraulic conductivity in cm/sec

k = 9.4E-05 cm/sec

r = well radius in cm 2.54

R = bore radius in cm 7.62

L = effective length in cm 374.904

H1 = head ratio at t1 0.805

t1 = elapsed time at H1 70.2 sec

H2 = head ratio at t2 0.216

t2 = elapsed time at H2 540.2 sec

AWARE, INC.

IN SITU VARIABLE HEAD
HYDRAULIC CONDUCTIVITY TEST

PIEZOMETER NO. AW-4
TEST NO. 1

PROJECT NO: 6966

CLIENT: CIBA GEIGY

GEOLOGIC UNIT: Beekmantown

SOIL CLASSIFICATION: Dolomite

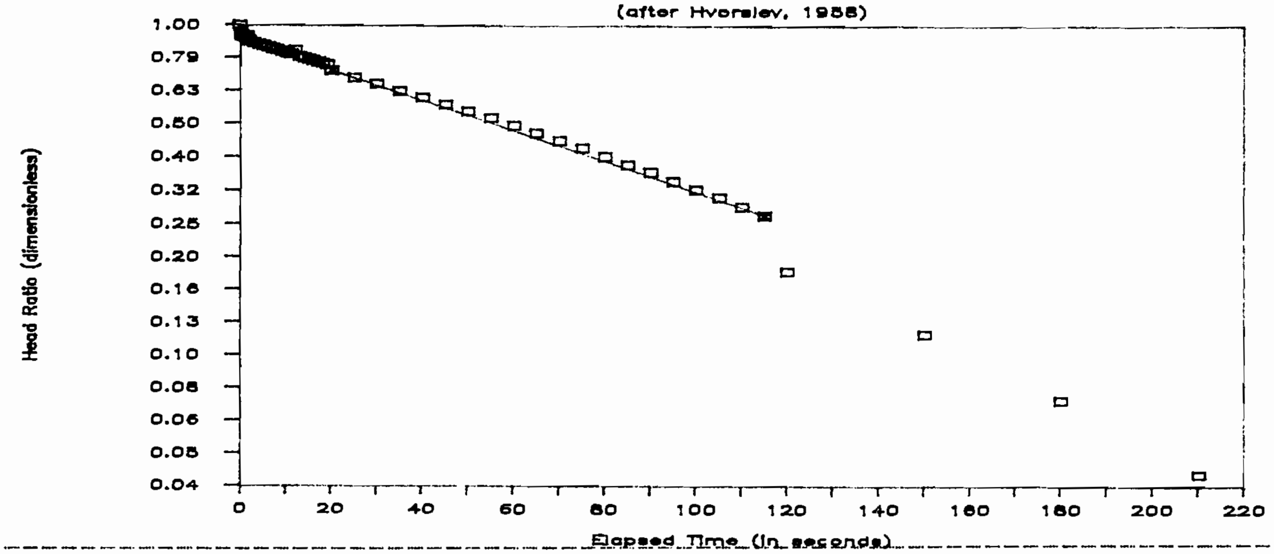
TESTED BY: JQR

DATE OF TEST: October 4, 1988

TEST DATA (PARTIAL LIST)

ELAPSED TIME	HEAD RATIO
0.0	1.000
0.6	0.930
1.2	0.924
1.8	0.902
3.2	0.883
6.2	0.859
9.2	0.835
12.2	0.840
15.2	0.791
18.2	0.770
25.2	0.694
40.2	0.604
55.2	0.523
70.2	0.447

GRAPHICAL ANALYSIS
(after Hvorslev, 1958)



METHOD:

$$k = \frac{r^2}{2L(t_2 - t_1)} \ln(L/R)\ \ln(H_1/H_2)$$

k = hydraulic conductivity in cm/sec

k = 3.4E-04 cm/sec

r = well radius in cm 2.54
R = bore radius in cm 7.62
L = effective length in cm 387.096

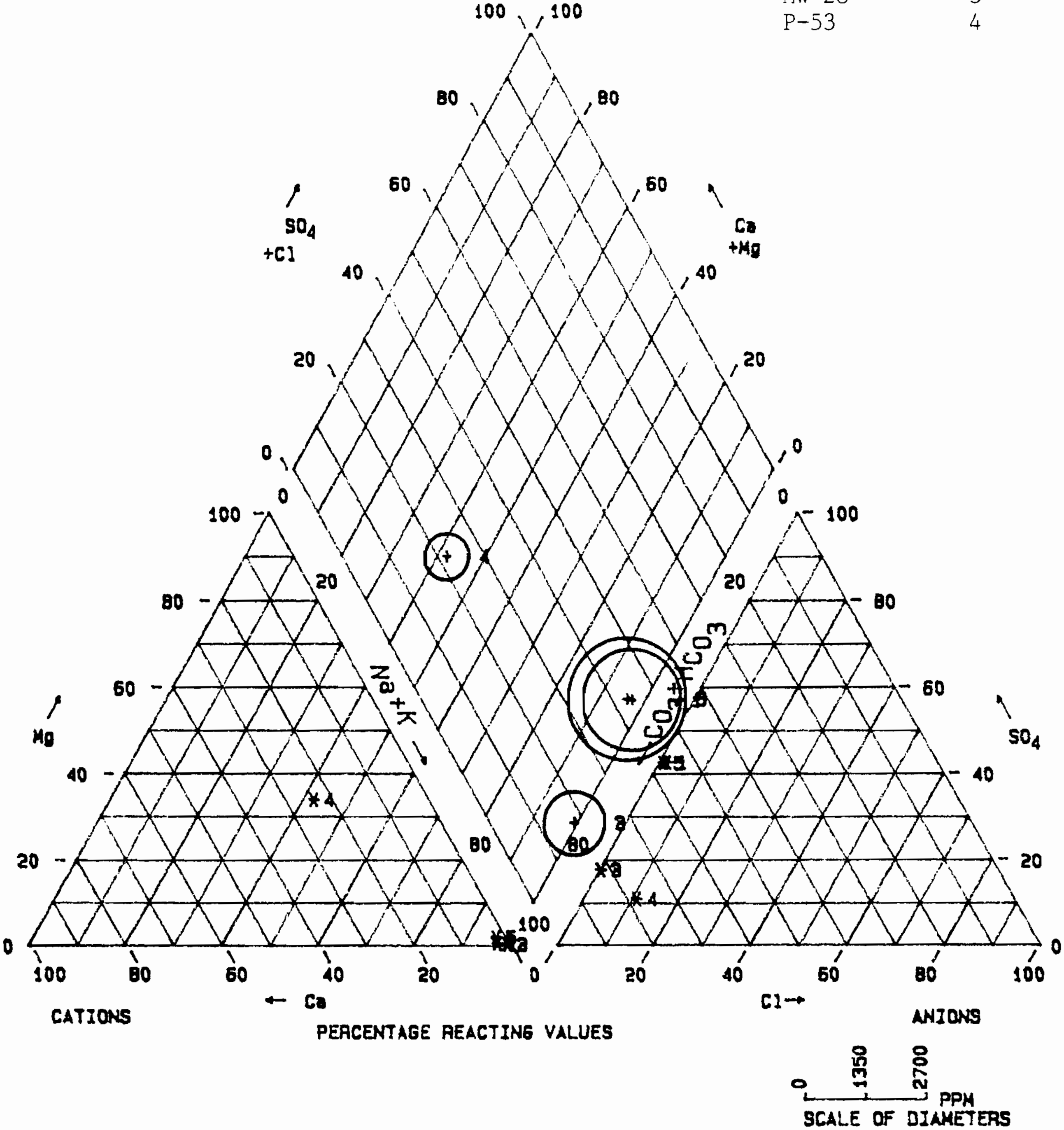
H1 = head ratio at t1 0.729
t1 = elapsed time at H1 20.2 sec
H2 = head ratio at t2 0.268
t2 = elapsed time at H2 115.2 sec

APPENDIX D

MAJOR ION DATA GRAPHS

Overburden Horizon

Well No.	Reference
MW-9	1
MW-26	2
MW-28	3
P-53	4

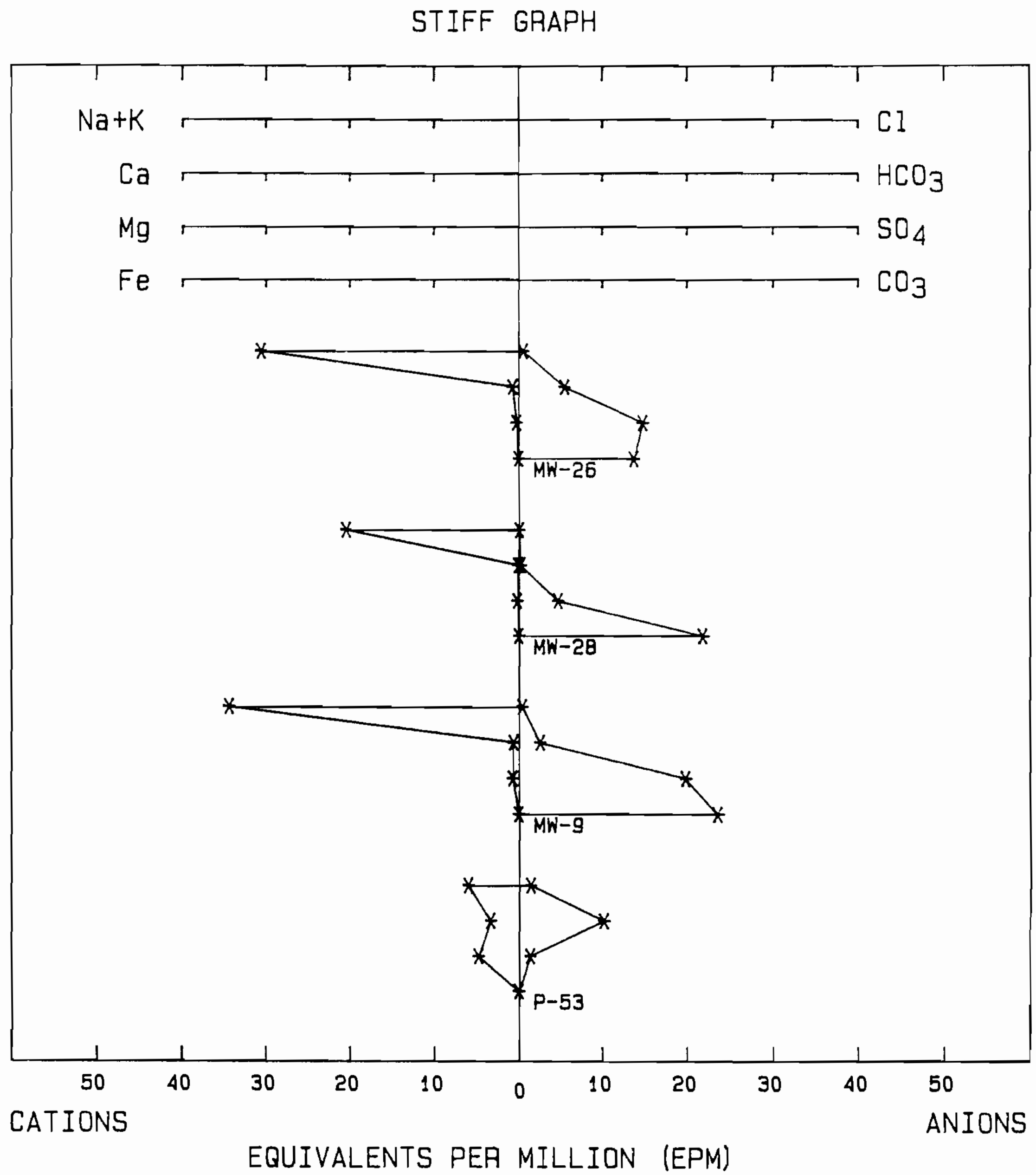


PROJECT: CIBA-GEIGY
FILE: 6966
LOCATION: GLENS FALLS

PIPER TRILINEAR DIAGRAM

AWARE INC.

FIGURE: D-1



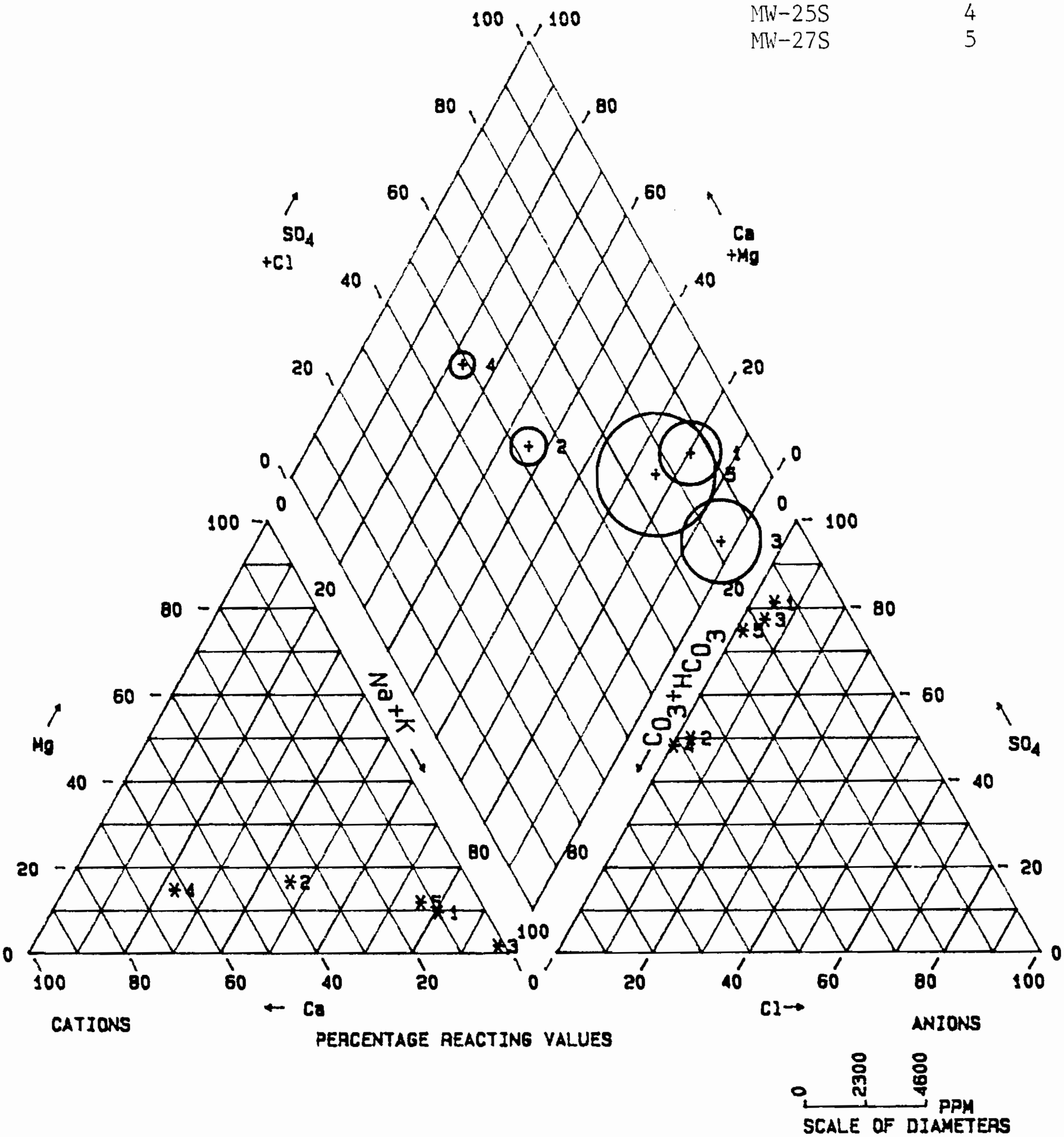
PROJECT: CIBA-GEIGY
FILE: 6966
LOCATION: GLENS FALLS

AWARE INC.

FIGURE: D-2

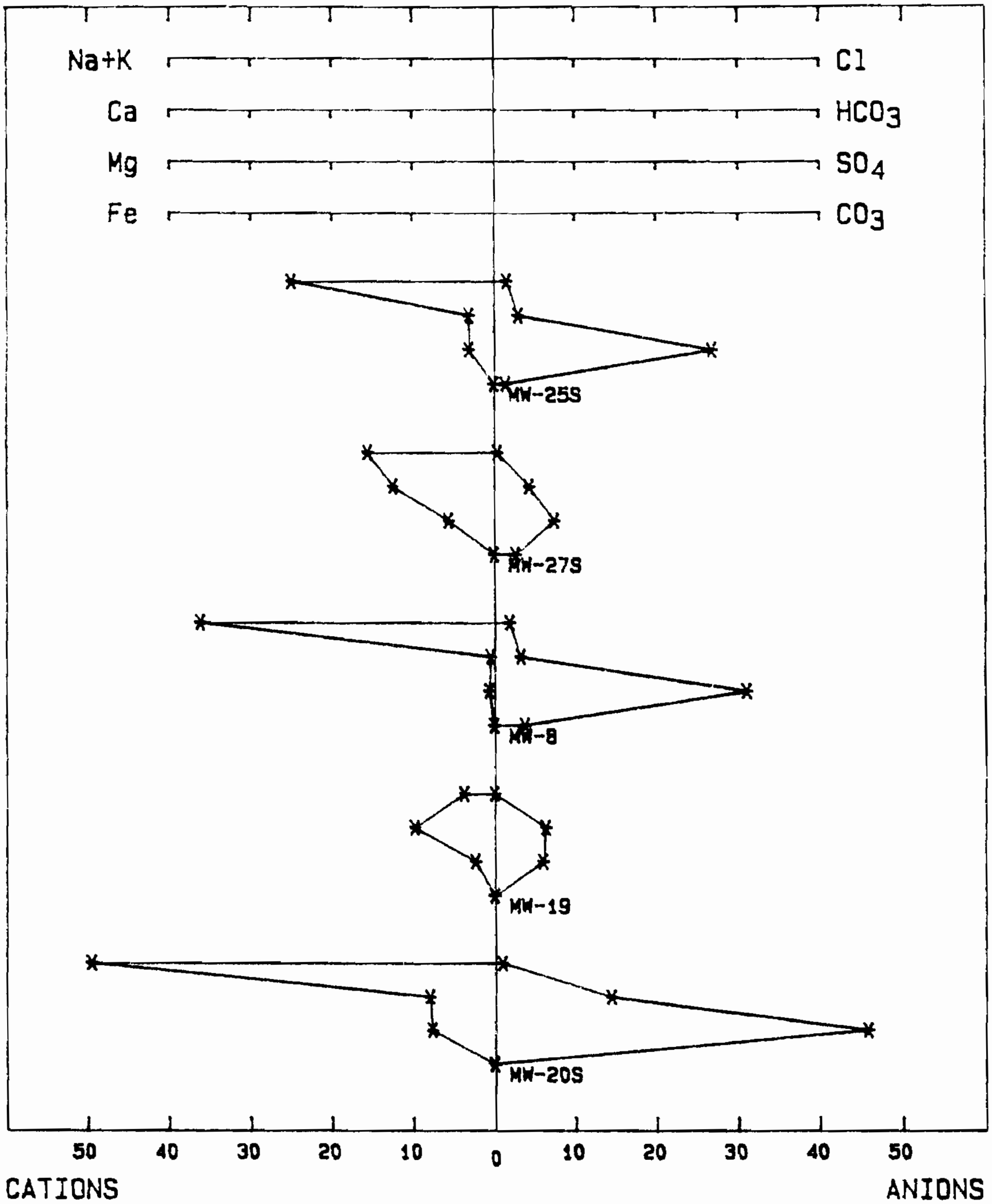
Hydrostratigraphic Horizon A

Well No.	Reference
MW-8	1
MW-19	2
MW-20S	3
MW-25S	4
MW-27S	5



PROJECT: CIBA-GEIGY FILE: 6966 LOCATION: GLENS FALLS	PIPER TRILINEAR DIAGRAM
AWARE INC.	FIGURE: D-3

STIFF GRAPH



EQUIVALENTS PER MILLION (EPM)

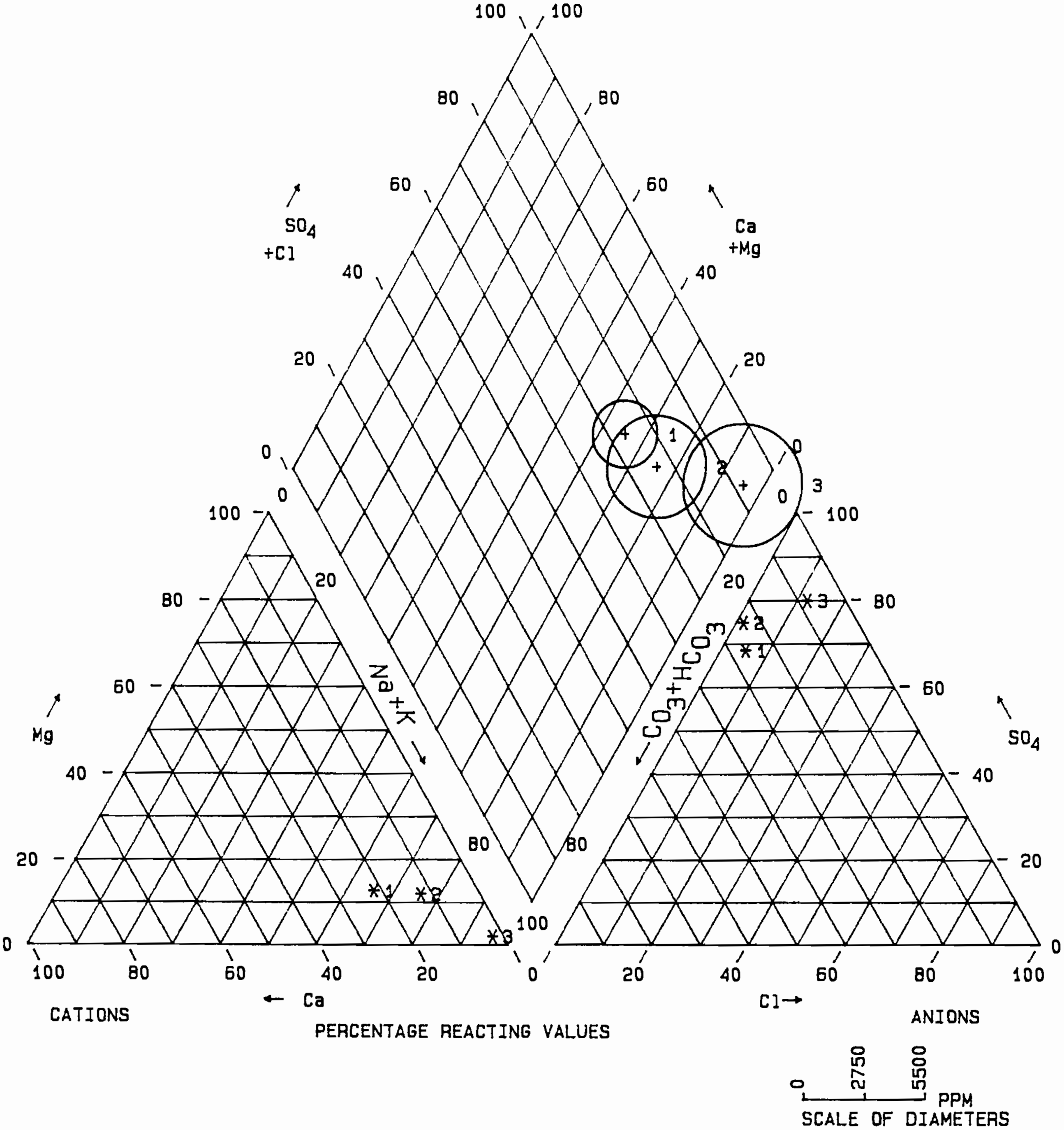
PROJECT: CIBA-GEIGY
FILE: 6966
LOCATION: GLENS FALLS

AWARE INC.

FIGURE: D-4

Hydrostratigraphic Horizon A

Well No.	Reference
MW-35S	1
MW-36S	2
MW-20S	3

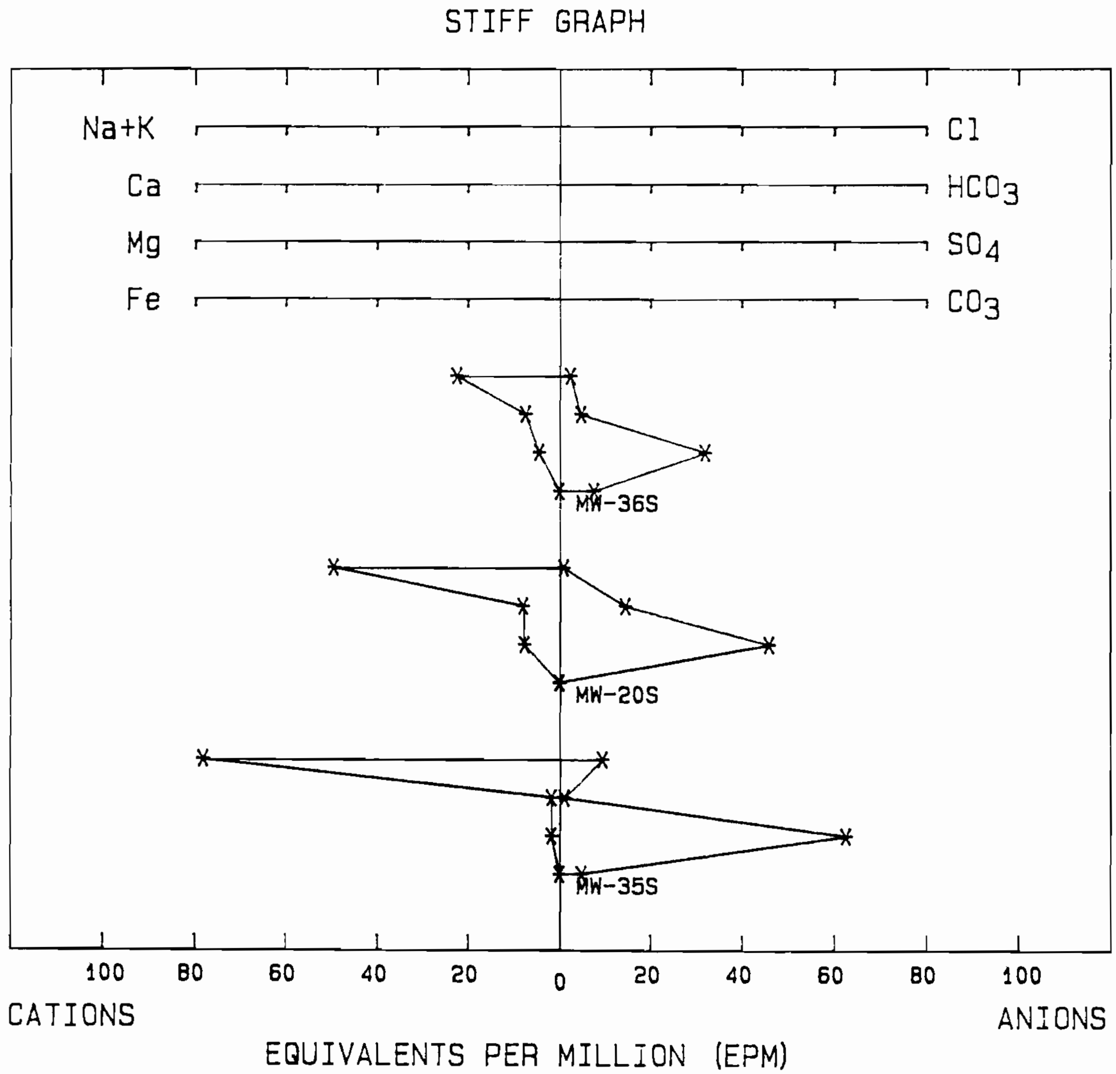


PROJECT: CIBA-GEIGY
FILE: 6966
LOCATION: GLENS FALLS

PIPER TRILINEAR DIAGRAM

AWARE INC.

FIGURE: D-5



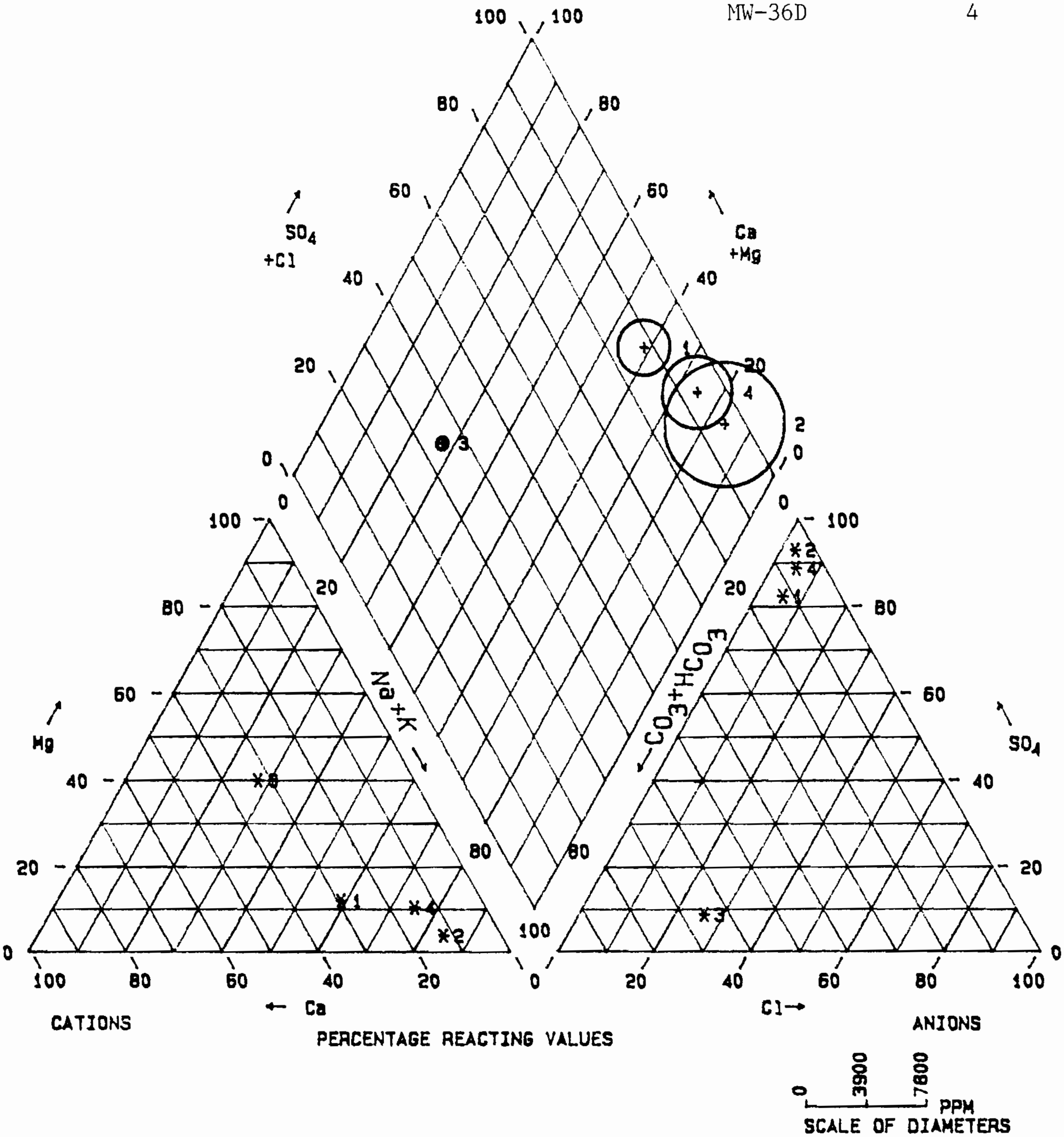
PROJECT: CIBA-GEIGY
FILE: 6966
LOCATION: GLENS FALLS

AWARE INC.

FIGURE: D-6

Hydrostratigraphic Horizon B

Well No.	Reference
MW-20D	1
MW-27D	2
MW-35D	3
MW-36D	4

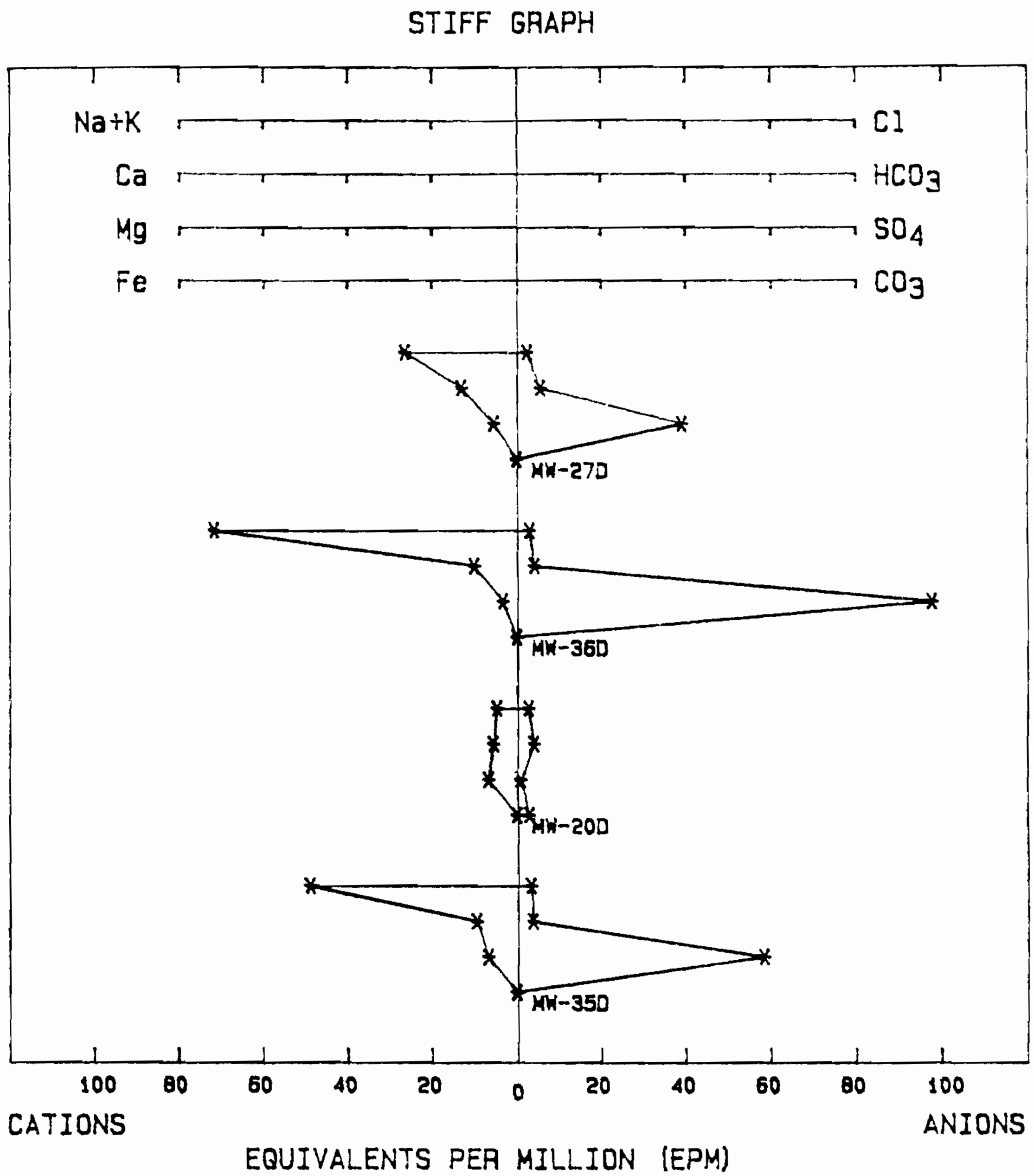


PROJECT: CIBA-GEIGY
FILE: 6966
LOCATION: GLENS FALLS

PIPER TRILINEAR DIAGRAM

AWARE INC.

FIGURE: D-7



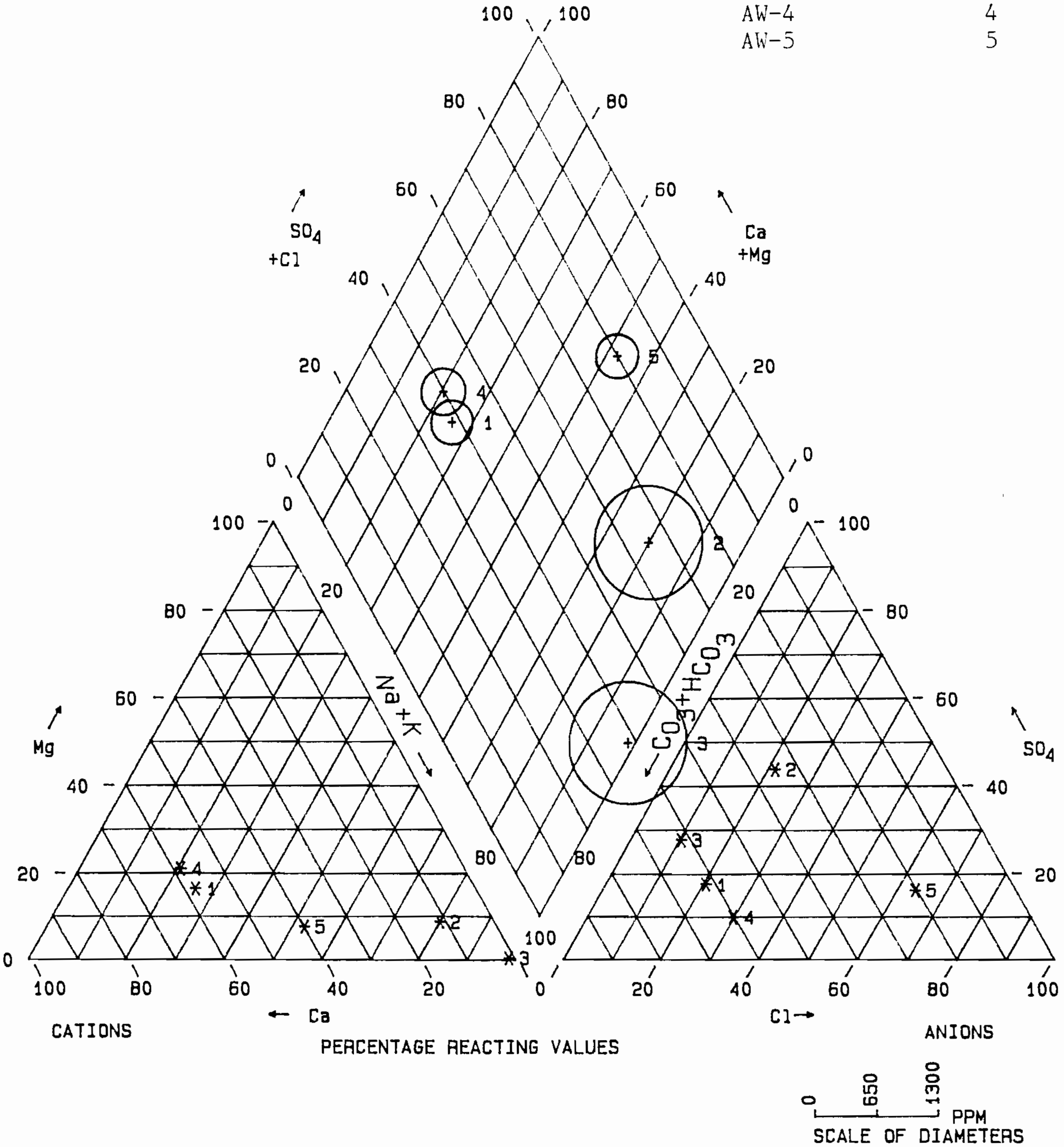
PROJECT: CIBA-GEIGY
FILE: 6966
LOCATION: GLENS FALLS

AWARE INC.

FIGURE: D-8

Hydrostratigraphic Horizon C

Well No.	Reference
AW-1	1
AW-2	2
AW-3	3
AW-4	4
AW-5	5



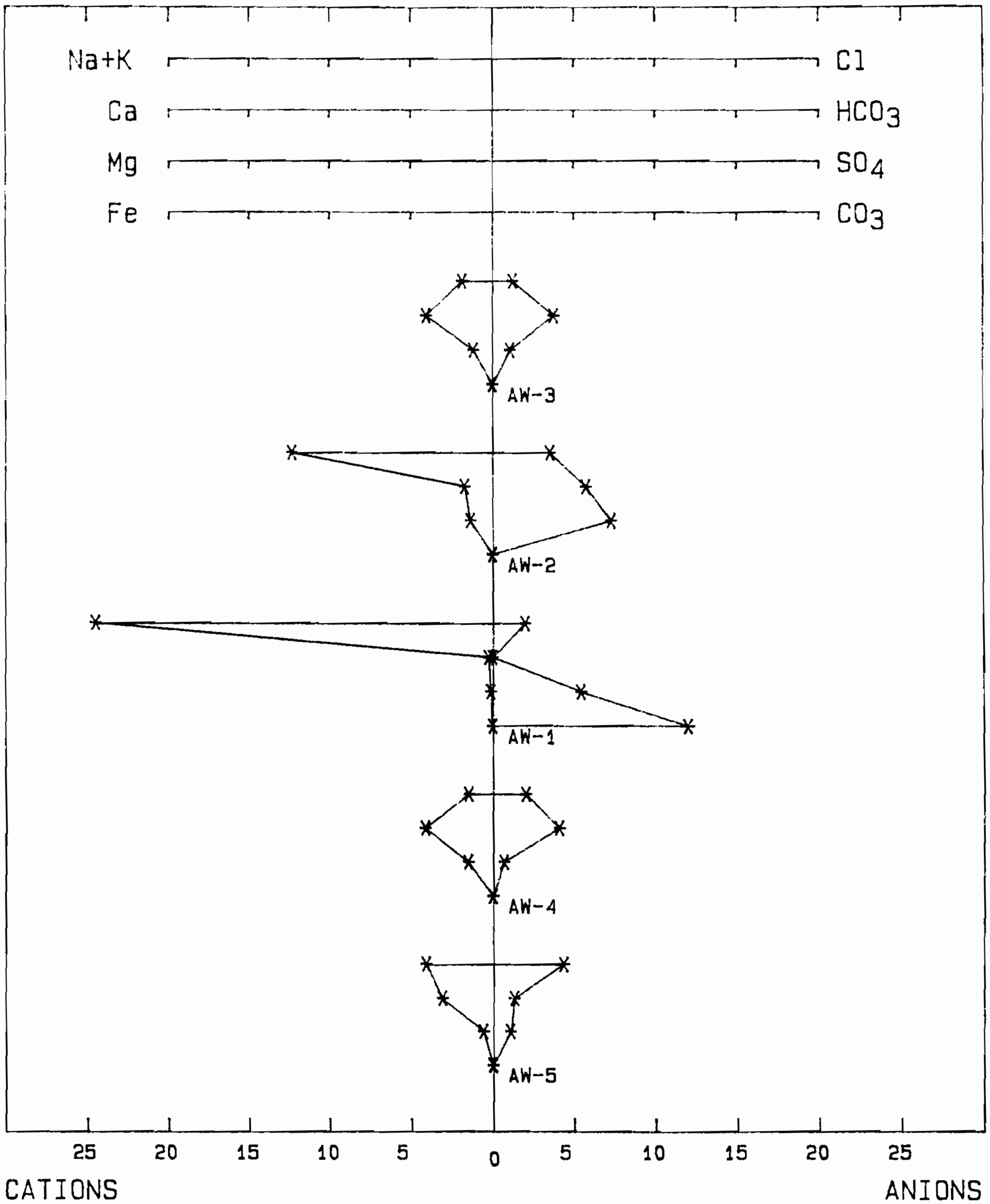
PROJECT: CIBA-GEIGY
FILE: 6966
LOCATION: GLENS FALLS - NY

PIPER TRILINEAR DIAGRAM

AWARE INC.

FIGURE: D-9

STIFF GRAPH



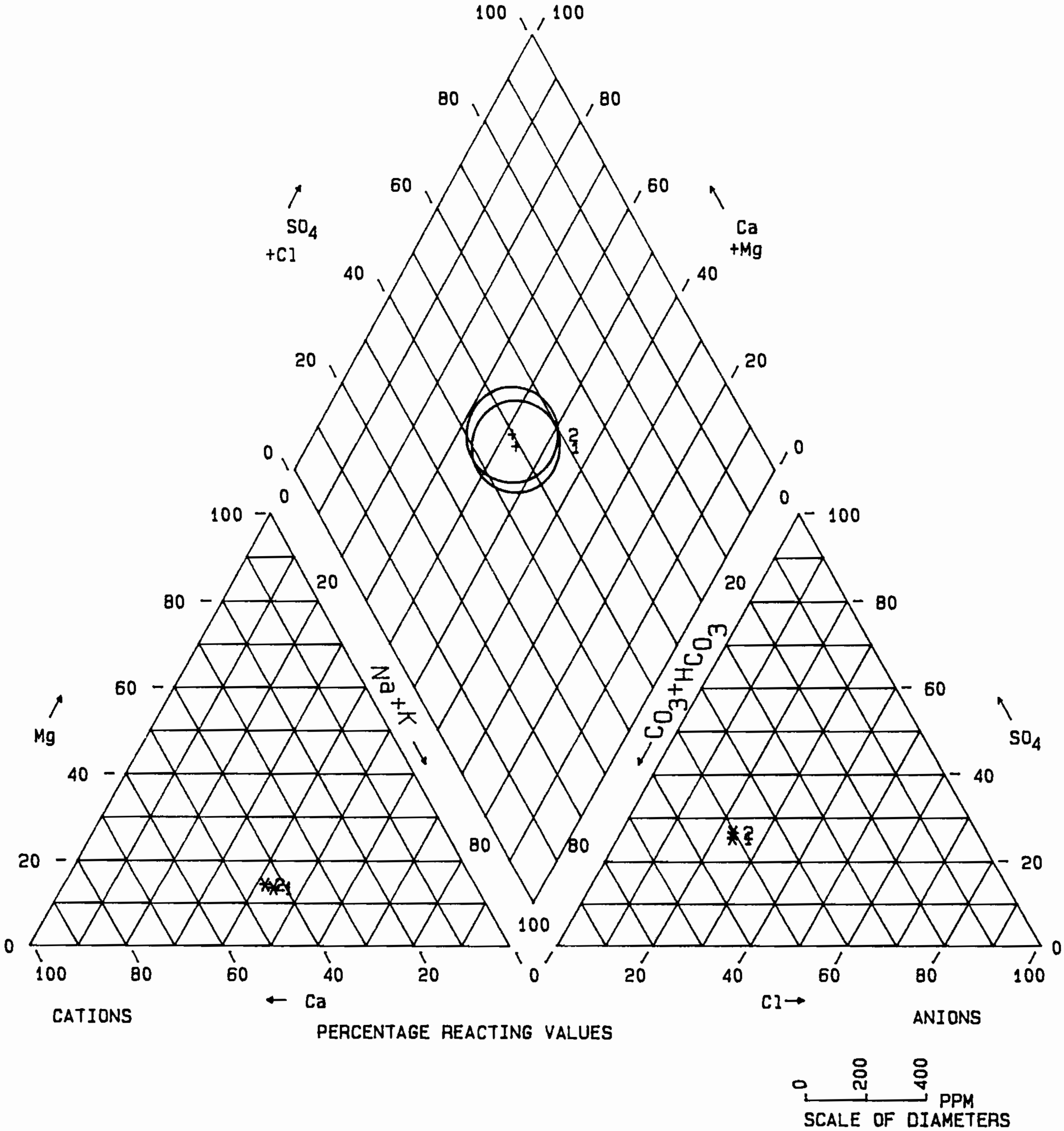
PROJECT: CIBA-GEIGY
FILE: 6966
LOCATION: GLENS FALLS - NY

AWARE INC.

FIGURE: D-10

Quarry Coreholes

Corehole No.	Reference
CH-2	1
CH-5	2

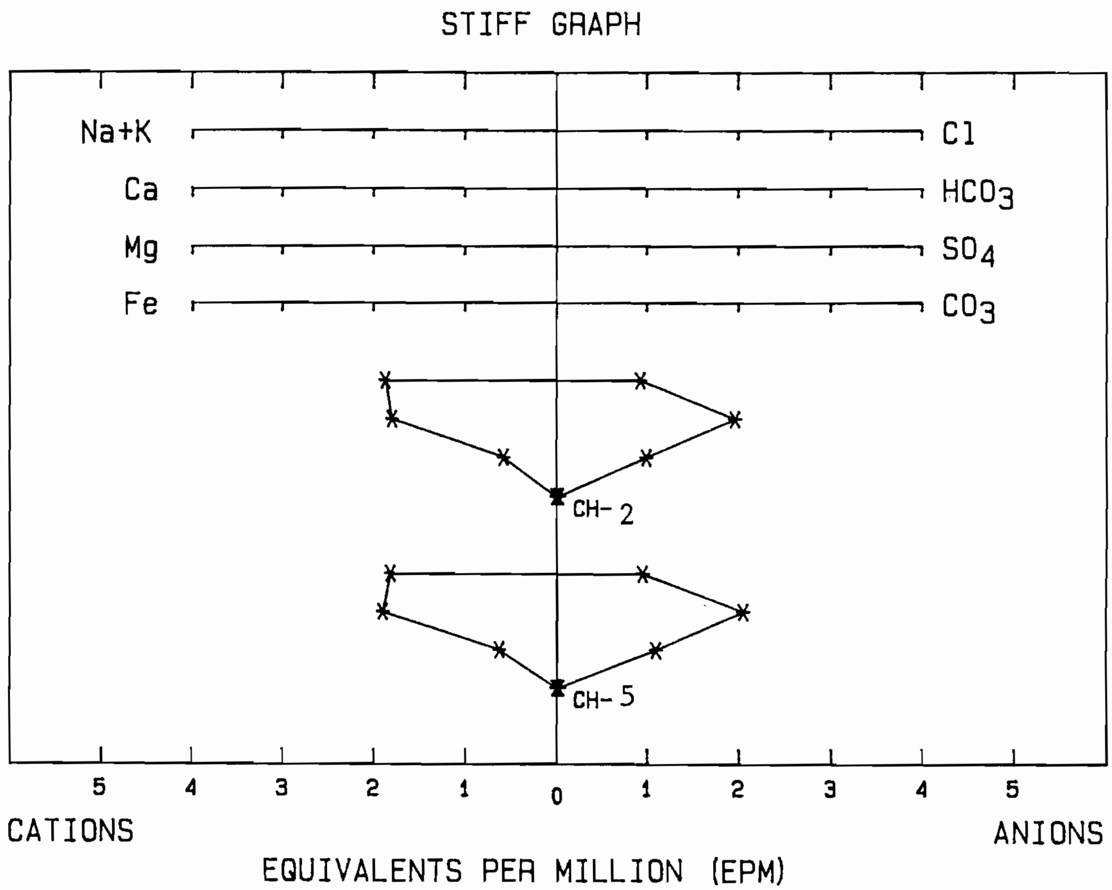


PROJECT: CIBA-GEIGY
FILE: 6966
LOCATION: GLENS FALLS

PIPER TRILINEAR DIAGRAM

AWARE INC.

FIGURE: D-11



PROJECT: CIBA-GEIGY
FILE: 6966
LOCATION: GLENS FALLS

AWARE INC.

FIGURE: D-12


LEGEND:
MW-40D ● PREVIOUSLY INSTALLED MONITORING WELL
AW-2 WELL INSTALLED BY AWARE, INC.
No. 4 ○ PRODUCTION WELL
dh79-5 QUARRY DRILL-HOLE
CH-3 □ QUARRY CORE-HOLE (LOCATION APPROXIMATE)
A A' HYDROSTRATIGRAPHIC CROSS SECTION
HUDSON
RIVER
UNIMPROVED ACCESS ROADS
APPROXIMATE QUARRY FLOOR
APPROXIMATE QUARRY RIM
LIMESTONE QUARRY (WESTERN FLOOR)
LIMESTONE QUARRY (EASTERN FLOOR)
CONVEYOR
NORTH LAGOON
NORTH WASTE PILE
SOUTH WASTE PILE
STORMWATER BASIN
WASTEWATER TREATMENT PLANT
VAN BUREN STREET
HARRISON AVENUE
SISSON ROAD
GLENS FALLS FEEDER CANAL
WARREN STREET
BOULEVARD
QUAKER ROAD
RIVER STREET
200 0 200 400
scale feet
NO. REVISIONS REV'D BY DATE APPRO'D BY
AWARE INCORPORATED
NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY
CIBA-GEIGY CORPORATION
GLENS FALLS PLANT
LOCATION OF WELLS AND CROSS SECTIONS
SCALE: AS SHOWN
DRAWN BY J.H.S.
DATE 12/88
CHECKED BY
APPROVED BY
DRAWING NUMBER 6966-1
NOTE: BASE MAP TAKEN FROM;
"TOPOGRAPHIC MAP LANDS OF GLENS FALLS PORTLAND CEMENT CO." LOCKWOOD SUPPORT SERVICES, INC., ROCHESTER N.Y. - (APRIL, 1988)
MALCOLM PIRNIE DRAWING No. 0267-87001-0; SEPT. 1987-(REDUCED)

NOTE: BASE MAP TAKEN FROM;
- "TOPOGRAPHIC MAP LANDS OF GLENS FALLS PORTLAND CEMENT CO." LOCKWOOD SUPPORT SERVICES, INC., ROCHESTER N.Y. - (APRIL, 1988)
- MALCOLM PIRNIE DRAWING No. 0267-87001-0; SEPT. 1987 - (REDUCED)

NO.	REVISIONS	REV'D BY	DATE	APPRO'D BY

AWARE INCORPORATED
NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY

CIBA-GEIGY CORPORATION
GLENS FALLS PLANT

STRUCTURAL CONTOUR MAP
HYDROSTRATIGRAPHIC HORIZON B

SCALE: AS SHOWN

DRAWN BY	DATE	CHECKED BY	APPROVED BY	DRAWING NUMBER
J.H.S.	12/88			6966-2

NO.	REVISIONS	REV'D BY	DATE	APPRO'D BY

AWARE INCORPORATED
NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY

CIBA-GEIGY CORPORATION
GLENS FALLS PLANT

STRUCTURAL CONTOUR MAP
HYDROSTRATIGRAPHIC HORIZON C

SCALE: AS SHOWN

DRAWN BY	DATE	CHECKED BY	APPROVED BY	DRAWING NUMBER
J.H.S.	12/88			6966-3

NO.	REVISIONS	REV'D BY	DATE	APPRO'D BY

AWARE INCORPORATED
NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY

SCALE: AS SHOWN

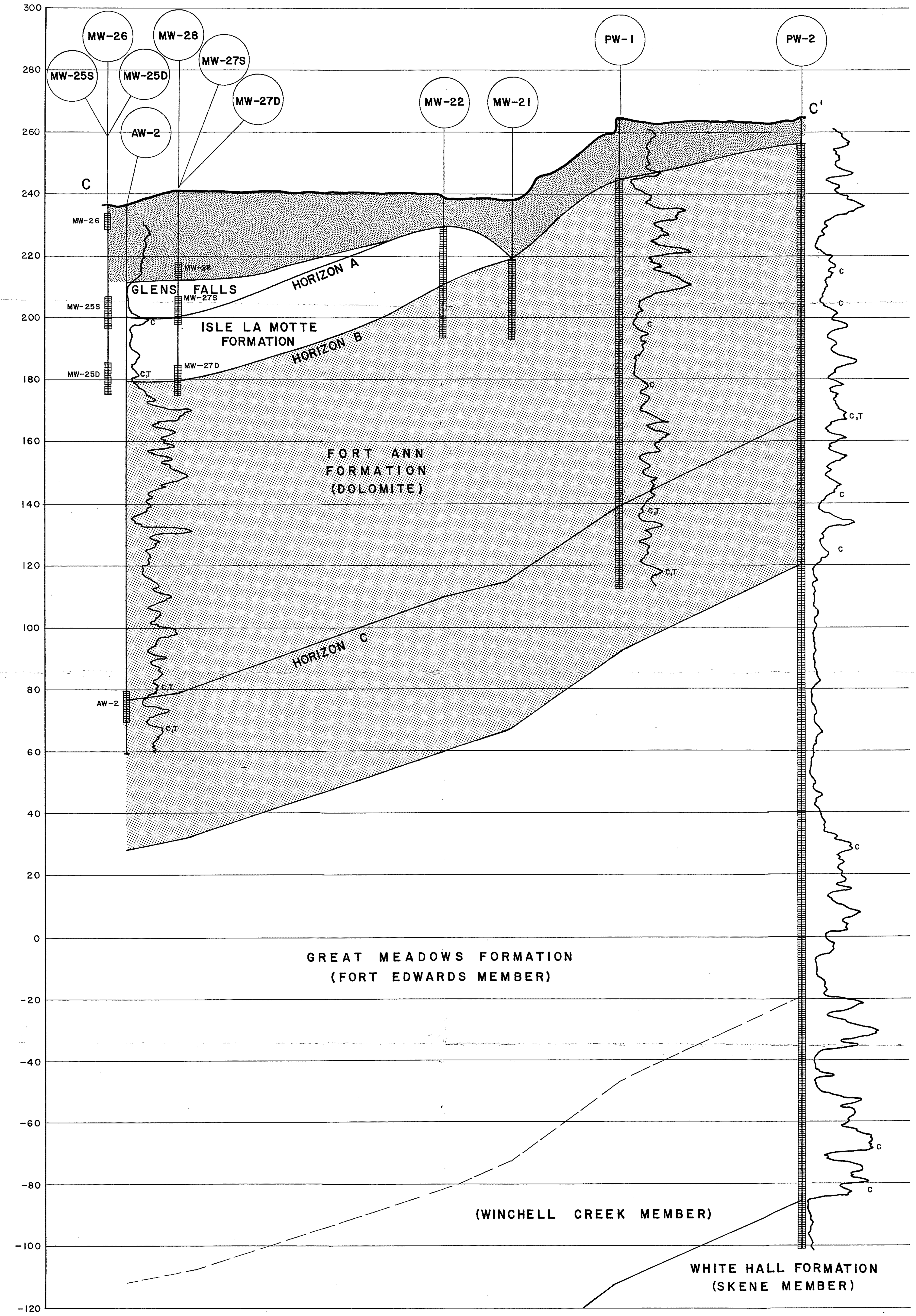
DRAWN BY	DATE	CHECKED BY	APPROVED BY
E.L.B.	12/88		

CIBA-GEIGY CORPORATION
GLENS FALLS PLANT

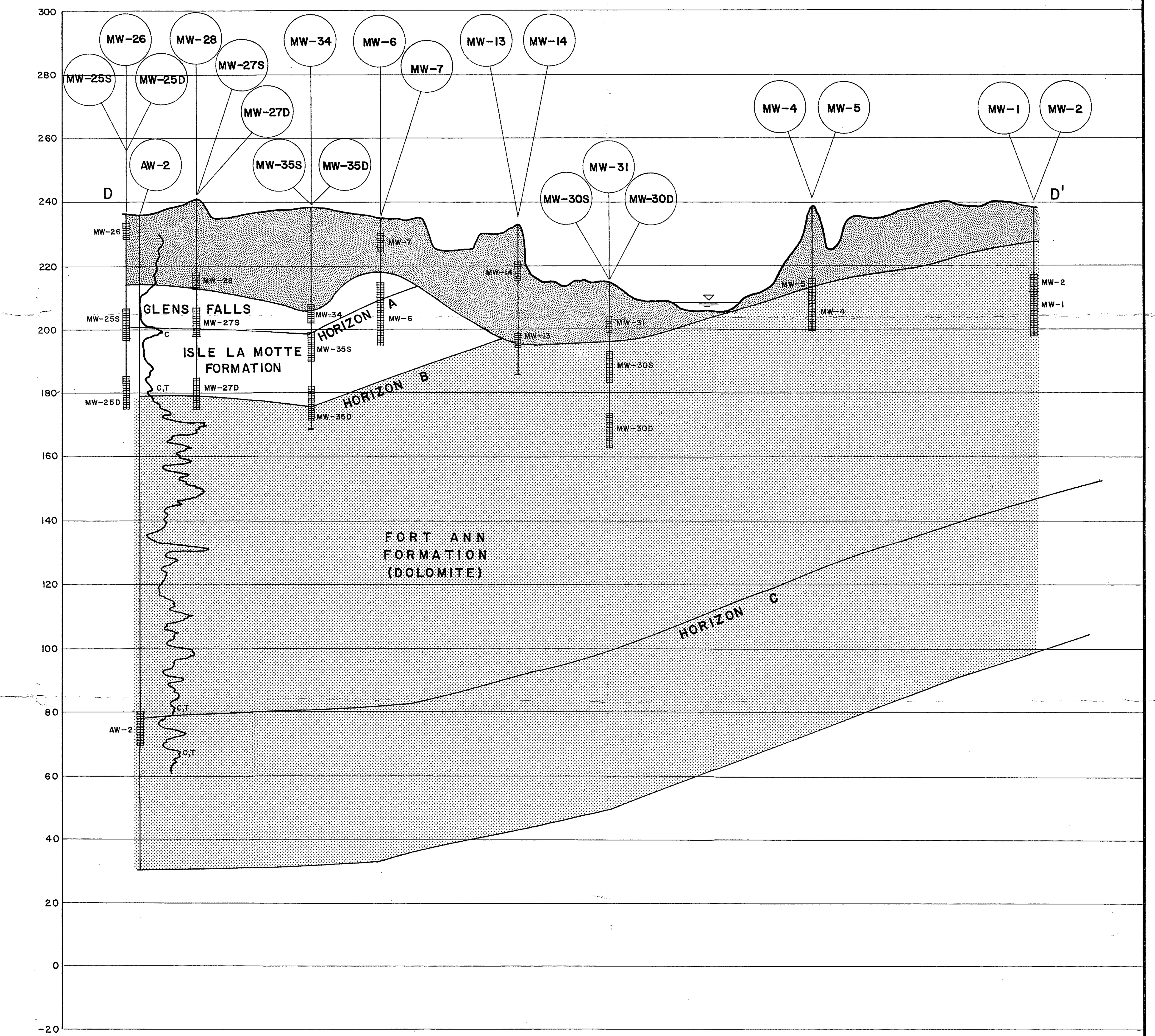
HYDROSTRATIGRAPHIC CROSS SECTION A-A'

DRAWING NUMBER 6966-4


ELEVATION (msl)
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
B
B'
AW-5
dh 74-4
AW-4
MW-28
MW-27S
MW-27D
MW-20S
MW-20D
MW-15
MW-16
MW-40S
MW-40D
AW-1
CANAL
SNAKE HILL FORMATION (SHALE)
UPPER SUGAR RIVER LIMESTONE
LOWER SUGAR RIVER LIMESTONE
GLENS FALLS FORMATION (LIMESTONE)
LARRABEE LIMESTONE
ISLE LA MOTTE FORMATION
HORIZON A
HORIZON B
HORIZON C
FORT ANN FORMATION (DOLOMITE)
QUARRY (EASTERN FLOOR)
HUDSON RIVER
GREAT MEADOWS FORMATION (FORT EDWARDS MEMBER)
LEGEND
IDENTIFICATION OF WELLS ACTUAL CONSTUCTION CONSISTS OF SEPARATE BOREHOLES.
GAMMA LOG.
SCREEN/OPEN ROCK INTERVAL
INDICATES CALIPER LOG DEFLECTION.
INDICATES TEMPERATURE LOG DEFLECTION.
GEOLOGIC FORMATION CONTACT.
INTRA-FORMATION CONTACT.
20 0 20 scale VERT. feet
200 0 200 scale HORIZ. feet
AWARE INCORPORATED
NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY
NO. REVISIONS REV'D BY DATE APPRO'D BY
CIBA-GEIGY CORPORATION
GLENS FALLS PLANT
HYDROSTRATIGRAPHIC CROSS SECTION B-B'
SCALE: AS SHOWN
DRAWN BY B.J.B.
DATE 12/88
CHECKED BY
APPROVED BY
DRAWING NUMBER 6966-5

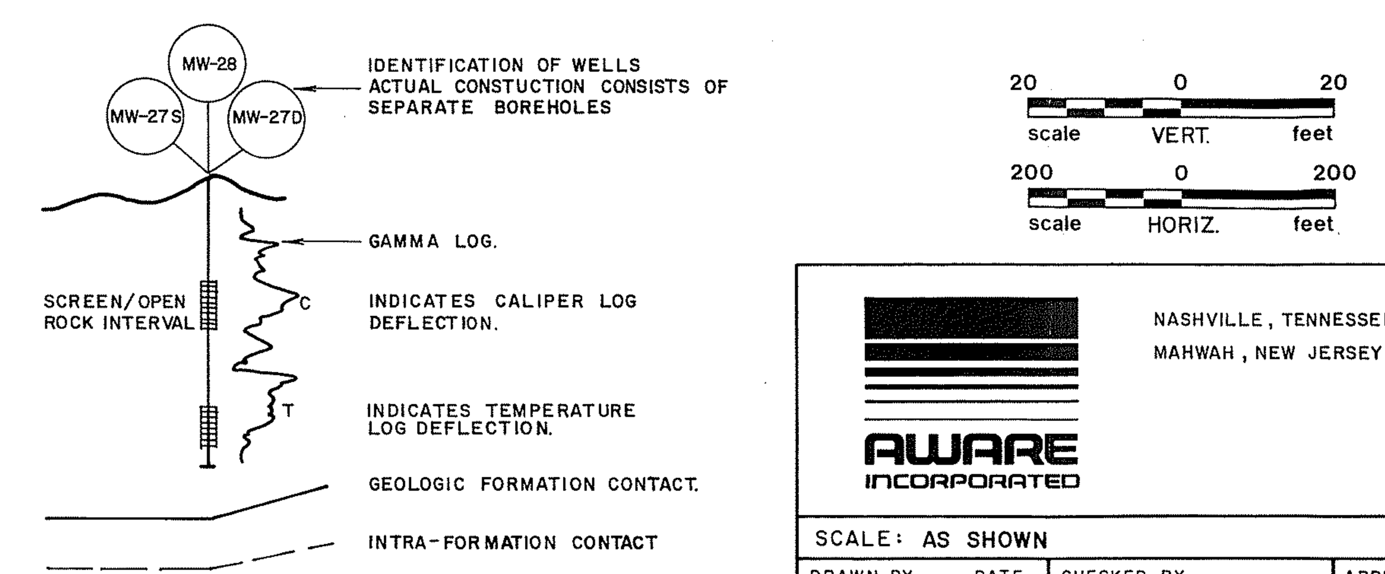


HYDROSTRATIGRAPHIC CROSS SECTION C-C'



HYDROSTRATIGRAPHIC CROSS SECTION D-D'

LEGEND



AWARE INCORPORATED
NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY

NO.	REVISIONS	REV'D BY	DATE	APPRO'D BY

CIBA-GEIGY CORPORATION
GLENS FALLS PLANT

HYDROSTRATIGRAPHIC
CROSS SECTION C-C' & D-D'

SCALE: AS SHOWN				
DRAWN BY B.J.B.	DATE 12/88	CHECKED BY	APPROVED BY	DRAWING NUMBER 6966-6

NOTE: BASE MAP TAKEN FROM;

- "TOPOGRAPHIC MAP LANDS OF GLENS FALLS PORTLAND CEMENT CO." LOCKWOOD SUPPORT SERVICES, INC., ROCHESTER N.Y. - (APRIL, 1988)
- MALCOLM PIRNIE DRAWING No. 0267-87001-0; SEPT. 1987 - (REDUCED)

NO.	REVISIONS	REV'D BY	DATE	APPRO'D BY

AWARE INCORPORATED
NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY

CIBA-GEIGY CORPORATION
GLENS FALLS PLANT

GENERALIZED PIEZOMETRIC SURFACE HORIZON A

SCALE: AS SHOWN

DRAWN BY	DATE	CHECKED BY	APPROVED BY	DRAWING NUMBER
J.H.S.	12/88			6966-7

NOTE: BASE MAP TAKEN FROM;

- "TOPOGRAPHIC MAP LANDS OF GLENS FALLS PORTLAND CEMENT CO." LOCKWOOD SUPPORT SERVICES, INC., ROCHESTER N.Y. - (APRIL, 1988)
- MALCOLM PIRNIE DRAWING No. 0267-87001-0; SEPT. 1987 - (REDUCED)

NO.	REVISIONS	REV'D BY	DATE	APPRO'D BY

AWARE INCORPORATED

NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY

CIBA - GEIGY CORPORATION
GLENS FALLS PLANT

GENERALIZED PIEZOMETRIC SURFACE
HORIZON B

SCALE: AS SHOWN

DRAWN BY	DATE	CHECKED BY	APPROVED BY	DRAWING NUMBER
J.H.S.	12/88			6966 - 8

NOTE: BASE MAP TAKEN FROM;
- "TOPOGRAPHIC MAP LANDS OF GLENS FALLS PORTLAND CEMENT CO." LOCKWOOD SUPPORT SERVICES, INC., ROCHESTER N.Y. - (APRIL, 1988)
- MALCOLM PIRNIE DRAWING No. 0267-87001-0; SEPT. 1987-(REDUCED)

NO.	REVISIONS	REV'D BY	DATE	APPRO'D BY

AWARE INCORPORATED
NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY

CIBA - GEIGY CORPORATION
GLENS FALLS PLANT

GENERALIZED PIEZOMETRIC SURFACE
HORIZON C

SCALE: AS SHOWN

DRAWN BY	DATE	CHECKED BY	APPROVED BY	DRAWING NUMBER
J.H.S.	12/88			6966 - 9

NOTE: BASE MAP TAKEN FROM;

- "TOPOGRAPHIC MAP LANDS OF GLENS FALLS PORTLAND CEMENT CO." LOCKWOOD SUPPORT SERVICES, INC., ROCHESTER N.Y. - (APRIL, 1988)
- MALCOLM PIRNIE DRAWING No. 0267-87001-0; SEPT. 1987 - (REDUCED)

NO.	REVISIONS	REV'D BY	DATE	APPRO'D BY

AWARE INCORPORATED

NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY

SCALE: AS SHOWN

DRAWN BY	DATE	CHECKED BY	APPROVED BY
J.H.S.	12/88		

CIBA - GEIGY CORPORATION
GLENS FALLS PLANT

WATER QUALITY DATA SUMMARY
INORGANICS

DRAWING NUMBER
6966 - 10


LEGEND:
MW-40D PREVIOUSLY INSTALLED MONITORING WELL
AW-2 WELL INSTALLED BY AWARE, INC.
No. 4 PRODUCTION WELL
dh79-5 QUARRY DRILL-HOLE
CH-3 QUARRY CORE-HOLE (LOCATION APPROXIMATE)
UI UNIDENTIFIED HORIZON
ND NONDETECTED
NS NOT SAMPLED
CB CHLOROBENZENE (ppb)
o-DCB O-DICHLOROBENZENE (ppb)
OB OVERBURDEN
A HORIZON A
B HORIZON B
C HORIZON C
N
HUDSON
RIVER
UNIMPROVED ACCESS ROADS
VAN BUREN STREET
HARRISON AVENUE
SISSON ROAD
GLENS FALLS FEEDER CANAL
WARREN STREET
BOULEVARD
QUAKER ROAD
RIVER STREET
FEEDER CANAL
APPROXIMATE QUARRY FLOOR
APPROXIMATE QUARRY RIM
LIMESTONE QUARRY (WESTERN FLOOR)
LIMESTONE QUARRY (EASTERN FLOOR)
CONVEYOR
SEEP
Q-Pond
NORTH LAGOON
SOUTH WASTE PILE
NORTH WASTE PILE
STORMWATER BASIN
WASTEWATER TREATMENT PLANT
CB o-DCB
UI ND ND
UI ND ND
C ND ND
(MW-40S)
CB o-DCB
A 2000 ND
B 1300 ND
(MW-36S)
CB o-DCB
OB ND ND
A ND ND
(MW-9)
CB o-DCB
A 860 ND
B 92 ND
(MW-20D)
CB o-DCB
OB ND 37,000
A ND ND
B NS NS
C ND 21
(MW-25S)
CB o-DCB
A ND ND
(MW-19)
CB o-DCB
OB ND 190
A ND ND
B 3400 410
(MW-27S)
CB o-DCB
OB ND ND
(P-53)
CB o-DCB
OB ND ND
A ND ND
B 41 ND
(MW-34)
CB o-DCB
C ND ND
(AW-3)
CB o-DCB
A ND ND
CB o-DCB
B ND ND
CB o-DCB
ND ND
(Q-Pond)
CB o-DCB
C ND ND
(AW-4)
CB o-DCB
C ND ND
(AW-5)
dh 74-6
dh 74-5
dh 74-4
dh 74-1
dh74-3
dh74-2
dh 79-1
dh 79-5
dh 79-2
dh 79-3
dh 79-4
CH-1 CH-2 CH-3 CH-4 CH-5 CH-6 CH-7 CH-8 CH-9 CH-10 CH-11 CH-12 CH-13
MW-40D AW-1 MW-16 MW-15 P-46 MW-24 MW-23S MW-23D MW-36D MW-8 MW-20S No.5 MW-26 MW-25D AW-2 P-71 MW-27D MW-28 MW-35S MW-35D MW-7 MW-6 MW-29S MW-10 MW-22 MW-21 No.4 No.1 No.3 No.6 MW-14 MW-13 MW-31 MW-30D MW-30S MW-17S MW-17 MW-18 MW-37S No.2 MW-5 MW-4 MW-2 MW-1 MW-33D MW-33S MW-45 No.7 No.9 No.8
200 0 200 400
scale feet
NO. REVISIONS REV'D BY DATE APPRO'D BY
AWARE INCORPORATED
NASHVILLE, TENNESSEE
MAHWAH, NEW JERSEY
CIBA - GEIGY CORPORATION
GLENS FALLS PLANT
WATER QUALITY DATA SUMMARY
ORGANICS
SCALE: AS SHOWN
DRAWN BY J.H.S.
DATE 12/88
CHECKED BY
APPROVED BY
DRAWING NUMBER 6966-11
NOTE: BASE MAP TAKEN FROM;
• "TOPOGRAPHIC MAP LANDS OF GLENS FALLS PORTLAND CEMENT CO." LOCKWOOD SUPPORT SERVICES, INC., ROCHESTER N.Y. - (APRIL, 1988)
• MALCOLM PIRNIE DRAWING No. 0267-67001-0; SEPT. 1987 - (REDUCED)