BEFORE THE
ENVIRONMENTAL PROTECTION AGENCY

13.4.4

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In the Matter of: :

GROVELAND WELLS SUPERFUND SITE :

PUBLIC HEARING ON FEASIBILITY :

STUDY :

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Tuesday,
July 9, 1985

Groveland Town Hall
Groveland, Mass.

The above-entitled matter convened, pursuant to notice, at 7 p.m.

BEFORE: MERRILL HOHMAN, DIRECTOR
Environmental Protection Agency
Waste Management Division
Region I

APPEARANCES:

On Behalf of U.S. Congressman Nick Mavroules:

Mr. Mike Greenstein

On Behalf of Water Commission for Groveland:

MS. JANET ANGELIS

On Behalf of Well Pollution Committee:

DR. F. JOHN OSBORNE

On Behalf of State Senator Nicholas Costello:

MR. THOMAS MOUGHAN

MR. HOHMAN: Welcome. I'd like to open this hearing. I'm Merrill Hohman. I'm the Director of the Waste Management Division for the New England Regional Office of the Environmental Protection Agency.

This is an informal public hearing to take comments on EPA's feasibility study for the Groveland Wells Superfund Site and a similar feasibility study done by Valley Manufactured Products for a portion of the area.

Let me begin by introducing a few of the people who are here. On my immediate left is Jim Ciriello from EPA, our Site Manager for the site. They love you Jim. Put that on the record. On my right is Jim Colman, he is the Acting Director of the DEQE Office of Incident Response and to his right is Bob Bois, DEQE Regional Engineer. At the door is Kathy Connolly from EPA's Office of Public Affairs, who is taking sign-ups. We also have Bruce Marshall who is the Assistant Site Manager from EPA. Sally Edwards who is our Enforcement Specialist for this particular site and John George from NUS, consultants for EPA on this site.

A couple of comments on the procedure we'll follow. This is an informal record, an informal hearing. But it's on the record and as you can see there is a record being made of this. A transcript will be available at EPA's office in the John F. Kennedy Building. And also here in the Groveland Public Library.

If anyone for any purpose wants your own personal copy, I would suggest you contact the stenographer directly at the end of the evening.

In terms of testimony, there are sign-up sheets at the table by the front door and if anybody wants to testify, if you sign up, I'll call you in the order you sign up. If someone has a particular problem with the time schedule please let Kathleen Connolly at the front desk know about that and we'll try to accommodate you.

Also I would ask if you do want to make testimony please limit yourself to 10 minutes. If you have lengthier material than that I suggest you summarize it and submit the detailed comments for the record.

This is not a question and answer session. It is an opportunity for you to tell us on the record what you think about the different options that EPA has proposed. And in addition, we will continue to accept written comments on the studies, as long as they are postmarked no later than July 17.

Before we begin I do have one announcement I want to make which may impact what some of you wish to say in your testimony and that is that EPA's Regional Administrator Mike Deland, tomorrow will formally announce what we call an initial remedial measure which is a fast tract clean-up action here in Groveland.

Let me just summarize the basis for that. First EPA's supply and demand report completed in June '85 indicated that the maximum daily demand cannot be met in Groveland relying on Station No. 3 alone. Second, on June 4 of this year the Massachusetts Department of Environmental Quality Engineering formally concurred with Groveland's Water Department's request that a water supply emergency does exist in Groveland. Third, the RIRFS, remedial investigation feasibility study that EPA just completed, indicates that the ground water at Station No. 1 at this time is free of contamination.

The various remedial options in that feasibility study include returning Well No. 1 to service at a reduced pumping rate. And it is EPA's opinion based on those facts that restoring Well No. 1 to limited service is consistent with the alternatives in our feasibility study and it's a cost effective remedy and the State of Massachusetts has concurred with that. Therefore, EPA is proposing to spend up to $400,000 to take the following actions:

Number 1 is to restore Station No. 1 to a useable condition by installing a necessary pump, piping and so forth.

Number 2 is to provide a portable granular activated carbon treatment system at Station No. 1 to assure that there is good drinking water quality from that pumping.

Number 3 is to hook Station 1 back into the public water supply for the town.

Number 4 is the installation of an appropriate monitoring wells around Station 1 to be sure that we are aware if contamination does begin to move to that Station.

The State of Massachusetts, as I said, we have consulted with them. They've agreed with us and they think it's an appropriate measure. The state has agreed that they will pay the 10 percent cost share required for remedial action and that they will assure us the long term operation maintenance of the site.

Before EPA actually obligates this money we will pursue our normal enforcement policy which is to give potentially responsible parties the opportunity to do the work instead of using money from the Superfund. That decision will be made I will expect in a relatively short period of time and then we'll be able to very quickly hire a consulting engineer and begin the design, fitting and so forth to put Well No. 1 back in operation.

There should be a news release in the Boston papers tomorrow formally announcing that action, but I thought we would announce it tonight because it may impact what people wish to say.

Now we have so far one person signed up who wishes to testify and that's Mike Greenstein, Chief District

Aide for U.S. Congressman Nick Mavroules. Mr. Greenstein.

MR. GREENSTEIN: Thank you Mr. Hohman, gentlem of the Board, ladies and gentlemen and officials of the tc of Groveland. The Congressman wanted me to present his statement on the Groveland Superfund site matter. As directed, the statement is directed at Mr. Ciriello and it reads as follows:

"My comments are brief and to the point. On be of the Selectmen and townspeople, I forcefully urge the U. Environmental Protection Agency to recommend and select th course of action which will work best to restore the wells Groveland and to both allocate and expend the sums necessa to implement that action.

"Because the public health and future economic viability of the Town of Groveland are inextricably linked to the restoration of the wells in question, I would sugge that a disproportionate emphasis on cost effectiveness in initially choosing the solution alternative may prove short-sighted in the long-term and detrimental to the best interests of the community.

"The selection of the most appropriate solutio is essential if both the wells and confidence of Groveland are to be restored.

Sincerely, Nicholas Mavroules, Member of Congress."

Here's the original, signed by the Congressman to Mr. Ciriello.

Thank you very much.

MR. HOHMAN: Thank you Mr. Greenstein. Janet Angelis, Water Commissioner for Groveland

MS. ANGELIS: That was indeed good news that we just received and I think it's consistent with what the Board of Water Commissioners is going to suggest to you tonight.

We are preparing a written statement and I'd like to make a few comments. As stated in your feasibility study there are two objectives in the Groveland Well site and that is restoring the Johnson Creek Aquifer and/or providing supplemental drinking water supply to Groveland.

We concur with these and we believe that the best remedial action we need both of them, not one or the other.

I believe the Well Pollution Committee is going to address the first objective and I'd like to limit my comments pretty much to the second objective because that after all is our own.

It's clear to us after reviewing the RIFS and the Supply/Demand Evaluation Report that Well No. 1 is, in fact, the best alternative to meet both our short term and our long term needs.

It has several advantages. One, we know the quality and quantity of the water in that area. One of the other alternatives for a supplemental supply, in none of those other alternatives do we have that much information. To try to develop a new well would be more costly to rely more heavily on Well No. 3 or the proposed 4 would have questions of water quality, potential problems that we don't know about both riverside and landside. And the water from Well No. 2 never on a par with the water from Well No. 1 and never was approved by DEQE for long-term term use, only for temporary use. We know that Well No. 2 will draw more contamination and will be far more costly to treat than the water coming from Well No. 1.

We suggest that pumping Well No. 1 with treatmen with adequate safeguards is the best solution. As I say bot from a short term and in the long term. We do want to make it clear to you that the Board of Water Commissioners will not put No. 1 on line without treatment. We want to be absolutely certain that they're monitoring wells, that that water is treated so that no contamination has any chance of entering our water supply system.

And of course in the long term if objective 1 is addressed that the Johnson Creek Aquifer is restored, then Well No. 1 may perhaps again be our primary water supply an we will have regained the use of a very important regional resource. Thank you.

MR. HOHMAN: Thank you. F. John Osborne, the Well Pollution Committee and Water Commissioner.

DR. OSBORNE: Yes, I'm speaking on behalf of the Well Pollution Committee. This primary objective is the cleansing of the aquifer.

Janet Angelis has discussed the issue of Stat No. 1 having returned the water supply. I wish to addres the issue of the restoration of the aquifer.

There are two aspects of this. One is the impact of recovery wells that we hope to have put on the aquifer and to the issue of the making sure the Valley Company Manufacturing plant that has shown signs of contamination -- that contamination is contained on their site.

The issue of the recovery wells -- we would l to see that the report written by George Allan for DEQE and was also a consultant for the town, his report is taken into the record and accepted. We believe this plan is adequate. The recovery wells are on town property. T will be no land taking. The issue has been thoroughly researched regards to the ability to recover contaminatio from the ground water by GZA and by George Allan's, Dufresne-Henry Company.

We would like to see that DEQE report entered into the record with the EPA study.

On the issue of the feasibility study of the Valley' screw ' there are seven alternatives that have been put forward. I would like to say on behalf of the town we're not interested in putting the company out of business, we, however, do want to be assured that we have the problem contained. .

Alternative 7 appears to be the cheapest one r Valley's point of view. It might not necessarily be the absolutely the most reliable. However, it might well tur out to be cost effective and successful. Therefore, we would like to suggest that alternative 7 could be accepte on behalf of the town provided that one of the alternativ 3, 4, 5 or 6 which involves limited excavation be adopted as a backup response. Thank you very much.

MR. HOHMAN: Thank you Dr. Osborne. Dr. Osbc you referenced the DEQE report. We have a copy of that. We have a copy of that in the office and we'll reference that into the record rather than seeing the whole thing from the transcript. Okay?

Thomas Moughan, Legislative Aide from State Senator Nicholas Costello's office.

MR. MOUGHAN: Mr. Chairman, ladies and gentle I'd like to enter this statement from Senator Costello in the record at the hearing. Rather than read the entire statement just paraphrase briefly that the Senator wishes to offer his support to the town of Groveland for its efforts to correct the well pollution problem insófar as he is able to support the state's need for additional funding if that is required. He urges the EPA to assist the town in reactivating Well No. 1 which EPA seems to b in line to do as well as clean the aquifer that supplies town of Groveland with this necessary water supply.. Than..

MR. HOHMAN: Thank you. We'll provide this to the stenographer and put it in the record. Does anyo else wish to make a statement or comment on the record? If there's no one else that wishes to comment I will remi you again that we will take written comments, postmarked on or before July 17 in considering the decision and agai if there is no one else that wishes to make a statement. Do either of the late arrivals wish to make a statement Do you wish to make a statement? Okay. If there's no on else then at this point I'll declare this public hearing closed.

(Whereupon, at 11:00 p.m., the hearing was concluded.)

REPORTER'S CERTIFICATE

This is to certify that the attached proceed

before ENVIRONMENTAL PROTECTION AGENCY

in the matter of:

GROVELAND WELLS SUPERFUND SITE
PUBLIC HEARING ON FEASIBILITY
STUDY.

were held as herein appears and that this is the origin

transcript thereof for the file of the Department

or Commission.

— —

Steve Ka

Official Reporter

DATE: JULY 12,1985

EXECUTIVE COURT REPORTERS
(301) 565-0064

. the request of
J Osborne, Town of Groveland,
this report is submitted as
part of the public hearing, 9 July 1985, [illegible]
transcript.

INTERIM REPORT ON

HYDROGEOLOGICAL INVESTIGATION

PHASE III

GROVELAND, MASSACHUSETTS

Submitted by:

DUFRESNE-HENRY, INC.
89 MAIN STREET
CONCORD, MA 01742

INTRODUCTION

This study has been initiated by the Mass. DEQE to update the data developed by the previous Dufresne-Henry, Inc. Phase II Report, dated April 2, 1984 with new information provided by EPA and its sub-contractor, ERT, Inc. of Concord, Mass. In addition, this study is to evaluate the available groundwater control techniques and removing and treating the contamination. The end result being a preliminary engineering report on the remediation of the aquifer in the Mill Pond/Johnson Creek area. The area of the study is delineated on Figure 1.

EVALUATION OF NEW DATA

A review was made of the following data supplied by ERT:

1. Groundwater Analytical Data (Draft)
2. Boring logs (Draft)
3. Plan of Trichloroethene - Round 2 and Round 3 (Figures 5-22 and 5-23) (Draft)
4. Cross-Section of Trichloroethene - Round 2 and Round 3 (Draft)
5. Seismic Refraction Survey by Weston Geophysical dated September 1984.

In addition ERT provided a base map based on recent aerial photography; the scale being 1"=200'.

The three sample rounds undertaken by ERT verify previous analysis in that the highly contaminated plume appears to terminate just north of DEQE-1. The migration of the plume in the overburden beyond this point appears to be minimal. A comparison between ERT's Round 2 samples (May-June 1984) and Round 3 (August 1984) show a reduction in contaminant levels in some of the northerly wells (i.e. DEQE-3 and DEQE-4) over this period. A similar reduction is noted in the highly contaminated portion of the plume emanating from the Valley Manufacturing property.

Figure 2 represents the contamination plume based on ERT's Round 3 samples. A comparison of this diagram with the like diagram included in our April 1984 Phase II Report (Figure 2), which was based on November 1983 sampling, indicates that the plume has not expanded. In fact the most recent samples indicate that the 1PPM contour has withdrawn toward the source of the contamination.

The ERT data verifies previous analysis from DEQE-1 that indicated the fractured bedrock has also been contaminated.

Using the well logs and seismic data supplied by ERT, we modified the ledge contour map from our Phase II Report. Figure 3 represents the revised ledge contours based on previous information as well as the new data. As would be expected, the new data allowed refinements to be made to the previous ledge contour map. Basically, however, the overall perspective shows a narrow, deep valley in the vicinity of Mill Pond widening out as one proceeds northerly; Station No. 1 and No. 2 being in the deeper portion down gradient from the contamination plume.

Based upon the review of the available information, additional field exploration was recommended.

FIELD EXPLORATIONS

The field exploration program for the design phase of the study consisted of the following:

a. Installation of eight monitoring wells

b. Field permeability testing at seven monitoring well installations

c. Completion of a four-hour pumping test at Well No. 4, north of Mill Pond.

d. Collection and headspace gas chromatograph screening of twelve water samples.

The locations of the monitoring wells installed during the current program, as well as previously existing installations, are presented on Figure 4, well installation logs are presented in the Appendix. Brief descriptions of field procedures are given in the following sections.

Well Installations

Drilling for the well installation program was conducted by GZA Drilling, Inc. of Canton, Massachusetts and Guild Drilling of East Providence, Rhode Island using both truck-mounted and tracked drilling rigs. Boreholes were typically advanced with either 3-inch or 4-inch casing via drive and wash procedures. Soil samples were collected at intervals ranging from 5 to 20 feet during the drilling process.

Soil samples collected by split spoon procedures were visually classified and logged by GZA's engineer on site. A portion of each sample was sealed immediately after collection in an 8-ounce glass jar which was stored in an ice-packed cooler for subsequent volatile organic analyses using a portable organic vapor analyzer (H-Nu Model PI-101). The H-Nu employs a photoionization detector to measure relative levels of volatile hydrocarbons (referenced to a benzene standard) in the headspace of the sealed jars. The analyses cannot be directly translated to quantitative concentrations of any compounds present, but are intended to be relative indicators of the degree of organic contamination. As such, the results are employed to assess the vertical distribution of hydrocarbon contamination within each borehole as an aid in siting groundwater sampling instruments.

Monitoring wells, consisting of 5- to 20-foot lengths of 1.5 inch diameter PVC wellscreen attached to flush-threaded PVC riser pipe, were installed within each borehole. Silica sand filters were installed around the wellscreens as the drill casing was withdrawn and bentonite-clay seals were then placed above the filter sand layers to minimize hydraulic communication between soil strata. Wells were typically installed at the base of the boreholes, at or near the bottom of the outwash aquifer. At selected locations 0.5 inch PVC screens were installed above the 1.5 inch screens in shallower portions of the aquifer isolated by bentonite clay seals. Wells were completed with concrete surface seals and locking steel protective casings. Details of each installation are presented on the well logs in the appendix.

Permeability Testing

Well point permeability tests were conducted on selected monitoring wells to evaluate the hydraulic conductivity of the outwash sands. Constant head (drawdown) and rising head (recovery) tests were conducted and analyzed in accordance with procedures outlined by Hvorslev (1949). Testing procedures involved either withdrawal of a quantity of water followed by measurement of the rate of water level recovery or pumping of the well at a constant rate until the water level stabilized to within ± 0.02 feet. Results of the testing are presented on Table 1.

Pumping Test

To refine estimates of hydraulic properties of the outwash sands in the vicinity of the proposed recovery area and evaluate potential induced infiltration from Mill Pond and Johnson Creek a pumping test was performed at Well No. 4. The test was originally scheduled to run for 24 hours but was terminated at 4.5 hours due to imminent overflow of the trench to which the discharge water had been routed. Well No. 4 was pumped at 22.4 gallons per minute using a centrifugal pump provided by the Groveland Water Department. Discharge was routed through 4-inch PVC pipe to a 6-foot wide by 60-foot long recharge trench situated east of Mill Pond.

Water levels within eight wells were monitored during the pumping and recovery periods including regular measurements at three sampling stations within multi-level well DEQE-1. Plots of time-drawdown data were prepared for five monitoring points and distance-drawdown information was plotted at two time intervals. Recovery readings from station DEQE-1-3 were also plotted in terms of residual drawdown versus recovery time ratio. Discussion of the pump test data analyses is presented later in this Report.

Groundwater Sampling and Analyses

Groundwater samples were collected by GZA from the newly installed monitoring wells and the previously existing wells for volatile organic analyses. A minimum volume of water equal to five times the standing volume of the well was purged by centrifugal pumping prior to collecting samples. Samples were collected with individual, precleaned stainless steel bailers with Teflon ball-check valves. Precleaned 40-milliliter glass vials with Teflon/silicone rubber septum caps were employed as sample containers. Vials were filled, sealed, and immediately packed in ice for shipment to the laboratory.

Samples were analyzed via headspace gas chromatograph techniques using a Century Systems Model OVA-128. Peaks observed on the GC chromatograms were tentatively identified by matching elution times with retention times of known compounds. Approximate quantification of concentrations was completed for trichloroethylene by correlating peak heights with those of standards prepared and analyzed in the laboratory. The data is presented in Table 2.

Hydrogeologic Analyses

A hydrogeologic assessment of the Mill Pond site was presented in our Phase II Report. It provided a preliminary evaluation of interception system design parameters. Supplemental field investigations completed during the present studies have permitted refinements of aquifer hydraulic characteristics. These refinements and their implications with respect to recovery well design are discussed in the following sections.

Hydraulic Properties

Estimates of aquifer hydraulic properties were developed based on analysis of pumping test data as well as information from well point permeability tests. Transmissivity and storage coefficient values were estimated from the pumping test water level data using techniques developed by Jacob and Boulton (Johnson, 1974 and Walton, 1972) for unconfined aquifers. The values summarized on Table 3 were derived from semi-log plots of time vs. drawdown, distance vs. drawdown, and residual drawdown vs. time ratio via the Jacob approximation of the Theis equation. Data from the distance-drawdown plots are believed to be the most representative of actual conditions. The average transmissivity estimated from distance-drawdown data is 1,100 ft^2/day. Using an average saturated thickness of approximately 40 feet at the Mill Pond site, a hydraulic conductivity of 25 to 30 ft/day is calculated.

The average storage coefficient from the distance-drawdown plots is 0.03 - a value on the lower end of the anticipated range for unconfined aquifers. The storage coefficient derived from the early time drawdown data for DEQE-1-3 is within the range expected for confined aquifers, possibly indicative of the first phase of a delayed yield condition. However, analysis of the data using a type curve method by Walton (1970) for a fully penetrating well in an unconfined aquifer assuming delayed yield produces anomalous results for transmissivity and storage coefficient.

This could be caused by the fact that the pumping well was only a partially penetrating well within an anisotropic aquifer (based on the layering observed in test boring samples). Thus conditions for the pumping test violate the assumptions of the analytical technique. The most appropriate analytical procedures for evaluating the data from the Mill Pond site would probably be solutions for unconfined, anisotropic aquifers considering the effects of partial penetration. (See for example Neuman, 1974 and Neuman, 1975). These solutions are not readily available in usable formats, however, and it was beyond the scope of the current study to develop such techniques.

In summary, the values of transmissivity and storage coefficient estimated via the Jacob method, though representative of a simplistic approach to a complex hydrogeologic scenario, are believed to be reasonable approximations for use in design for the recovery wells. It is noted that hydraulic conductivity values derived from pump test transmissivities correlate well with the results of well point permeability testing. Further refinement of hydraulic characteristic estimates can be provided only through extended duration pumping tests (three to five days) which may require installation of additional pumping and recharge facilities. Three dimensional computer flow modeling would probably be required for evaluation of such testing due to the limited applicability of available analytical techniques.

Induced Infiltration Analysis

Analyses directed at quantifying the amount and rate of induced infiltration from Johnson Creek and Mill Pond during the pumping test were conducted using techniques outlined by Walton (1970) and Rorabaugh (1956). Results of these evaluations reveal anomalously high values of induced infiltration, in excess of 50 percent of the total pumpage. It is noted that the available analytical solutions for induced infiltration assume isotropic aquifer properties and fully penetrating wells - two assumptions not satisfied by actual conditions. In qualitative terms, screening of the well only at the base of the aquifer coupled with substantially higher horizontal than vertical hydraulic conductivities, will reduce induced infiltration significantly below calculated values. It is believed that the actual contribution of induced infiltration will be fairly small (e.g. <10 percent of total pumpage) for the pumping scenario simulated during the pumping test.

Test Pits

In addition to constructing a trench for the pumping test, we had a backhoe excavate to determine if there was a buried pipe in the vicinity of the Mill Pond. The excavation was made near a 30-inch riser pipe south of the gravel road to the dam. A 48-inch steel pipe was uncovered 7 feet below the top of the 30-inch riser. The pipe was filled with sand and had no trace of water. The alignment indicates that it could be a potential route for groundwater to flow from the pond to the tributary that appears near DEQE-3 where surface water was sampled during the Phase II Study (referred to as S-6) and indicated TCE of 580 ppb. Additional investigation is warranted near this 48-inch pipe to determine if indeed it is a route for plume migration.

REMEDIAL TECHNOLOGIES

Groundwater control technologies can be broadly divided into three primary categories:

a) Physical containment
b) Containment by hydraulic manipulation
c) Groundwater extraction

Containment strategies attempt to achieve remedial objectives by reducing contaminant flux to a point where dilution by ambient groundwater or surface water lowers pollutant concentrations to acceptable levels. These alternatives differ from groundwater extraction in that they make no direct effort to remove contaminants from the environment. The latter strategy entails removal of contaminated groundwater for either off-site disposal or treatment on-site. For the great majority of contaminant plumes encountered, the volumes of groundwater involved preclude off-site disposal as a cost effective alternative.

Physical containment alternatives can consist of impervious surface barriers to minimize infiltration of precipitation or a combination of a surface cap and vertical subsurface barriers designed to retard groundwater flow. Surface caps are constructed by placing either an impermeable synthetic membrane or a layer of relative impervious soil (i.e., clay) over a specially prepared surface graded to promote runoff. The cap is then covered with a blanket of granular material to facilitate drainage followed by a shallow-rooted vegetative cover to minimize erosion and protect the integrity of the liner.

Subsurface barrier technologies include the following:

a) Slurry trench cutoff walls
b) Thin wall cutoffs
c) Sheet pile walls
d) Grout curtains

In terms of constructability, reliability, and durability, a slurry trench cutoff wall is deemed to be the most appropriate barrier technology for the conditions encountered at the Groveland site. Slurry trench cutoff walls are constructed by excavating a narrow (3 feet wide) vertical trench through unconsolidated strata to bedrock using a bentonite slurry to stabilize the excavation wells. The trench is then backfilled with a soil-bentonite or cement-bentonite mix, creating a low permeability wall around the contaminated zone. For both economic and performance-related reasons, soil-bentonite backfills are generally preferable to cement-bentonite mixes.

Cutoff walls are almost invariably used in conjunction with surface caps, although partial cutoff walls without surface barriers are occasionally used to redirect groundwater flow. Slurry cutoff wall/surface cap containment do not eliminate discharge of contaminants from the contained zone; rather they are designed to reduce the flux to acceptable levels. Depending upon the quality of the bedrock which forms the base of the containment, additional measures to control leakage--such as a grout curtain or hydraulic manipulation within the contained area--may be required.

Hydraulic manipulation is a form of containment which relies on control of piezometric heads via groundwater pumping and recharge as opposed to physical barriers. In its most commonly used form, hydraulic containment involves pumping from the downgradient end of the contaminant plume with recharge near the upgradient edge, creating a recirculation effect. To minimize leakage of contaminants from the zone of contained groundwater, a surface barrier is usually recommended in conjunction with hydraulic manipulation. This form of containment is usually employed alone only as an interim remedial measure to temporarily retard contaminant migration. Long-term application would require essentially permanent operation and maintenance requirements to sustain effective containment. For this reason, hydraulic manipulation would typically be used with groundwater treatment as a final remedial alternative.

Groundwater extraction would involve removal of groundwater via pumping wells situated within the most highly contaminated zone(s), followed by on-site treatment. After treatment to acceptable levels, the effluent is discharged to surface waters or back to the ground. Key variables associated with groundwater extraction alternatives include placement of the pumping wells, required withdrawal rates, and necessary "turnover" times for aquifer renovation. Depending upon the nature and cost of the required treatment train, clean water exclusion via physical barriers (surface cap and/or cutoff wall) can represent a cost-effective addition to the groundwater extraction alternative.

DEVELOPMENT AND EVALUATION OF REMEDIAL ALTERNATIVES

Based on the technologies identified in the preceding section, a limited number of potentially appropriate remedial alternatives tailored specifically for the Groveland site have been developed. During this development, a number of assumptions were made regarding the appropriateness of remedial technologies.

First, a surface barrier alone as a containment alternative was eliminated because of this option's ineffectiveness in dealing with the existing groundwater contamination. Second, a soil-bentonite slurry cutoff wall with a surface cap was selected as the most appropriate containment technology and was considered both with and without a grout curtain. Third, hydraulic manipulation either alone or in conjunction with physical containment was ruled out due to excessive maintenance requirements and limited long term benefits. Finally, it was assumed that the substantial cost of a clean water exclusion system in comparison with anticipated treatment costs, rendered this technology impractical.

Remedial technologies were thus assembled into the following three alternatives:

1. Surface cap and slurry cutoff wall - install bentonite slurry cutoff wall around perimeter of plume with either clay cap or synthetic liner.

2. Surface cap, slurry cutoff wall, grout curtain - Alternative 1 with a 20 foot grout curtain added at base of wall.

3. Groundwater extraction and treatment-pump groundwater from two wells situated north of Mill Pond, treatment and discharge to surface water.

In terms of achieving remedial objectives (i.e., minimizing discharge of contamination from the concentrated TCE plume to the main body of the aquifer) Alternative 1 must be considered questionable. Bedrock coring data and results of on-site permeability testing reported by ERT suggest that the rock in the vicinity of the Mill Pond site is variably fractured and, in places, highly permeable (for example, ERT reports a hydraulic conductivity of 68 ft/day in rock at well ERT-17). Thus, while a cutoff wall will greatly reduce flow through overburden strata, it is possible, if not likely, that substantial leakage will occur from the contained area through the fractured rock at the base of the wall. Previous studies by GZA at a site exhibiting similar stratigraphy suggest that hydraulic gradients in rock below the wall will increase and a significant percentage of the original ambient flow may leak from the site below the cutoff wall. The potential for leakage of this magnitude renders the cutoff wall option of dubious effectiveness; thus, it has been eliminated from further consideration.

Both of the remaining alternatives can potentially address the remedial objectives in an adequate fashion but they differ significantly in terms of implementability and cost. The slurry cutoff/grout curtain option would require a massive regrading effort in the Mill Pond area, including filling of a number of acres of wetland and rerouting of Johnson Creek. In addition, land acquisition of private property would be necessary since the plume area extends beyond the town property. The extent of town owned land is shown on Figure 2 and 3. Acquisition of various local and state permits would be required along with an estimated minimum four month construction period. It is estimated that approximately one year would elapse between authorization of funding and completion of the project. The estimated total cost of this remedial option would be approximately $2,000,000; excluding any land acquisition costs.

The groundwater extraction and treatment alternative would require construction of pumping wells, a treatment plant, and associated piping. Permits would be required for effluent discharge. It is estimated that the system could be operating within six months of authorization of funding. The total cost of the groundwater extraction/treatment alternative is discussed hereinafter.

Comparison of the two alternatives in terms of environmental benefits, implementability, and costs reveals that the groundwater extraction and treatment option is clearly superior. This approach is, therefore, the recommended alternative for the Mill Pond site.

RECOVERY WELL DESIGN

The main design parameters for the recovery/system are as follows:

A. Number of Wells

B. Well siting (areal location)

C. Screened interval

D. Pumping rates

Items A, B and C are governed more by considerations such as cost, contamination distribution (both areally and vertically), and access constraints than by hydraulic factors. Refinements in contamination distribution interpretations facilitated by data from the present study indicate that the leading edge of the 10 ppm TCE plume lies somewhere in the vicinity of wells DEQE-1 and DEQE-5, near the base of the aquifer. Data from wells DEQE-4 and DEQE-6 suggest that the plume begins to rise through the aquifer and discharge to Johnson Creek downgradient of this location. Interception is therefore recommended in the immediate vicinity of wells DEQE-1 and DEQE-5, with screened intervals at the base of the aquifer.

Hydraulic considerations suggest that multiple wells would be recommended over a single pumping center to minimize induced infiltration. However, given the limited width of the plume, it is difficult to justify more than two interceptor wells based on cost-effectiveness. Therefore, the recommended interception system would consist of two deep (approximately 65 feet) pumping wells installed at locations shown on Figure 4, screened over the bottom 10 feet of the outwash aquifer. Wells would consist of 8-inch diameter PVC wellscreen and riser installed in 18-inch minimum diameter drill holes and surrounded by a gravel packed material.

Pumping rates at each well would remain as the critical variable for the interception system. It is desired to select pumping rates which would maximize recovery of the contaminant plume while minimizing induced infiltration. Based on the limited analyses conducted during the current studies, a flow rate of 15-20 gpm per well is considered appropriate for these objectives. It is recommended that verification of the effectiveness of this pumping rate be provided during initial operation of the proposed system via three dimensional computer flow modelling and field monitoring.

EVALUATION OF ALTERNATIVES FOR TREATING EXTRACTED GROUNDWATER

There are several general types of treatment available for the contaminants present at this site.

1. Synthetic Resin Adsorption

   Synthetic resins have been manufactured to adsorb particular contaminants. According to EPA Research and Development Report EPA-600/S2-82-027, dated September, 1982, Ambersorb XE-340 by Rohm & Haas has been used to successfully remove chlorinated solvents in the ppb range. There is no information available on their use with contaminants at concentrations in the ppm range.

   Capital costs for an installation using Ambersorb in a pressure vessel are high. Operating costs are high due to the use of an electric steam generator needed to regenerate the resin. In addition, the collection of condensate and the separation of the organics for disposal create operational problems. According to a Rohm and Haas representative, Ambersorb is no longer manufactured due to lack of a market. The recommended resin is now Amberlite XAD Series. Due to a lack of experience with its use and similar operating problems, we do not feel it is appropriate for this site.

2. Granular Activated Carbon (GAC)

GAC is a proven effective technique for removing chlorinated solvents from water. Using pressure tank adsorbers, GAC has reduced a wide range of contaminants to the low ppb range. Experience has shown that the types and levels of contaminants at this site are amenable to adsorption and removal by GAC.

3. Aeration

The efficiency of aeration depends on the relative ease by which the contaminants can be driven from the liquid phase to the gas phase. Volatile compounds with low solubility in water are most easily stripped from water. Chlorinated solvents, such as those at this site are amenable to air stripping.

Air stripping is commonly accomplished by the following methods:

<u>Cascade aeration</u>: Contaminated water is flowed over land or artificial steps; although inexpensive, efficiency is poor.

<u>Spray aeration</u>: Contaminated water is run through a nozzle and sprayed onto land or a pond. It requires a very high pressure pump for the nozzle and large unused area. Operational problems due to freezing could develop during winter months.

<u>Diffused aeration basin</u>: A large reservoir is constructed with provisions for bubbling air through the contaminated water. This is used primarily in industrial plant operations, requires large air supplies, a large area, and considerable equipment. Efficiency of removal is less than the next method.

Packed towers: Contaminated water is trickled through a cylindrical column filled with special polypropylene packing which provides a large surface area. A blower at the bottom of the tower forces air up through the falling water. Since the air and water flow is easily controlled and the flow is contained, this method is very efficient and requires no large land area.

The techniques for packed towers has been developed over the last 10 years as more groundwater contamination sites were discovered. The procedures and construction methods have made packed towers the most efficient aeration technique for removal of volatile organics.

For efficient design of a packed tower, key parameters should be obtained by a pilot plant test. In January of 1983, a pilot study conducted by Oil Recovery Systems under contract to the Town, indicated that the contaminants at Well No. 4 could be reduced by 99 percent at an air to water ratio of 10:1(CFM/GPM). At the time of this pilot test, the total volatile organic level was in the 20 ppm range. Although the concentration has increased significantly to about 40 ppm, similar removal efficiency can be obtained. However, this level of treatment from a single unit will not be sufficient to meet the NPDES Permit. It will be necessary to install two aerators in series to meet the established criteria.

SELECTION OF TREATMENT

Activated carbon and air stripping are both widely used for treating contaminated groundwater. The choice of the appropriate technique depends upon several criteria including desired effluent and economics. Since both have a track record of achieving the desired effluent criteria to meet the NPDES Permit, a cost comparison between the two is needed.

Figure 5 shows a schematic of each of the following treatment options. The following comparison addresses the individual treatment process itself, not the interceptor wells and collection system which would be the same for each treatment alternative.

1. Granular Activated Carbon

The carbon usage rate is a function of the contamination level. For levels in the ppm range, the literature indicates a usage rate between 4-12 lbs. GAC per 1000 gallons of water treated.

The treatment system would consist of a pressure vessel containing 20,000 pounds of GAC, which is a full truckload.

Using a value of 4 lbs/1000 gallons, a total of 5 million gallons of water could be treated; with a pumping rate of 40 gallons per minute (GPM), the GAC would last about 87 days. With a cost of $0.90 per pound, the replacement cost for GAC would be $75,600 per year.

Using a value of 12 lbs/1000 gallons, a total of 1.67 MG of water would be treated before replacement. The GAC would need to be replaced once a month. The annual cost would amount to $227,000.

Costs for heating the building enclosure which house the GAC adsorber would be minimal since the temperature need only be 50°F.

Capital costs are estimated as following for a single adsorber:

Adsorber & GAC	$75,000
Piping, foundation & Installation	12,000
Enclosure for Adsorber (incl.foundation)	37,000
Fence & Site Work	4,000
TOTAL:	$128,000

2. Packed Town Air Stripper

Packed tower air stripping economies can be obtained if the treatment process can "stand alone". If air emission standards require a vapor phase adsorption unit, the cost effectiveness of the treatment process is adversely affected. In fact, the vapor phase adsorption unit could be more expensive than the air stripper itself. In this case, an air pollution control device is not required according to DEQE Air Quality Section. (See letter dated May 1, 1985).

Because of the high levels of total volatile organics (TVO) in the raw water (40 ppm) the effluent from a single air stripper with 99 percent removal efficiency would exceed the NPDES Permit. Therefore, two towers in series would be necessary. The operating costs associated with such a system would be mainly power costs. This would be two 2HP blower motors and the 1-1/2HP pump and motor to transfer the water from the first tower to the second. Assuming continuous operation of all units and the current rates charged by the Groveland Light Department, this annual cost is estimated at $3,000. This is based on the Small Power Class B rate. There would be no demand charge. For comparison sake, this only includes the treatment process not the extraction process (i.e., submersible pumps).

Capital costs are estimated as follows:

Packed tower stripper (2) & blowers	$40,000
Building for blowers	11,000
Underground sumps (2) (2000 gal)	8,000
Piping	5,000
Sump Pump	4,000
Fence & site work	2,000
TOTAL:	$70,000

For both the GAC and aeration option, it would be necessary for the Groveland Light Department to install 3-phase power to the site. The cost of this installation is estimated at $3,000.

3. Aeration and GAC

Replacing the second air stripper with a GAC adsorber would not significantly reduce the operating cost of dual aerators. The cost savings of eliminating the second blower would be outweighed by the replacement cost of the GAC. Based on published results and the writer's experience with a GAC adsorber in Acton, an average carbon usage rate of 0.5 lbs. carbon per 1000 gallons of treated water is typical for TVO concentration in the 300-400 ppb range. The GAC would have to be replaced every two years, which is equivalent to approximately $9,000 per year.

The capital cost would be increased significantly due to the cost of the adsorber, GAC, piping and foundation. In addition, the size of the building used for the dual aerators would have to be increased to house the adsorber.

In terms of technology, capital and operating cost, and effect on the environmental, alternative 2 consisting of two packed towers in series is the most feasible option.

The towers would be approximately 30 inches in diameter and have 16 feet of packing; a 2HP blower would be required for each.

The following is a description of how the recommended system would function:

The water from each interceptor well would be pumped through manifold pipe to the first tower. It would exit the tower into an underground concrete sump. A low lift vertical pump would lift the water to the top of second tower where it would fall into a second sump. The treated water would exit the second sump through an overflow pipe which would carry the water by gravity to the brook at the bottom of the dam spillway. The operation of the vertical pump in the sump would be controlled by water level probes located in a "stilling well" in the sump. The blower to tower number 1 would be activated by the submersible pump in either interceptor well. The blower to tower number 2 would be started simultaneously with the sump pump.

GROUNDWATER DISCHARGE

The recommended location of the proposed treatment facility is in the vicinity of DEQE-1 on town owned land.

Available discharge points for the effluent from the air stripper include the town's sewer system and surface water bodies.

The sewer system option was removed from consideration because of the cost associated with installing approximately 3000 feet of gravity sewer to reach the nearest point of the system. The town has no plans to extend the sewer system to the Washington Street area in the foreseeable future.

The potential surface water discharge points are Johnson's Creek and the Mill Pond. Since the town does not own the Mill Pond, approval would need to be obtained from the two owners. On the other hand,the town does own a significant amount of land north of the Mill Pond dam. The most appropriate discharge point would be to Johnsons Creek at the base of the spillway. The ground elevation at this point is approximately 10 feet lower than the ground at the treatment site. This difference in elevation would enable the effluent to flow by gravity to Johnsons Creek. This discharge point would be less noticeable to the public, thereby keeping the "curious nuisance" factor to a minimum.

The current NPDES Permit MA0102661 is still suitable for the proposed discharge and does not need to be amended. The effluent standards established in the Permit are still viable. The

Permit, which was issued in April of 1983 terminates one year after start of discharge. A new Permit would then need to be issued. In addition, the Permit expires 5 years after date of issuance. A copy of the final site plan would have to be approved by the EPA and the Division of Water Pollution Control.

As stated earlier, the Air Quality Section of the DEQE has determined that the expected air discharge for the packed towers will not exceed current established standards.

Because of the location of the site relative to surface water, it will be necessary to obtain a permit from the Groveland Conservation Commission under the Wetlands Protection Act (Chapter 131, Sec. 40). Based on our experience on December 6, 1982 when we attended a hearing with the Conservation Commission on behalf of the town for permission to undertake similar activities, we do not anticipate a problem in receiving approval from the Conservation Commission.

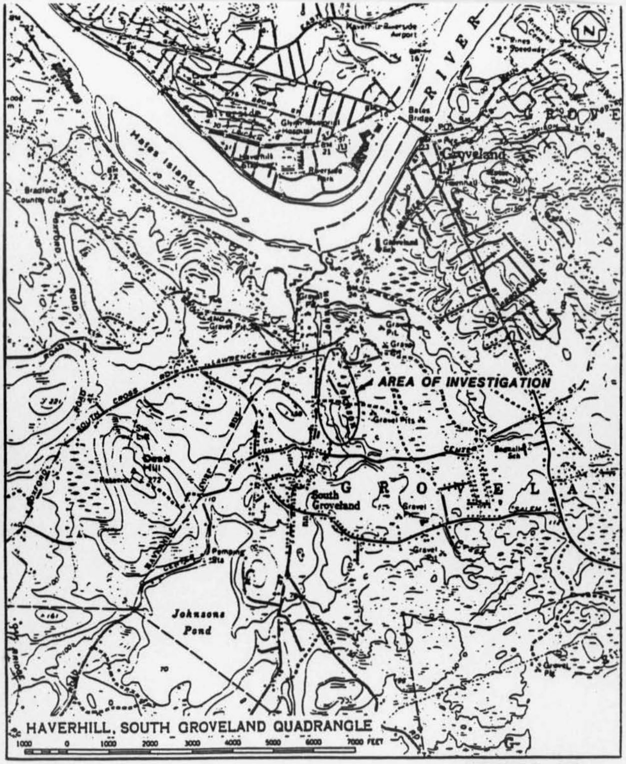
It will also be necessary to obtain a Building Permit from the Town for the proposed treatment facility.

DURATION OF RECOVERY/TREATMENT PROCESS

The anticipated duration of the groundwater recovery/treatment process can be estimated using Darcian flow theory and making a number of simplifying assumptions. First, it must be assumed that the suspected source of the contamination (within the Valley Screw property) will be terminated. It is our understanding that the DEQE is addressing this issue with the Owner. It can then be assumed that the contamination will migrate at the same rate as the ambient groundwater -- a reasonable assumption considering TCE's adsorption characteristics. The time of travel between the source of the contamination and the recovery point can then be calculated by dividing the distance along a flow line by the calculated transport velocity. Using a flow distance of about 1100 feet and transport velocity of 1.5 feet/day (see Phase II Report) a travel time of approximately two years is calculated.

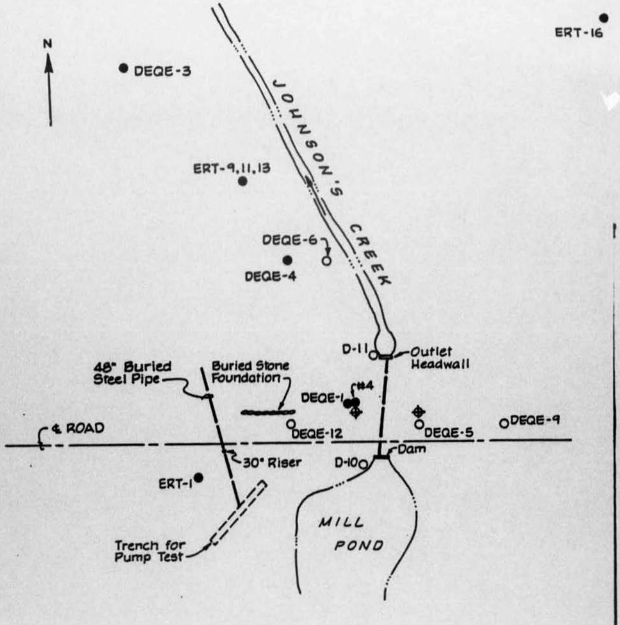
The travel time computed represents the approximate time required for one "flush" of the recovery system. Based on studies by GZA and others, it is anticipated that 2 to 3 flushes of the system will be required to reduce contaminant levels from the present 10 ppm to the proposed standard of 100 ppb for TCE. Total pumping time is therefore estimated to be four to six years. Monitoring of the actual extraction and treatment system will permit this estimate to be refined.

FIGURES



SITE PLAN
FIGURE 1

Dufresne-Henry



LEGEND

- ○ NEW MONITORING WELLS
- ● EXISTING MONITORING WELLS
- ⊕ PROPOSED RECOVERY WELL LOCATIONS

FIGURE 4

Client No.		SKETCH OF WELL LOCATIONS SCALE: 1" = 100'	DH Dufresne-Henry Inc. A
Proj. Mgr.			
Date ,			

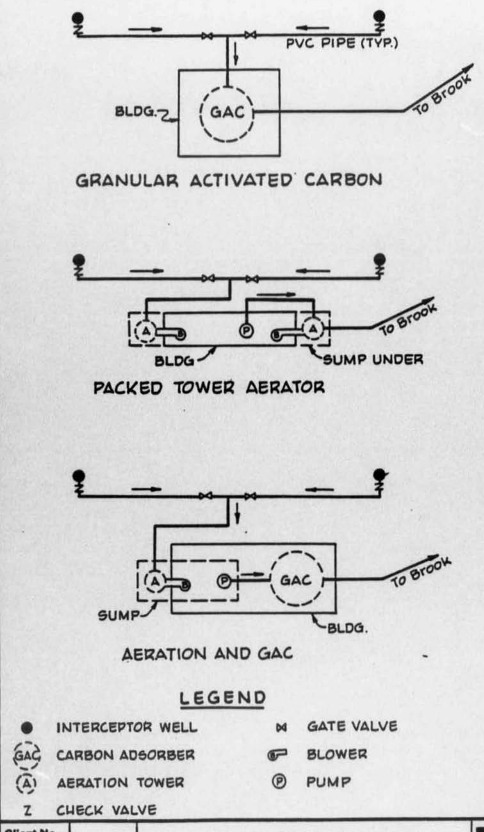


FIGURE 5

Client No.		SCHEMATIC OF TREATMENT OPTIONS N.T.S.	DH Dufresne-Henry Inc.
Proj. Mgr.			
Date			A

TABLES

TABLE 1

SUMMARY OF WELL POINT PERMEABILITY TESTING RESULTS

Well Number	Test Type	Hydraulic Conductivity (ft/day)
#4	Constant Head	74
#4	Rising Head	26
DEQE-4-2	Constant Head	26
DEQE-5-2	Constant Head	46
DEQE-6-3	Constant Head	3
DEQE-6-3	Rising Head	3
DEQE-7	Constant Head	210
DEQE-8	Rising Head	9
DEQE-9	Constant Head	180-280

TABLE 2

GC SCREENING RESULTS

Well Number	Date Stamped	Estimated TCE Concentration (ppm)
DEQE-1-3	3/14/85	9
DEQE-1-4	3/14/85	18
DEQE-4-2	3/14/85	1.5
DEQE-5-2	3/14/85	0.2
DEQE-5-2	5/1/85	14
DEQE-6-1	3/14/85	1.5
DEQE-6-2	3/14/85	9
DEQE-6-3	3/14/85	1.5
DEQE-7	5/1/85	0.4
DEQE-8	5/1/85	20
DEQE-9	5/1/85	0.2
DEQE-12	5/1/85	<0.05

NOTES:

1) GC screening with Century Systems Model OVA-128 portable GC using heated headspace procedures

2) Tentative identification of trichloroethylene made by matching peak elution times with retention times of standards.

3) Reported concentrations are approximate only.

TABLE 3

PUMPING TEST DATA SUMMARY

Well No.	Method of Analysis	Transmissivity GPD/FT	Transmissivity FT^2/DAY	Coefficient of Storage
D-1-3	Jacob 1	4,200	560	0.006
D-1-3	Jacob 2	19,700	2,630	--
D-1-3	Recovery	4,930	660	--
--	Distance-Drawdown (10 min.)	8,330	1,100	0.017
--	Distance-Drawdown (270 min.)	7,885	1,050	0.04

APPENDIX

The Commonwealth of Massachusetts

Department of Environmental Quality Engineering
Metropolitan Boston - Northeast Region
5 Commonwealth Avenue
Woburn, Massachusetts 01801

S. RUSSELL SYLVA
Commissioner

935-2160

May 1, 1985

DuFresne-Henry, Inc.
89 Main Street
Concord, MA 01742

RE: GROVELAND - Metropolitan Boston/
Northeast Region - Airstripping
off of Washington Street
Groveland, MA 01830
FINAL APPROVAL

Attention: Mr. George R. Allen

Gentlemen:

The Metropolitan Boston/Northeast Region of the Department of Environmental Quality Engineering, in reply to the request contained in a letter from DuFresne-Henry, Inc. received on March 21, 1985, has reviewed the information relative to the proposed aeration tower to be installed on Town of Groveland property located off of Washington Street in Groveland, Massachusetts.

A review of the submitted information by Department engineers indicates that the proposed aeration tower will be used to strip volatile organic compounds from contaminated groundwater. This Region has determined that the expected emissions from, and the projected impact of this project are acceptable under existing Departmental guidelines, and hereby grants FINAL APPROVAL for the airstripping unit as submitted.

Should you have any questions concerning this matter, please do not hesitate to contact Mr. Michael J. Maher, Air Quality Section Chief, at 5 Commonwealth Avenue, Woburn, Massachusetts 01801.

Very truly yours,

Richard J. Chalpin

Richard J. Chalpin
Acting Regional Environmental Engineer

RJC/Ewl/pd

cc: Board of Health, Town Hall, Groveland, MA 01830
DAQC, One Winter Street, Boston, MA 02108 - Implementation Branch

GOLDBERG-ZOINO & ASSOCIATES, INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT Aquifer Contamination Study Groveland, MA	REPORT OF BORING NUMBER GEOE#5 SHEET 1 OF 2 DATE 2/22/85 FILE A-1897.1

BORING CO. GZA Drilling, Inc.
FOREMAN A. Johnson
GZA ENGINEER M. Plummer/mlb

BORING LOCATION
GROUND ELEV.
DATE STARTED 2/22/85 DATE ENDED 2/25/85

CASING

SIZE: HW (4")
HAMMER: 300 lb.
FALL: 24"

SAMPLER

TYPE: 24" Split Spoon OTHER:
HAMMER: 140 lb.
FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME

DEPTH	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRTA. CHG. and GEN. DESC.	EQUIPMENT INSTALLED	FIELD TESTING 1	RMKS.
								Protective Casing & Lock		2
10		S-1	24/18	10-12	2-1 1-1	Loose, brown, fine SAND, trace Silt.			neg.	
								12-14'		
20	26	S-2	24/4	20-22	4-4	Loose, brown, fine SAND, trace Silt.			neg.	
	24				3-4					
	28									
	29									
	27									
	53									
	58									
	80									
	72									
	80									
30	62	S-3	24/5	30-32	6-8	Medium dense, brown, fine SAND, trace Silt.			0.3	
	64				11-14					
	67									
	61									
	77									
	83									
	86									
	77									
	81									
40	92									3
	77	S-4	24/6	40-42	6-10	Medium dense, brown, fine SAND, trace Silt			0.2	4
	70									
	80									
	79									
	84									
	52									
	61									
	63							Bentonite Seal 46-48'		
	59									
	55									

REMARKS:

1. Field testing results represent total organic vapor levels, referenced to a benzene standard, measured in the headspace of sealed soil sample jars using an HNu Model PI-101 photoionization analyzer. Sample injection size was 10 cc. Results in parts per million (ppm). ND indicates reading less than 1 ppm. Testing was completed at GZA's Newton laboratory.
2. Augered to 10' then to 20', into running sand, removed augers and drove casing.
3. Dropped spoon and rods penetrated first foot of "wash".
4. Washed ahead of casing to 50' and rewashed following casing.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT: Aquifer Contamination Study, Groveland, MA

REPORT OF BORING NUMBER [illegible]
SHEET 2 OF [illegible]
DATE 2/22/85 FILE [illegible]

BORING CO. GZA Drilling, Inc.
FOREMAN A. Johnson
GZA ENGINEER M. Plummer/mlb

BORING LOCATION See location plan
GROUND ELEV.
DATE STARTED 2/22/85 DATE ENDED 2/25/85

CASING
SIZE: HW (4")
HAMMER: 300 lb.
FALL: 24"

SAMPLER
TYPE: 24" Split Spoon
HAMMER: 140 lb.
FALL: 30"
OTHER:

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME

DEPTH	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	SAMPLE DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRATA CHG. and GEN. DESC.	EQUIPMENT INSTALLED	FIELD TESTING	RMKS.
50	71	S-5	24/12	50-52	5-12	6" of gray, CLAY & SILT, trace fine Sand.				5
	62				17-17	6" of medium dense, brown, fine to coarse SAND, trace Silt, trace fine Gravel.	FINE TO COARSE SAND		6.2	
	57									
	66									
	71									
	75									
	62							1½" PVC Slotted Wellscreen 55-65'		
	70									
	73									
	77									
	66	S-6	12/8	60-61	15-18	Medium dense, brown and grey, fine to coarse SAND, trace fine Gravel, trace Silt.			2.0	6
	72									
	80									
	86									
60	95						65.0'			
		S-7	24/6	65-67	38-18	Very dense, gray-brown, fine to coarse SAND and angular fine to coarse GRAVEL, trace(+) Silt.	TILL		25.0	7
					35-31	Bottom of boring at 67 feet.				

REMARKS:

5. Washed ahead of casing to 60 feet.
6. Soil came up in casing at 1 foot, driven through and sampled 2 feet, blowcounts noted for second foot only.
7. Rotary bit pressure indicates denser stratum at 65'.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG-ZOINO & ASSOCIATES, INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT: Aquifer Contamination Study, Groveland, MA	REPORT OF BORING NUMBER [illegible]; SHEET 1 OF 2; DATE 2/26/85; FILE A-1497.1

BORING CO. GZA Drilling, Inc.
FOREMAN A. Johnson
GZA ENGINEER M. Plummer/mlb

BORING LOCATION
GROUND ELEV.
DATE STARTED 2/25/85 DATE ENDED 2/26/85

CASING
SIZE: HW (4")
HAMMER: 300 lb.
FALL: 24"

SAMPLER
TYPE: 24" Split spoon OTHER:
HAMMER: 140 lb.
FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME

DEPTH	CAS. BL./FT.	SAMPLE NO.	PEN./REC.	SAMPLE DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRATA CHG. and GEN. DESC.	EQUIPMENT INSTALLED	FIELD TESTING	RMKS.
								Concrete Seal 0-2 feet		1
								½" PVC Screen 8-10 feet		
10	7							Bentonite Seal 12-14'		2
	11									
	13									
	13									
	17									
	28									
	33									
	53									
	43									
	47									
20	38	S-1	24/6"	20-22	9-13	Medium dense, brown, fine SAND				
	42				11-10	and fine to coarse GRAVEL, trace Silt			4.0	
	47									
	35							½" PVC Piezometer Tube 0-25'		
	43									
	49									
	61									
	64									
	69									
30	71									
	154									
	87									
	72									
	56									
	55									
	49									
	71									
	73									
	75									
	59									
40	100							Bentonite Seal 40-42'		3
	121									
	100									
	98									
	72							1½" PVC Slotted Wellscreen 45-55'		
	72									
	69									
	81									
	92									
	100									

REMARKS:
1. See note 1 on DEQE #5 boring log for explanation of field testing results.
2. Augered to 10', removed augers and drove casing down.
3. Casing washed to 40' and spoon dropped, 4' of sand up in casing, no sample taken.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG-ZOINO & ASSOCIATES, INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT: Aquifer Contamination Study, Groveland, MA	REPORT OF BORING NUMBER GEOE-4; SHEET 2 OF 2; DATE 2/26/85; FILE A-1897.3

BORING CO.	GZA Drilling, Inc.	BORING LOCATION	see location plan
FOREMAN	A. Johnson	GROUND ELEV.	
GZA ENGINEER	M. Plummer/mib	DATE STARTED	2/25/85
		DATE ENDED	2/26/85

CASING		SAMPLER	
SIZE:	HW (4")	TYPE:	24" Split Spoon
HAMMER:	300 lb.	HAMMER:	140 lb.
FALL:	24"	FALL:	30"
		OTHER:	

GROUNDWATER READINGS			
DATE	DEPTH	CASING AT	STABILIZATION TIME

DEPTH	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRATA CHG. and GEN. DESC.	EQUIPMENT INSTALLED	FIELD TESTING	RMKS.
50	122									
	72									
	68									
	90									
	93						56.5'			
	92	S-2	24/6"	55-57	28-28	Very dense, brown, fine to medium			7.0	
	112/6				57-31	SAND and GRAVEL, little(+) Silt.				
						Bottom of boring at 57.0 feet.				
60										

REMARKS:

4. Casing blow counts indicate stratum at 56.6, casing bumped back to 55' and monitor well installed.
5. Four bags of filter sand to surround screen 45 to 55 feet.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG·ZOINO & ASSOCIATES, INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT: Aquifer Contamination Study, Groveland, MA

REPORT OF BORING NUMBER DEQE-7
SHEET 1 OF 1
DATE 4/30/85 FILE 3-1837.1

BORING CO. Guild Drilling Co.
FOREMAN M. Fisher
GZA ENGINEER G. Draper

BORING LOCATION see location plan
GROUND ELEV.
DATE STARTED 4/30/85 DATE ENDED 4/30/85

CASING
SIZE: 3" 3" (NW)
HAMMER: 300 lb.
FALL: 24"

SAMPLER
TYPE: Split Spoon OTHER:
HAMMER: 140 lb.
FALL: 30"

GROUNDWATER READINGS			
DATE	DEPTH	CASING AT	STABILIZATION TIME
5/1	1.4	out (OW)	18 hours

DEPTH	CAS. BL./FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRATA CHG. and GEN. DESC.	EQUIPMENT INSTALLED	FIELD TESTING	RMKS.
							PEAT 2.0	Concrete Seal 0-2 feet		
5								Bentonite Seal 5.5-7.5 feet		
10		S-1	18/7	9-10.5	10-13-19	Medium dense, brown, fine SAND, some fine to coarse Gravel, some Silt.	SAND AND GRAVEL		1.3	
15										
20		S-2	18/3	19-20.5	25-11-12	Dense, brown, fine to medium SAND and fine to coarse GRAVEL, little Silt.		1½" PVC Wellscreen 17.5-27.5 feet	4	
25							27.0			
30		S-3	18/11	29-30.5	30-37 37	Very dense, brown, fine to coarse GRAVEL and fine to medium SAND, little Silt (Glacial Till).			18	
						Bottom of boring at 30.5 feet.				
35										

REMARKS:

1. See log for Boring DEQE-5 for explanation of field testing results.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE

GOLDBERG-ZOINO & ASSOCIATES, INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT Aquifer Contamination Study Groveland, MA	REPORT OF BORING NUMBER DEQE-[illegible] SHEET 1 OF 1 DATE [illegible] FILE [illegible]

BORING CO. Guild Drilling Co.
FOREMAN M. Fisher
GZA ENGINEER G. Draper
BORING LOCATION see location plan
GROUND ELEV.
DATE STARTED 4/30/85 DATE ENDED 4/30/85

CASING
SIZE: 3" 3" (NW)
HAMMER: 300 lb.
FALL: 24"

SAMPLER
TYPE: Split Spoon OTHER:
HAMMER: 140 lb.
FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME
5/1	1.4	out (OW)	18 hours

DEPTH	CAS. BL./FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRTA. CHG. and GEN. DESC.	EQUIPMENT INSTALLED	FIELD TESTING	RMKS.
							PEAT	Concrete Seal 0-2 feet		
							2.0			
5								Bentonite Seal 5.5-7.5 feet		
10		S-1	18/7	9-10.5	10-13-19	Medium dense, brown, fine SAND, some fine to coarse Gravel, some Silt.	SAND AND GRAVEL		1.3	
15										
20		S-2	18/3	19-20.5	25-11-12	Dense, brown, fine to medium SAND and fine to coarse GRAVEL, little Silt.		1½" PVC Wellscreen 17.5-27.5 feet	4	
25										
							27.0			
30		S-3	18/11	29-30.5	30-37 37	Very dense, brown, fine to coarse GRAVEL and fine to medium SAND, little Silt (Glacial Till).			18	
						Bottom of boring at 30.5 feet.				
35										

REMARKS:

1. See log for Boring DEQE-5 for explanation of field testing results.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

NOTICE: If the film image is less clear than this notice, it is due to the quality of the document being filmed

GROVELAND WELLS
ADMINISTRATIVE RECORD

GRO 007

0379

GOLDBERG-ZOINO & ASSOCIATES, INC. GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS	PROJECT: Aquifer Contamination Study, Groveland, MA	REPORT OF BORING NUMBER DEQE-8; SHEET 1 OF 1; DATE 5/11/85; FILE 1-2897.2

BORING CO. Guild Drilling Co.
FOREMAN M. Fisher
GZA ENGINEER G. Draper
BORING LOCATION see location plan
GROUND ELEV.
DATE STARTED 5/1/85 DATE ENDED 5/1/85

CASING
SIZE: 3" (NW)
HAMMER: 300 lb.
FALL: 24"

SAMPLER
TYPE: 18" Split Spoon
OTHER:
HAMMER: 140 lb.
FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME
5/2	13	out (OK)	20 hours

DEPTH	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRATA CHG. and GEN. DESC.	EQUIPMENT INSTALLED	FIELD TESTING	RMKS.
							PEAT 2.5'	Bentonite Seal 1-2 feet		
5										
							SAND	1½" PVC Wellscreen 8-13 feet		
10		S-1	18/18	9-10.5	2-5-5	Loose, brown, fine to medium SAND, trace Silt.			80	
							13'			2
15							GLACIAL TILL	Bentonite Seal 14-15 feet		
						Bottom of boring at 16 feet.				

REMARKS:

1. See log for Boring DEQE-5 for explantion of field testing results.
2. Change in density of material at 13'±, probably from SAND to TILL.
3. Drove casing into gray, foliated, metamorphic rock at 16 feet.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT: Aquifer Contamination Study, Groveland, MA

REPORT OF BORING NUMBER DEQE-10
SHEET 1 OF 1
DATE 5/2/85 FILE A-3897.3

BORING CO. Guild Drilling co
FOREMAN M. Fisher
GZA ENGINEER G. Draper/mlb

BORING LOCATION see location plan
GROUND ELEV.
DATE STARTED 5/2/85 DATE ENDED 5/2/85

CASING
SIZE: 2" HSA
HAMMER: lb.
FALL:

SAMPLER
TYPE: 18" Split Spoon OTHER:
HAMMER: 140 lb.
FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME
5/2	2.52	out (OW)	1 hour

DEPTH	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRATA CHG. and GEN. DESC.	EQUIPMENT INSTALLED	FIELD TESTING 1	RMKS.
							MEDIUM SAND			
5								1½" PVC Wellscreen 0-8.5 feet		
						Loose, brown, medium SAND, trace Silt.				
		S-1	18/4	9-10.5	1	Dark brown, Organic SILT and fine SAND.				
		S-1A	/2	9.5-10	10		9.5'			
10		S-1B	/4	10-10.5	20	Dense, gray, fine to medium SAND, little fine Gravel, trace Silt.			0.5	
						Bottom of boirng at 10.5 feet.				
15										

REMARKS:
1. See log for boring DEQE-5 for explanation of field testing results.
2. Pieces of wood in sample.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT: Aquifer Contamination Study, Groveland, MA

REPORT OF BORING NUMBER DEQE-11
SHEET 1 OF 1
DATE 5/2/85 FILE A-1897.1

BORING CO. Guild Drilling co.
FOREMAN M. Fisner
GZA ENGINEER G. Draper/mlb

BORING LOCATION see location plan
GROUND ELEV.
DATE STARTED 5/2/85 DATE ENDED 5/2/85

CASING
SIZE: 2" HSA
HAMMER: lb.
FALL:

SAMPLER
TYPE: 18" Split Spoon OTHER:
HAMMER: 140 lb.
FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME
5/2	2.4	out (OW)	1 hour

DEPTH	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRATA CHG. and GEN. DESC.	EQUIPMENT INSTALLED	FIELD TESTING	RMKS.
5							BROWN SAND	1½" PVC Wellscreen 0-9 feet		
10		S-1	18/18	9-10.5	12 10 10	Medium dense, brown, medium SAND, trace Gravel, trace Silt.	10'		2	
						Bottom of boring at 10.5 feet.				
15										

REMARKS:

1. See log for DEQE-5 for explanation of field testing results.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.

GOLDBERG-ZOINO & ASSOCIATES, INC.
GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT: Aquifer Contamination Study, Groveland, MA

REPORT OF BORING NUMBER DEQE-12
SHEET 1 OF 1
DATE 5/2/85 FILE 3-1897 [illegible]

BORING CO. Guild Drilling Co.
FOREMAN M. Fisher
GZA ENGINEER G. Draper

BORING LOCATION see location plan
GROUND ELEV.
DATE STARTED 5/2/85 DATE ENDED 5/2/85

CASING
SIZE: 2" ID Hollow Stem Auger
HAMMER: lb.
FALL:

SAMPLER
TYPE: Split Spoon OTHER:
HAMMER: 140 lb.
FALL: 30"

GROUNDWATER READINGS

DATE	DEPTH	CASING AT	STABILIZATION TIME

DEPTH	CAS. BL. /FT.	SAMPLE NO.	PEN./REC.	SAMPLE DEPTH	BLOWS/6"	SAMPLE DESCRIPTION	STRATA CHG. and GEN. DESC.	EQUIPMENT INSTALLED	FIELD TESTING	RMKS.
							FILL	Concrete Seal 0-2 feet		
5							5.0'			
							GRAVELLY SAND			
10								Bentonite Seal 12-13 feet		
15								1½" PVC Wellscreen 14-24 feet.		
20		S-1	18/14	19.5-21	21-20-20	Dense, gray-brown, fine to medium SAND, little fine Gravel, little(-) Silt.			3.5	
25		S-2	18/10	24.5-26	20-10-10	Medium dense, gray-brown, coarse GRAVEL and fine to medium SAND, trace(+) Silt.				
						Bottom of boring at 26 feet.				
30										

REMARKS:

1. See log for DEQE-5 for explanation of field testing results.
2. Five boring attempts located 10-20 feet north of DEQE-12. Encountered refusal of augers at 5-5.5 feet.

NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES AND THE TRANSITION MAY BE GRADUAL. 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORINGS LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO FACTORS NOT ACCOUNTED FOR AT THE TIME MEASUREMENTS WERE MADE.