

6. SUPPLEMENTAL
REMEDIAL INVESTIGATION
REPORT - AUGUST 31, 1990

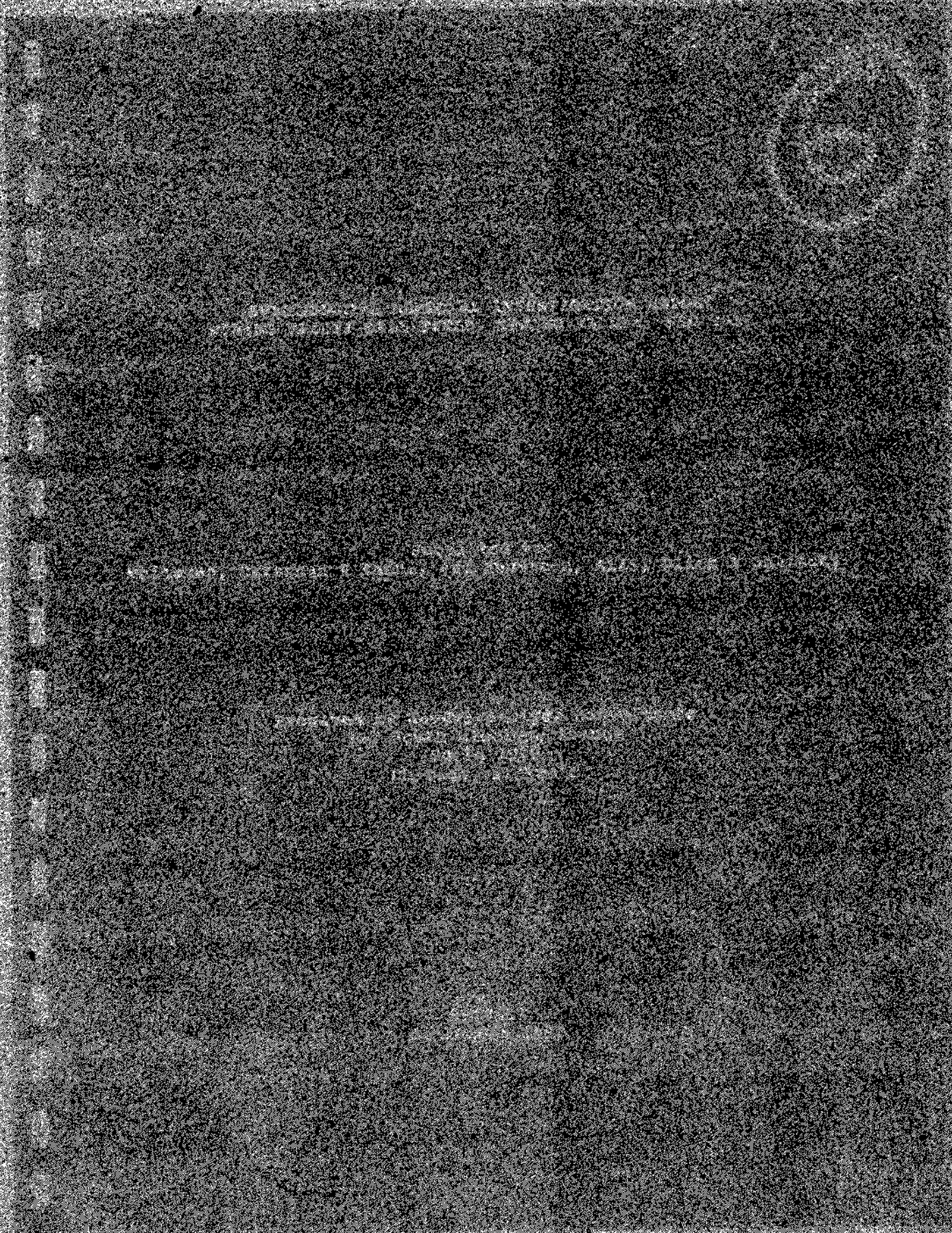


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**SUPPLEMENTAL REMEDIAL INVESTIGATION REPORT
SPRING VALLEY WELL FIELD, SPRING VALLEY, NEW YORK**

0.0 INTRODUCTION

This Supplemental Remedial Investigation (SRI) Report was prepared in accordance with an "Order on Consent" executed by the New York State Department of Environmental Conservation (DEC) on 7 August 1990 under Article 27, Title 13, of the Environmental Conservation Law of the State of New York. This report is supplemental to the original "Remedial Investigation (RI) Report, Spring Valley Well Field Site" prepared by GHR Engineering in February 1989. The goal of the SRI is to supplement the hydrogeological information contained in the original RI, and to determine if there is a hydrogeological connection in the bedrock aquifer between the West Street/North Cole Avenue area and the Spring Valley Well Field (SVWF). This goal was accomplished by determining groundwater flow directions in the vicinity of the former Cosco West Street facility using four piezometer nests. The flow directions determined from the piezometers supported the conclusion that the West Street/North Cole Avenue area is outside the radius of influence of the SVWF and that a hydrogeological connection in the bedrock aquifer is not supported by the data. The groundwater flow direction beneath the site is east toward Pascack Brook, not north northeast toward the SVWF.

Four bedrock piezometer nests were installed for the SRI in accordance with a DEC-approved work plan in the West Street/North Cole Avenue area. See Figure 1 for the locations of the piezometer nests. Four piezometers were installed in each piezometer nest: pneumatic piezometer at 200 ft; well point piezometer at 192 ft; pneumatic piezometer at 100 ft; and a well point piezometer at 92 ft.

This report contains background information from the RI

regarding the Spring Valley Well Field (Section 1); a summary of the findings of the SRI (Section 2); description of piezometer installation procedures and other field procedures (Sections 3-10); and data evaluations and conclusions (Section 11).

1.0 BACKGROUND

In 1978 the Rockland County Health Department (RCHD) detected Trichloroethylene (TCE) and Tetrachloroethylene (PCE) in water from the Spring Valley Well Field operated by the Spring Valley Water Company (SVWCo). Subsequent water analyses have identified TCE, PCE and trace levels of 1,1,1 Trichloroethane (TCA) and Dichloroethylene (DCE) in the Spring Valley Well Field.

A remedial investigation titled "Remedial Investigation Report, Spring Valley Well Field" was completed in February, 1989, by GHR Engineering Associates (GHR) for the New York State Department of Environmental Conservation (NYDEC). The remedial investigation was conducted "to gather information required to determine the nature, sources, and extent of contamination in soil, air, surface water, sediment, and groundwater, and to evaluate the need for remedial action."

The former Continental Plastics Corporation (CPC) property on North Cole Avenue was identified as a possible source of contamination in the Remedial Investigation (RI) prepared by GHR. This manufacturing operation was located 200 feet northwest of the former Cosco West-Street facility. Prior to 1976, the CPC property was occupied for approximately 15 years as a machine shop by a variety of owners. According to the RI, CPC used the property between 1976 and 1986 to manufacture plastics. Discharges were made to a septic tank on the property by both the machine shop and CPC. The RI inferred that chemical wastes from CPC and the former operations were discharged to the septic tank. According to the RI, sewage "was disposed of in a septic tank, leading to the

possibility of industrial waste disposal by subsurface infiltration". According to data in the RI, groundwater contamination in the bedrock aquifer is higher, on average, below the former CPC facility than below the former Cosco West-Street facility. The RI also pointed out that "partially full barrels of fuel oil at the site were either leaking, or positioned on the banks of Reach B" when CPC ceased operation in 1986.

The former Cosco West-Street facility (the " West-Street facility") was identified as a potential source of the VOC contamination observed in the Spring Valley Well Field. GHR claimed in the RI that: 1) Cosco was using TCE in a vapor degreasing process and was discharging TCE-contaminated waste water into a drainage channel (Reach B) which flowed for 2500 feet to within 500 feet of the Spring Valley Well Field; 2) TCE, PCE and TCA were found in Reach B near the West-Street facility; 3) TCE, PCE, and TCA contaminated groundwater, similar to groundwater from the Spring Valley Well Field, was found in the bedrock aquifer beneath the West-Street facility; and 4) TCE-contaminated soil was detected on property immediately north of the West Street (on the railroad right-of-way) by GHR during the course of their RI.

According to the RI, TCE, TCA, and PCE "are common solvents which are available to the general public". The compounds "are widely used in degreasing operations ranging from backyard automobile maintenance to large scale industrial machinery and production. PCE is also a common dry-cleaning ingredient." The widespread use of these chemicals requires exploration of other possible sources of contamination to the Spring Valley Well Field such as the Village vehicle maintenance garage on West Street, the maintenance facility at the construction company facility located over SVWCo "Well No. 17", and numerous dry cleaning and automotive repair establishments. Cosco reported that it never used PCE at its West Street facility and only used TCA for a brief period in 1984.

Woodward Clyde Consultants (WCC) reviewed the RI report for Cosco Industries on 2 May 1989, and concluded that: "The data in the RI report do not support the conclusion that the West-Street plant area is a primary, or even a secondary source of the volatile organic compound (VOC) contamination of the Spring Valley Well Field. A substantial amount of additional work would be necessary to properly understand the source, pathway, and receptor system in the investigation area."

Lawler, Matusky & Skelly Engineers ("LMS") has also examined the State's RI for Cosco Industries. LMS concluded that "Though the RI collected two sets of bedrock water-level measurements, water levels were not contoured. Nevertheless, the RI concluded that chemicals migrated from the West-Street bedrock to the well field. The bedrock monitoring wells constructed during the RI are in a relatively straight line from the well field to the former Cosco facility. Therefore, while a gradient generally toward the well field exists, the groundwater flow direction is not defined. The available data on water levels in MW-4B, 7B, 9B, and 17B suggest that the bedrock groundwater at the West-Street facility may be at or beyond the capture zone of the well field. "

Because of the data gaps, inconsistencies, and unsupported statements identified in the RI, Cosco proposed conducting a supplemental remedial investigation to evaluate some of the uncertainties. This proposal was the basis for the Order on Consent issued by DEC. Cosco proposed installing four bedrock piezometer nests in order to obtain information regarding the three-dimensional character of groundwater flow at shallow and intermediate levels in the bedrock aquifer in the vicinity of the West-Street facility.

Cosco believes that the new piezometers, in conjunction with data from the RI, will help understand the driving gradients

between a) the till deposit and the upper part of the bedrock aquifer (above 100 ft below grade); b) the surface water and the upper part of the bedrock aquifer, and c) the upper part of the bedrock aquifer and the intermediate part of the bedrock aquifer (from 100 ft to 200 ft below grade). By understanding these relationships, Cosco thinks it is or will be possible to make a determination of the direction of groundwater flow in the vicinity of the Cosco Plant site.

The proposed piezometers are not intended to develop any additional data with respect to groundwater flow in the glacial till deposit that overlies the bedrock. The wells installed in the glacial till deposit during the initial RI are adequate to understand the vectorial nature of groundwater flow in the till deposit.

2.0 SUMMARY OF FINDINGS

WCC finished installing the Spring Valley piezometers on 29 June 1990. Four piezometer nests were completed with four piezometers per nest. Water level measurements indicate that all 16 piezometers are functioning properly. Water levels appear to have stabilized in all piezometers as of 20 August 1990 (see Table 1).

WCC has completed an assessment of groundwater flow directions in the bedrock aquifer beneath the former Cosco West-Street facility. The results of this assessment are presented in this section.

Groundwater flow directions were calculated by solving three-point problems using water-level data from the new piezometers. The three-point solutions indicate that groundwater in the bedrock aquifer beneath the former Cosco West-Street facility flows east toward Pascack Brook (see Figures 2 and 3). This conclusion is not

facility was north-northeast toward the SVWF. Groundwater flow in the bedrock aquifer at 200 feet deviates 43 degrees east from a line connecting the former Cosco West Street facility and the SVWF (see Figure 2). Groundwater flow in the bedrock aquifer at 100 feet deviates 59 degrees east from a line connecting the former Cosco West Street facility and the SVWF (see Figure 3). It is our opinion that the analyses of these flow vectors does not support a conclusion that groundwater beneath the former Cosco West Street facility flows to the SVWF. For a more detailed technical discussion of groundwater flow directions refer to Section 11.2.

WCC identified two additional lines of evidence to support the conclusion that groundwater flow in the bedrock aquifer is not affected by pumping at the SVWF:

- 1) groundwater flow directions calculated using piezometers 1, 2, & 3, located furthest from the SVWF, point more northerly than flow direction calculated using piezometers 1, 2, and 4, located closer to the SVWF. This pattern is opposite to the expected pattern if the SVWF were influencing groundwater flow vectors in the West Street area;
- 2) The vertical hydrostatic gradient in piezometer 2, located closest to Pascack Brook, is lower than gradients in piezometers 1, 3, and 4. Piezometers 1, 3, and 4 are roughly the same distance from the river and have nearly identical gradients. The fact that gradients increase toward the Brook suggests that Pascack Brook, not the SVWF controls groundwater flow in the study area.

For a more technical discussion of these findings refer to Sections 11.2.2, Evaluation of Flow-Direction Data, and 11.3, Evaluation of Vertical Hydrostatic Gradients.

WCC concludes that the statements in the RI regarding

groundwater flow directions in the bedrock aquifer beneath the former Cosco West-Street facility are not supported by the data from this supplemental investigation. The RI concluded (RI, page 6-22, paragraph 1) that "hydraulic head in bedrock wells are higher in the southwestern portion of the site in the vicinity of the former Cosco facility, with the lowest hydraulic head being in wells associated with the well field". In making this statement, GHR did not consider the fact that the bottoms of the "wells associated with the well field" are drilled deeper than the wells near the former Cosco facility by almost 100 feet. Given the strong natural downward gradients in all of the RI and SRI piezometers (See Table 2), the deep wells would have inherently lower water levels. When assessing groundwater flow direction in this type of aquifer, it is important that the wells selected be screened in an interval that is at or near the same depth and have approximately the same topographic elevation. This was not the case for the evaluation made in the RI and is, in our opinion, the basic reason for the difference in the interpretation of flow direction. The flow-directions calculated by WCC (See Section 11.2) compare piezometers with approximately the same topographic elevation and screened-depth interval, thereby eliminating the depth and elevation variables.

Before the piezometers were installed in the open boreholes, WCC's supervising geologist and the DEC field representative noticed that groundwater was cascading in borings B-1 (minor), B-2, and B-3 from just below the surface casings. The surface casings were drilled at least 6.6 ft beneath the glacial till into the underlying bedrock and sealed with cement grout. The observation of cascading water indicates that the upper portion of the bedrock is highly permeable and that water from the glacial deposits is able to flow around the surface-casing seal into the bedrock portion of the boring. The wells drilled in the RI were sealed about 5 ft into the bedrock beneath the glacial deposits. If a similar problem occurred in the RI wells, groundwater from the till

would have moved into the open, bedrock-section of the monitoring wells. This movement would have resulted in erroneous indications of contamination in the bedrock aquifer and some unknown averaging of water levels in the monitoring wells. For these reasons, use of the monitoring wells could give very misleading data for the evaluation of groundwater and/or contaminant movement in the vicinity of the Spring Valley Well Field.

The following sections of the SRI review the drilling procedures, piezometer-installation procedures, and miscellaneous procedures as they occurred in the field. The following topics and activities will be reviewed:

- 1) Drilling and Piezometer Installation procedures;
- 2) Caliper Logging Procedures (Section 4);
- 3) Procedures for Measuring Water Levels (Section 5);
- 4) Drilling, Analysis and Disposition of Cuttings (Section 6);
- 5) Survey Procedures (Section 7);
- 6) Field Documentation Procedures (Section 8);
- 7) Decontamination Procedures (Section 9);
- 8) Health and Safety Plan (Section 10); and
- 9) Data Evaluation and Conclusions (Section 11)

3.0 REVIEW OF DRILLING AND WELL INSTALLATION PROCEDURES

WCC drilled the borings and installed the piezometers in accordance with the DEC-approved work plan. DEC requested that caliper logging be added to the field activities just prior to the start of field operations, so this work was not included in the work plan. Some minor deviations from the work plan were made in the field. These deviations were approved by Mr. Christopher J. Magee, Engineering Geologist, Bureau of Eastern Remedial Action, Division of Hazardous Waste Remediation, New York State Department of Environmental Conservation. The following topics and procedures related to drilling and well installation will be reviewed in this section:

- 1) Subsurface Conditions;
- 2) Locations of Piezometers;
- 3) Drilling Procedures;
- 4) Piezometer-Installation Procedures;

3.1 Subsurface Conditions

The Triassic-Jurassic Brunswick Formation is the primary bedrock unit in the Spring Valley area. The Brunswick formation is approximately 7000 feet thick below the study area, and consists of conglomerates, sandstones, and shaly mudstone. The upper part of the formation is generally conglomeratic, while the lower part contains considerable shaly mudstone.

The Brunswick formation is overlain by approximately 30 feet of unconsolidated glacial deposits. The glacial deposits consist of fine-grained till and glacial-lacustrine sediments overlain by coarse-grained, outwash deposits.

WCC examined outcrops of the Brunswick Formation along the New York Thruway approximately 2 miles west of Spring Valley. Contrary

to subsurface conditions reported in the RI report, the formation was not pervasively fractured in outcrop. No fractures, joint surfaces or quartz/calcite veins were observed.

Little subsurface information could be gathered during the SRI because no cores were collected and only finely ground cuttings were returned to the surface. The surficial deposits consisted of fine to coarse-grained, well-sorted, brown sands with thin, grayish-brown, silty-clay layers in borings 1 and 2. A trace of gravel was commonly present in the sands.

The cuttings from the Brunswick Formation were nearly uniform in appearance in all four borings. The cuttings indicated that the Brunswick Formation consists of dark reddish-brown, fine to coarse, well graded, angular to sub angular sandstone with varying amounts of quartz, carbonate and igneous gravel. A few, thin, reddish-brown siltstone and shale layers were also identified in the Brunswick. These lithologies were very soft, and only a few chips survived the drilling process. The water returned to the surface became muddier when drilling through these soft units because of disintegration of the siltstone and shale. Some of the zones of hole enlargement revealed by the caliper logs (Figures 4-7) may be related to wash-out of the fine-grained units. For detailed lithologic information refer to the boring logs in Appendix A.

3. 2 Locations of Piezometers

Piezometer nest locations were chosen using the following four criteria: 1) they should be located as far from existing industrial wells as possible; 2) they should be situated at approximately the same ground surface elevation; 3) to the extent possible, they should be placed in triangular patterns so that groundwater flow vectors can be calculated; and 4) they should be located slightly outside the area covered by the wells in the till deposit because of the expected diffusive nature of groundwater flow in the till.

The locations shown on Figure 1 satisfy these criteria and closely match the locations proposed in the work plan. The piezometers were installed in the following order: Piezometer 2, Piezometer 3, Piezometer 4, and Piezometer 1. The order of drilling was based on factors such as access permission and ease of access. Verbal descriptions of the piezometer locations are presented in Table 3.

3.3 Drilling Procedures

Drilling through the unconsolidated surface deposits began on 8 June, 1990 and was performed with an Ingersol Rand TH-60 air-rotary rig equipped with a 9 & 7/8-inch tri-cone roller bit. The drilling sub-contractor was Kendrick Drilling out of Chester, New York. The driller was Terry Kendrick and the inspector was Paul Herr, Senior Staff Geologist for WCC. Utility clearances and access rights were arranged by LMS prior to the start of field operations.

The work plan specified auger drilling in the unconsolidated deposits, but the driller requested and received permission from the DEC field representative to use air rotary drilling for both the shallow and deep segments of the borings. The driller felt that air rotary drilling would be more effective if boulders or cobbles were encountered.

The roller bit was advanced through the unconsolidated deposits and at least three feet into the underlying bedrock in preparation for setting the surface casing. The driller identified bedrock by increased drilling resistance and by a high percentage of reddish-brown sandstone chips in the cuttings. The upper bedrock surface was soft and weathered, so the exact depth to bedrock was difficult to determine. This problem was exacerbated in borings 1 and 4 because hole collapse cut off the return of cuttings and precluded identification of bedrock by the presence of sandstone

chips in the cuttings. As a precaution, the borings were extended an additional 4 to 31 feet from the point where the driller tentatively identified bedrock in order to insure a good bedrock seal.

After the hole was seated into bedrock, the drill steel was withdrawn and six-inch ID steel surface casing was placed in the hole. A plug of dry cement was placed inside the casing and a thick cement/bentonite grout was tremied into the annulus between the casing and the wall of the boring to create a competent seal between the unconsolidated deposits and the underlying bedrock.

Hole collapse and other drilling problems were encountered within the unconsolidated deposits above the Brunswick Formation. Heaving, coarse-grained sands were encountered in borings 1 and 4. Hole collapse resulted in slow drilling, generation of large volumes of cuttings, sticking of drill steel in the hole, creation of near-surface void spaces, and difficulty in setting the surface casing. Large volumes of concrete were required to fill the void spaces created during drilling of borings 1 and 4.

In the borings with hole-collapse (1 and 4) the 6-inch surface casings and drive shoes were driven through the unconsolidated materials and into the bedrock using the percussion bit. The casing was then reamed out to a position slightly below the casing and grout was placed inside the casing to form a seal with the bedrock.

The grout was allowed to set for 48 hours before drilling the bedrock portion of the borings. While the grout was setting, the rig moved to the next piezometer locations to drill and install the next surface casing.

3.3.1 Procedure for Drilling Through the Bedrock Units

After the grout around the surface casing had set, the borehole was advanced into the Brunswick Formation using the air rotary method with a 6-inch, pneumatic, hammer bit as stated in the work plan. Air rotary drilling was used instead of water-rotary drilling because of the potential for loss of circulation into highly permeable fractures. Permeable zones were encountered so the air rotary choice was a fortunate one.

Bedrock was encountered in all four borings immediately below the surface casing. A good bedrock seal was therefore obtained in all borings. Drilling within the Brunswick Formation proceeded quickly (2-3 ft per minute) and without incident. Minor hole enlargement occurred at a few thin intervals in all four borings. See the caliper logs on Figures 4-7 for the locations of the hole-enlargement intervals. The zones of hole enlargement usually corresponded with zones of soft drilling and increased water production. These soft zones may be beds of loosely cemented sandstone and conglomerate as described by WCC in outcrop, or fracture zones as described in the RI.

Considerable water was produced from the Brunswick Formation during drilling. This water had no detectable levels of organic vapors based on photo-ionization detector (HNU) readings made with an 11.7 electron-volt probe. Readings were made on 8-ounce glass jars of formation water. The jars were agitated prior to measuring the head-space organic vapor levels. No measurable levels of organic vapors were encountered in the breathing zone in any of the borings. The DEC field representative allowed the water produced to be discharged to the ground since no organic vapors were detected with the HNU.

The carousel was fully loaded with 10, 20-foot drill strings prior to drilling. Depth control was achieved during drilling by:

observing the number of drill strings missing from the carousel; multiplying by 20; adding the bit length; and subtracting the stick-up. The DEC field representative agreed that acceptable depth control could be achieved without numbering the drill steel prior to drilling as specified in the work plan. Bedrock drilling in all borings terminated at a depth of approximately 201 feet below ground surface.

3.4 Procedure for Installing Piezometers

Four piezometers, two pneumatic and two well point piezometers, were installed in each borehole at approximately 200 feet (pneumatic), 192 feet (well point), 100 feet (pneumatic) and 92 feet (well point). See the piezometer installation sheets on Figures 8-11 for the exact depth of each piezometer.

The well point piezometers consisted of one-half-inch diameter, flush-joint, PVC pipes with screened intervals made by slotting the pipe with a hack saw. Joints in the PVC pipe were sealed with teflon tape. The bottoms of the PVC pipes were plugged with PVC caps. Two well point piezometers were installed in each boring with screened intervals from approximately 193 to 191 feet and 93 to 91 feet.

The pneumatic piezometers consisted of 4.75 inch long and 1-inch in diameter piezometer tips connected to double, polyethylene tubes with heavy duty polyethylene sheaths. The piezometer tip included a one-inch diameter, 3-inch long polyethylene filter with 60-micron pores. One pneumatic piezometer was connected to each of the two well point piezometers with black electrical tape during installation. Three tape wraps were used per 10-foot length of PVC pipe to secure the pneumatic piezometer to the well point piezometer.

Depth control was achieved by carefully measuring the 1/2 inch

PVC pipe used for the well point piezometers. Total length was measured by making duplicate measurements of each PVC pipe segment prior to installation. This pre-measured PVC pipe was used to position both the well point and pneumatic piezometers. The pre-measured PVC pipe was bundled and labeled awaiting installation.

The following procedure was used to position the deep (200 ft and 192 ft) piezometers:

- 1) depth control for the pneumatic piezometers was achieved by taping the pneumatic piezometer head to the 1/2-inch PVC pipe at a distance of roughly .5 ft from the capped end of the PVC pipe (the PVC pipe was allowed to protrude slightly below the pneumatic piezometer to protect it from damage during installation);.
- 2) slots for the well point piezometer were cut in the PVC pipe from exactly 7 to 9 feet above the pneumatic piezometer head;
- 3) the PVC pipe was cut such that the depth of the pneumatic piezometer would be 200 ft and the top of the PVC riser would be about 1.4 ft below ground surface when the pipe was placed in the boring (for example, $CUTOFF = 200.1 \text{ ft (measured length of PVC)} - 200 \text{ ft (desired depth of pneumatic piezometer)} - .5 \text{ ft (distance PVC protrudes below pneumatic piezometer)} + 1.4 \text{ ft (distance between top of PVC and ground surface)}$);
- 4) nylon-reinforced strapping tape was attached to the top segment of PVC pipe to act as a hanger to suspend the piezometer in the well; and
- 5) a mark was placed on the hanger exactly 200 ft from the pneumatic piezometer head (in the numerical example above, the mark would be 1.4 ft beyond the cut end of the PVC pipe; and

- 6) the PVC pipe was hung in the boring so the mark on the hanger was even with the ground surface.

The above procedure left the pneumatic piezometer positioned at 200 ft and the well point positioned at 191-193 ft (average 192 ft) once the piezometers were placed in the borehole.

The same procedure explained above was used to maintain depth control for the 100 foot and 92 foot piezometers. The final depths of most of the piezometers deviated slightly from the target depths of 200 ft, 192 ft, 100 ft and 92 ft because of slight settling during installation. Depth adjustment factors were calculated by subtracting the target distance of the PVC riser below ground surface from the actual distance following installation.

The grout used during installation differed from the mixture in the work plan. The DEC field representative suggested using a thicker grout mix containing 12 pounds of bentonite and 96 pounds of cement to 30 gallons of water. WCC agreed to this change because the thicker grout would reduce grout loss into the formation.

3.4.1 Installation Procedure for Deep Piezometers

The filter pack for the piezometers consisted of clean, bagged, silica sand meeting the requirement of ASTM C33. A one-foot layer of filterpack sand was placed on the bottom of the borehole (201-200 ft depth). The piezometer was then assembled and lowered to a bottom depth of 200 feet. Once the piezometer was in place, additional filter-pack sand was slowly added to the annular space between the borehole and the piezometer. A weighted tape measure was used to monitor the elevation of the filter pack and detect possible sand bridging. The filter pack was installed to approximately 2 feet above the pneumatic piezometer tip (200-198 ft depth).

A 4-foot thick seal of additive-free, 3/8-inch diameter, sodium-bentonite pellets was added to the annular space above the filter pack (198-194 ft depth). Bentonite pellets were used instead of the bentonite slurry stated in the work plan. The DEC field representative agreed to the use of bentonite pellets. Bridging was not a problem during installation of the bentonite seals.

After the bentonite seal was in place, four feet of sand was added to the annular space (depth 194-190) to act as a filter pack for the slotted PVC pipe (slotted from 193 to 191 feet). A 4-foot thick seal of 3/8-inch sodium-bentonite pellets containing no additives was then added to the annular space above the filter pack (198-194 ft depth). The annulus was then tremie grouted with a cement/bentonite grout to a depth of 110 feet.

Great care was taken not to plug the upper completion zone at 100 feet with grout. The following precautions were taken:

- 1) The volume of grout introduced to the borehole was calculated to bring the grout to 110 feet, 10 feet below the upper completion zone;
- 2) The grout was pumped slowly to avoid agitating the grout and plugging of the 100-foot completion zone;
- 3) A glass jar filled with water and secured with a nylon cord was used to detect the grout level in the boring (this jar could sink through the water column but float on the water/grout interface);
- 4) The completion zone was washed with a water jet directed against the sides of the boring; and
- 5) After the grout had set for 15 hours, bentonite pellets were

used to carefully bring the final grout level to 101 feet.

The grouting process was difficult in general. Large volumes of grout were lost into the formation. Bentonite was used to seal some of the permeable zones into which the grout was flowing. Bentonite pellets were added to the hole after the grout level had stabilized. Stabilization usually occurred just below zones of hole enlargement where grout was apparently flowing into the bedrock along permeable beds or fractures. The second grouting attempt was usually successful.

3.4.2 Installation Procedure for Shallow Piezometers

The installation procedure for the shallow piezometers was nearly identical to the procedure for the deep piezometers. A one-foot layer of filterpack sand was placed at the bottom of the borehole (101-100 ft depth). The second piezometer was then assembled and lowered to a bottom depth of approximately 100 feet. Once the piezometer was in place, additional filter-pack sand was slowly added to the annular space between the borehole and the piezometer (100-98 ft depth). A weighted tape measure was used to monitor the elevation of the filter pack and detect possible sand bridging. The filter pack was installed to approximately 2 ft above the screened interval of the piezometer.

A 4-foot thick seal of additive-free, 3/8-inch diameter, sodium-bentonite pellets was added to the annular space above the filter pack (198-194 ft depth). After the bentonite seal was in place, four feet of sand was added to the annular space (depth 94-90 ft) to act as a filter pack for the slotted PVC pipe (slotted from 93 to 91 feet). A 4-foot thick sodium-bentonite seal containing no additives was then added to the annular space above the filter pack (90-86 ft depth). The remaining annulus was tremie grouted to the surface with cement/bentonite grout.

Flush-mounted, 10 or 12-inch diameter, utility boxes were installed over the 6-inch surface casing. A concrete surface seal was constructed around each utility box.

4.0 CALIPER LOGGING PROCEDURE

DEC requested that caliper logs be run in the open boreholes to measure borehole diameter as a function of depth. According to DEC, fractures in the Brunswick Formation could be identified on caliper logs as zones of hole enlargement. Caliper logging was not contained in the original work plan, but was added to the drilling program based on conversations between WCC, Cosco and DEC.

Caliper logging was performed by the WCC field representative (Paul Herr) with the assistance of the drilling sub-contractor. A Sopris, model-2500, portable, logging unit equipped with a three-arm caliper tool was used to log the borings. Logging took place immediately after drilling was completed and prior to well installation.

The caliper tool was calibrated with 4.5-inch and 7-inch calibration rings prior to logging. The tool was then lowered into the open borehole on an electric winch. The caliper arms were then opened, and the hole logged at a rate of 10 feet per minute. Caliper logging of all the boreholes proceeded without incident. Good quality logs were obtained and several zones of hole enlargement could be identified in each boring. The zones of hole enlargement corresponded to areas of soft drilling, increased water production, and grout loss during grouting. The caliper logs can be found on Figures 4-7.

5.0 PROCEDURE FOR MEASURING WATER LEVELS

Water levels were measured in both the pneumatic and well point piezometers from the date of installation until 20 August

1990 on a daily basis, excluding most weekends. Water levels were measured by the WCC field representative until 29 June 1990. After this date the measurements were taken by the following Cosco employees: John Klebetz, Ray Caputo, and Teo Arteaga. The Cosco employees were trained to use the equipment during four training sessions conducted by WCC. The Cosco employees made daily measurement and submitted the unprocessed field data to WCC for conversion into water level elevations. No conversions were made in the field by the Cosco employees.

5.1 Procedures Used to Measure Water Levels in the Well Point Piezometers

The procedures for measuring water levels in the well point piezometers were straightforward. A Slope Indicator Company, electronic, air/water interface probe, model 51453 was used to make the measurements. The interface probe consists of a probe tip connected to a reel by a plastic-coated wire with depth markings at every 1/100th of a foot. Controls for the unit consisted of an on/off switch, sensitivity adjustment, and battery check button.

Measurements were made by lowering the probe down the 1/2-inch PVC riser of the well-point piezometers. When the probe came in contact with the water surface inside the piezometer a circuit was completed and visual and audible alarms were activated at the surface. Depth to water was then determined by holding the probe wire against the top of the steel surface casing and recording the depth. Water level elevations were calculated from the measured depth to water using the following formula:

$$\text{Water Level Elevation} = \text{Elevation of Top of Casing (see Figures 8-11)} - \text{Measured Depth to Water From Top of Casing}$$

Table 1 contains a completed set of water level elevations in the well-point piezometers calculated using the above equation. The

raw field data used to calculate the water level elevations is presented in Table 4. Hydrographs depicting water levels in the well point piezometers as a function of time are presented in Figures 12 through 19. Water-level evaluations are presented in Section 11.

A correction factor of .43 ft was subtracted from the measured water depth from the period 27 June 1990 until 17 July 1990 because the probe tip was pulled off the unit. After temporary repairs, the probe was .43 ft shorter, so a correction factor was needed to adjust water depth readings. Rob Smith of DEC observed the temporary repair of the probe, tested its accuracy, and gave permission to use the probe while a replacement was being arranged. A replacement probe was used from 17 July 1990 until 13 August 1990 so no correction factor was subtracted from the measured water depths during this period. The factory-repaired probe was returned on 14 August 1990, but it was one foot shorter than the original length. From August 14 to present a one-foot correction factor has been subtracted from the measured water depths.

5.2 Procedure for Measuring Water Levels in the Pneumatic Piezometers

Water levels were measured in the pneumatic piezometers using a Slope Indicator Company, model 211 pneumatic indicator. This unit consists of a high pressure nitrogen tank and pressure gauge, a supply pressure regulator and supply-pressure gauge, valves for controlling gas flow, a sensitive digital gauge for measuring the static gas pressure in the pneumatic piezometer, a return-flow float gauge, and a quick-connect fitting for connecting the pneumatic-piezometer-input lead to the pneumatic indicator. The model 211 pneumatic indicator can measure hydrostatic water levels with an accuracy of + or - 3 inches.

Water level measurements were made using the following

procedure: turn on digital gauge; turn input control valve to vent and zero the digital display using the zero knob; connect the clear, polyethylene input lead with the quick connect fitting to the pneumatic indicator; connect the clear, polyethylene output lead to the air-flow-indicator mounted on the lid of the pneumatic indicator; turn the input control valve to "input" and the gas supply valve to "on"; as soon as float-ball on the air-flow indicator rises turn gas supply to "off" and record the reading on the digital gauge after the reading stabilizes.

The pneumatic indicator measures hydrostatic water pressure by forcing pressurized nitrogen into the input lead which is connected to the pneumatic piezometer tip. When the pressure in the input lead equals the in-situ water pressure a diaphragm in the piezometer tip is unseated and nitrogen flows past the diaphragm, into the output lead, and back to the surface. The return air flow in the output lead is detected with the float gauge. When return flow is detected, the gas supply is turned off, and the static gas pressure in the input lead is measured with the sensitive, digital, pressure gauge in "pounds per square inch".

The hydrostatic water pressure is converted to water level elevation by the following procedure:

- 1) Convert hydrostatic pressure in PSI to "feet of water" by multiplying by 2.3068;
- 2) Determine the elevation of the pneumatic piezometer tip by subtracting the depth of the pneumatic piezometer tip from the ground surface elevation (see Figures 8-11 for elevations); and
- 3) Determine water level elevation by adding the hydrostatic pressure in "feet of water" calculated in "1)" to the elevation of the piezometer tip calculated in "2)".

Water level elevations measured in the pneumatic piezometers during the period 18 June 1990 until 20 August 1990 are tabulated in Table 1. The raw field data used to calculate water level elevations in the pneumatic piezometers are presented in Table 4. The hydrographs showing water level elevation as a function of time are presented in Figures 12-19. The readings made with the pneumatic piezometers are in-phase with the readings made in the nearby well point piezometers. This tracking of readings indicates that accurate water levels are being obtained from both types of piezometers, with the exception of a few outliers.

The well point piezometers are installed eight feet above the pneumatic piezometers. The offset in the hydrographs (Figures 12 to 19) is a measure of the natural downward vertical gradient between the upper and lower piezometers, not a measurement error in the pneumatic piezometers. See Section 11.1 for water level interpretations.

6.0 DRUMMING, ANALYSIS AND DISPOSITION OF CUTTINGS

The procedures for logging and handling cuttings conformed with NYDEC's "Final Division Technical and Administrative Guidance Memorandum (TAGM) for Disposal of Drill Cuttings".

Cuttings from the borings were described and logged in accordance with the Unified Soil Classification System. Cuttings were placed in 55 gallon drums and sealed. A sequential identification number was painted on each drum of cuttings for identification and tracking purposes. This number was recorded on a cuttings control log.

After completion of drilling activities, headspace gas in each of the drums was sampled with a photo-ionization detector (PID) equipped with an 11.7 EV. probe. This reading was recorded on the cuttings-control log. See Table 5 for the HNu readings associated

with each barrel. Sealed drums were stored in a secure area at the southeast corner of the Cosco, Church Street facility.

6.1 Sampling Procedure for Soil Cuttings

Soil samples were collected from the four barrels with the highest PID readings. Soil samples were scooped directly into pre-washed, quality controlled, 500 ml., wide-mouthed glass jars fitted with teflon-lined caps. The following information was recorded in the log book: time of collection, sample description, drum from which sample was taken, volume sampled, and number of containers. A duplicate sample was taken from "barrel B-4-3" and labeled "B-4-3B". The samples were placed in insulated containers and cooled to 4°C using blue-ice packages. Glass to glass contact was prevented by the use of packaging wrap and styrofoam pellets.

The chain-of-custody form was filled out to provide an accurate written record for tracing the possession and holding of samples from the time of collection through data analysis and reporting. The following information was specified for each sample on the chain-of-custody form: 1) sample number reflecting the barrel sampled, 2) sampling date, 3) sampling time, and 4) analyses to be performed.

The chain-of-custody form was signed by each sampling participant. It was placed in a water tight plastic bag and taped to the underside of the cooler lid containing the samples designated on the form. The lid of the cooler was securely taped shut prior to shipment.

All samples were shipped via overnight mail on the same day they were collected. The holding time for the samples was 10 days.

6.2 Analytical Results for Soil Cuttings

Soil samples were analyzed for volatile organic compounds using EPA method 8240 (from SW-846, Third Edition). EPA method 8240 is capable of detecting the primary contaminants identified in the Spring Valley Well Field, including: Trichloroethylene (TCE), Tetrachloroethylene (PCE), 1,1,1 Trichloroethane (TCA) and Dichloroethylene (DCE). Detection limits for EPA method 8240 are approximately 5 parts per billion.

The analytical results indicated low concentrations of acetone (Not Detected to .170 ppm); methyl ethyl ketone (Not Detected to .020 ppm); toluene (Not Detected to .007 ppm); and xylene (Not Detected to .008 ppm), 4-methyl-2-pentanone (Not Detected to .008 ppm). Refer to Table 6 for a comparison of HNu readings to chemical analysis of the cuttings. For information regarding sample-specific detection limits or surrogate recovery data refer to the laboratory "certificates of analysis" in Appendix B.

6.3 Possible Sources of the Chemicals Identified in the Cuttings

WCC has identified a number of possible sources for the chemicals observed in the cuttings, including:

- 1) a slow oil leak observed on the rotary table of the drilling rig;
- 2) leaking sewers in the vicinity of piezometers 1 and 2;
- 3) chemicals routinely used by the analytical laboratory; and
- 4) rubber gaskets used to seal the tap holes in the covers of the 55 gallon drums;
- 5) some, as yet, unidentified source.

These potential sources are evaluated in the following paragraphs.

A sample of rig oil from the gear box on the rotary table was sent in for analysis because a few drops of this oil were observed dripping into the cuttings. The sample was prepared by adding 5 drops of rig oil to 6 ounces of clean silica sand and 1 ounce of distilled water. The sample was shaken to homogenize the three components.

Ethylbenzene, toluene, and xylene were identified in the rig-oil sample. Toluene and xylene were observed in the cuttings but not ethylbenzene. The toluene and xylene observed in the cuttings could have originated from the leaking rig oil.

A sewer-like odor was noted on barrels B-1-11 and B-2-7 when they were opened for sampling. A leaking sewer in the area could also be responsible for the chemicals detected.

A possible explanation for both the methyl ethyl ketone (MEK) and the acetone is laboratory contamination. Both of these chemicals are commonly used for cleaning glassware and other purposes. The source of the acetone might be also be explained by the rubber gaskets used to seal the tap-holes in the drum covers. A jarred sample of these gaskets gave an HNU reading of 7 parts per million. It is possible that acetone was used to clean the barrels in the factory and was retained by the gasket material.

The cuttings contamination could also be related to soil and or groundwater contamination in the study area. If such contamination is present, the source is unknown because none of the chemicals identified in the soils, groundwater, and industrial effluent in the RI were observed in the cuttings.

A trip blank was shipped with the samples as a quality

assurance, quality control measure. No volatile organics were detected in the trip blank, so cross-contamination during shipment is not a likely source of the chemicals detected.

6.4 Assessment of Whether Cuttings Constitute a Hazardous Waste

WCC's risk assessment staff (Cindy Fuller and Peter Tong) reviewed the cuttings analyses to determine if they constitute a threat to human health, and if they would be considered as hazardous wastes under applicable federal regulations.

In general, the chemicals identified in the cuttings are considered non-toxic (acetone, toluene, xylene, and 4-methyl-2-pentanone) or of low toxicity (methyl ethyl ketone). None of the chemicals in the cuttings pose a health threat at the concentrations encountered.

Classification of the cuttings as a hazardous or non-hazardous waste under USEPA regulations hinges upon their origin. If they chemicals are classified as spent solvents they would constitute a listed hazardous waste under both USEPA and New York State regulations. If they are classified as chemicals of unknown origin they could be considered as non-hazardous solid wastes.

Since none of the solvents known to be present in the industrial effluent, soils and groundwater in the study area (TCE and PCE) showed up in the cuttings, it is WCC's judgement that the origin of the chemicals should be classified as "unknown" and they should not be classified as listed wastes.

If the chemicals identified in the cuttings are not considered as listed wastes, their designation as hazardous or non-hazardous could be evaluated using the USEPA's new Toxicity-Characteristic-Leaching-Procedures (TCLP) standards. Of the chemicals identified in the cuttings, only methyl ethyl ketone is considered a hazardous

waste under the TCLP regulations, and only at concentrations greater than 200 parts per billion (ppb). Cosco did not run TCLP analyses on the cuttings, but calculated a maximum, estimated TCLP concentration of 1 ppb. The following assumptions were used in the calculation:

- 1) The cuttings contain 20 ppb of MEK; and
- 2) All of the MEK in the cuttings would be leached during the TCLP analysis.

Given these two conservative assumptions, an estimated, maximum, TCLP concentration of 1 part per billion was calculated for MEK using the formula given below:

$$\text{TCLP concentration in micrograms per liter} = (\text{Contaminant Concentration in micrograms per kilogram of soil}) \times (1 \text{ kilogram}/1000 \text{ grams}) \times (100 \text{ grams of soil/sample}) \times (1 \text{ sample}/2000 \text{ grams of solvent}) \times (1 \text{ gram extract/cubic centimeter}) \times (1000 \text{ centimeters/liter})$$

The calculated value is far below the TCLP regulatory standard of 200 ppb for MEK, so WCC recommends that the cuttings be disposed of as a solid waste under applicable New York State laws.

Under New York State procedures, DEC Technical and Administrative Guidance Memorandum (TAGM) No. HWR-89-40326, cuttings from off-site drilling are presumed non-hazardous unless proven otherwise. DEC makes its rulings on a case-by-case basis and will rule on the Cosco cuttings based on the data presented in this report.

If DEC rules that the cuttings are non-hazardous, Cosco proposes transporting the cuttings using a licensed hazardous waste hauler to a permitted solid waste management facility, or spreading

the cuttings out on the soil surface at the Cosco Church Street facility. Both procedures should be allowed under TAGM No. HWR-89-4032 assuming the cuttings are non-hazardous. Manifests are not required for wastes tested and found to be non-hazardous. The project manager would issue "trip tickets" and collect receipts for tipping fees if the cuttings are disposed of in a solid waste landfill.

7.0 SURVEY PROCEDURES

Well location, ground elevation, and elevation of top of riser were determined for each piezometer. Elevations were surveyed to within .01 inch. All survey points were tied into the nearest USGS benchmark. This allowed the wells to be described relative to the National Geodetic Vertical Datum (NGVD). The survey data can be found on the Piezometer Installation Forms (Figures 8-11) and in Table 3. Two separate surveys were conducted for this investigation. The initial survey was checked by tying into one of the wells installed for the original RI. A 10-foot error was discovered. This error was caused because a faulty benchmark was used as a basis for the survey. An additional 10-foot error occurred at piezometer number 3 because of an error during a survey loop. Cosco found these survey results unacceptable and hired another survey firm to re-do the survey.

The survey conducted by Geod Corporation was tied into one of the existing monitoring wells from the RI, monitoring well 18, to verify that both the RI and SRI were using the same datum. The surveyors surveyed top of protective casing and a paint mark located near ground surface. It was assumed that the paint mark was also used as reference points in the RI. The following elevations were obtained from the two surveys at monitoring well 18.

	RI ELEVATION (in feet)	SRI ELEVATION (in feet)
TOP OF CASING, MW-18	467.42	467.34
GROUND SURFACE	464.57	464.51

The elevations from the two surveys agree quite closely. The small differences could be caused by: small measurement errors in both surveys; use of different reference points for ground surface because the ground is steeply sloping at MW-18; use of different reference points for top-of-protective-casing because keys for MW-18 could not be located by DEC. WCC concludes that both surveys reflect elevations in feet NGVD.

In addition to the survey, photographs were taken of each piezometer cluster. The photographs were described in the log book, including facing direction. The location of each piezometer cluster was also described verbally in the log book.

8.0 FIELD DOCUMENTATION PROCEDURES

Field log books were used to document field activities and record data. Entries were described in as much detail as possible so that persons going to the site could reconstruct a particular situation without reliance on memory. Efforts were made to record the entries legibly, and to protect the log book from damage.

Field log books were assigned to field personnel, but were stored in the project file when not in use. Each log book was identified by a project-specific number. The title page of each note book contained: 1) person or organization to whom the book was assigned, 2) book number, 3) project name, and 4) start and end dates.

Entries into the log book contained a variety of information. At the beginning of each entry, the date, start time, weather, names of personnel present, level of personal protection being used, and the signature of the person making the entry was entered. The names of visitors to the site and the purpose of their visit were recorded in the field log book.

Activities performed, measurements made, and samples collected were recorded. All entries were made in ink and no erasures were made. If an incorrect entry was made, the information was crossed out with a single strike mark. Photographs taken to document field activities were also documented in the log book. All equipment used to make measurements were identified, along with the date of calibration. Additional documentation completed in the field included: boring logs (Appendix B), piezometer installation forms (Figures 8-11), and daily reports.

9.0 DECONTAMINATION PROCEDURES

The following decontamination procedures were followed to avoid spreading contamination between boreholes and increasing the volume of contaminated materials.

An area at the southeast corner of the Cosco Church Street facility was designated to perform decontamination. Decontamination water infiltrated into an area of bare soil under a large tree south of the decon site. The DEC field representative, Chris Magee, gave permission to discharge the decontamination water to the ground provided that the location of the infiltration area was noted in the log book.

Decontamination of all drilling equipment was performed in the designated decontamination area prior to drilling, between each borehole location, and before leaving the site. Decontamination consisted of scrubbing to remove any encrusted materials followed

by use of a high-pressure, steam-cleaning unit. Following decontamination, cleaned drill steel was placed back on the rig for immediate re-use.

Interface probes and other non-dedicated equipment were not decontaminated because the piezometers were not designed for groundwater sampling.

10.0 HEALTH AND SAFETY PROCEDURES

Health and safety procedures were carried out in accordance with the WCC Health and Safety Plan which was included as Appendix 1 of the Work Plan. A health and safety briefing was conducted with each member of the drilling crew prior to drilling. All personnel at the drill site signed a form to acknowledge that they had received and read the health and safety plan.

Drilling operations proceeded safely and without injury to the drilling personnel, inspector, or general public. No combustible gasses were detected with the combustible gas meter, and no organic vapors were detected with the HNu photo-ionization detector. Volatile organic vapors were detected in Boring 1, but at low levels. All drilling operations were conducted in level D, and no upgrades were necessary. Drilling personnel were reminded to wear safety glasses, and/or hard hats on a few occasions. None of the drilling personnel voiced any health complaint during the course of drilling or well installation.

One drilling accident occurred while drilling Boring Number 3, but it posed no threat to the health and safety of the drilling crew. A 3-inch water main was punctured just after beginning Boring 3 on Park Street. Drilling was halted at the first indication of water in the borehole. After the accident water flowed from the borehole at a rate of 5-10 gallons per minute and flowed west along the north gutter of Park Street until it entered

a storm sewer drain about 80 yards away.

The SVWCo excavated and repaired the damaged water main and took responsibility for incorrectly marking its location. The SVWCo said that it had accidentally marked the location of an abandoned pipe during its utility check and had left the active water main unmarked.

11.0 DATA ANALYSIS

11.1 Evaluation of Groundwater Hydrographs

Groundwater hydrographs are plots of daily piezometer water levels as a function of time. Sixteen hydrographs, one for each piezometer, are presented on Figures 12 through 19. Piezometers are grouped as shallow (92 ft or 100 ft) or deep (192 ft or 200 ft) on the figures.

Water levels were not measured on weekends except during the period that WCC's field representative was on site (prior to 29 June 1990). The lack of weekend data should not interfere with data interpretation because the wavelength of the water level oscillations appears to be on a larger scale. In order to plot precipitation data on the same x-axis as the hydrographs, rainfall that occurred during the weekend was added to the Monday total.

The hydrographs for the shallow piezometers show overall falling water levels over the period of observation until August 9th when the levels rose sharply. The sharp rise corresponded with an 8-inch rain event from August 6-13th. Superimposed on the overall falling trend are a series of somewhat shorter wavelength oscillations which occur in all of the shallow piezometers. Deep piezometers in nests 1 and 4 show a pattern of groundwater fluctuations very similar to the shallow piezometers. Deep piezometers 2 and 3 show a pattern of groundwater fluctuations unlike the other piezometers.

The hydrographs were compared to time-series plots of rainfall and SVWF pumping rates in an effort to determine which of these factors affects water levels in the piezometers. Precipitation data were plotted as a function of time along the bottom of each hydrograph. Periods of low pumping rates in the SVWF are represented by arrows along the tops of the hydrographs and on

Figure 22.

Precipitation events on July 22-24 (1.00-in), and August 6-13 (8.03 in) seem to be related to upward hydrograph deflections in all of the shallow hydrographs and in the deep piezometer hydrographs for nests 1 and 4. Another rain event on July 12-16 (1.82-in) appears to be related to upward deflections in both the shallow and deep piezometers in piezometer nests 1 and 4.

The pumping rate at the SVWF averaged around 1800 gallons per minute (gpm) over the period from 18 June 1990 until 20 August 1990. Periods of slightly reduced pumping occurred on June 20 (1620 gpm), June 31 (1530 gpm), July 12-13 (1600 gpm), July 15 (1660 gpm), July 23 (1410), August 6 (1410 gpm), August 11 (1480 gpm), August 15 (1620 gpm), August 16 (1690 gpm), August 18 (1680 gpm), and August 19 (1459 gpm). In general, periods of reduced pumping do not correspond to periods of high water levels in either the shallow or deep piezometers.

Deep bedrock piezometers in piezometer nests 2 and 3 show a pattern of water level oscillations unlike the other shallow or deep piezometers. The pattern in both piezometers consists of falling or stable water levels until a sharp rise on 5 July 1990, followed by stable or rising levels until a sharp drop on 18 July 1990, and finally a gradual rise until 20 August 1990. The deep piezometers in piezometer nests 2 and 3 may be responding to local pumping wells or other unknown factors. Water levels in these piezometers do not correlate with either precipitation or pumping rates in the SVWF.

11.2 Evaluation of Groundwater Flow Directions in the Shallow and Deep Levels of the Bedrock Aquifer

11.2.1 Methodology for Calculating Groundwater Flow Directions

Groundwater flow directions were calculated by solving a series of three-point problems. Three-point problems are solved by finding the plane defined by three points. In this hydrogeologic application the three points are pressure heads measured in feet of water, and the resulting plane is a piezometric surface, the dip direction of which indicates the groundwater flow direction. The three point solution assumes that the groundwater aquifer behaves as a homogeneous, isotropic medium on a macroscopic scale. Based WCC's review of the regional hydrogeology we believe this assumption is warranted.

Water level elevations from three piezometers screened at approximately the same elevation interval and with approximately the same surface elevations were input into the three-point equation shown on Figure 20. This equation yields a strike direction for the plane defined by the pressure heads in the three piezometers. Dip direction (flow direction) is determined by adding 90 degrees to the strike direction calculated for the three-point problem.

Two three-point problems were solved for each of the four piezometer depths (92 ft, 100 ft, 192 ft, and 200 ft) for a total of eight three-point problems for each day of water level readings. The first problem at each depth was solved using piezometer locations 1, 2, and 3. The triangular area defined by these points is titled "Triangle A" on Figure 21. The second three-point problem at each depth was solved using piezometer locations 1, 2, and 4. The triangular area defined by these points is titled "Triangle B" on Figure 21. Note that the piezometers at 92 and 192 feet are simple well-point piezometers with 1/2 inch PVC risers. The

piezometers at 100 and 200 feet are pneumatic piezometers.

The flow directions resulting from the three-point calculations are shown on Table 7. Water level elevations from the period 29 June 1990 through 18 August 1990 were used in the calculations (see Table 1). The following eight three point problems were solved for each day of water level readings:

Three-Point Problems for the Shallow Portion of the Bedrock Aquifer

- 1) 92 ft well point piezometers using locations 1, 2, and 3;
- 2) 92 ft well point piezometers using locations 1, 2, and 4;
- 3) 100 ft pneumatic piezometers using locations 1, 2, and 3;
- 4) 100 ft pneumatic piezometers using locations 1, 2, and 4;

Three-Point Problems for the Deep Portion of the Bedrock Aquifer

- 5) 192 ft well point piezometers using locations 1, 2, and 3;
- 6) 192 ft well point piezometers using locations 1, 2, and 4;
- 7) 200 ft pneumatic piezometers using locations 1, 2, and 3; and
- 8) 200 ft pneumatic piezometers using locations 1, 2, and 4.

The flow-direction calculations in Table 7 were automated by programming them into a computer spreadsheet program. This program was tested against manual calculations to verify its accuracy. The groundwater flow directions are presented in Table 7 as azimuths. Azimuths are angles measured from true north in a clockwise direction.

11.2.2 Evaluation of Flow-Direction Data

The flow-direction data in Table 7 is presented graphically in Figures 23, 24, 25, and 26. Figure 22 shows the overall daily average groundwater flow directions calculated by averaging the solutions for all eight three-point problems. Figure 22 is

presented using a scale of 0 to 90 degrees. The overall average flow directions fluctuated between "north 78.6 degrees east" and "north 81.7 degrees east" over the period of observation with the average being north 80.1 degrees east.

The overall groundwater flow direction appears to be very stable (See Figure 22A) even though the water level elevations in the piezometers have fluctuated by as much as 5.5 feet (See hydrographs in Figures 12-19). The "north 81 degrees east", overall, average flow direction indicates that Pascack Brook controls groundwater flow near the former Cosco West Street facility.

Figure 24 shows the daily average flow directions at shallow and deep bedrock levels. The average daily shallow flow direction is an average of the solutions for three-point problems number 1, 2, 3, and 4. The average daily deep flow direction is an average of the solutions for three-point problems number 5, 6, 7, and 8. The average flow direction in the shallow bedrock averages around north 88 degrees east, or almost due east. The average flow direction at the deep bedrock level averages north 73 degrees east.

The variations in flow direction for the daily average shallow and deep flow directions do not seem to correlate with either rainfall or pumping rates in the SVWF, with the exception of a northward shift in the shallow flow direction beginning on August 7th which may be related to the strong rain event starting August 6th.

Figures 25 and 26 display the daily flow direction data at the level of the individual three-point problems. Figures 25 and 26 yield the most detailed information regarding flow directions. These figures indicate that the flow directions calculated for triangle 1-2-3, which is located further from the well field, are more northerly than the flow directions calculated for triangle 1-

2-4, located closest to the well field. This observation does not support the hypothesis that pumping at the SVWF exerts dominant control of groundwater flow near the Cosco facility. If the well field were the dominant influence, the flow direction for the triangle closest to the well field would point closer to the well field.

11.3 Evaluation of Vertical Hydrostatic Gradients

Vertical hydrostatic gradients were calculated for the following intervals in each piezometer nest:

- 1) Water table to 92 ft;
- 2) 92 ft to 100 feet;
- 3) 100 ft to 192 ft;
- 4) 192 ft to 200 ft; and
- 5) Water table to 200 ft (overall gradient).

Daily hydrostatic gradients for each of the above intervals are presented in Table 2. The following equation was used to calculate hydrostatic gradients:

HYDROSTATIC GRADIENT = DIFFERENCE IN MEASURED WATER LEVEL/
DISTANCE BETWEEN PIEZOMETERS (or distance between water table and
piezometer for the shallowest gradient interval)

Daily, overall, vertical hydrostatic gradients from Table 2 are presented graphically in Figure 27. Vertical, overall hydrostatic gradients are roughly .3 ft/ft in piezometer nests 1, 3, and 4, but are higher in piezometer 2 (.51 ft/ft). Very little variation occurs in the overall daily gradients as a function of time. All of the overall gradients indicate strong downward hydrostatic gradients in the study area. The downward gradients indicated that the study area is within a zone of groundwater recharge.

The overall vertical gradient in piezometer 3, the background piezometer, is nearly equal to the gradient in piezometers 1 and 4 located much closer to the SVWF. If the well field were affecting the vertical gradients in the study area, gradients should increase as distance to the well field decreases. The vertical-gradient data does not show such an increase, and therefore supports the hypothesis that the effects of pumping at the SVWF do not extend to the former Cosco West Street facility.

The gradient data indicates that Pascack Brook, not the SVWF, controls groundwater flow in the study area. The vertical hydrostatic gradient in piezometer 2, located closest to Pascack Brook, is higher than gradients in piezometers 1, 3, and 4. Piezometers 1, 3, and 4 are roughly the same distance from the river and have nearly identical gradients. The fact that gradients increase toward the Brook suggests that Pascack Brook, not the SVWF controls groundwater flow in the study area.

11.4 Conclusions

Two basic theoretical conclusions are possible regarding the impact of groundwater pumping at the SVWF on groundwater flow in the study area:

- 1) The former Cosco West Street facility is beyond the radius of influence of the well field and groundwater in the bedrock aquifer will migrate east, toward Pascack Brook; or
- 2) The former Cosco West Street facility is within the radius of influence of the SVWF and groundwater in the bedrock aquifer will migrate north-northeast toward the well field.

Three lines of hydrogeologic evidence were identified in the SRI which point to the first conclusion, namely:

- 1) Average shallow and deep flow vectors calculated from three point problems point east or east-northeast in the direction of Pascack Brook;
- 2) Average flow vectors calculated for triangle A, located furthest from the SVWF, point more northerly than average flow vectors calculated for triangle B. This pattern is opposite to the expected pattern if the SVWF were influencing groundwater flow vectors in the West Street area.
- 3) The vertical hydrostatic gradient in piezometer 2, located closest to Pascack Brook, is lower than gradients in piezometers 1, 3, and 4. Piezometers 1, 3, and 4 are roughly the same distance from the river and have nearly identical gradients. The fact that gradients increase toward the Brook suggests that Pascack Brook, not the SVWF controls groundwater flow in the study area.

The data do not support the second hypothesis. Therefore, WCC concludes that the former Cosco West Street facility is beyond the radius of influence of the SVWF.

WCC further concludes that the statement in the RI that bedrock groundwater flow is toward the SVWF is unsupported because:

- 1) the design of the seals for the piezometers was inappropriate because the top of the bedrock was permeable and groundwater from the glacial deposits could migrate to the open, bedrock portion of the boreholes;
- 2) The piezometers were completed as open boreholes, making it impossible to assign water levels to a particular depth;
- 3) Piezometers of different depth and surface elevation were

compared to assess the direction of flow. This procedure was inappropriate given the natural downward vertical hydrostatic gradients in the area; and

- 4) The piezometers were aligned to determine groundwater flow direction on a one dimensional rather than a three dimensional basis. This procedure does not fairly evaluate the range of possible flow directions.

These factors are largely responsible for the differences in conclusions between the RI and the SRI.

FIGURES

LOCATION OF PIEZOMETER NESTS

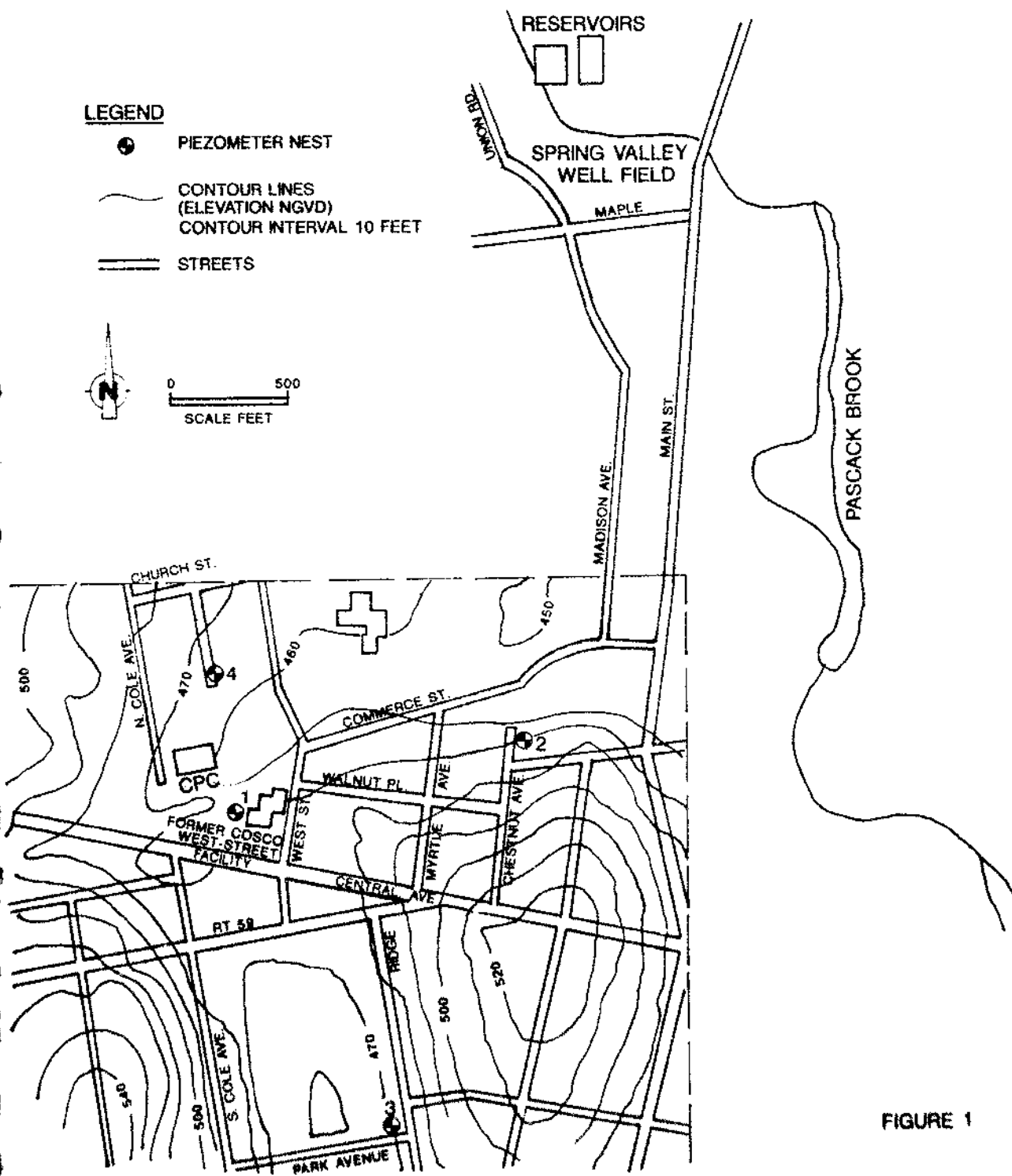


FIGURE 1

DIRECTION OF GROUNDWATER FLOW IN DEEP BEDROCK AQUIFER

CALCULATED BY AVERAGING ALL EIGHT DAILY FLOW VECTORS
USING BOTH WELL POINT AND PNEUMATIC PIEZOMETERS

LEGEND



PIEZOMETER NEST



CONTOUR LINES
(ELEVATION NGVD)
CONTOUR INTERVAL 10 FEET



STREETS



0 500
SCALE FEET

Direction of groundwater flow was
calculated by solving three point
problems using piezometric data
collected on 6/29/90.

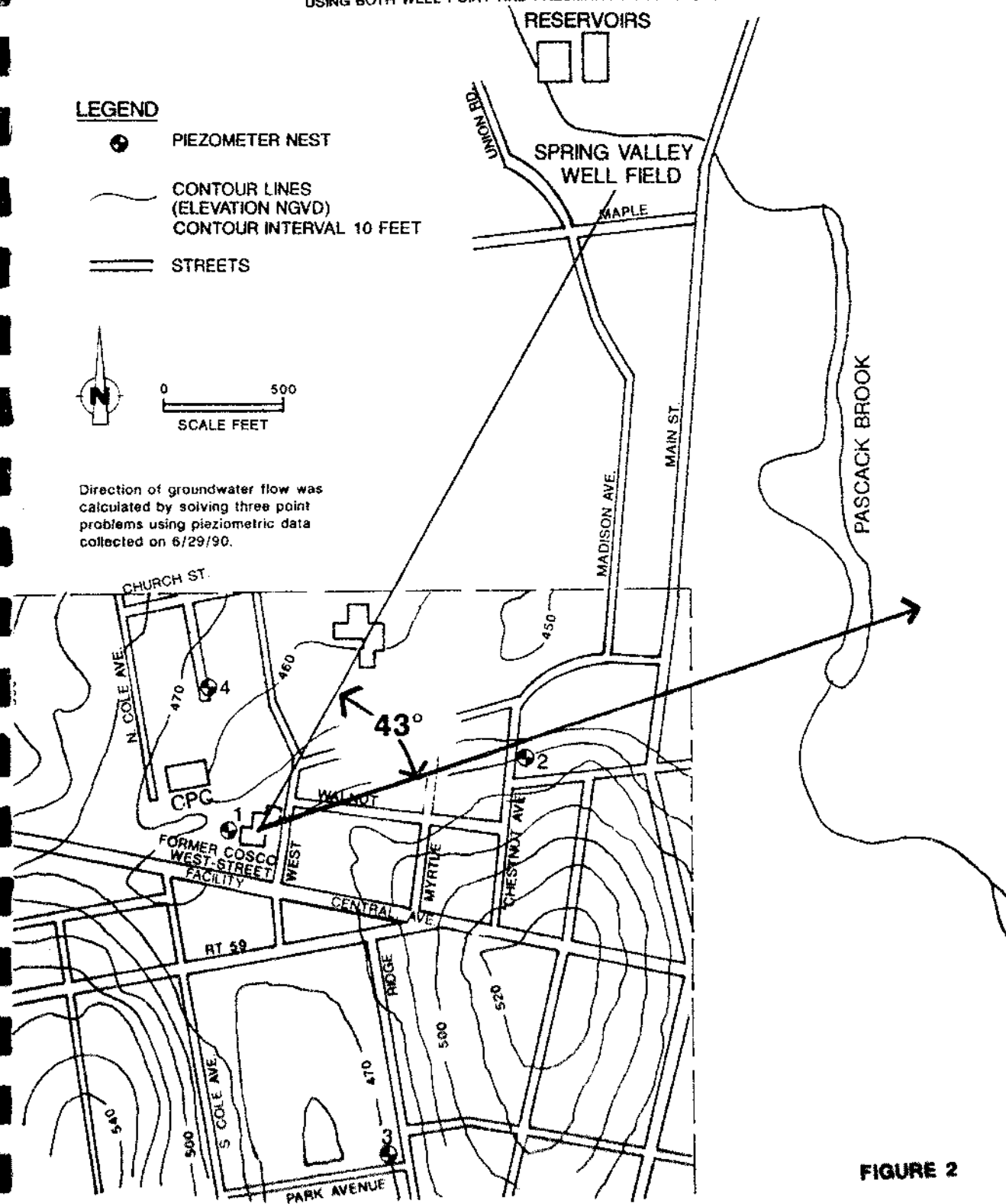


FIGURE 2

DIRECTION OF GROUNDWATER FLOW IN SHALLOW BEDROCK AQUIFER

CALCULATED BY AVERAGING ALL EIGHT DAILY FLOW VECTORS
USING BOTH WELL POINT AND PNEUMATIC PIEZOMETERS

LEGEND

-  PIEZOMETER NEST
 -  CONTOUR LINES
(ELEVATION NGVD)
CONTOUR INTERVAL 10 FEET
 -  STREETS
- Data from 92 ft and 100 ft
piezometers used to calculate
flow directions.



0 500
SCALE FEET

Direction of groundwater flow was
calculated by solving three point
problems using piezometric data
collected on 6/29/90.

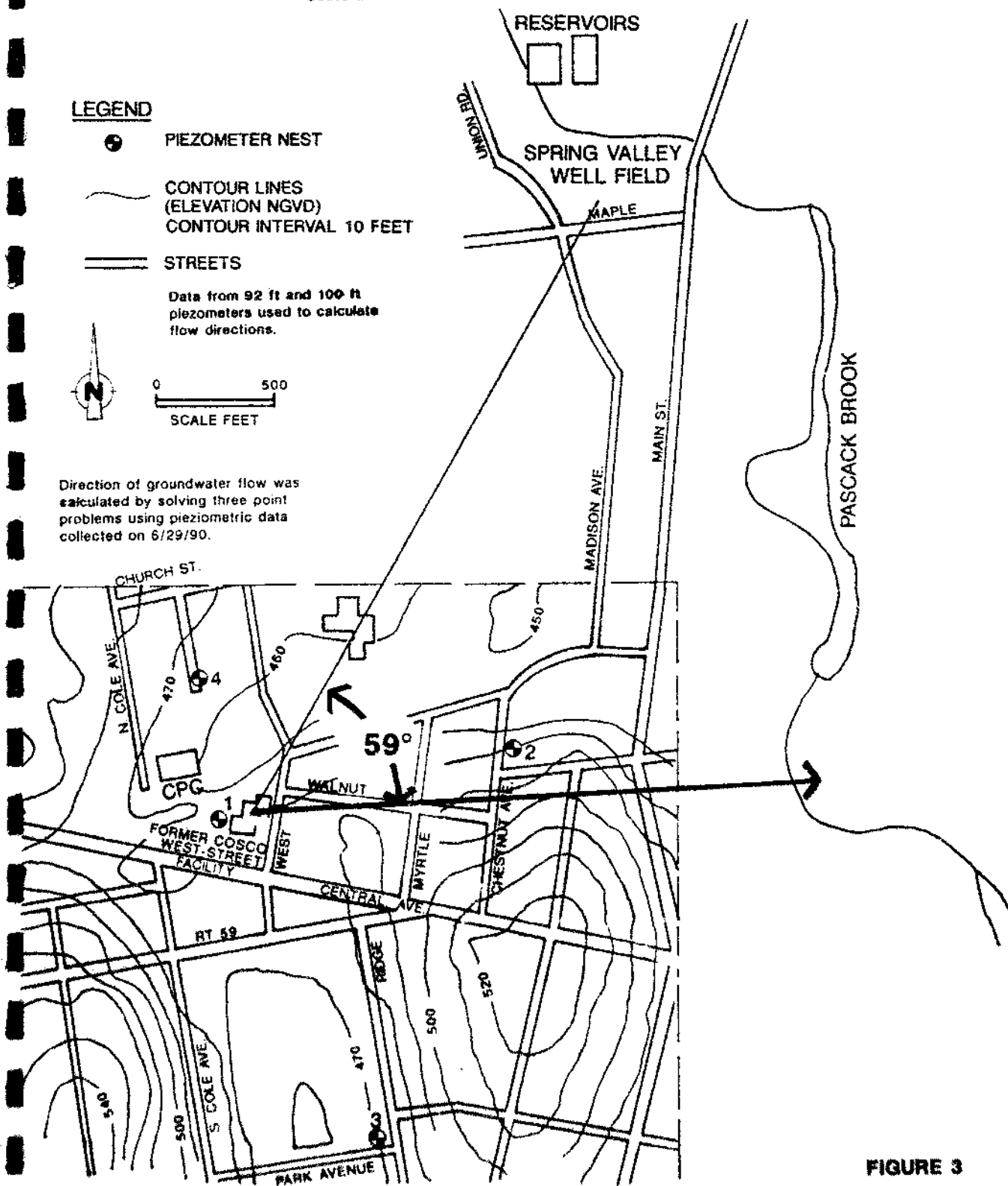
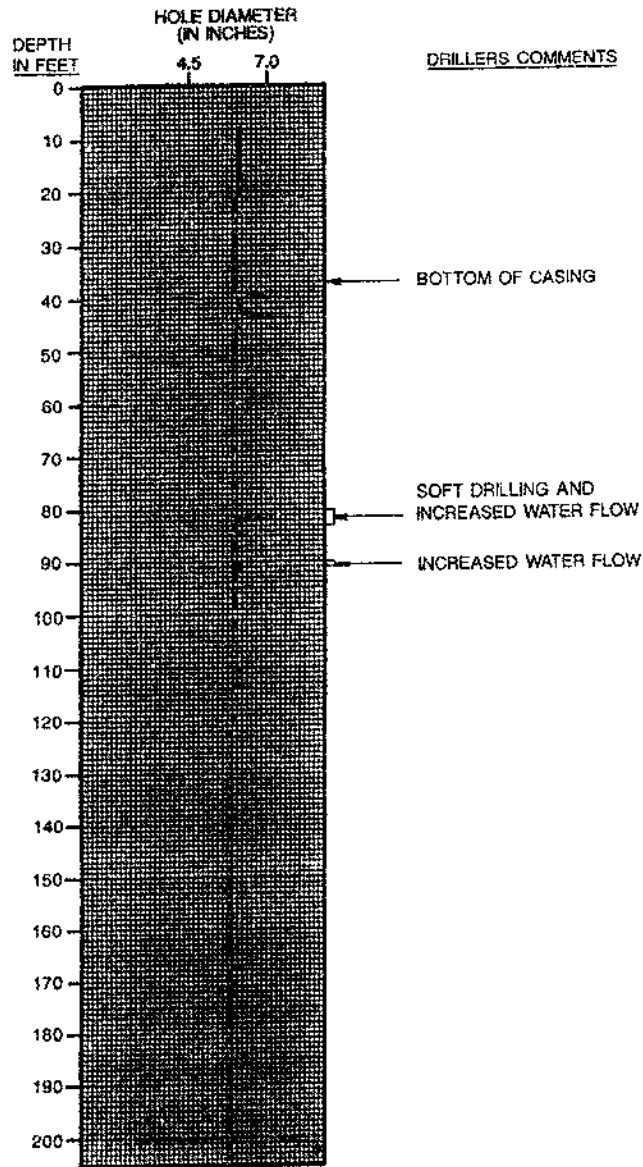


FIGURE 3

CALIPER LOG

BORING NUMBER 1

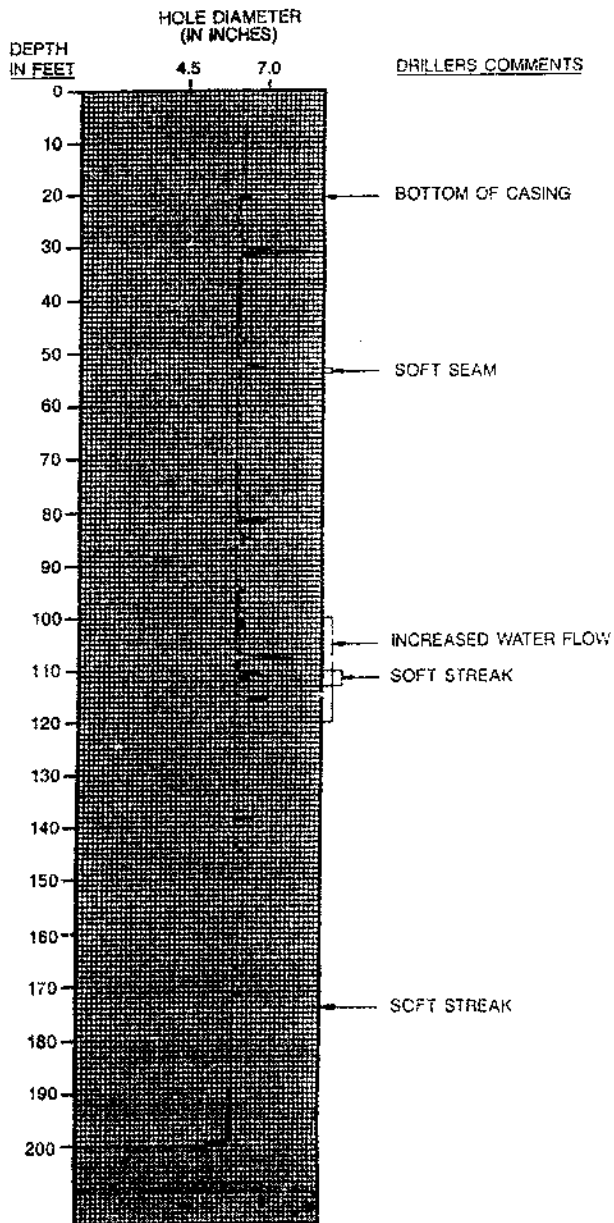


NOTE: LOGGING RATE WAS 10 FEET PER MINUTE.
LOGGING TOOL WAS CALIBRATED WITH 4.5 INCH
AND 7.0 INCH CALIBRATION RINGS PRIOR TO LOGGING

FIGURE 4

CALIPER LOG

BORING NUMBER 2

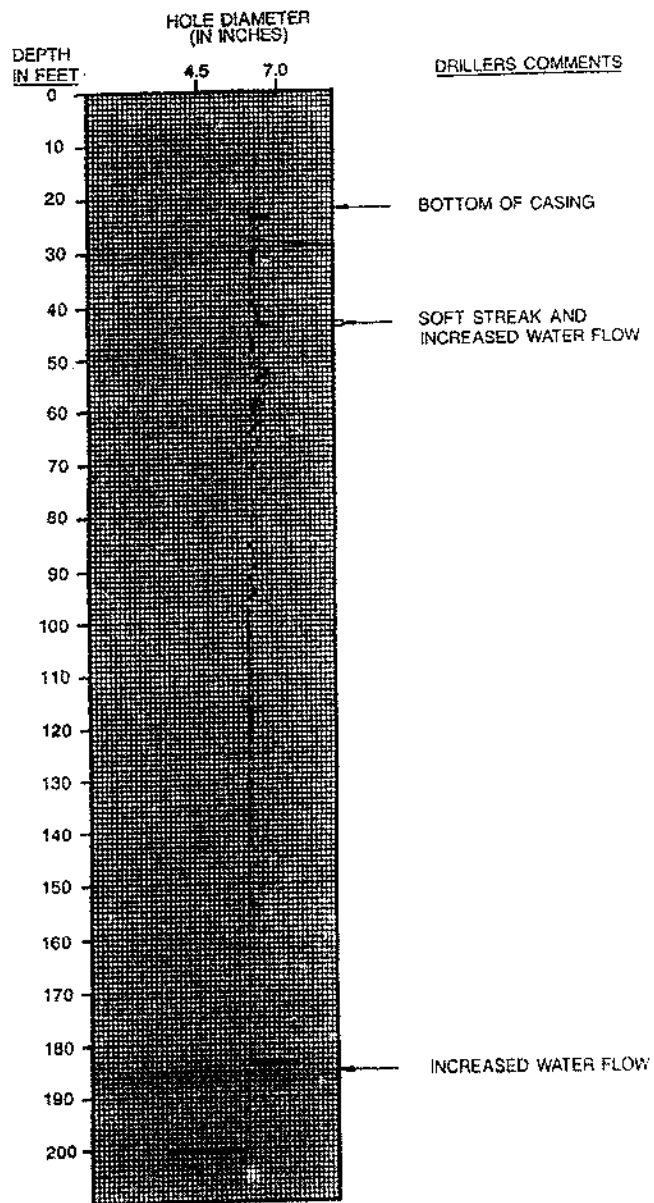


NOTE: LOGGING RATE WAS 10 FEET PER MINUTE.
LOGGING TOOL WAS CALIBRATED WITH 4.5 INCH
AND 7.0 INCH CALIBRATION RINGS PRIOR TO LOGGING

FIGURE 5

CALIPER LOG

BORING NUMBER 3

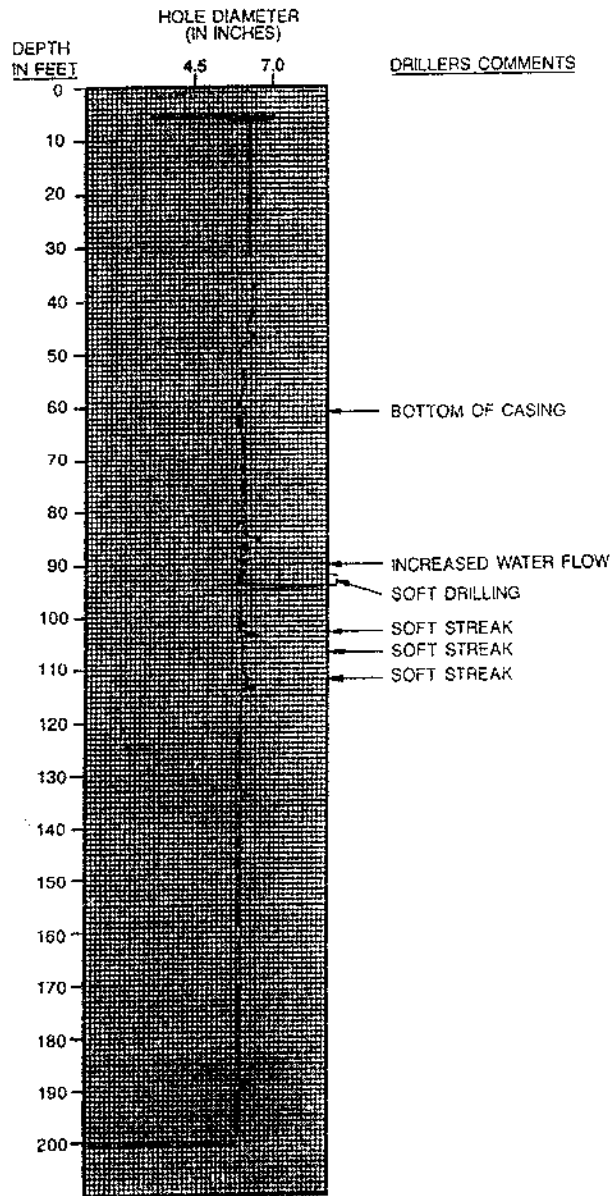


NOTE: LOGGING RATE WAS 10 FEET PER MINUTE.
LOGGING TOOL WAS CALIBRATED WITH 4.5 INCH
AND 7.0 INCH CALIBRATION RINGS PRIOR TO LOGGING

FIGURE 6

CALIPER LOG

BORING NUMBER 4



NOTE: LOGGING RATE WAS 10 FEET PER MINUTE
 LOGGING TOOL WAS CALIBRATED WITH 4.5 INCH
 AND 7.0 INCH CALIBRATION RINGS PRIOR TO LOGGING

FIGURE 7

PIEZOMETER NUMBER: P-1
RIRING NUMBER: B-1

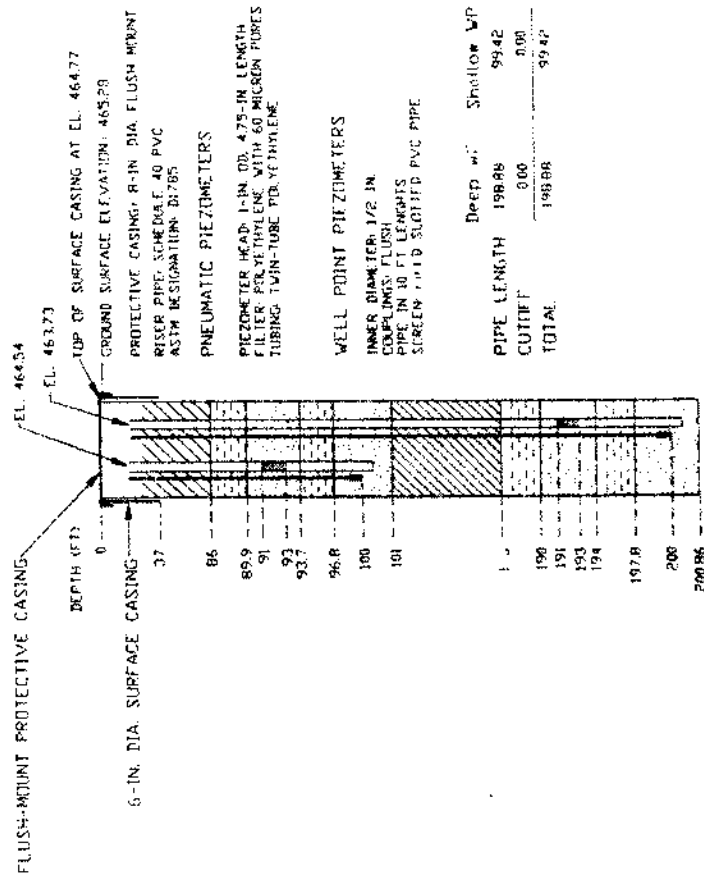


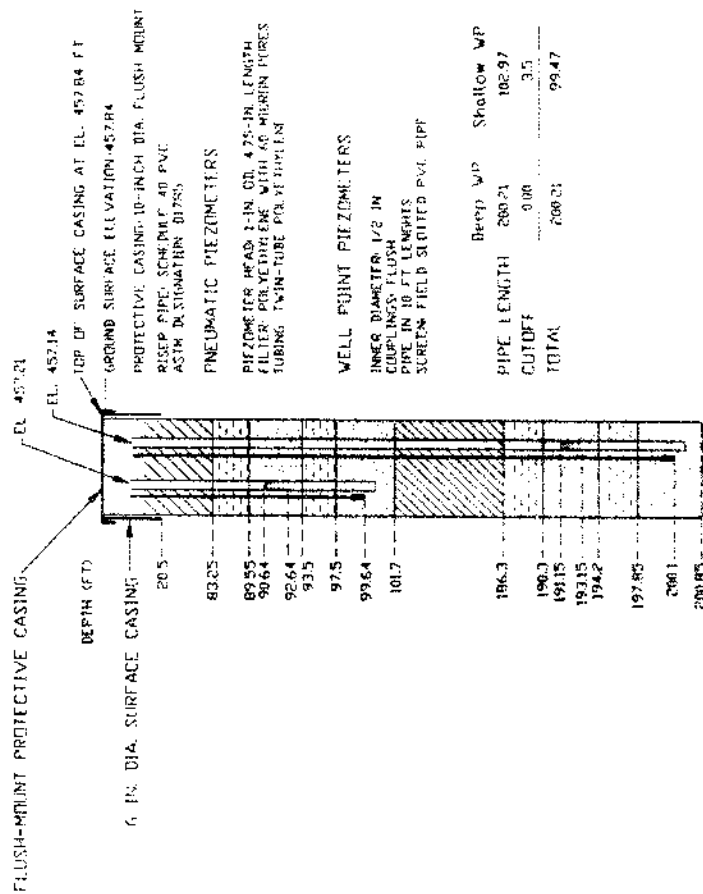
FIGURE 8

Woodward-Clyde Consultants
ENGINEERS, CONSULTANTS, AND ENVIRONMENTAL SCIENTISTS

PIEZOMETER INSTALLATION
FORM

DATE: 3/17/80
PROJECT NO: 89C3517 T08

PIEZOMETER NUMBER: P-2
BORING NUMBER: B-2



- 1/2 -inch PVC Riser
- Pneumatic Piezometer
- Screened Interval
- Cement/ Bentonite Grout
- Seal (3/8in. Bentonite Pellets)
- Filter-Pack Sand
- Grout Mix: 30 Gallons water, 12 pounds bentonite, and 96 pounds of cement

FIGURE 9

Woodward-Clyde Consultants ENGINEERS, CONSULTANTS, AND ENVIRONMENTAL SCIENTISTS	
PIEZOMETER INSTALLATION FORM	
DATE OF PIEZOMETER INSTALLATION	DATE OF PIEZOMETER INSTALLATION
PIEZOMETER NUMBER	PIEZOMETER NUMBER
PIEZOMETER TYPE	PIEZOMETER TYPE
PIEZOMETER LOCATION	PIEZOMETER LOCATION
PIEZOMETER DEPTH	PIEZOMETER DEPTH
PIEZOMETER DIA.	PIEZOMETER DIA.
PIEZOMETER MATERIAL	PIEZOMETER MATERIAL
PIEZOMETER INSTALLER	PIEZOMETER INSTALLER
PIEZOMETER CHECKER	PIEZOMETER CHECKER
PIEZOMETER DATE	PIEZOMETER DATE
PIEZOMETER TIME	PIEZOMETER TIME
PIEZOMETER PAGE	PIEZOMETER PAGE
PIEZOMETER TOTAL	PIEZOMETER TOTAL
PIEZOMETER 89C3517	PIEZOMETER 89C3517

PIEZOMETER NUMBER: P-3
BORING NUMBER: B-3

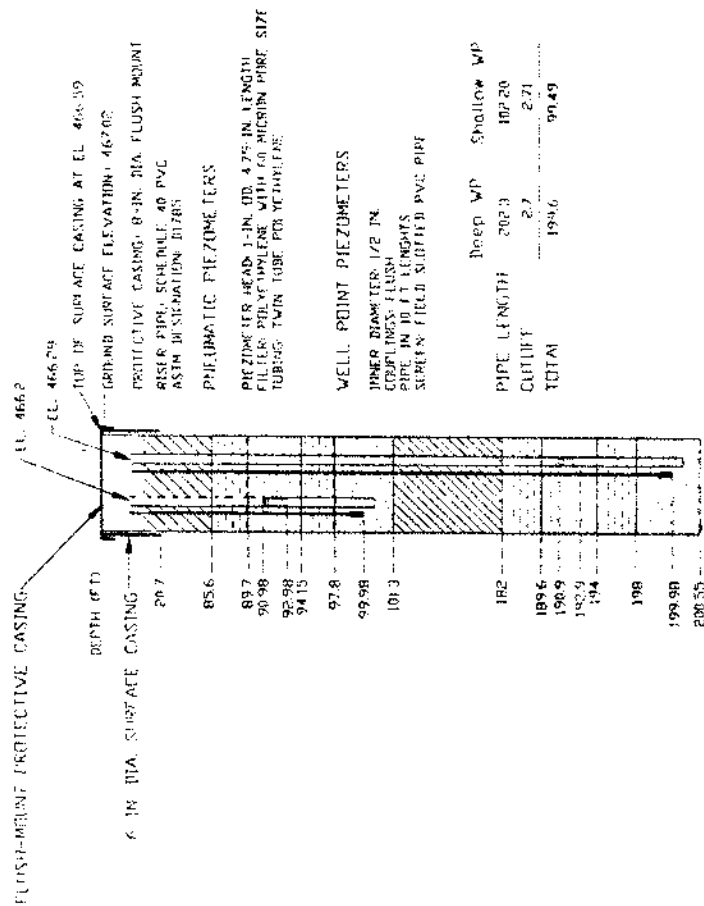


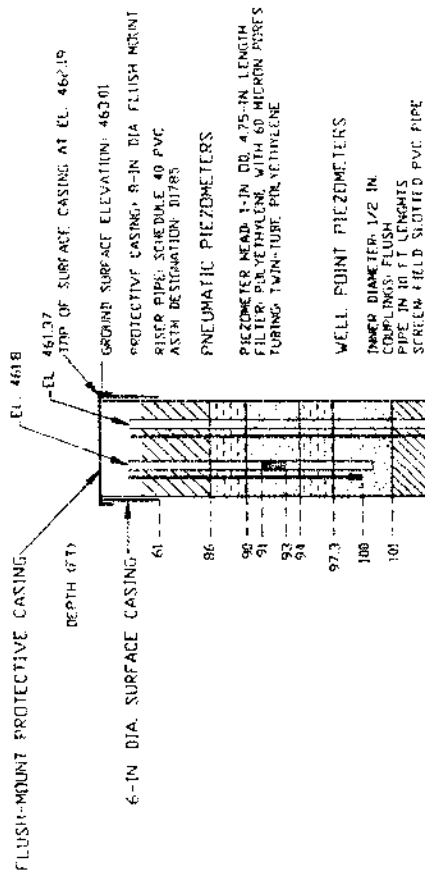
FIGURE 10

Woodward-Clyde Consultants
PROCESS, DESIGN, AND INSTALLATION

PIEZOMETER INSTALLATION
FORM

DATE: 12/17/90
BY: 89C3517

PIEZOMETER NUMBER P-4
BORING NUMBER B-4



	Deep WP	Shallow WP
PIPE LENGTH	203.75	99.4
CUTOFF	4.93	0.8
TOTAL	198.82	98.6

- 1/2 -inch PVC Riser
- Pneumatic Piezometer
- Screened Interval
- Cement/ Bentonite Grout
- Seal (3/8in. Bentonite Pellets)
- Filter-Pack Sand
- Grout Mix: 30 Gallons water, 12 pounds bentonite, and 96 pounds of cement

FIGURE 11

Woodward-Clyde Consultants
ENGINEERING, SURVEYING, AND ENVIRONMENTAL ARCHITECTURE

PIEZOMETER INSTALLATION

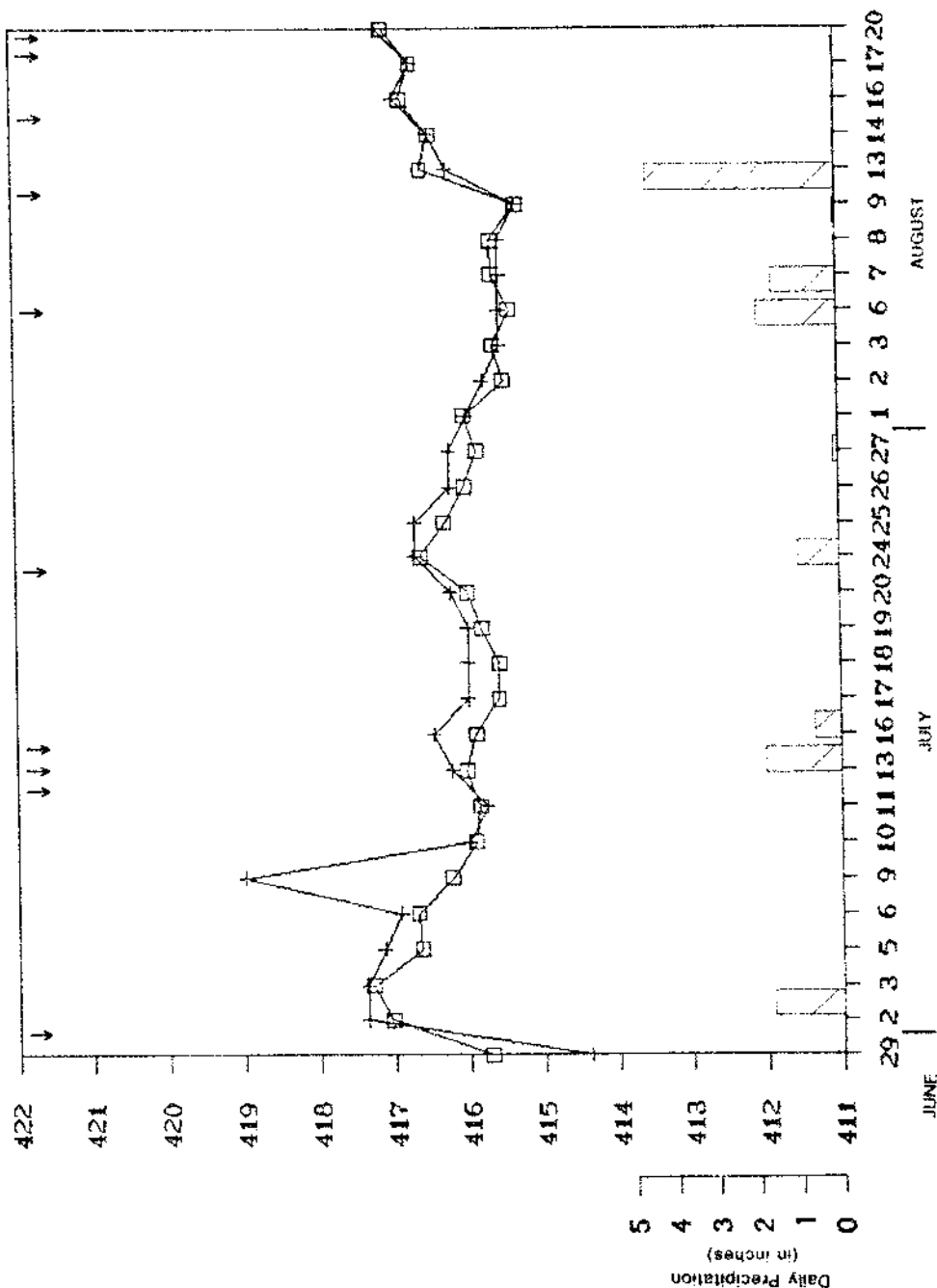
FORM

DATE	BY	REVISION	DATE	BY
8/17/98	8/17/98	8/17/98	8/17/98	8/17/98

89C3517

PIEZOMETER 1 SHALLOW BEDROCK

HYDROGRAPH



□ 92 ft well point + 100 ft pneumatic

↓ LOW PUMPING RATE AT SPRING VALLEY WELL FIELD

NOTE: Dates shown on the x axis are not continuous because data were not collected on weekends or holidays

FIGURE 12

PIEZOMETER 2 SHALLOW BEDROCK

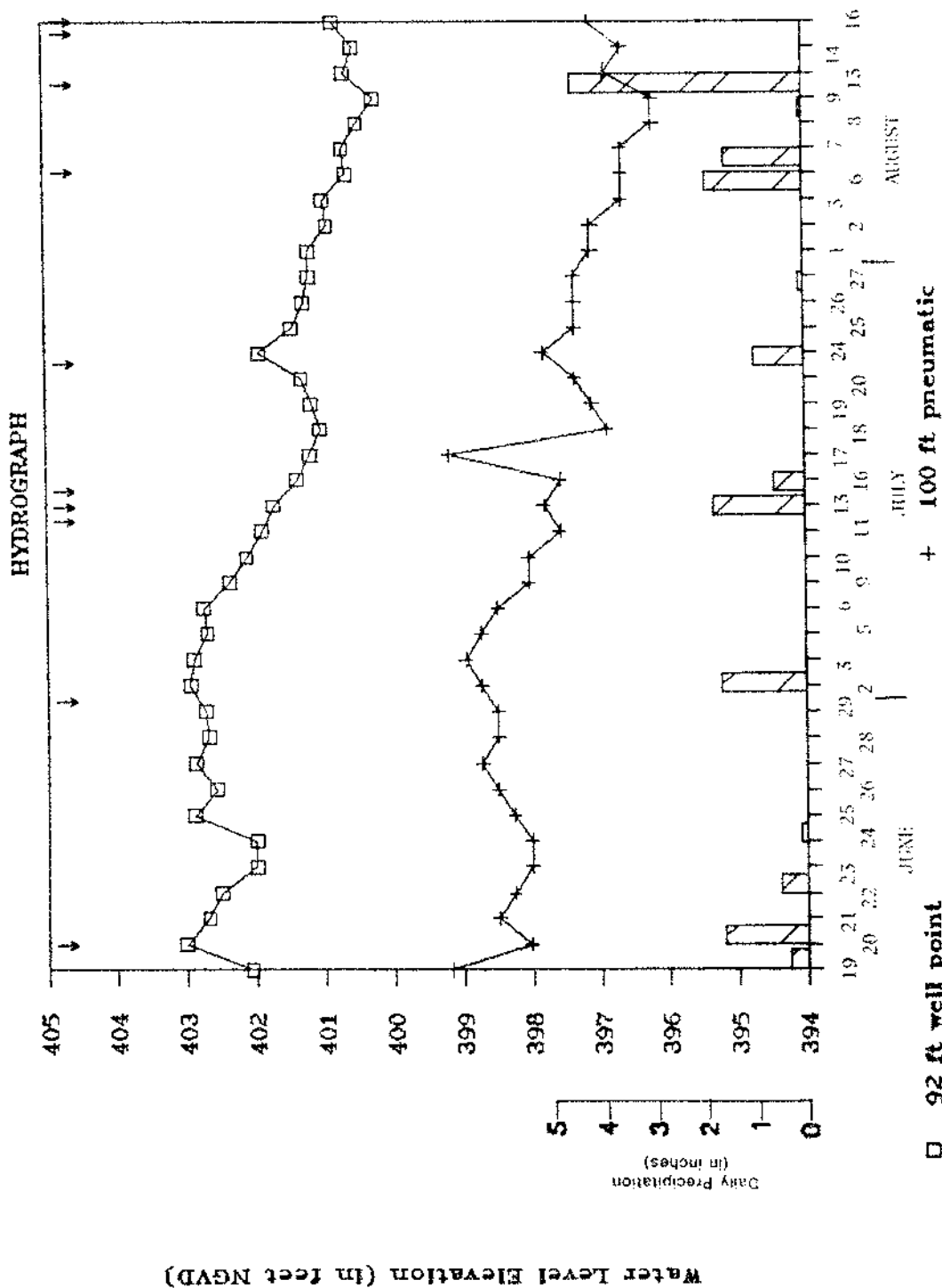


FIGURE 13

PIEZOMETER 3 SHALLOW BEDROCK

HYDROGRAPH

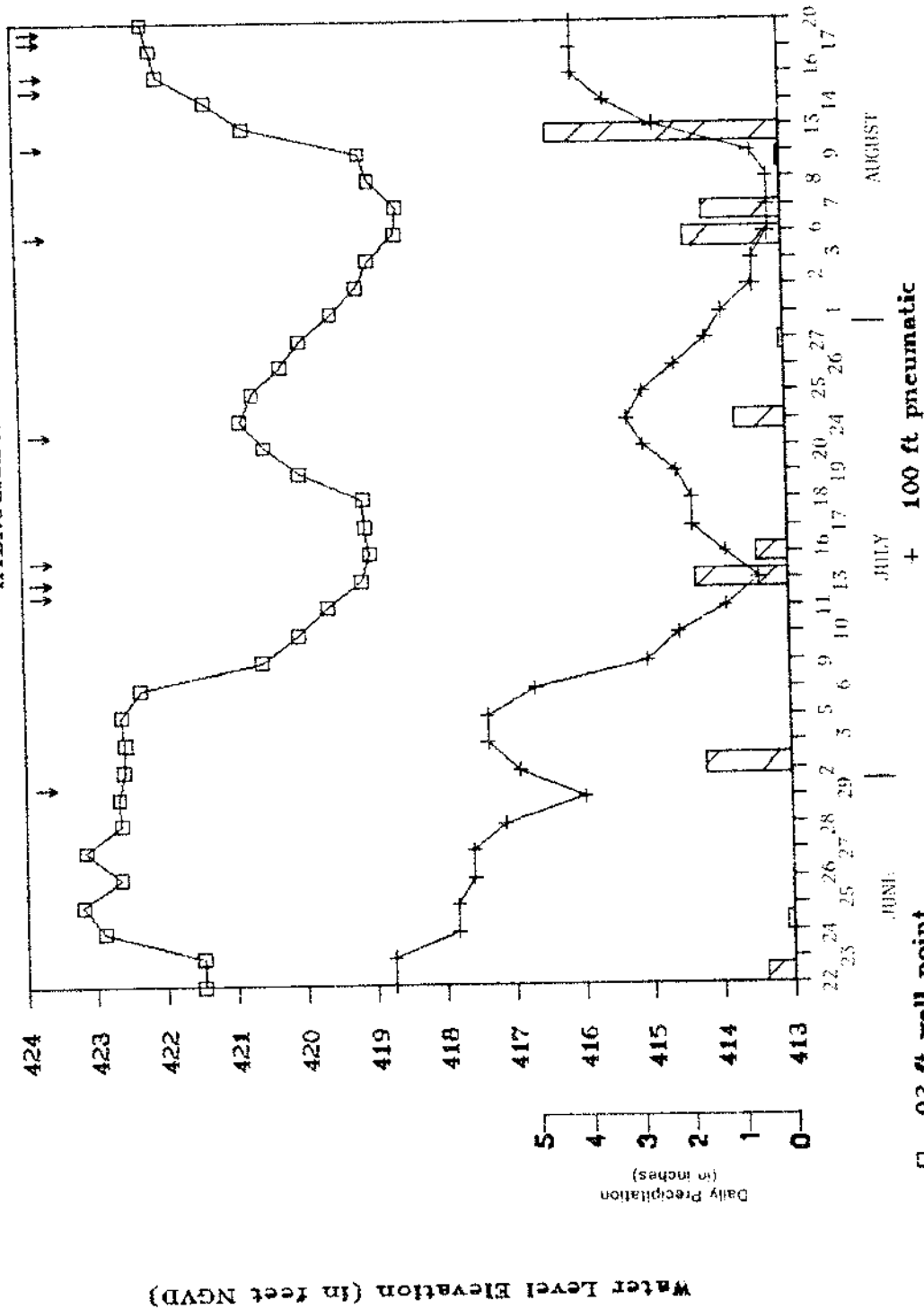


FIGURE 14

PIEZOMETER 4 SHALLOW BEDROCK

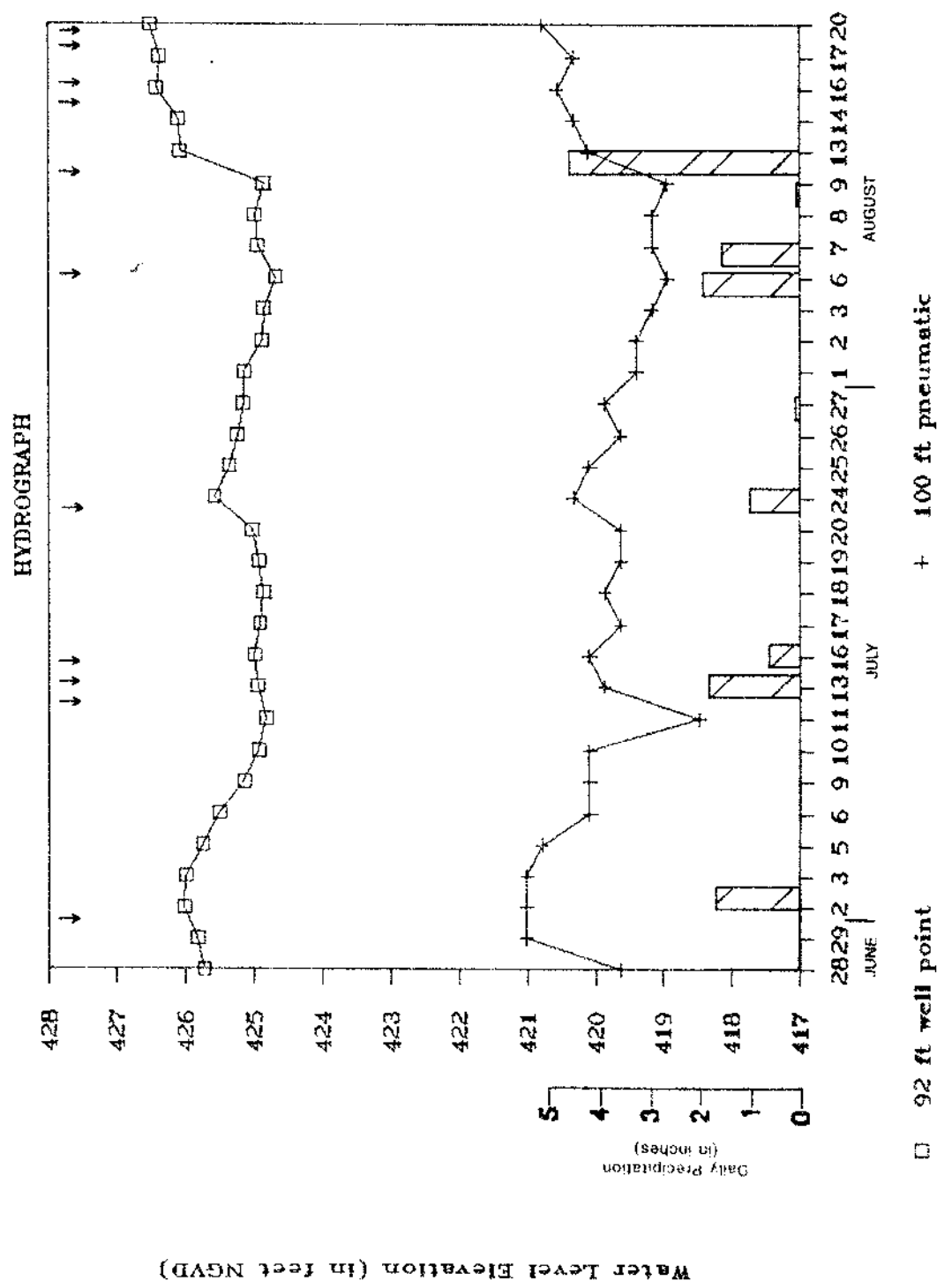


FIGURE 15

NOTE: Dates shown on the x axis are not continuous because data were not collected on weekends or holidays.

PIEZOMETER 1 DEEP BEDROCK

HYDROGRAPH

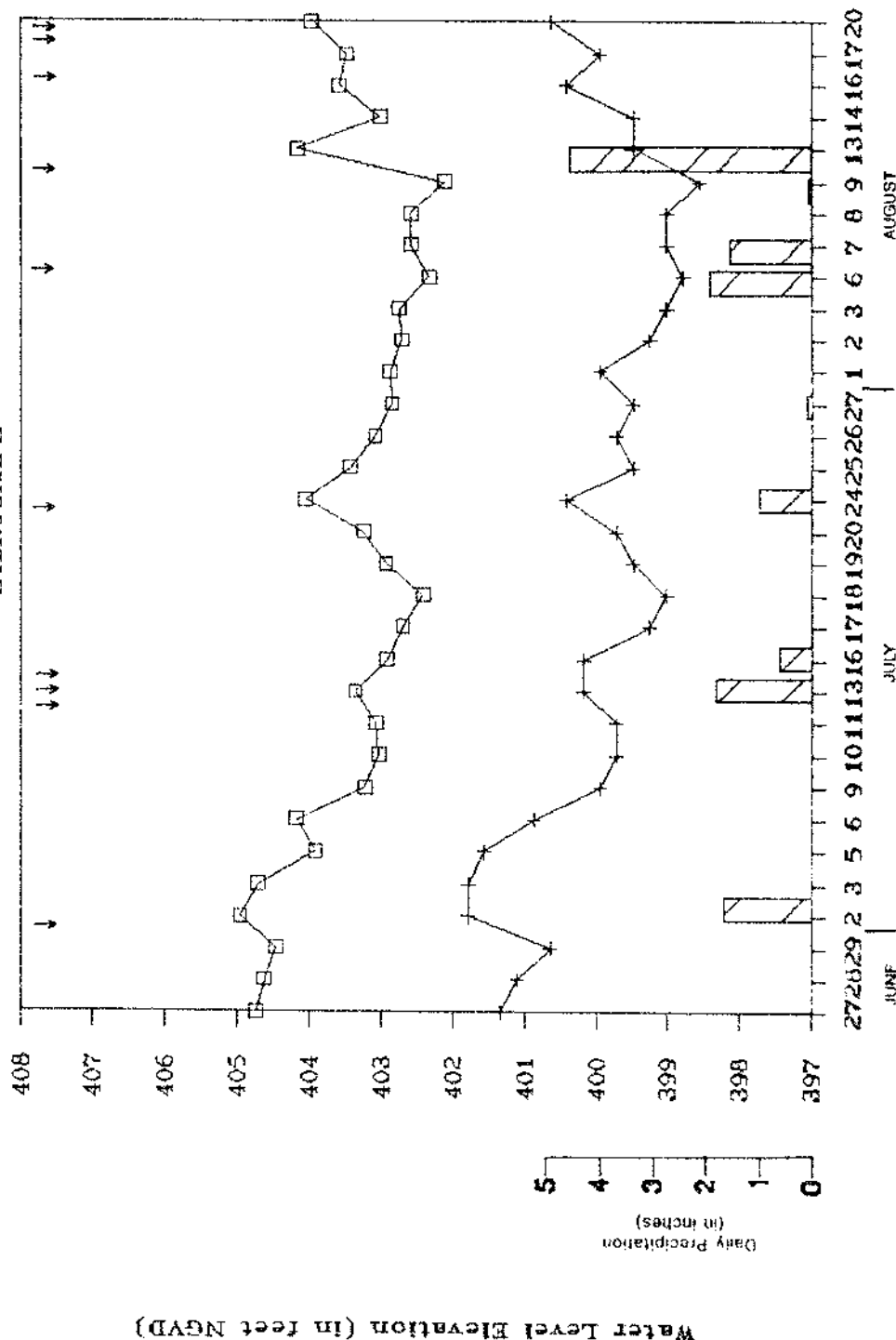


FIGURE 16

PIEZOMETER 2 DEEP BEDROCK

HYDROGRAPH

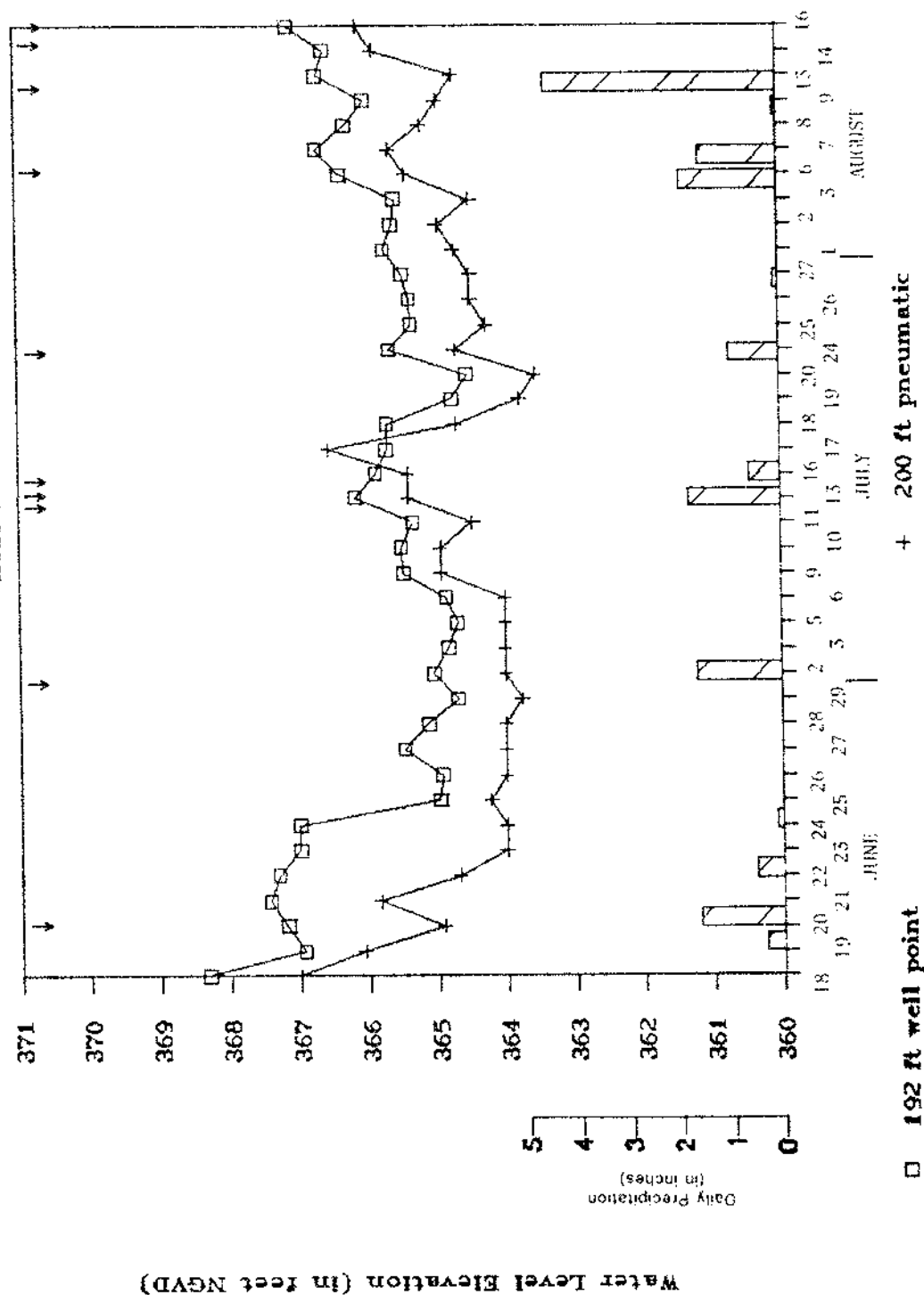


FIGURE 17

PIEZOMETER 3 DEEP BEDROCK

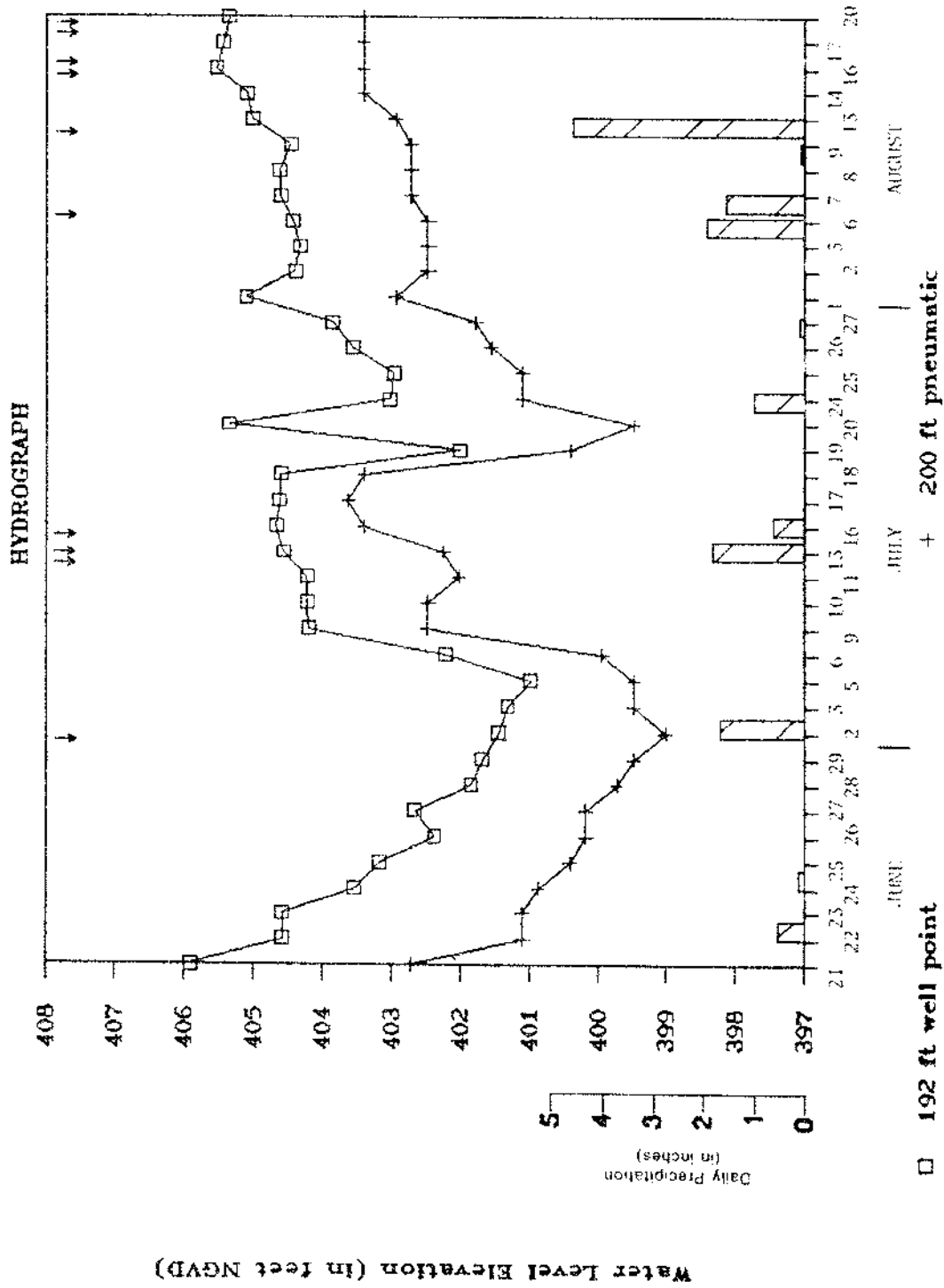


FIGURE 18

PIEZOMETER 4 DEEP BEDROCK

HYDROGRAPH

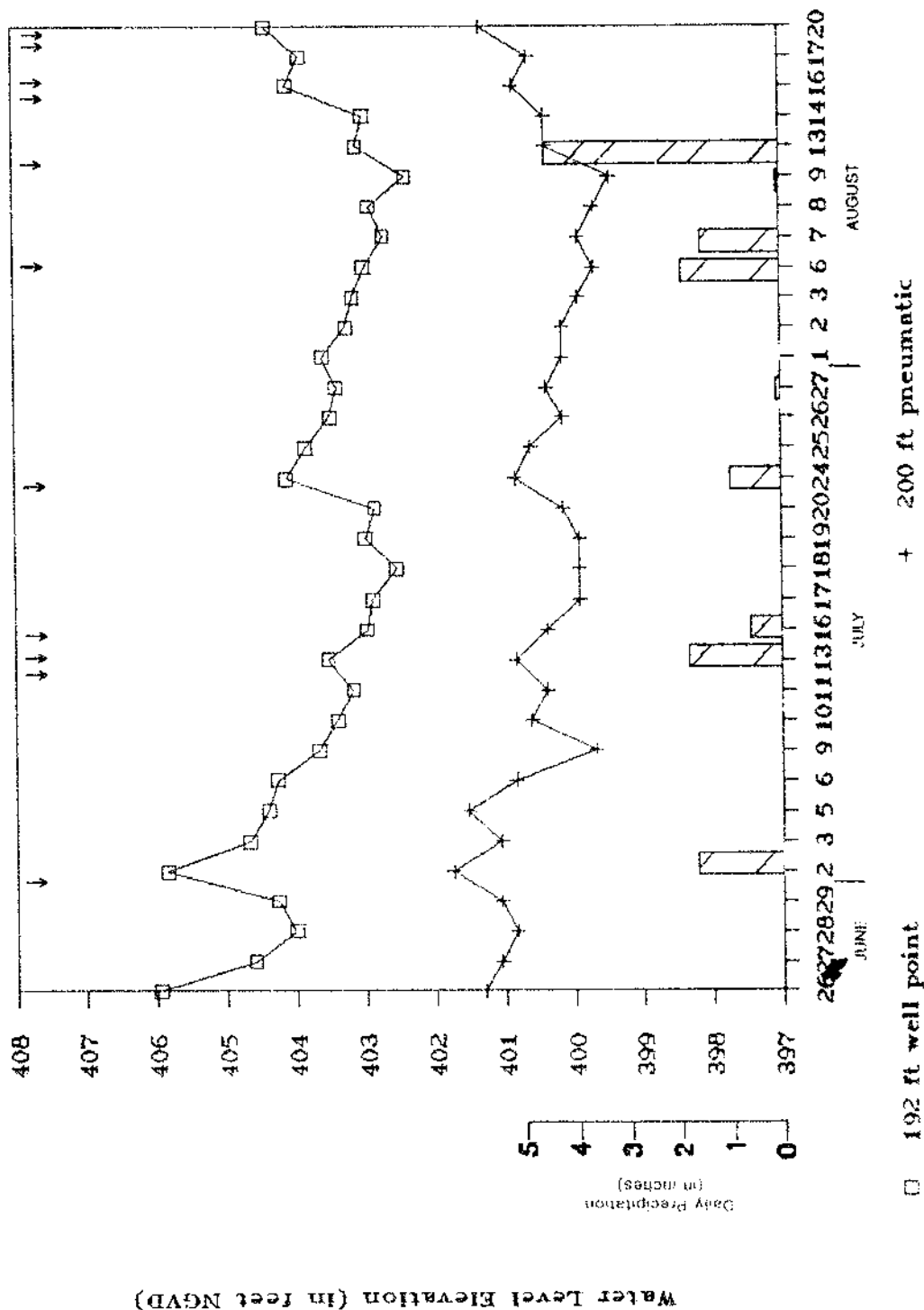
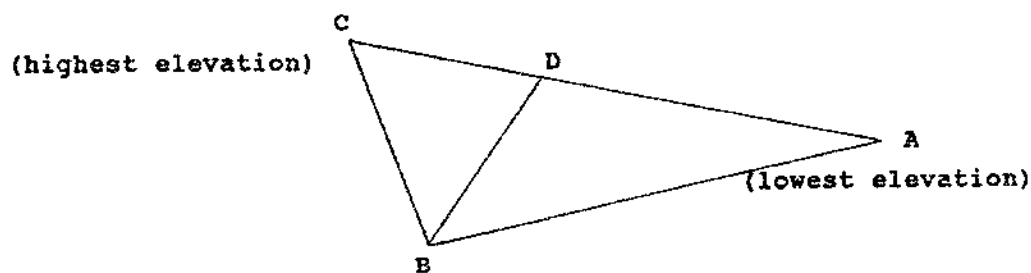


FIGURE 19

NOTE: Dates shown on the x axis are not continuous because data were not collected on weekends or holidays.

FIGURE 20
SOLUTION METHODOLOGY FOR THREE-POINT PROBLEMS

THREE POINT PROBLEM: From 3 points of known elevation lying on a plane, determine the directions of strike (line of constant elevation lying on the plane) and dip (line perpendicular to strike and pointing down-gradient).



THREE-POINT SOLUTION: Since the elevation of "B" is known, if a point "D" can be found on line segment AC which has the same elevation, the strike direction can be determined by connecting points D and B. Point D can be found using a simple proportionality relationship.

$$\frac{\text{Elevation A} - \text{Elevation B}}{\text{Elevation A} - \text{Elevation C}} = \frac{\text{Distance AD}}{\text{Distance AC}}$$

This equation can be re-written as:

$$\text{Distance AD} = \text{Distance AC} \times \frac{\text{Elev. of A} - \text{Elev. of B}}{\text{Elev. of A} - \text{Elev. of C}}$$

The strike direction can be determined graphically once the distance AD is known by connecting a line between points B and D. The dip direction is determined by adding 90 degrees to the strike direction.

LOCATION OF TRIANGLES USED IN THREE-POINT PROBLEMS

LEGEND

-  PIEZOMETER NEST
-  CONTOUR LINES
(ELEVATION NGVD)
CONTOUR INTERVAL 10 FEET
-  STREETS

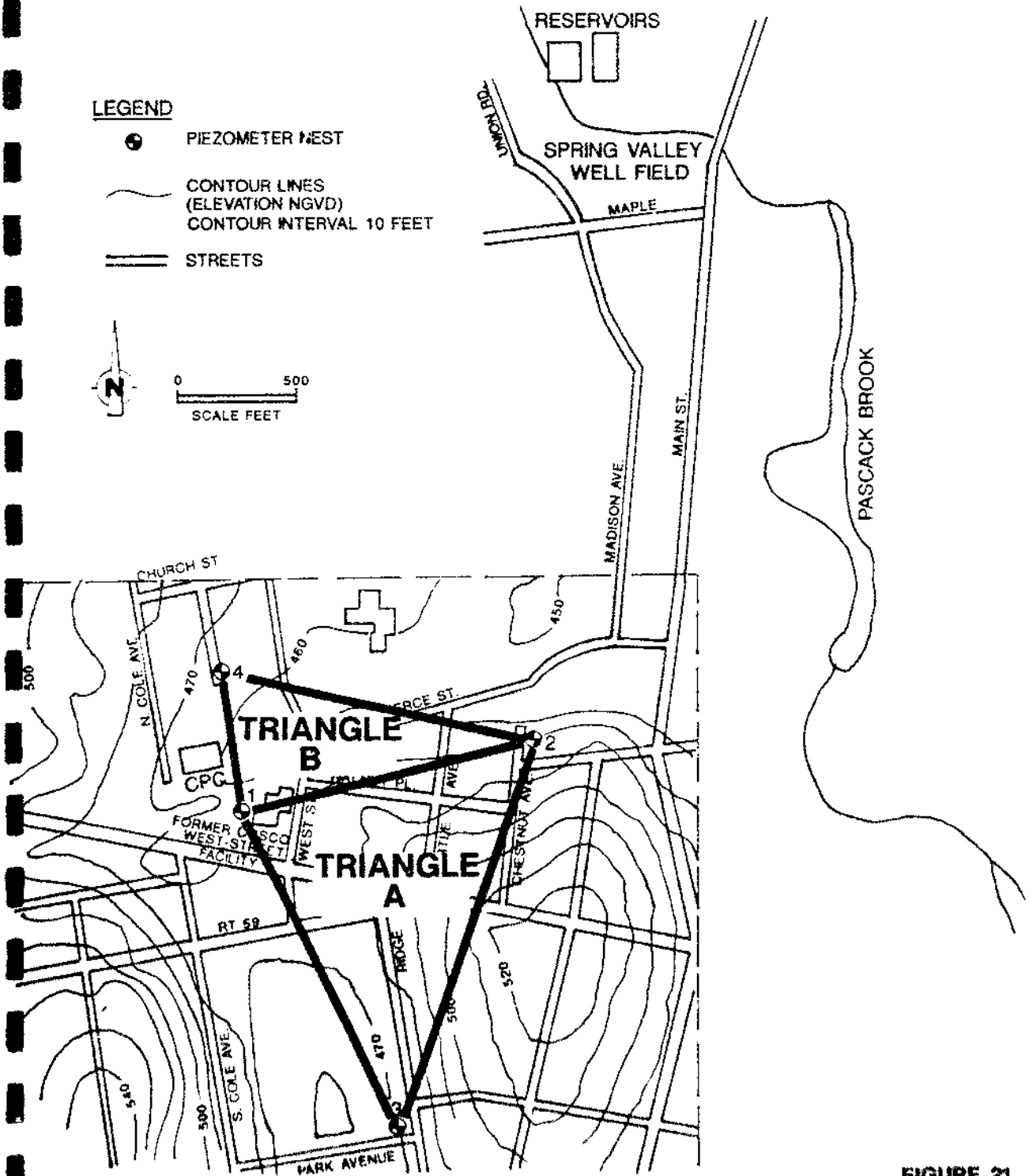
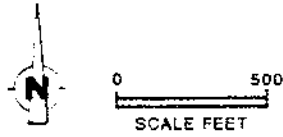
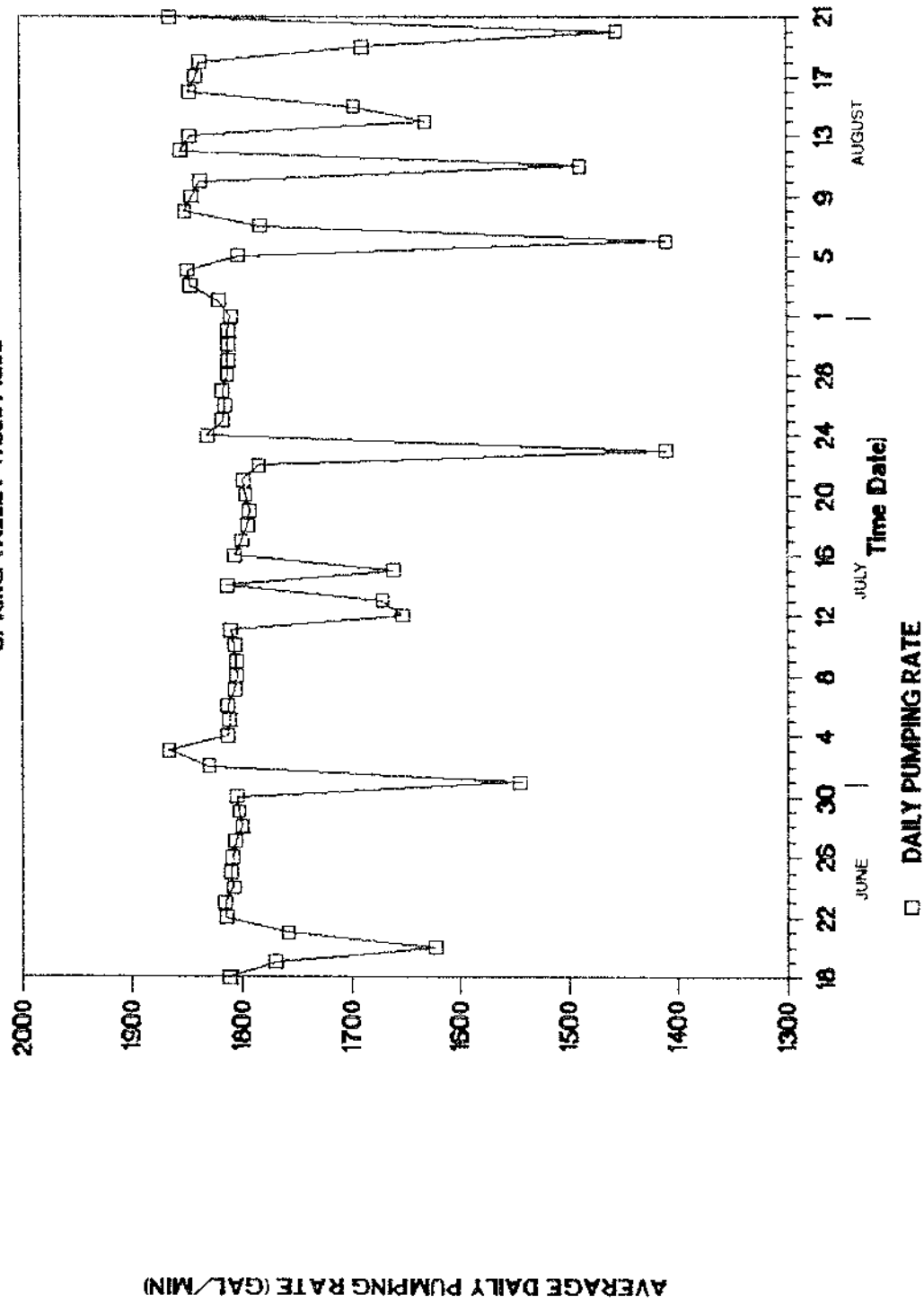


FIGURE 21

AVERAGE DAILY PUMPING RATE FOR THE

SPRING VALLEY WELL FIELD

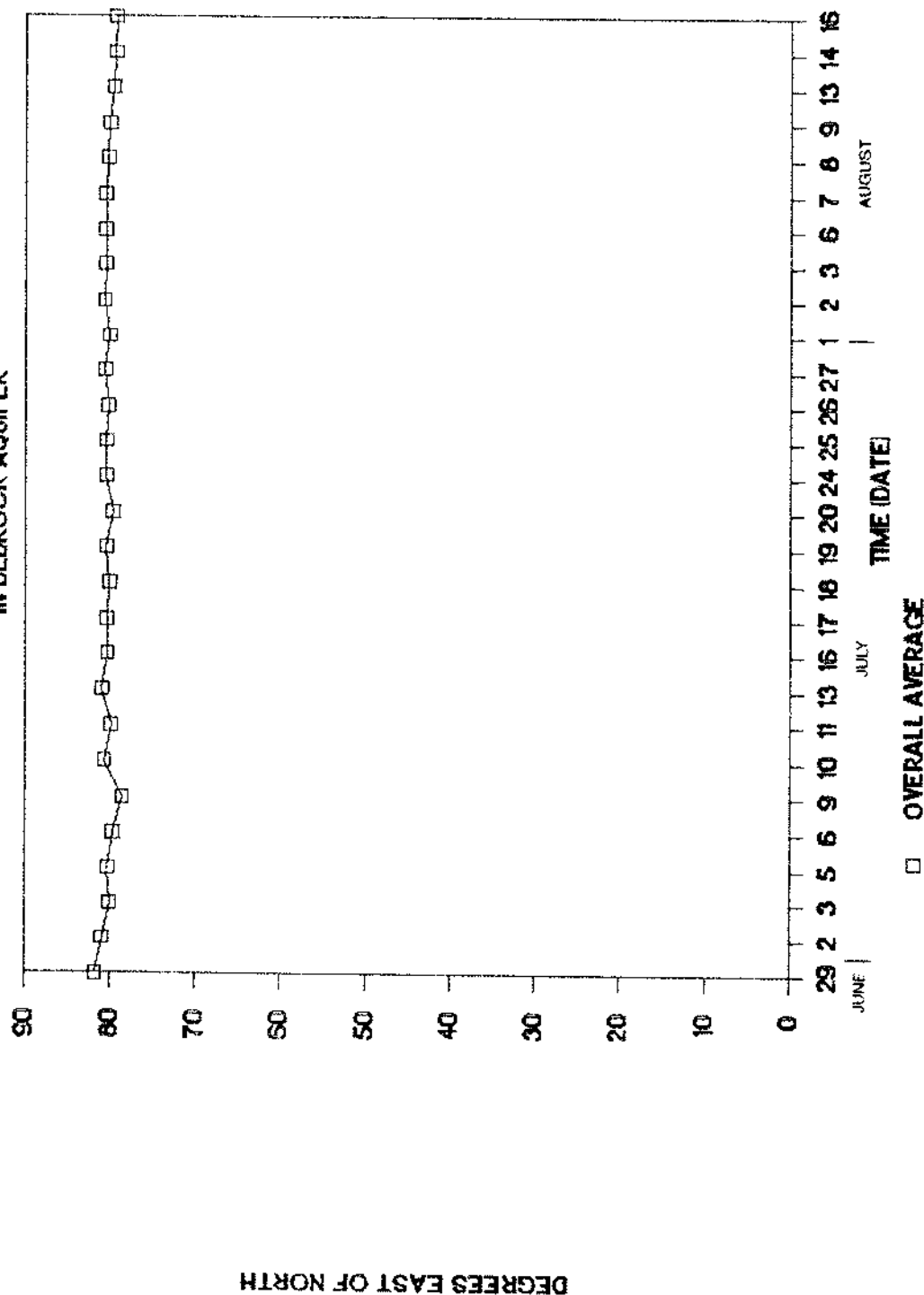


NOTE: Dates shown on the x-axis are not continuous because data were not collected on weekends or holidays

FIGURE 22

OVERALL AVERAGE GW FLOW DIRECTIONS

IN BEDROCK AQUIFER

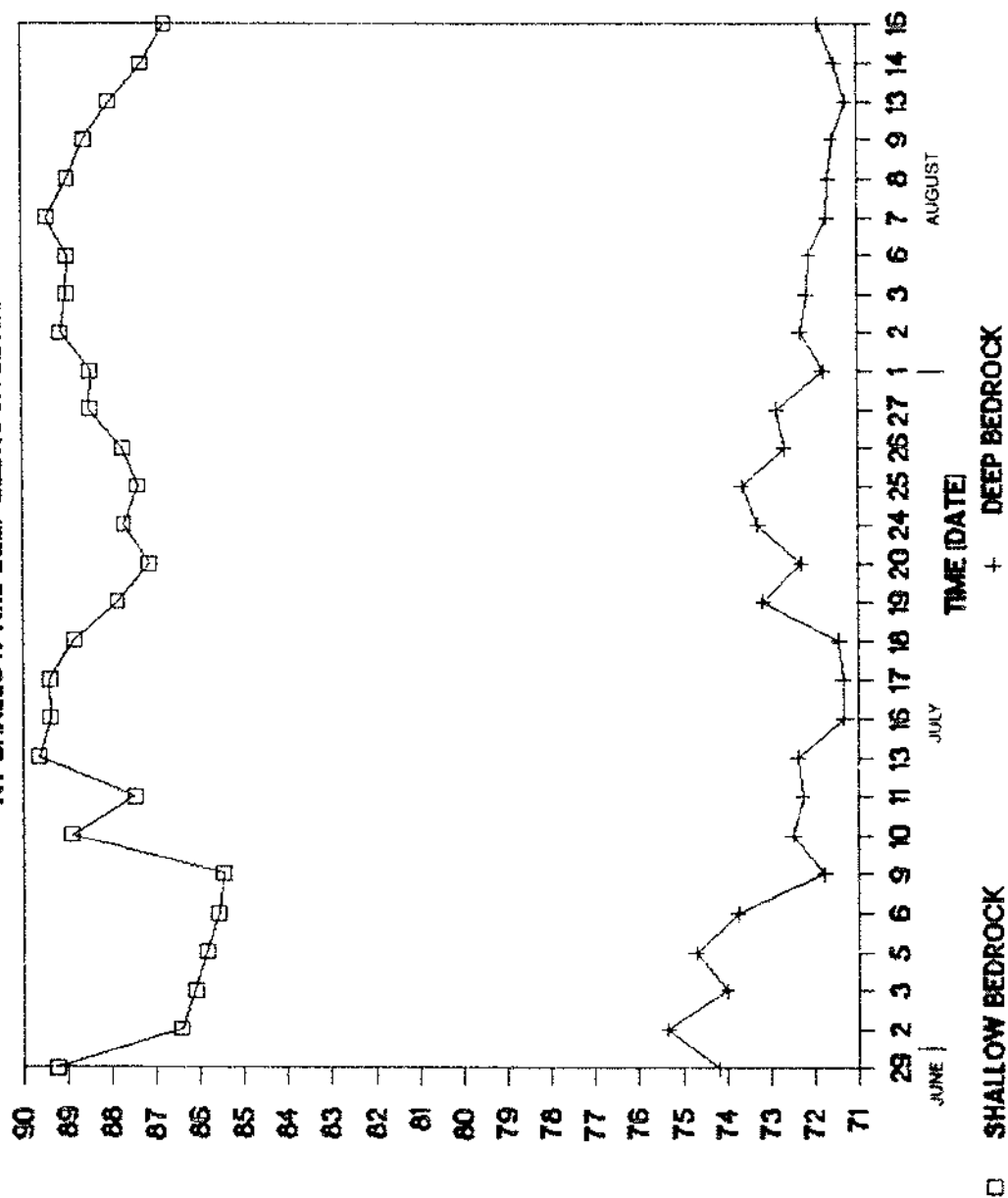


NOTE: Dates shown on the x-axis are not continuous because data were not collected on weekends or holidays

FIGURE 23

AVERAGE GW FLOW DIRECTIONS

AT SHALLOW AND DEEP BEDROCK LEVELS

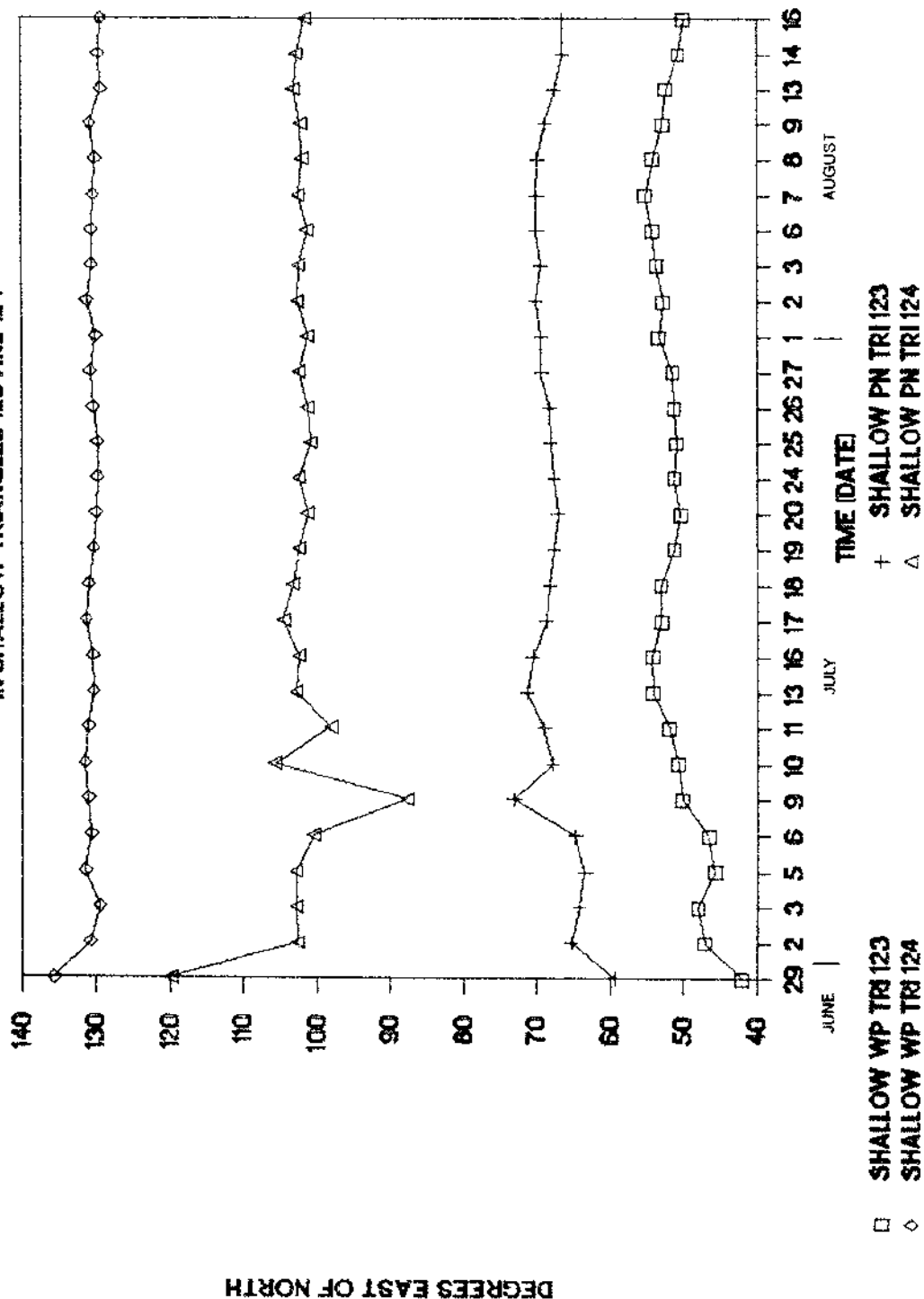


NOTES: 1. Dates shown on the x-axis are not continuous because data were not collected on weekends or holidays.
2. The y-axis scale has been expanded to accentuate minor variations in flow directions.

FIGURE 24

COMPARISON OF GR WATER FLOW DIRECTIONS

IN SHALLOW TRIANGLES 123 AND 124

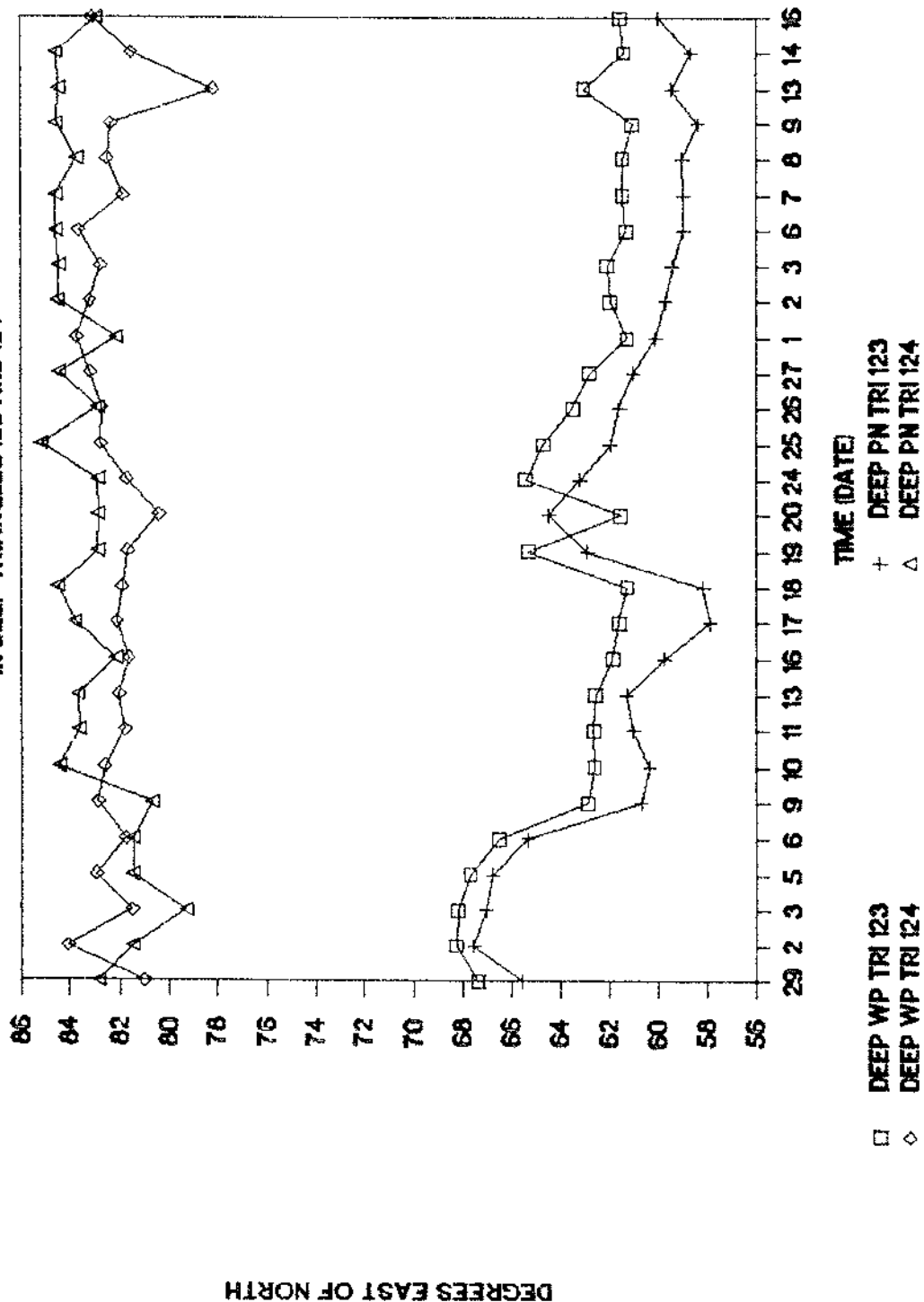


NOTE: Dates shown on the x axis are not continuous because data were not collected on weekends or holidays

FIGURE 25

COMPARISON OF GR WATER FLOW DIRECTIONS

IN DEEP TRIANGLES 123 AND 124

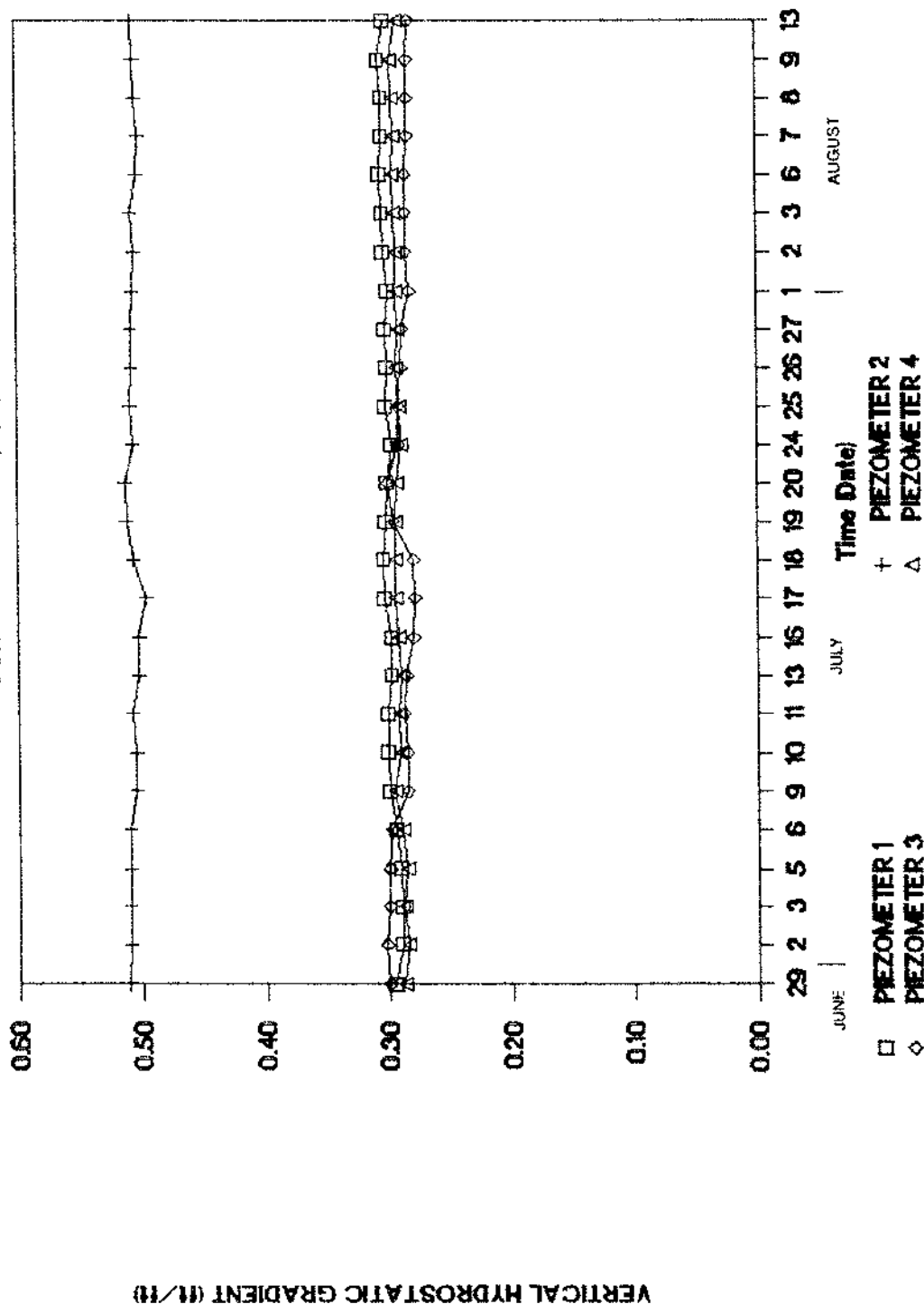


NOTE: Dates shown on the x axis are not continuous because data were not collected on weekends or holidays

FIGURE 26

OVERALL VERTICAL HYDROSTATIC GRADIENTS

FOR PIEZOMETERS 1, 2, 3, AND 4



NOTE: Dates shown on the x-axis are not continuous because data were not collected on weekends or holidays.

FIGURE 27

TABLES

TABLE 1
WATER LEVEL FLUCTUATIONS IN PLEZONCTEYES
ELEVATIONS IN FEET ABOVE

TABLE 1
WATER LEVEL FLUCTUATIONS IN PLEZONCTEYES
ELEVATIONS IN FEET ABOVE

Legit. #1-02 a well point pump-out installed at a depth of 92 feet.

1) Water levels could not be collected in pre-damper nest 2 on June 23 and 24 because the damper is not accessible on wetters.

1) Water levels could not be collected in pre-dryer nest 2 on June 23 and 25 because the tentacles in that accessible on wet days.

TABLE 1

COSCO, SPRING VALLEY
SUPPLEMENTAL REMEDIAL INVESTIGATION
PROJECT NO: R92317
DATE: 8/26/90

PIEZOMETER NUMBER	DEPTH INTERVAL	VERTICAL GRADIENTS (in ft/ft)																								AVERAGE	STANDARD DEVIATION	
		6/29	7/2	7/5	7/6	7/9	7/10	7/11	7/13	7/16	7/17	7/18	7/19	7/20	7/26	7/27	8/1	8/2	8/3	8/6	8/7	8/8	8/9	8/13	8/16			8/17
1	Vertical Gradient Between Water Table and 92 ft	0.49	0.48	0.48	0.49	0.49	0.49	0.49	0.49	0.50	0.50	0.50	0.50	0.49	0.48	0.49	0.49	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.48	0.48	0.48	0.49
1	Vertical Gradient Between 92 ft and 100 ft	0.17	-0.04	-0.01	-0.06	-0.03	-0.36	-0.01	-0.01	-0.01	-0.07	-0.05	-0.05	-0.02	-0.03	-0.01	-0.05	0.00	-0.04	0.01	-0.02	0.01	0.01	0.00	0.04	-0.01	0.00	-0.01
1	Vertical Gradient Between 100 ft and 192 ft	0.11	0.13	0.14	0.14	0.17	0.14	0.14	0.14	0.15	0.14	0.15	0.14	0.14	0.14	0.14	0.15	0.14	0.14	0.14	0.14	0.14	0.16	0.14	0.14	0.14	0.14	0.14
1	Vertical Gradient Between 192 ft and 200 ft	0.48	0.40	0.36	0.29	0.41	0.41	0.42	0.40	0.34	0.43	0.42	0.43	0.44	0.46	0.49	0.42	0.37	0.43	0.47	0.44	0.45	0.44	0.44	0.39	0.40	0.44	0.42
1	OVERALL GRADIENT BETWEEN WATER TABLE AND 200 ft	0.30	0.29	0.29	0.29	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.31	0.30	0.30	0.31	0.30	0.30	0.30	0.30
2	Vertical Gradient Between Water Table and 92 ft	0.49	0.49	0.49	0.49	0.50	0.50	0.50	0.50	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.50	0.50	0.50	0.51	
2	Vertical Gradient Between 92 ft and 100 ft	0.53	0.53	0.49	0.50	0.53	0.54	0.51	0.54	0.49	0.48	0.48	0.52	0.51	0.50	0.52	0.51	0.48	0.51	0.48	0.54	0.50	0.51	0.54	0.51	0.47	0.46	0.50
2	Vertical Gradient Between 100 ft and 192 ft	0.37	0.36	0.37	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34	0.35	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.34	0.33	0.32	0.33	0.33	0.32	0.35	0.34
2	Vertical Gradient Between 192 ft and 200 ft	0.12	0.13	0.10	0.09	0.11	0.07	0.07	0.11	0.10	0.06	-0.11	0.13	0.12	0.12	0.12	0.11	0.12	0.13	0.08	0.14	0.12	0.13	0.14	0.13	0.25	0.12	0.11
2	OVERALL GRADIENT BETWEEN WATER TABLE AND 200 ft	0.51	0.51	0.51	0.51	0.51	0.50	0.51	0.50	0.50	0.50	0.50	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.50	0.51	0.50	0.50	0.50	0.50	0.51	0.50	0.51
3	Vertical Gradient Between Water Table and 92 ft	0.41	0.41	0.41	0.41	0.42	0.44	0.45	0.45	0.46	0.46	0.46	0.46	0.45	0.44	0.44	0.45	0.45	0.45	0.46	0.46	0.46	0.46	0.46	0.44	0.42	0.42	0.44
3	Vertical Gradient Between 92 ft and 100 ft	0.84	0.71	0.65	0.66	0.71	0.69	0.68	0.72	0.71	0.66	0.59	0.68	0.68	0.69	0.70	0.71	0.75	0.70	0.71	0.69	0.67	0.72	0.70	0.74	0.76	0.77	0.70
3	Vertical Gradient Between 100 ft and 192 ft	0.16	0.17	0.17	0.18	0.15	0.12	0.11	0.11	0.10	0.10	0.11	0.11	0.11	0.11	0.13	0.12	0.11	0.10	0.10	0.10	0.09	0.10	0.11	0.11	0.12	0.12	0.12
3	Vertical Gradient Between 192 ft and 200 ft	0.27	0.30	0.23	0.19	0.28	0.21	0.22	0.27	0.29	0.16	0.12	0.15	0.20	0.73	0.24	0.25	0.26	0.27	0.24	0.23	0.24	0.23	0.24	0.22	0.25	0.24	0.25
3	OVERALL GRADIENT BETWEEN WATER TABLE AND 200 ft	0.30	0.30	0.30	0.30	0.30	0.28	0.28	0.29	0.29	0.28	0.28	0.30	0.30	0.30	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.29
4	Vertical Gradient Between Water Table and 92 ft	0.36	0.36	0.36	0.36	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.36	0.35	0.35	0.37
4	Vertical Gradient Between 92 ft and 100 ft	0.60	0.63	0.62	0.62	0.68	0.63	0.61	0.79	0.64	0.61	0.66	0.63	0.66	0.68	0.66	0.70	0.66	0.72	0.69	0.71	0.72	0.72	0.73	0.74	0.75	0.76	0.72
4	Vertical Gradient Between 100 ft and 192 ft	0.18	0.16	0.18	0.18	0.17	0.18	0.18	0.17	0.18	0.19	0.18	0.19	0.18	0.18	0.18	0.18	0.18	0.17	0.18	0.17	0.17	0.17	0.18	0.18	0.18	0.18	0.18
4	Vertical Gradient Between 192 ft and 200 ft	0.69	0.51	0.45	0.35	0.43	0.50	0.35	0.35	0.36	0.32	0.33	0.33	0.39	0.34	0.41	0.42	0.38	0.43	0.39	0.41	0.41	0.35	0.40	0.37	0.34	0.41	0.39
4	OVERALL GRADIENT BETWEEN WATER TABLE AND 200 ft	0.29	0.28	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29	0.29

NOTES: 1) Depth to water table was determined during drilling operations in the unconsolidated deposits.

TABLE 2

TABLE 3

PIEZOMETER LOCATIONS AND SURVEY DATA

DESCRIPTIONS OF PIEZOMETER NEST LOCATIONS

ID	TYPE	LOCATION
PN-1	FLUSH-MOUNT	15 West Street. In parking lot on west side of building. Access from Central Avenue. Exact location: 42 ft W and 24 ft south of NW corner of building.
PN-2	FLUSH-MOUNT	Beckerle Lumber. Black-top parking lot on right side (east) of dead-end of Chestnut Avenue. Exact location: 93 ft E of Chestnut Ave. and 47 ft S. of N. property line (fence).
PN-3	FLUSH-MOUNT	On Park Avenue near intersection with Ridge. Exact location: 6 ft south of north curb on Park Avenue and 110 ft. W of Ridge.
PN-4	FLUSH-MOUNT	Dead end of Collins Street south of Church Street. Exact location: 35 ft N of dead end of Collins Street and 6 ft W of fence line on E side of Collins Street.

ELEVATION SURVEY DATA

LOCATION	DESCRIPTION	ELEVATION (in ft NGVD)
Piezometer Nest 1	Top of steel surface casing	464.77
Piezometer Nest 1	Ground surface	465.28
Piezometer Nest 2	Top of steel surface casing	457.52
Piezometer Nest 2	Ground surface	457.84
Piezometer Nest 3	Top of steel surface casing	466.59
Piezometer Nest 3	Ground surface	467.02
Piezometer Nest 4	Top of steel surface casing	462.19
Piezometer Nest 4	Ground Surface	463.01

- NOTES: 1) PN-1 = Piezometer nest 1
 2) The survey was performed on July 16 & 17, 1990 by Geod Corporation, Newfoundland, New Jersey.

COOCO, SPRING VALLEY
SUPPLEMENTAL MEDICAL INVESTIGATION
PROJECT NO: 8903317
DATE: 8/23/90

TABLE 4
WATER DEPTHS AND HYDRAULIC PIZOMETER READINGS COLLECTED IN THE FIELD

[illegible]

Well 97-02 is well point piezometer installed at a depth of 92 feet. Depth is water measured in feet from "top of surface casing".

NOTES:-

7) Water levels could not be collected in piezometer nest 2 on June 25 and 26 because the location is not accessible on weekends.

23. In external, water levels were not measured on weekends because the Conoco plant personnel were not available to take the readings.

TABLE 5

Project: Cosco--Spring Valley
 Project Number: 89C3517
 Date: 8/17/90
 Prepared By: Paul Herr

TABLE 5
 Organic Vapor Readings on Cuttings

BORING 1		BORING 2		BORING 3		BORING 4	
BARREL #	Conc (ppm)	BARREL #	Conc (ppm)	BARREL #	Conc (ppm)	BARREL #	Conc (ppm)
B-1-1	0.0	B-2-1	0.0	B-3-1*	1.0	B-4-1	4.5
B-1-2	0.5	B-2-2	0.0	B-3-2	1.0	B-4-2	22.0
B-1-3	1.2	B-2-3	0.0	B-3-3	0.5	B-4-3*	37.0
B-1-4	0.0	B-2-4	0.0	B-3-4	0.75	B-4-4	1.0
B-1-5	0.0	B-2-5	0.0	B-3-5	1.0	B-4-5	8.0
B-1-6	0.0	B-2-6	0.0	B-3-6	0.0	B-4-6	UD
B-1-7	1.5	B-2-7*	2.0	B-3-7	0.5	B-4-7	5.0
B-1-8	0.5	B-2-8	0.0			B-4-8	0.5
B-1-9	2.0	B-2-9	0.0			B-4-9	0.5
B-1-10	0.0					B-4-10	0.5
B-1-11*	10.0					B-4-11	
B-1-12	0.0					B-4-12	
B-1-12A	0.0						
B-1-13	0.0						
B-1-14	0.0						
B-1-15	0.0						

* Analytical samples were collected from these barrels.

Conc = Organic vapor readings in ppm made with an HNu photo-ionization detector equipped with an 11.7 electron volt probe.

ppm = parts per million

NOTES:

- 1) Organic vapor readings were made on the headspace gas from the drummed cuttings. The tap-hole was opened with a wrench and the probe tip inserted into the barrel headspace.
- 2) Forty-four drums are being stored on pallets in a secured area at the Cosco Church Street facility.

Project: Cosco--Spring Valley
Project Number: B9C3517

Date: 8/17/90
Prepared By: Paul Herr

TABLE 6 VOLATILE ORGANIC ANALYSIS OF CUTTINGS

	ACETONE (PPM)	METHYL ETHYL KETONE (PPM)	4-METHYL 2-PENTANONE (PPM)	TOLUENE (PPM)	XYLENE (PPM)	MMU READING ON HEAD SPACE (PPM)	COMMENTS
SAMPLE B-1-11	0.170	0.020	BDL	0.004*	0.008	10.0	Barrel emitted a sewer-like odor when opened for sampling.
SAMPLE B-2-7	0.110	BDL	0.008*	0.007	0.004*	2.0	Barrel emitted a sewer-like odor when opened for sampling.
SAMPLE B-3-1	BDL	BDL	BDL	0.007	BDL	1.0	
SAMPLE B-4-3A	0.051	BDL	BDL	0.006	BDL	37.0	
SAMPLE B-4-3B	0.056	BDL	BDL	0.007	BDL	37.0	Duplicate of sample B-4-3A.
SAMPLE RIG OIL	BDL	BDL	BDL	0.230	1.00	NA	Rig oil also had 0.140 ppm ethylbenzene.
SAMPLE TRIP BLANK	BDL	BDL	BDL	BDL	BDL	NA	The trip blank consisted of a sample jar filled with distilled water.

* = Estimated value
BDL = Below detection limit
NA = NOT APPLICABLE
MMU = MMU photo-ionization detector with 11.7 electron volt probe.

NOTES:

- 1) Refer to "Certificates of Analysis" in Appendix B for the laboratory QA/QC data and detection limits.
- 2) The cuttings barrels were sampled on 28 June 1990. Samples were collected based on MMU readings of the headspace gas in the barrels. The barrel with the highest MMU photo-ionization detector reading was sampled for laboratory analysis. Rob Smith from the regional office of DEC was present during sampling.
- 3) The "Rig Oil" sample was prepared to evaluate the possible impact of oil leaks from the rotary table of the rig on the cuttings. The rig-oil sample was prepared by adding 5 drops of rig oil to 6 ounces of clean silica sand and one ounce of distilled water.

APPENDICES

APPENDIX A

FIELD REVENUE LOSS

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LOG OF BORING

B-1A

SHEET 1 OF

Project <u>Cosco</u>		Project No. <u>8963517</u>	
Location <u>Spring Valley, NY</u>		Elev and Datum	
Drilling Agency <u>Kendrick</u>		Date Started <u>6-12-90</u>	Date Finished <u>6-26-90</u>
Drilling Equipment <u>Ingersoll Rand TH-60</u>		Completion Depth	Rock Depth
Size and Type of Bit <u>9 1/8 in. Tricone roller bit</u>		No Samples	Dist - Undist - Core -
Casing <u>6 in ID</u>		Water Level	First Compl 3 1/4 24hr
Casing hammer	Weight -	Drop <u>percussion</u>	Foreman <u>Terry Kendrick</u>
Sampler	Weight -	Drop -	Inspector <u>Paul Herr</u>
Sampler hammer	Weight -	Drop -	

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec ft	Pen ft	Re bl/6 in	HNU	
		0-4 ft Gravel fill, dark brown to black.	1							B-1A abandoned at 3 ft because of possible structure.
			2							
			3							
		4-7 (C54412) Dark grayish brown sandy silty clay, wet, no odor,	4							Water at 7 ft 3 in below grade on 6-13-90.
			5							
			6							
		7-9 Fine to coarse sand (1042413) brown, 20% medium gravel, wet, 10% granules, silty,	7							installing 8 ft long 10 in ID temporary surface casing.
			8							
			9							
		10-25 (1572414) reddish brown, fine- coarse gr. wet sand, silty, little gravel and granules	10							Drilling halted for day at 9 ft.
			11							
			12							
			13							
			14							



CORRECTION

THE FOLLOWING DOCUMENTS
HAVE BEEN REPHOTOGRAPHED
TO ASSURE LEGIBILITY

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LOG OF BORING

SHEET 1 OF

B-1A

Project <u>Cosco</u>		Project No. <u>89C3517</u>	
Location <u>Spring Valley, NY</u>		Elev and Datum	
Drilling Agency <u>Reedrick</u>		Date Started <u>6-12-90</u>	Date Finished <u>6-26-90</u>
Drilling Equipment <u>Lager-soll Rand TH-60</u>		Completion Depth	Rock Depth
Size and Type of Bit <u>9 1/8 in Tricone roller bit</u>		No Samples	Dist -
Casing <u>6 in ID</u>		Water Level	First
Casing hammer	Weight -	Drop	perussion
Foreman <u>Jerry Reedrick</u>		Inspector <u>Paul Herr</u>	
Sampler		Weight -	
Sampler hammer		Drop -	

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec. 11	Pen. Rn	Pen. Rn	HNu	
		0-4 ft Gravel fill, dark brown to black.	1							B-1A abandoned at 3 ft because of possible structure.
			2							
			3							
		4-7 (C, 5Y 4/2) Dark grayish brown sandy silty clay, wet, no odor,	4							Water at 7 ft 3 in below grade on 6-13-90.
			5							
			6							
		7-9 Fine to coarse sand, (10YR 4/3) brown, 20% medium gravel, wet, 10% granules, silty,	7							installing 8 ft long 10 in ID temporary surface casing.
			8							
			9							
		10-25 (5Y 2/4) reddish brown, fine- coarse gr. wet sand, silty, little gravel and granules	10							Drilling halted for day at 9 ft.
			11							
			12							
			13							
			14							

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LOG OF BORING B-1
SHEET 2 OF

Casing Bore	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Loc	Type	Rec II	Pen Rn bl/s in	HNU	
			14							
			15							
			16							
			17							
			18							
			19							
			20							
			21							
			22							
			23							
			24							
		25-36 (C.54R 2.514)	25							
		Dark reddish brown fine	26							
		sand; poorly graded,	27							
		also some med. - coarse	28							
		sand with trace gravel.	29							
			30							
			31							
			32							
			33							
										Driver thinks he is in bedrock at 25 ft

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LOG OF BORING B-1

SHEET 3 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole seving, ETC.)
				No	Type	Rec #	Pen in bl/g in	HNU	
			33						
			34						Large quantities of caved material coming out of hole
			35						
		36-41 same as above.	36						Drill steel sticking in hole. Hole has collapsed.
			37						Drive casing to 3736 ft.
			38						
			39						
			40						
			41						
			42						
			43						
			44						
		45-55 (2.5YR 2.5/4) Tan reddish brown fine to coarse, well graded sandstone, some fine, poorly graded sandstone, fine gravel, clasts mainly quartz, also reddish dolomite and other lithologies. Traces of red limestone and red quartzite, and dark reddish brown shale. Chips can be broken with fingers.	45						0 HNU reading on headspace
			46						
			47						
			48						
			49						
			50						
			51						
			52						

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LOG OF BORING B-1

SHEET 4 OF 11

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SHEET 4 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Type	Res	Per	Re	bl/s in	
			52							
			53							
			54							
		55-65 Same as 45-55, but no shale noted.	55							
			56							
			57							
			58							
			59							
			60							
			61							
			62							
			63							
			64							
		65-75 Same as 45-55, but more silty shale, and some dark gray dolomite marble (1%) clasts.	65							
			66							
			67							
			68							
			69							
			70							
			71							

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LOG OF BORING B-1

SHEET 5 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Type	Rec ft	Pen ft	HNu	
			71						
			72						
			73						
			74						
			75						
			76						
			77						
			78						
			79						
			80						
			81						
			82						
			83						
			84						
			85						
			86						
			87						
			88						
			89						
			90						

75-85 Same as 45-55,
except siltstone instead
of shale. Siltstone is
soft and dark reddish
brown.

85-95 Same as 45-55,
but trace of dark gray
marble clasts. Very slight
trace of shale.

80-82.6 Driller reported
soft drilling, and
more water.

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LOG OF BORING B-1

SHEET 2 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Type	Rec	Pen	HNu	
			90						Driller reported increase in water around 90 ft.
			91						
			92						
			93						
			94						
		95-105 Same as 45-55, but trace of dark gray dolomite marl, and very slight trace of shale.	95						Driller noted slight shear on cuttings. HNu gave no response. Shear dissipated quickly. Cause of shear unknown.
			96						
			97						
			98						
			99						
			100						
			101						
			102						
			103						
			104						
		105-115 Same as 45-55, but shale is gray instead of dark reddish brown, only a trace of shale noted	105						
			106						
			107						
			108						
			109						

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LOG OF BORING B-1

SHEET 2 OF 11

Casing Bore	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Log	Type	Rec It	Per Fo	b/6 in	
			109						
			110						
			111						
			112						
			113						
			114						
		115-125 Same as 45-55, but mainly sandstone, very little gravel, almost no free quartz granules.	115						
			116						
			117						
			118						
			119						
			120						
			121						
			122						
			123						
			124						
		125-135 Same as 45-55, except only a very slight trace of shale noted.	125						
			126						
			127						
			128						

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LOG OF BORING B-1

SHEET 2 OF 11

Casing Blows	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole ceving, ETC.)
				No	Type	Rec	Re	Pen lb/ft	
			128						
			129						
			130						
			131						
			132						
			133						
			134						
			135						
		135-145 Same as 45-55, but more sandstone chips.	136						
			137						
			138						
			139						
			140						
			141						
			142						
			143						
			144						
		145-155 Same as 45-55, but trace of dark reddish brown siltstone instead of shaly fairly soft & st. Also trace of tan limestone clasts.	145						
			146						
			147						

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LOG OF BORING B-1
SHEET 9 OF 11

Casing Bore	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec ft	Pen ft	W/S in	
			147						
			148						
			149						
			150						
			151						
			152						
			153						
			154						
		155-165 Same as 45-55, but free of dark grey dolomite and siltstone instead of shale	155						
			156						
			157						
			158						
			159						
			160						
			161						
			162						
			163						
			164						
			165						
			166						

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LOG OF BORING B-1

SHEET 10 OF 11

Casing Blows	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole seving, ETC.)
				No Loc	Type	Rec ft	Pen Rg bl/s in	HNU	
		165-175 Same as 45-55, except no gravel, and somewhat hard siltstone instead of shale.	166 167 168 169 170 171 172 173 174						
		175-185 Same as 45-55, but no shale.	175 176 177 178 179 180 181 182 183 184 185						

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LOG OF BORING B-1
SHEET 11 OF 11

Casing Blows	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole sealing, ETC.)
				No Log	Type	Rec T	Pen Rq b/6 in	MINI	
		185-195 Same as 45-55, but no shale.	185						
			186						
			187						
			188						
			189						
			190						
			191						
			192						
			193						
			194						
		195-201 Same as above	195						
			196						
			197						
			198						
			199						
			200						
			201						
									- End of boring 201 ft.

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LOG OF BORING R-2
SHEET 2 OF 11

Casing Blows	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole sealing, ETC.)
				No	Type	Rec	Pen	Bl/s	
			14						
		15-20 (10R 4/13) weak red fine - coarse sand, well graded, dry, no rock chips,	15						0 6 in casing in 20.25 ft lengths (with thread), or 20.1 ft without thread.
			16						
			17						
			18						
			19						
		20-21 (10R 4/13) weak red fine - coarse sandstone with trace of gravel of various lithologies. Size of gravel unknown because only chips are being returned.	20						0 - water entering hole at 20 ft. Entering slowly. hole open to 20 ft
			21						
			22						
			23						0 - bottom of casing at 20.55 ft below ground surface.
		23-34 (2.5 YR 2.5/4) Dark reddish brown, fine to coarse grained sandstone, trace granules and gravel, main lithol- ogies of large clasts, quartz; red, fine-gr. igneous and reddish quartzite. Sand grains are mainly quartz, with some feld- spar and other rock types.	24						Resumed drilling on 6-15-90
			25						
			26						
			27						
			28						
			29						
			30						
			31						
			32						
			33						

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LOG OF BORING B-2

SHEET 3 OF 11

Casing Elev. ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole sealing, ETC.)
			No	Type	Rec	Pen	HR	
		33						
	34-44 Same as 23-34 ft.	34						
		35						
		36						
		37						
		38						
		39						
		40						
		41						
		42						
		43						
	44-54 Same as 23-34 ft.	44						
		45						
		46						
		47						
		48						
		49						
		50						
		51						

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LOG OF BORING B-2
SHEET 4 OF 11

Casing Blows	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Type	Rec	Per	HNu	
			51						
			52						
			53						
		54-64 Same as 23-34 ft	54						Driller reported a soft seam between 53 and 54 feet.
			55						
			56						
			57						
			58						
			59						
			60						
			61						
			62						
			63						
		64-74 Same as 23-34 ft	64						
			65						
			66						
			67						
			68						
			69						
			70						

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LOG OF BORING B-2
SHEET 5 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole sealing, ETC.)
				No Loc	Type	Rec It	Pen Rn bl/6 in	HNU	
			70						
			71						
			72						
			73						
		74-84 Same as 23-34, but with some soft, dark reddish brown siltstone. Shells are large, so it may be cave.	74						
			75						
			76						
			77						
			78						
			79						
			80						
			81						
			82						
			83						
		84-94 Same as 23-34H, but less gravel.	84						
			85						
			86						
			87						
			88						
			89						

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LOG OF BORING B-2
SHEET 6 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Loc	Type	Rec	Fe	Per bl/sin	
			89							
			90							
			91							
			92							
			93							
		94-104 Same as 23-34, but less gravel, quartzite is not apparent, a few lt. gray, med. sandstone chips noted.	94							
			95							
			96							
			97							
			98							
			99							
			100							
			101							
			102							Increased water flow into hole around 100-105 feet. Increased to 5-10 gal./min.
			103							
		104-114 Same as 23-34, but quartzite not apparent.	104							
			105							
			106							
			107							
			108							

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LOG OF BORING B-2
SHEET 7 OF 11

Casing Blows	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Type	Rec	Rs	HNU	
			108						
			109						
			110						110-113 driller reported softer drilling.
			111						
			112						
			113						
		114-124 Same as 23-34, but trace of fine-med. gr. sandstone chips. Sandstone is highly feldspathic and dark grey in color. Could be a syenite?	114						
			115						Got no HNU reading from water sample from 115 ft.
			116						
			117						
			118						
			119						
			120						water flow line gradually increased to 15 gpm.
			121						
			122						
			123						
		124-134 Same as 23-34, but sandstone mainly fine grained and poorly graded	124						
			125						
			126						
			127						

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LOG OF BORING B-2

SHEET 8 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Loc	Type	Rec T	Pen Rb	
			127						
			128						
			129						
			130						
			131						
			132						
			133						
		134-144 Same as #23-34 except trace dark grey syntite clasts.	134						
			135						
			136						
			137						
			138						
			139						
			140						
			141						
			142						
			143						
			144						
			145						
			146						

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LOG OF BORING B-2

SHEET 9 OF 11

Casing Blows

ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
			No	Loc	Type	Rec	It	FW	
		146							
	144-154	147							
	Same as 23-31, but	148							
	have dk gray syenite,	149							
	and chips are smaller.	150							
		151							
		152							
		153							
	154-164 Same as 23-34,	154							
	but have dk gray syenite	155							
	clasts.	156							
		157							
		158							
		159							
		160							
		161							
		162							
		163							
		164							
		165							

162 ft - Driller made
accurate measurement
of flow rate as
> 30 gpm

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LOG OF BORING 8-2

SHEET 10 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec 11	Pen RS bl/6 in	HNu	
		164-174 Dark reddish brown, soft, fine grained, poorly graded sand, no gravel, large chips.	165						
			166						
			167						
			168						
			169						
			170						
			171						
			172						
			173						
		174-184 Same as 23-34 except trace dark redish brown siltstone, and very small chips.	174						Driller noted softer drilling at 174 ft, and cuttings came back as uniform, fine gr, soft sandstone.
			175						
			176						
			177						
			178						
			179						
			180						
			181						
			182						
			183						
			184						

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LOG OF BORING B-2
SHEET 4 OF 11

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

SHEET 11 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Type	Rec	Per	Re	
		184-194 Same as 23-34 but large, tan quartzite boulder hit at 93 ft.	184						
			185						
			186						
			187						
			188						
			189						
			190						
			191						
			192						
			193						
		194-201 Same as 23-34	194						
			195						
			196						
			197						
			198						
			199						
			200						
			201						
									Driller measured water flow at 30-40 gpm at 201 ft.

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LOG OF BORING

B-3B

SHEET 1 OF 11

Project <u>Cosco</u>		Project No. <u>89C3517</u>	
Location <u>Spring Valley, NY Pmk Street</u>		Elev and Datum	
Drilling Agency <u>KENDRICK</u>		Date Started <u>6-12-90</u>	Date Finished
Drilling Equipment <u>Ingersoll Rand 7 ft 60</u>		Completion Depth	Rock Depth
Size and Type of Bit <u>9 1/2 Triane Splitter Bit</u>		No Samples	Dist - Undist - Core -
Casing <u>6 in ID</u>		Water Level	First Compl 24hr
Casing hammer	Weight -	Drop	Perussion
Sampler		Foreman <u>Terry Kendrick</u>	
Sampler hammer		Inspector <u>Paul Herr</u>	

Casing	Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole casing, ETC.)	
					No Loc	Type	Rec	Rs	Pen	Rs		bl/6 in
			0-12 (7.5 YR 416) strong brown, moist, fine-coarse sand, well graded, fine fine gravel, clayey around 10 ft, wet around 10 ft.	0								B-3A Hit water main around 6 ft. Drilling halted and hole B-3A abandoned.
			12-17 (2.5 YR 314) Dark reddish brown fine-coarse sand, moist, probably weathered bed-rock.	12								Water at 10.75 ft.

LOG OF BORING B-515

SHEET 2 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec ft	Pen No	bl/6 in	HNU	
			14							Driller hit hard drilling at 14 ft, probably competent bedrock.
			15							
			16							
		17-21 (10 R 3/5) Dusky red sandstone, fine to coarse grained, well graded, trace pebbles (gravel).	17							
			18							
			19							
			20							Hole for casing drilled to 20 ft, 8 in.
			21							
		21-30 (2.5 R 2.5/14) Dark reddish brown, fine to coarse sandstone, well graded, angular to subangular, trace gravel, clasts mainly quartz and red, fine grained igneous rock. Sand sized grains seem to be mainly quartz. Mineralogy is difficult to determine because of red oxide coatings.	22							Hole open to 19.7 ft. Casing driven to 20 ft 8".
			23							6-20-90 Resumed drilling at 20 ft 8 in.
			24							Sandstone easily broken with fingers.
			25							
			26							
		25-35 Same as 21-25,	27							
			28							
			29							
			30							
			31							Sandstone chips can no longer be broken with fingers.
			32							
			33							

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LOG OF BORING B-3B
SHEET 3 OF 11

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

SHEET 3 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec Ft	Per Ft b/6 in	HNU		
			33							
			34							
		35-45 Same as 21-25, but fewer red, fine grained igneous clasts.	35					0		
			36							
			37							
			38							
			39							
			40							
			41							
			42							
			43							Driller reporting soft rock between 42 and 43 ft. water flow increased at this depth.
			44							
		45-55 Same as 21-25 ft, but less gravel clasts, ~~and considerable silt~~ , dark reddish brown silt- stone.	45							
			46							
			47							
			48							
			49							
			50							
			51							
			52							

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LOG OF BORING B-3R

SHEET 4 OF 11

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

SHEET 4 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec II	Rs Pen bl/s in	HNu	
			52						
			53						
			54						
		55-65 Same as 21-25,	55					0	
		but fewer pebbles in	56						
		sandstone, and consider-	57						
		able soft, dark reddish	58						
		brown siltstone, siltstone	59						
		is laminated (platy).	60						
			61						
			62						
			63						
			64						
		65-75 Same as 21-25,	65						
			66						
			67						
			68						
			69						
			70						
			71						

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LOG OF BORING B-3B
SHEET 5 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec #	Pen Re	bl/s in	HNu	
			71							
			72							
			73							
			74							
		75-85 Same as 21-25, but more variable clast	75							
		1. talcogites, little fine grained red clasts observed.	76							
			77							
			78							
			79							
			80							
			81							
			82							
			83							
			84							
		85-95 Same as 21-25, but trace of grey syonite clasts, red-fine grained clasts seen platy.	85						0	
			86							
			87							
			88							
			89							
			90							

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LOG OF BORING B-38
SHEET 6 OF 11

Casing Blows	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec 11	Re Pen bl/6 in	HNU	
			90						
			91						
			92						
			93						
			94						
		95-105 Same as 21-25.	95						
			96						
			97						
			98						
			99						
			100						
			101						
			102						
			103						
			104						
		105-115 Same as 21-25, but more coarse sand to granule sized clasts in sample.	105						
			106						
			107						
			108						
			109						

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LOG OF BORING B-3B
SHEET 7 OF 11

Casing Blows	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Log	Type	Rec H	Pen R b/6 in	HNU	
			109						
			110						
			111						
			112						
			113						
			114						
		115-125 Same as 21-25, but the sandstone is fine grained and poorly graded, trace of syenite clasts noted.	115					0	
			116						
			117						
			118						
			119						
			120						
			121						
			122						
			123						
			124						
		125-135 Same as 21-25, but more coarse sand to granule-sized clasts.	125						
			126						
			127						
			128						

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LOG OF BORING R-373
SHEET 8 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole seving, ETC.)
				No Loc	Type	Rec T1	Pen	Ra bl/6 in	H/Nu	
			129							
			130							
			131							
			132							
			133							
			134							
		135-145 Same as 21-25, but mainly disaggregated grains, chips small.	135							
			136							
			137							
			138							
			139							
			140							
			141							
			142							
			143							
		145-155 Same as 21-25, but considerable caved, soft sandstone	144							
			145							
			146							
			147							

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LOG OF BORING B-3B

SHEET 9 OF 11

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS										
SHEET 9 OF 11										
Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole saving, ETC.)	
				No	Loc	Type	Rec	Re bl/6 in		HNu
			147							
			148							
			149							
			150							
			151							
			152							
			153							
			154							
		155-165 Same as 21-25, but finer buff colored limestone(?).	155						0	
			156							
			157							
			158							
			159							
			160							
			161							
			162							
		165-175 Same as 21-25, but trace of platy, soft limestone. ~~etc.~~	163							
			164							
			165							
			166							

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LOG OF BORING B-38

SHEET 4 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Loc	Type	Res	Pen	Gr	
			167							
			168							
			169							
			170							
			171							
			172							
			173							
			174							
		175-185 Same as 21-25, but finer gray silt/clay, plenty.	175							0
			176							
			177							
			178							
			179							
			180							
			181							
			182							
			183							
			184							
			185							
			186							Increased water flow at 186 ft.

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LOG OF BORING B-38

SHEET 11 OF 11

Casing Blows	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Loc	Type	Res	Pen	Re	
		185-195 Same as 21-25	186							
			187							
			188							
			189							
			190							
			191							
			192							
			193							
			194							
			195							
			196							
			197							
			198							
			199							
			200							
			201							

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LOG OF BORING B-4
SHEET 1 OF 11

Project <u>Cosco</u>				Project No. <u>89C3517</u>			
Location <u>Spring Valley</u>				Elev and Datum			
Drilling Agency <u>Kendrick</u>				Date Started <u>6-11-90</u>		Date Finished <u>6-25-90</u>	
Drilling Equipment <u>Ingersoll Rand TH-60</u>				Completion Depth <u>200</u>		Rock Depth	
Size and Type of Bit <u>9 7/8 in Tricone Roller Bit</u>				No Samples	Dist	Undist	Core
Casing <u>6 in ID</u>				Water Level	First <u>5</u>	Compl <u>35.8</u>	24hr <u>43</u>
Casing hammer - Weight - Drop <u>Percussion</u>				Foreman <u>Terry Kendrick</u>			
Sampler -				Inspector <u>Paul Herr</u>			
Sampler hammer - Weight - Drop -							

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec Ft	Pen Rs bl/6 in	HNU	
		0-5 (7.5 4R 3/4)	0						
		Dark brown, fine-coarse moist, well graded sand, srs rounded, trace fine to med gravel, trace s.s. lt.	1					0	
			2						
			3						
			4						
		5-10	5					0	
		Dark brown (7.5 4R 3/4) coarse sand and granules (30%), trace fine to coarse gravel, angular to rounded clasts, wet, trace s.s. lt; well graded	6						
			7						
			8						
			9						
		10-15 same as above	10					0	
			11						
			12						
			13						
			14						

Sample B-4-1
low cuttings
from 0-15 ft
approximately

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LOG OF BORING B-4
SHEET 2 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec 17	Pen Rs	bl/6 in	HNU	
			14							
		15-20 No returns	15							
			16							Hole collapsing around 6 ft.
			17							well
			18							
			19							
		20-25 No returns	20							
			21							
			22							
			23							
			24							
		25-30 (SYR 4-3)	25							
		Reddish brown, fine	26							
		med-coarse sand and	27							
		granules (cc 2), wet,	28							
		fine fine gravel, may	29							
		be caved material,	30							
		well graded,	31							
			32							
			33							

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LOG OF BORING B-4
SHEET 3 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Log	Type	Rec II	Pen R	b/6 in	HNu	
		30-43 No returns	33							
			34							
			35							
			36							
			37							
			38							
			39							
			40							
			41							
			42							
		43-60 No returns	43							
			44							
			45							
			46							
			47							
			48							
			49							
			50							
			51							
			52							

Drilled to 49 ft.
may have hit
bedrock at 27?
Drill steel sticking
in hole.

Re-entered hole -
drilling to 55 ft.

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LOG OF BORING B-4

SHEET 4 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec ft	Re bl/6 in	HNu	
			53						
			54						
			55						
			56						
			57						
			58						
			59						
			60						
			61						
			62						
			63						
			64						
			65						
			66						
			67						
			68						
			69						
			70						
			71						

Drove casing to 57 ft and then cleaned out casing with percussion b.t. water at 58.9 after cleaning.

Drilled to 61 ft.

60-61 ft. - Cuttings appear to be coarse sand and gravel. No definite bedrock chips, but driller thinks he is in bedrock. A few dark red (10R 3/2) med-coarse gr sandstone chips were noted in the cuttings which may be bedrock. Similar chips recovered while cleaning casing with percussion b.t.

61-65 (10R 3/3) Dusky red fine to med sandstone, poorly graded, trace coarse sand to fine gravel, numerous quartz gravel present, also a few lithologies, clasts subangular.

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LOG OF BORING B-4

SHEET 5 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Rec ft	Pen Re bl/6 in	HNu	
		70-80 (2.54R 2.5/4) Dark reddish brown, fine- coarse grained, well graded, subangular, soft sandstone, trace quartz and lt. gray limestone clasts, some marble clasts also noted.	71						
			72						
			73						
			74						
			75						
			76						
			77						
			78						
			79						
		80-90 Same as 70-80 but clasts mainly red- dish dolomite and dark dusty red sandstone, trace of reddish quartzite.	80						HNu reading on mud sample.
			81						
			82						
			83						
			84						
			85						
			86						
			87						
			88						
			89						89.6 ft. Under report increase in water flow
			90						

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LOG OF BORING B-4
SHEET 6 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Type	Rec	Pen	HNu	
			90						
		90-100 Same as 80-90	91						
		but clasts include trace	92						92-94 ft. Driller
		of bluish sandstone and	93						reported soft zone
		tan colored limestone.	94						
			95						HNu reading on
			96						drilling fluids.
			97						
			98						
			99						
		100-110 Same as 70-80 ft,	100						
		but clasts mainly quartz.	101						
			102						
			103						103- soft streak
			104						
			105						
			106						
			107						107- soft streak
			108						
			109						

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LOG OF BORING TS-4
SHEET 7 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole seving, ETC.)
				No Loc	Type	Rec #	Pen in bl/s	HR	
			109						
		110-120 Same as 70-80,	110						
		but clasts mainly red sand-	111						
		stone and redish dolomite	112						112 soft streak.
		and limestone. Quarts	113						
		still abundant.	114						
			115						
			116						
			117						
			118						
			119						
		120-130 Same as 70-80,	120						
		but clasts mainly	121						
		redish-purple dolomite	122						
		and quartz.	123						
			124						
			125						
			126						
			127						
			128						

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LOG OF BORING B-4
SHEET 8 OF 11

CONCRETE ENGINEERING

SHEET 6 OF 11

Casing Blows	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Log	Type	Rec II	Pen Re	b/6 in	FINU	
			128							
			129							
		130-140	130							
		Same as 70-80, but	131							
		face reddish brown shale,	132							
		and pink to red limestone	133							
		clasts. Quartz still abundant	134							
		Some lt. gray limestone.	135							
			136							
			137							
			138							
			139							
		140-150 Same as above.	140							
			141							
			142							
			143							
			144							
			145							
			146							
			147							

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LOG OF BORING B-

SHEET 9 OF 11

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTALISTS

SHEET 9 OF 11

Casing Blows	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Loc	Type	Res ft	Pen Rr bl/6 in	HNU	
			147						
			148						
			149						
		150-160 Dark reddish brown fine-med grained, poorly graded sandstone, soft, few clasts, may be cave.	150						
			151						
			152						
			153						
			154						
			155						
			156						
			157						
			158						
			159						
		160-170 Same as 70-80, but clasts mainly gte, and face of soft clayey siltstone.	160						Driller reported slight increase in water flow.
			161						
			162						
			163						
			164						
			165						
			166						

Woodward-Clyde Consultants

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

LOG OF BORING B-4
SHEET 12 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole seving, ETC.)
				No Loc	Type	Rec #	Pen #	Bl/s in	
			166						
			167						
			168						
			169						
		170-180 Same as 70-80,	170						
		but clasts mainly grt							
		and red limestone	171						
			172						
			173						
			174						
			175						
			176						
			177						
			178						
			179						
		180-190 Same as above,	180						
		but more clayey silt-							
		stone.	181						
			182						
			183						
			184						
			185						

LOG OF BORING

B-4

SHEET 11 OF 11

[illegible]

APPENDIX B

LABORATORY CERTIFICATES OF ANALYSIS



CORRECTION

THE FOLLOWING DOCUMENTS
HAVE BEEN REPHOTOGRAPHED
TO ASSURE LEGIBILITY

Woodward-Clyde Consultants

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

LOG OF BORING B-4
SHEET 6 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Type	Rec ft	Pen ft	bl/sft	HNU	
		90-100 Same as 80-90 but clasts include trace of bluish sandstone and tan colored limestone.	90							
			91							
			92							92-94 ft. Driller reported soft zone
			93							
			94							
			95							HNu reading on drilling fluids.
			96							
			97							
			98							
			99							
		100-110 Same as 70-80 ft, but clasts mainly quartz.	100							
			101							
			102							
			103							103 - soft streak
			104							
			105							
			106							
			107							107 - soft streak
			108							
			109							

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LOG OF BORING B-4

SHEET 7 OF 11

Casing Feet	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No	Type	Rec	Pen	bl/s in	
			109						
		110-120 Same as 70-80,	110						
		but clasts mainly red sand-	111						
		stone and redish dolomite	112						112 soft streak.
		and limestone. Quartz	113						
		still abundant.	114						
			115						
			116						
			117						
			118						
			119						
		120-130 Same as 70-80,	120						
		but clasts mainly	121						
		redish-purple dolomite	122						
		and quartz.	123						
			124						
			125						
			126						
			127						
			128						

Woodward-Clyde Consultants

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

LOG OF BORING

B-4

SHEET 8 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES						REMARKS (Drilling fluid, fluid loss, Hole sealing, ETC.)
				No	Type	Rec	Pen	Rs	b/s	
			128							
			129							
		130-140	130							
		Same as 70-80, but	131							
		face reddish brown shale,	132							
		and pink to red limestone	133							
		clasts. Quartz still abundant.	134							
		Some lt. gray limestone.	135							
			136							
			137							
			138							
			139							
		140-150 Same as above.	140							
			141							
			142							
			143							
			144							
			145							
			146							
			147							

Woodward-Clyde Consultants

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

LOG OF BORING B-

SHEET 2 OF 11

Casing Blows	ELEV. FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)
				No Log	Type	Rec T	Pen R	b/g in	
			147						
			148						
			149						
		150-160 Dark reddish brown fine-med grained, poorly graded sandstone, soft, few clasts, may be cave.	150						
			151						
			152						
			153						
			154						
			155						
			156						
			157						
			158						
			159						
		160-170 Same as 70-80, but clasts mainly gte, and face of soft clayey siltstone.	160						Driller reported slight increase in water flow.
			161						
			162						
			163						
			164						
			165						
			166						

Woodward-Clyde Consultants

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

LOG OF BORING B-4
SHEET 1 OF 11

Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole sealing, ETC.)
				No Loc	Type	Rec 11	Pen R3 bl/6 in	HNo	
			166						
			167						
			168						
			169						
		170-180 Same as 70-80, but clasts mainly qtz and red limestone	170						
			171						
			172						
			173						
			174						
			175						
			176						
			177						
			178						
			179						
		180-190 Same as above, but more clayey silt- stone.	180						
			181						
			182						
			183						
			184						
			185						

LOG OF BORING B-4
SHEET 11 OF 11

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS										SHEET <u>11</u> OF <u>11</u>	
Casing Blows	ELEV, FT	DESCRIPTION	DEPTH FT	SAMPLES					REMARKS (Drilling fluid, fluid loss, Hole caving, ETC.)		
				No Loc	Type	Rec ft	Pen RS bl/6 in	HNU			
			185								
			186								
			187								
			188								
			189								
		190-200 Same as 70-80, no siltstone present,	190								
			191								
			192								
			193								
			194								
			195								
			196						0 HNu reading on drilling fluid sample.		
			197								
			198								
			199								
			200								
			201								

APPENDIX B

LABORATORY CERTIFICATES OF ANALYSIS

CERTIFICATE OF ANALYSIS

----- CORRESPOND TO ----- EMS HERITAGE LABORATORIES, INC. 8205 S. CASS AVE. SUITE 106 DARIEN, IL 60559 (708)969-9030	----- SAMPLE ----- LAB SAMPLE ID: C122821 DATE PRINTED: 13-JUL-90 DATE RECEIVED: 02-JUL-90 DATE COMPLETE: 12-JUL-90
--	---

----- REPORT TO ----- ATTN: PAUL HERR WOODWARD CLYDE CONSULTANTS 122 SOUTH MICHIGAN AVENUE SUITE 1920 CHICAGO, IL 60603	----- BILL TO ----- ATTN: ACCOUNTING WOODWARD-CLYDE CONSULTANTS 122 SOUTH MICHIGAN AVENUE SUITE 1920 CHICAGO, IL 60603
---	--

----- DESCRIPTION -----

DATE SAMPLED : 28-JUN-90 TIME : 13:54:00 PO NUMBER : 89C3517
DESCRIPTION : COSCO-SPRING VALLEY, PROJECT #89C3517
: 8-1-11

----- ANALYSIS -----

VOLATILE ORGANICS (HEATED PURGE & TRAP) SW846-8240
ANALYST : S. BUSSEY DATE : 11-JUL-90 INSTRUMENT : GC/MS VOA REP : 0

PARAMETER	RESULT	DET LIM
ACETONE.....	170 UG/KG	25
ACROLEIN.....	BDL UG/KG	62
ACRYLONITRILE.....	BDL UG/KG	86
BENZENE.....	BDL UG/KG	6
BROMODICHLOROMETHANE.....	BDL UG/KG	6
BROMOFORM.....	BDL UG/KG	6
BROMOMETHANE.....	BDL UG/KG	12
CARBON DISULFIDE.....	BDL UG/KG	6
CARBON TETRACHLORIDE.....	BDL UG/KG	6
CHLOROBENZENE.....	BDL UG/KG	6
CHLOROETHANE.....	BDL UG/KG	12
CHLOROFORM.....	BDL UG/KG	6
CHLOROMETHANE.....	BDL UG/KG	12
DIBROMOCHLOROMETHANE.....	BDL UG/KG	6
CIS-1,3-DICHLOROPROPENE.....	BDL UG/KG	6
DICHLORODIFLUOROMETHANE.....	BDL UG/KG	6
1,1-DICHLOROETHANE.....	BDL UG/KG	6
1,2-DICHLOROETHANE.....	BDL UG/KG	6
1,1-DICHLOROETHENE.....	BDL UG/KG	6
1,2-DICHLOROPROPANE.....	BDL UG/KG	6
ETHYLBENZENE.....	BDL UG/KG	6
FLUOROTRICHLOROMETHANE.....	BDL UG/KG	18
2-HEXANONE.....	BDL UG/KG	12
METHYLENE CHLORIDE.....	BDL UG/KG	6
METHYL ETHYL KETONE.....	20 UG/KG	12
4-METHYL-2-PENTANONE.....	BDL UG/KG	12
STYRENE.....	BDL UG/KG	6

EMS LABORATORIES, INC.

SAMPLE ID: C122821

1,1,2,2-TETRACHLOROETHANE.....	BDL UG/KG	6
TETRACHLOROETHENE.....	BDL UG/KG	6
TETRAHYDROFURAN.....	BDL UG/KG	31
TOLUENE.....	EST 4 UG/KG	6
1,2-DICHLOROETHENE (TOTAL).....	BDL UG/KG	6
TRANS-1,3-DICHLOROPROPENE.....	BDL UG/KG	6
1,1,1-TRICHLOROETHANE.....	BDL UG/KG	6
1,1,2-TRICHLOROETHANE.....	BDL UG/KG	6
TRICHLOROETHENE.....	BDL UG/KG	6
VINYL ACETATE.....	BDL UG/KG	12
VINYL CHLORIDE.....	BDL UG/KG	12
XYLENE (TOTAL).....	8 UG/KG	6
SURROGATE RECOVERY.....		
DICHLOROETHANE-D4.....	97 % RECOVERY	50
TOLUENE-D8.....	105 % RECOVERY	50
BROMOFLUOROBENZENE.....	97 % RECOVERY	50
ALSO DETECTED:.....		
UNKNOWN.....	EST 21 RT-31.25.....	

BDL BELOW DETECTABLE LIMITS
EST ESTIMATED VALUE
RT RETENTION TIME

QUALITY ASSURANCE OFFICER:

Christine S. [Signature]

PAGE 2 LAST PAGE

CERTIFICATE OF ANALYSIS

CORRESPOND TO

EMS HERITAGE LABORATORIES, INC.
8205 S. CASS AVE. SUITE 106
DARIEN, IL 60559
(708)969-9030

SAMPLE

LAB SAMPLE ID: C122822
DATE PRINTED : 13-JUL-90
DATE RECEIVED: 02-JUL-90
DATE COMPLETE: 12-JUL-90

REPORT TO

ATTN: PAUL HERR
WOODWARD CLYDE CONSULTANTS
122 SOUTH MICHIGAN AVENUE
SUITE 1920
CHICAGO, IL 60603

BILL TO

ATTN: ACCOUNTING
WOODWARD-CLYDE CONSULTANTS
122 SOUTH MICHIGAN AVENUE
SUITE 1920
CHICAGO, IL 60603

DESCRIPTION

DATE SAMPLED : 28-JUN-90 TIME : 14:00:00 PO NUMBER : 89C3517
DESCRIPTION : COSCO-SPRING VALLEY, PROJECT #89C3517
: B-2-7

ANALYSIS

VOLATILE ORGANICS (HEATED PURGE & TRAP) SW846-8240
 ANALYST : S. RIECHMAN DATE : 11-JUL-

DATE : 11-JUL-90 INSTRUMENT : GC/MS VOA

REP : 0

PARAMETER	RESULT	DET LIM
ACETONE.....	110 UG/KG	26
ACROLEIN.....	BDL UG/KG	66
ACRYLONITRILE.....	BDL UG/KG	92
BENZENE.....	BDL UG/KG	6
BROMODICHLOROMETHANE.....	BDL UG/KG	6
BROMOFORM.....	BDL UG/KG	6
BROMOMETHANE.....	BDL UG/KG	13
CARBON DISULFIDE.....	BDL UG/KG	6
CARBON TETRACHLORIDE.....	BDL UG/KG	6
CHLOROBENZENE.....	BDL UG/KG	13
CHLOROETHANE.....	BDL UG/KG	6
CHLOROFORM.....	BDL UG/KG	13
CHLOROMETHANE.....	BDL UG/KG	6
DIBROMOCHLOROMETHANE.....	BDL UG/KG	6
CIS-1,3-DICHLOROPROPENE.....	BDL UG/KG	6
DICHLORODIFLUOROMETHANE.....	BDL UG/KG	6
1,1-DICHLOROETHANE.....	BDL UG/KG	6
1,2-DICHLOROETHANE.....	BDL UG/KG	6
1,1-DICHLOROETHENE.....	BDL UG/KG	6
1,2-DICHLOROPROPANE.....	BDL UG/KG	6
ETHYLBENZENE.....	BDL UG/KG	20
FLUOROTRICHLOROMETHANE.....	BDL UG/KG	13
2-HEXANONE.....	BDL UG/KG	6
METHYLENE CHLORIDE.....	BDL UG/KG	13
METHYL ETHYL KETONE.....	EST 8 UG/KG	13
4-METHYL-2-PENTANONE.....	BDL UG/KG	6
STYRENE.....		

EMS LABORATORIES, INC.

SAMPLE ID: C122822

1,1,2,2-TETRACHLOROETHANE.....	BDL UG/KG	6
TETRACHLOROETHENE.....	BDL UG/KG	6
TETRAHYDROFURAN.....	BDL UG/KG	33
TOLUENE.....	7 UG/KG	6
1,2-DICHLOROETHENE (TOTAL).....	BDL UG/KG	6
TRANS-1,3-DICHLOROPROPENE.....	BDL UG/KG	6
1,1,1-TRICHLOROETHANE.....	BDL UG/KG	6
1,1,2-TRICHLOROETHANE.....	BDL UG/KG	6
TRICHLOROETHENE.....	BDL UG/KG	6
VINYL ACETATE.....	BDL UG/KG	13
VINYL CHLORIDE.....	BDL UG/KG	13
XYLENE (TOTAL).....	EST 4 UG/KG	6
.....		
SURROGATE RECOVERY.....		
.....		
DICHLOROETHANE-D4.....	99 % RECOVERY	50
TOLUENE-D8.....	103 % RECOVERY	50
BROMOFLUOROBENZENE.....	100 % RECOVERY	50

BDL BELOW DETECTABLE LIMITS
EST ESTIMATED VALUE

QUALITY ASSURANCE OFFICER:

Christine S. [Signature]

PAGE 2 LAST PAGE

C E R T I F I C A T E O F A N A L Y S I S

----- CORRESPOND TO -----

EMS HERITAGE LABORATORIES, INC.
8205 S. CASS AVE. SUITE 106
DARIEN, IL 60559
(708)969-9030

----- SAMPLE -----

LAB SAMPLE ID: C122823
DATE PRINTED : 13-JUL-90
DATE RECEIVED: 02-JUL-90
DATE COMPLETE: 12-JUL-90

----- REPORT TO -----

ATTN: PAUL HERR
WOODWARD CLYDE CONSULTANTS
122 SOUTH MICHIGAN AVENUE
SUITE 1920
CHICAGO, IL 60603

----- BILL TO -----

ATTN: ACCOUNTING
WOODWARD-CLYDE CONSULTANTS
122 SOUTH MICHIGAN AVENUE
SUITE 1920
CHICAGO, IL 60603

----- DESCRIPTION -----

DATE SAMPLED : 28-JUN-90 TIME : 14:11:00 PO NUMBER : 89C3517
DESCRIPTION : COSCO-SPRING VALLEY, PROJECT #89C3517
: B-3-1

----- ANALYSIS -----

VOLATILE ORGANICS (HEATED PURGE & TRAP) SW846-8240

ANALYST : S. RIECHMAN

DATE : 11-JUL-90 INSTRUMENT : GC/MS VOA

REP : 0

PARAMETER	RESULT	DET LIM
ACETONE.....	BDL UG/KG	22
ACROLEIN.....	BDL UG/KG	56
ACRYLONITRILE.....	BDL UG/KG	78
BENZENE.....	BDL UG/KG	6
BROMODICHLOROMETHANE.....	BDL UG/KG	6
BROMOFORM.....	BDL UG/KG	6
BROMOMETHANE.....	BDL UG/KG	11
CARBON DISULFIDE.....	BDL UG/KG	6
CARBON TETRACHLORIDE.....	BDL UG/KG	6
CHLOROBENZENE.....	BDL UG/KG	6
CHLOROETHANE.....	BDL UG/KG	11
CHLOROFORM.....	BDL UG/KG	6
CHLOROMETHANE.....	BDL UG/KG	11
DIBROMOCHLOROMETHANE.....	BDL UG/KG	6
CIS-1,3-DICHLOROPROPENE.....	BDL UG/KG	6
DICHLORODIFLUOROMETHANE.....	BDL UG/KG	6
1,1-DICHLOROETHANE.....	BDL UG/KG	6
1,2-DICHLOROETHANE.....	BDL UG/KG	6
1,1-DICHLOROETHENE.....	BDL UG/KG	6
1,2-DICHLOROPROPANE.....	BDL UG/KG	6
ETHYLBENZENE.....	BDL UG/KG	6
FLUOROTRICHLOROMETHANE.....	BDL UG/KG	17
2-HEXANONE.....	BDL UG/KG	11
METHYLENE CHLORIDE.....	BDL UG/KG	6
METHYL ETHYL KETONE.....	BDL UG/KG	11
4-METHYL-2-PENTANONE.....	BDL UG/KG	11
STYRENE.....	BDL UG/KG	6

PAGE 1

EMS LABORATORIES, INC.

SAMPLE ID: C122823

1,1,2,2-TETRACHLOROETHANE.....	BDL UG/KG	6
TETRACHLOROETHENE.....	BDL UG/KG	6
TETRAHYDROFURAN.....	BDL UG/KG	28
TOLUENE.....	7 UG/KG	6
1,2-DICHLOROETHENE (TOTAL).....	BDL UG/KG	6
TRANS-1,3-DICHLOROPROPENE.....	BDL UG/KG	6
1,1,1-TRICHLOROETHANE.....	BDL UG/KG	6
1,1,2-TRICHLOROETHANE.....	BDL UG/KG	6
TRICHLOROETHENE.....	BDL UG/KG	6
VINYL ACETATE.....	BDL UG/KG	11
VINYL CHLORIDE.....	BDL UG/KG	11
XYLENE (TOTAL).....	BDL UG/KG	6
.....		
SURROGATE RECOVERY.....		
.....		
DICHLOROETHANE-D4.....	99 % RECOVERY	50
TOLUENE-DB.....	102 % RECOVERY	50
BROMOFLUOROBENZENE.....	102 % RECOVERY	50

BDL BELOW DETECTABLE LIMITS

QUALITY ASSURANCE OFFICER:

Christine S. [Signature]

PAGE 2 LAST PAGE

C E R T I F I C A T E O F A N A L Y S I S

----- CORRESPOND TO ----- EMS HERITAGE LABORATORIES, INC. 8205 S. CASS AVE. SUITE 106 DARIEN, IL 60559 (708)969-9030	----- SAMPLE ----- LAB SAMPLE ID: C122824 DATE PRINTED : 13-JUL-90 DATE RECEIVED: 02-JUL-90 DATE COMPLETE: 12-JUL-90
--	--

----- REPORT TO ----- ATTN: PAUL HERR WOODWARD CLYDE CONSULTANTS 122 SOUTH MICHIGAN AVENUE SUITE 1920 CHICAGO, IL 60603	----- BILL TO ----- ATTN: ACCOUNTING WOODWARD-CLYDE CONSULTANTS 122 SOUTH MICHIGAN AVENUE SUITE 1920 CHICAGO, IL 60603
---	--

----- DESCRIPTION -----

DATE SAMPLED : 28-JUN-90 TIME : 13:39:00 PO NUMBER : 89C3517
DESCRIPTION : COSCO-SPRING VALLEY, PROJECT #89C3517
: B-4-3A

----- ANALYSIS -----

VOLATILE ORGANICS (HEATED PURGE & TRAP) SW846-8240 REP : 0
ANALYST : S. RIECHMAN DATE : 11-JUL-90 INSTRUMENT : GC/MS VOA

PARAMETER	RESULT	DET LIM
ACETONE.....	51 UG/KG	22
ACROLEIN.....	BDL UG/KG	55
ACRYLONITRILE.....	BDL UG/KG	77
BENZENE.....	BDL UG/KG	6
BROMODICHLOROMETHANE.....	BDL UG/KG	6
BROMOFORM.....	BDL UG/KG	6
BROMOMETHANE.....	BDL UG/KG	11
CARBON DISULFIDE.....	BDL UG/KG	6
CARBON TETRACHLORIDE.....	BDL UG/KG	6
CHLOROBENZENE.....	BDL UG/KG	6
CHLOROETHANE.....	BDL UG/KG	11
CHLOROFORM.....	BDL UG/KG	6
CHLOROMETHANE.....	BDL UG/KG	11
DIBROMOCHLOROMETHANE.....	BDL UG/KG	6
CIS-1,3-DICHLOROPROPENE.....	BDL UG/KG	6
DICHLORODIFLUOROMETHANE.....	BDL UG/KG	6
1,1-DICHLOROETHANE.....	BDL UG/KG	6
1,2-DICHLOROETHANE.....	BDL UG/KG	6
1,1-DICHLOROETHENE.....	BDL UG/KG	6
1,2-DICHLOROPROPANE.....	BDL UG/KG	6
ETHYLBENZENE.....	BDL UG/KG	6
FLUOROTRICHLOROMETHANE.....	BDL UG/KG	16
2-HEXANONE.....	BDL UG/KG	11
METHYLENE CHLORIDE.....	BDL UG/KG	6
METHYL ETHYL KETONE.....	BDL UG/KG	11
4-METHYL-2-PENTANONE.....	BDL UG/KG	11
STYRENE.....	BDL UG/KG	6

MS LABORATORIES, INC.

SAMPLE ID: C122824

1,1,2,2-TETRACHLOROETHANE.....	BDL UG/KG	6
TETRACHLOROETHENE.....	BDL UG/KG	6
TETRAHYDROFURAN.....	BDL UG/KG	28
TOLUENE.....	6 UG/KG	6
1,2-DICHLOROETHENE (TOTAL).....	BDL UG/KG	6
TRANS-1,3-DICHLOROPROPENE.....	BDL UG/KG	6
1,1,1-TRICHLOROETHANE.....	BDL UG/KG	6
1,1,2-TRICHLOROETHANE.....	BDL UG/KG	6
TRICHLOROETHENE.....	BDL UG/KG	6
VINYL ACETATE.....	BDL UG/KG	11
VINYL CHLORIDE.....	BDL UG/KG	11
XYLENE (TOTAL).....	BDL UG/KG	6
SURROGATE RECOVERY.....		
DICHLOROETHANE-D4.....	101 % RECOVERY	50
TOLUENE-D8.....	102 % RECOVERY	50
BROMOFLUOROBENZENE.....	100 % RECOVERY	50

BDL BELOW DETECTABLE LIMITS

QUALITY ASSURANCE OFFICER:

Christine S. [Signature]

PAGE 2 LAST PAGE

CERTIFICATE OF ANALYSIS

----- CORRESPOND TO ----- EMS HERITAGE LABORATORIES, INC. 8205 S. CASS AVE. SUITE 106 DARIEN, IL 60559 (708)969-9030	SAMPLE ----- LAB SAMPLE ID: C122825 DATE PRINTED : 13-JUL-90 DATE RECEIVED: 02-JUL-90 DATE COMPLETE: 12-JUL-90
--	---

----- REPORT TO ----- ATTN: PAUL HERR WOODWARD CLYDE CONSULTANTS 122 SOUTH MICHIGAN AVENUE SUITE 1920 CHICAGO, IL 60603	----- BILL TO ----- ATTN: ACCOUNTING WOODWARD-CLYDE CONSULTANTS 122 SOUTH MICHIGAN AVENUE SUITE 1920 CHICAGO, IL 60603
---	--

----- DESCRIPTION -----

DATE SAMPLED : 28-JUN-90 TIME : 13:39:00 PO NUMBER : 89C3517
DESCRIPTION : COSCO-SPRING VALLEY, PROJECT #89C3517
: B-4-3B

----- ANALYSIS -----

VOLATILE ORGANICS (HEATED PURGE & TRAP) SW846-8240
ANALYST : S. RIECHMAN DATE : 11-JUL-90 INSTRUMENT : GC/MS VOA REP : 0

PARAMETER	RESULT	DET LIM
ACETONE.....	56 UG/KG	24
ACROLEIN.....	BDL UG/KG	59
ACRYLONITRILE.....	BDL UG/KG	82
BENZENE.....	BDL UG/KG	6
BROMODICHLOROMETHANE.....	BDL UG/KG	6
BROMOFORM.....	BDL UG/KG	6
BROMOMETHANE.....	BDL UG/KG	12
CARBON DISULFIDE.....	BDL UG/KG	6
CARBON TETRACHLORIDE.....	BDL UG/KG	6
CHLOROBENZENE.....	BDL UG/KG	12
CHLOROETHANE.....	BDL UG/KG	6
CHLOROFORM.....	BDL UG/KG	12
CHLOROMETHANE.....	BDL UG/KG	6
DIBROMOCHLOROMETHANE.....	BDL UG/KG	6
CIS-1,3-DICHLOROPROPENE.....	BDL UG/KG	6
DICHLORODIFLUOROMETHANE.....	BDL UG/KG	6
1,1-DICHLOROETHANE.....	BDL UG/KG	6
1,2-DICHLOROETHANE.....	BDL UG/KG	6
1,1-DICHLOROETHENE.....	BDL UG/KG	6
1,2-DICHLOROPROPANE.....	BDL UG/KG	6
ETHYLBENZENE.....	BDL UG/KG	18
FLUOROTRICHLOROMETHANE.....	BDL UG/KG	12
2-HEXANONE.....	BDL UG/KG	6
METHYLENE CHLORIDE.....	BDL UG/KG	12
METHYL ETHYL KETONE.....	BDL UG/KG	12
4-METHYL-2-PENTANONE.....	BDL UG/KG	12
STYRENE.....	BDL UG/KG	6

EMS LABORATORIES, INC.

SAMPLE ID: C122825

1,1,2,2-TETRACHLOROETHANE.....	BDL UG/KG	6
TETRACHLOROETHENE.....	BDL UG/KG	6
TETRAHYDROFURAN.....	BDL UG/KG	29
TOLUENE.....	7 UG/KG	6
1,2-DICHLOROETHENE (TOTAL).....	BDL UG/KG	6
TRANS-1,3-DICHLOROPROPENE.....	BDL UG/KG	6
1,1,1-TRICHLOROETHANE.....	BDL UG/KG	6
1,1,2-TRICHLOROETHANE.....	BDL UG/KG	6
TRICHLOROETHENE.....	BDL UG/KG	12
VINYL ACETATE.....	BDL UG/KG	12
VINYL CHLORIDE.....	BDL UG/KG	6
XYLENE (TOTAL).....	BDL UG/KG	
.....		
SURROGATE RECOVERY.....		
.....		
DICHLOROETHANE-D4.....	99 % RECOVERY	50
TOLUENE-DB.....	102 % RECOVERY	50
BROMOFLUOROBENZENE.....	101 % RECOVERY	50

BDL BELOW DETECTABLE LIMITS

QUALITY ASSURANCE OFFICER:

Quintina S. [Signature]

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C E R T I F I C A T E O F A N A L Y S I S

----- CORRESPOND TO ----- EMS HERITAGE LABORATORIES, INC. 8205 S. CASS AVE. SUITE 106 DARIEN, IL 60559 (708)969-9030	----- SAMPLE ----- LAB SAMPLE ID: C122827 DATE PRINTED : 12-JUL-90 DATE RECEIVED: 02-JUL-90 DATE COMPLETE: 11-JUL-90
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----- REPORT TO ----- ATTN: PAUL HERR WOODWARD CLYDE CONSULTANTS 122 SOUTH MICHIGAN AVENUE SUITE 1920 CHICAGO, IL 60603	----- BILL TO ----- ATTN: ACCOUNTING WOODWARD-CLYDE CONSULTANTS 122 SOUTH MICHIGAN AVENUE SUITE 1920 CHICAGO, IL 60603
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----- DESCRIPTION -----

DATE SAMPLED : TIME : NONE PO NUMBER : 89C3517
DESCRIPTION : COSCO-SPRING VALLEY, PROJECT #89C3517
: TRIP BLANK

----- ANALYSIS -----

VOLATILE ORGANICS SW846-8240	DATE : 11-JUL-90	INSTRUMENT : GC/MS VOA	REP : 0
ANALYST : S. RIECHMAN			

PARAMETER	RESULT	DET LIM
ACETONE.....	BDL UG/L	20
ACROLEIN.....	BDL UG/L	50
ACRYLONITRILE.....	BDL UG/L	70
BENZENE.....	BDL UG/L	5
BROMODICHLOROMETHANE.....	BDL UG/L	5
BROMOFORM.....	BDL UG/L	5
BROMOMETHANE.....	BDL UG/L	10
CARBON DISULFIDE.....	BDL UG/L	5
CARBON TETRACHLORIDE.....	BDL UG/L	5
CHLOROBENZENE.....	BDL UG/L	5
CHLOROETHANE.....	BDL UG/L	10
CHLOROFORM.....	BDL UG/L	5
CHLOROMETHANE.....	BDL UG/L	10
DIBROMOCHLOROMETHANE.....	BDL UG/L	5
CIS-1,3-DICHLOROPROPENE.....	BDL UG/L	5
DICHLORODIFLUOROMETHANE.....	BDL UG/L	5
1,1-DICHLOROETHANE.....	BDL UG/L	5
1,2-DICHLOROETHANE.....	BDL UG/L	5
1,1-DICHLOROETHENE.....	BDL UG/L	5
1,2-DICHLOROPROPANE.....	BDL UG/L	5
ETHYLBENZENE.....	BDL UG/L	5
FLUOROTRICHLOROMETHANE.....	BDL UG/L	5
2-HEXANONE.....	BDL UG/L	10
METHYLENE CHLORIDE.....	BDL UG/L	5
METHYL ETHYL KETONE.....	BDL UG/L	10
4-METHYL-2-PENTANONE.....	BDL UG/L	10
STYRENE.....	BDL UG/L	5

EMS LABORATORIES, INC.

SAMPLE ID: C122827

1,1,2,2-TETRACHLOROETHANE.....	BDL UG/L	5
TETRACHLOROETHENE.....	BDL UG/L	5
TETRAHYDROFURAN.....	BDL UG/L	25
TOLUENE.....	BDL UG/L	5
1,2-DICHLOROETHENE (TOTAL).....	BDL UG/L	5
TRANS-1,3-DICHLOROPROPENE.....	BDL UG/L	5
1,1,1-TRICHLOROETHANE.....	BDL UG/L	5
1,1,2-TRICHLOROETHANE.....	BDL UG/L	5
TRICHLOROETHENE.....	BDL UG/L	10
VINYL ACETATE.....	BDL UG/L	10
VINYL CHLORIDE.....	BDL UG/L	5
XYLENE (TOTAL).....	BDL UG/L	
SURROGATE RECOVERY.....		
DICHLOROETHANE-D4.....	95 % RECOVERY	50
TOLUENE-D8.....	99 % RECOVERY	50
BROMOFLUOROBENZENE.....	92 % RECOVERY	50

BDL BELOW DETECTABLE LIMITS

QUALITY ASSURANCE OFFICER:

Christie S. [Signature]

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C E R T I F I C A T E O F A N A L Y S I S

----- CORRESPOND TO ----- EMS HERITAGE LABORATORIES, INC. 8205 S. CASS AVE. SUITE 106 DARIEN, IL 60559 (708)969-9030	----- SAMPLE ----- LAB SAMPLE ID: C122826 DATE PRINTED : 13-JUL-90 DATE RECEIVED: 02-JUL-90 DATE COMPLETE: 12-JUL-90
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----- REPORT TO ----- ATTN: PAUL HERR WOODWARD CLYDE CONSULTANTS 122 SOUTH MICHIGAN AVENUE SUITE 1920 CHICAGO, IL 60603	----- BILL TO ----- ATTN: ACCOUNTING WOODWARD-CLYDE CONSULTANTS 122 SOUTH MICHIGAN AVENUE SUITE 1920 CHICAGO, IL 60603
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----- DESCRIPTION -----

DATE SAMPLED : 29-JUN-90 TIME : 17:00:00 PO NUMBER : 89C3517
DESCRIPTION : COSCO-SPRING VALLEY, PROJECT #89C3517
: RIG OIL

----- ANALYSIS -----

VOLATILE ORGANICS (HEATED PURGE & TRAP) SW846-8240 REP : 0
ANALYST : S. BUSSEY DATE : 11-JUL-90 INSTRUMENT : GC/MS VOA

PARAMETER	RESULT	DET LIM
ACETONE.....	BDL UG/KG	100
ACROLEIN.....	BDL UG/KG	260
ACRYLONITRILE.....	BDL UG/KG	360
BENZENE.....	BDL UG/KG	26
BROMODICHLOROMETHANE.....	BDL UG/KG	26
BROMOFORM.....	BDL UG/KG	26
BROMOMETHANE.....	BDL UG/KG	51
CARBON DISULFIDE.....	BDL UG/KG	26
CARBON TETRACHLORIDE.....	BDL UG/KG	26
CHLOROBENZENE.....	BDL UG/KG	26
CHLOROETHANE.....	BDL UG/KG	51
CHLOROFORM.....	BDL UG/KG	26
CHLOROMETHANE.....	BDL UG/KG	51
DIBROMOCHLOROMETHANE.....	BDL UG/KG	26
CIS-1,3-DICHLOROPROPENE.....	BDL UG/KG	26
DICHLORODIFLUOROMETHANE.....	BDL UG/KG	26
1,1-DICHLOROETHANE.....	BDL UG/KG	26
1,2-DICHLOROETHANE.....	BDL UG/KG	26
1,1-DICHLOROETHENE.....	BDL UG/KG	26
1,2-DICHLOROPROPANE.....	BDL UG/KG	26
ETHYLBENZENE.....	140 UG/KG	26
FLUOROTRICHLOROMETHANE.....	BDL UG/KG	77
2-HEXANONE.....	BDL UG/KG	51
METHYLENE CHLORIDE.....	BDL UG/KG	26
METHYL ETHYL KETONE.....	BDL UG/KG	51
4-METHYL-2-PENTANONE.....	BDL UG/KG	51
STYRENE.....	BDL UG/KG	26

EMS LABORATORIES, INC.

SAMPLE ID: C122826

1,1,2,2-TETRACHLOROETHANE.....	BDL UG/KG	26
TETRACHLOROETHENE.....	BDL UG/KG	26
TETRAHYDROFURAN.....	BDL UG/KG	130
TOLUENE.....	230 UG/KG	26
1,2-DICHLOROETHENE (TOTAL).....	BDL UG/KG	26
TRANS-1,3-DICHLOROPROPENE.....	BDL UG/KG	26
1,1,1-TRICHLOROETHANE.....	BDL UG/KG	26
1,1,2-TRICHLOROETHANE.....	BDL UG/KG	26
TRICHLOROETHENE.....	BDL UG/KG	51
VINYL ACETATE.....	BDL UG/KG	51
VINYL CHLORIDE.....	BDL UG/KG	26
XYLENE (TOTAL).....	1000 UG/KG	
.....		
SURROGATE RECOVERY.....		
.....		
DICHLOROETHANE-D4.....	99 % RECOVERY	50
TOLUENE-D8.....	101 % RECOVERY	50
BROMOFLUOROBENZENE.....	96 % RECOVERY	50
.....		
ALSO DETECTED:.....		
PROPYL BENZENE.....	EST 88 RT=31.2.....	

BDL BELOW DETECTABLE LIMITS
EST ESTIMATED VALUE
RT RETENTION TIME

QUALITY ASSURANCE OFFICER:

Christine Salas

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