ATTACHMENT E-14

Modifications to the Existing Groundwater Recovery System for the CSI Area

MODIFICATIONS TO EXISTING
GROUNDWATER RECOVERY SYSTEM

THE TORRINGTON COMPANY
SYLVANIA, GEORGIA

REVISED
MAY 29, 1996

SUBMITTED TO:

GEORGIA ENVIRONMENTAL PROTECTION DIVISION
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2580 NORTHEAST EXPRESSWAY
ATLANTA, GEORGIA 30345

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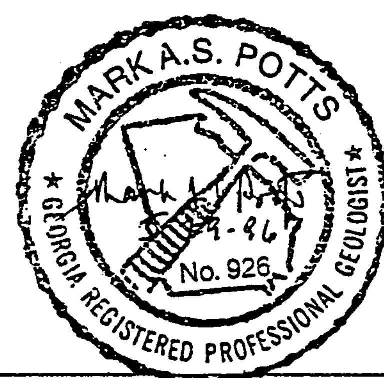
GEOLOGY CERTIFICATION

I certify that I am a qualified ground-water scientist who has received a baccalaureate or post-graduate degree in the natural sciences or engineering, and have sufficient training and experience in ground-water hydrology and related fields, as demonstrated by state registration and completion of accredited university courses, that enable me to make sound professional judgments regarding ground-water monitoring and contaminant fate and transport. I further certify that this report was prepared by myself or by a subordinate working under my direction.

5.29.96
Date

Signature



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SECTION I

BACKGROUND

The Torrington Company (Torrington) has a Post-Closure Care Permit for the following closed RCRA surface impoundments at its Sylvania, Georgia facility: the emergency pond, the retention pond, the Concentrated Cyanide Surface Impoundment (CCSI), the Dilute Cyanide Surface Impoundment (DCSI), and three Solid Waste Management Units (SWMUs).

Cyanide and metals are the primary groundwater contaminants at the CCSI and DCSI area. Volatile Organic Compounds (VOCs) and a few semi-VOCs have also been detected at low concentrations in the groundwater. These constituents originated from F006 wastewater stored in the CCSI and DCSI during operation of the impoundments as part of the wastewater treatment system. The impoundments were taken out of service in 1984 and were closed and capped in 1987.

Groundwater collection and treatment for cyanide and metals contamination was implemented in July 1988. Groundwater is collected from the perched water table using an intercepter trench, located down gradient and sidegradient of the closed CCSI and DCSI. The trench was installed as outlined in Section C-8 of the post-closure care application for the CCSI and DCSI dated January 26, 1988, and submitted to the Georgia Environmental Protection Division (EPD). A base map of the CCSI and DCSI area showing the surveyed location of the intercepter trench and the perched water table monitoring wells is included as Figure 1.

Groundwater flowing into the two sections of the trench is collected in a central sump with a capacity of 1,500 gallons. The water is then pumped into a 20,000-gallon holding tank and analyzed on a weekly basis for pH and total cyanide and on a quarterly basis for VOCs.

Continued evaluation of the groundwater recovery system indicates that the constituents present in the perched water table in the CCSI and DCSI area are being contained, collected, and removed by the intercepter trench. Atlanta Environmental Management, Inc. (AEM) was contracted by Torrington to determine if the recovery trench system could be modified to increase the rate of constituent removal from the perched water table. The evaluation results are presented in this report. The Torrington Company intends to implement the system pending final permit modification approval.

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SECTION II

INTERCEPTER TRENCH EVALUATION

Since its installation, the CCSI and DCSI area intercepter trench has effectively contained and collected impacted groundwater. The system is checked weekly with a visual inspection of the sump area, and water samples are collected from the 20,000-gallon holding tank for pH and total cyanide analysis.

The highest groundwater constituent concentrations occur beneath and down gradient (northeast) of the CCSI and DCSI area. Groundwater flow in the CCSI and DCSI area is to the northeast. The intercepter trench was designed and installed in 1988 to contain impacted groundwater. Review of the perched water table surface for December 1994 indicates impacted groundwater is recovered by the trench system (see Figure 2).

The volume of groundwater flow through an aquifer is controlled by the aquifer's ability to transmit water (transmissivity) and the difference in groundwater elevation and/or pressure across the aquifer (hydraulic gradient). The transmissivity of an unconfined aquifer is controlled by the aquifer saturated thickness and hydraulic conductivity. Operation of the intercepter trench has lowered the water table elevation within the trench's capture zone, thus reducing the aquifer's saturated thickness that water flows through. Operation of the intercepter trench has also reduced the hydraulic gradient in the trench area. As a result of the reduced aquifer transmissivity (saturated thickness) and reduced hydraulic gradient, groundwater flow rates from beneath the CCSI and DCSI to the recovery trench and, thus constituent recovery rates, have been reduced.

Constituent recovery rates can be increased by increasing groundwater flow rates and/or reducing groundwater travel distances to the trench. Groundwater travel distances can be reduced by installing additional intercepter trench(es). The groundwater flow rate can be increased by increasing the aquifer's saturated thickness and/or the hydraulic gradient. Both aquifer transmissivity and hydraulic gradient can be increased by recharging the aquifer near the CCSI and DCSI area. AEM has utilized computer modeling to evaluate the effectiveness of installing additional recovery trenches and infiltration wells in the area to reduce contaminant travel time to the trench and improving the rate (efficiency) of constituent removal.

SECTION III

GROUNDWATER FLOW MODEL

A. MODEL COMPUTER CODE

The analytical model QuickFlow™, developed by Mr. James O. Rumbaugh, III (Geraghty & Miller, 1991), was used to model the groundwater flow in the trench area. The model was used to produce two-dimensional, steady-state groundwater flow simulations to evaluate the impact of the original intercepter trench on the groundwater flow system, as well as the impact of infiltration wells and additional intercepter trench installations. The model runs on IBM-compatible personal computers running the DOS operating system.

B. MODEL ASSUMPTIONS AND LIMITATIONS

QuickFlow™ is a two-dimensional analytical groundwater flow model. The model simulates groundwater flow using analytical functions and equations developed by Strack (1989), Theis (1935), and Hantush and Jacob (1955). The analytical functions and equations are based on the following assumptions:

1. The aquifer is homogeneous, thus having uniform hydraulic conductivity, storativity, and porosity.
2. The aquifer has a constant thickness and infinite areal extent.
3. Pumping wells penetrate and are screened across the entire aquifer.
4. All water removed from the aquifer comes from aquifer storage.
5. Water removed from aquifer storage is discharged instantaneously as the head (water level elevation) is lowered.

6. Laminar flow is maintained throughout the aquifer and any pumping wells.

7. Pumping wells are 100 percent efficient.

8. The water table surface has no slope.

Natural aquifer systems rarely meet all the assumptions of the mathematical equations describing groundwater flow. Trench and well installation techniques used in the perched water table comply with assumption 3. Because groundwater flow rates and elevations were allowed to equilibrate after groundwater infiltration or removal rates were changed (steady-state solutions) assumptions 4, 5, 6, and 7 were met or had very little impact on simulation results. Assumption 8 is met because the model uses the law of superposition to evaluate the effects of multiple analytical functions (wells, line sinks) in a uniform flow field. The law of superposition states that changes in water level at a point in an aquifer resulting from different pumping wells and trenches are added and/or subtracted to calculate the final water level elevation. Using the same principle, a uniform hydraulic gradient can also be simulated by the model.

An aquifer can be considered of infinite areal extent if it extends beyond the area of influence of the simulated stresses (wells, intercepter trenches). Because of the low hydraulic conductivity of the perched water table aquifer, the simulated wells and trenches area of influence is limited to the CCSI and DCSI area, and the aquifer is considered to be of infinite areal extent. The aquifer is also considered to be homogeneous in this limited area. The aquifer in the CCSI and DCSI area is considered to meet the analytical equations assumptions well enough to evaluate the impact of infiltration wells and intercepter trenches on the groundwater flow field in the area.

C. MODEL PARAMETERS

Aquifer parameters were evaluated as part of the original interceptor trench design process. Cross sections A-A' and B-B' were constructed at that time (Figures 3, 4, and 5) and presented in the report *Determination of Discharge Volumes for the Intercepter Trench* dated June 14, 1988. As illustrated in Figures 4 and 5, the perched water table aquifer simulated bottom elevation was 168 feet Above Mean Sea Level (ft AMSL), an average value for the aquifer in the area of the intercepter trench.

The average volume of recovered groundwater is known from recovery system records maintained as part of the operation of the existing recovery trench. Using this data and the known surface area of the seepage face into the recovery trench, Darcy's law was used to calculate an average hydraulic conductivity of 1.3 feet per day for the CCSI and DCSI area. A porosity of 30 percent was used for particle track calculations by the model. A uniform hydraulic gradient was used to simulate the existing water table surface prior to the current trench installation in 1988 based on historic water level elevation data.

SECTION IV

MODEL SIMULATIONS

Multiple scenarios were simulated using the groundwater flow model. The first is the equilibrium surface with the intercepter trench installed in its present configuration (see Figure 6). Additional model simulations were run to evaluate various infiltration well, infiltration trench and recovery trench configurations. The infiltration well and recovery trench configuration presented in Figure 7 illustrates the most effective scenario for removing cyanide-contaminated groundwater at the CCSI and DCSI area in the least amount of time.

A. EXISTING INTERCEPTER TRENCH SYSTEM

Intercepter trenches were simulated as line segments with a constant water level elevation of 168.2 ft AMSL (constant head line sinks). If adjacent water levels are greater than that of the constant head line sink, water flows into the sink. If adjacent water levels are less than that in the constant head line sink, water flows from the sink to the adjacent aquifer. The modeled steady-state solution with the current line sink configuration is presented in Figure 6. Water level contours, as well as particle tracks, are presented in the figure. A particle track represents the path a water particle introduced at some location in the aquifer would follow. Approximate travel times along the particle tracks are also presented in the figure.

Comparison of the observed and simulated water level contours indicates that an acceptable match exists (model is calibrated) for evaluating the use of infiltration wells to modify the flow system. Groundwater flow is to the north-northeast and into the northwestern section of the trench, as well as to the northeast and into the southeastern section of the trench. The maximum water level elevation within the trench area was simulated to be 174 ft AMSL and was observed to be 176 ft AMSL during December 1994. Along the northwestern section of the trench, simulated aquifer-saturated thickness ranged from 6 feet to less than 1 foot, and observed aquifer-saturated thickness ranged from 4 feet to less than 1 foot. Along the southeastern section of the trench, the aquifer-saturated thickness ranged from 6 feet to less than 1 foot, and the observed aquifer-saturated thickness ranged from 7 feet to less than 1 foot. The simulated groundwater recovery volume of the recovery trench was within 200 gallons per day of the average observed groundwater recovery rate of 1,600 gallons per day.

Simulated groundwater flow from the CCSI and DCSI area is to the north-northeast, into the northwestern section of the interceptor trench. Groundwater flow southeast of the CCSI is to the northeast, into the southeastern section of the intercepter trench. The observed water table contours indicates that the actual groundwater flow divide for water traveling to the northwestern versus the southeastern section of the trench actually occurs beneath the capped CCSI.

Simulated groundwater travel times from beneath the CCSI to the intercepter trench average one to two years. Simulated groundwater travel times from beneath the DCSI to the intercepter trench average one to six months because the DCSI is located closer to the trench.

B. EXISTING INTERCEPTER TRENCH SYSTEM WITH INFILTRATION WELLS AND ADDITIONAL RECOVERY TRENCHES

Two additional recovery trenches and eleven infiltration wells were simulated. The infiltration wells and additional recovery trenches effectively increase the aquifer transmissivity (saturated thickness), and the hydraulic gradient across the area while reducing the travel distance for groundwater flowing to the recovery trenches. This will greatly reduce the time required to remove the dissolved cyanide in the CCSI and DCSI area.

The modeled steady-state solution with the additional intercepter trenches and four infiltration well areas is presented in Figure 7. Water level elevation contours, particle tracks and particle track travel times are presented in the figure. The combined groundwater infiltration rate of the infiltration well system was simulated to be 1,750 gallons per day.

The recovery trench and infiltration well locations are presented in Figure 8. Because of the low hydraulic conductivity of the perched water table aquifer, the infiltration wells are located in groups of two or three to allow adequate water volumes to flow into the aquifer to generate the required water levels.

The two additional recovery trenches run northeast-southwest on the western and eastern sides of the CCSI. The infiltration wells are located to the northeast and southwest of the CCSI and DCSI as presented in Figure 8. Water infiltration from these wells will move radially outward from the well clusters. Water will flow toward the CCSI and DCSI from the northeast and southwest and to the recovery trenches as depicted by the particle tracks on Figure 7. If the infiltration wells are operated in equilibrium a small area beneath the CCSI and DCSI may develop where groundwater can possibly stagnate. To prevent groundwater from stagnating beneath the CCSI and DCSI the northeastern infiltration wells will be shut down for two weeks once every six months to prevent equilibrium conditions from establishing a stagnation point in the area.

Operation of the infiltration wells and additional recovery trenches will flush groundwater containing the highest cyanide concentrations beneath the CCSI and DCSI to the recovery trenches along the paths outlined by the particle tracks presented in Figure 7. By increasing the hydraulic gradient between the aquifer and the recovery trenches and reducing the travel distance for water flowing from the CCSI and DCSI, the time required to flush water from beneath the CCSI and DCSI to the nearest recovery trench has been reduced from one to two years to one to twelve months.

The infiltration wells will be installed as described in Attachment 1. The additional recovery trenches will be installed in a similar manner as the original recovery trenches. The trenches will be installed approximately one foot into the basal clay of the perched water table with a one to three percent grade drop to a sump. The trenches will be approximately three feet wide and consist of perforated drain pipe encased in approximately five feet of gravel and covered with native sediment and soil to land surface. The trenches will thus effectively dewater the perched water table.

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SECTION V

DISCUSSION

The CCSI and DCSI area intercepter trench was designed and installed in 1988 to contain the area of groundwater impact. Review of the perched water table contours for December 1994 indicates impacted groundwater is effectively captured and recovered by the trench system (see Figure 2). The current intercepter trench was installed to contain groundwater from the most highly contaminated source area (beneath the CCSI and DCSI), as well as impacted groundwater down gradient.

Constituents present in the groundwater adsorb to aquifer materials. The quantity of a compound that will adsorb is dependent on the compound and the aquifer material but generally increases with increased concentration in the groundwater. As groundwater flows through an aquifer, dissolved constituents are adsorbed on aquifer materials reducing the concentration in the groundwater. The adsorbed material then slowly re-dissolves into the groundwater becoming a constituent source. Because of this phenomenon, large quantities of water must flow through an aquifer to remove the dissolved constituents. To increase the effectiveness of the intercepter trench system at the CCSI and DCSI area, larger quantities of water must flow through the aquifer.

The groundwater flow simulations indicate that the use of infiltration wells will effectively increase water level elevations in the area and, thus, increase the hydraulic gradient and saturated aquifer thickness groundwater can flow through. This will allow larger volumes of water to be flushed through the aquifer, increasing the rate at which constituents are recovered and reducing the time required to remediate the aquifer.

The rate at which the groundwater constituents are recovered can also be increased by reducing the distance the groundwater has to travel to be recovered. Installation of two additional recovery trenches running northeast-southwest, one to the southeast and one to the northwest side of the CCSI (Figure 7), would reduce groundwater travel time to a recovery trench. The groundwater flow simulations indicate installation of the infiltration wells and the two additional recovery trenches would reduce the groundwater travel time from beneath the CCSI and DCSI from approximately one to two years to approximately one to three months. The model simulations also indicate approximately 1750 gallons per day of additional groundwater will be generated by the new infiltration wells and recovery trenches.

Since the installation of the intercepter trench in the CCSI and DCSI area, Torrington has installed underground utility pipelines within a single underground secondary containment pipeline adjacent to the CCSI (see Figure 1). The base of the secondary containment pipeline is approximately 7 feet below land surface. Review of past and present water table maps indicates the base of the pipeline would be below the water table if the recovery trench had not lowered the water table in the CCSI and DCSI area. The installation of the proposed recovery trench southeast of the CCSI will prevent water introduced at the infiltration wells from flooding the secondary containment pipeline.

SECTION VI

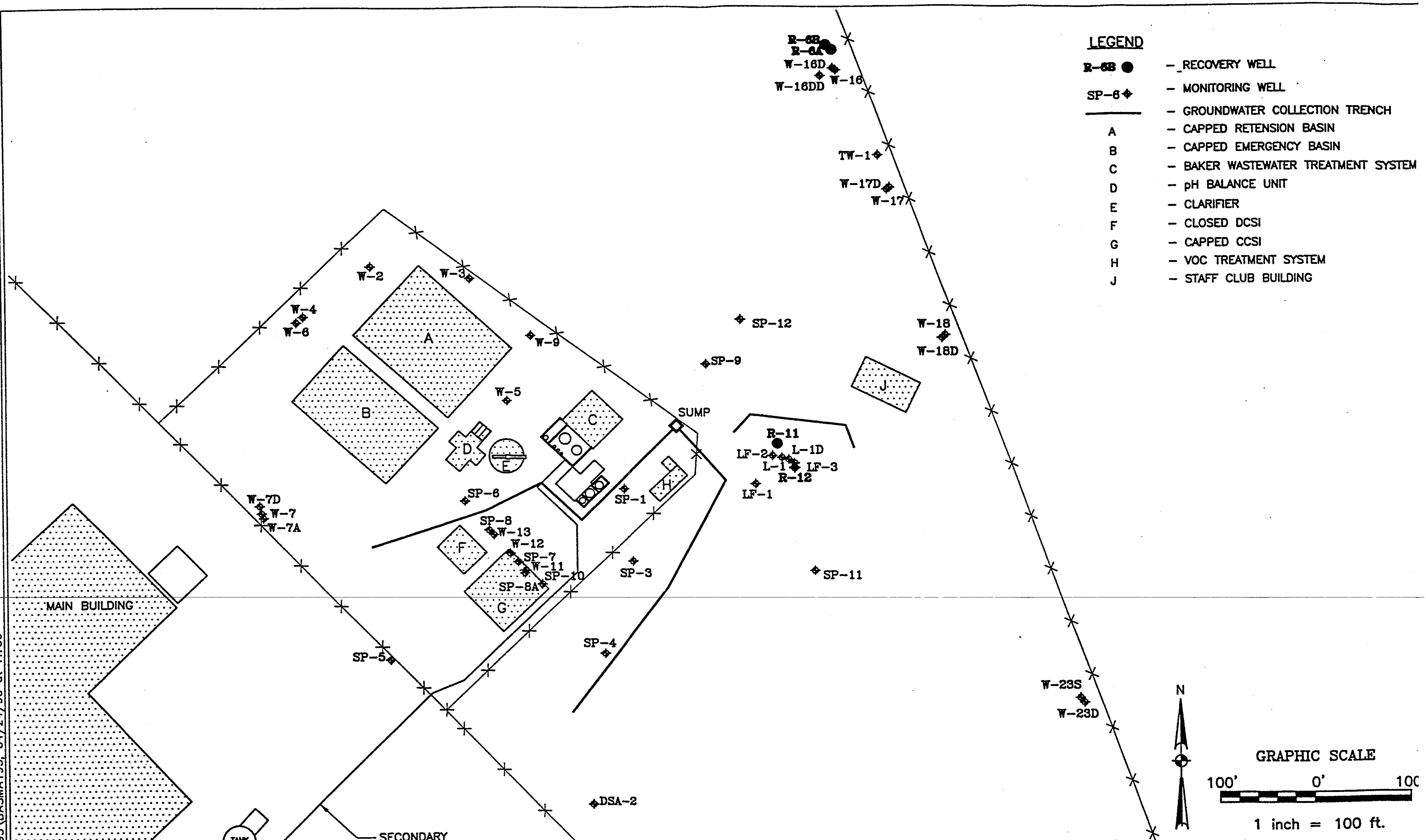
RECOMMENDATIONS

Although the perched water table aquifer in the CCSI and DCSI area does not strictly comply with all the assumptions of the analytical equations used in the model, the aquifer does present a good approximation of the assumptions. The simulations clearly indicate that the quantity of groundwater flowing through the aquifer can effectively be increased with the installation of the simulated infiltration wells. Also, the simulations indicate that the distance the groundwater flows before being recovered and, thus, travel times for recovered groundwater can be reduced with the installation of two additional intercepter trenches. For these reasons AEM recommends the following:

- Infiltration wells (11) will be installed at the approximate locations shown in Figure 8. The wells will be 6-inch-diameter PVC with water levels maintained in the wells with float switches installed in accordance with specifications presented in Attachment 1.

- Two additional intercepter trenches will be installed at the CCSI and DCSI area in the approximate locations presented in Figure 8. These trenches will discharge into the existing intercepter trench.

FIGURES



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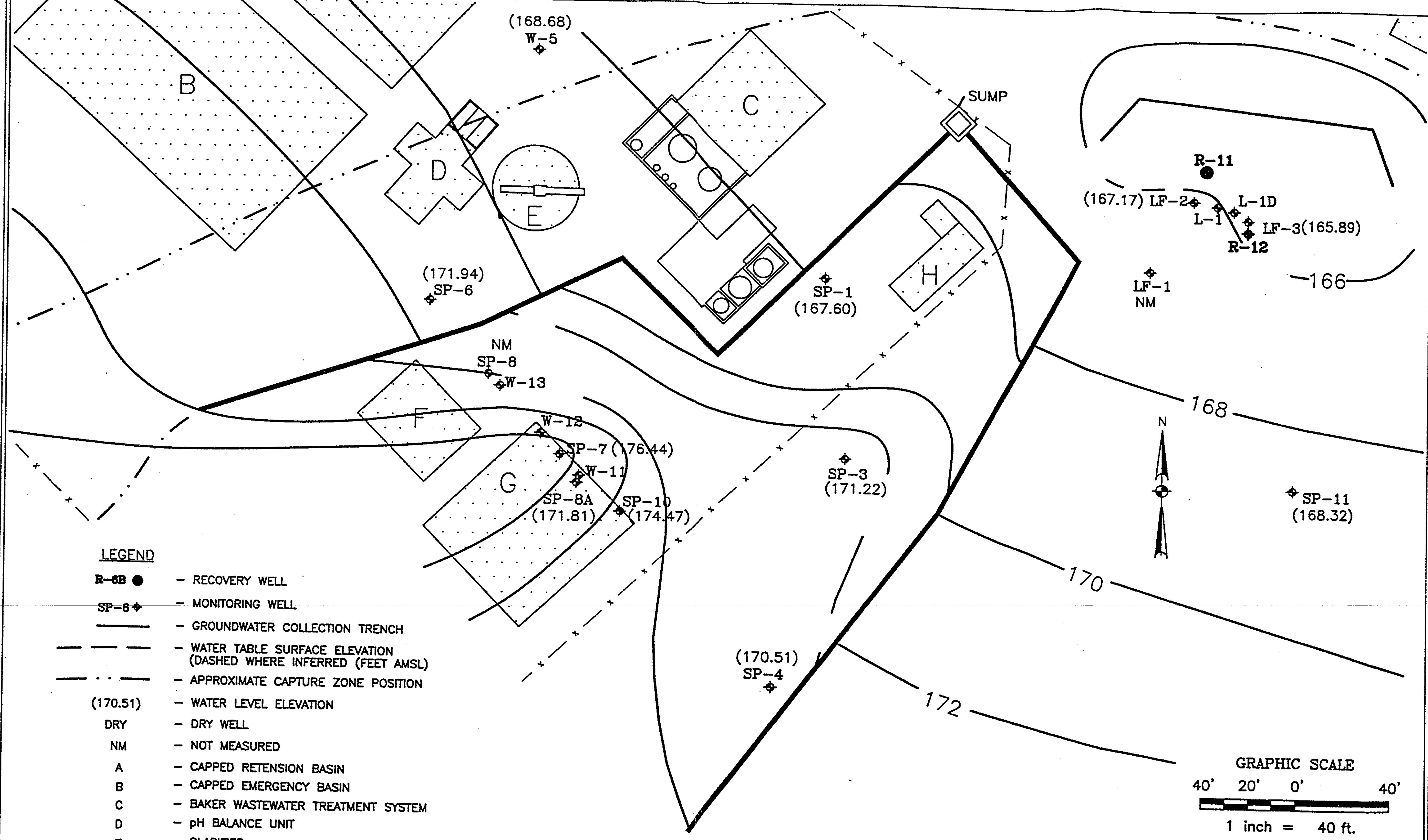
THE TORRINGTON COMPANY
CSI INJECTION WELL EVALUATION
SYLVANIA, GEORGIA

PROJECT NO. 95-01-91	DRAWN GRP
Scale 1" =100'	Date: MAY, 1995

Atlanta Environmental Management, Inc.
2580 Northeast Expressway
Atlanta, Georgia 30345

FIGURE 1

MONITORING WELL AND INTERCEPTER TRENCH LOCATIONS



LEGEND

R-6B ●	– RECOVERY WELL
SP-6 ⌖	– MONITORING WELL
———	– GROUNDWATER COLLECTION TRENCH
— — —	– WATER TABLE SURFACE ELEVATION (DASHED WHERE INFERRED (FEET AMSL)
—·· —	– APPROXIMATE CAPTURE ZONE POSITION
(170.51)	– WATER LEVEL ELEVATION
DRY	– DRY WELL
NM	– NOT MEASURED
A	– CAPPED RETENSION BASIN
B	– CAPPED EMERGENCY BASIN
C	– BAKER WASTEWATER TREATMENT SYSTEM
D	– pH BALANCE UNIT
E	– CLARIFIER
F	– CLOSED DCSI
G	– CAPPED CCSI
H	– VOC TREATMENT SYSTEM
J	– STAFF CLUB BUILDING

THE TORRINGTON COMPANY

SYLVANIA, GEORGIA

PROJECT NO. 95-01-91	DRAWN GRP
Scale 1" =40'	Date: SEPT. 1995

Atlanta Environmental Management, Inc.
2580 Northeast Expressway
Atlanta, Georgia 30345

FIGURE 2

PERCHED WATER TABLE SURFACE
(DECEMBER 1994)

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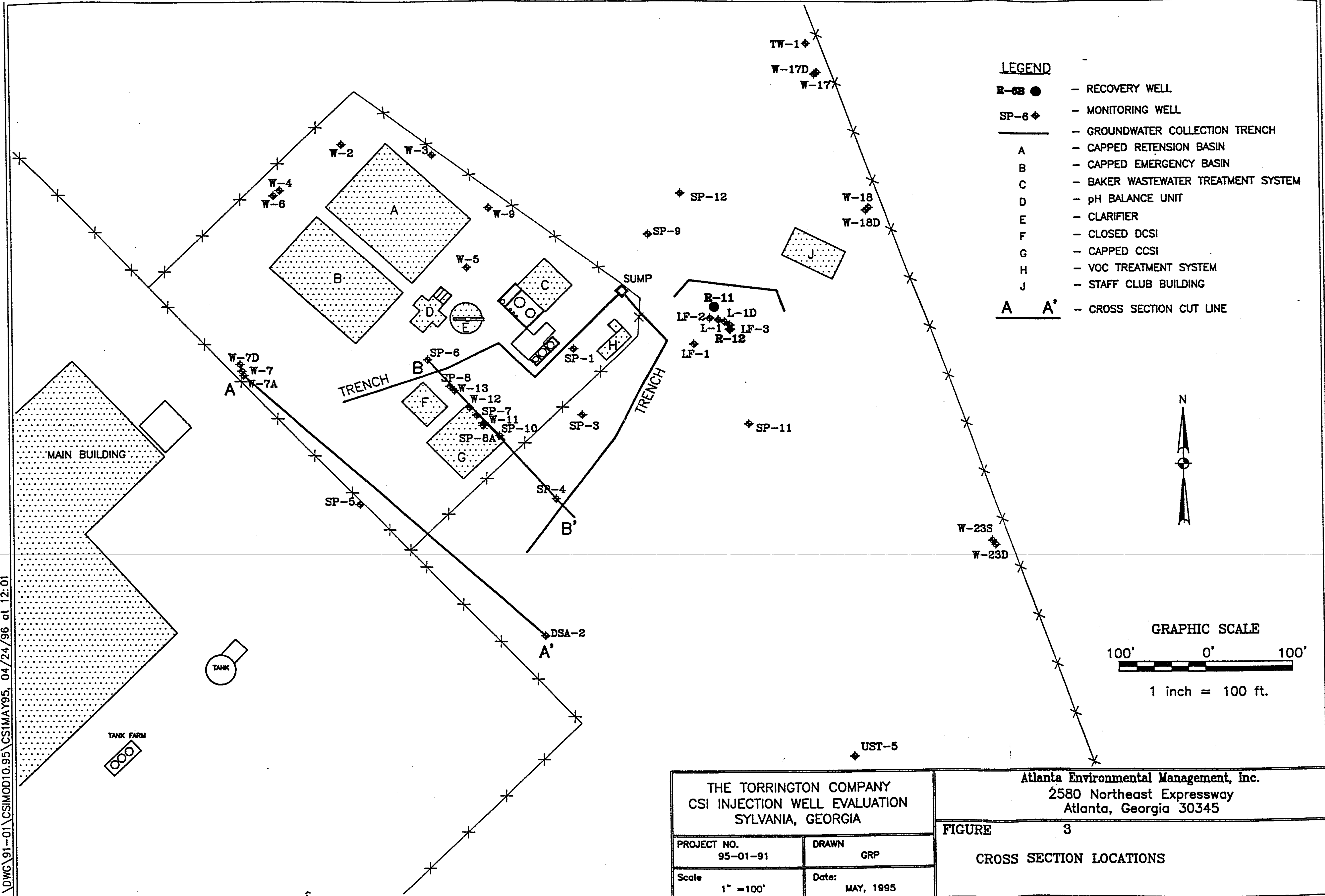


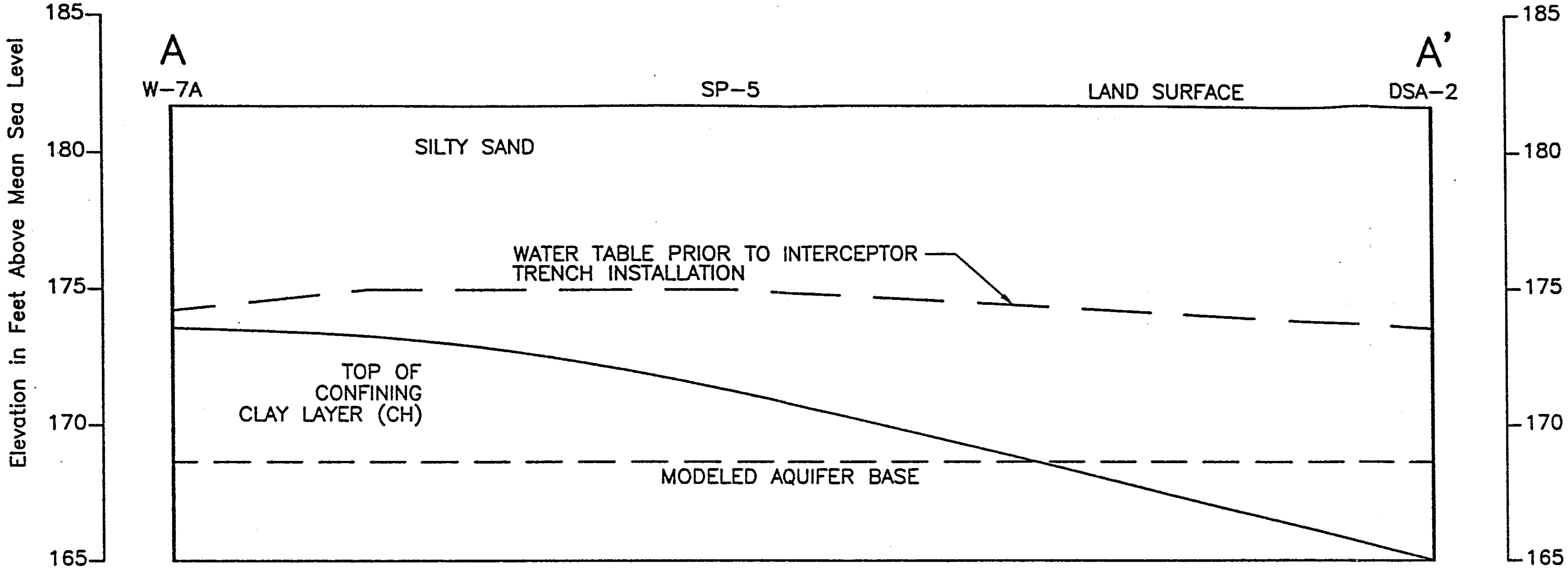
THE TORRINGTON COMPANY
CSI INJECTION WELL EVALUATION
SYLVANIA, GEORGIA

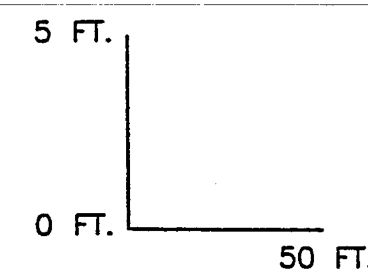
PROJECT NO. 95-01-91	DRAWN GRP
Scale 1" =100'	Date: MAY, 1995

Atlanta Environmental Management, Inc.
2580 Northeast Expressway
Atlanta, Georgia 30345

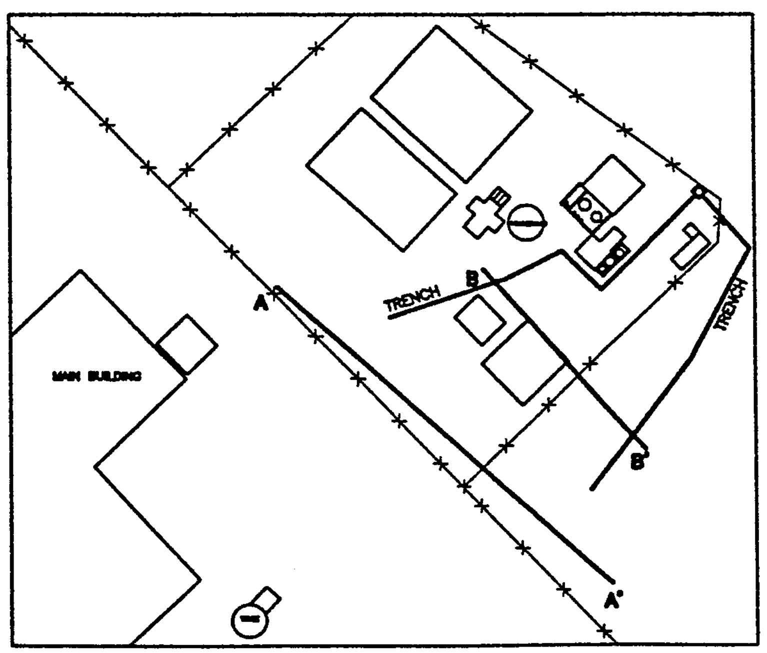
FIGURE 3

CROSS SECTION LOCATIONS





VERTICAL
EXAGGERATION = 10X



THE TORRINGTON COMPANY CSI INJECTION WELL EVALUATION SYLVANIA, GEORGIA	
PROJECT NO. 95-01-89	DRAWN: GRP
SCALE: AS SHOWN	DATE: MAY, 1995

Atlanta Environmental Management, Inc.
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Atlanta, Georgia 30345

FIGURE 4

CROSS SECTION A – A'

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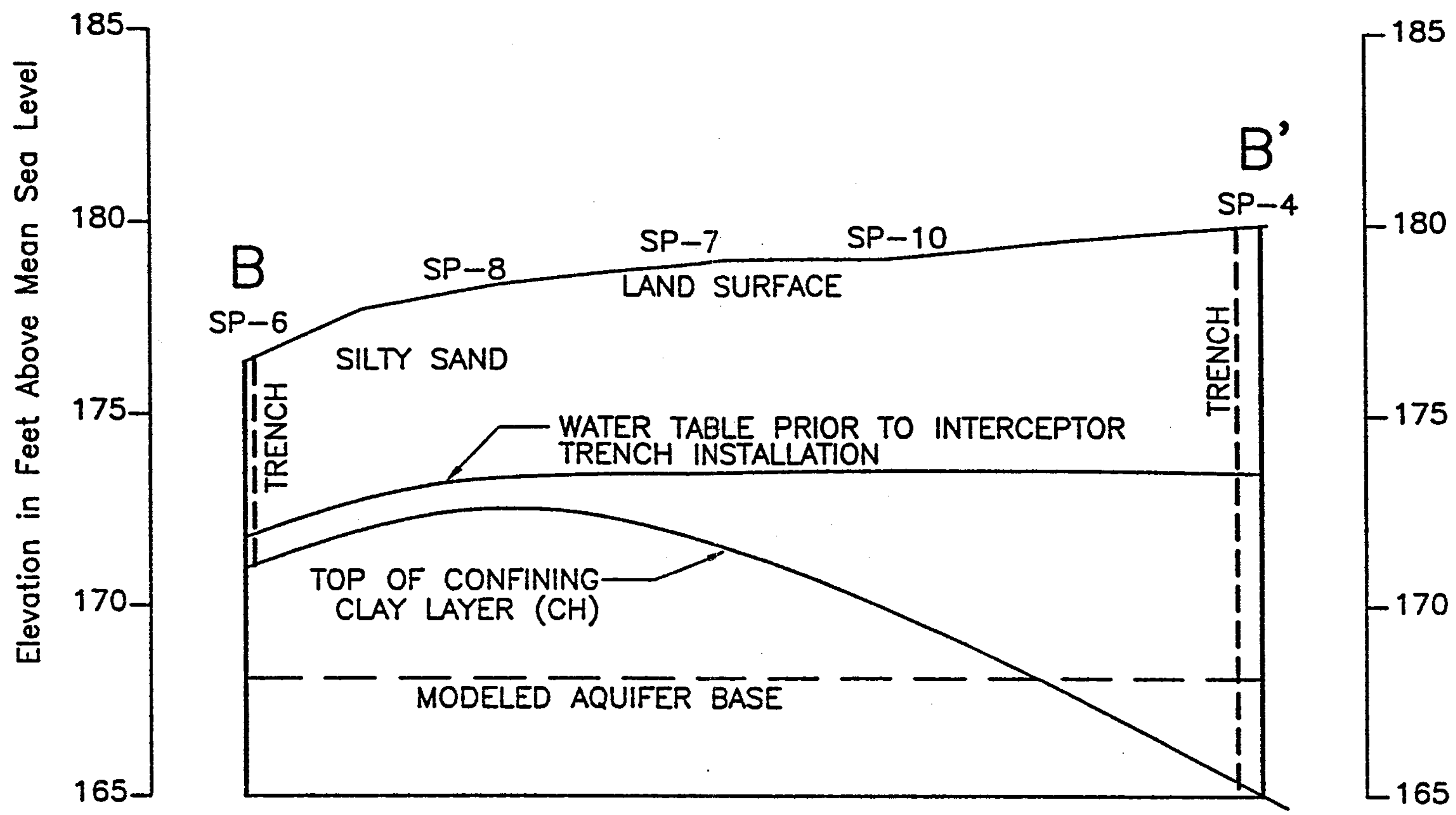

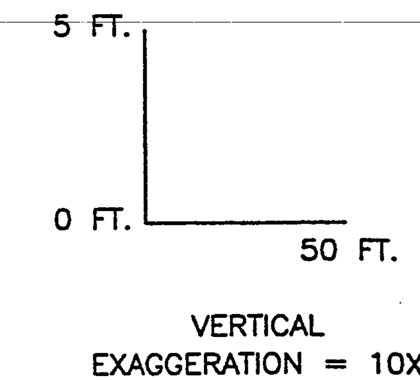

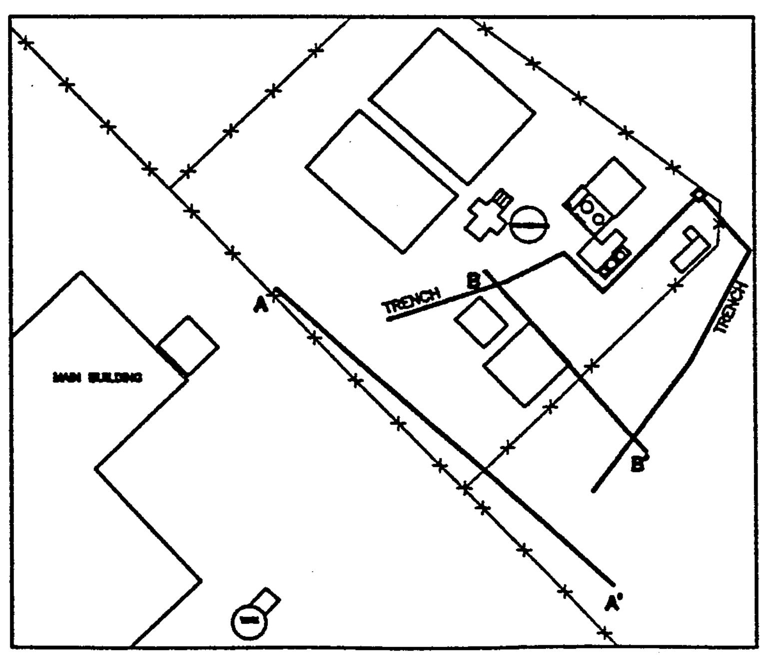

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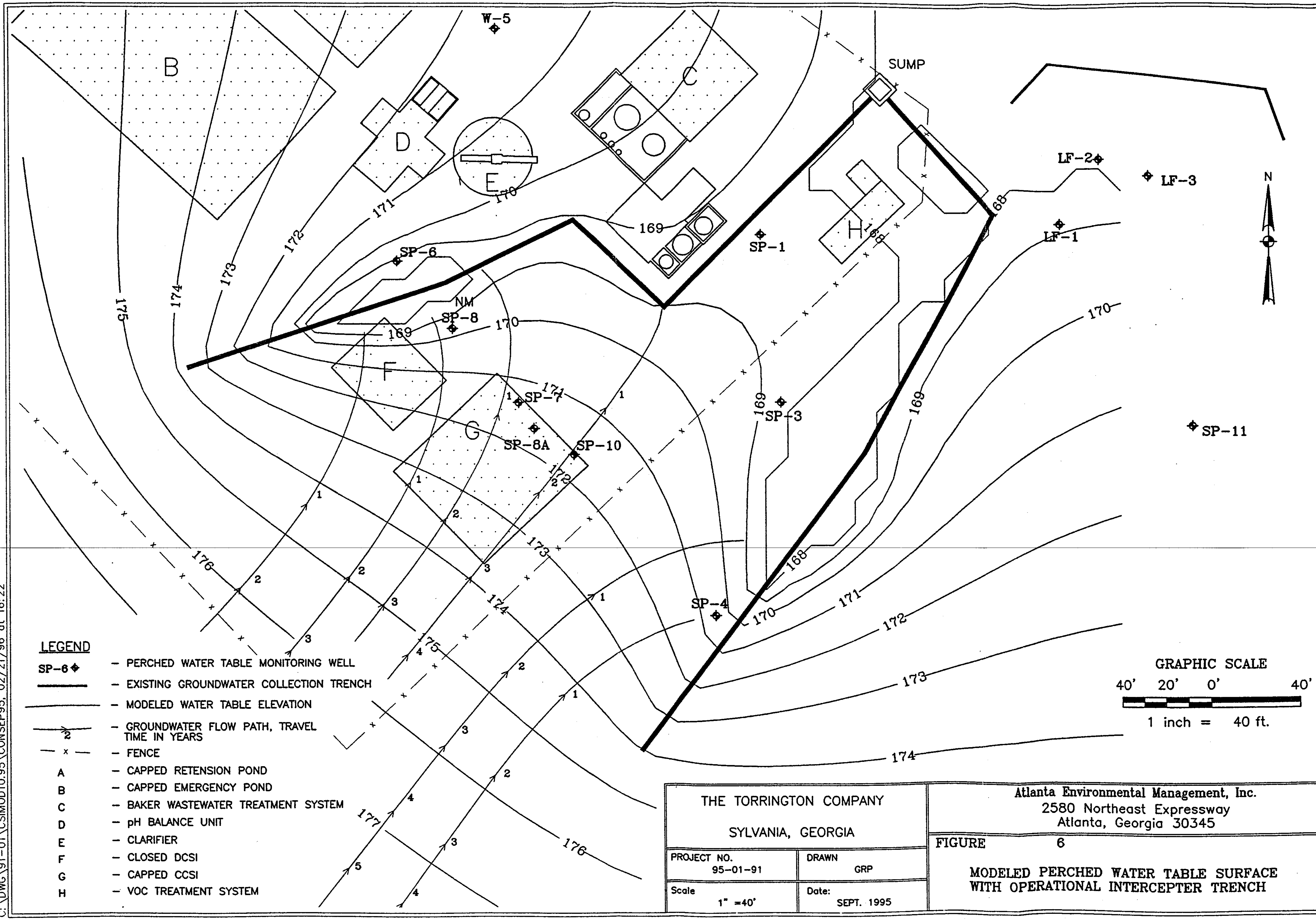
THE TORRINGTON COMPANY CSI INJECTION WELL EVALUATION SYLVANIA, GEORGIA	Atlanta Environmental Management, Inc. 2580 Northeast Expressway Atlanta, Georgia 30345
PROJECT NO.: 95-01-89 — DRAWN: GRP	FIGURE 5
SCALE: AS SHOWN — DATE: MAY, 1995	CROSS SECTION B – B'



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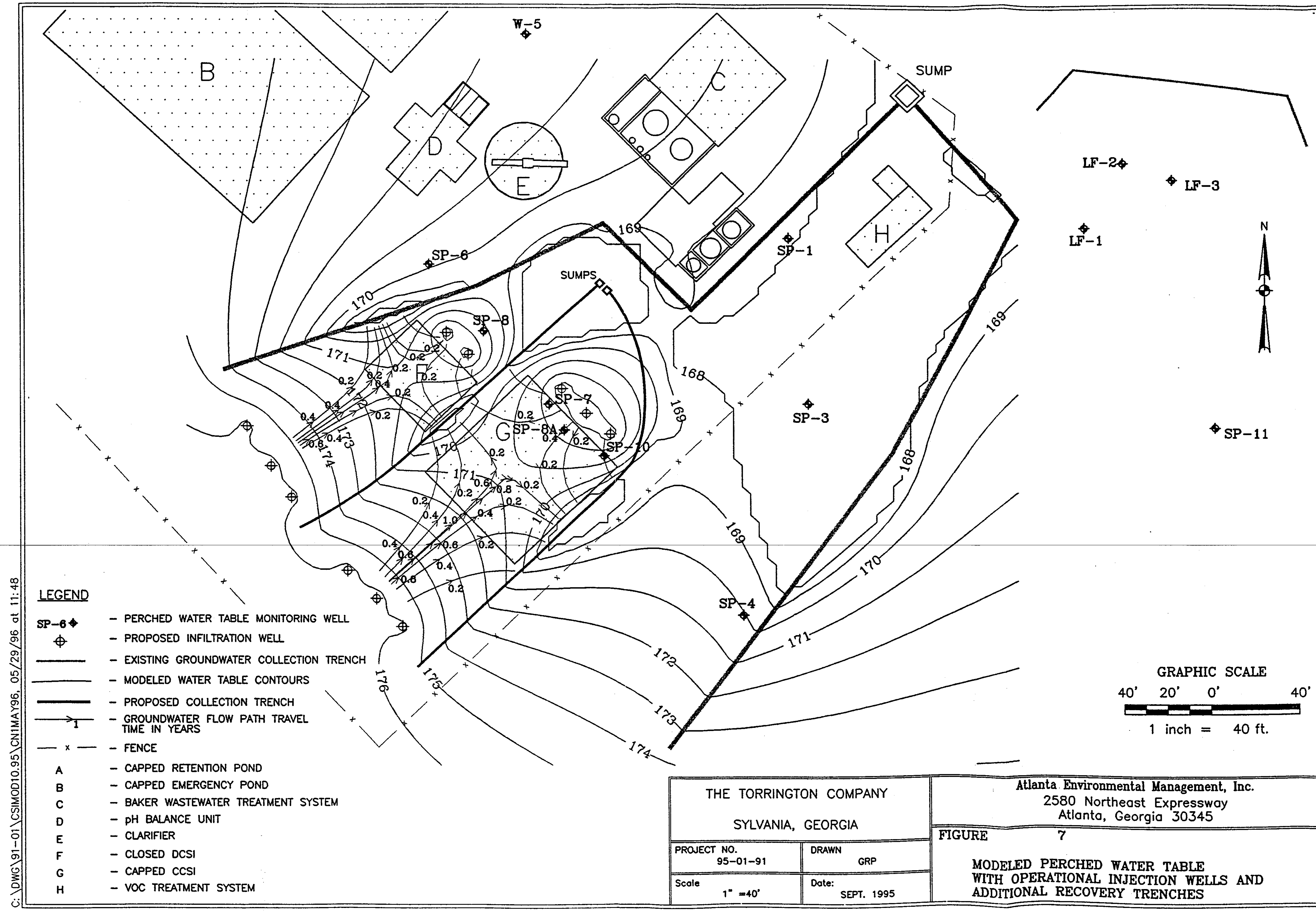

W-5
B
C
D
E
SUMP
SUMPS
H
G
LF-1
LF-2
LF-3
SP-1
SP-3
SP-4
SP-6
SP-7
SP-8
SP-8A
SP-10
SP-11
N
168
169
170
171
172
173
174
175
176
GRAPHIC SCALE
40' 20' 0' 40'
1 inch = 40 ft.
LEGEND
SP-6 – PERCHED WATER TABLE MONITORING WELL
– PROPOSED INFILTRATION WELL
– EXISTING GROUNDWATER COLLECTION TRENCH
– MODELED WATER TABLE CONTOURS
– PROPOSED COLLECTION TRENCH
1 – GROUNDWATER FLOW PATH TRAVEL TIME IN YEARS
– FENCE
A – CAPPED RETENTION POND
B – CAPPED EMERGENCY POND
C – BAKER WASTEWATER TREATMENT SYSTEM
D – pH BALANCE UNIT
E – CLARIFIER
F – CLOSED DCSI
G – CAPPED CCSI
H – VOC TREATMENT SYSTEM
THE TORRINGTON COMPANY
SYLVANIA, GEORGIA
PROJECT NO. 95-01-91
DRAWN GRP
Scale 1" =40'
Date: SEPT. 1995
Atlanta Environmental Management, Inc.
2580 Northeast Expressway
Atlanta, Georgia 30345
FIGURE 7
MODELED PERCHED WATER TABLE WITH OPERATIONAL INJECTION WELLS AND ADDITIONAL RECOVERY TRENCHES
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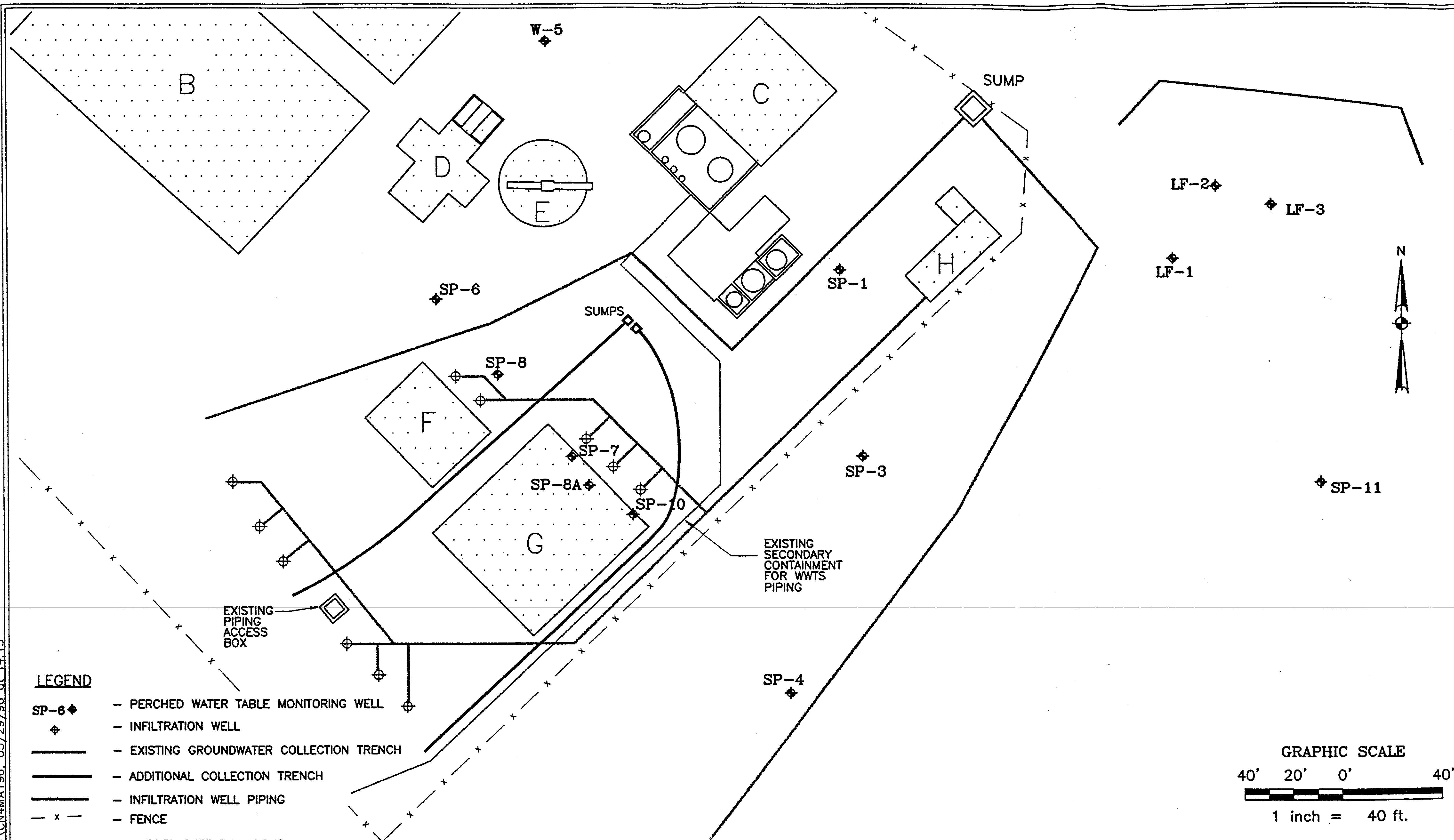

LEGEND

SP-6 ⌖ – PERCHED WATER TABLE MONITORING WELL
⌖ – INFILTRATION WELL
– EXISTING GROUNDWATER COLLECTION TRENCH
– ADDITIONAL COLLECTION TRENCH
– INFILTRATION WELL PIPING
— x — – FENCE

A – CAPPED RETENTION POND
B – CAPPED EMERGENCY POND
C – BAKER WASTEWATER TREATMENT SYSTEM
D – pH BALANCE UNIT
E – CLARIFIER
F – CLOSED DCSI
G – CAPPED CCSI
H – VOC TREATMENT SYSTEM

THE TORRINGTON COMPANY SYLVANIA, GEORGIA		Atlanta Environmental Management, Inc. 2580 Northeast Expressway Atlanta, Georgia 30345
PROJECT NO. 95-01-91	DRAWN GRP	FIGURE 8
Scale 1" =40'	Date: SEPT. 1995	ADDITIONAL INTERCEPTER TRENCHES AND INFILTRATION WELLS

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ATTACHMENTS

ATTACHMENTS

INFILTRATION WELL INSTALLATION PROCEDURES

1.1 DECONTAMINATION PROCEDURES

Prior to commencement of drilling activities and between all wells, all drilling equipment (drilling rig, hollow-stem augers, rods, bits, sampling equipment, and tools) will be thoroughly cleaned and decontaminated at a designated decontamination area using a steam cleaner. All screens and casings will be decontaminated prior to coming on site. Sampling equipment will be steam cleaned before collecting any sample that may be submitted for laboratory analysis.

1.2 DRILLING METHODS

The borings will be drilled using Hollow-Stem Auger (HSA) drilling techniques. Depth to the water table will be documented on boring logs. HSA drilling will be performed using 10-inch-diameter HSAs. PVC or Teflon bottom plugs may be used to prevent soil from entering the inside of the augers. Bottom plugs of wood or other materials may not be used. The removal of the bottom soil plug from the HSA following completion of drilling activities may also be accomplished by reaming the HSA with appropriate-size augers if necessary.

Continuous split-spoon samples will be collected during HSA drilling for lithologic description. The remaining borehole cuttings will be placed in DOT-approved drums.

The wells will be developed using a surge block, submersible pump, and/or bailer until the water removed is clear.

ATTACHMENT A-1

TYPICAL INFILTRATION WELL CONSTRUCTION FOR GROUNDWATER REMEDIATION

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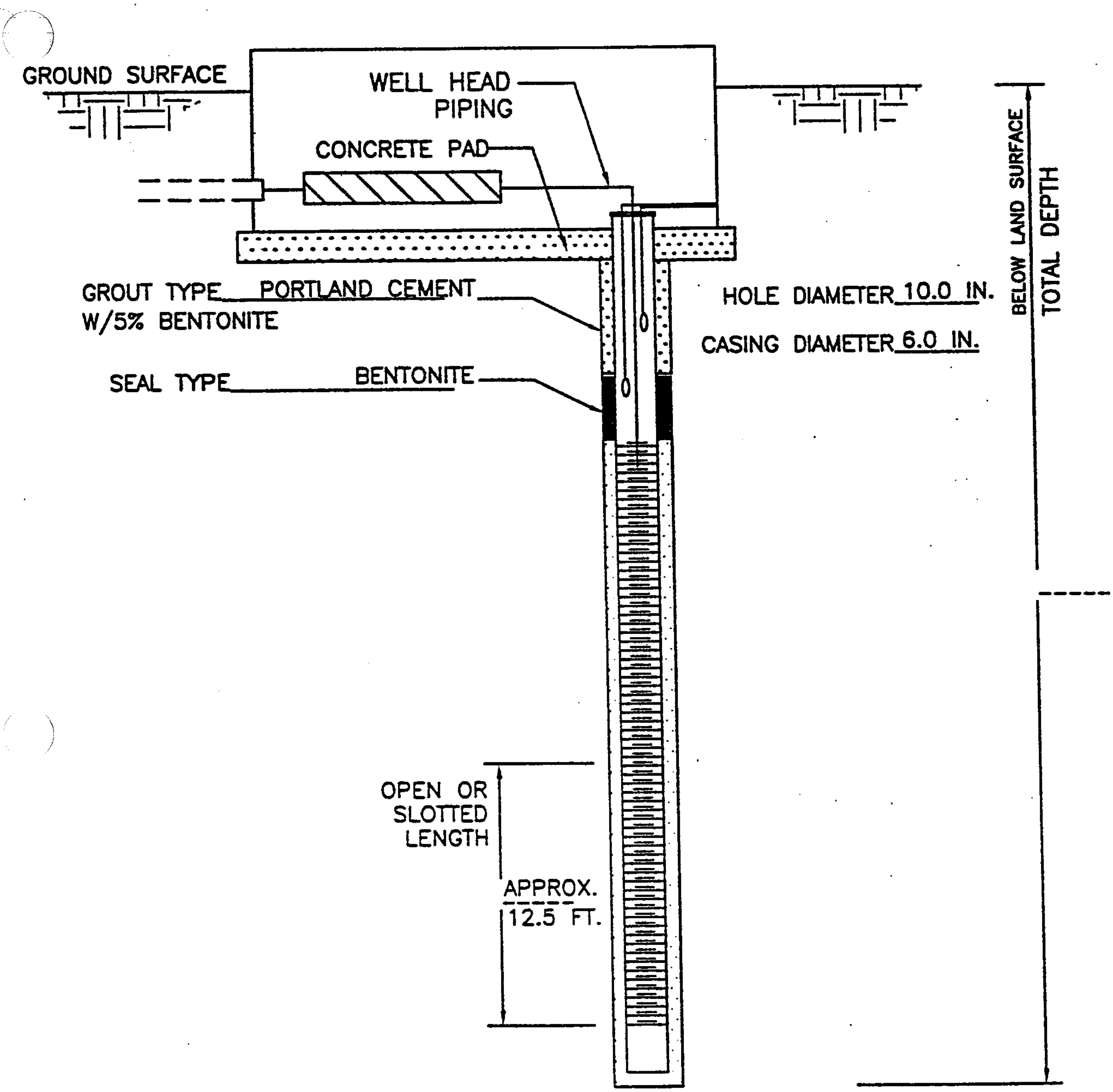
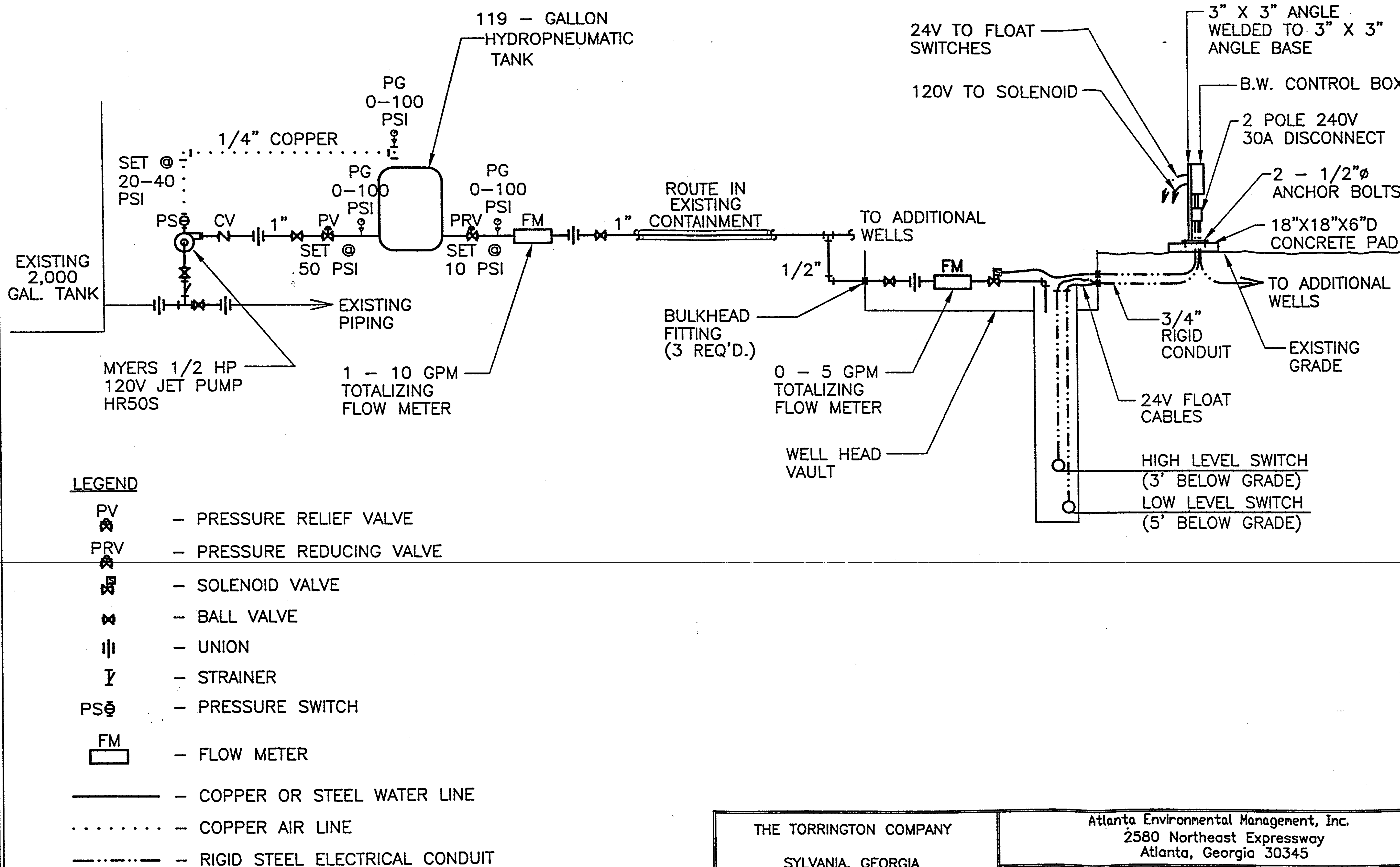


THE TORRINGTON COMPANY SYLVANIA, GEORGIA	Atlanta Environmental Management, Inc. 2580 Northeast Expressway Atlanta, Georgia 30345
PROJECT NO. 95-01-89 / DRAWN: GRP	FIGURE A-1
SCALE: NOT TO SCALE / DATE: MAY, 1995	TYPICAL INFILTRATION WELL CONSTRUCTION FOR GROUNDWATER REMEDIATION

ATTACHMENT A-2

INFILTRATION WELL SYSTEM PIPING SCHEMATIC



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THE TORRINGTON COMPANY

SYLVANIA, GEORGIA

PROJECT NO. 95-01-89	DRAWN: GRP
SCALE: NOT TO SCALE	DATE: APRIL, 1995

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FIGURE A-2

INFILTRATION WELL SYSTEM
PIPING SCHEMATIC