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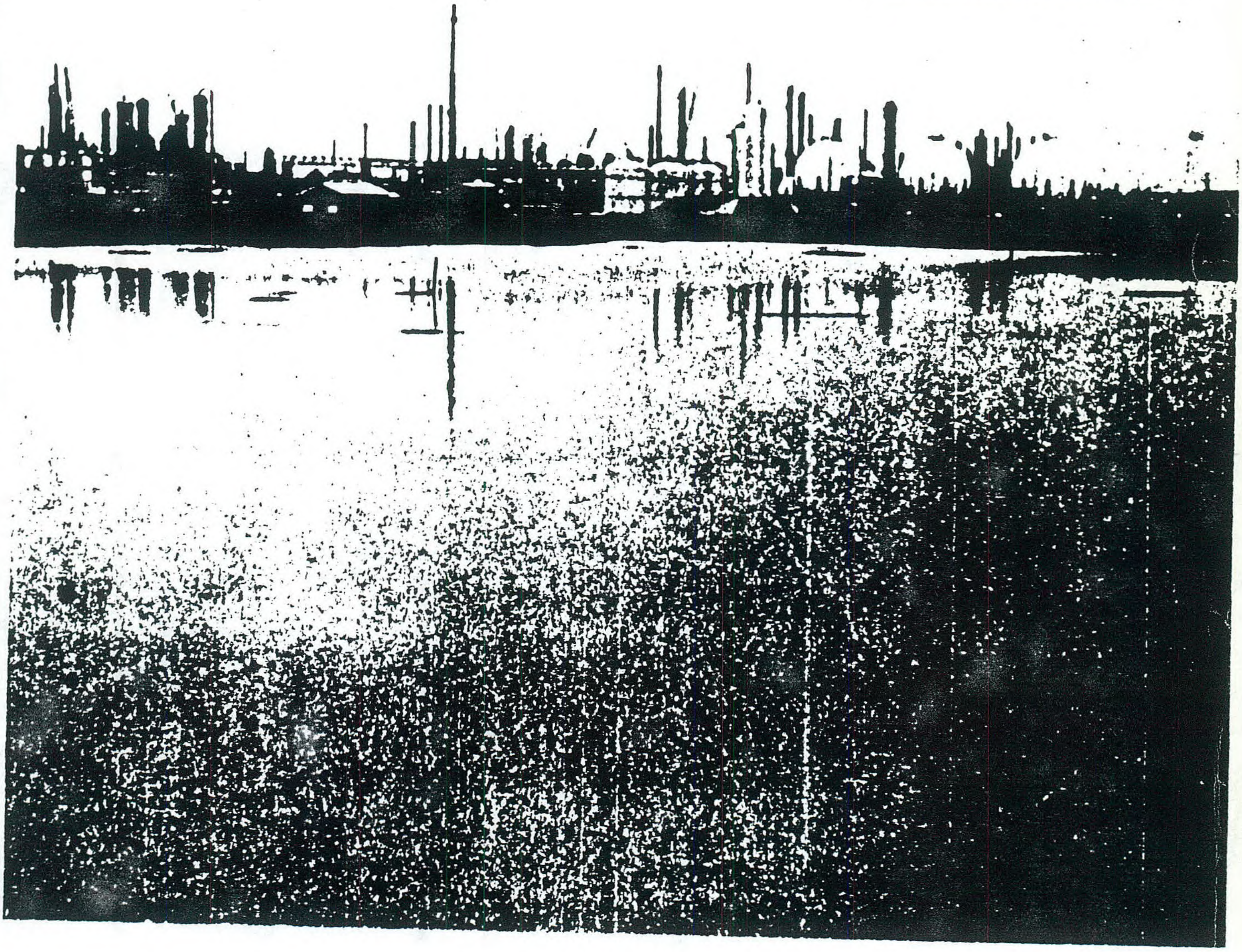

ENVIRONMENTAL ENGINEERING SERVICES

DRAFT - ATTORNEY WORK PRODUCT

WORK PLAN FOR FINAL CLEANUP

WALLKILL NEW YORK

MARCH 1989

by

ENVIRONMENTAL TECHNOLOGY SERVICES
SHAKTI CONSULTANTS, INC.
JAMESBURG, NEW JERSEY - CHARLESTON, WEST VIRGINIA

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WORK PLAN FOR FINAL CLEANUP, MARCH 1989

WALLKILL NEW YORK

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WORK PLAN FOR FINAL CLEANUP

WALLKILL NEW YORK

1.0 Introduction

Shakti Consultants has been retained by General Switch to continue in support of Stroock, Stroock and Lavan in negotiating the details of a consent agreement with the Justice Department and to continue to refine the method of cleanup for the Wallkill site to remedy the soil and groundwater contamination at the site (Figure 1).

This submission is a Work Plan for Final Cleanup that is to be appended to the Consent Order. A summary of the proposed program is a follows:

Summary

- The groundwater from the Parella well will be pumped through a merry-go-round air stripper and a secondary biological reactor that will reduce the contaminant concentration from 250 ppm in the influent water to below 5 ppb in the effluent.

  In addition, contaminants will be drawn from the vapor space in the well above the the water level to collect soil vapors.

  It is the conclusion of Neil Isabel Regional Air Pollution Engineer for New York State Department of Environmental Protection (NYDEC) that the emission of hydrocarbons from the air stripper will require a permit. The air flow leaving the air stripper will be below acceptable air criteria effective at that time.

- Solvent-contaminated soil will be treated by excavation of heavily contaminated soils in the areas detailed in the attached site map Figure 9, and by soil treatment by mechanical rotor tilling.

- Purging of the contaminants from the soil will then be completed by dispersion of the treated groundwater through the glacial till, leaching out the solvent in each of the three areas of soil contamination. The treated effluent from the air stripper will infiltrate into the tetrachloroethylene contaminated soils on site to induce cleaning of the soils and leaching of the contaminants that will be intercepted by the cone of depression of the Parella well. Groundwater interception using the Parella well will control and intercept the flow of contaminants to downstream receptors and cleanup the aquifer in a closed cyclic process.

Proposed Remedial Methods

Based on previous experience with contaminated soil and groundwaters, several technologies were identified for minimizing the impact of on-site soil contamination and to address groundwater recovery and treatment. These alternatives are described in the document "Proposal for Final Clean-up, Wallkill, NY" previously submitted. The feasibility of these alternative has been discussed at some length in that document and with the USEPA Region II, Technical Staff. Inappropriate methods were culled from these alternatives and the following remedial methods are presented for final cleanup.

2.1 Soil Cleanup

o PARTIAL SOIL TREATMENT	TREAT SOIL TO 4 FEET, WITH EXCAVATION TO 6 FEET IN HEAVILY CONTAMINATED AREAS*.
o FLUSH REMAINING SOLVENT	PURGE REMAINING SOLVENT FROM THE DEEPER SOIL HORIZONS BY INFILTRATING WATER FROM THE PARELLA WELL THROUGH THE GLACIAL TILL FOR RECAPTURE AT THE PARELLA WELL.

* Where the General Switch manufacturing building foundations are not undermined.

PROPOSED METHOD

IN-SITU SOIL TREATMENT

The Problem - Infiltration of Contaminants to the Groundwater

At present the infiltration of volatile contaminants in the soil into the groundwater is considered to be one of the prime potential impacts of the contaminants at General Switch. At present the soil is surcharged with run-off water from the site, a seasonal perched water condition is observed and the resultant leachate production is infiltrating the groundwater beneath the site.

The remedy of in-situ soil treatment is dictated by the requirements of the Land Ban, preventing excavation and landfill disposal of solvent-contaminated soils.

Description of Alternative

In the soil cleanup we propose to be guided by the soil sampling data presented in Figures 9 through 15. We propose to treat soil contaminated with more than 50 ppm of tetrachloroethylene in the following manner:

o Three soil hot spots have been identified as being contaminated by solvents including tetrachloroethylene: in areas TPA, TPD and TP6. We propose to excavate and treat the contaminated soils inside the limits of the contaminated soil areas at the three hot spots detailed in the plan view and cross-section previously submitted to you in September 1988 (Figures 9 through 13). Excavation that will undermine the General Switch manufacturing building will not be considered. A Photovac GC 10S50 will be operating on site during the investigation to guide the excavation and treatment. Field decisions will be made regarding the depth of the excavation based on Photovac analysis of the soil and footing foundation security. The decision will be made jointly by the On-Scene Coordinators of the USEPA and NY State DEC and Shakti Consultants once the depth of the footings in areas TPA and TPD are exposed in the two areas adjacent to the building. In any regard, the excavation will not proceed below the level of the foundation base within 10 feet of the footings.

TPD: At the hot spot located adjacent to the loading dock contaminated soils within the area of TPA will be excavated to 4 feet depth. The soil at four feet will be tested with the Photovac for the volatile content of these soils. If the soil is contaminated to less than 50 ppm tetrachloroethylene, a confirmatory laboratory sample will be analyzed by USEPA Method SW846 (Method 624 modified for soils analysis). If the Photovac indicates levels of soil contamination above 50 ppm, the soil will be excavated to 6 feet depth in an area 5-feet in radius surrounding soil boring locations T-7, T-8, T-9, T-10 and T-11. General Switch will excavate the soil and distribute it to the other hot spots for rotor tilling treatment.

The soil in the base of the excavation will be analyzed in the laboratory.

If soil is encountered in the bottom of the excavation at a concentration more than 50 ppm, an underground drain system will be put into place at this location and used to infiltrate treated groundwater into the till, to flush the remaining tetrachloroethylene to the recovery well. This excavation next to the loading dock will be backfilled with clean consolidated soil.

Further cleaning of the soil beneath the excavation will be by infiltration of groundwater, flushing the contaminants to capture at the Parella well. This area is the loading area of the building and in this location the treated groundwater will infiltrate into the glacial till through the system of under drains below the loading area. The drains will be 6 inch in diameter and separated by ten feet and stretch across the limits of the excavation. The drains will be capped with a concrete pad to support the delivery trucks. The purpose here is to allow continued use of the loading bay, consistent with the goals of the cleanup.

TPA: Area TPA is at the rear of the building in a natural depression adjacent to the building footings, sandwiched between the building and the property fence. At this hot spot, high-level contamination of the soil will be excavated to 6 feet depth in an area 5 feet in radius surrounding soil boring locations T-20, T-17, T-16 and T-15, where soil contamination is expected to be above 50 ppm tetrachloroethylene, provided the building foundations are not undermined.

TABLE 6-MICROBIOLOGICAL
MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminants	MCL	Determination of MCL violation
Coliform bacteria	Membrane filter method (M.F.): (a) Reporting period average: 1 coliform per 100 ml average; and/or[1] (b) Maximum sample value criteria: 4 coliform per 100 ml in no more than one[1][2] sample when less than 20 samples are taken, or no more than 5 percent of the samples when 20 or more samples are taken during the reporting period.	Membrane filter method (M.F.): A violation occurs when the reporting period average or the maximum sample value criteria during the reporting period is exceeded.
	Multiple tube fermentation technique (M.T.F.) (a) Reporting period criteria: Coliform shall not be present in more than 10 percent of all portions analyzed during the reporting period; and/or[1] (b) Maximum sample value criteria: Coliform shall not be present in three or more portions in no more than[1][2] one sample when less than 20 samples are taken, or no more than 5 percent of the samples when 20 or more samples are taken during the reporting period.	Multiple tube fermentation technique (M.T.F.) A violation occurs when the reporting period average or the maximum sample value criteria during the reporting period is exceeded.

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1. The State may permit a supplier of water serving fewer than 9,400 people, to exclude one positive sample per reporting period in accordance with criteria acceptable to the commissioner.

2. If a single sample exceeds 4 coliform per 100 ml. (M.F.) or coliform bacteria occur in three or more 10 ml. portions (M.T.F.) two consecutive daily check samples must be obtained from the same sampling point, using the same monitoring methods as the monitoring sample. Daily check samples must be taken until two consecutive daily samples are less than 1 ml. per 100 ml. or show no presence of coliform. If a check sample is positive, State notification must be made.

TABLE 7-RADIOLOGICAL
MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminant	MCL	Type of Water System	Determination of MCL violation
Combined radium 226 and radium 228 Gross alpha activity (including radium 226 but excluding radon and uranium	5 picocuries per liter 15 picocuries per liter	Community	A violation occurs when the annual composite of four quarterly samples or the average of the analysis of four quarterly samples exceeds the MCL.
		Noncommunity	Not applicable
Beta particle and photon radioactivity from manmade radionuclides	Four millirems per year as the annual does equivalent to the total body or any internal organ. The department shall determine the concentration capable of producing four millirems per year.	Community using surface water serving more than 100,000 people	A violation occurs when the annual composite of four quarterly samples or the average of the analyses of four quarterly samples exceeds the MCL.
		Community using surface source serving 100,000 or fewer people or community using ground water.	Not applicable
		Noncommunity	Not applicable.

About the Founder

John Bee Shakti Consultants, Inc

Certified Professional Geologist
American Institute of Professional Geologists, #6173

Experience

John Bee's 15 years of professional experience have made him completely familiar with hazardous substance spill scenarios and cleanup operations. In addition, he has extensive experience in writing, editing and publication of professional reports and books.

As a Senior Geologist and Project Manager for Union Carbide, he directed the site investigations, spill responses and remedial actions at major Union Carbide sites and coordinated compliance with the hazardous materials spill and hazardous waste regulations facing this corporation.

As a consultant to the US Environmental Protection Agency his experience as a Senior Geologist and Project Manager included major sites involving air, surface water, groundwater and solid waste management. He directed the investigation and remedial action at over fifty hazardous material spills and hazardous waste sites.

As a Senior Emergency Response Team Member, his experience includes the management of responses to chemical fires, oil spills, hazardous materials transportation incidents and air pollution episodes in New York, New Jersey, Ohio, Louisiana, Texas and Puerto Rico. Areas of specific training and experience include geology, hydrology, analytical chemistry and toxicology, civil engineering, environmental monitoring, emergency response techniques, site safety supervision, the engineering and operation of groundwater cleanup equipment such as air strippers, hazardous waste treatment plants, the preparation of proposals and the accounting of multi-million dollar site operations. Skills used include an intimate knowledge of environmental law, regulations and enforcement policy.

As an Engineering Geologist in England and Canada, John Bee performed site investigations for civil and environmental engineering projects for power stations, docks, roads, dams, quarries, earth-retaining structures and slope stability, spoil tips, groundwater contamination, mapping and aerial photographic interpretation.

Instructor

Instructor to Emergency Response Branch, Region II U.S. EPA. Conducted the following courses:

- Groundwater Pollution and Monitoring Course
- Environmental Monitoring and Sampling Seminars
- Site Costing and Accounting under the 311 Act and Superfund
- Geophysics in Hazardous Material Investigation.
- Emergency Response Management.

Author and Lecturer

Organized numerous conferences and presented seminars on Hazardous Materials Response and Hydrogeology; Geophysics; Environmental Law and Regulations.

Emergency Response

Union Carbide Emergency Response/Chronic Spills Study: For Union Carbide following the Bhopal disaster wrote procedures for the response to hazardous materials spills and the investigation of chronic environmental problems. These procedures were written to assist Divisional Environmental Managers in the management of environmental incidents, to respond effectively to the environmental imperatives of various spill situations and to provide timely, safe and effective site assessment, spill management and cleanup that included:

- Measures to Contain a Spill Situation
- The Site Assessment of a Spill
- Health and Safety at Spill Sites
- Standard Operating Procedures for Environmental Sampling
- A Standard Tracking Procedure to Ensure Quality Analytical Results
- Public Relations Efforts at a Spill Site

Geophysics

Trained and experienced in Geophysical Surveys such as resistivity surveys, terrain conductivity and magnetometer surveys used in hazardous materials site investigations.

Public Relations

Coordinated the public relations efforts at numerous environmentally sensitive sites.

Part 223 - Lbs/hr of regenerator coke burn-off or million Btu/hr heat input of incinerator waste heat boiler fuel
Part 224 - Ton/hr of acid produced

Part 228 - Gallons/hr or gallons/day of coating applied

Part 229 - Gallons of storage capacity or gallons/day or gallons/yr of throughput

197. Unit

Enter the appropriate code number indicating the units in which the input (production rate or capacity) presented in previous question was expressed:

1 - lbs/hr
13 - tons/hr

30 - gallons
31 - gallons/hr
32 - gallons/day
33 - gallons/year

60 - megawatts (MW)
61 - Btu x 10^6/hr

198. Actual Emissions

If application is for a Permit to Construct, enter the anticipated emissions in units prescribed below, by Part number, based on stack tests performed on pilot or similar full scale installations, or reliable material balance. If application is for a Certificate to Operate, specify actual emissions in units prescribed below by Part number based on accepted stack test(s) of this installation.

Part 205 - lbs/hr or lbs/day
212 - lb/hr or grains/DSCF
213 - lbs/hr
214 - grains/DSCF or lbs/ton
216 - grains/DSCF
220 - lbs/ton, lb/hr or grains/DSCF
223 - grains/DSCF, lbs/1000(input), lbs, grains/100 DSCF, lbs/10^6 Btu or % (vol)
228 - lbs/gal
229 - gallons of storage capacity or gallons/day or gallons/yr of throughput

The actual emissions will be compared with permissible emissions; therefore, it must be verifiable.

199. Unit

Enter the code to indicate the units in which the actual emissions in the previous question are presented:

1 - lbs/hr
2 - lbs/hr x10^{-3}
3 - lbs/hr x10^{-6}
4 - lbs/day

5 - lbs/1000 lbs (input)
6 - (lbs/1000 lbs) x 10^{-3} (input)

9 - lbs/gallon
10 - lbs/ton
11 - lbs/million Btu
12 - lbs/mw-hr
13 - tons/hr
14 - lbs/100 lbs input (refuse charged)

20 - grains/DSCF
21 - grains/100 DSCF

30 - gallons
31 - gallons/hr
32 - gallons/day
33 - gallons/year

40 - micro curies/ml
41 - 10^{-3} micro curies/ml
42 - 10^{-6} micro curies/ml

43 - 10^{-9} micro curies/ml (pico curies/ml)
44 - 10^{-12} micro curies/ml
45 - 10^{-15} micro curies/ml
46 - 10^{-18} micro curies/ml
47 - 10^{-21} micro curies/ml

50 - % vol
51 - ppm (vol)
52 - ppb (vol)

90 - % control
92 - % opacity

94 - Trace
98 - Not applicable

200.	How Determined	Use code to designate how the actual emissions are determined. 1 - Stack test of emissions from this process or unit 2 - Stack test of emissions from identical process or unit 3 - Stack test of emissions from geometrically similar process or unit 4 - Manufacturer's guarantee 5 - Published emission factors 6 - Material balance calculations 7 - Continuous stack monitoring 9 - Other
201.	% Control Efficiency	Enter actual efficiency of emission control equipment specified in Section D for each contaminant.
202.	Emission Rate Potential (ERP) (lbs/hr)	Enter the emission rate potential in lbs/hr (See NYCRR 200.1(s) for definition). If conversion of units is required from units specified in the applicable rule which are other than pounds per hour, show calculations in Section K.
203.	Actual Hourly Emissions (lbs/hr)	Enter the actual hourly emission in lbs/hr based on normal daily operation of the process.
204.	Actual Annual Emissions	Enter the actual annual emissions in lbs/hr. For radioactive air contaminants enter curies/yr.
205.	10^x	For very large or very small annual emissions utilize the exponent of 10 to specify the correct magnitude. Enter the exponent (x) and indicate whether plus (+) or minus (-). If exponent is not needed, enter zero.

206-217. For other air contaminants emitted, complete these questions in accordance with instructions for questions 54-68.

218-229. " " " " " " "

230-241. " " " " " " "

242-253. " " " " " " "

254-265. " " " " " " "

SYSTEM FOR ASSIGNING IDENTIFICATION NUMBERS AND LETTERS

I. STACKS – ASSIGN A DIFFERENT NUMBER TO EACH STACK WITHIN A PLANT, USING NO MORE THAN A THREE DIGIT NUMBER.

II. PROCESSES/UNITS ASSIGN A DIFFERENT LETTER TO EACH PROCESS OR UNIT VENTING TO A COMMON STACK.

III CONTROL EQUIPMENT – ASSIGN A DIFFERENT NUMBER TO EACH PIECE OF CONTROL EQUIPMENT VENTING TO A COMMON STACK, USING NO MORE THAN A TWO DIGIT NUMBER.

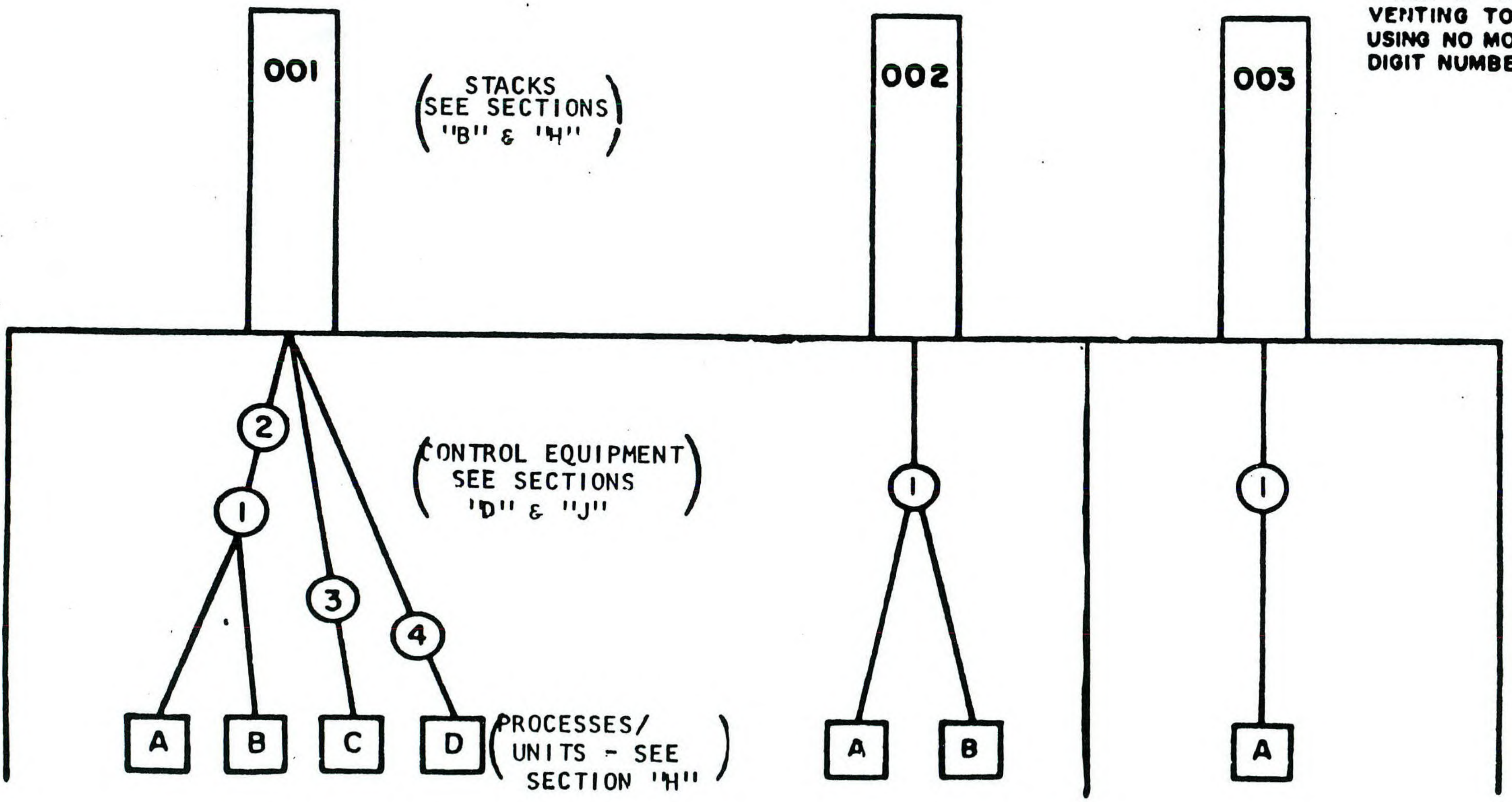

FIGURE 1

TABLE 1-INORGANIC CHEMICALS AND PHYSICAL CHARACTERISTICS MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminants	MCL (milligrams per liter)	Determination of MCL violation
Primary		If the results of a monitoring sample analysis exceed the MCL, the supplier of water shall collect three more samples from the same sampling point within 30 days or as soon as practical. An MCL violation occurs when the average[1] of the four results exceeds the MCL.
Arsenic	0.05	
Barium	1.00	
Cadmium	0.01	
Chromium	0.05	
Lead	0.05	
Mercury	0.002	
Selenium	0.01	
Silver	0.05	
Fluoride	2.2	
Secondary		
Chloride	250.0	
Copper	1.0	
Corrosivity	Noncorrosive[4]	
Iron	0.3[2]	
Manganese	0.3[2]	
Sodium	No designated limits[3]	
Sulfate	250.0	
Zinc	5.0	
Color	15 Units	
Odor	3 Units	

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1. Rounded to the same number of significant figures as the MCL for the substance in question.

2. If iron and manganese are present, the total concentration of both should not exceed 0.5 mg/l. Higher levels may be allowed when justified by the supplier of water.

3. Water containing more than 20 mg/l of sodium should not be used for drinking by people on severely restricted sodium diets. Water containing more than 270 mg/l of sodium should not be used for drinking by people on moderately restricted sodium diets.

TABLE 1-INORGANIC CHEMICALS AND PHYSICAL CHARACTERISTICS
MAXIMUM CONTAMINANT LEVEL DETERMINATION (Con't)

l. Corrosivity shall be determined by the calcium carbonate saturation method or other method acceptable to the commissioner. Corrosive water may be allowed by the State based on justification submitted by the supplier of water which shall include, but not be limited to:

a. data concerning increases in metal concentration of point of use water as compared to source water metal content;

b. distribution water quality characteristics such as calcium, hardness, alkalinity, total dissolved solids, and pH;

c. documentation of the lack of complaints of potential adverse effects; and

d. a report summarizing, for at least a period of one year, the above.

TABLE 2-NITRATE
MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminant	MCL	Determination of MCL violation
Nitrate (as N)	10.0 mg/l[1]	If the results of a monitoring sample analysis exceed the MCL, the supplier of water shall collect another sample from the same sampling point, within 24 hours of the receipt of results or as soon as practical. An MCL violation occurs when the average of the two results exceeds the MCL.

1. An MCL of 20 mg/l may be permitted at a noncommunity water system if the supplier of water demonstrates that:
   a. the water will not be available to children under six months of age;
   b. notice that nitrate levels exceed 10 mg/l and the potential health effects of exposure will be continuously posted in a conspicuous location;
   c. local and State public health authorities will be notified annually of nitrate levels that exceed 10mg/l; and
   d. no adverse health effects shall result.

TABLE 3-ORGANIC CHEMICALS
MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminant	MCL	Type of water system	Determination of MCL violation
Pesticides/Herbicides[3]			
Endrin	0.0002 mg/l	Community and Noncommunity	If the results of a monitoring sample analysis exceed the MCL, the supplier of water shall collect three more samples from the same sampling point, as soon as practical, but within 30 days. An MCL violation occurs when the average of the four sample results exceeds the MCL.
Lindane	0.004 mg/l		
Methoxychlor	0.05 mg/l[4]		
Toxaphene	0.005 mg/l		
2,4-D	0.05 mg/l[4]		
2,4,5-TP Silvex	0.01 mg/l		
General Organic Chemicals			
Principal organic contaminant (POC)	0.005 mg/l[4]	Community and Noncommunity	If the results of a monitoring sample analysis exceed the MCL, the supplier of water shall collect one to three more samples from the same sampling point, as soon as practical, but within 30 days. An MCL violation occurs when at least one of the confirming samples is positive and the average of the initial sample and all confirming samples exceeds the MCL.
Unspecified organic contaminant (UOC)	0.05 mg/l[4]		
Total POCs and UOCs	0.1 mg/l[4]		
Vinyl chloride	0.002 mg/l[4]		
Trihalomethanes[2]			
Total trihalomethanes	0.10 mg/l[1]	Community	The results of all analyses per quarter must be arithmetically averaged and must be reported to the State within 30 days of the public water system's receipt of the analyses. A violation occurs if the average of the four most recent sets of quarterly samples (12-month running average) exceeds the MCL.
		Noncommunity	Not applicable.

TABLE 3-ORGANIC CHEMICALS
MAXIMUM CONTAMINANT LEVEL DETERMINATION (Con't)

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1. Effective one year after commencing sampling according to the minimum monitoring requirements.
2. The State may require a supplier of water to monitor for maximum total trihalomethane potential at a frequency specified by the State.
3. Pesticides/Herbicides:

   Endrin (1,2,3,4,10,hexachloro-6,7,-epoxy-1,4,4a,5,-6,7,8,8a octahydro-1,4-endo,endo-5,8-dimethano naphthalene).

   Lindane (1,2,3,4,5,6-hexachloro-cyclohexane, gamma isomer).

   Methoxychlor (1,1,1-Trichloro-2, 2-bis p-methoxyphenyl ethane).

   Toxaphene ($C_{10}H_{10}Cl_8$ -technical chlorinated camphene, 67-69 percent chlorine).

   2,4-D (2,4-dichlorophenoxyacetic acid).

   2,4,5-TP Silvex (2,4,5-trichlorophenoxypropionic acid).
4. The effective date of the MCL is January 9, 1989.

TABLE 4-ENTRY POINT TURBIDITY
MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminant	MCL	Determination of MCL violation
Entry point turbidity (surface water only)	1 NTU [1,2,3,4] (Monthly Average)	A violation occurs when the average of all daily entry point analyses for the month exceeds the MCL (rounded off to the nearest whole number).
	5 NTU [2,3,4] (Two-consecutive-day average)	A violation occurs when the average of two consecutive daily entry point analyses exceeds the MCL (rounded off to the nearest whole number).

. The commissioner may establish a monthly average entry point turbidity MCL of 5 NTU based on justification submitted by the supplier of water. Such justification shall demonstrate that the higher turbidity does not:

a. interfere with disinfection;

b. prevent maintenance of a minimum of 0.2mg/l free chlorine residual at representative points within the distribution systems; or

c. interfere with microbiological determinations, and substantiate why meeting a 1 NTU level is not feasible.

2. If the daily entry point analysis exceeds 1 NTU for a system with a monthly average MCL of 1 NTU or if a daily entry point analysis exceeds 5 NTU for a system with a monthly average MCL of 5 NTU, a repeat sample must be taken as soon as practicable and preferable within one hour. If the repeat sample exceeds 1 NTU for a system with a monthly average MCL of 1 NTU or 5 NTU the supplier of water must make State notification. The repeat sample must be used for the monthly average and the two consecutive day average.

. NTU=Nephelometric Turbidity Units

. If the two consecutive day average exceeds the MCL, the supplier of water shall analyze for microbiological contamination at a point downstream of the first consumer, but as close to the first consumer as is feasible. The additional microbiological sample should be taken within one hour as soon as feasible after determining the two consecutive day average. The supplier of water shall report the result of this microbiological analysis to the State within 48 hours of obtaining the result. The result of this analysis shall not be used for monitoring purposes.

TABLE 5-DISTRIBUTION SYSTEM TURBIDITY
MAXIMUM CONTAMINANT LEVEL DETERMINATION

Contaminant	MCL	Determination of MCL violation
Distribution system turbidity	5NTU (Monthly average)	A violation occurs when the monthly average of the results of all distribution samples collected in any calendar month exceeds the MCL (rounded off to the nearest whole number).

TP6: Soil will be excavated at TP6 to a maximum depth of 4 feet as denoted in Figure 10, based on the Photovac, OVA and Laboratory data presented in that figure. Note the Photovac indicated a concentration of 21 ppm tetrachloroethylene and the equivalent laboratory duplicate result showed 3.08 ppm. Note that the Photovac consistently indicated one order of magnitude higher concentrations for the soil samples. The USEPA method involves loss of volatile between the time of sampling and analysis. The laboratory analysis is the standard method for this analysis.

Treated groundwater from the Parella well will be introduced into the two open excavation TP6 and TPA and into the under drain system at TPD in order to flush the remaining volatile organics through the glacial till to the Parella well for recapture and treatment.

If during the time of the cleanup, the foundation adjacent to TPA is threatened with collapse, an under drain for infiltration of treated groundwater similar to area TPD will be installed. This decision will be made jointly by Shakti Consultants and the On-Scene-Coordinators of the USEPA and NYDEC.

The soil removed from the excavations will be spread in 8" lifts adjacent to the excavation and rotor tilled to reduce the volatile concentration of Tetrachloroethylene by 95-99.9% in accordance with the guidance " Interim Treatment Levels for Soil and Debris" June 1, 1988 USEPA Office of Emergency and Remedial Response. (see Appendix D).

Laboratory analysis will be completed during soil treatment to determine the reduced soil contaminant concentration.

Applying the guidance, we are proposing the treatment levels in Tables 1A for Organics. The table data on contaminants are divided into chemical groups. Tetrachloroethylene is a halogenated aliphatic compound. Each group has two types of treatment levels. The first is a concentration range for lower levels of contamination; these concentration ranges are similar to residual concentrations being proposed by OSW in setting BDAT standards for RCRA-listed waste codes. The second is a percent reduction range for higher concentrations of contamination. When the indicated threshold concentration is exceeded for a particular constituent in the untreated soil or debris, then the treatment level for that constituent is to achieve a reduction of the contamination in the untreated waste within the range of the corresponding percent reduction.

For example, a soil with 200 ppm of tetrachloroethylene, a halogenated aromatic compound, would have a goal to achieve of 95% reduction for a maximum residual level after treatment of 10 ppm. For untreated wastes which significantly exceed the threshold concentration, the percent reduction may approach the upper end of the range. For example, as the concentration of tetrachloroethylene increases significantly above the 200 ppm level, the reduction may approach 99.9% to approach the residual goal of 10 to 50 ppm.

5/27/88

Table 1A
Treatment Levels for Treatability Variances for Contaminated Soil and Debris*
Organics
(concentration based on total waste analysis)

Structural Functional Group		Trtmt.Rng (ppm)	Thresh'd Conc.(ppm)	Percent Reduc.Rng.
W01	Halogenated Non-Polar Aromatics	0.5-10	100	90-99.9
W02A	Dioxins, Furans	0.00001-0.05	0.5	90-99.9
W02B	PCBs	0.1-10	100	90-99.9
W02C	Herbicides	0.002-0.02	0.2	90-99.9
W03	Halogenated Phenols, Cresols & Ethers	0.5-40	400	90-99
W04	Halogenated Aliphatics	0.5-2	40	95-99.9
W05	Halogenated Cyclics	0.5-20	200	90-99.9
W06	Nitrated Aromatics & Aliphatics	2.5-10	10,000	99.9-99.99
W07	Non-Polar Aromatics & Heterocyclics	0.5-20	200	90-99.9
W08	Polynuclear Aromatics	0.5-20	400	95-99.9
W09	Other Polar Organics	0.5-10	100	90-99.9

* When the untreated concentration is between the treatment level and the threshold concentration, the treatment should reduce the concentration in the residuals to no more than the maximum of the treatment range (in this case, the percent reduction does not apply). When the untreated concentration is above the threshold concentration, the treatment should achieve at least the minimum of the percent reduction range.

After the soil is rotor tilled and reduced to the required residual tetrachloroethylene concentration, the soil will then be stockpiled, covered with plastic and tarpaulins.

After soil rotor tilling is completed and after completion of groundwater treatment, the treated soil that was stockpiled will be placed into the excavations at TPA and TP6. The soil will be replaced in the excavations in 8" lifts. The soil lifts will be spread across the floor of the excavation and compacted.

The contaminated soil areas will be closed in a manner that minimizes the need for further maintenance and controls. The finished closure of stabilized soil at TP6 to the south of the truck yard and at TPA will be seeded to minimize erosion. The truck area will be covered with a concrete pad.

There will be a final quality control inspection and certification by an Professional Engineer or Professional Geologist.

Advantages:

The site will be closed in a manner that:

- Reduces the concentration of contaminants to an acceptable level in the upper soil horizons.
- Reduces post-closure release of leachate, contaminated run-off and waste decomposition products to ground waters of the state or to the atmosphere.
- Minimizes or eliminates threats to human health and the environment. Protects public health and the environment through control of transport pathways.

Pathways of Dispersion at the Site

The major pathways of dispersion of contaminants at this site are by production of leachate that infiltrates the groundwater and by air dispersion by volatilization. Contaminants in the soil represent a potential long-term threat in the soil environment and groundwater quality, but this threat can be reduced considerably if the contaminants can be removed from the soil. The use of soil treatment envisaged in this alternative will minimize leachate produced and infiltrating into the groundwater. Once the soil contamination area is treated, further leachate production and the impact of downward percolation of leachate into this contaminated aquifer from this soil will be minimized.

Disadvantages

Air Emissions: The loss of contaminants from the soil during treatment via vapor phase transport will be significant, and concerns over the air impact of some uncontrolled release of volatiles during soil cleanup are warranted. Protective respirators will be used by remedial workers during soil treatment. The sites in the parking area are remote from residential dwellings. Access to the sites will be restricted during soil tilling. The area near location TPA is adjacent to a residential dwelling. Soil tilling will be conducted 200 feet from the fenceline of the residence. Air monitoring will be conducted to determine the fence line exposure. This exposure will be kept below the OSHA time weighted average for tetrachloroethylene.

Potential Receptors

Once the soil is treated, the remaining significant pathway of dispersion will be by infiltration of any contaminant to the groundwater and contaminated groundwater flow to a receptor. The groundwater will be captured by pumping that well to treatment.

Residual Problems

At this site the anticipated leaching of contaminants that are not treated or removed are to be captured by the groundwater recovery operation. Thus, the methods proposed complement each other to address the overall site remedy.

An undefined amount of vaporization of the solvents from the soil will occur after the soil treatment is completed.

Commercial Availability & Previous Applications

Soil treatment has been used extensively in civil engineering for the soil moisture control in the foundations for airport runways and at NPL sites.

Soil vapor extraction has been used on the sites described in Appendix D

Costs

TABLE 1. CAPITAL COST FOR SOIL EXCAVATION AND ROTOR TILLING

Equipment		
Excavation (Backhoe -10 days @$500)	$5,000	
(Bulldozer -20 days @$320)	6,500	
Mixing (Farm Tiller -10 days @500)	5,000	
Compaction (Roller -20 day @$175)	3,500	
Soil Testing	4,000	
QA/QC Final Inspection	4,000	
Subtotal	$28,000	$28,000
Contingency and Engineering at 25%		4,000
TOTAL CAPITAL COST		$32,000

TABLE 1A. ANNUAL COST ESTIMATE - SOIL TREATMENT

Maintenance at 4% of Capital Cost	$2,500
TOTAL ANNUAL COST	$2,500

2.2 Groundwater Capture

o	PUMP PARELLA WELL	FOR GROUNDWATER PLUME CAPTURE
o	PUMP ADDITIONAL WELLS	IF REQUIRED TO CAPTURE TH PLUME

PROPOSED METHOD INTERCEPTOR WELL FOR GROUNDWATER CAPTURE

The Problem:

A plume of tetrachloroethylene contaminated groundwater has been demonstrated in the fractured bedrock aquifer in the vicinity of the Parella well

Description of Alternative

Based on available data, presented in the Proposed Cleanup, the Parella well pumping at 4 gpm has a radius of influence of at least 350 feet and controls the hydrology of the area. Pumping the Parella well will pull down the potentiometric head in the shale at this well by 40 feet (allowing for an 80% efficient well). The well is situated upon a major fracture in the area and will intercept the flow of groundwater contaminants flowing past the well to Highland Avenue.

Data Needs

A pump test of the Parella well will be conducted to demonstrate the zone of influence of the well and define the effect of pumping for an extended period of time on the hydrology of the site in order to provide reliable drawdown predictions. A pump test using an electropiezometer system is scheduled for the Parella well to demonstrate the zone of influence of the well. The transmissivity and storativity of the fractured bedrock aquifer will be obtained along with the concentration of contaminants in the effluent required for final treatment system design.

Feasibility

The method proved successful in 1984 under the removal action of USEPA at Sarnay Farm, in New York State, during which an estimated 20.7 pounds of tetrachloroethylene were removed from the aquifer. The Parella well has proven to be the most prolific well in the area in terms of yield and has been consistently contaminated. The efficiency of the well may be increased by hydrofracturing of the shale.

Advantages

The well will act as an interceptor well for contaminants flowing southwards along Highland Avenue and minimize contamination of supply wells downgradient.

The plume will be captured by physically altering the potentiometric pressure in the aquifer, altering the regional direction of groundwater flow and providing a drawdown cone under the site. According to data presented by Fred C. Hart, the aquifer in the fractured bedrock may affect the water levels in wells in the base of the glacial till. Within the zone of influence of the pumping well, the contaminated groundwater flows to the well where it is permanently removed from the aquifer. If the Parella well does not perform to the anticipated efficiency in capturing the contaminant plume, additional wells will be used.

Disadvantages

Additional wells may need to be pumped if the Parella well is not sufficient to speed up the aquifer rehabilitation. Water will be removed from the aquifer. However, the effect on local water resources is expected to be minimal. Up to the present time, over 30 wells were drawing water from the aquifer - the regional water table was pulled down twenty feet. Many of these households are now on municipal supply and thus the demand for groundwater is very much reduced. Thus pumping the Parella well again will not effect the available water resources appreciably. A well survey of the remaining homes on Highland Avenue that are still using groundwater has been conducted. The residences of Wood, Seeley and Gilbert remain unconnected to municipal supply. There was no significant contamination of these wells during the last sampling round. If the well water is analyzed at more than the drinking water criteria for priority pollutant volatile organics, additional hook-up to municipal supply will be undertaken by General Switch. Pumping the Parella well will produce a local drawdown cone that will change the groundwater flow direction to a net inflow to the Parella well, and water to those wells that remain in use will draw water from the hillside at the back (north) of Highland Avenue. See Figure 6. Existing abandoned wells will be used to demonstrate sufficient drawdown to capture the contaminant plume.

Time Frame

The Parella well is already drilled, but will need to be uncovered and a new pump installed.

Further information and costs will be presented about this course of action following the pump test.

TABLE 2. CAPITAL COST FOR WELL PUMPING

Well Construction	$ 0	
Well rehabilitation	1,000	
Easement for well use	2,000	
Excavation	2,000	
Submersible pump for 4"-diameter	750	
Replacement pump	750	
Electrical at 12%	1250	
Piping and controls	4,000	
Site Work	2,250	
Subtotal	$14,000	$14,000
Contingency and Engineering at 25%		3,500
TOTAL CAPITAL COST		$17,500

TABLE 2A. ANNUAL COST ESTIMATE - WELL PUMPING

Labor	$3,000
Power at $0.05/kWh	1,000
Maintenance at 4% of Capital Cost	2,500
TOTAL ANNUAL COST	$6,500

(Costs are not inclusive of treatment: see treatment alternatives)

2.3 GROUNDWATER TREATMENT

o TREAT THE GROUNDWATER WITH AN AIR STRIPPER

Aquifer Restoration

The US Attorney has proposed the following requirements with regard to aquifer restoration

- Aquifer restoration to 5 ppb of tetrachloroethylene (PCE), 5 ppb of trichloroethylene, 7 ppb of 1,1-dichloroethylene, and 2 ppb of vinyl chloride.
- Cleanup of groundwater by air stripper at 99.9% efficiency if levels of vinyl chloride concentration in all exhaust gas discharged to the atmosphere do not exceed 10 ppm.

PROPOSED METHOD **MERRY-GO-ROUND AIR STRIPPER**

Description of Alternative

The groundwater from the Parella well will be pumped through a merry-go-round air stripper and a secondary biological reactor that will reduce the anticipated groundwater contaminant concentration from 250 ppm in the influent to the system to 5 ppb in the effluent. Thus, we will treat the groundwater to the NY State revised standard of 5 ppb, see attached copy of the new New York State MCLs, effective January 9, 1989.

The innovative merry-go-round system, designed by Robert Cobiella, the past USEPA on-scene-coordinator (OSC) for the site, will in many respects supersede the conventional packed column air stripper. The packed column air stripper is a single air lift while the merry-go-round air stripper is a series of air stripping lifts. At each air stripping lift, air is entrained into the water stream and volatilizes the contaminant at a rate proportional to the Henry's Constant of the volatile contaminant and the temperature of the air and water.

The treated water will then be infiltrated into the tetrachloroethylene contaminated soils on site to induce cleaning of the soils and leaching of the contaminants that will be intercepted by the cone of depression of the Parella well. There is the added opportunity to draw contaminants from the vapor space in the well - particularly if the well is not cased (open hole) above the the water level.

Data Needs

The data required to design and size the equipment will be supplied by the planned pump test.

Feasibility

The system has been operated with success at Pompey, New York at a National Priority Listed (NPL) site by the USEPA Emergency Response Division, Site Mitigation Section, Edison, New Jersey. The system was moved after 9 months upon completion of this groundwater cleanup. The air stripper reduced the contaminants from 700 ppb to non detectable in three months. There was a rebound in concentration to 240 ppb upon shut down at three months that required the further six months of treatment to address.

The system is now operating at the American Thermostat NPL site in South Cairo, New York about 1-hours drive from the Wallkill site. The system is operating in the same fractured bedrock type of aquifer. A videotape of this operation is available upon request.

Air stripping efficiency depends on the transfer rate of the contaminant from water to air. A measure of the resistance to mass transfer from water to air is the Henry's Law Constant, H (Mackay, et al, 1979). The larger the Henry's Law Constant, the greater will be the equilibrium concentration of the contaminant in the air. Thus, contaminants with large Henry's Law Constants are more easily removed by air stripping (Kavanaugh and Trussell, 1980).

The Henry's Law Constants for each of the organic contaminants identified by the U.S. Attorney is presented in Table 3. In this table are vapor pressure and water solubility for each compound. Mackay and Wolkoff (1973) and Mackay and Leinonen (1975) suggested that these two parameters be combined to give an effective Henry's Law Constant for organic materials in water:

In general, it can be said that the combination of high Henry's Law Constant, high vapor pressure, and low solubility indicate a potential for successful air stripping. McCarty, et al (1979) noted that those compounds such as tetrachloroethylene, with a Henry's Constant value greater than 10-3 atm m3/mole are good candidates for removal by air stripping (Figure 19).

TABLE 3. HENRY'S CONSTANT

	Tetrachloro ethylene (PCE)	Trichloro ethylene	1,1-Dichloro ethylene	Vinyl chloride.
Henry's Law Constant (atm:m3/mole)	28.7 x 10^3	11.7 x 10^{-3}	15 x 10^{-3}	640 x 10^{-3}
Vapor Pressure (torr,25%C)	14	57.9	591	2660
Solubility in Water (mg/l, 25%C)	150	100	5000	1.1
Effective Henry's Law Constant	10^2	10^{-2}	10^{-2}	10_{-1}
Evaluation of Stripping Efficiency	Very Good	Very Good	Very Good	Excellent

The evaluation row in Table 3 summarizes the Henry's Law Constant, vapor pressure, solubility of the compounds of concern at the site to indicate the amenability of each compound to removal by air stripping. The evaluations for the compounds presented range from Excellent to Very Good and indicate that air stripping is feasible for these compounds.

Such systems have been demonstrated to achieve 99+ % removal efficiency with tetrachloroethylene.

The proposed system will consist of a series of 15 air lifts (Figure 21) that in series air strip the volatile contaminants from the well water. The yield of influent water from the Parella well is no more than 4 gpm and based on past sampling is expected to be initially at 260 ppm tetrachloroethylene, stabilizing at 95 ppm. However, as the contribution from soil leaching begins to affect the groundwater captured, the contaminant strength may increase to its initial value.

The air lift units will be piped in a merry-go-round arrangement that will take water from the well and from two 6,000 gallon central storage tanks. The water will be circulated through the series of air lifts and at each air lift experiences air stripping at approximately 65% removal efficiency.

TABLE 4. SUMMED REMOVAL PERCENTAGES

Number of Air Lifts	Summed Removal Percentage	Concentration
1	67.75%	250,000 ppb
2	71.54	
3	82.15	
4	88.39	
5	92.46	
6	95,10	
7	96.82	
8	97.93	
9	99.125	
10	99.43	
11	99.64	
12	99.76	
13	99.84	
14	99.9	
15	99.93	17.5 ppb

The air stripping lifts sum up to 99.9% **removal** of the volatile contaminant from the groundwater. The air lifts will be piped in two sets. The first set of 8 air lifts will discharge into the first central storage tank. This tank will overflow into the second set of air lifts with a final settling in the second tank with overflow to the distribution system.

The removal percent follows a diminishing return curve, while the removal efficiency remains the same, the amount of contaminant removed decreases in proportion to the reduced total concentration to be treated such that the largest expense is incurred in reducing the concentration below 65% of the initial concentration.

To enhance removal of the volatile the air lifts will circulate water through them at twice the influent and over flow rate of 4 gpm. Thus, the Merry-Go-Round air stripper, revolving at 8 gpm, will be more efficient and complete the cleanup quickly.

In iron-rich shale formations above 0.5% iron content, a practical limit of removal of 99.8% removal is determined by the entrainment of Tetrachloroethylene in iron flocculate that forms and fouls the system. This, apparent practical limit for air stripping can be overcome by allowing the iron floc to settle out and steep in the central storage tanks. The first central storage tank is pH adjusted to pH 4. This adjustment will affect iron components of the pumps necessitating the purchase of acid resistant components made of aluminum and stainless steel. An alternative is to use a centrifugal impeller system in the flow system.

Nutrients of basal salts and glucose in the form of Epsom salts and pellet fertilizer at 0.1% of the flow and Karo Syrup at 0.01% of the flow are added to the first tank. The first tank is seeded with treatment plant sludge. The microbes in turn assimilate the tetrachloroethylene and iron and precipitate magnesium salts that are filtered out with two down-draining sand filters arranged in parallel to allow for cleaning and maintenance.

The thrust of this method is to also treat the contaminated soils on site by leaching and biological activity. The glacial till is only moderately to poorly permeable. A simple french-drain leaching field will be employed in the area of the loading dock to disseminate the leaching water. Two open pools will be used to surcharge the soil in the less trafficed areas, TPA and TP6. Once the biological activity is established the bacteria will digest the remaining tetrachloroethylene. It is anticipated that the bacterial count will be near zero upon discharge from the system.

It is advantageous to establish and disseminate a bacterial colony into the contaminated soil by adding nutrients and oxygenation to the overflow. In fact, care must be taken to avoid a nutrient/bacteria rich discharge from the treatment plant that will cause an impermeable algal gel growth in the surface soils, leaching field and the bottom of any infiltration lagoon. Provision will be made to prevent the formation and allow breakup of such an impermeable coating.

If nutrients are not added to the second tank the remaining bacteria will consume the remaining tetrachloroethylene in the tank and the population will decline. An established nutrified and aerated bacterial colony will infiltrate into the soil in the same manner that the solvent did and will digest the tetrachloroethylene in the soil. A cap on the site will not be employed and surface water infiltration will be encouraged during treatment. Additional water for soil infiltration and plume capture may be obtained as needed by hydrofracturing the Parella well.

To operate the merry-go-round air stripper with 15 lifts, at 8 gpm, a 120 scfm air supply is required. Throughput capacities for multistage systems are slightly lower than the calculated flow capacity of a single airlift (12 to 15 times the cross-sectional area of the riser pipe in square inches = gpm), at least in the smaller size strippers. This system can be operated at about 10 gpm per square inch of riser pipe area. Air flow capacity per stage operates at about 1 scfm per gpm per lift, yielding an air to water ratio per stage of 7.48 to 1. Laboratory reported removal rates for single lifts at this ratio are 62-68%.

TABLE 5. REQUIRED AIR SUPPLY FOR AIR STRIPPER

Lifts	Water Flow (gpm)	Air Flow scfm
1	4	4
2	4	8
3	4	12
4	4	16
15	4	60
15	8	120

The airlift stripping system at American Thermostat has been fully operational since February 24, 1987. The current operation is unattended, running at a flow rate of about 3000 gpd (2 gpm). The proposed Wallkill project will treat groundwater at 5700 gpd. Flows, pressures and vacuum controls are in a manually set balance. An automatic shutoff is operative to prevent overflow in the event of transfer pump failure. The system initially was checked twice a week by the Technical Assistance Team (TAT) or the OSC. Now the system is checked once per month and winterized in December.

Samples are taken periodically and analyzed by a commercial laboratory through a TAT special project fund. The previous data shows raw water at 10,300 ppb tetrachloroethylene, and effluent water treated with a seven stage air stripper averaging 48 ppb, for a removal rate of 99.53%. Data from September 1988 indicates groundwater at 12,000 ppb is being captured in the pumping well and no Tetrachloroethylene is detectable to 10 ppb detection limit in the effluent, with the addition of a sprinkler system on the effluent pipe. Removal rates have ranged from 99.5 to 99.86% during the operation to date. With this system the influent groundwater concentration was reduced from 144,500 ppb to 2,000 ppb in 15 months. This system was not provided with the added enhancement of the secondary biological reactor.

To reach an effluent criteria of 5 ppb is a matter of increasing the number of air lifts to 15, employing biological polishing and incurring slightly higher power and supervision costs. Multistage airlift stripping can easily be scaled up to meet the needs of any groundwater/surface water/aquifer volatile cleanup action. These multistage air strippers can be sized for flow rates up into the millions of gallons per day, and costs per gallon can reasonably be expected to be lower for larger systems than for the smaller ones, and also lower for longer remedial actions than for short term projects as the initial capital investment is offset by more gallons treated.

Robert Cobiella is available for clarification of the feasibility of the method. He and George Zachos, Section Chief of the Site Mitigation Section have offered their assistance to Mel Hauptman, the USEPA technical staff on this project, monitoring the remedial effort. This may begin once the consent order is signed and and letter of understanding exchanged between the two USEPA Sections.

Advantages

A full scale model has already been proven to be effective and has completed the treatment operation at an NPL site during which many design refinements were incorporated. We do not need to go to an established air-stripper manufacturer to have the system designed and fabricated. The air stripper can be fabricated on-site using Kimax piping and shipped blowers and pumps. We have taken a videotape of the American Thermostat stripper so that this technology may be replicated easily, by a machine shop close to Edison. We have completed a materials take-off from the American Thermostat stripper and located the parts suppliers. The system will be cheaper to construct than a packed-column air stripper and operates unattended for long periods of time. An Air 100 Permit was not required for the American Thermostat system and meeting the air discharge criteria were not a problem. A permit was obtained for the Hicksville MEK spill. The NY State Air Permits branch is developing policy with regard to permitting air strippers.

Sufficient information is in hand at this time to evaluate the field performance of the multistage airlift stripping technology. It is a high efficiency, low cost technique for purging volatile organic chemicals from water. It is effective, practical, operable, flexible, reliable, amenable to fabrication in the field at a scale tailored to the problem of the site and simple enough to be fabricated by readily available construction-level skilled tradesmen anywhere in this country. It can be fabricated of materials capable of withstanding high or low pH liquids. It will readily move viscous liquids or high solid content liquids. It has no moving parts in contact with the liquid being stripped and so is relatively free from the effects of abrasive materials.

Residuals Generated

No solids are generated as a result of air stripping of volatile organics.

Secondary Environmental Impact

Air stripping has a potential air pollution problem associated with it. Existence of an actual problem depends on the geographical location (state, air quality region, etc.) of the stripper, the efficiencies of the stripper and the expected concentration of contaminants in the influent water.

Previous Applications

Applications of air stripping to the removal of organic pollutants are numerous. Although treatment of contaminated groundwaters is a relatively new use for this technology, many groundwater treatment systems are now in full-scale operation.

O&M Requirements

Air stripping requires minimal operator attention, maintenance, and electricity. The tower itself contains no moving parts. Attention to mineral deposition and biological matting of the column packing will be required.

Interferences

High iron content of the groundwater would interfere with packed column air stripping of volatile organics. This problem is avoided with an airlift system. Reliability of air stripper operation can be a problem for installations where cold weather operation is required. Cold weather would decrease the driving force for volatilization. Heating the influent water may be required for winter operation or a shut down for the months of January, February and March may be considered.

Disadvantages

State regulatory authorities may require air emission source registration and permitting. **Requirement** for vapor recovery may be imposed adding additional capital and operating expense.

Time Frame

Delivery of a unit is possible 90 days after the date of the purchase order. The equipment could be operational within a further 150 days.

We propose to treat groundwater at Wallkill by air stripping to below the acceptable drinking water criteria and discharge that groundwater into the ground. We request that the USEPA confer with the NY State DEC to define the terms under which infiltration of treated water will be allowed.

Costs

The system is not an expensive proposition. At American Thermostat the cost as of April 1, 1987 for the groundwater treatment was $55,000 for the construction, fabrication, running-in and operation of the airlift system for the first month. The cost included a shelter building and all its internal and external component items. Total treated throughput in the first month as of April 1, 1987 was over 150,000 gallons of contaminated groundwater. The capital and operating cost of the airlift stripping was 36¢ per gallon at this time. Projected system shut-down will be at the 300,000 gallons treated, and the cost at that time is forecast at $60,000 attributable to airlift stripping. Final cost per gallon for the completed action is thus expected to be about 20¢ per gallon.

For comparison purposes, the purification of 5.7 million gallons of groundwater at the Hicksville, L.I., New York site by a heated-feed, packed-column air stripper, admittedly a much more difficult to strip material (MEK), but also a much larger system used for an extended period of time, cost about 18¢ per gallon. At the Wallkill site, after 18 months of operation, 3 million gallons of water will have been treated and recycled.

It is our intention to build the air stripper forthwith so that it may be used for the air stripping of the water from the pump test. Neil Isabel, the Regional Air Pollution Engineer for Region III, NYDEC, has given verbal permission to conduct the pump test on the Parella well without a permit in order to obtain hard data on the removal efficiency and exhaust vapor concentration. Caesar Manfredi, NYSDEC Division of Water, will give a temporary authority to conduct a pump test contingent upon review of the air stripper design.

TABLE 6. CAPITAL COST ESTIMATE
MERRY-GO-ROUND AIR STRIPPING

For 18 month operation:

Multistage Stripper	$11,500	
2 x 6,000 gallon tanks (Rental $200/mo plus 500 x 2 liners)	4,500	
Flow Meter	3,000	
Pipes, Valves, Specialties	1,000	
Feed Pumps (2 blowers, 1 vac*, 1 turbine)	7,000	
Electrical at 12%	3,500	
Piping at 8%	2,500	
Instrumentation at 5%	1,500	
Insulated Trailer/Sumps @ $15/ft^2	12,000	
Site Work at 5%	1,500	
Excavation	3,000	
Subtotal	$51,000	$51,000
Contingency and Engineering at 25%		13,000
TOTAL CAPITAL COST		$64,000

TABLE 6A. ANNUAL COST ESTIMATE - AIR STRIPPING

Labor ($500/month discounted in house)	$3,000
Power at $0.10/kWh ($300/mo)	5,500
Chemicals ($50/mo)	1000
Maintenance at 4% of Capital Cost	2,500
TOTAL ANNUAL COST	$12,000
At double (8 gpm operation)	

$/gallons-$0.20-35

Suppliers

Fabrication - Local
Piping - Kimax, Amsco Sales, Fairfield NJ.(201) 575-8350
Pumps - Ring Compressor, Fuji, NY (212) 697-0116
Impeller - Wright-Austin, Detroit, Michigan
(dealer Koechlein, NJ 201 652-6274)

TABLE 11B. CAPITAL COST ESTIMATE. MERRY-GO-ROUND AIR STRIPPER

Materials Take Off - Multistage Air-stripper, 15 Air lifts

Item Kimax	Quantity Pipe	Description	Stock Number Process Pipe	Unit Cost	Extended
1.	2x15	2"dia T Straight	6310-2020	$47.40	$1422
2.	15	2"dia Reducing T 2"x 1/2"	6311-2048	27.75	416.25
3.	2x15	2"End Plug	6344-2000	9.8	294
4.	15	2"Straight 6'	6300-20072	53.75	806.25
5.	2x15	Sweep Elbow 90 Degree Short	6304-2090	31.10	933
6.	2x15	Short Straight 4"	6300-20004	27.95	838.50
7.	15	Sweep Elbow 45 Degree Short	6301-2045	31.55	473.25
8.	15	Compact Y	-	50	750
9.	15	Straight 5"	6300-20060	44.5	667.5
10.	15	Straight 6"	6300-20006	27.95	419.25
11.	1	Portable Glass Cutter	7310-56802	250	250
Couplings					
12.	11	2" Beaded Couplings	7126-2000	19.90	3,283.50
13.	1	1/2"Beaded Couplings	7126-4800	11.00	165
14.	1	Split Coupling(Threaded to Beaded)		50	50

Plumbing - Water Piping

1.	2	Threaded PVC Drum Tap	$10.25	$20.50
2.	50 ft	2" dia. PVC Straight	11.75/10 ft	58.75
3.	1	2" dia. PVC Y	3.65	3.65
4.	2	2" dia. PVC Street L	2.65	5.30
5.	2	2" Plumbing Couplings	.49	.98
6.	8	2" dia. PVC 45 Degree Angles	.80	6.40
7.	15(x)	2" dia. PVC Ts	1.55	23.25
8.	15(x)	1/2" pvc	6.90	103.50
9.	1	Ball Valve	7.15	7.15

Materials Take Off - Multistage Air-stripper

Item	Quantity	Description	Unit Cost	Extended	
Plumbing - Air Supply					
10	2	4" dia. PVC 90 Degree Elbows	4.75	9.5	
11	50 ft	4" dia. PVC Straight	32	160	
12	2	4" dia. PVC 45 Degree Elbows	6.8	13.6	
13	1	4" dia. PVC T	6.79	6.79	
14	2	4" dia. PVC Valves	26.00	26.	
15	1	2"pvc x 2" Threaded Coupling	3.4	3.4	
Vent					
16	15	4"x 4" PVC 90 T	6.79	101.85	
17	15	2" x 4" Adaptors	3.4	51	
18	8	4" dia. PVC 45 Degree Elbow	.80	6.4	
19	20 ft	4" dia. PVC Straight	32.0	64.0	
20	1	4" dia. PVC T	6.79	6.79	
23.		2 x 6,000 gallon tanks		4,500	
		Flow Meter		3,000	
		Pipes, Valves, Specialties		1,000	
		Feed Pumps (2 blowers, 1 vac, 1 turbine)		7,000	
		Electrical at 12%		3,500	
		Piping at 8%		2,500	
		Instrumentation at 5%		1,500	
		Insulated Building/Sumps @ $15/ft^2		12,000	
		Site Work at 5%		1,500	
		Excavation		3,000	
		Subtotal		$40,178.81	$40,178.81
		Contingency and Engineering at 25%			13,500
		TOTAL CAPITAL COST			$53,678.81

For 18 month operation:
or equivalent component

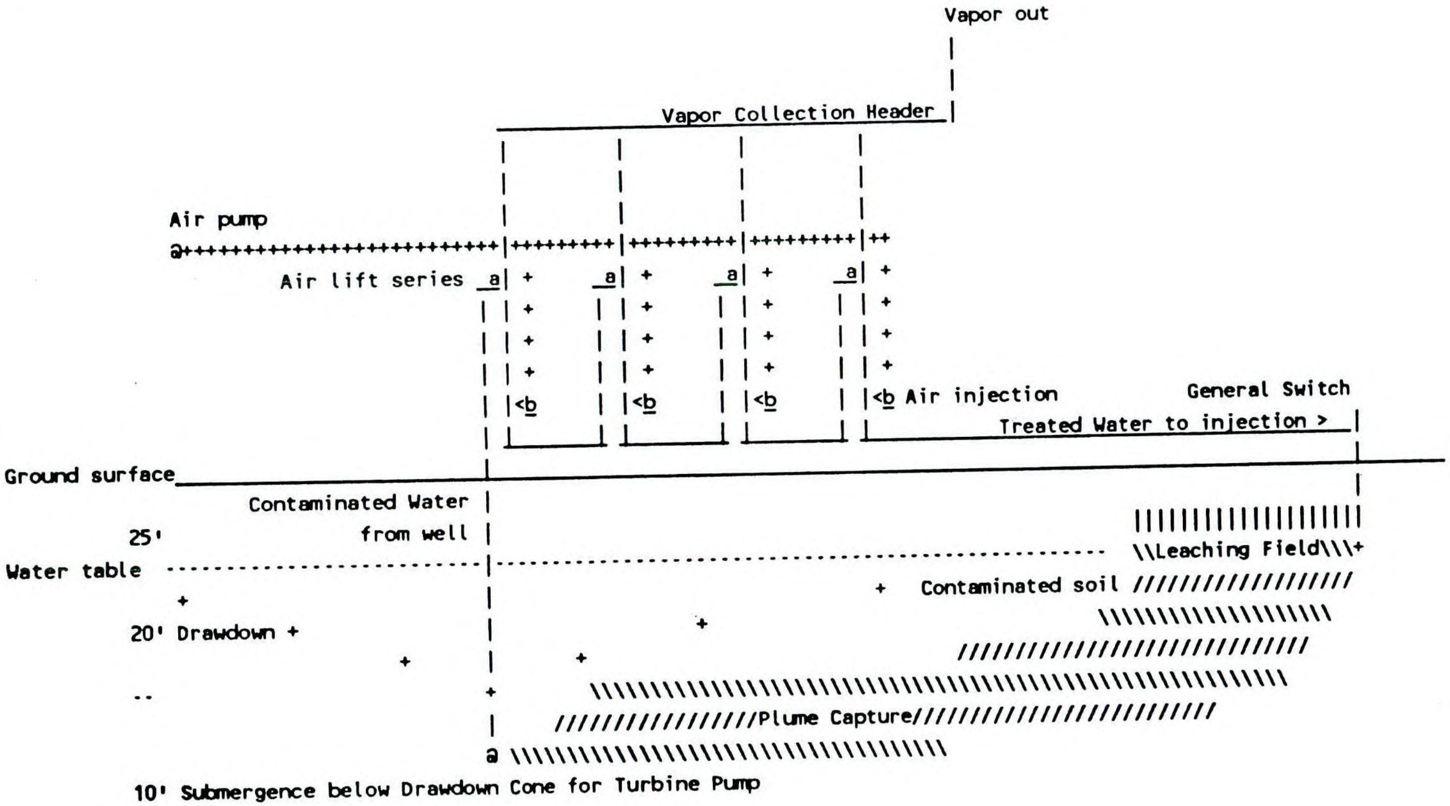


Figure 20: Multistage Airlift System

3.0 Sampling and Analysis

General Switch agreed to analyze all soil and water samples using a Photovac Portable Gas Chromatograph and, in addition, to analyze in an independent, mutually acceptable laboratory one of every ten water samples for all priority pollutant volatile organics (Method 624) and to analyze one in ten soil samples for all priority pollutants volatile organics (Method 8240). The sampling protocol for this procedure is described in the Appendix D and appended to the consent decree.

3.1 Well Testing

General Switch assumes the responsibility of testing and the provision of public water for those homes identified in the consent order. These homes are the Seeley, Wood and Gilbert residences on Highland Avenue. The sampling protocol for these homes is detailed in the Appendix B. Those wells that yield water that contains 5 ppb or more of tetrachloroethylene will be connected to private water supply by General Switch.

3.2 Quality Control of the Treatment Process

For quality control of the treatment process the following samples will be required:

- o Sample of raw water from the Parella well
- o Sample influent to Tank #1 from the discharge of the first set of air lifts
- o Sample of the discharge from Tank #1, entrance to the second set of air lifts
- o Exit from Tank #2
- o Duplicate and Blank Quality Control (QC).

Cost of Analyses:

Various laboratories in the area, such as Camo Laboratories of Poughkeepsie, are capable of conducting single compound volatile analyses for tetrachloroethylene (Method 601/602) and full priority pollutant volatile scans (Method 624/8240).

The range of analysis costs per sample are:

	Water	Soil
Volatile organics:		
Purgeable Halocarbons by GC Method 601	$70-$120	$130-170

These same labs can run a full priority pollutant volatile scan

GC/MS Method 624/8240	$180-240	$200-250

The Portable GC Photovac 10S50 will be used to reduce the cost of analysis. As per the requirements of the USEPA, one in ten water samples and one in ten soil samples will need to go for full volatile scan in a laboratory (Method 624/8240). After six months of sample analysis under this order, when the complement of contaminants is well established, one in ten soil and water samples screened using the Photovac will be tested in the laboratory by methods 601/602 for the indicator compound tetrachloroethylene and one in forty of the Photovac samples will be tested by method 624/8240. The cost of a sample round of the treatment system using a laboratory for all samples would be approximately $500 per round.

Sampling Costs and Schedule

Schedule Months	1	3	6	9	12	15	18	21	24	27	30	33	36	Sampling & Analysis Cost
Treatment System														
1 sample round														
Influent/effluent	35													$3,500
per day for 1 week	4 QC													800
1 sample round per week	8													800
for the next 2 months	2 QC													400
2 sample rounds/month		8												800
for the next 4 months		2 QC												400
1 sample round/month				12xxxxxxxx										1,200
for the next 12 months				2 QC										400
1 sample rounds/2 month									xxxxxxx9xxx					1,100
for the next 18 months											2 QC			400
Drinking Water Well Samples														
It is anticipated that 10 Method 624														
samples will be required of														
monitor and water supply		10					10					10		$6,000
wells each year		2 QC					2 QC					2 QC		1,200
Soil Samples Required														
During Soil Treatment														
Drains/Soil Treatment	20					20				20				$6,000
(5 per excavation)	2 QC					2 QC					2 QC			1,200
Air samples														
	2					2				2				$1,000
	1 QC					1 QC				1 QC				600
Final Well Sampling -Parella Well														
6 months after cleanup complete											1			200
									Subtotal					$26,00

Note: QC Samples are run for the full suite of Volatile Organic Priority Pollutants

4.0 Institutional Requirements

Regulations under the the Resource Conservation and Recovery Act (RCRA), the Safe Drinking Water Act (SDWA), and the Federal Water Pollution Control Act (Clean Water Act or CWA), and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) have the broadest applications to remedial actions. As part of the Consent Order we ask that the USEPA and New York State provide letters detailing the exact regulation requiring the permits required by the government agencies: to enumerate the required permits.

4.1 Permits

The results of the continuing institutional analysis for the site are presented, as part of the non-cost considerations of the remedial actions proposed. Federal programs such as the Clean Water Act, the Clean Air Act and various Resource Conservation and Recovery Act programs have been authorized by the USEPA to be administered by New York State. Various State regulations may apply to the site cleanup operations.

New York State Permits and Regulations

For Federally supervised sites and for sites that produce plumes from hazardous waste disposal sites, NY State supervision is conducted by the Division of Hazardous Waste Remediation. The Regional Engineer for Environmental Quality, Harry Agarawal for the NY State DEC has responsibility for administering both the Water and Hazardous Waste regulation and is the point of contact in obtaining a decision on the required State permits. Harry Agarawal reports to Al Klaus, the Regional Director of Environmental Quality Engineering. Ronald Pergardia, in Albany, has special responsibility for sites involving PRPs (Potentially Responsible Parties). The Regional Air Pollution Engineer, Neil Isabel, also reports to Al Klaus. The NYSDEC lawyer for this site is Lou Evans. Permits that are required for this site include:

o *NPDES Permits*

Discharge of pollutants or contaminants from a point source into U.S. waters requires a National Pollutant Discharge Elimination System (NPDES) permit pursuant to CWA section 402.

Discharge of pollutant contaminants into a publicly owned treatment works (POTW) may require permits issued by the local POTW, however, this alternative was previously dismissed.

- Groundwater Reinjection Permit, NYSDEC: Division of Water:

The injection of treated water from the Parella Well into an underground formation may require a Groundwater Reinjection Permit under the NPDES program administered by Caesar Manfredi of the NYSDEC: Division of Water. The reinjection of treated groundwater as a means of site cleanup is an acceptable policy of the NY State DEC detailed in two documents: Groundwater Policy Statements on the Reinjection of Groundwater. The Division of Hazardous Waste Remediation has the choice of administering NY State regulations either through a Division of Water Permit or through an Administrative Order.

According to Caesar Manfredi, as the site is being administered under CERCLA, the discharge of treated water into the ground may not require a permit but will have to meet the conditions of a permit (NYC Regulation Part 750). According to NY State regulations, under a permit, the discharge will meet the NY State Groundwater Quality Standard that is now 5 ppb for tetrachloroethylene, except in an area of containment such as a slurry wall or injection into a drawdown cone of recovery wells. In a decision on the appropriate groundwater requirements, the Division of Hazardous Waste Remediation will contact the Division of Water.

Caesar Manfredi has agreed to allow us to discharge the water to the ground during a pump test provided that we demonstrate to his satisfaction that the effluent criteria will be met. This demonstration may be in the form of a description of the air stripper operation in terms of discharge rate and time and anticipated effluent concentration. Whereupon Caesar Manfredi will issue us with a letter of temporary authorization to conduct the pump test.

- Clean Air Act Permits

Air Emissions: Regarding the air emission levels from site activity, General Switch has agreed to meet air emission levels permitted by existing permits granted by the State of New York. The air stripper will be located on the General Switch property and not at the Parella well. The water will be pumped out of the Parella well for treatment by the stripper on the General Switch site and the treated water discharged in the excavated holes formed during soil cleanup at the three hot spots.

According to the USEPA, a permit may not be required for such on site remedial activity though the NY State air criteria will be observed.

According to Neil Isabel, NYSDEC Regional Air Pollution Engineer, emissions of pollutants to the air from the air stripper will require a New York State Air Permit (Air Resource Regulations 211.13 & 211-14). The criteria exhaust levels that will be permitted depend on the substance emitted, its quantity, and the air quality classification of the area. The NYSDEC will assess the impact of the exhaust. Based on past experience Neil Isabel does not envisage any problems in permitting the air stripper. The stripper must be separated from the exhaust from other manufacturing process operations.

Section 6 NYS RR 212 details the regulations for process and exhaust systems. An Air 100 Form will need to be completed that details the geographic location and chemical emissions from the site along with the emission rate potential (the emission rate without any controls) and the emission rate with controls. Neil Isabel requires an estimate of the rate of emission of solvent from the soil during soil treatment.

New York State DEC is reviewing hydrocarbon emissions from sites because of the ozone exceedences experienced in the State this last summer. It is noted that Orange County is in attainment for ambient ozone levels. John Davis of the Bureau of Source Control (518) 457-5618 is reviewing policy in regard to air strippers and will probably define the rate of emissions from a site above which controls are required. This policy may ask for an evaluation of the anticipated air emissions from the soil treatment and may either prevent the application of rotor tilling and evaporation of hydrocarbons as a remedial measure for spill sites or for the control of these emissions

According to Neil Isabel we do not need a temporary air permit to conduct the pump test. We can conduct the pump test with the air stripper to provide hard data on the air emissions for the Air 100 Permit and he anticipates no problems in permitting the system.

The NY State DEC has not been issuing permits for land treatment of volatile contaminated soil. Neil Isabel requires an estimate of the rate of emission of solvent from the soil during soil treatment by rotor tilling. He has informed Shakti Consultants that this rate will most likely be acceptable.

- RCRA Program Permits

Transportation of hazardous waste to an off-site treatment, storage, or disposal facility (TSDF) requires RCRA manifests and TSDF permits but will not be required for on-site treatment.

5.0 Completion of Cleanup

Groundwater:
The completion of the groundwater cleanup will be achieved when the groundwater that is recovered during the pumping from the Parella well yields readings below the adopted criteria of 5 ppb of PCE and remains below that level for six months.

After the influent concentration reaches 5 ppb, in order to confirm that the clean-up standard is maintained, General Switch will then proceed to monitor the well water in the Parella well for two quarters. If the well water remains at less than 5 ppb, six months after the initial shut down, the cleanup will be deemed complete, (i.e., the achievement of the stated criteria) If the groundwater tested at that time exceeds the stated criteria, then treatment will be resumed.

Soil Cleanup:
The completion of soil cleanup will be when the agreed upon volume of soil is excavated, rotor tilled thereby reducing the soil solvent concentration by 95-99.9% and replaced and the site will be given a release from the order at the end of groundwater pumping after the deeper soil horizons have been treated by leaching with the treated water from the Parella Well when the groundwater from the Parella well has maintained a concentration at or below 5 ppb for a period of six months.

TREATMENT COSTS

Alternative	Capital Cost	O&M 12 month
GROUNDWATER TREATMENT Pump Parella well into Merry-go-round air stripper.	$64,000	$12,000
Well Rehabilitation	17,500	6,500
SOIL TREATMENT Till soil to 4 feet/6 feet	32,000	2,500
Analysis		12,000
Subtotal	$113,500	$33,000

Figure 1. Site Location Map - General Switch

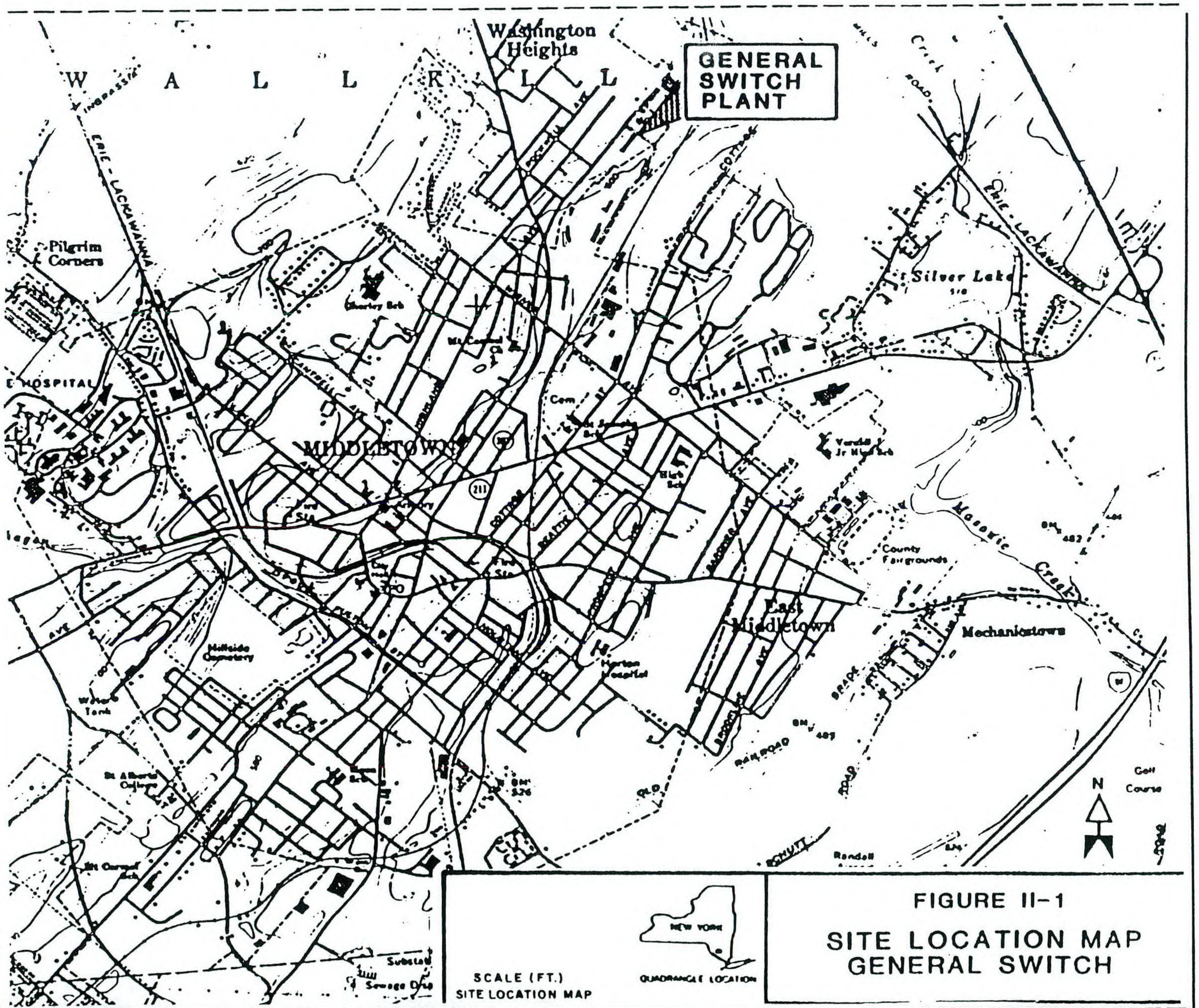
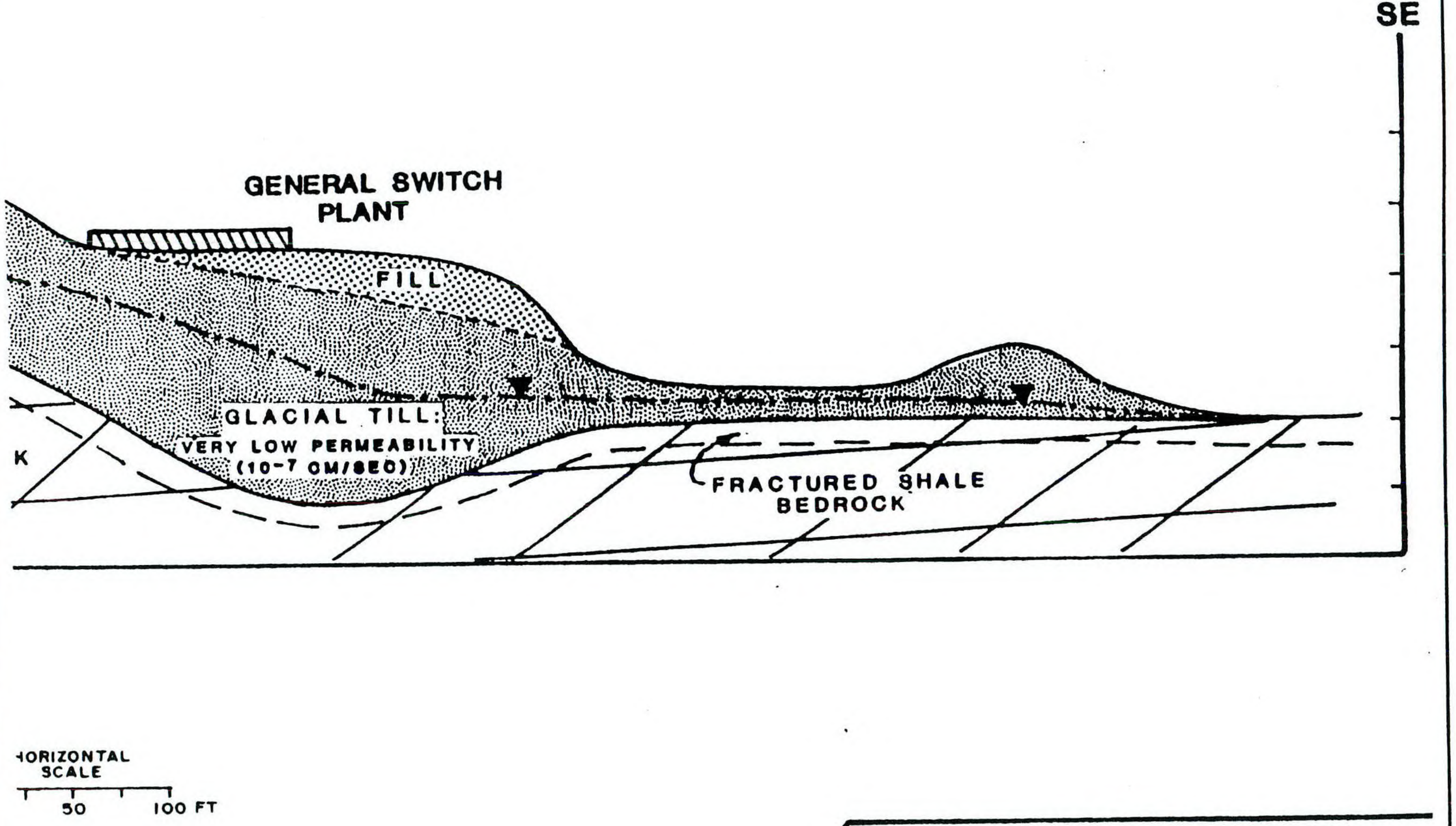


FIGURE II-1

SITE LOCATION MAP
GENERAL SWITCH



)N BEDROCK LIMITED TO
'OOT CORE

FIGURE IV-1

GENERALIZED
GEOLOGIC CROSS-SECTION
GENERAL SWITCH

Figure 2. Generalized Cross Section - General Switch

Shakti Consultants, Inc.

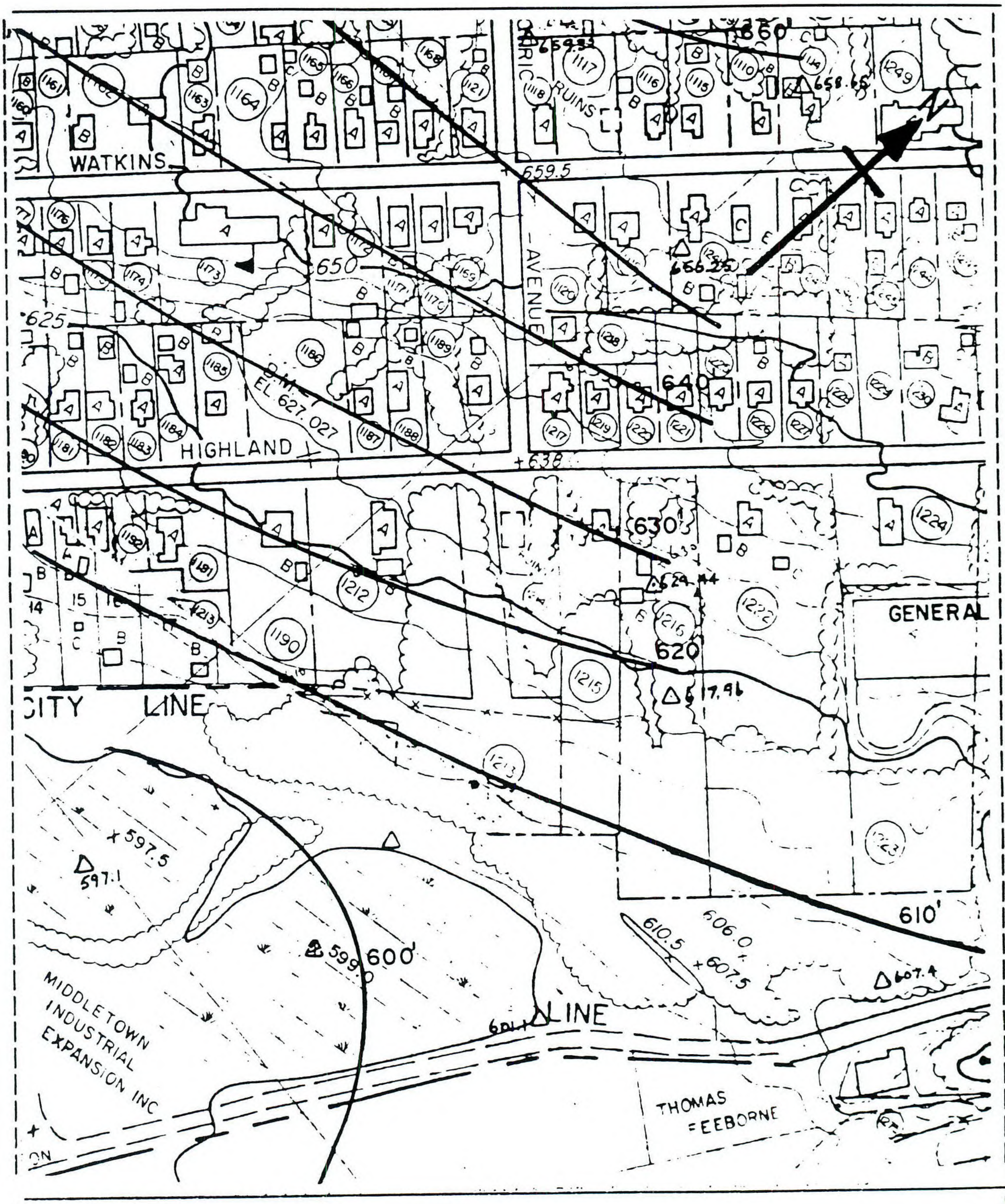


Figure 3. Water Table Elevations in the Glacial Till, Jan 1984

Shakti Consultants, Inc.

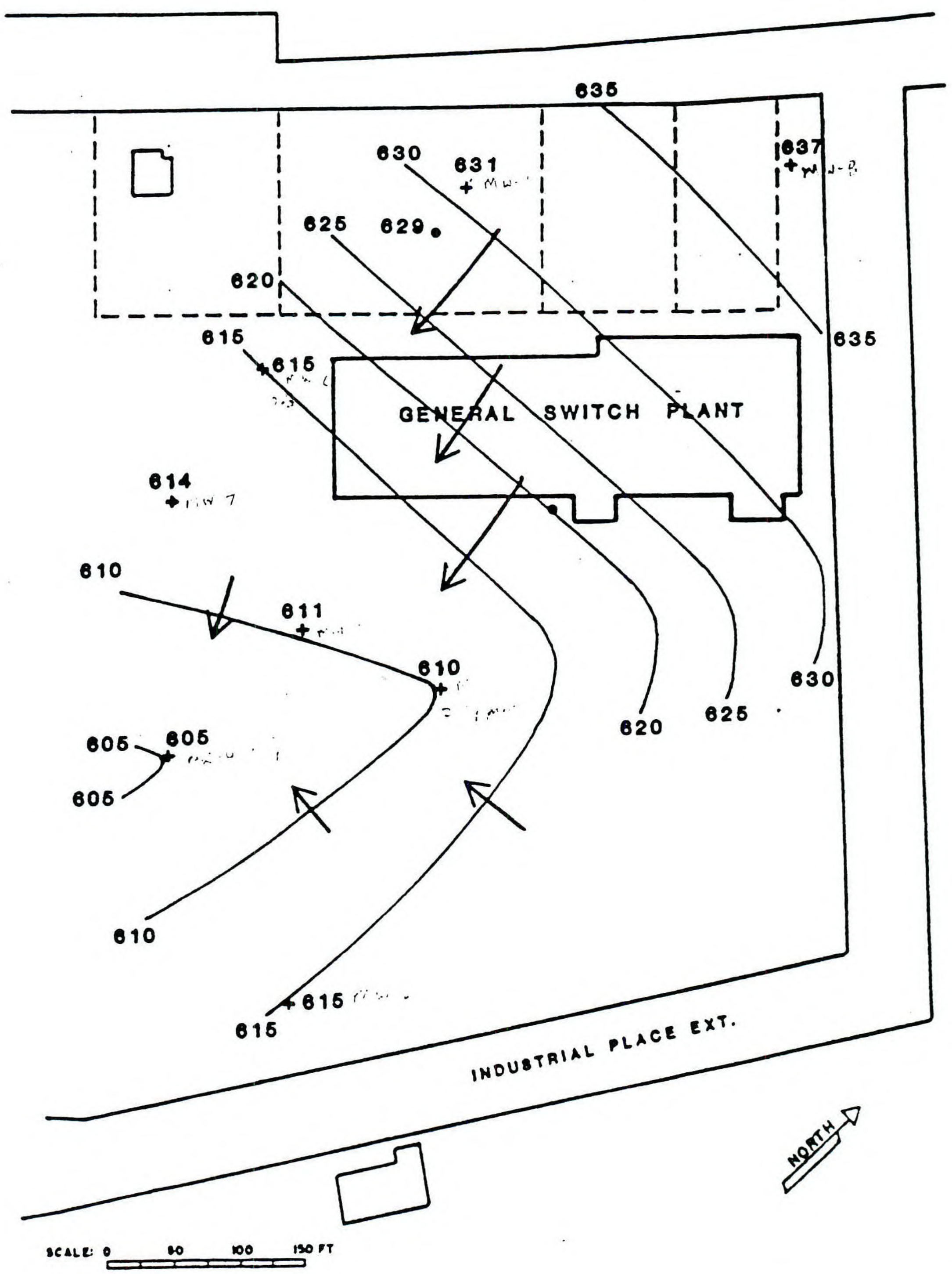


Figure 4. Contour Map of Water Levels - General Switch

Shakti Consultants, Inc.

LEGEND

* WATER LEVELS MEASURED IN WELLS OPEN TO BASE OF SHALLOW TILL AND TOP OF SHALLOW BEDROCK

610 ——— 610 CONTOUR OF WATER LEVELS MEASURED 9-14-84

⟶ POTENTIAL FLOW DIRECTION

CONTOUR INTERVAL = 5'

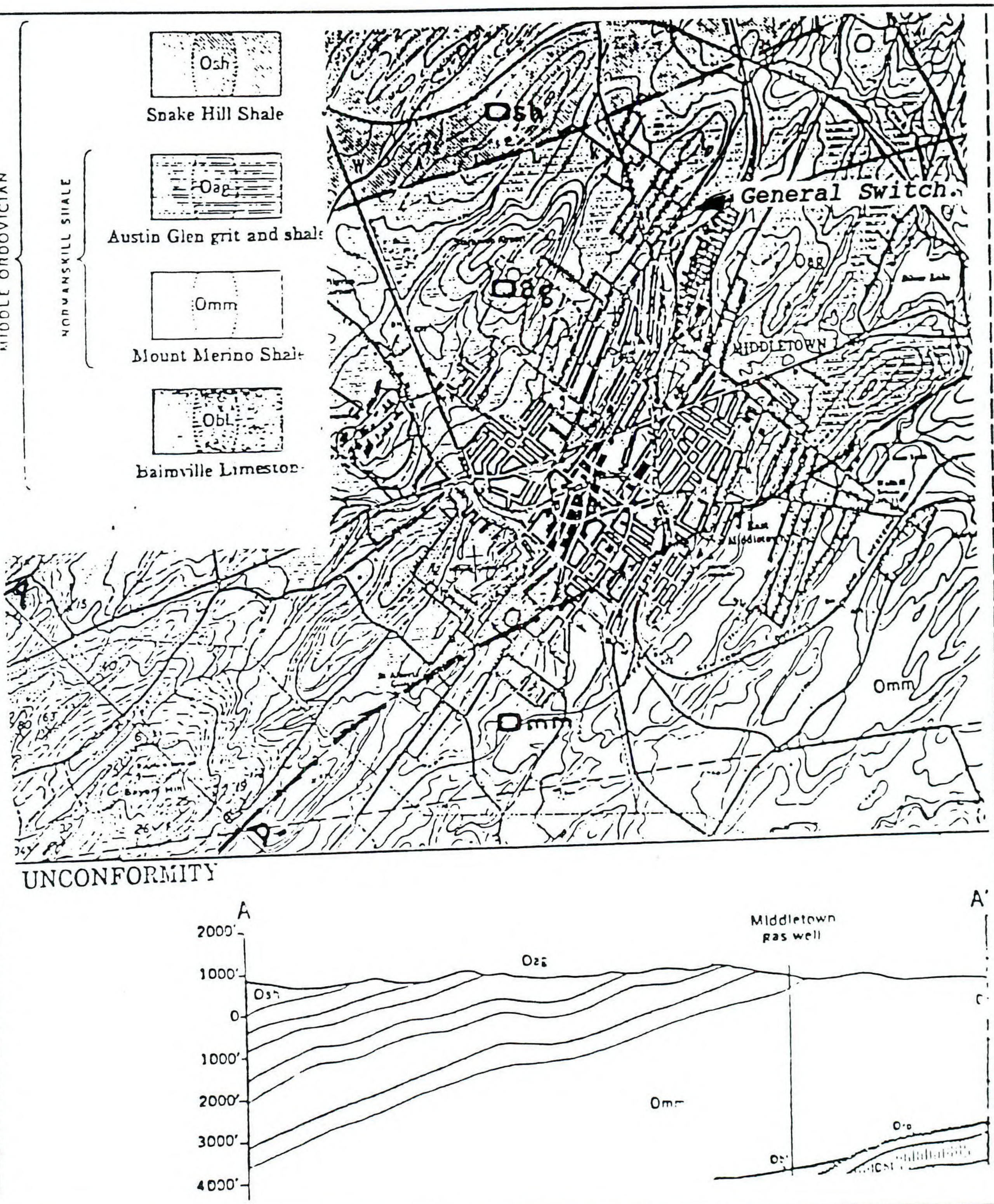


Figure 5. Geologic Map and Cross Section

Figure 6. Composite Groundwater Contours - Washington Heights

Shakti Consultants, Inc.

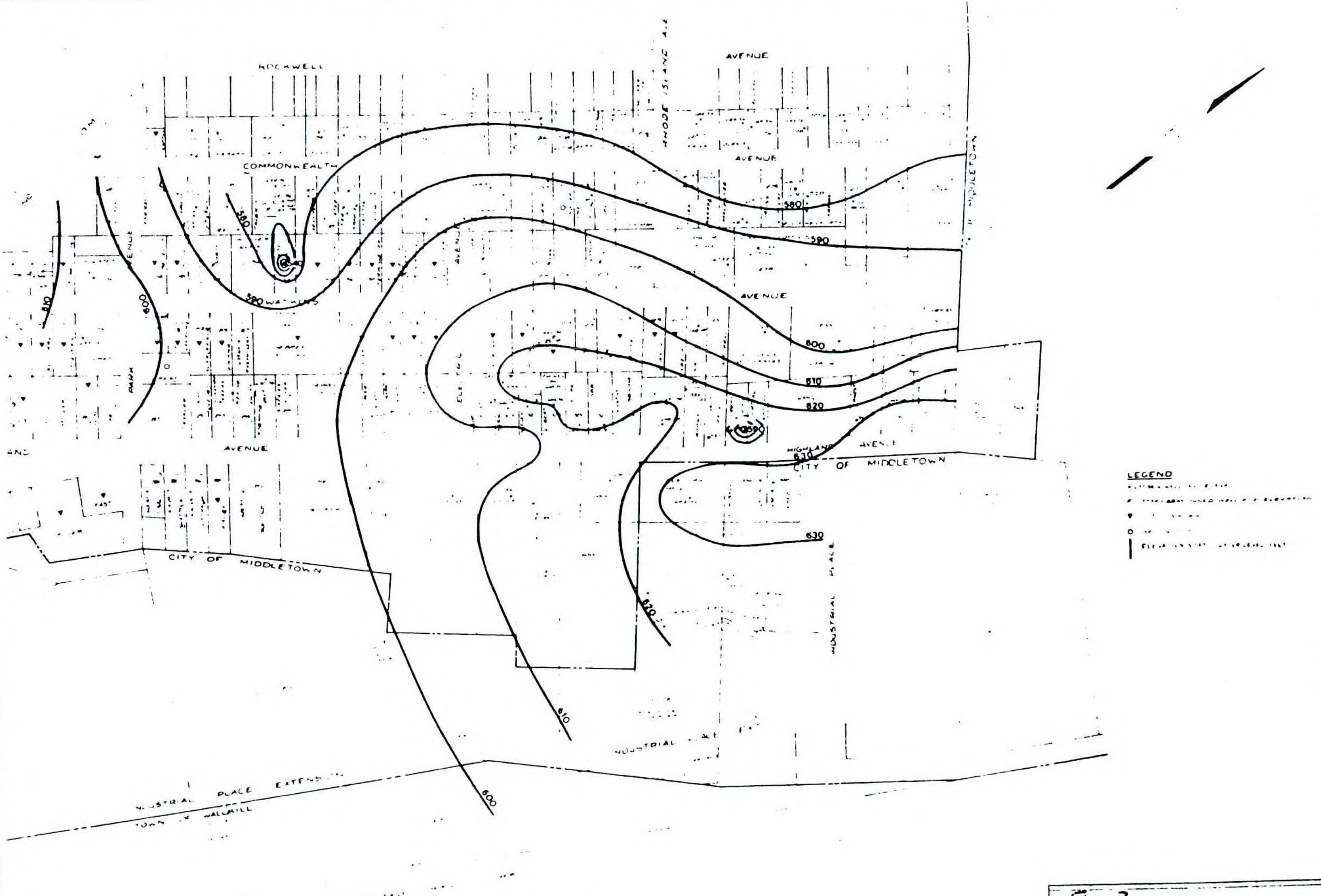


Fig. 3.

WASHINGTON HEIGHTS

WALLKILL SITE MAP

COMPOSITE GROUNDWATER CONTOURS

Figure 1. Levels of Tetrachloroethylene (ppb) in the Parella Well during Pumping. Oct. 17-Dec. 26, 1983

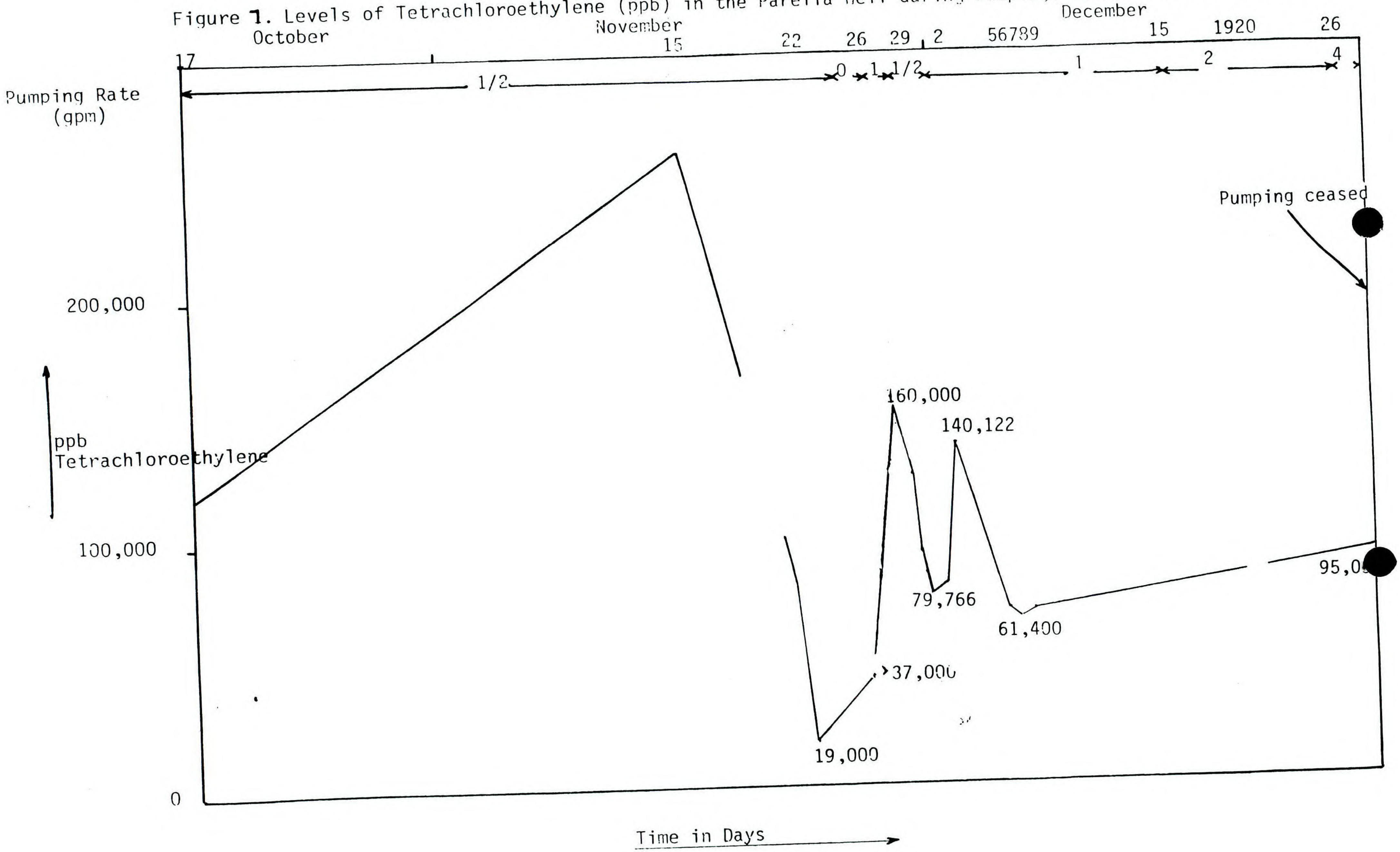
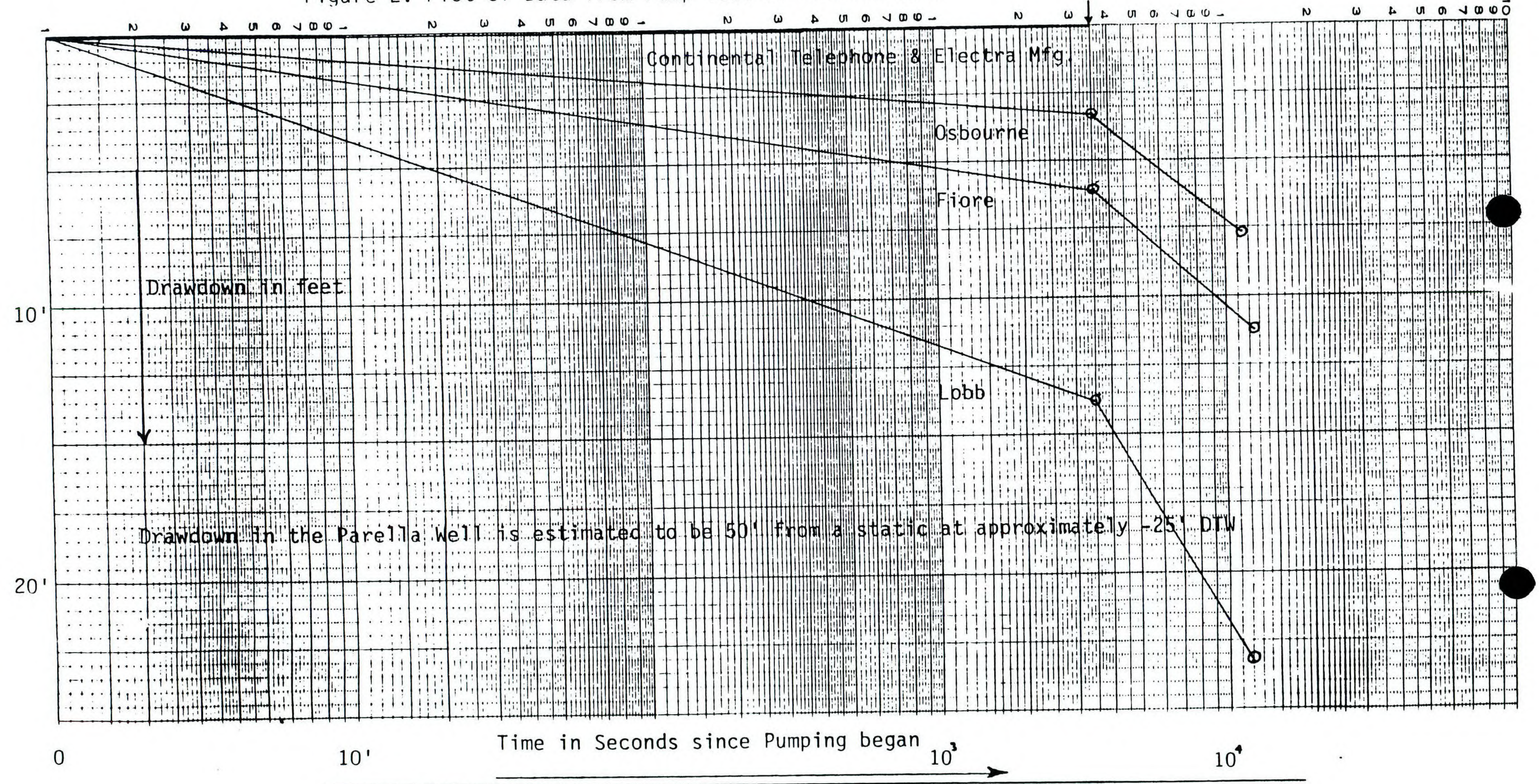


Figure 2. Plot of Data from Pump Test 1. Parella Well



Drawdown in the Parella Well is estimated to be 50' from a static at approximately -25' DTW

Figure 8. Plot of Data from the Pump Test 1. Parella Well

Shakti Consultants, Inc.

Table 1: Parella Pump Test #1

Time Of Reading Flow Rate		1495–1500 hr. Static	1610–1630 hr. 4 gpm	1656–1730 hr. 4 gpm	End Of Test
Residences/Well	Distance In Feet From Parella Well	Water Levels Measured In Ft. From Top Of Casing			Total Draw-Down
Parella Well					50'*
Osbourne	185'	26.94'	30.33'	34.55'	7.61' = 34.55-26.94
Lobb	144'	25.81'	39.68'	49.00'	23.19' = 49.00-25.81
Fiore	150'	22.28'	28.37'	33.45'	11.17' = 33.45-22.28
Electra Mfg.	194'	10.38'	10.36'	10.40'	.02 = 10.40-10.38
Continental Telephone	350'	21.35'	21.37'	21.53'	.18 = 21.53-21.35

Table 2: General Switch Pump Test #1

2/2/84

Time Of Reading Flow Rate		Static t_o = 12:13 2 gpm	13:53 – 14:21 2 gpm	16:26 – 16:40 2 gpm	End Of Test
Residences/Well	Distance In Feet from General Switch	Water Level In Feet From Top Of Casing			Total Draw-Down
General Switch	0	13.79'	>300'	>300'	>286'
Parella	370'	23.58'	23.92'	26.16'	-2.58
Osbourne	490'	32.61'	32.94'	34.56'	-1.95
Electra Mfg.	210'	13.70'	13.61'	13.59'	+ .11**
Perry	370'	65.72'	62.04'	59.13'	+6.59
Continental Telephone	670'	23.13'	23.1'	23.13'	0
Wand	650'	79.97'	79.15'	78.83'	+1.14
Pitt	580'	33.98'	33.98'	34.05'	-.07
Perez	260'	15.82'	15.80'	16.02'	-.2
Guild Molders	1040'	7.96'	7.94'	7.94'	+.02

*Estimated at the elevation of the pump when the Parella well lost suction.

**Positive values indicate a well that is recovering.

Table 3: Ruppert Pump Test #1

Time Of Reading Flow Rate		Static E0=11:15 11:05-11:15	12:00-12:35 11 gpm-6gpm	13:46-14:18 2 gpm	End Of Test
Residences/Well	Distance In Feet From Ruppert Well		Water Level In Feet From Top Of Casing		Total Draw-Down
Ruppert	0	Approx 33'	180'	180'	-147'
Barry	50'	32.78'	37.95'	42.05'	-42.05'
Continental Telephone	290'	23.07'	23.55'	23.70'	-.63'
Knapp	250'	43.40'	42.32'	42.62'	+.78'
Van Pelt	310'	30.27'	29.2'	28.87'	+1.4'
Stout	400'	18.00'	18.00'	18.26'	-.26'
Robaina	270'	37.26'	37.55'	37.76'	-.5'
Estrada	480'	24.21'	24.21'	24.33'	-.12'
Morse	420'	111.13'	109.17'	107.94'	+3.19'
Rassmussen	360'	44.47'	44.50'	44.74'	-0.27'
Winner	480'	73.98'	70.16'	67.85'	+6.13'
Palermo	600'	81.53'	79.44'	77.94'	+3.59'

*Water levels at pump intake by assumption when pump broke suction: Well annulus blocked preventing direct water level measurement.

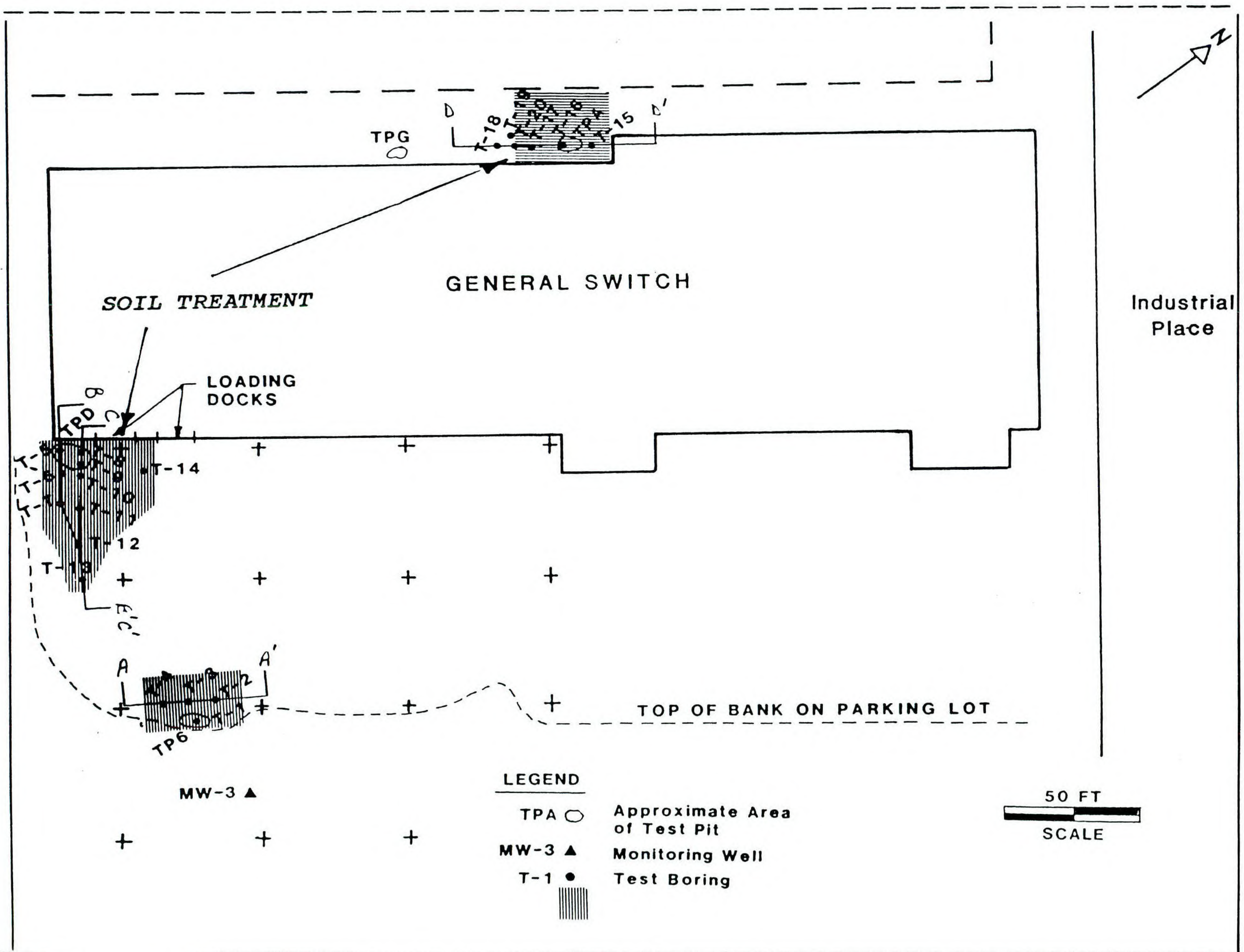


Figure 9. Location of Test Borings and Areas for Soil Treatment

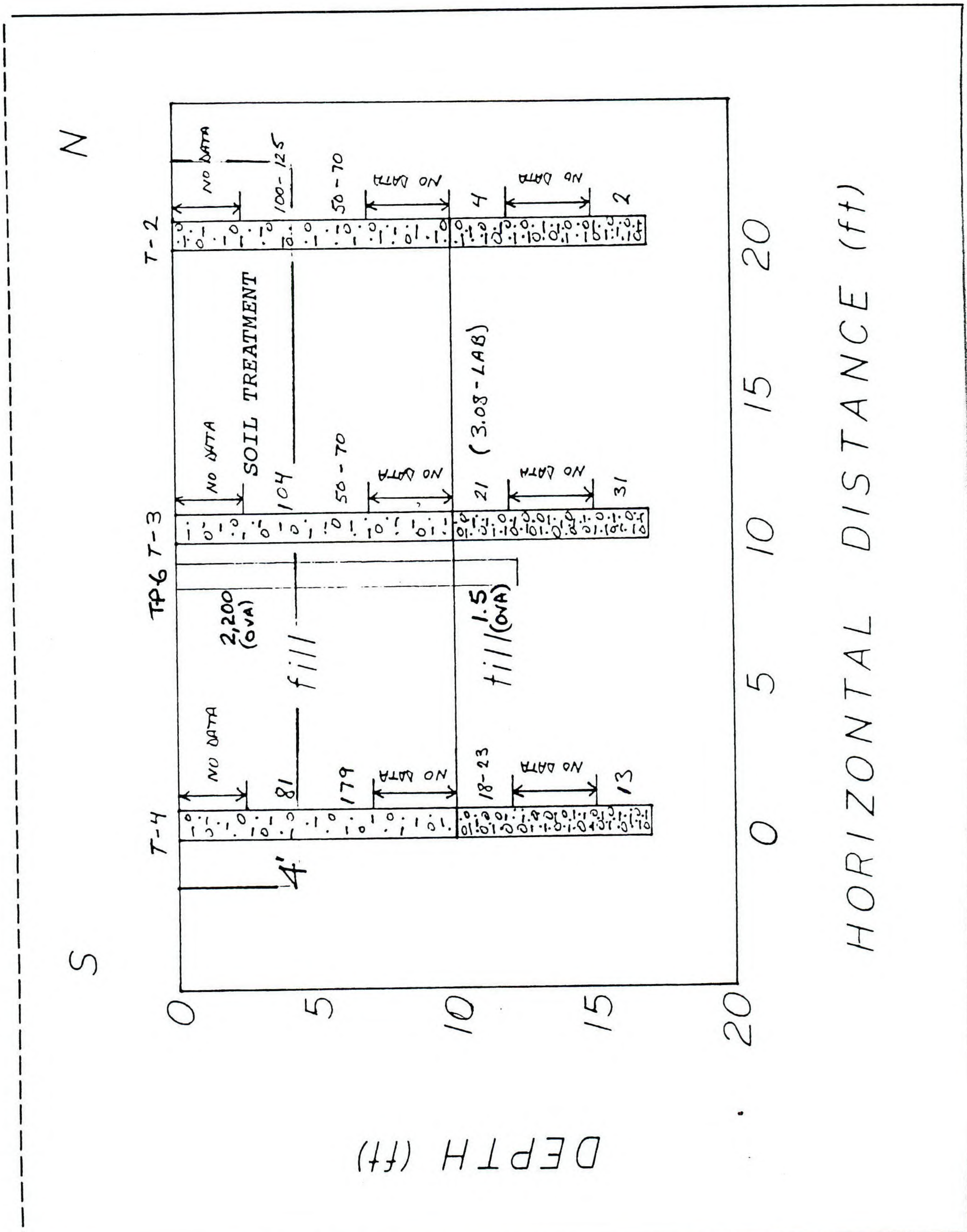


Figure 10. Cross-Section: Analytical Data & Depths for Soil Treatme

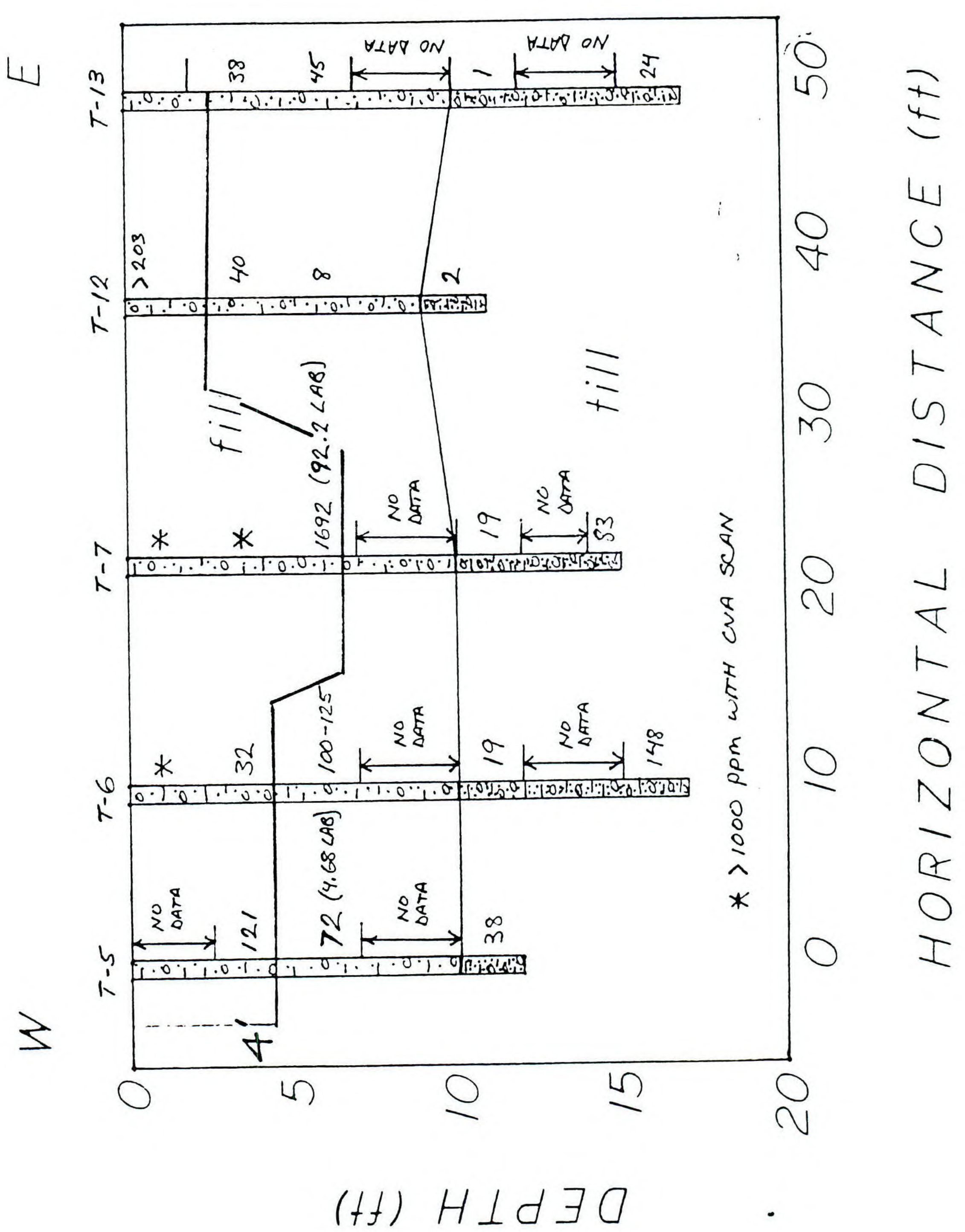


Figure 11. Cross-Section: Analytical Data & Depths for Soil Treatm

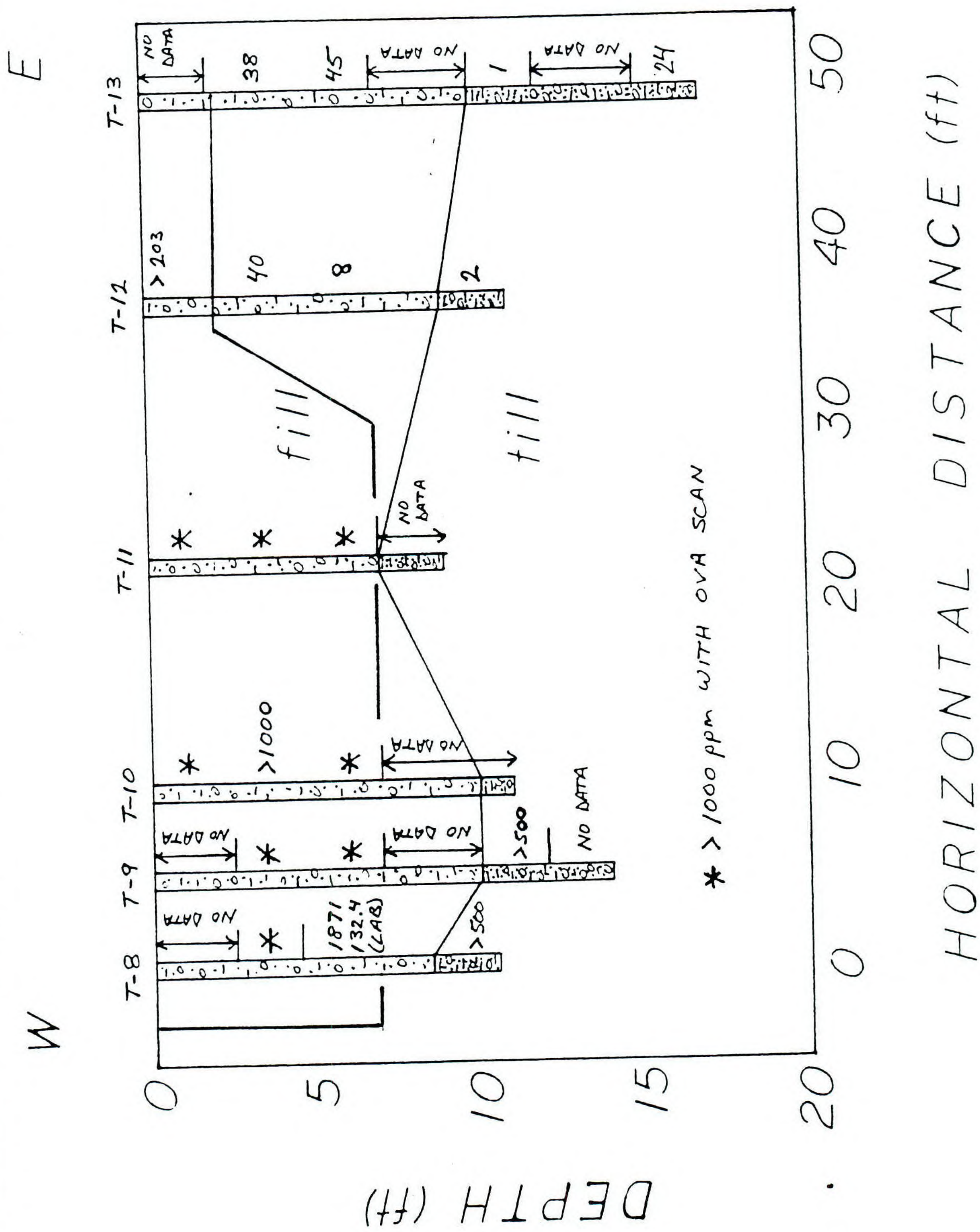


Figure 12. Cross-Section: Analytical Data & Depths for Soil Treatme

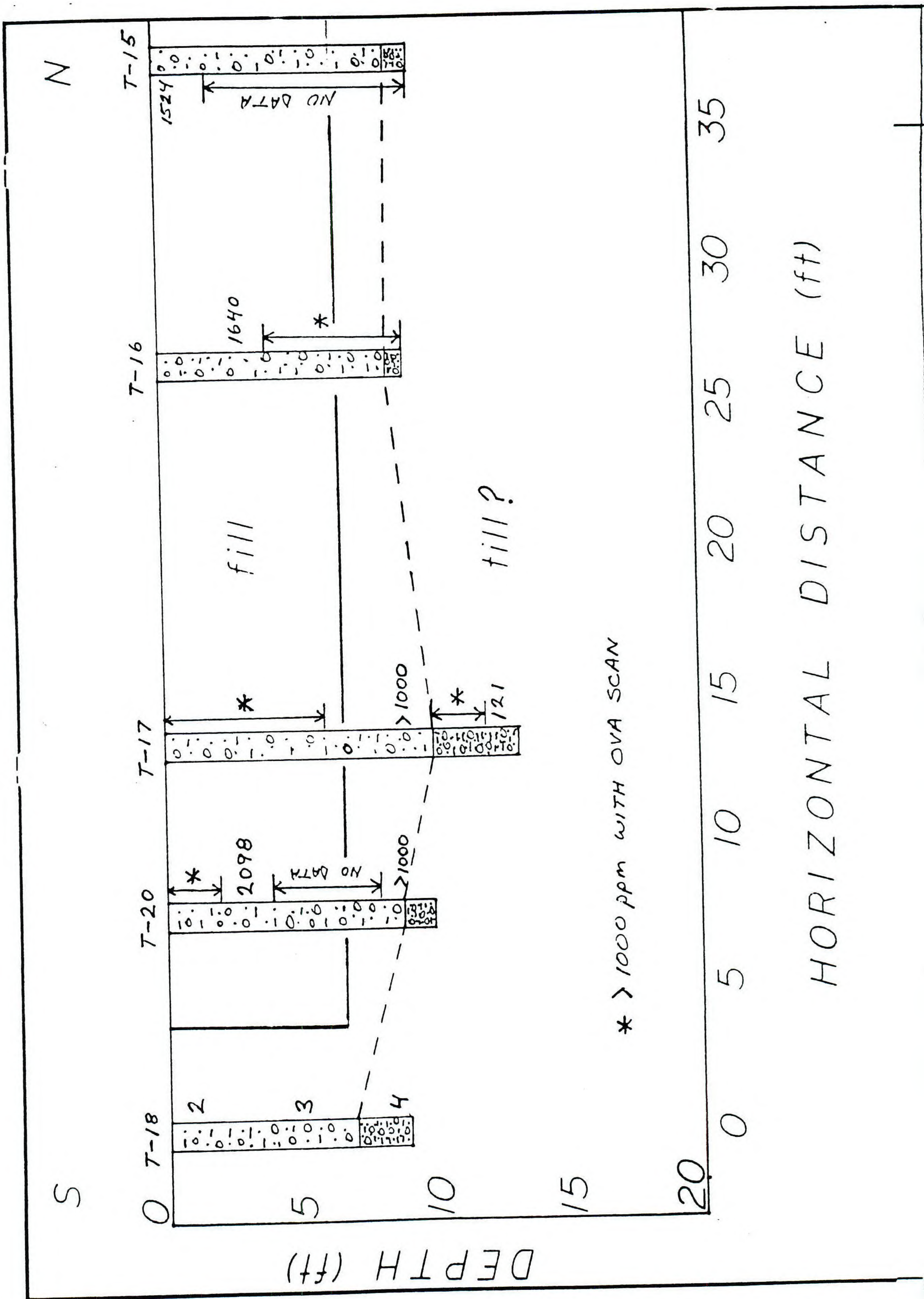


Figure 13. Cross-Section: Analytical Data & Depths for Soil Treatm

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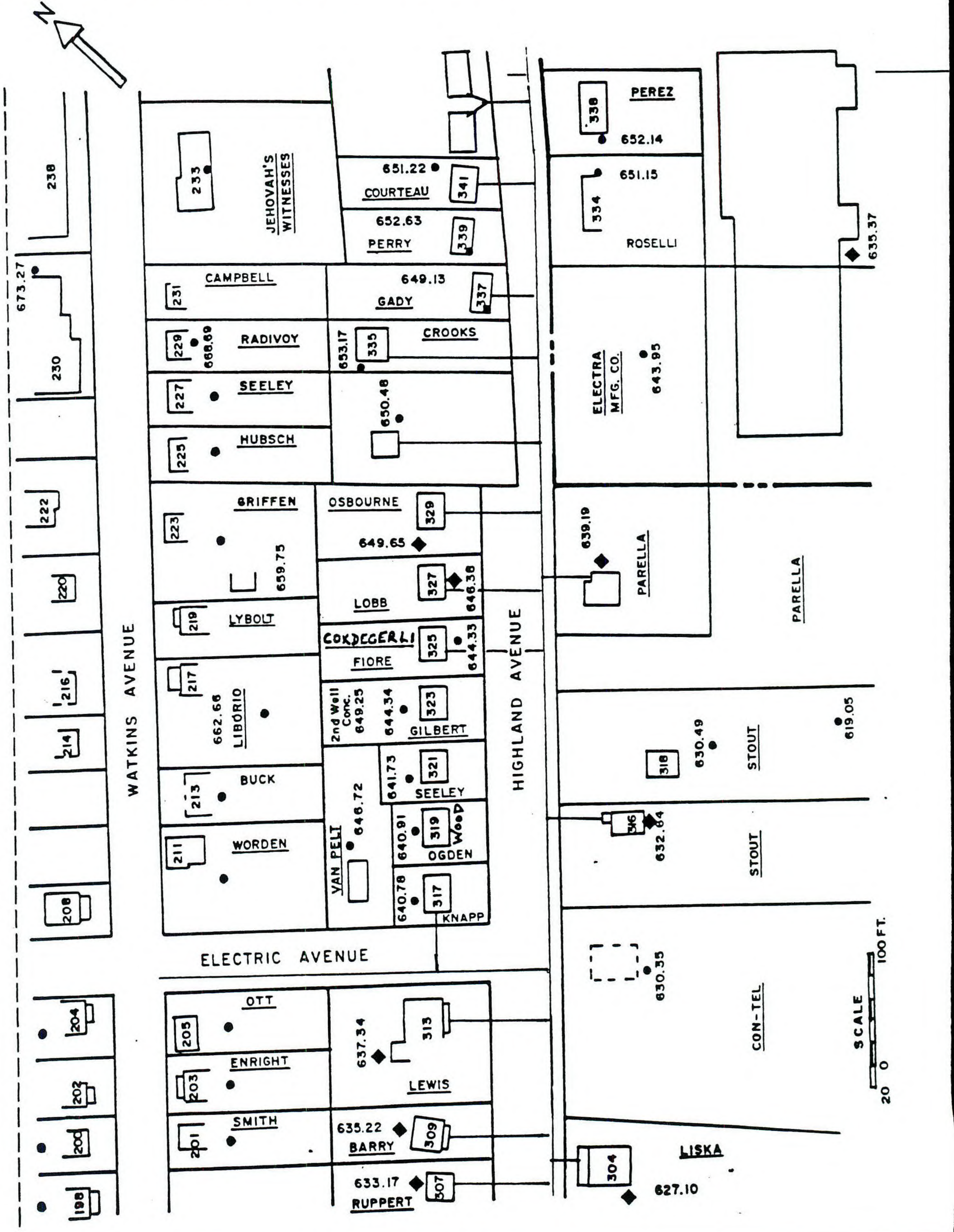
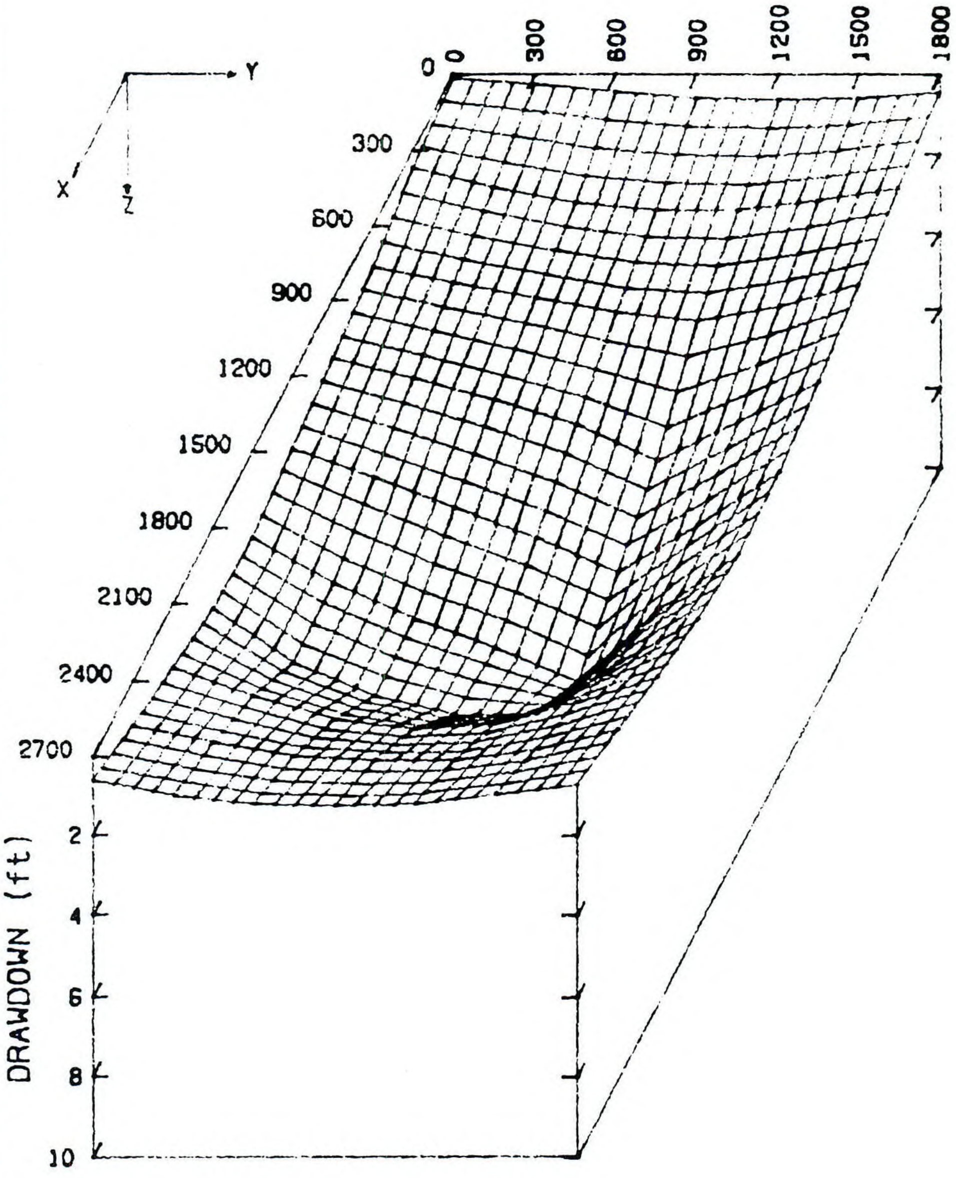


Figure 14. Location of Contaminated Wells & Water Supply Lines

LEGEND

◆ WELLS CONTAINING GREATER THAN 50 PPB PCE

● UNCOMTAMINATED WELLS



GROUNDWATER LEVEL AFTER 5 YEARS OF PUMPING

NOTE: SCALE OF X AND Y AXES DIFFERS
FROM THAT OF Z AXIS

Figure 15. Zone of Influence of a Pumping Well

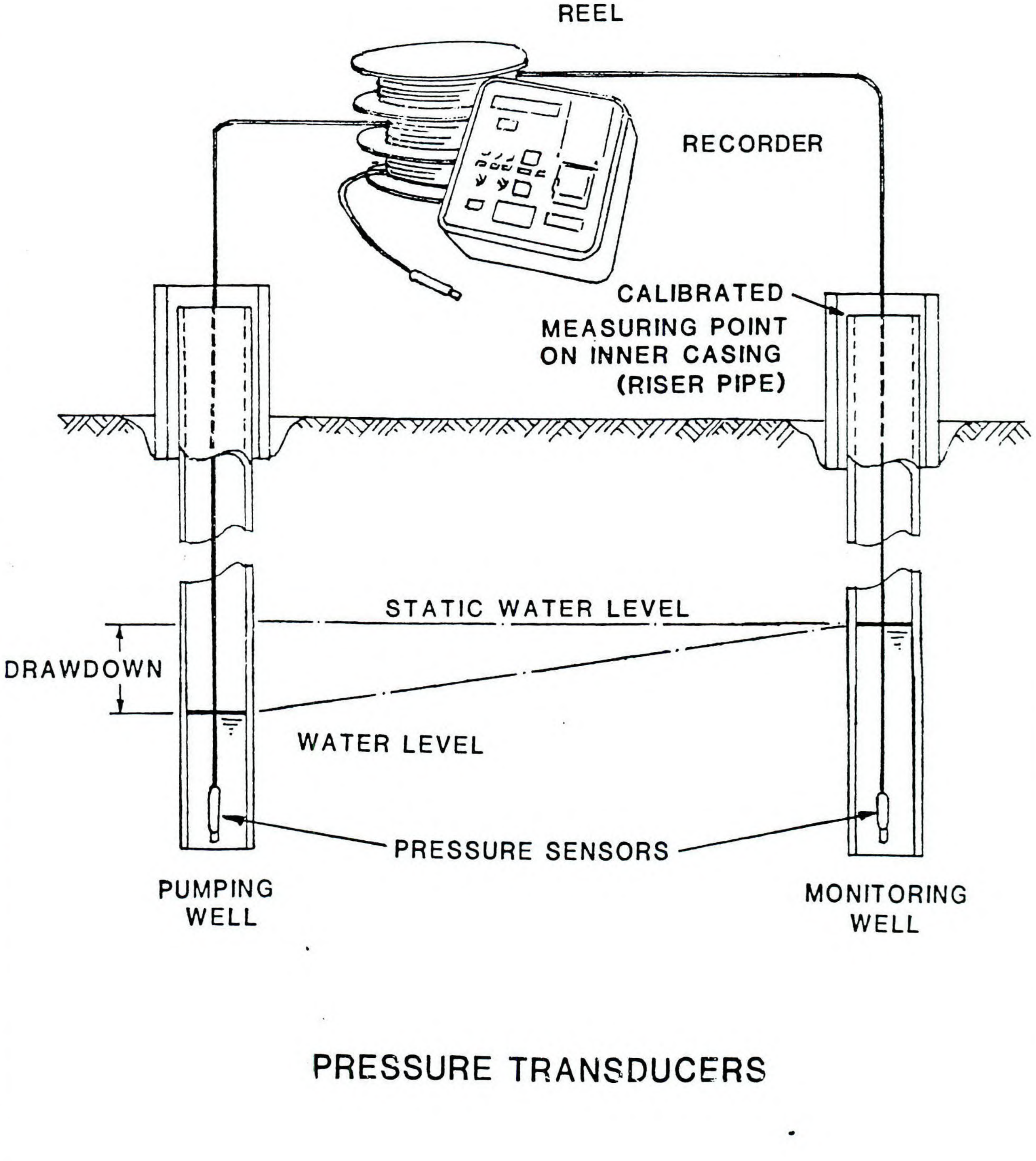


Figure 16. Pressure Transducer System

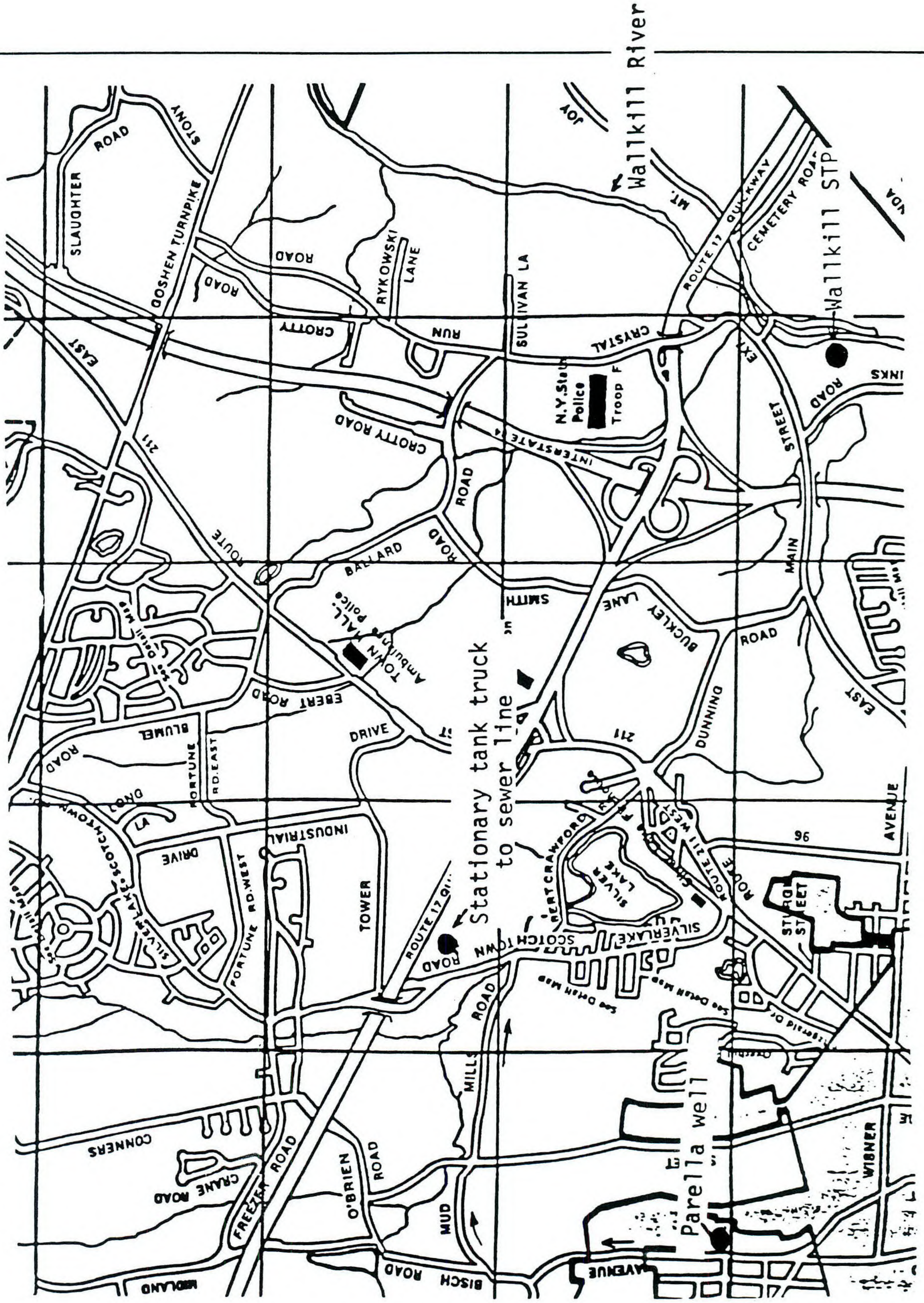


Figure 17. The Parella Well in Relation to the Wallkill STP

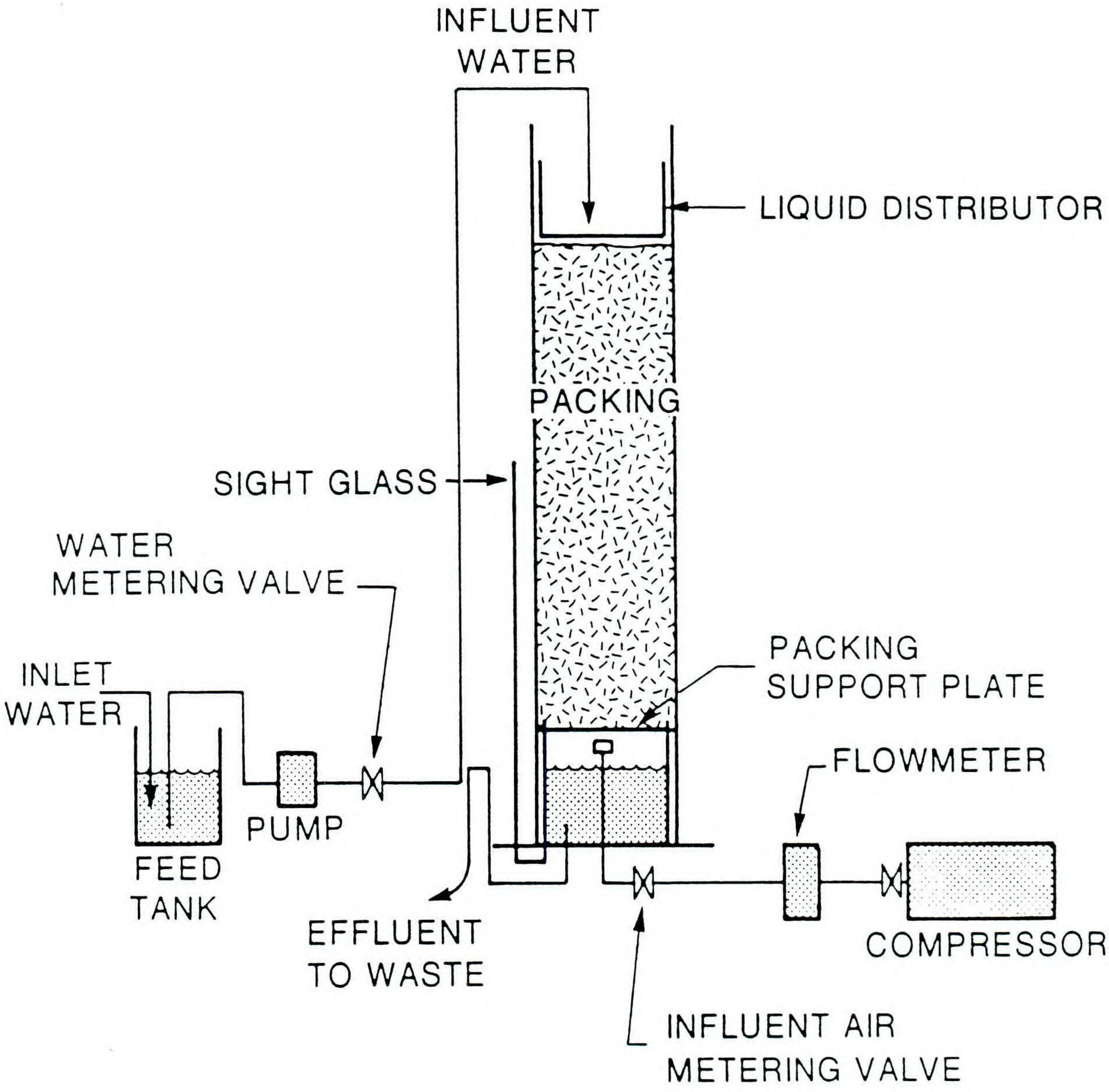
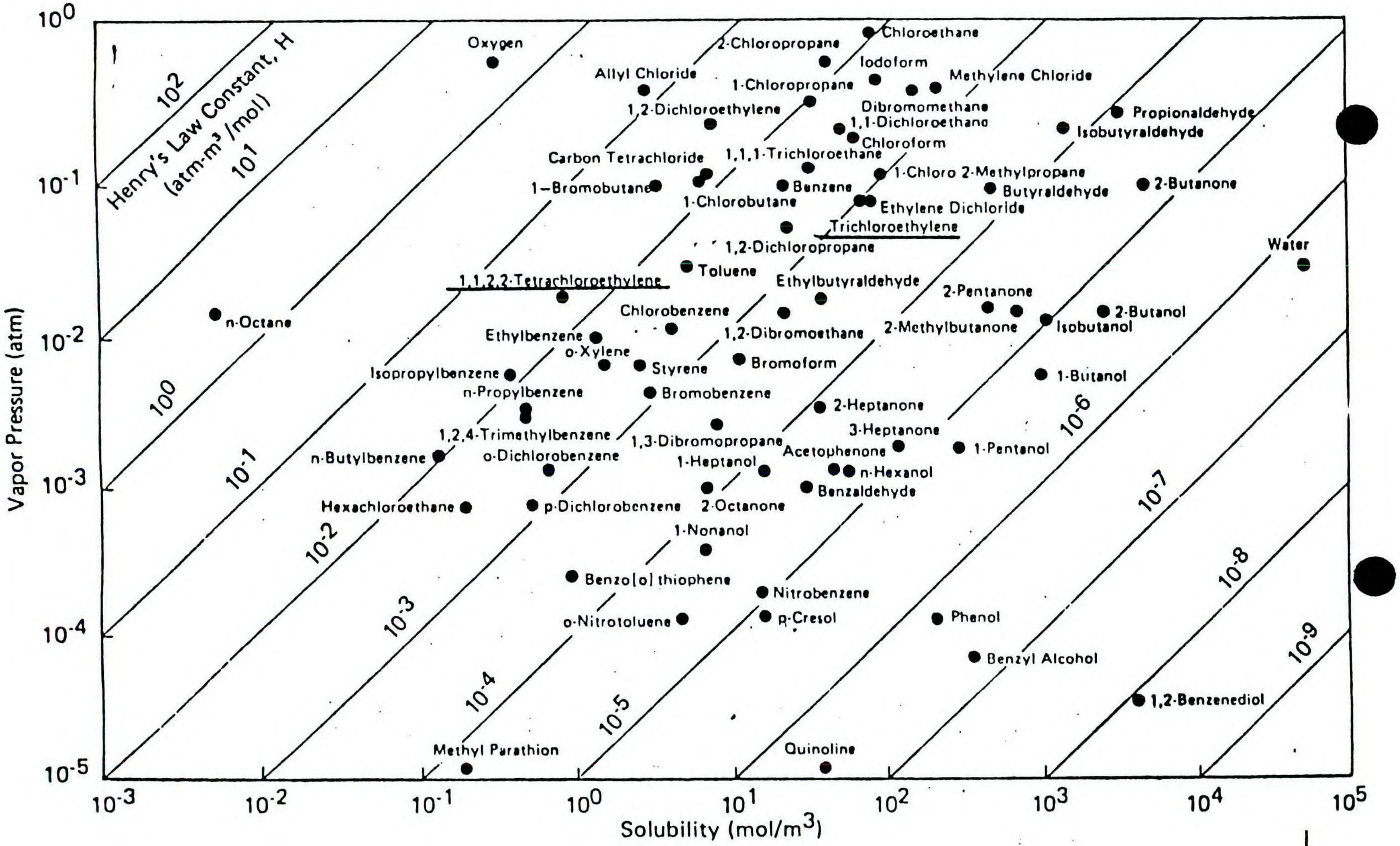


Figure 18. Packed Tower Air Stripper

Figure 19



Source: Mackay and Yuen [15]. *(Reprinted with permission from the authors.)*

FIGURE 15–2 Solubility, Vapor Pressure and Henry's Law Constant for Selected Chemicals

Figure 20. Merry-Go-Round Air Stripper

Shakti Consultants, Inc.

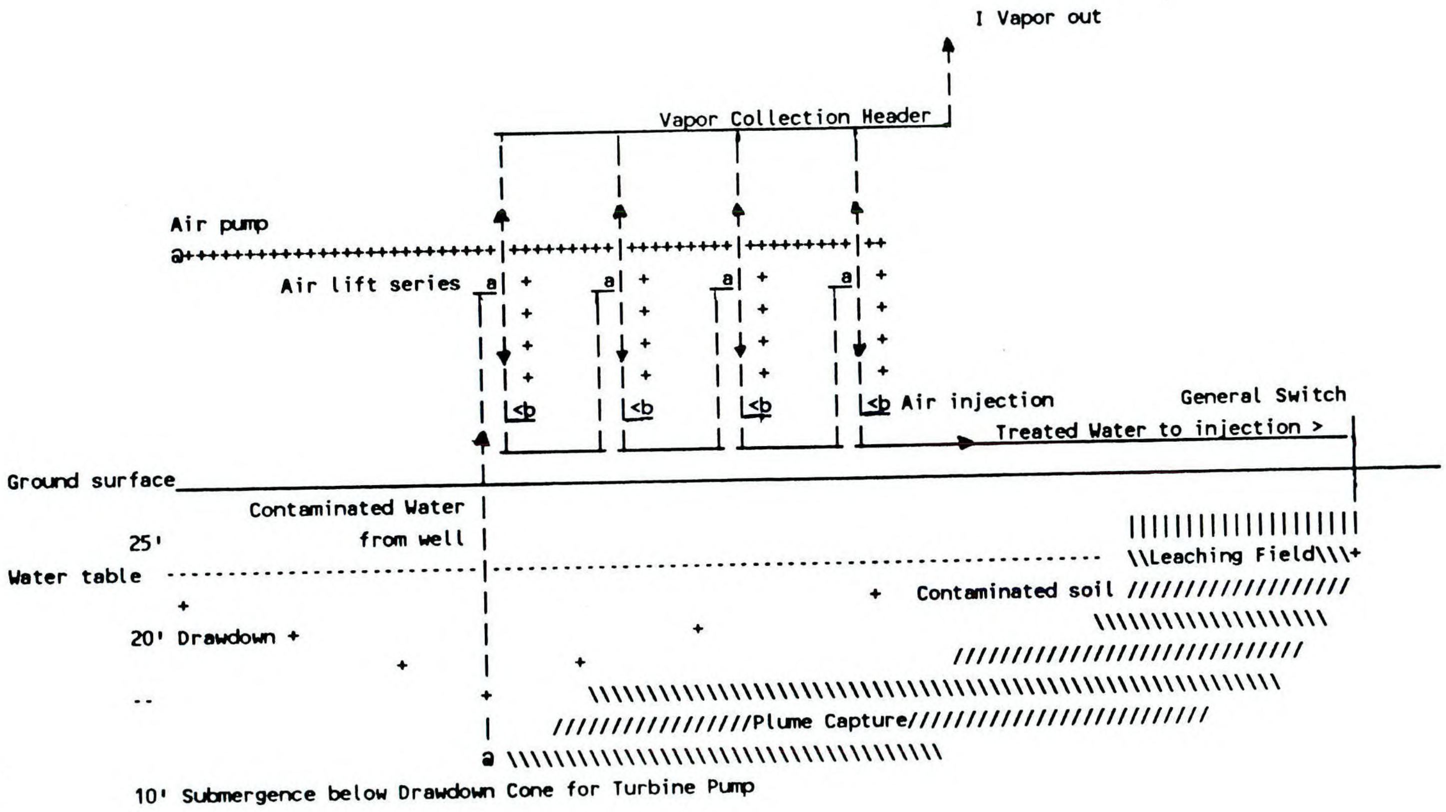


Figure 20: Multistage Airlift System (without central storage tanks)

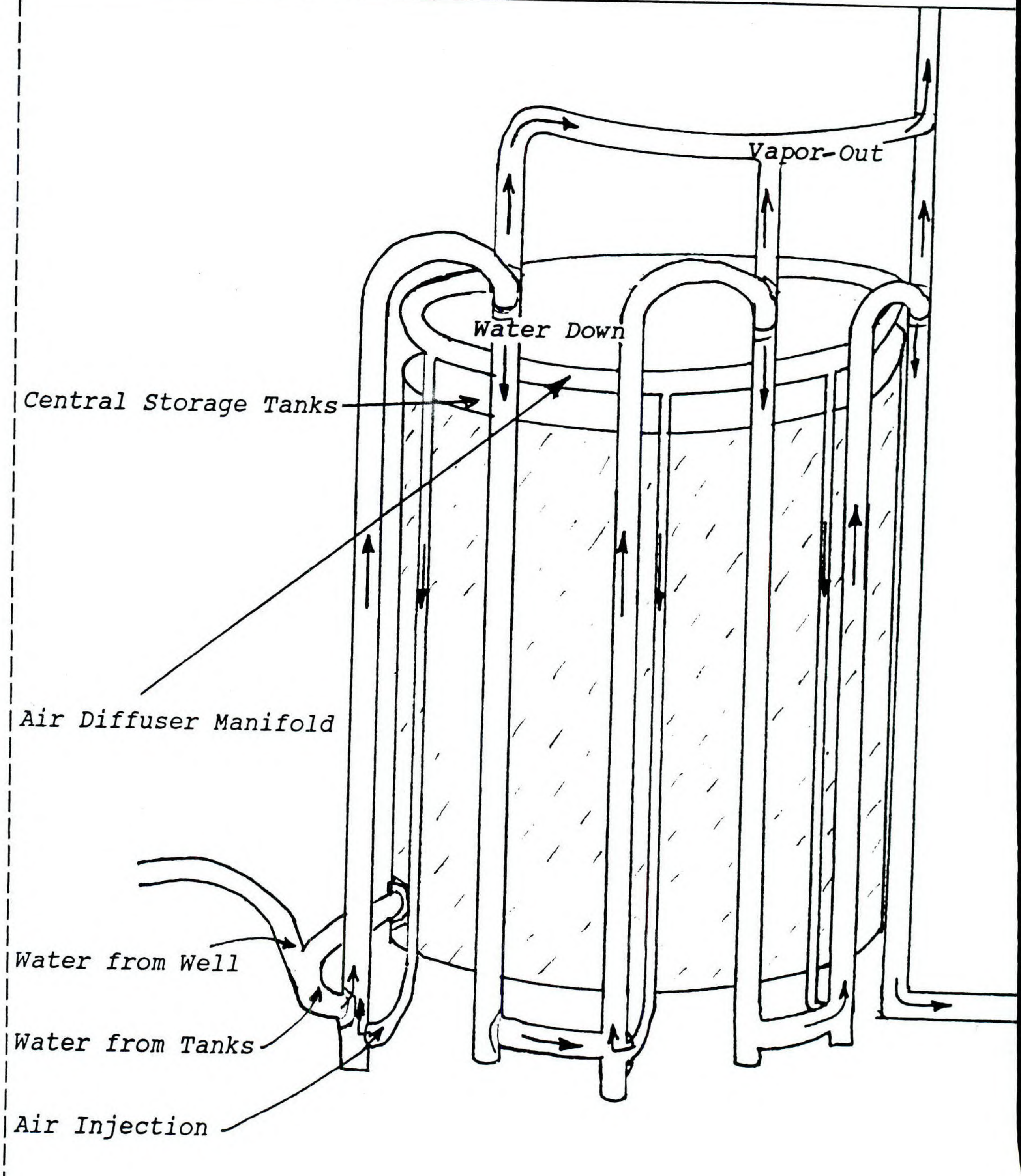
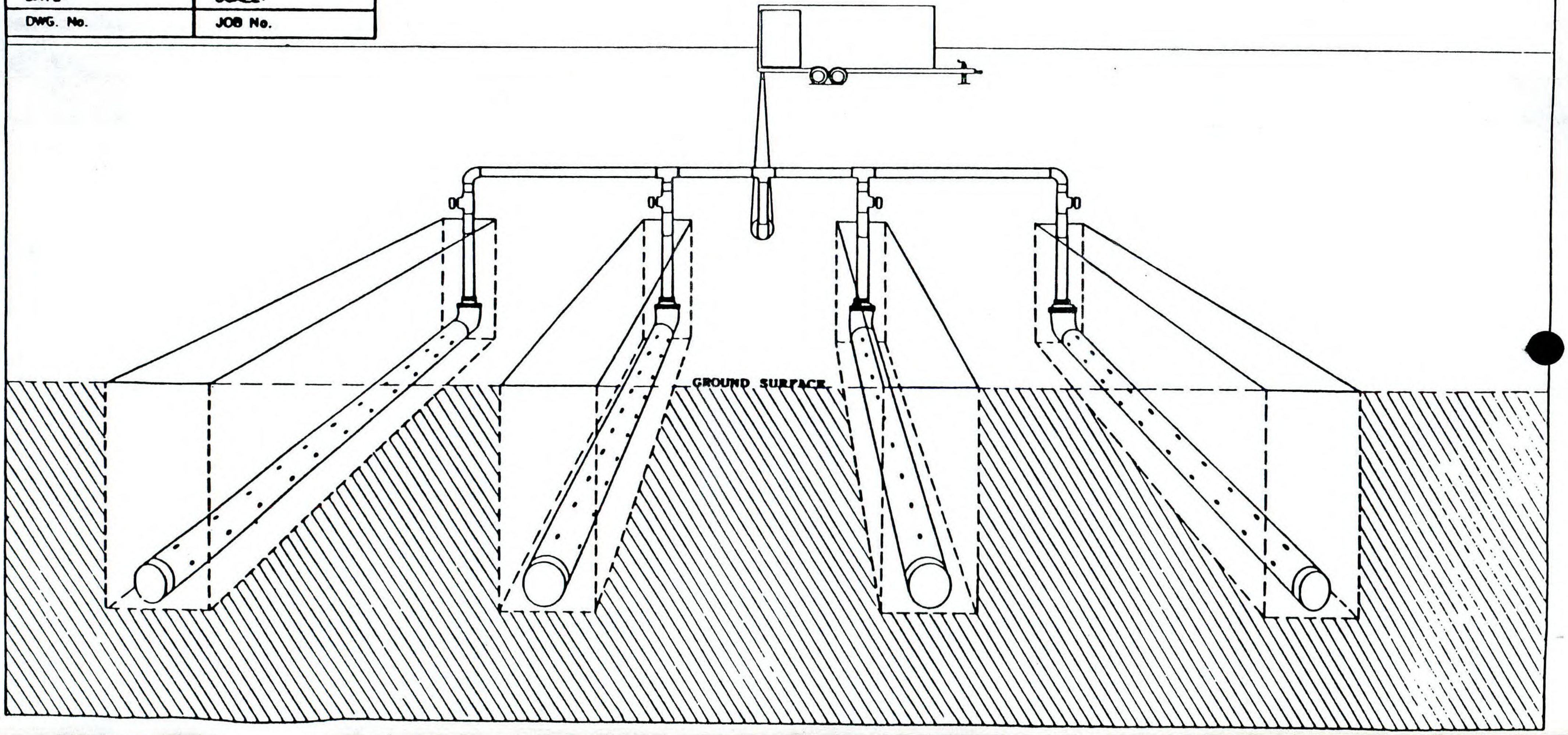


Figure 21. Multistage Air Stripper

Shakti Consultants, Inc.

TYPICAL TRENCH LAYOUT

DATE:	SCALE:
DWG. No.	JOB No.



Appendix A

STANDARD OPERATING PROCEDURE FOR PHOTOVAC AND LABORATORY CHEMICAL SAMPLING AND ANALYSIS

Standard Operating Procedure for Photovac and Laboratory Chemical Analyses

Purpose

As part of the Consent agreement between the U.S. Justice Department and General Switch, details of the proposed operating procedures for the Photovac Portable GC that will be used are detailed.

The purpose of a Photovac and laboratory chemical analyses program is to provide information regarding the lateral and vertical extent of volatile organic (VOC) contamination in the excavated soils and groundwater at the site of this investigation and to provide data with which to assess the efficiency of the treatment system. There are various techniques that can be used to relate the Photovac analysis results to standards of known composition and concentration and thus to extend the usefulness and reliability of the field investigation technique:

This procedure is based on site analysis conducted by Shakti Consultants, the USEPA Region I and the USEPA National Team. The following standard operating procedures describes the field sampling methodology, the normal operation of the portable gas chromatograph, interferences and QA/QC.

HEADSPACE ANALYSIS OF SOIL GAS AND WATER SAMPLES

Purpose

The concentration of volatile organics in soil and water may be determined by analysis of the headspace over a soil or water sample. During the survey the Photovac portable gas chromatograph and Laboratory analysis program is used as a basis for correlating the Photovac results to laboratory derived volatile organics analysis results for soil or water samples.

Method

Sampling Procedures - Headspace analysis

Samples of soil are obtained by subcoring soil from a split spoon sampler or tube sampler. A volume of 30 cu mm of soil is are placed in a 40 ml vial such that the vial is three quarters full. The vials are then placed in a warm water bath held at 20 degrees C and heated for 20 minutes to drive the volatiles into the headspace of the vial. A 100 ul injection is then drawn from the headspace of the vial with an airtight syringe and introduced into the Photovac.

Dry soil samples are prepared for analysis by the addition of 10 ml of distilled water to the VOA vials.

Water samples are obtained either as grab samples or from a precleaned bailer. The 40 ml vial is filled 3/4 full leaving a headspace from which the injection volume is drawn.

VOA samples destined for laboratory analysis are obtained in duplicate VOA vials with no headspace. The VOA vials are stored upside down on ice prior to the Photovac analysis, and prior to and during shipment for laboratory analysis.

Sample Analysis

The Photovac analysis is conducted using a Photovac Model 10S50 portable gas chromatograph (GC). The Photovac GC utilizes photoionization at a stable temperature maintained by the inboard GC column oven. The sample is injected through a model # SA1020 encapsulated capillary column, nine feet in length, with a packing material of CPsil 19CB.

The 10S50 gas chromatograph contains a built-in integrator and 4 libraries enabling the computer to interpret a chromatogram qualitatively and quantitatively when comparing the sample to a standard of known concentrations that is run and programmed into the Photovac library.

QA/QC - Calibration

As part of the field analytical procedure, the Photovac is calibrated with a volatile organics standard. A standard is injected at the beginning, after every 10 sample runs and at the end of the daily analysis program to confirm positive identification and determine variation in the detector response.

The standard is supplied by the contract Laboratory. The standards are made up under controlled conditions by the testing laboratory from priority pollutant standards supplied and guaranteed by Supelco.

A 100 ul aliquot of the headspace from the standard is injected into the Photovac. The GC prints out the specific peaks for the compounds at the retention time for the volatile organics at the specific column temperature and carrier gas flow.

Chromatograms display the library listing and show the analysis conditions including the gain setting used. The data from this chromatogram of the standard is retained in the on board computer and used to evaluate other chromatograms of the standards for the calibration range and to establish a lower detection limit. For example from experience, the detection limit for Benzene in water is 10 ppb.

Standards: The standards are composed of volatile organics in water that have high sensitivity and well defined peak separation, such as Benzene, Toluene, Ethylbenzene and Xylene (BTEX) or Tetrachloroethylene.

Preparation of Water Standards

The accuracy of the standards is dependent on the precautions taken in the transfers of liquids and care is taken to prevent headspace loss. Cross contamination by using contaminated syringes is avoided and checked by blank injections prior to standard preparation.

Procedure

Standards are prepared according to EPA method 624 protocols. Standards are made using analytical balances. The preferred method of making standards is to weigh small quantities of the volatile organic compounds in gas-tight syringes. These quantities are transferred to 20 ml of methanol and the whole reweighed (See Appendix A, Photovac Technical Bulletin #27 and Procedure For Weighing Liquids With A Syringe").
The concentration is then calculated directly on a wt/wt basis (ppm = ug/g).

Results of Calibration Range Injections:
xxx

	LOWER LIMIT		CENTER LIMIT		UPPER LIMIT	
Chromatograms	#3	#4	#2		#1	
	calculated ppm	actual	calculated	actual	calculated	actual
Benzene	.875	.624/.608	10.5	10.24	105	98.49
TCE	.666	.549/.549	8.0	7.56	80	71.76
Toluene	.875	.949/.906	10.5	9.69	105	105.8
Tetra	.666	.718/.761	8.0	8.59	80	93.75

Injections

A 100 ul injection of the standard is introduced into the Photovac to obtain the retention time for the volatile organics at the specific column temperature and carrier gas flow.

The peaks derived from the standard is labelled by the inboard computer and integrated according to the peak size. The specific peak for a compound is then identified for the computer and assigned the known concentration of the standard. This chromatogram is then retained by the inboard computer and may be recalibrated at any time.

The computer identifies the sample peak with the retention time of the standard of the identified compound. All other peaks for the identified compound obtained during the Photovac analysis are assigned concentrations based on, and with respect to, the standard peak size. Once per week, a sample of the standard is included in the samples for Laboratory analysis to monitor any standard drift.

Duplicate Samples

Selected duplicate samples are retained in VOA vials from the split spoon samples. Equal volumes of soil are placed in the VOA vials so that a reasonable comparison of volatile organic contamination between samples is made. Based on the results of the Photovac analysis, duplicate samples are identified for laboratory analysis.

One in ten duplicate water samples and one in twenty soil samples are chosen for laboratory analysis. Water samples are placed in 2 duplicate VOA 40 ml glass vials with teflon sealed lids and sent to the Laboratory. Soil samples are placed in 950 ml amber glass jars with Teflon seals. The samples identified for laboratory analysis are chosen to cover a range of volatile organic concentrations from approximately 100 ppb to 100 ppm. The laboratory analysis is conducted to provide quantitative data for the selected duplicate samples. This information is used as a basis for developing a correlation between the volatile organics concentration in the soil identified through Laboratory analysis and the Photovac data.

Interferences

The following precautions are taken to minimize the possibility of contamination influencing results:

A field blank of distilled water accompanies samples throughout the sampling effort and is analyzed at the time that samples are analyzed. This field blank analysis protocol identifies inaccuracies introduced during soil and water sample collection and transport.

Blank runs: At the beginning of each day ultra zero air is injected into the gas chromatograph to determine if any internal contamination is present. Each day syringes used in the analyses are screened for contamination by injecting ultra zero air into the GC. Blank runs are conducted after analyzing samples containing compounds at substantial concentrations. This screens for the possibility of contamination carry-over.

Background samples are taken on-site and analyzed periodically during the daily sampling effort. In addition, samples are taken from an area on or off-site that has been designated to be uncontaminated.

Duplicate injections of samples and standards are processed through the gas chromatograph for approximately 10% of the total samples analyzed.

Decontamination of Sampling Tool and Sample Container Cleaning Procedures:

The sampling tools used in a soils investigation, may include a drill rig and split-spoon components, stainless lab spatulas and a 3/8" diameter stainless steel rod. These tools are required to obtain the soil sample and transfer and tamp the contents of the split-spoon into the 40 ml amber glass, teflon-capped septum vials or the 950 ml amber glass bottles.

Water samples are collected using the VOA vial to grab a sample or a teflon bailer to obtain a water sample from a properly developed and evacuated well.

Hand tools are cleaned in the following manner:

- Thorough washing with non phosphate detergent and tap water, utilizing a scrub brush
- Distilled water rinse (pressure-type sprayer)
- Acetone rinse (Reagent grade)
- Air dry
- Distilled water rinse (twice)

Sample Containers

The sample containers used in this collection program are prepared by the analytical laboratory selected to perform all of the analysis.

Bottles are prepared by the laboratory in accordance with current "organic-cleaned" protocol, as follows. The bottles are acetone rinsed, methylene chloride rinsed and oven-dried at 100 degrees C for one hour.

The containers for the Photovac analysis of volatile organics soil samples are identical to the water sample vials, and are provided with the same laboratory prep. The field blanks (aqueous) samples are collected in two 40 ml vials "preped" as previously described.

Documentation

Field notebooks are maintained by assigned field personnel. In addition, a printout of the analysis (chromatographic data) is maintained. This analysis documentation includes a listing of the certified gas standards of the compounds, chromatograms, the time of analysis, a summary of analysis parameters, the retention times and concentrations of identified compounds, and a details of the sampling and precolumn/backflush analysis annotated on the computer printout.

Results

The results of the Photovac and laboratory analyses are displayed in a comparison table. A correlation between the laboratory data and the Photovac data is established.

Conclusion - Detection Limits;

Using the lower limit as the detection limit allows for adequate sensitivity for analysis of contaminants in groundwater and soil. A 100 ul injection of sample at an instrument gain of 100 will show 20 ppb Tetrachloroethylene.

Appendix B

STANDARD OPERATING PROCEDURES FOR POTABLE AND MONITORING WELL SAMPLING

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STANDARD OPERATING PROCEDURES FOR POTABLE AND MONITORING WELL SAMPLING

STANDARD OPERATING PROCEDURES
POTABLE AND MONITOR WELL SAMPLING

Purpose. Representative groundwater samples can be collected from potable water supply wells or monitoring wells located within close proximity to a spill site. These wells are sampled to detect the presence and degree of contamination in the groundwater in the vicinity of each well at the time of sampling. If the results from this sampling campaign indicate groundwater contamination, then additional potable or monitoring wells located over a larger area may be sampled.

This standard operating procedure provides information on the following:

- Sample collection/preservation;
- Analytical requirements;
- Chain-of-custody control; and
- Summary Checklist (Appendix A)
- Data sheets (Appendix B)
- Calculation of saturated well volume (Appendix C)
- Test procedures (Appendix D)
- Equipment (Appendix E)

Introduction

A detailed approach to well sampling is developed after complete review of the construction of the existing well and groundwater data. See survey sheets in Appendix B and Background Review Section.

The question of conducting interviews with home owners or public water supply officials and the extent of such interviews, is determined in the context of a public relations plan. Permission to enter property is obtained for all private well locations. For each sample location, a supplementary data sheet is completed (see Appendix B and SOP for sampling and instituting analysis).

The information required prior to sampling of potable wells is as follows:

- Precise location of well on property in relation to septic system or other contaminant sources
- Accessibility to well
- Name of driller and date installed
- Depth of well
- Well construction details
- Pump type and setting
- Access to the well
- Is water pumped into a holding tank before household distribution?
- Are any water treatment systems used?
- Well use data. Pumping rate, incidence and duration of use

Once the well information is obtained, the precise location and method of sample collection is detailed.

In order for valid representative groundwater samples to be collected from monitor wells, it is very important to properly prepare the well prior to sample collection. This preparation entails developing groundwater flow to the well (well development), removing all the water which is standing in the casing (evacuation) and taking the sample from water which has recently been recharged from the aquifer.

If the wells can be accessed directly, an attempt is made to remove at least 3-5 well volumes prior to sample collection. If the wells cannot be reached, and the home or facility utilizes a holding tank or water treatment system, every attempt is made to grab a sample before it enters the holding tank or is treated. If this is not possible, then several holding tank volumes are evacuated prior to sample collection, and the collection method used is noted on the sample sheet. The samples are drawn directly from the tap or spigot into the sample bottles.

NOTE: A special case is when sampling for a floating layer, which requires procedures to minimize mixing and emulsification of the separate layer or in obtaining samples at discrete depth intervals in a well.

SAMPLING PROCEDURES

1. Water Height Measurement

After unlocking and removing the well cap, the position of the pump assembly is observed. If the pump is suspended at the top of the casing, it is lifted out of the casing. If it is submerged in the well, the pump is left in the well or measurement of the height of the water, or the static water level will be lowered and inaccurate. If the surface of the well water is below the top of a pump assembly which has been lowered into the well, the pump is partially removed and allowed to drain into the well. The pump is removed from the casing once it has drained completely. Time is allowed for the recovery of the static water level. Note this occurrence when recording the well water height.

The height of the water in the well is measured using a steel tape calibrated in decimal feet (See Water Level Measurement Section) or an equivalent method.

2. Removing Standing Water

The volume of well water to be evacuated prior to sampling is determined by subtracting the water surface measurement from the well depth. The difference is then multiplied by the appropriate gallons/foot of well volume, a factor found in the Appendix D. A bucket and stop watch or equivalent may be used to measure the rate of pumping from the well.

The method of evacuation should be pertinent to the goals of the sampling effort. In fractured rock or limestone or where the contaminant plume is at some distance or depth from the well intake, the evacuation of 3-5 well volumes may not duplicate the demands upon an aquifer caused by peak-load pumping. After extensive clothes washing, during sprinkling of gardens or extensive municipal supply pumping, the contaminant plume may temporarily be drawn upwards or sideways into the well resulting in higher health risks.

The pump location is critical to subsequent representative sampling and should be specified for each well. During evacuation, the pump should be located immediately below the water table or drawdown level in the well. Thus, all stagnant water in the borehole will be evacuated. If the pump is located at the well screen depth then stagnant water can remain in the well at the water table, and samples should only be taken at the well screen depth.

For product lighter than water, a protocol of well evacuation and 1 week of resting the well may be indicated so that floating product may again accumulate. In either case, the well screen should be located above and below the current water table to allow for seasonal fluctuations of the water table.

In cases where a well is emptied until dry and is very slow to recover, the volume required for evacuation may be reduced to two or three standing water volumes.

During the pumping of a groundwater well to take a sample, the drawdown with time may be noted to obtain the hydraulic characteristics of the aquifer involved.

Additional Considerations The nature of the pollutant parameter being monitored is the primary factor for specifying well evacuation and sampling methods. These specifications are most conveniently based on the general class of pollutant or parameter which requires monitoring in a particular program.

Physical properties include such parameters as conductance, color, pH, temperature, and turbidity. In general, most sampling methods are acceptable to monitor these parameters, provided they allow a thorough rinsing between sampling events. However, studies by Gibb, et al., (see reference below) have clearly shown that methods which affect gas composition of the sample will affect pH and volatiles concentration. Consequently, since gas lift pumping methods may leave water in the well in a disturbed and aerated condition, these methods are not suitable for well evacuation when volatiles or pH are a parameter of interest.

*Gibb, S.P.; R. M. Schuller; and R. A. Griffin. 1981. Procedures for the Collection of Representative Water Quality Data from Monitoring Wells. Illinois State Water Survey and Illinois State Geological Survey, Cooperative Groundwater Report, Champaign, Illinois.

Similarly, since concentration of metals can be significantly influenced by changes in pH, sampling for metals should not be allowed with gas lift or suction methods. The guidance provided above for well evacuation when pH is the parameter of interest also applies for metals. In addition, equipment used for monitoring metal concentrations should be metal free. Consequently, bailers and positive displacement pumps are most suitable for sampling metals provided they are constructed of appropriate materials. The methods acceptable for well evacuation are less restricted, but gas lift methods or equipment that alter the metal concentration of water remaining in the well through leaching or adsorption should be avoided.

Inorganic, non-metallic constitutent or parameters include acidity, alkalinity, bromide, chloride, fluoride, nitrate, etc. Most of the sampling and well evacuation methods described above are generally acceptable when considering the inorganic, non-metallic parameters. However, for parameters affected by pH or dissolved-gas changes, such as alkalinity, methods that minimize changes in dissolved gas composition are recommended for sampling. These methods include bailers, squeeze pumps, piston pumps; gas lift techniques are not recommended for well evacuation.

Generalized organic parameters include parmeters such as oil and grease, COD, TOC, TOX. Most sampling and well evacuation methods are suitable for these parameters, with the exception of the more sensitive parameters such as TOX. These sensitive parameters require methods suitable for sampling volatile organics.

It is appropriate that sampling for volatile organics be done with a glass or Teflon bailer after flushing with a non-aerating pump or bailer. Positive displacement pumps may be acceptable in sampling, provided they are constructed with suitable materials (Teflon or glass in most cases).

A well with a low yield may require a waiting period so that sufficient water reenters the well to provide a sample.

Once the required volume has been purged from the well, the sample to be analyzed may be collected.

3. Sample Collection, Preservation & Field Analyses

Wells may be sampled only after the water has been sufficiently recharged to obtain the needed amount of sample. All wells included in a given program are sampled within a one week time interval, weather permitting. Once the well is adequately evacuated, actual sampling may be performed using 1) steam cleaned bailers rinsed in distilled water, 2) dedicated bailers or 3) peristaltic pumps.

The bottom-loading bailers used are fitted with a teflon check valve at their base. Each bailer is fitted with a stainless steel wire leader and a new piece of nylon cord. A different pre-cleaned bailer is devoted to each well. If the bailer has not been used for well evacuation, the first 3 bails of water are wasted to rinse off any cleaning agents which might still be present on the bailer. The samples are poured directly from the bailer to sample jars. If filtering or chemical preservation of the samples is required these steps are followed immediately the water is removed from the well. For filtration, the use of a 0.45 micron filter is generally considered appropriate.

If dedicated bailers are not available, the bailers are steam cleaned and rinsed with distilled water. In addition, those wells which are suspected of being contaminated are sampled last in the sequence. It is prudent to avoid sampling highly contaminated wells on the same day as those wells anticipated to be clean.

For peristaltic pumps, suction tubing is dedicated to a particular well and is cleaned with distilled water between samplings.

Data relating to samples are recorded on a uniquely numbered sample documentation form. Each sample is defined with the following entries:

Date and time sample is collected
Sample I.D. number
Location of sampling point
Type of sample (e.g., soil, groundwater, surface water)
Field measurements

In addition, information regarding shipment of samples is recorded on the chain of custody forms.

Analyses of pH, temperature, and specific conductance are made in the field at the time of sampling because these parameters change rapidly and a laboratory analysis might not be representative of the true groundwater quality. Enough water from the well is removed to determine temperature of water, specific conductivity, and pH. Values for the parameters are recorded on field data sheets and the water discarded in a manner so as to avoid potential contamination.

All groundwater samples are carefully packed on ice for shipment to the R/D Lab. Proper chain-of-custody procedure is followed when transferring the samples from the field to the lab.

After each sample is obtained and placed in its container:

The sample bottle is capped and the bottle labelled. Labels show the sample number, date, sample source, preservative added, if any, and analysis to be performed.

All pertinent information is entered on field data sheets and chain-of-custody forms. Observations as to the odor or color of the water sample are included on the data sheets.

Samples are transferred to an ice chest for shipment to the laboratory.

All equipment is cleaned thoroughly between samples.

For VOA or VOX sampling:

The samples are collected in approximately 50 ml airtight, glass pharmaceutical vials with plastic caps lined by teflon septa. Each sample is clearly labeled as to location and number before the sample is collected.

Each sample consists of two 50 ml vials. Each vial is filled completely and checked to insure that no air is entrained once the cap is in place.

Each vial is wrapped to minimize the possibility of breakage during shipment.

For base neutrals/acid extractables:

Two liter jugs of water are taken and filled 2/3 full and the fill level marked on the outside of the bottle.

All analytical work is completed in compliance with standard USEPA requirements. (see Appendix D)

III. Chain of Custody Procedures

1. Sample Custody

The field sampler is personally responsible for the care and custody of unused, empty or sample filled containers until they are transferred or properly dispatched. Sample containers are kept under the custody of one designated person at any given time. A sample is under custody if:

a. It is in the samplers actual physical possession; or
b. It is in view, after being in the samplers physical possession; or
c. It is locked up to prevent tampering; or
d. It is in a designated secure area.

2. Field Log Book

Information pertinent to field sampling and measurements is recorded in a bound log book or a log book composed of the serially numbered data sheets filed in a three ring binder. The field sampling plan is appended to the log book as partial documentation of the sampling program. Specific entries that are included in the log book include at least, the following:

a. Each page dated and signed;
b. Date and time of sampling;
c. Sample identification number;
d. Location of sampling point;
e. Type of sample (e.g., grab, composite, groundwater, wastewater, sludge, soil, etc.)
f. Deviations from sampling plan;
g. Field measurements (e.g., pH, conductivity, temperature, etc.);
h. Field observations;
i. Photographs; and
j. Sample custody transfer and transport.

3. Sample Labels

Every sample container is uniquely labeled to prevent misidentification. Labels are attached to containers as they are generated in the field. The labels include the following:

a. Date and time sample collected;
b. Sample identification number;
c. Place of collection; and
d. Signature of collector.

4. Sample Seals

Sample seals are used to prevent unauthorized tampering from the time samples are collected until containers are opened in the laboratory. The seals may be attached over the sample container cap in such a way that the seal must be torn in order to open the container. The following information is recorded on each seal:

a. Date of sampling;
b. Signature of collector.

5. Chain-of-Custody Record (Field Activities)

Samples are accompanied by a Chain-of-Custody Record whenever possession of custody is transferred or relinquished. Each Chain-of-Custody Record sheet is filled out with a carbon paper duplicate before the field sample custodian relinquishes possession or arranges for shipment. The original record accompanies the samples relinquished. Each record sheet includes the following information (see Appendix B):

a. Signature of field sampler/sample custodian;

b. Beginning date-time of possession;

c. Final date-time of possession; and

d. For each sample:

e. Date-time of collection;

f. Sample identification number;

g. Location of sampling point; and sample type.

6. Transfer of Custody and Shipment

The following are guidelines for shipping non-hazardous samples:

a. Samples are sealed in containers marked with name and address of laboratory;

b. Samples are placed in a strong outside container such as a picnic cooler. Ice, dry ice or "blue ice" may be used inside plastic bags between the containers and box.

c. The outer container is sealed completely with tape or glue and the sample dispatcher signs across the tape or glue joints at several locations on the package to serve as an "outer seal."

d. The container is properly addressed and a shipping list affixed.

e. Samples may be transported by rented or common carrier air, truck, bus, railroad, and entities such as Federal Express. If sent by mail, the package registered with return receipt requested. If sent by common carrier, a Bill of Lading is used. Receipts from post offices and Bills of Lading are retained as part of the permanent documentation. A convenience is to take the sample shipment to the nearest UCC shipping department.

Appendix C

PERMITS FOR SITE OPERATION

SUMMARY OF CODE REVISION

STANDARDS

General MCLs

The **New York State Department of Health** has adopted standards to limit organic chemical contamination of public drinking water supplies. The code revision (to Part 5 of the State Sanitary Code) establishes maximum contaminant levels (MCLs) or standards for:

Principal Organic Contaminant (POC)	- 0.005 mg/l (5 ug/l)
Unspecified Organic Contaminant (UOC)	- 0.050 mg/l (50 ug/l)
Total of POCs and UOCs	**- 0.10 mg/l (100 ug/l)**

POCs would be defined as any organic chemical belonging to any of six general chemicals classes:

Halogenated Alkanes
Halogenated Ethers
Halobenzenes and Substituted Halobenzenes
Benzene and Alkyl- or Nitrogen-Substituted Benzenes
Substituted, Unsaturated Aliphatic Hydrocarbons
Halogenated Non-aromatic Cyclic Hydrocarbons

POCs, by definition, exclude trihalomethanes and other organic chemicals with a specific MCL of their own.

UOCs would be defined as any organic chemical not covered by another MCL.

The Department recognizes the possible need for exceptions from the proposed MCLs for POCs and UOCs if the presence of a specific organic chemical does not represent contamination and sufficient, valid scientific information demonstrates that they do not pose an unreasonable risk to human health. When justified, the regulation contains provisions to allow for the establishment of a more lenient (higher) MCL.

The regulation also allows a water supplier to submit justification for a higher MCL for up to 60 days following application of a paint or lining to a potable water appurtenance. The Commissioner may allow the higher MCL if he determines that no unreasonable risk to human health would result.

The Department recognizes the need to use a stricter (lower) interim guideline value for a contaminant which lacks a chemical-specific MCL but for which the available toxicological data are judged sufficient to warrant more stringent control. The regulation allows for consideration of lower interim guidelines when justified. The Department believes that, from a public health perspective, the benefits associated with the broad nature of the general MCLs outweigh the fact that interim guidelines may have to be used in some cases. For example, the existing guidelines for PCBs - 1 ug/l; aldicarb - 7 ug/l; carbofuran - 15 ug/l; atrazine - 25 ug/l will be retained until a specific MCL for each chemical is developed.

Individual MCLs

The code revision includes a specific MCL of 0.002 mg/l (2 ug/l) for vinyl chloride and lowers the existing MCLs for two organic chemicals. The revised MCLs are 0.050 mg/l (50 ug/l) for both methoxychlor and 2,4-D.

Implementation Dates

The effective date of the MCLs in this code revision is January 9, 1989. Monitoring and other requirements are effective as of publication in the State Register.

MONITORING

Contaminants

The code revision requires monitoring for certain organic chemicals and allows State discretion to require monitoring of other organic chemicals when the State believes that contaminants have been or may be present in concentrations which exceed the MCL. All community water systems are required to monitor for the 52 POCs listed on Table 1 and for vinyl chloride. The code uses the same nomenclature of the Environmental Laboratory Approval Program, so chemical names used previously in the proposal are listed in parentheses on Table 1.

The monitoring requirement also extends to noncommunity systems that regularly serve at least 25 of the same persons, four hours or more per day, for four or more days per week, for 26 or more weeks per year. These systems are called nontransient, noncommunity water systems.

The contaminants must be analyzed by EPA methods 502.2, 524.1, 524.2 or a combination of 502.1 and 503.1. The analysis must be capable of detecting the contaminants as low as 0.0005 mg/l (0.5 ug/l). All systems that serve 150 or more service connections from groundwater sources also must analyze at least one sample from each source for 1,2-dibromoethane (EDB) and 1,2-dibromo-3-chloropropane (DBCP). EPA Method 504, with a detection level of 0.00002 mg/l (0.02 ug/l), must be used for EDB and DBCP.

Since POCs are defined by the chemical class above, the standard applies to many more chemicals than those listed on Table 1. The regulations allow the State to require monitoring for other contaminants (POCs or UOCs) when the State believes they might exceed the MCL or present a risk to public health.

Location of Sample Collection

The regulations require each source to be sampled at specific locations dictated by ground or surface sources. The location of sampling for each groundwater source is at or before the first service connection and prior to mixing with other sources. The regulations allow the State to specify another location. This provision can be used to require monitoring following treatment to remove organics or to accept certain sources as representative of other nearby sources in the same aquifer under certain conditions at State discretion.

The regulations require systems with surface sources to sample at points in the distribution system representative of each source or at entry point or points to the distribution systems after any treatment plant.

Initial Sampling

The initial monitoring requirement for each source depends on the type and size of the system as scheduled below:

System Type/Size	Required Samples per source
Community serving 10,000 or more persons	One per quarter for one year by 12/31/88
Community serving 3,300-9,999 persons	One per quarter for one year by 12/31/89
Community serving fewer than 3,300 persons and more than 149 service connections	One per quarter for one year by 12/31/90
Community serving fewer than 150 service connections	One by 6/30/91
Nontransient, Noncommunity	One by 6/30/92
Noncommunity	State Discretion

Systems serving over 10,000 persons were notified by mail in October 1987 to perform the required sampling under existing Code, Section 5-1.75, and EPA regulations.

As with other contaminants, the State may use Section 5-1.51(e) to require a system to monitor sooner or more frequently whenever the potential exists for an MCL violation. Consequently, systems with sources that have been shown by previous monitoring to be contaminated may be required to monitor before the above schedule.

Vulnerability to Contamination

The State will assess the vulnerability to contamination of all sources of water supply based on:

a. previous monitoring results

b. number of persons served by the public water system

c. proximity of the system to a larger system

d. proximity to commercial or industrial use, disposal or storage of volatile synthetic organic chemicals; and

e. the degree of protection afforded the source of water supply.

Detailed guidance in determining vulnerability will be developed similar to EPA's as presented in the Federal Register, November 13, 1985, Volume 50, No. 219.

For systems serving fewer than 150 service connections, more than one sample will be required for those sources that are determined to be vulnerable. Following a determination of nonvulnerability, the State may reduce initial and some of the repeat sampling described below for intermediate sized systems (more than 150 service connections, but population less than 3,300 persons). It is unlikely that systems serving 3,300 or more persons would have monitoring reduced since EPA's guidance considers all systems this large to be vulnerable to contamination. Statewide surveys show that volatile organic chemicals are more than twice as likely to be found in sources of these larger systems.

Repeat Monitoring

At those sources where contaminants are detected, (at 0.0005 mg/l or above) monitoring would be required to continue on quarterly intervals. Systems with 150 or more service connections for which contaminants are not detected would be required to repeat monitoring every three years. Systems with fewer than 150 service connections would not be required to repeat monitoring unless they are determined to be vulnerable.

DETERMINATION OF COMPLIANCE

If the results of a sample exceed the MCLs, the supplier of water would be required to collect one to three confirmation samples as soon as practical but no later than 30 days. If the average of all samples (monitoring sample plus confirmation sample(s)) exceeds the MCL, a MCL violation occurs. Those systems with sources that exceed the MCLs after the effective date will be put on a compliance schedule and required to provide public notification. Both short and long-term compliance strategies will be developed. The long-term strategy in most cases, would be to develop alternative sources or provide treatment. Potential short-term strategies include an alternative water source, minimal use of a contaminated source, such as stand-by for peak demand, conservation measures, temporary treatment, and consumer advisories.

Persistent violators of MCLs, or monitoring and reporting requirements will be subject to enforcement actions as for other contaminants regulated in the code.

NOTIFICATION

The supplier of water must make State, consumer and public notification for MCL or other violations according to requirements similar to those existing for other contaminants.

The regulations also require systems to notify its consumers as to the availability of monitoring results for volatile organic chemicals. Notification will be included in the first set of water bills issued by the system after the receipt of the result or by other written notice within three months. The State would accept as written notice, a one-time publication in a daily newspaper of general circulation in the area served by your system. The notice should:

1. identify a person and supply the telephone number to contact for information on the monitoring results, and
2. where appropriate, state that quarterly monitoring will continue for the remainder of the year.

A legal notice is acceptable provided it is conspicuous and does not contain unduly technical language, unduly small print or similar problems that frustrate the purpose of the notice.

TABLE 1
ORGANIC CHEMICALS IN REQUIRED MONITORING
VINYL CHLORIDE AND 52 PRINCIPAL ORGANIC CONTAMINANTS
(AS PER ENVIRONMENTAL LABORATORY APPROVAL PROGRAM)

CHEMICAL NAME ELAP NOMENCLATURE	CHEMICAL NAME USED PREVIOUSLY IN PROPOSAL
benzene	
bromobenzene	
bromochloromethane	
bromomethane	
n-butylbenzene	
sec-butylbenzene	
tert-butylbenzene	
carbon tetrachloride	
chlorobenzene	
chloroethane	
chloromethane	
2-chlorotoluene	(o-chlorotoluene)
4-chlorotoluene	(p-chlorotoluene)
dibromomethane	
1,2-dichlorobenzene	(o-dichlorobenzene)
1,3-dichlorobenzene	(m-dichlorobenzene)
1,4-dichlorobenzene	(p-dichlorobenzene)
dichlorodifluoromethane	
1,1-dichloroethane	
1,2-dichloroethane	
1,1-dichloroethene	(1,1-dichloroethylene)
cis-1,2-dichloroethene	(cis-1,2-dichloroethylene)
trans-1,2-dichloroethene	(trans-1,2-dichloroethylene)
1,2-dichloropropane	
1,3-dichloropropane	
2,2-dichloropropane	
1,1-dichloropropene	
cis-1,3-dichloropropene	
trans-1,3-dichloropropene	
ethylbenzene	
hexachlorobutadiene	
isopropylbenzene	
p-isopropyltoluene	(p-cymene)
methylene chloride	(dichloromethane)
n-propylbenzene	
styrene	
1,1,1,2-tetrachloroethane	
1,1,2,2-tetrachloroethane	
tetrachloroethene	(1,1,2,2-tetrachloroethylene)
toluene	
1,2,3-trichlorobenzene	
1,2,4-trichlorobenzene	
1,1,1-trichloroethane	
1,1,2-trichloroethane	
trichloroethene	(1,1,2-trichloroethylene)
trichlorofluoromethane	(fluorotrichloromethane)
1,2,3-trichloropropane	
1,2,4-trimethylbenzene	
1,3,5-trimethylbenzene	
m-xylene	
o-xylene	
p-xylene	

§ 261.11 Criteria for listing hazardous waste.

(a) The Administrator shall list a solid waste as a hazardous waste only upon determining that the solid waste meets one of the following criteria:

(1) It exhibits any of the characteristics of hazardous waste identified in Subpart C.

(2) It has been found to be fatal to humans in low doses or, in the absence of data on human toxicity, it has been shown in studies to have an oral LD 50 toxicity (rat) of less than 50 milligrams per kilogram, an inhalation LC 50 toxicity (rat) of less than 2 milligrams per liter, or a dermal LD 50 toxicity (rabbit) of less than 200 milligrams per kilogram or is otherwise capable of causing or significantly contributing to an increase in serious irreversible, or incapacitating reversible, illness. (Waste listed in accordance with these criteria will be designated Acute Hazardous Waste.)

(3) It contains any of the toxic constituents listed in Appendix VIII unless, after considering any of the following factors, the Administrator concludes that the waste is not capable of posing a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported or disposed of, or otherwise managed:

(i) The nature of the toxicity presented by the constituent.

(ii) The concentration of the constituent in the waste.

(iii) The potential of the constituent or any toxic degradation product of the constituent to migrate from the waste into the environment under the types of improper management considered in paragraph (a)(3)(vii) of this section.

(iv) The persistence of the constituent or any toxic degradation product of the constituent.

(v) The potential for the constituent or any toxic degradation product of the constituent to degrade into non-harmful constituents and the rate of degradation.

(vi) The degree to which the constituent or any degradation product of the constituent bioaccumulates in ecosystems.

(vii) The plausible types of improper management to which the waste could be subjected.

(viii) The quantities of the waste generated at individual generation sites or on a regional or national basis.

(ix) The nature and severity of the human health and environmental damage that has occurred as a result of the improper management of wastes containing the constituent.

(x) Action taken by other governmental agencies or regulatory programs based on the health or environmental hazard posed by the waste or waste constituent.

(xi) Such other factors as may be appropriate.

Substances will be listed on Appendix VIII only if they have been shown in scientific studies to have toxic, carcinogenic, mutagenic or teratogenic effects on humans or other life forms.

(Wastes listed in accordance with these criteria will be designated Toxic wastes.)

(b) The Administrator may list classes or types of solid waste as hazardous waste if he has reason to believe that individual wastes, within the class or type of waste, typically or frequently are hazardous under the definition of hazardous waste found in Section 1004(5) of the Act.

(c) The Administrator will use the criteria for listing specified in this section to establish the exclusion limits referred to in § 261.5(c).

Subpart C—Characteristics of Hazardous Waste

§ 261.20 General.

(a) A solid waste, as defined in § 261.2, which is not excluded from regulation as a hazardous waste under § 261.4(b), is a hazardous waste if it exhibits any of the characteristics identified in this Subpart.

[*Comment*: § 262.11 of this chapter sets forth the generator's responsibility to determine whether his waste exhibits one or more of the characteristics identified in this Subpart]

(b) A hazardous waste which is identified by a characteristic in this subardous Waste Number which precedes the name of the waste. This number must be used in complying with the notification requirements of Section 3010 of the Act and certain recordkeeping and reporting requirements under Parts 262 through 265 and Part 270 of this chapter.

(d) The following hazardous wastes listed in § 261.31 or § 261.32 are subject to the exclusion limits for acutely hazardous wastes established in § 261.5: [Reserved]

[45 FR 33119, May 19, 1980, as amended at 45 FR 74892, Nov. 12, 1980; 48 FR 14294, Apr. 1, 1983]

§ 261.31 Hazardous wastes from non-specific sources.

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
Generic:		
F001	The following spent halogenated solvents used in degreasing: tetrachloroethylene, trichloroethylene, methylene chloride, 1,1,1-trichloroethane, carbon tetrachloride, and chlorinated fluorocarbons; and sludges from the recovery of these solvents in degreasing operations.	(T)
F002	The following spent halogenated solvents: tetrachloroethylene, methylene chloride, trichloroethylene, 1,1,1-trichloroethane, chlorobenzene, 1,1,2-trichloro-1,2,2-trifluoroethane, ortho-dichlorobenzene, and trichlorofluoromethane; and the still bottoms from the recovery of these solvents.	(T)
F003	The following spent non-halogenated solvents: xylene, acetone, ethyl acetate, ethyl benzene, ethyl ether, methyl isobutyl ketone, n-butyl alcohol, cyclohexanone, and methanol; and the still bottoms from the recovery of these solvents.	(I)
F004	The following spent non-halogenated solvents: cresols and cresylic acid, and nitrobenzene; and the still bottoms from the recovery of these solvents.	(T)
F005	The following spent non-halogenated solvents: toluene, methyl ethyl ketone, carbon disulfide, isobutanol, and pyridine; and the still bottoms from the recovery of these solvents.	(I, T)
F006	Wastewater treatment sludges from electroplating operations except from the following processes: (1) sulfuric acid anodizing of aluminum; (2) tin plating on carbon steel; (3) zinc plating (segregated basis) on carbon steel; (4) aluminum or zinc-aluminum plating on carbon steel; (5) cleaning/stripping associated with tin, zinc and aluminum plating on carbon steel; and (6) chemical etching and milling of aluminum.	(T)
F019	Wastewater treatment sludges from the chemical conversion coating of aluminum	(T)
F007	Spent cyanide plating bath solutions from electroplating operations (except for precious metals electroplating spent cyanide plating bath solutions).	(R, T)
F008	Plating bath sludges from the bottom of plating baths from electroplating operations where cyanides are used in the process (except for precious metals electroplating plating bath sludges).	(R, T)
F009	Spent stripping and cleaning bath solutions from electroplating operations where cyanides are used in the process (except for precious metals electroplating spent stripping and cleaning bath solutions).	(R, T)
F010	Quenching bath sludge from oil baths from metal heat treating operations where cyanides are used in the process (except for precious metals heat-treating quenching bath sludges).	(R, T)
F011	Spent cyanide solutions from salt bath pot cleaning from metal heat treating operations (except for precious metals heat treating spent cyanide solutions from salt bath pot cleaning).	(R, T)
F012	Quenching wastewater treatment sludges from metal heat treating operations where cyanides are used in the process (except for precious metals heat treating quenching wastewater treatment sludges).	(T)
F024	Wastes, including but not limited to, distillation residues, heavy ends, tars, and reactor clean-out wastes from the production of chlorinated aliphatic hydrocarbons, having carbon content from one to five, utilizing free radical catalyzed processes. [This listing does not include light ends, spent filters and filter aids, spent dessicants, wastewater, wastewater treatment sludges, spent catalysts, and wastes listed in § 261 32]	(T)

[46 FR 4617, Jan. 16, 1981, as amended at 46 FR 27477, May 20, 1981; 49 FR 5312, Feb. 10, 1984]

EFFECTIVE DATE NOTE: At 49 FR 5312, Feb. 10, 1984, the waste stream identified by EPA hazardous waste no. F024 was added to the table in § 261.31, effective August 10, 1984.

§ 261.32 Hazardous wastes from specific sources.

Industry and EPA hazardous waste No.	Hazardous waste	Hazard code
Wood preservation: K001	Bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol.	(T)
Inorganic pigments:		
K002	Wastewater treatment sludge from the production of chrome yellow and orange pigments.	(T)
K003	Wastewater treatment sludge from the production of molybdate orange pigments	(T)
K004	Wastewater treatment sludge from the production of zinc yellow pigments	(T)
K005	Wastewater treatment sludge from the production of chrome green pigments	(T)
K006	Wastewater treatment sludge from the production of chrome oxide green pigments (anhydrous and hydrated)	(T)
K007	Wastewater treatment sludge from the production of iron blue pigments	(T)
K008	Oven residue from the production of chrome oxide green pigments	(T)
Organic chemicals:		
K009	Distillation bottoms from the production of acetaldehyde from ethylene	(T)
K010	Distillation side cuts from the production of acetaldehyde from ethylene	(T)
K011	Bottom stream from the wastewater stripper in the production of acrylonitrile	(R, T)
K013	Bottom stream from the acetonitrile column in the production of acrylonitrile	(R, T)
K014	Bottoms from the acetonitrile purification column in the production of acrylonitrile	(T)
K015	Still bottoms from the distillation of benzyl chloride	(T)
K016	Heavy ends or distillation residues from the production of carbon tetrachloride	(T)
K017	Heavy ends (still bottoms) from the purification column in the production of epichlorohydrin.	(T)
K018	Heavy ends from the fractionation column in ethyl chloride production	(T)
K019	Heavy ends from the distillation of ethylene dichloride in ethylene dichloride production.	(T)
K020	Heavy ends from the distillation of vinyl chloride in vinyl chloride monomer production.	(T)
K021	Aqueous spent antimony catalyst waste from fluoromethanes production	(T)
K022	Distillation bottom tars from the production of phenol/acetone from cumene	(T)
K023	Distillation light ends from the production of phthalic anhydride from naphthalene	(T)
K024	Distillation bottoms from the production of phthalic anhydride from naphthalene	(T)
K093	Distillation light ends from the production of phthalic anhydride from ortho-xylene	(T)
K094	Distillation bottoms from the production of phthalic anhydride from ortho-xylene	(T)
K025	Distillation bottoms from the production of nitrobenzene by the nitration of benzene	(T)
K026	Stripping still tails from the production of methy ethyl pyridines	(T)
K027	Centrifuge and distillation residues from toluene diisocyanate production	(R, T)
K028	Spent catalyst from the hydrochlorinator reactor in the production of 1,1,1-trichloroethane.	(T)
K029	Waste from the product steam stripper in the production of 1,1,1-trichloroethane	(T)
K095	Distillation bottoms from the production of 1,1,1-trichloroethane	(T)
K096	Heavy ends from the heavy ends column from the production of 1,1,1-trichloroethane.	(T)
K030	Column bottoms or heavy ends from the combined production of trichloroethylene and perchloroethylene.	(T)
K083	Distillation bottoms from aniline production	(T)
K103	Process residues from aniline extraction from the production of aniline	(T)
K104	Combined wastewater streams generated from nitrobenzene/aniline production	(T)
K085	Distillation or fractionation column bottoms from the production of chlorobenzenes	(T)
K105	Separated aqueous stream from the reactor product washing step in the production of chlorobenzenes.	(T)
Inorganic chemicals:		
K071	Brine purification muds from the mercury cell process in chlorine production, where separately prepurified brine is not used.	(T)
K073	Chlorinated hydrocarbon waste from the purification step of the diaphragm cell process using graphite anodes in chlorine production.	(T)
K106	Wastewater treatment sludge from the mercury cell process in chlorine production	(T)
Pesticides:		
K031	By-product salts generated in the production of MSMA and cacodylic acid	(T)
K032	Wastewater treatment sludge from the production of chlordane	(T)
K033	Wastewater and scrub water from the chlorination of cyclopentadiene in the production of chlordane.	(T)
K034	Filter solids from the filtration of hexachlorocyclopentadiene in the production of chlordane.	(T)
K097	Vacuum stripper discharge from the chlordane chlorinator in the production of chlordane.	(T)
K035	Wastewater treatment sludges generated in the production of creosote	(T)
K036	Still bottoms from toluene reclamation distillation in the production of disulfoton	(T)
K037	Wastewater treatment sludges from the production of disulfoton	(T)
K039		

Hazardous waste No	Substance
P039	O,O-Diethyl S-[2-(ethylthio)ethyl] phosphorodithioate
P041	Diethyl-p-nitrophenyl phosphate
P040	O,O-Diethyl O-pyrazinyl phosphorothioate
P043	Diisopropyl fluorophosphate
P044	Dimethoate
P045	3,3-Dimethyl-1-(methylthio)-2-butanone, O-[(methylamino)carbonyl] oxime
P071	O,O-Dimethyl O-p-nitrophenyl phosphorothioate
P082	Dimethylnitrosamine
P046	alpha, alpha-Dimethylphenethylamine
P047	4,6-Dinitro-o-cresol and salts
P034	4,6-Dinitro-o-cyclohexylphenol
P048	2,4-Dinitrophenol
P020	Dinoseb
P085	Diphosphoramide, octamethyl-
P039	Disulfoton
P049	2,4-Dithiobiuret
P109	Dithiopyrophosphoric acid, tetraethyl ester
P050	Endosulfan
P088	Endothall
P051	Endrin
P042	Epinephrine
P046	Ethanamine, 1,1-dimethyl-2-phenyl-
P084	Ethenamine, N-methyl-N-nitroso-
P101	Ethyl cyanide
P054	Ethylenimine
P097	Famphur
P056	Fluorine
P057	Fluoroacetamide
P058	Fluoroacetic acid, sodium salt
P065	Fulminic acid, mercury(II) salt (R,T)
P059	Heptachlor
P051	1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,endo-1,4:5,8-dimethanonaphthalene
P037	1,2,3,4,10,10-Hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-endo,exo-1,4:5,8-demethanonaphthalene
P060	1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-endo, endo-dimeth- anonaphthalene
P004	1,2,3,4,10,10-Hexachloro-1,4,4a,5,8,8a-hexahydro-1,4:5,8-endo,exo-dimethanonaphthalene
P060	Hexachlorohexahydro-exo,exo-dimethanonaphthalene
P062	Hexaethyl tetraphosphate
P116	Hydrazinecarbothioamide
P068	Hydrazine, methyl-
P063	Hydrocyanic acid
P063	Hydrogen cyanide
P096	Hydrogen phosphide
P064	Isocyanic acid, methyl ester
P007	3(2H)-Isoxazolone, 5-(aminomethyl)-
P092	Mercury, (acetato-O)phenyl-
P065	Mercury fulminate (R,T)
P016	Methane, oxybis(chloro-
P112	Methane, tetranitro- (R)
P118	Methanethiol, trichloro-
P059	4,7-Methano-1H-indene, 1,4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-
P066	Methomyl
P067	2-Methylaziridine
P068	Methyl hydrazine
P064	Methyl isocyanate
P069	2-Methyllactonitrile
P071	Methyl parathion
P072	alpha-Naphthylthiourea
P073	Nickel carbonyl
P074	Nickel cyanide
P074	Nickel(II) cyanide
P073	Nickel tetracarbonyl
P075	Nicotine and salts
P076	Nitric oxide
P077	p-Nitroaniline
P078	Nitrogen dioxide
P076	Nitrogen(II) oxide
P078	Nitrogen(IV) oxide
P081	Nitroglycerine (R)
P082	N-Nitrosodimethylamine
P084	N-Nitrosomethylvinylamine
P050	5-Norbornene-2,3-dimethanol, 1,4,5,6,7,7 hexachloro, cyclic sulfite
P085	Octamethylpyrophosphoramide
P087	Osmium oxide
P087	Osmium tetroxide
P088	7-Oxabicyclo[2.2.1]heptane-2,3-dicarboxylic acid
P089	Parathion
P034	Phenol, 2-cyclohexyl-4,6-dinitro-
P048	Phenol, 2,4-dinitro-
P047	Phenol, 2,4-dinitro-6-methyl-
P020	Phenol, 2,4-dinitro-6-(1-methylpropyl)-
P009	Phenol, 2,4,6-trinitro-, ammonium salt (R)
P036	Phenyl dichloroarsine
P092	Phenylmercuric acetate
P093	N-Phenylthiourea
P094	Phorate
P095	Phosgene
P096	Phosphine
P041	Phosphoric acid, diethyl p-nitrophenyl ester
P044	Phosphorodithioic acid, O,O-dimethyl S-[2-(methylamino)-2-oxoethyl]ester
P043	Phosphorofluoric acid, bis(1-methylethyl)-ester
P094	Phosphorothioic acid, O,O-diethyl S-(ethylthio)methyl ester
P089	Phosphorothioci acid, O,O-diethyl O-(p-nitrophenyl) ester
P040	Phosphorothioic acid, O,O-diethyl O- pyrazinyl ester
P097	Phosphorothioic acid, O,O-dimethyl O-[p-((dimethylamino)-sulfonyl)phenyl]ester
P110	Plumbane, tetraethyl-
P098	Potassium cyanide
P099	Potassium silver cyanide
P070	Propanal, 2-methyl-2-(methylthio)-, O-[(methylamino)carbonyl]oxime
P101	Propanenitrile
P027	Propanenitrile, 3-chloro-
P069	Propanenitrile, 2-hydroxy-2-methyl-
P081	1,2,3-Propanetriol, trinitrate- (R)
P017	2-Propanone, 1-bromo-
P102	Propargyl alcohol
P003	2-Propenal
P005	2-Propen-1-ol
P067	1,2-Propylenimine
P102	2-Propyn-1-ol
P008	4-Pyridinamine
P075	Pyridine, (S)-3-(1-methyl-2-pyrrolidinyl)-, and salts
P111	Pyrophosphoric acid, tetraethyl ester
P103	Selenourea
P104	Silver cyanide
P105	Sodium azide
P106	Sodium cyanide
P107	Strontium sulfide
P108	Strychnidin 10-one, and salts
P018	Strychnidin 10 one, 2,3 dimethoxy
P108	Strychnine and salts
P115	Sulfuric acid, thallium(I) salt

Hazardous waste No	Substance
P110	Tetraethyl lead
P111	Tetraethylpyrophosphate
P112	Tetranitromethane (R)
P062	Tetraphosphoric acid, hexaethyl ester
P113	Thallic oxide
P113	Thallium(III) oxide
P114	Thallium(I) selenite
P115	Thallium(I) sulfate
P045	Thiofanox
P049	Thiomidodicarbonic diamide
P014	Thiophenol
P116	Thiosemicarbazide
P026	Thiourea, (2-chlorophenyl)-
P072	Thiourea, 1-naphthalenyl-
P093	Thiourea, phenyl-
P123	Toxaphene
P118	Trichloromethanethiol
P119	Vanadic acid, ammonium salt
P120	Vanadium pentoxide
P120	Vanadium(V) oxide
P001	Warfarin, when present at concentrations greater than 0.3%
P121	Zinc cyanide
P122	Zinc phosphide, when present at concentrations greater than 10%

(f) The commercial chemical products, manufacturing chemical intermediates, or off-specification commercial chemical products referred to in paragraphs (a) through (d) of this section, are identified as toxic wastes (T) unless otherwise designated and are subject to the small quantity exclusion defined in § 261.5 (a) and (f).

[*Comment*: For the convenience of the regulated community, the primary hazardous properties of these materials have been indicated by the letters T (Toxicity), R (Reactivity), I (Ignitability) and C (Corrosivity). Absence of a letter indicates that the compound is only listed for toxicity.]

These wastes and their corresponding EPA Hazardous Waste Numbers are:

Hazardous Waste No.	Substance
U001	Acetaldehyde (I)
U034	Acetaldehyde, trichloro-
U187	Acetamide, N-(4-ethoxyphenyl)-
U005	Acetamide, N-9H-fluoren-2-yl-
U112	Acetic acid, ethyl ester (I)
U144	Acetic acid, lead salt
U214	Acetic acid, thallium(I) salt
U002	Acetone (I)
U003	Acetonitrile (I,T)
U248	3-(alpha-Acetonylbenzyl)-4 hydroxycoumarin and salts, when present at concentrations of 0.3% or less
04	Acetophenone
U006	Acetyl chloride (C,R,T)
U007	Acrylamide
U008	Acrylic acid (I)
U009	Acrylonitrile
U150	Alanine, 3-[p-bis(2-chloroethyl)amino] phenyl-, L-
U011	Amitrole
U012	Aniline (I,T)
U014	Auramine
U015	Azaserine
U010	Azirino(2',3':3,4)pyrrolo(1,2-a)indole-4,7-dione, 6-amino-8-[((aminocarbonyl) oxy)methyl]-1,1a,2,8,8a,8b-hexahydro-8a-methoxy-5-methyl-,
U157	Benz[j]aceanthrylene, 1,2-dihydr[illegible]thyl-
U016	Benz[c]acridine
U016	3,4-Benzacridine
U017	Benzal chloride
U018	Benz[a]anthracene
U018	1,2-Benzanthracene
U094	1,2-Benzanthracene, 7,12-dime[illegible]
U012	Benzenamine (I,T)
U014	Benzenamine, 4,4'-carbonimidoylbis(N,N dimethyl-
U049	Benzenamine, 4-chloro-2-methyl-
U093	Benzenamine, N,N'-dimethyl-4-phenylazo-
U158	Benzenamine, 4,4'-methylenebis(2-chloro-
U222	Benzenamine, 2-methyl-, hydrochloride
U181	Benzenamine, 2-methyl-5-nitro
U019	Benzene (I,T)
U038	Benzeneacetic acid, 4-chloro-alpha-(4-chlorophenyl)-alpha-hydroxy, ethyl ester
U030	Benzene, 1-bromo-4-phenoxy-
U037	Benzene, chloro-
U190	1,2-Benzenedicarboxylic acid anhydride
U028	1,2-Benzenedicarboxylic acid, [bis(2-ethylhexyl)] ester
U069	1,2-Benzenedicarboxylic acid, dibutyl ester
U088	1,2-Benzenedicarboxylic acid, diethyl ester
U102	1,2-Benzenedicarboxylic acid, dimethyl ester
U107	1,2-Benzenedicarboxylic acid, di-n-octyl ester
U070	Benzene, 1,2-dichloro-
U071	Benzene, 1,3-dichloro-
U072	Benzene, 1,4-dichloro-
U017	Benzene, (dichloromethyl)-
U223	Benzene, 1,3-diisocyanatomethyl- (R,T)
U239	Benzene, dimethyl-(I,T)
U201	1,3-Benzenediol
U127	Benzene, hexachloro-
U056	Benzene, hexahydro- (I)
U188	Benzene, hydroxy-
U220	Benzene, methyl-
U105	Benzene, 1-methyl-1-2,4-dinitro-
U106	Benzene, 1-methyl-2,6-dinitro-
U203	Benzene, 1,2-methylenedioxy-[illegible]
U141	Benzene, 1,2-methylenedioxy-4-propenyl-
U090	Benzene, 1,2-methylenedioxy-4-propyl-
U055	Benzene, (1-methylethyl)- (I)
U169	Benzene, nitro- (I,T)
U183	Benzene, pentachloro-
U185	Benzene, pentachloro-nitro-
U020	Benzenesulfonic acid chloride (C,R)
U020	Benzenesulfonyl chloride (C,R)
U207	Benzene, 1,2,4,5-tetrachloro-
U023	Benzene, (trichloromethyl)-(C,R,T)
0234	Benzene, 1,3,5-trinitro- (R,T)
U021	Benzidine
U202	1,2-Benzisothiazolin-3-one, 1,1 dioxide
U120	Benzo[j,k]fluorene
U022	Benzo[a]pyrene
U022	3,4-Benzopyrene

Hazardous Waste No	Substance
U041	Oxirane, 2-(chloromethyl)-
U182	Paraldehyde
U183	Pentachlorobenzene
U184	Pentachloroethane
U185	Pentachloronitrobenzene
U242	Pentachlorophenol
U186	1,3-Pentadiene (I)
U187	Phenacetin
U188	Phenol
U048	Phenol, 2-chloro-
U039	Phenol, 4-chloro-3-methyl-
U081	Phenol, 2,4-dichloro-
U082	Phenol, 2,6-dichloro-
U101	Phenol, 2,4-dimethyl-
U170	Phenol, 4-nitro-
U242	Phenol, pentachloro-
U212	Phenol, 2,3,4,6-tetrachloro-
U230	Phenol, 2,4,5-trichloro-
U231	Phenol, 2,4,6-trichloro-
U137	1,10-(1,2-phenylene)pyrene
U145	Phosphoric acid, Lead salt
U087	Phosphorodithioic acid, 0,0-diethyl-, S-methylester
U189	Phosphorous sulfide (R)
U190	Phthalic anhydride
U191	2-Picoline
U192	Pronamide
U194	1-Propanamine (I,T)
U110	1-Propanamine, N-propyl- (I)
U066	Propane, 1,2-dibromo-3-chloro-
U149	Propanedinitrile
U171	Propane, 2-nitro- (I)
U027	Propane, 2,2'oxybis[2-chloro-
U193	1,3-Propane sultone
U235	1-Propanol, 2,3-dibromo-, phosphate (3:1)
U126	1-Propanol, 2,3-epoxy-
U140	1-Propanol, 2-methyl- (I,T)
U002	2-Propanone (I)
U007	2-Propenamide
U084	Propene, 1,3-dichloro-
U243	1-Propene, 1,1,2,3,3,3-hexachloro-
U009	2-Propenenitrile
U152	2-Propenenitrile, 2-methyl- (I,T)
U008	2-Propenoic acid (I)
U113	2-Propenoic acid, ethyl ester (I)
U118	2-Propenoic acid, 2-methyl-, ethyl ester
U162	2-Propenoic acid, 2-methyl-, methyl ester (I,T)
U233	Propionic acid, 2-(2,4,5-trichlorophenoxy)-
U194	n-Propylamine (I,T)
U083	Propylene dichloride
U196	Pyridine
U155	Pyridine, 2-[(2-(dimethylamino)-2-thenylamino]-
U179	Pyridine, hexahydro-N-nitroso-
U191	Pyridine, 2-methyl-
U164	4(1H)-Pyrimidinone, 2,3-dihydro-6-methyl-2-thioxo-
U180	Pyrrole, tetrahydro-N-nitroso-
U200	Reserpine
U201	Resorcinol
U202	Saccharin and salts
U203	Safrole
U204	Selenious acid
U204	Selenium dioxide
U205	Selenium disulfide (R,T)
U015	L-Serine, diazoacetate (ester)
U233	Silvex
U089	4,4'-Stilbenediol, alpha,alpha'-diethyl-
U206	Streptozotocin
U135	Sulfur hydride
U103	Sulfuric acid, dimethyl ester
U189	Sulfur phosphide (R)
U205	Sulfur selenide (R,T)
U232	2,4,5-T
U207	1,2,4,5-Tetrachlorobenzene
U208	1,1,1,2-Tetrachloroethane
U209	1,1,2,2-Tetrachloroethane
U210	Tetrachloroethylene
U212	2,3,4,6-Tetrachlorophenol
U213	Tetrahydrofuran (I)
U214	Thallium(I) acetate
U215	Thallium(I) carbonate
U216	Thallium(I) chloride
U217	Thallium(I) nitrate
U218	Thioacetamide
U153	Thiomethanol (I,T)
U219	Thiourea
U244	Thiram
U220	Toluene
U221	Toluenediamine
U223	Toluene diisocyanate (R,T)
U222	O-Toluidine hydrochloride
U011	1H-1,2,4-Triazol-3-amine
U226	1,1,1-Trichloroethane
U227	1,1,2-Trichloroethane
U228	Trichloroethene
U228	Trichloroethylene
U121	Trichloromonofluoromethane
U230	2,4,5-Trichlorophenol
U231	2,4,6-Trichlorophenol
U232	2,4,5-Trichlorophenoxyacetic acid
U234	sym-Trinitrobenzene (R,T)
U182	1,3,5-Trioxane, 2,4,5-trimethyl-
U235	Tris(2,3-dibromopropyl) phosphate
U236	Trypan blue
U237	Uracil, 5[bis(2-chloromethyl)amino]-
U237	Uracil mustard
U043	Vinyl chloride
U248	Warfarin, when present at concentrations of 0.3% or less
U239	Xylene (I)
U200	Yohimban-16-carboxylic acid, 11,17-dimethoxy-18-[(3,4,5-trimethoxy-benzoyl)oxy]-, methyl ester
U249	Zinc phosphide, when present at concentrations of 10% or less

[45 FR 78529, 78541, Nov. 25, 1980, as amended at 46 FR 27477, May 20, 1981; 49 FR 19923, May 10, 1984]

Effective Date Note: At 49 FR 19923, May 10, 1984, § 261.33 was amended by revising three entries in the table in paragraph (e), and adding three entries to the table in paragraph (f) identified by hazardous waste numbers U248, (3-(alpha-Acetonylbenzyl)-4-hydroxycoumarin and salts, when present at concentrations of 0.3% or less, and Warfarin, when present at concentrations of 0.3% or less), and U249, (Zinc phosphide, when present at concentrations of 10% or less), effective November 12, 1984. For the convenience of the user, the superseded entries from the table in paragraph (e) are set out below.

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 122333505

Henry G. Williams
Commissioner

April 1, 1987

MEMORANDUM

TO: Bureau Directors, Regional Water Engineers, Section Chiefs

SUBJECT: Division of Water Technical and Operational Guidance Series (2.1.2)
UNDERGROUND INJECTION/RECIRCULATION (UIR) AT GROUNDWATER REMEDIATION SITES
(Originator: Mr. Nadler)

I. PURPOSE

This document provides guidance on the applicability of SPDES permits and groundwater effluent standards to the use of UIR as a remediation measure.

II. DISCUSSION

At groundwater contamination sites, including inactive hazardous waste sites, an increasingly popular remedial measure involves pumping out contaminated groundwater, treating it, and then recirculating a portion of it to the ground in order to speed the movement of pollutants toward the purge wells. A portion of the treated groundwater (blowdown) is always discharged to either surface waters or to a POTW so that the system operates at a net hydraulic deficit. This helps to prevent pollutants from migrating beyond the target area. The blowdown, if discharged to a surface water body, will normally require either a SPDES permit or temporary authorization. If the blowdown is discharged to a POTW, it must meet all pretreatment and sewer district requirements.

This document addresses only that portion which is injected into the ground. For the injected water we need to know if the UIR system requires a SPDES permit and if the groundwater effluent standards, contained in 6 NYCRR Section 703.6 apply.

III. GUIDANCE

I. SPDES Requirement

a. UIR systems will require a SPDES permit unless they meet the criteria of paragraph b of this section.

b. A SPDES permit will not be required if either of the following conditions is met:

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-0001

Henry G. Williams
Commissioner

April 1, 1987

MEMORANDUM

TO: **Regional Water Engineers, Bureau Directors, Section Chiefs**

SUBJECT: Division of Water Technical and Operational Guidance Series (2.1.3)
PRIMARY AND PRINCIPAL AQUIFER DETERMINATIONS
(Originator: Mr. DeGaetano)

PURPOSE

To clarify the meaning of the terms "Primary Water Supply Aquifer" and "Principal Aquifer" as they are set forth in the Upstate New York Groundwater Management Program, and to establish guidance for determining whether an aquifer is considered a Primary Water Supply Aquifer or Principal Aquifer.

DISCUSSION

"Geographic targeting", as set forth in the Upstate New York Groundwater Management Program, is the adoption of special program policies and/or priorities to provide a special (i.e., extra) level of protection in locations where the groundwaters are both highly productive and highly vulnerable. The basic categories of areas which have been identified for use in geographic targeting, in order of priority, are:

- Public Water Supply Wellhead Areas.
- Primary Water Supply Aquifer Areas.
- Principal Aquifer Areas.
- Other Areas.

ever locate in that particular spot. In protecting the groundwater resource, we cannot presume to know where development may or may not locate at some time in the distant future.

Productivity, And Natural Water Quality

As used in the definitions of Primary Water Supply Aquifer and Principal Aquifer, the term "highly productive" means aquifers with capability to provide water for public water supply of a quantity and natural background quality which is of regional significance. As discussed above, the range of populations currently served by the Primary Water Supply Aquifers serves to illustrate the intended meaning of this term.

Existing contamination which is the result of man's activities is not part of "natural background". On the other hand, some aquifers have the physical capability to supply significant quantities of water, but the natural background quality of the water makes it unsuitable for drinking. Aquifers with naturally unpotable water will not be considered Principal Aquifers. Consistent with 6 NYCRR Part 703, this means water with a natural chloride concentration of more than 250 mg/liter or a natural total dissolved solids concentration of more than 1,000 mg/liter.

Vulnerability, Confined vs. Unconfined Aquifers, And Unconsolidated vs. Bedrock Aquifers

As used in defining "Primary Water Supply Aquifer" and "Principal Aquifer", the term "highly vulnerable" refers to aquifers which are highly susceptible to contamination from human activities at the land surface over the identified aquifer. Additionally, so that the special policies designed to protect them can be applied fairly and equitably, such aquifers must be generally identifiable based on available mapping if they are to be considered Primary Water Supply Aquifers or Principal Aquifers.

Unconfined (water table) aquifers consisting of unconsolidated geologic deposits (a) are the most common type of high-yielding aquifer system in upstate New York, (b) are generally mapped, so that regulated entities and the general public can be provided with at least reasonably accurate comprehensive mapping showing where they exist, and (c) are vulnerable to contamination from the land surface over the aquifer. These aquifers, where they are sufficiently productive, fall within the meaning of "Primary Water Supply Aquifer" and "Principal Aquifer".

Where a highly productive aquifer is overlain by thick, continuous impermeable deposits and the predominant recharge to the aquifer is from land areas outside of the aquifer area, the aquifer does not fall within the meaning of the terms "Primary" and "Principal". Special protective policies applied to the land area over the aquifer will provide little if any additional protection for it. Where the major sources of recharge for confined aquifers can be iden-

Factors Used In Principal Aquifer Determinations

During the development of the draft Upstate New York Groundwater Management Program it was recognized that criteria would likely be necessary to determine whether a specific geographic location is considered to be within a Principal Aquifer area. For that criteria the draft report suggested a minimum sustained well yield of ten (10) gallons per minute, to be obtainable generally for locations throughout the aquifer and not just from one isolated spot.

There has now been considerable experience in making Principal Aquifer determinations. Experience suggests that the single criterion of 10 gpm sustained well yield does not fully reflect the intent of the phrase "aquifers known to be highly productive or whose geology suggests abundant potential water supply".

The actual boundary of an aquifer area is determined by the pattern of geologic deposits, not by an arbitrary well yield number. However, the value of 10 gpm sustained well yield tends to occur near the edge of an aquifer area, where the thickness of saturated permeable deposits is quite small. Maps illustrating the locations of unconsolidated aquifers often use 10 gpm (somewhat arbitrarily) as the lower end of the range of well yields associated with highly productive aquifers.

Further inside of the boundaries of major aquifers there are ordinarily very substantial areas where the sustained yield to wells is considerably in excess of of 10 gpm. Thus, a continuous area of locations which can sustain 10 gpm may help to define the boundary of an aquifer area but does not establish whether the aquifer is sizable enough to be considered a "Principal Aquifer". The term "Principal Aquifer" is intended to reflect the overall capability of the aquifer to supply water, rather than just the capability at the boundary of the aquifer area.

The attached Table 1 provides relevant data for the upstate Primary Water Supply Aquifers and several aquifers considered to be "Principal Aquifers". The data are from the "Atlas of Eleven Selected Aquifers in New York", U.S. Geological Survey, 1982, plus other hydrological reports and data available in DEC files.

On the Table, the columns showing existing population served and the existing average daily pumpage indicate the range of public water supply usage associated with identified "Primary Water Supply Aquifers". The area of the aquifer, thickness of saturated deposits (both average and maximum), and maximum obtainable well yields (actual or estimated) are types of data which are available or obtainable for most unconsolidated aquifers. When considered collectively, they are indicative of the overall capability of an aquifer to supply water. They can serve as a common basis of comparison for considering whether an aquifer is a Principal Aquifer.

To qualify as a Principal Aquifer, overall yields should be comparable to those of the smaller Primary Water Supply Aquifers. Roughly, this means the ability to supply a population of 5,000-10,000 people, or a yield of 500,000 to

4. Where an applicant believes that more detailed hydrogeologic information will change the identification of a particular location as being within/outside a Primary Water Supply Aquifer Area or Principal Aquifer Area, the pertinent information should be submitted to the Department with a request for a determination. The information should be submitted through the regulatory program having jurisdiction in the particular situation (e.g., for a landfill site, the Division of Solid and Hazardous Wastes). It is not appropriate to establish specific, detailed guidelines for the types of information and the methods of field investigation which may be required, because conditions in specific locations are too variable. However, hydrogeologic staff of the Division of Water will be available to consult with other regulatory program staff and with applicants as needed on the information required in specific instances.

5. The Division of Water is ultimately responsible for making the formal determination as to whether a location is within a Primary Water Supply Aquifer Area or a Principal Aquifer Area. Requests for determinations by the Division of Water will be referred to the DOW by the appropriate regulatory program offices as per Item #4 above.

Daniel M. Barolo
Director, Division of Water

cc: Dr. Banks
Mr. Pagano
Ms. Chrimes
Ms. Ballentine
Regional Engineers for Environmental Quality

211.13-211.14

Historical Note

Secs. amd. filed July 11, 1967; renum. 377.13-377.14, Title 9, filed Sept. 1971.

PART 212

GENERAL PROCESS EMISSION SOURCES

(Statutory authority: Environmental Conservation Law, §§ 3-0301, 19-0301, 19-0303)

Historical Note

Part (§§ 212.1-212.10) renum. Part 378, Title 9, filed Sept. 1971; new (§§ 212.1-212.4) filed April 28, 1972; repealed, new (§§ 212.1-212.8) filed April 27, 1973; Oct. 16, 1985 eff. Nov. 15, 1985. Amended Part title.

Section 212.1 **Determination of environmental rating.** When an application is made for a permit to construct or for a certificate to operate for a process emission source, the commissioner will issue an environmental rating for each air contaminant from each emission point in accordance with Table 1 of this Part.

Historical Note

Sec. renum. 378.1, Title 9, filed Sept. 1971; new filed April 28, 1972; repealed, new filed April 27, 1973; repealed, filed Feb. 22, 1979; new added by renum. and amd. 212.2, filed Oct. 16, 1985 eff. 30 days after filing.

212.2 **Emissions from existing emission sources.** Emissions of air contaminants to the outdoor atmosphere from any process emission source are restricted as follows:

(a) No person will cause or allow emissions that violate the requirement specified in Table 2, Table 3 or Table 4 of this Part for the environmental rating issued by the commissioner; or

(b) In instances where determination of permissible emission rate using process weight is not applicable (see Table 5) and for an environmental rating of B or C, no person will cause or allow emissions of solid particulates that exceed 0.15 grains of particulates per cubic foot of exhaust gas, corrected for dilution air and expressed at standard conditions on a dry gas basis.

(c) Where it can be shown to the satisfaction of the commissioner that emissions from a process emission source which is required to have reasonably available control technology (RACT) pursuant to Table 3 of this Part cannot be reduced for reasons of technological or economic feasibility, the commissioner may accept a lesser degree of control, or seasonal use of control equipment, or the commissioner may determine that no control of the process emisson source constitutes RACT.

Historical Note

Sec. amd. filed July 11, 1967; renum. 378.2, Title 9, filed Sept. 1971; new filed April 28, 1972; repealed, new filed: May 17, 1972; May 27, 1973; amd. filed Feb. 22, 1979; renum. 212.1, new added by renum. and amd. 212.3, filed Oct. 16, 1985 eff. 30 days after filing.

212.5 Opacity of emissions limited. (a) No person will cause or allow emissions having an average opacity during any six consecutive minutes of 20 percent or greater from any process emission source, except only the emission of uncombined water.

(b) Upon written application by a source owner or operator, the commissioner, at his discretion may accept for an emission source an equivalent opacity standard exceeding the opacity standard of subdivision (a) of this section, if the source owner can demonstrate through acceptable tests for such source that he is in compliance with all applicable emission requirements other than the opacity standard and that the source and any associated emission control equipment is being operated and maintained in a manner acceptable to the commissioner. An equivalent opacity standard for an emission source will only be granted where reasonably available control technology, as determined by the commissioner, has been utilized. In such cases, the source owner or operator will not cause or allow emissions to exceed the equivalent opacity.

Historical Note

Sec. repealed, new filed Dec. 24, 1970; renum. 378.5, Title 9, filed Sept. 1971; new filed April 27, 1973; amd. filed Feb. 22, 1979; renum. 212.4, new added by renum. and amd. 212.7, filed Oct. 16, 1985 eff. 30 days after filing.

212.6 Exceptions. The following process emission sources are not subject to the provisions of this Part:

(a) process emission sources which are exempt under section 201.6 of this Title;

(b) kilns and clinker coolers in portland cement plants with respect to particulate emissions and opacity of emissions only;

(c) ferrous jobbing foundry melting furnaces in operation on or prior to February 6, 1968 with respect to particulate emissions only;

(d) by-product coke oven batteries with respect to opacity, sulfur compound emissions and emissions of particulates which are given an A rating;

(e) petroleum liquid storage and transfer facilities subject to Part 229 or Part 230 of this Title, with respect to petroleum liquids which are not given an A rating;

(f) process emission sources other than kilns and clinker coolers in a portland cement plant with respect to opacity of emissions only;

(g) process emission sources in a sulfuric or nitric acid plant which are regulated by Part 224 of this Title with respect to emissions of nitrogen oxides, oxides of sulfur, sulfuric acid mist and smoke;

(h) process emission sources in a petroleum refinery subject to Part 223 of this Title with respect to sulfur compound emissions and emissions of volatile organic compounds which are not given an A rating;

(i) process emission sources from which emissions of oxides of sulfur are attributable only to sulfur in fuel with respect to emissions of oxides of sulfur;

(j) solvent metal cleaning processes subject to Part 226 of this Title with respect to emissions of volatile organic compounds which are not given an A rating;

(k) iron and/or steel processes with respect to opacity and emissions of particulates which are not given an A rating;

(b) *Table 2.*

Degree of Air Cleaning Required for Gases and Liquid Particulate Emissions (Environmental Rating A, B, C or D) and Solid Particulate Emissions (Environmental Rating A or D) but excluding Volatile Organic Compound Emissions in the New York City Metropolitan Area*

EMISSION RATE POTENTIAL (LB/HR)

Environmental rating	*Less than 1.0*	*1 to 10*	*10 to 20*	*20 to 100*	*100 to 500*	*500 to 1,000*	*1,000 to 1,500*	*1,500 to 4,000*	*4,000 to 10,000*	*10,000 and greater*
A	**	99% OR GREATER OR BEST AVAILABLE CONTROL TECHNOLOGY								
B	**		90%	91%	94%	96%		97%	98%	99% or greater
C	**		70%	75%	85%	90%		93%	95%	98% or greater
D	NO AIR CLEANING REQUIRED									

* See Table 3 of this Part for degree of air cleaning required for volatile organic compound emissions in the New York City Metropolitan Area.

** Degree of air cleaning required shall be specified by the commissioner.

(d) *Table 4.*

Permissible Emission Rates Based on Process Weight for Solid Particulate Emissions (Environmental Rating B or C)

Process weight per hour (lb/hr)	*Permissible emission rate (lb/hr)* *Existing source*	*New source or modification*
100	0.51	0.51
500	1.5	1.5
1,000	2.4	2.4
5,000	6.8	6.8
10,000	11	11
25,000	20	20
50,000	32	32
75,000	42	42
100,000	51	51
250,000	58	0.030 grain per standard cubic foot of undiluted exhaust gas on a dry basis.
500,000	64	
750,000	68	
1,000,000	71	
2,000,000	78	
5,000,000	88	

To determine values of permissible emission rate not shown in table:

for all process weight sources up to 100,000 lb/hr, use $E = 0.024P^{0.67}$;

for existing process weight sources in excess of 100,000 lb/hr, use $E = 39P^{0.082-50}$. where E = permissible emission rate; P = process weight in lb/hr.

(e) *Table 5.*

Processes for which Permissible Emission Rate is Based on Process Weight

a. Stone dryers (asphalt concrete plants)
b. Expanded aggregate kilns (lightweight aggregate plants)
c. Continuous process material dryers emitting solid particulates and water only
d. Brass and bronze melting furnaces
e. Ferro alloy production furnaces
f. Lime kilns
g. Glass production furnaces
h. Graphitizing and silicon carbide furnaces
i. Gypsum dryers
j. Primary aluminum reduction furnaces

Historical Note

Sec. renum. 378.9, Title 9, filed Sept. 1971; new filed Feb. 22, 1979; amd. filed Oct. 16, 1985 eff. 30 days after filing.

212.10

Historical Note

Sec. filed July 11, 1967; renum. 378.10, Title 9, filed Sept. 1971.

212.11

Historical Note

Sec. filed July 11, 1967; repealed, filed Dec. 24, 1970.

OP	LOCATION	FACILITY	EMISSION POINT	
				I

A ADD
B CHANGE
C DELETE

READ INSTRUCTIONS CONTAINED IN FORM 76-11-12 BEFORE ANSWERING ANY QUESTION

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

COPIES	
WHITE	ORIGINAL
GREEN	DIVISION OF AIR
WHITE	REGIONAL OFFICE
PINK	FIELD REP
YELLOW	APPLICANT

PROCESS, EXHAUST OR VENTILATION SYSTEM

APPLICATION FOR PERMIT TO CONSTRUCT OR CERTIFICATE TO OPERATE

SECTION A

1 NAME OF OWNER/FIRM

2 NUMBER AND STREET ADDRESS

3 CITY - TOWN - VILLAGE | 4 STATE | 5 ZIP

6 OWNER CLASSIFICATION
A ☐ COMMERCIAL B ☐ INDUSTRIAL C ☐ UTILITY D ☐ FEDERAL E ☐ STATE F ☐ MUNICIPAL G ☐ EDUC. INST. H ☐ HOSPITAL I ☐ RESIDENTIAL J ☐ OTHER

7 NAME & TITLE OF OWNERS REPRESENTATIVE | 8 TELEPHONE

9 NAME OF AUTHORIZED AGENT | 10 TELEPHONE

11 NUMBER AND STREET ADDRESS

12 CITY - TOWN - VILLAGE | 13 STATE | 14 ZIP

15 NAME OF P.E. OR ARCHITECT PREPARING APPLICATION | 16 N.Y.S. P.E. OR ARCHITECT LICENSE NO. | 17 TELEPHONE

18 SIGNATURE OF OWNERS REPRESENTATIVE OR AGENT WHEN APPLYING FOR A PERMIT TO CONSTRUCT

19 FACILITY NAME IF DIFFERENT FROM OWNER/FIRM

20 FACILITY LOCATION (NUMBER AND STREET ADDRESS)

21 CITY - TOWN - VILLAGE | 22 ZIP

23 BUILDING NAME OR NUMBER | 24 FLOOR NAME OR NUMBER

25 START UP DATE MO. / YR. | 26 DRAWING NUMBERS OF PLANS SUBMITTED

27 PERMIT TO CONSTRUCT
A ☐ NEW SOURCE
B ☐ MODIFICATION

28 CERTIFICATE TO OPERATE
A ☐ NEW SOURCE
B ☐ MODIFICATION
C ☐ EXISTING SOURCE

SEC. B

29 EMISSION POINT ID	30 GROUND ELEVATION (FT)	31 HEIGHT ABOVE STRUCTURES (FT)	32 STACK HEIGHT (FT)	33 INSIDE DIMENSIONS	34 EXIT TEMP (°F)	35 EXIT VELOCITY (FT/SEC)	36 EXIT FLOW RATE (ACFM)

37 SOURCE CODE	38 HRS/DAY	39 DAYS/YR	40 % OPERATION BY SEASON Winter	Spring	Summer	Fall

SEC. C

41 DESCRIBE PROCESS OR UNIT

1	2
3	4
5	6
7	8

SEC. D

EMISSION CONTROL EQUIPMENT ID	CONTROL TYPE	MANUFACTURER'S NAME AND MODEL NUMBER	DISPOSAL METHOD	DATE INSTALLED MONTH / YEAR	USEFUL LIFE
42	43	44	45	46 /	47
48	49	50	51	52 /	53

SECTION E

CALCULATIONS

SECTION F

CONTAMINANT NAME	CAS NUMBER	INPUT OR PRODUCTION	UNIT	ENV RATING	EMISSIONS ACTUAL	UNIT	HOW DET	PERMISSIBLE	% CONTROL EFFIC'CY	HOURLY EMISSIONS (LBS/HR) ERP	ACTUAL	ANNUAL EMISSIONS (LBS/YR) ACTUAL	10ˣ	PERMISSIBLE
54	55 - -	56	57	58	59	60	61	62	63	64	65	66	67	68
69	70 - -	71	72	73	74	75	76	77	78	79	80	81	82	83
84	85 - -	86	87	88	89	90	91	92	93	94	95	96	97	98
99	100 - -	101	102	103	104	105	106	107	108	109	110	111	112	113
114	115 - -	116	117	118	119	120	121	122	123	124	125	126	127	128
129	130 - -	131	132	133	134	135	136	137	138	139	140	141	142	143

SEC. G

SOLID FUEL TYPE	TONS/YR	%S	LIQUID FUEL TYPE	THOUSANDS OF GALLONS/YR	%S	GAS TYPE	THOUSANDS OF CF/YR	BTU/CF
144	145	146	147	148	149	150	151	152

APPLICABLE RULE	APPLICABLE RULE
153	154

Upon completion of construction sign the statement listed below and forward to the appropriate field representative

THE PROCESS, EXHAUST OR VENTILATION SYSTEM HAS BEEN CONSTRUCTED AND WILL BE OPERATED IN ACCORDANCE WITH STATED SPECIFICATIONS AND IN CONFORMANCE WITH ALL PROVISIONS OF EXISTING REGULATIONS

155 SIGNATURE OF AUTHORIZED REPRESENTATIVE OR AGENT | DATE

AGENCY USE ONLY

156 LOCATION CODE	157 FACILITY ID NO	158 U.T.M. (E)	159 U.T.M. (N)	160 SIC NUMBER	161 DATE APPL RECEIVED	162 DATE APPL REVIEWED	163 REVIEWED BY
					/ /	/ /	

PERMIT TO CONSTRUCT

164 DATE ISSUED	165 EXPIRATION DATE	166 SIGNATURE OF APPROVAL	167 FEE
/ /	/ /		

168
1 DEVIATION FROM APPROVED APPLICATION SHALL VOID THIS PERMIT
2 THIS IS NOT A CERTIFICATE TO OPERATE
3 TESTS AND/OR ADDITIONAL EMISSION CONTROL EQUIPMENT MAY BE REQUIRED PRIOR TO THE ISSUANCE OF A CERTIFICATE TO OPERATE

CERTIFICATE TO OPERATE

169 DATE ISSUED	170 EXPIRATION DATE	171 SIGNATURE OF APPROVAL	172 FEE
/ /	/ /		

173
1 ☐ INSPECTED BY__________ DATE__________
2 ☐ INSPECTION DISCLOSED DIFFERENCES AS BUILT VS PERMIT, CHANGES INDICATED ON FORM
3 ☐ ISSUE CERTIFICATE TO OPERATE FOR SOURCE AS BUILT
4 ☐ APPLICATION FOR C.O. DENIED __________ DATE __________ INITIALED

174 SPECIAL CONDITIONS:

1	2
3	4
5	6
7	8

New York State Department of Environmental Conservation

INSTRUCTIONS FOR THE PREPARATION AND SUBMISSION OF AN APPLICATION FOR A PERMIT TO CONSTRUCT OR A CERTIFICATE TO OPERATE

PROCESSES, EXHAUST AND/OR VENTILATION SYSTEMS

A. GENERAL

In accordance with the rules of the New York State Department of Environmental Conservation, the owner of an air contamination source (process and exhaust and/or ventilation systems) must have a Certificate to Operate, which is valid for a period up to three years. To continue operating, the source owner must renew his Certificate to Operate on or prior to the Certificate's expiration date. If a source is new or a modification is planned, the owner must secure a Permit to Construct before construction can proceed. After completion of construction, the source owner must apply for and obtain a Certificate to Operate to commence operation. An existing process that is relocated from one facility to another is considered a new source and requires submission of an application for a Permit to Construct before construction can proceed.

A modification under Section 201.2 of 6 NYCRR 201 (Permits and Certificates) means any physical change or change in the method of operation of a process which (a) increases the hourly emission rate, emission concentration or emission opacity of any air contaminant or (b) involves the installation or alteration of any air cleaning installation, air cleaning device or control equipment or (c) involves conversion of fuel used in any process to a fuel with a higher ash content than the fuel used prior to the change. Routine maintenance, repair and replacement of original equipment or parts thereof are not considered physical changes. An increase or decrease in the hours of operation is not considered a change in the method of operation if the total emissions do not cause air pollution or contravention of any applicable ambient air quality standard and the cumulative permissible emission resulting from any increase in the hours of operation is equal to or less than the applicability emission limits for prevention of significant deterioration or source growth in nonattainment areas.

The following are not considered modifications:

1. Alteration of stacks including manifolding existing stacks to a new common stack.
2. Relocation of a temporary (mobile) asphalt concrete plant.
3. Installation of a stack gas conditioning system to improve the particulate collection efficiency of an existing electrostatic precipitator.

However, the source owner must apply for and obtain an amended Certificate to Operate for the affected emission source when the alteration or relocation is completed. Where a process, exhaust and/or ventilation system is located in a nonattainment area of the State for particulates or sulfur dioxide, the source owner must submit an acceptable air quality impact evaluation report prior to the alteration of a stack See Section J-5 (page 12) of these instructions.

Completed application forms 76-19-3 and 76-19-4 must be submitted with 3 sets of plans to the appropriate FIELD REPRESENTATIVE (air pollution control program) for the county where the source is located (See form 70-00-1 for the list of addresses). The application must be signed by the owner or his authorized agent. The signature of the agent, to be acceptable, must be accompained by a letter of authorization.

Tax relief to encourage construction of air pollution control equipment is available. To be eligible, the equipment must remove, reduce or render less noxious air contaminants emitted from an air contamination source and be in conformance with the New York State emission requirements (See form 76-11-16, Tax Relief for Air Pollution Control Facilities).

To comply with the State Education Law an application for a Permit to Construct for a new source or modification, including stack test reports and other supportive engineering reports, must be prepared under the direct supervision of and bear the seal of a professional engineer licensed in the State of New York. Certification by a professional engineer will not be required for sources which have been altered resulting only in a change in process weight or emission rate potential and sources for which repairs of existing emission control equipment are replacements "in kind."

B. APPLICATION REVIEW AND PERMIT FEES

All applications received by the Department must be processed within a time period specified by 6 NYCRR 621 (Uniform Procedures). Additionally, the Department must determine whether or not the application is for a minor project. All processes, exhaust and/or ventilation systems are considered minor except:

1. Process, exhaust and ventilation systems with particulate emissions in excess of 100 pounds per hour.
2. Process, exhaust and ventilation systems which emit SO_2 at a rate exceeding ten pounds per hour.

3. Recovery boilers and lime kilns in chemical pulp mills.

4. Kilns and clinker coolers in portland cement plants.

5. Blast furnaces, sintering processes, basic oxygen furnaces, cupolas, scarfing and cutting processes, lime kilns, continuous galvanizing mills and transfer of molten metal from blast furnaces to other furnaces in iron and steel plants.

6. Reduction cells and anode baking processes in primary aluminum ore reduction plants.

7. Absorber exit stacks and sulfuric acid concentrators in sulfuric acid plants.

8. Catalyst regenerators and desulfurization processes in petroleum refineries.

9. Kilns and coolers in lime plants.

10. Charging, pushing and quenching processes and waste heat stacks and desulfurization systems in by-product coke manufacturing plants.

11. Construction of new or expansion of existing storage facilities designed for or capable or storing one million or more gallons or liquid natural gas, liquid petroleum gas or other liquid fuels.

12. Sulfur recovery plants.

13. Fuel conversion plants.

14. Process, exhaust and ventilation systems emitting air contaminants assigned an environmental rating of "A" under Part 212 (6 NYCRR 212) and whose total emission rate of such "A" contaminants exceeds one pound per hour.

15. Process, exhaust and ventilating systems from which the total emission rate of all air contaminants exceeds 50 tons per day.

16. Process, exhaust and ventilating systems subject to hearing requirements under federal regulations which implement the federal Clean Air Act.

For non-minor projects a determination will be made whether the proposed project may or will not have a significant effect on the environment and whether a draft environmental impact statement is warranted. The Department may also require the applicant to provide reasonable public notice of the application and opportunity for public comment.

The fee for a Permit to Construct for a non-minor process source is $100. The fee for recertification of a non-minor process source is $30 for a three year certificate, $20 for a two year certificate and $10 for a one year certificate.

Applications for a permit or certificate must be accompanied by a check or money order made payable to the "Department of Environmental Conservation." Payment in cash will not be accepted. There is no fee for all other permits and certificates.

C. APPLICABLE EMISSION STANDARDS

A Permit to Construct may not be issued unless the source owner or his authorized agent can show that the proposed new process and exhaust and/or ventilation system or modification will comply with applicable emission standards. Such verification can consist of stack tests performed on pilot or similar full scale installations or reliable material balance calculations which estimate the emissions expected from the new source or modification.

The State emission rules and the federal emission rules, where also applicable for specific air contaminants from specific process units, are listed below by industry type. For processes and exhaust and/or ventilation systems, concerning which there are no applicable specific state or federal emission standards, the emission standard or degree of emission control required under Part 212 is based on an environmental rating assigned to each air contaminant emitted from each source (See Section D, Environmental Rating).

1. Ferrous Jobbing Foundries

See Part 213, Contaminant Emissions from Ferrous Jobbing Foundries, for particulate emission standards applicable to cupolas and open hearth furnaces.

See Part 212, Process, Exhaust an/or Ventilation Systems, for requirements and emission standards applicable to (a) other air contaminants from these sources and (b) particulates as well as other contaminants from any other emission source in a ferrous jobbing foundry. For such foundries emission control is based on environmental ratings of (a) "D" for carbon monoxide emissions from the cupola or open hearth furnace, (b) "B" for particulate emissions from other emission sources and (c) "C" for odorous volatile organic compounds from core or mold baking ovens.

2. By-Product Coke Oven Batteries

See Part 214, By-Product Coke Oven Batteries, for particulate emissions standards, opacity and other visible emission limitations, sulfur compound emissions (measured as hydrogen sulfide) and oven door maintenance and work plan requirements applicable to by-product coke oven batteries.

See Part 212, Processes and Exhaust and/or Ventilation Systems, for emission standards applicable to gaseous emissions other than sulfur compounds from by-product coke oven batteries.

3. Portland Cement Plants

See Part 220, Portland Cement Plants, for (a) particulate emission standards and other requirements applicable to any kiln or clinker cooler and (b) opacity standards applicable to any emission source of a portland cement plant.

See Part 212, Processes and Exhaust and/or Ventilation Systems, for particulate emission standards applicable to emission sources other than a kiln or cooler and for requirements and emission standards applicable to other air contaminants from any emission source in a portland cement plant. For emission sources other than a kiln or cooler, emission control is usually based on an environmental rating of "B" for particulate emissions.

4. Petroleum Refineries

See Part 223, Petroleum Refineries, for emission standards for particulates, opacity, carbon monoxide, sulfur compound (measured as hydrogen sulfide) and volatile organic compounds. Emission sources regulated include (a) fluid catalytic cracking unit catalyst regeneration, (b) fluid catalytic cracking unit incinerator-waste heat boilers and (c) fuel gas combustion devices in a petroleum refinery.

5. Sulfuric and Nitric Acid Plants

See Part 224, Sulfuric and Nitric Acid Plants, for nitrogen oxides, sulfur dioxide, sulfuric acid mist and opacity emission standards applicable to any emission source in a sulfuric and/or nitric acid plant for which source an application for a Permit to Construct is received subsequent to March 15, 1973.

See Part 212, Processes and Exhaust and/or Ventilation Systems, for emission standards applicable to any emission source in a sulfuric acid and/or nitric acid plant for which source an application for a Permit to Construct is received on or prior to March 15, 1973.

6. Gasoline Storage and Transfer

See Part 229, Gasoline Storage and Transfer, for equipment specifications and requirements for the control of gasoline vapor emissions resulting from (a) the storage of gasoline in fixed roof tanks, (b) the transfer of gasoline at bulk plants and loading terminals and (c) the transfer of gasoline into underground storage tanks at gasoline filling stationary located in the New York City Metropolitan Area.

See also 40 CFR 60, Subpart K, for equipment specifications and other requirements applicable statewide for the control of gasoline vapor emissions from storage vessels for which an application for a Permit to Construct is received subsequent to June 11, 1973.

7. Surface Coating Processes

See Part 228, Surface Coating Processes, for volatile organic compound (VOC) emission standards and other requirements for specific coating lines (new and existing) at any facility in

a. the New York City Metropolitan Area or

b. a nonattainment area for ozone, other than the New York City Metropolitan Area, where the annual potential emissions of VOC from the facility is equal to or exceeds 100 tons per year.

New processes involving a coating line of the type specified in Table 1 of Part 228, at a facility located in an attainment area for ozone and for which an application for a Permit to Construct is received on or subsequent to August 23, 1979, are also regulated under Part 228.

See Part 205, Photochemically Reactive Solvents and Organic Solvents From Certain Processes - New York City Metropolitan Area, for VOC emission standards and equipment requirements for coating lines at any facility located in the New York City Metropolitan Area which are not of the type specified in Table 1 of Part 228.

See also Part 212, Processes and Exhaust and/or Ventilation Systems, for VOC emission standards for surface coating processes at a facility involving coating lines not of the type specified in Table 1 of Part 228, which are neither located in the New York City Metropolitan Area nor in any other nonattainment area for ozone. For emission sources with an emission rate potential less than 100 tons per year no control is generally required since such VOC emissions are usually assigned an environmental rating of "D." For sources whose emission rate potential is equal to or exceeds 100 tons per year the emissions may be assigned a "B" or "C" rating depending on the location of the source. Particulate emission control is usually based on an environmental rating of "B" for particulate emissions.

8. Asphalt Concrete (Black Top) Plants

See Part 60, Chapter 1, Title 40, Code of Federal Regulatins (CFR), Subpart I, for particulate emission standards applicable to any emission source in an asphalt concrete plant for which source an application for a Permit to Construct is received subsequent to June 11, 1973. See also Part 61, Title 40, CFR, Subpart B, regarding visible emission standard applicable to all asphalt concrete plants using commercial asbestos.

See Part 212, Processes and Exhaust and/or Ventilation Systems, for emission standards applicable to any emission source in an asphalt concrete plant for which source an application for a Permit to Construct is received on or prior to June 11, 1973. For most such emission sources, emission control is based on process weight with an environmental rating of "B" for particulate emissions.

An existing asphalt plant relocated from one area of the State to a new location within the State will not be considered a new source or modification if such plant was in compliance with Part 212 at the former location. Asphalt plants relocated from out of state to New York State will also not be considered a new source or modification if the other State's particulate emission standards are as restrictive as the emission standards of 6 NYCRR 212 applicable to existing sources and if the owner provides sufficient information to insure that the plant was operating in compliance with the other state's rules; i.e., possession of a valid permit or certificate equivalent to the Certificate to Operate. For relocations meeting the above criteria, notification of the FIELD REPRESENTATIVE (Air Pollution Control Program) for the County where the plant is to be located, prior to relocation, and filing of a new application for a Certificate to Operate is required.

9. Secondary Lead Smelters

See Part 60, Chapter 1, Title 40, Code of Federal Regulations, Subpart L, for particulate emission standards applicable to pot furnaces of more than 550 lbs/hr charging capacity, cupolas, blast furnaces and reverberatory furnaces for which an application for a Permit to Construct is received subsequent to June 11, 1973.

See Part 212, Processes and Exhaust and/or Ventilation Systems, for requirements and emission standards applicable to the above emission sources for which a Permit to Construct is received on or prior to June 11, 1973 and any other emission source in a secondary lead smelter. Emission control is usually based on an environmental rating of "A" for emissions of lead or its compounds.

10. Secondary Brass and Bronze Ingot Production Plants

See Part 60, Chapter 1, Title 40, Code of Federal Regulations, Subpart M for particulate emission standards applicable to any reverberatory or electric furnace of 2200 lbs/hr or greater production capacity and any blast furnace or cupola of 550 lbs/hr or greater production capacity for which an application for a Permit to Construct is received subsequent to June 11, 1973.

See Part 212, Processes and Exhaust and/or Ventilation Systems, for requirements and emission sources for which a Permit to Construct is received on or prior to June 11, 1973 and any other emission source in a secondary brass and bronze ingot production plant. Emission control is based on environmental ratings of "A" for emissions of lead or lead compounds and "B" for emissions of zinc and tin or their compounds.

11. Iron and Steel Plants

See Part 216, Iron and/or Steel Processes, for particulate and opacity emission standards for any confined iron and/or steel process including blast furnaces, basic oxygen furnaces and electric arc furnaces. Unconfined iron and/or steel processes require the application of best available control technology to reduce emissions.

See also Part 212, Processes and Exhaust and/or Ventilation Systems, for emission standards applicable to gaseous air contaminants. An equivalent opacity may be applied to the emissions from a confined iron and/or steel process when it can be demonstrated that best available control technology is being utilized and that there is compliance with applicable emission standards.

12. Sewage Treatment Plants

See Part 60, Chapter 1, Title 40, Code of Federal Regulations, Subpart O, for particulate and opacity emission standards applicable to any furnace used for burning sludge produced by any municipal sewage treatment plant for which a Permit to Construct is issued subsequent to June 11, 1973. See Part 61, Chapter 1, Title 40, CFR, Subpart E (Section 61.52), for mercury emission standards applicable to any furnace or drier used for burning or drying sludge.

See also Part 212, Process and Exhaust and/or Ventilation Systems, applicable to such furnaces for which an application for a Permit to Construct is received on or prior to June 11, 1973 and any other emission source in a sewage treatment plant. Emission control for such sources is usually based on an environmental rating of "B" for particulate emissions and "A" for mercury emissions.

13. Plants Manufacturing Products Containg Asbestos or Asbestos Material and Spraying of Asbestos

See Part 221, Asbestos-Containing Surface Coating Material, for prohibition of spraying of asbestos or asbestos materials.

See Part 61, Chapter 1, Title 40, Code of Federal Regulations, Subpart B, for opacity standards and air cleaning requirements applicable to any emission source involving the manufacture of products containing asbestos. This includes, but is not limited to, the manufacture of fireproofing and insulating material, floor tile, paints, coatings and adhesives.

14. Plants Processing Beryllium Ore, Beryllium, Beryllium Oxides, Beryllium Alloys or Beryllium Containing Waste and Machine Shops Processing Beryllium, Beryllium Oxides or any Beryllium Alloy Containing More than 5% Beryllium by Weight

See Part 61, Chapter 1, Title 40, Code of Federal Regulations, Subpart C, for emission standards applicable to any emission source involving (a) the processing of beryllium ore, beryllium, beryllium oxides and alloys of beryllium and the burning or rubbish containing beryllium and (b) the machining of beryllium, beryllium oxides or any alloy containing more than 5% beryllium by weight. This includes, but is not limited to, ceramic plants, foundries and propellant plants.

15. Mercury Ore Processing Plants and Plants Using Mercury Chlor-Alkali Cells to Produce Chlorine Gas and Alkali Metal Hydroxides

See Part 61, Chapter 1, Title 40, Code of Federal Regulations, Subpart E, for emission standards applicable to any emission source involving the processing of mercury ore to recover mercury and mercury chloralkali cells which produce chlorine and alkali metal hydroxide.

16. Primary Aluminum Plants

See Part 60, Chapter 1, Title 40, Code of Federal Regulations, Subpart S, for fluoride and opacity standards applicable to potroom groups and anode bake plants for which an application for a Permit to Construct was received subsequent to October 23, 1974.

See Part 212, Process and Exhaust and/or Ventilation Systems, for emission standards applicable to any emission source in a primary aluminum plant for which an application for a Permit to Construct is received on or prior to October 23, 1974. Emission control is based on an environmental rating of "B"for emissions of fluorides.

17. Phosphate Fertilizer Plants Including Wet Process, Superphosphate, Diammonium Phosphate, Triple Superphosphate, Granular Triple Superphosphate Storage Facilities

See Part 60, Chapter 1, Title 40, Code of Federal Regulations, Subparts T, U, V, W and X for fluoride emission standards applicable to reactors, filters, evaporators, hotwells, acid sumps, cooling tanks, granulators, dryers, coolers, screens, mills, mixers, curing belts (dens) and cookers for which an application for a Permit to Construct is received subsequent to October 22, 1974.

See Part 212, Process and Exhaust and/or Ventilation Systems, for emission standards from phosphate fertilizer plant sources for which an application for a Permit to Construct is received on or prior to October 22, 1974. Emission control is based on an environmental rating of "B"for emissions of fluorides.

18. Ferroalloy Production Facilities

See Part 60, Chapter 1, Title 40, Code of Federal Regulations, Subpart Z, for carbon monoxide and particulate emission standards applicable to (a) electric submerged arc furnaces which produce silicon metal, ferrosilicon, calcium silicon, silicomanganese zirconium, ferrochrome silicon silvery iron, high-carbon ferrochrome, charge chrome standard ferromanganese, silicomanganese, ferromanganese silicon, or calcium carbide and (b) dust handling equipment for which an application for a Permit to Construct is received subsequent to October 21, 1974.

See Part 212, Process and Exhaust and/or Ventilation Systems, for emission standards applicable to any emission source in a ferroalloy production plant for which an application for a Permit to Construct is received on or prior to October 21, 1974. Particulate emission control is usually based on an environmental rating of "B".

19. Vinyl, Polyvinyl and Ethylene Dichloride Plants

See Part 61, Chapter 1, 40 CFR, Subpart F, for vinyl chloride emission standards applicable to all emission sources at (a) plants producing ethylene dichloride by reaction of O_2 and HCl with C_2H_2, (b) vinyl chloride manufacturing plants and (c) polyvinyl manufacturing plants. Sources include reactors, strippers, mixers, scales, holding containers, etc.

D. ENVIRONMENTAL RATING

Part 212, Processes and Exhaust and/or Ventilation Systems, requires the determination of an "environmental rating" as an initial step in the review of any application for a Permit to Construct or Certificate to Operate. The basis for the rating(s) is the potential environmental effects of air contaminant emissions on the source surroundings and include health, economic and aesthetic effects.

The factors considered in determining the environmental rating are:

a. toxic and other properties as well as emission rate potential of each air contaminant;

b. location of the source with respect to residences or other sensitive environmental receptors, including a consideration of the area's anticipated growth;

c. emission dispersion characteristics at or near the source, taking into account the physical location of the source relative to surrounding buildings and terrain; and

d. the projected maximum cumulative impact taking into account emissions from all sources in the facility under review as well as the pre-existing ambient concentration of the air contaminant under review.

"A" Rated Sources

a. Sources which emit any air contaminant(s) of relative high toxicity independent of emission rate potential.

b. Sources which emit any air contaminant(s) of low or moderate toxicity and which reasonably would be expected to result in serious adverse effects on receptors.

"B" Rated Sources

a. Sources which emit any air contaminant of low or moderate toxicity and which are located in an area of high or moderate population density where any state or national ambient air quality standard for air contaminants being emitted is likely to be contravened and due to a multiplicity of sources emitting such air contaminants in the area, an overall reduction in such air contaminant emissions is required to achieve compliance with ambient air quality standards.

b. Sources emitting air contaminants in an area of high or moderate population density whose emission rate potential is of such magnitude and whose emission dispersion characteristics are such that any ambient air quality level known to cause air pollution, such as soiling and or human sensory irritation, is likely to be exceeded.

c. New sources or modifications located in an area of high population density (other than the New York City Metropolitan Area) which emit volatile organic compounds (relatively low toxic properties) with an emission rate potential equal to or exceeding 100 tons per year.

"C" Rated Sources

a. Sources which emit any air contaminant(s) of low or moderate toxicity whose emission rate potential is of such magnitude and whose emission dispersion characteristics are such that any ambient air quality level known to cause air pollution, such as soiling and/or human sensory irritation, for any air contaminant being emitted is likely to be exceeded.

b. New sources or modifications located in an area of moderate or low population density which emit volatile organic compounds (relatively low toxic properties) with an emission rate potential equal to or exceeding 100 tons per year.

"D" Rated Sources

Sources which emit any air contaminate(s) of relatively low or moderate toxicity whose emission rate potential is of such small magnitude and where the emission dispersion characteristics are sufficiently favorable not to cause contravention of any established state or national ambient air quality standard or is unlikely to result in any ambient air quality level known to cause air pollution, such as soiling and human sensory irritation, to be exceeded.

E. APPLICATION OF PART 212 EMISSION STANDARDS

Where Part 212, Processes and Exhaust and/or Ventilation Systems, applies to an emission source, the emission standard or control requirements for each contaminant is based on (a) the environmental rating and (b) the physical state of the contaminant (e.g., particulate or gas).

1. Process Weight

For the following processes which emit solid particulate contaminants rated "B" or "C," the permissible emission rates are based on process weight:

a. stone driers (asphalt concrete plants)
b. expanded aggregate kilns (lightweight aggregate plants)
c. continuous process material dryers emitting solid particulates and water only.
d. brass and bronze melting furnaces
e. ferroalloy production furnaces

f. lime kilns
g. glass production furnaces
h. graphitizing and silicon carbide furnaces
i. gypsum driers
j. primary aluminum reduction furnaces

2. Particulate Concentration in Emission

For all other processes which emit solid particulate contaminants rated "B" or "C," the permissible emission rate is based on a particulate concentration in the emission not to exceed (a) 0.15 grains/DSCF of exhaust gas corrected for dilution air for those sources for which an application for a Permit to Construct was received on or prior to July 1, 1973 or (b) 0.050 grains/DSCF of exhaust gas corrected for dilution air for those sources for which an application for a Permit to Construct was received subsequent to July 1, 1973.

3. Emission Rate Potential

For processes which emit (a) solid particulates rated "A" or "D," or (b) gases other than volatile organic compounds, or (c) volatile organic compounds rated "A" or (d) liquid particulates, the permissible emission rate (degree of emission control required) is based on the emission rate potential or each rated air contaminant.

For processes which emit volatile organic compounds rated "B," "C" or "D," the permissible emission rate for total volatile organic compounds is based on the total emission rate potential of all similarly rated volatile organic compounds.

4. Water Spray Dust Control Systems

Particulate emissions from crushing, screening and material transfer processes which do not have stacks but which can be controlled by water sprays will be rated "D." Emissions shall not cause air pollution.

F. MAJOR FACILITIES (NEW EMISSION SOURCES AND MODIFICATIONS)

New processes, exhaust and ventilation systems or modifications of such sources are considered "major facilities" subject to prevention of significant deterioration (PSD) requirements and/or emission offsets if the cumulative permissible emissions at a facility exceed the applicability emission limits of 6 NYCRR 231. No person shall initiate construction of source at a major facility until the provisions of 6 NYCRR 231 (Major Facilities) have been met and a Permit to Construct has been issued.

New processes, exhaust and/or ventilation systems or modifications which meet the above criteria and which are located in an attainment area must meet the PSD provisions of 6 NYCRR 231 before a Permit to Construct will be issued. These provisions require:

1. Best Available Control Technology (BACT) for any new process, exhaust and/or ventilation system or modification for which the permissible emission rate exceeds the applicability emission limits of 6 NYCRR 231. BACT is determined on a case-by case basis.

2. An air quality impact evaluation report demonstrating that emissions from the major facility will not cause ambient air concentrations to exceed the allocated PSD increment for the specified air contaminant. The PSD increments are specified in Table 1 of Part 231; increment allocation will be made in accordance with procedures established by the Commissioner.

3. A report on the effects of the major facility on soil, visibility and vegetation when the facility is located within 62 miles (100 kilometers) of a federally designated Class I area.

4. Ambient air monitoring. An analysis of ambient air monitoring data for applicable air contaminants is required. Where appropriate, existing monitoring data may be used, otherwise, monitoring data must be collected by the source owner. Source owners should consult with the air pollution control program FIELD REPRESENTATIVE.

New processes, exhaust and/or ventilation systems or modifications of such sources, subject to the provisions of 6 NYCRR 231 and located in a nonattainment area or significantly impacting on a nonattainment area, must satisfy the emission offset provisions of 6 NYCRR 231 before a Permit to Construct will be issued. These provisions require:

1. Lowest Achievable Emission Rate (LAER) for any new source or modification for which the permissible emission rate exceeds the applicability emission limits of 6 NYCRR 231. LAER is determined on a case-by-case basis.

2. A reduction of the same air contaminant on more than a one-for-one basis from existing emission sources must be secured to provide a net air quality benefit for any new major facility.

3. An air quality impact evaluation report demonstrating that emissions from the major facility will not impact significantly on the nonattainment area for the specified contaminant (significant impacts are defined in Table 2 of Part 231) considering the effects of the major facility and any emission trade-offs secured.

4. All major facilities of the source owner located in the State to be in compliance with applicable rules or to be meeting steps of a compliance schedule contained in an administrative order or court decree.

Only major facilities emitting particulates, sulfur dioxide, nitrogen oxides, carbon monoxide and/or volatile organic compounds are subject to the PSD and/or emission offset provisions of 6 NYCRR 231.

G. PROCESS FUEL SULFUR LIMITATIONS

Where fuel is used in a process, the source owner must show that he has a firm commitment from a fuel supplier that sufficient quantities of fuel conforming with fuel sulfur limitations will be available for the process. See 6 NYCRR 225 for fuel sulfur limitations.

A Certificate to Operate may not be issued until it is shown that fuel used in any process meets applicable fuel sulfur limitations. Where coal or oil is used, the sulfur content of the fuel must be determined by fuel sampling and analysis conducted by the fuel supplier or source owner or his authorized agent. See form 76-11-11, Sampling and Reporting Sulfur Content of Coal and form 76-11-10, Sampling and Reporting Sulfur Content of Fuel Oil.

An exception to the fuel sulfur limitations may be granted (except where not permitted under federal requirements) if the source owner or fuel supplier can demonstrate that there is an insufficient supply of conforming fuel. To apply for such an exception the source owner must submit an application in a form prescribed by the Department. As a prerequisite to the granting of such an exception, the insufficiency of the supply of conforming fuel must be certified by the Commissioner of the State Energy Office. An exception shall be of limited duration and may include other conditions specified by the Commissioner of Environmental Conservation.

An exception to the fuel sulfur limitations may also be granted (except where not permitted under federal requirements) where a source owner desires to demonstrate the performance of experimental equipment and/or a process for removal of sulfur compounds from stack emissions. Such exception may only be granted for a source located in an attainment area for sulfur dioxide. An exception for "experiments" will be terminated prior to the specified expiration date if the emissions from the process result in the contravention of any applicable ambient air quality standard for sulfur dioxide.

Upon written application, a source owner may be issued an exception under a Commissioner's order permitting the use of fuels with a sulfur content higher than otherwise mandated by 6 NYCRR 225 if he can demonstrate that emissions of sulfur dioxide from such process fuels would not exceed those resulting from the use of conforming fuel. Such an exception may be issued where

1. Fuel is used as a process constituent

2. An acceptable emission control system for removal of sulfur dioxide is installed

3. Sulfur in the fuel is retained in the ash

4. The sulfur dioxide reacts with and is retained in the product or process constituents.

Exceptions to the fuel sulfur limitations may also be granted (except where not permitted under federal requirements) for reasons other than an insufficient supply of conforming fuel or experiments (See 6 NYCRR 225 for other exception requirements). Should a source owner desire an extension of any exception (except experiments) he must apply for such an extension not less than 60 days prior to the expiration of the exception or at such time specified in the exception.

H. STACK TESTING REQUIREMENTS

Part 202, Emission Testing, Sampling and Analytical Determinations, requires a source owner, upon the request of the Commissioner of Environmental Conservation, to perform an acceptable stack test and to submit an acceptable stack test report demonstrating compliance with applicable emission standards. The source owner will operate processes during stack testing in a manner specified by the Commissioner. Acceptable emission test methods are those contained in Appendix A of 40 CFR 60 and Appendix B of 40 CFR 61 for those air contaminants and/or parameters for which they are expressly applicable.

Upon completion of construction of the new process, exhaust and/or ventilation system or modification, and as a prerequisite to issuance of the initial Certificate to Operate (in the case of a new source) or any subsequent Certificate to Operate (in the case of a modification), the source owner or his authorized agent may be required to submit stack test reports acceptable to the Commissioner for all stacks and other emission points from processes, exhaust and/or ventilation systems. Stack tests are required as a condition for issuance of the initial Certificate to Operate

1. For a significant source (e.g., particulate emissions in excess of 100 pounds per hour) emitting any air contaminant rated "B" or "C,"

2. For any source with an emission rate potential of 1.0 pounds per hour or more of any "A" rated air contaminant having human carcinogenic properties,

3. For any source with an emission rate potential of 1.0 pounds per hour or more of any "A" rated air contaminant having high inhalation toxicity where control has been applied because the maximum ambient concentration, projected through an air quality impact evaluation based on the emission rate potential, exceeds the ambient air quality level expected to cause air pollution,

4. For sources which are required to comply with Part 60 or Part 61, Chapter 1, Title 40, Code of Federal Regulations, or

5. Where an inspection reveals that the process and/or emission control equipment is not operating properly.

Except where otherwise mandated under federal rules, stack tests ususally will not be required for the following:

1. Sources emitting particulate matter considered to be of moderate or low toxicity (e.g., "B" or "C" environmental rating) and which are equipped with a fabric filter gas cleaning system (baghouse, dust arrestor) provided the system is operated without visible leakage to the air and the fabric bags are properly positioned and maintained.

2. Electric induction furnaces used for melting ferrous metals in foundries.

3. Gas or oil fired reverberatory furnaces for melting ferrous metals in foundries except where the melt cycle includes oxygen lancing.

4. Electrically heated and thermostatically controlled metal melting furnaces (pots) where the estimated emission rate potential is less than 1 pounds per hour.

5. Sources at asphalt concrete plants emitting particulates (e.g., "B" or "C" environmental rating) and which are equipped with an exhaust system including a high energy venturi scrubber provided:

a. a pressure differential of 20 inches water gauge or more is maintained across the venturi throat, as indicated by a permantenly installed pressure gauge,

b. the scrubbing liquid to exhaust gas ratio is not less than 10 gallons of water per 1000 DSCF of exhaust gas and

c. the emission exhibits an average opacity <u>less</u> than 20 percent except for uncombined water.

Where stack tests are required, a Certificate to Operate will not be issued until such stack tests conducted by the source owner or his authorized agent show that the processes exhaust and/or ventilation system complies with applicable emission standards. As a prerequisite to the issuance of a Certificate to Operate for an existing installation, the source owner or his authorized agent may be required to submit an acceptable stack test report showing compliance with applicable emission standards where there has been no prior verification of compliance through stack tests. Although prior stack tests may have shown compliance, retesting may also be required as a prerequisite to the reissuance of a Certificate to Operate to show continued compliance if there is reason to believe that there has been an increase in emissions caused by a retrogression in operation of the installation since the prior stack tests.

Stack tests on continuous steady-state process at maximum operating rate, when possible, and tests for different contaminants may be run concurrently. Sampling strategy for cyclical operations will depend on the process and emission control desired but generally should be designed so that samples are withdrawn during one or more complete cycles. Both average and peak emission rates must be determined. Maximum emission for each contaminant may occur at different times or steps in the process. Normally, each contaminant will need to be measured during its own emission peak.

Emission control equipment, which may have varying efficiency within the operating range, shall be tested with operating variables held in the range of normal operation expected to give minimum overall collection efficiency, e.g., scrubber solution concentration and temperature. Screening tests may also be required to determine conditions for compliance test or tests.

If a source owner can demonstrate through acceptable stack tests that a process is in compliance with all applicable mass particulate emission standards and that the process and any associated emission control equipment is being operated and maintained in a manner acceptable to the FIELD REPRESENTATIVE, an equivalent opacity standard exceeding the applicable opacity standard may be applied. In such cases, the source owner shall not allow the opacity of emissions to exceed the equivalent opacity. An equivalent opacity standard shall only apply to processes which meet all applicable mass emission standards at the time the Certificate to Operate is issued. To be eligible for any equivalent opacity standard best available Control Technology (BACT) must be used to control the particulate emissions.

I. <u>EMISSION AND OPERATION MONITORING REQUIREMENTS</u>

Monitoring of emissions and/or operations for new sources, modifications and various existing sources is required under State and Federal rules. Performance specifications and specification test procedures for continuous emission monitoring are included in Appendix B of 40 CFR 60. These are:

1. Opacity - Performance Specification 1
2. Sulfur dioxide and oxides of nitrogen - Performance Specification 2

carbon dioxide - Performance Specification 3

The performance testing requirements are outlined in 40 CFR 60.8 and in Performance Specifications 1,2 and 3. Alternate continuous emission monitoring systems that do not meet the spectral response requirements in Performance Specification 1 but adequately demonstrate a definite and consistent relationship between their measurements and the opacity measurements of a system complying with the requirements in Performance Specification 1 may be approved by the Commissioner as equivalent. An alternate continuous emissions monitoring system that requires corrections for stack moisture conditions (e.g., an instrument measuring sulfur dioxide emissions on a wet basis could be used with an instrument measuring oxygen concentration on a dry basis if acceptable methods of measuring stack moisture conditions are used to allow accurate adjustments of the measured sulfur dioxide concentration to dry basis) may be approved by the Commissioner as equivalent.

All measurements - including continuous emission monitoring system, monitoring device, and performance testing measurements; all continuous monitoring system performance evaluations; all continous monitoring system or monitoring device calibration checks; adjustments and maintenance performed on these systems or devices; and other required information - shall be recorded and maintained in a permanent form suitable for inspection. The file shall be retained for at least three years following the date of such measurements, maintenance, reports and records.

A source owner required to install a continuous emission monitoring system shall, for each calendar quarter, submit a written report to the FIELD REPRESENTATIVE of excess emissions and the nature and the cause of the excess emissions, if known. All quarterly reports shall be post-marked by the 30th day following the end of each quarter. Additional details are available in 6 NYCRR and 40 CFR 60 referenced in Table 1 (pg. 11), which includes monitoring requirements applicable to various source categories.

J. APPLICATION CONTENT

APPLICATIONS MUST BE TYPEWRITTEN OR PRINTED AND MUST INCLUDE EACH OF THE FOLLOWING IN TRIPLICATE:

1. Completed form 76-19-3 and, if required, the appropriate number of form 76-19-4. Each non-identical unit or process requires a form 76-19-4 to be completed; for example, if four non-identical units vent to one emission point, four separate forms are required. Form 76-19-3 is a summary of all information on the units or processes venting to each emission point, and one set of form 76-19-3 must accompany all of the forms being submitted. If a single unit vents to one emission point, only complete form 76-19-3. Retain the yellow copy for future reference.

2. Plot plan, to scale, which includes:

a. north orientation and property lines of the facility where installation is located.

b. elevation above mean sea level and the height above ground level of all emision points (e.g., stacks or other points which emit contaminants to the outdoor atmosphere).

c. location of all existing and proposed emission points, including stationary combustion installations and incinerators. Distinguish between existing and proposed emission points and assign an identification number not exceeding 5 digits to each emisison point. Designate each unit by a letter of the alphabet.

d. shortest straight line distance from each numbered stack to (1) the property line of the facility where the installation is located and (2) the nearest building at or beyond the property line. Describe the normal use of such buildings; e.g., residence, retail store, etc.

e. direction of prevailing winds and other pertinent meteorological or topographical factors that would affect dispersion of air contaminants.

f. identification of significant land marks, such as highway intersections, roads, lakes and rivers in the vicinity of the facility.

3. Description of each process connected to an emission point including flow diagrams and emission points by identification numbers assigned on the plot plan.

TABLE 1

EMISSION AND OPERATION MONITORING REQUIREMENTS

Source Category	Rule Reference(1)	Emissions From	Emission Standard(2)		Monitoring Requirements
			Opacity	Contaminant	
1. Portland Cement Plants	6NYCRR220.7 40CFR60.63 >8/17/71(3)	Kiln Clinker Cooler	20% (Max)	None	Continuous emission monitoring for opacity. Record daily production and kiln feed rates. See 6NYCRR 200.7 for maintenance of records.
2. Petroleum Refineries	6NYCRR223.8 40CFR60.105 >6/11/73	Catalytic Cracker	30%(Av) (3 min. except.)	0.05%CO(4)	Continuous emission monitoring for opacity and CO.
		Fuel Gas Combustion	None	0.1gr H_2S(5) / dscf	Continuous emission monitoring for H_2S or equivalent SO_2. Report excess emissions (average of six continuous one-hour periods).
		Waste Heat Boiler	None	None	Record daily rate of combustion of fuel and hours of operation.
		Claus Sulfur Recovery Unit	None	0.25%(SO_2)(4)	With incineration.
				0.03%(RSC) 0.001%(H_2S)	Without incineration.
3. Sulfuric and Nitric Acid Plants	6NYCRR224.4 40CFR60.73 40CFR60.84 >8/17/71	All Process Sources	10%(Max)	3.0 lbs / Ton SO_2	Continuous emission monitoring for opacity and SO_2 at sulfuric acid plants.
				4.0 lbs / Ton NO_x	Continuous emission monitoring for opacity and NO_x at nitric acid plants
				For both plants record production rate & hours of operation daily. Report excess emissions (avg. of three continuous one-hour periods).	
4. Sewage Treatment Plants	40CFR60.153 >6/11/73	Sludge Incinerator	20%(Av)	None	Record daily weight or volume of sludge charged to incinerator.
5. Primary Aluminum Reduction Plants	40CFR60.194 >10/23/74	Potroom Group, Soderberg, Prebake	10%(Av)	None	Record daily weight of aluminum & anodes produced, daily raw material feed rates, and cell and potline voltages.
		Anode Bake	20%(Av)	None	
6. Phosphate Fertilizer Industry	40CFR60.203 40CFR60.213 40CFR60.223 40CFR60.233 >12/22/74	All Process Sources (e.g.,reactors filters, hot wells, evaporators)	None	None	Record daily weight of phosphorous bearing feed & equivalent P_2O_5 feed; continuous measurement & recording of pressure drop across scrubber.
7. Ferroalloy Production Facilities	40CFR60.264 40CFR60.265 >10/21/74	Electric Arc Furnace	15%(Av)	20%CO(4)	Continuous emission monitoring for opacity. See 40CFR60.264(b) for reporting excess emissions. Record daily product produced, weight & description of furnace charges, time & duration of tapping period, furnace power input, capture system volumetric flow rate & exhaust fan performance characteristics. See 40CFR 60.265 for detailed process monitoring requirements.
		Dust Handling Equipment	10%(Av)	None	
8. Iron and Steel Processes	6NYCRR216.4 40CFR60.273 >6/11/73	Electric Arc Furnaces			Continuous emission monitoring for opacity (fume control device & air cleaning device for dust handling equipment). Record daily the time & duration of each charge & tap; exhaust flow rate and pressure data. See 6NYCRR216.4 for detailed process monitoring requirements.
		a. Fume Control Device	3%(Av)	None	
		b. Shop Rood	0%(Av) except 20% charging 40% tapping	None	
		Dust Handling Equipment	10%(Av)	None	
9. Gasoline Storage and Transfer(6)	6NYCRR229	Gasoline Vapor Recovery Systems	None	None	Process (operation) monitoring required to demonstrate good working order & good operations. Operational parameters to be monitored & recorded depends on system used. a. Compression-Refrigeration-Absorption System(CRA): Absorber temperature and/or pressure. b. Compression-Refrigeration-Condensation System(CRC): Condenser temperature and/or pressure. c. Refrigeration System(RF): Stored brine solution temperature. d. Lean Oil Absorption System (LOA): Lean oil flow rate to absorber columns. e. Flame Oxidation System (FO): Exit gas temperature from combustor.

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(1) Rule references pertain to Chapter III, Title 6, New York State Official Compilation of Codes. Rules and Regulations (NYCRR); and Chapter I, Title 40, United States Code of Federal Regulations (CFR). Numbers following abbreviations refer to specific sections of rules.

(2) Emission standards are indicated only for those contaminants for which continuous emission monitoring is required.

(3) Rule applies to new sources or modifications to existing sources for which an application for a Permit to Construct was received subsequent to the date(s) shown.

(4) Percent by volume.

(5) Sulfur compound expressed as H_2S.

(6) Process (operation) monitoring required for new and existing sources.

4. Plan and elevation drawings which show:

a. design, dimensions and arangement of all process units, air cleaning devices and stack sampling ports.

b. details and arrangements of related equipment which affect the performance of the installation.

5. An acceptable air quality impact evaluation report for:

a. new processes, exhaust and/or ventilation systems with cumulative permissible emissions at a facility exceeding the applicable emission limits of 6 NYCRR 231.

b. any process, exhaust and/or ventilation system emitting an air contaminant possessing high inhalation toxicity properties.

Applications for sources other than the above may be required to include an acceptable air quality impact evaluation report if it appears likely that the emissions will cause air pollution or contravention of any applicable ambient air quality standard. The report shall include a diffusion analysis for each air contaminant emitted and shall provide:

a. quantitative estimates of air contaminant concentrations resulting from emissions from the proposed new source or modification,

b. quantitative estimates of total air contaminant concentrations resulting from the emissions compared with existing concentration levels in the vicinity of the emission source,

c. quantitative comparison of values determined with existing concentrations and all applicable ambient air quality standards or levels expected to cause air pollution and

d. where necessary to comply with 6 NYCRR 231

   i. a determination of the impact of the source on the prevention of significant deterioration increments (Table 1 of Part 231) or on the significant impacts for nonattainment areas (Table 2 of Part 231),

   ii. an analysis of ambient air monitoring data for applicable air contaminants and

   iii. an evaluation of the emission sources' effects on visibility, soil and vegetation when the source is located within 62 miles (100 kilometers) of a federally designated Class I area.

The methods of evaluation shall be in accordance with established mathematical procedures and principles of atmospheric transport and diffusion and shall be based on valid meteorological and air quality data for the area.

K. SPECIFIC INSTRUCTIONS FOR COMPLETING FORMS 76-19-3 and 76-19-4

COMPLETE ALL APPLICABLE QUESTIONS. ALL APPLICATIONS MUST BE TYPED OR PRINTED WITH A BALL-POINT PEN (PREFERABLY TYPED). SEND COMPLETED APPLICATIONS TO THE APPROPRIATE FIELD REPRESENTATIVE.

When there is insufficient space on either form 76-19-3 or form 76-19-4 to provide information on all equipment or emissions, additional 76-19-3 or 76-19-4 forms should be used. When this is done, the second and subsequent 76-19-3 forms must contain the name and address of the firm (questions 1, 2, 3, 4 & 5) and the emission point identification number (question 29) or the emission point identification number (question 175) and process description (question 181) from form 76-19-4.

In addition, the word CONTINUATION must be printed at the top of the form.

Instructions for Completing Form 76-19-3

SECTION A

	Question Number and Name	Specific Instructions
1.	Name of Owner/Firm	Name of owner of source for which application is being prepared. For corporations, include division or subsidiary name, if any.
2-5.	Number and Street Address, etc.	Mailing address of the owner or firm.
6.	Owner Classification	Check all classifications that apply.
7.	Name & Title of Owner's Representative	Employee of firm to be contacted regarding air pollution control at this facility and who is authorized by owner to act on his behalf.
8.	Telephone	Telephone number of owner's representative.
9-14.	Name of Authorized Agent, etc.	(Leave questions 9-14 blank if there is no authorized agent.) Name, telephone number and mailing address of consultant, contractor, vendor or other person authorized by owner to act as agent in filing application. A letter of authorization must be attached.
15-17.	Name of P.E. or Architect Preparing Plans, etc.	Name, license number and telephone number of P.E. or Architect preparing application, if applicable.
18.	Signature of Owner's Representative or Authorized Agent	Signature of representative or authorized agent must be affixed before application will be processed for a Permit to Construct
19-22.	Facility Name, etc.	Name and address of facility where process is located. Leave blank if same as owner/firm.
23-24.	Building Name or Number and Floor Name or Number	Building and floor name or number of actual physical location of process unit.
25.	Start-up Date	If application is for a Permit to Construct, specify month and year construction is expected to be completed. If application is for a Certificate to Operate for an existing source, specify month and year operation began.
26.	Drawing Numbers of Plans Submitted	Specify the drawing numbers of the plans submitted with this application.
27.	Permit to Construct	If applying for a Permit to Construct, check whether new source or modification; leave blank if applying for a Certificate to Operate.
28.	Certificate to Operate	If applying for a Certificate to Operate, check whether new source, modification or existing source; leave blank if applying for a Permit to Construct.

SECTION B

29.	Emission Point I.D. No.	Specify the number or letter assigned to the emission point through which the contaminants are emitted from the processes/units. Each stack within a facility must be as signed a different number or letter not to exceed five digits. The stacks must also be numbered on the plot plans and/or drawings submitted. See Figure 1.

30.	Ground Elevation	Elevation above mean sea level at the base of the stack to the nearest foot (e.g., 120 rather than 119.6). This information is available from USGS topography maps.
31.	Height Above Structures	Height of the stack above the building or structure to the nearest foot (e.g., 39 rather than 38.7). If top of stack is below the building height, it should be expressed as a negative number.
32.	Stack Height	Height of the stack measured from <u>ground level</u> to top of stack to the nearest foot (e.g., 62 rather than 62.3).
33.	Inside Dimensions	Inside diameter at the exit of stack expressed in inches to the nearest inch. For stacks of rectangular cross-section specify inside length and width in inches to the nearest inch (e.g., 40 x 20).
34.	Exit Temperature	Stack gas exit temperature (^{o}F).
35.	Exit Velocity	Stack gas exit velocity (ft/sec).
36.	Exit Flow Rate	Stack gas exit flow rate in cubic feet per minute at actual conditions.

If more than one non-identical process or unit vents to the emission point specified in Section B, complete the appropriate number of form 76-19-4 (one for each non-identical process or unit). Should this be the case, leave questions 37-41 blank.

37.	Source Code	Leave blank.
38.	Hours/Day	Number of hrs/day this source is or will be in operation.
39.	Days/Year	Number of days/yr this source is or will be in operation.
40.	% Operation By Season	Indicate the percentage of time this process is or will be in operation by season. Total of four percentages listed must equal 100. Winter: January - March, Spring: April - June, etc.

SECTION C

41.	Describe Process or Unit	<u>Briefly</u> describe the type of process or unit venting to the emission point specified in Section B.

SECTION D

Complete Section D only if a single process or unit is vented to the emission point (stack) or if the emissions from all units vented to this emission point are directed to the same emission control equipment. Complete form 76-19-4 for each process (unit) and leave this SECTION blank if emissions from each process (unit) are directed to <u>separate</u> emission control equipment.

42.	Emission Control Equipment I.D. No.	<u>Number</u> assigned to each emission control device being reported. Each emission control device connected to the same stack must be assigned a different number not to exceed two digits. Control equipment must be numbered on the plot plans and/or drawings submitted. See Figure 1.
43.	Control Type	Enter the code to designate the type of emission control equipment used.

02 - Settling chamber
03 - Louver collector
04 - Baffle chamber
06 - Centrifugal (dry)
07 - Centrifugal (wet)
08 - Fabric collector
09 - Electrostatic precipitator
10 - Thermal afterburner
11 - Spray tower
12 - Impingement plate scrubber
13 - Venturi scrubber
14 - Demister
15 - Packed tower
16 - Ejector condenser
17 - Activated bed adsorber

18 - Silica gel adsorber
19 - Catalytic unit
20 - Vapor condenser
21 - Control for VOC storage and transfer
23 - Absolute filter
98 - Other
99 - None

44.	Manufacturer's Name and Model Number	Specify name of manufacturer and model number of the control equipment specified in previous question.
45.	Disposal Method	Specify method of disposal of collected contaminants by entering code: 1 - Landfill - on-site 2 - Land fill - off-site 3 - Recycled in the process 4 - Recycled on-site 6 - Sold 7 - Public sewer 8 - Private sewer 9 - Other, explain in process description
46.	Date Installed	Actual or expected date of installation of control equipment (month and year).
47.	Useful Life	Expected years of useful life of emission control equipment.

48-53. If additional emission control equipment is used, complete these questions. Refer to instructions for questions 42-47.

SECTION E

Show calculations used to determine input or production rate, emission rate potential, actual emissions and annual emissions. Where appropriate, include pressure, temperature, % moisture by weight and gas flow rate. Calculations must be legible. If additional space is necessary, use additional paper and submit an original and three copies.

SECTION F

If more than one process or unit vents to the emission point specified in Section B, complete the apprropriate number of form 76-19-4 (one for each non-identical process or unit,) before completing this section. This section is used to summarize the total air contaminants emitted through the emission point specified in Section B.

54.	Contaminant Name	Specify the air contaminant emitted by complete name. List other contaminants under questions 69, 84, 99, etc., including sulfur dioxide derived from combustion of fuel used in the process. Do not abbreviate or use chemical formulas.
55.	CAS Number	Specify the contaminant Chemical Abstract Series Number.
56.	Input or Production	Enter input or production rate in units which are specified in the applicable regulation (e.g., 40 CFR 60 Subparts D through HH for Federal Regulations and 6 NYCRR Parts 200 through 259 for State Regulations). Do not insert the Federal Subpart letter or the State Part number.

40 CFR 60 Subpart O - Lbs/hr of sludge charged

Subpart S - Tons/hr of aluminum or aluminum equivalent produced per hour

Subpart Z - Megawatts of furnace power input

Subpart BB - Lbs/hr of black liquor solids entering recovery furnace

Subpart HH - Tons/hr of limestone feed per hour

Part 212 and 213 - Process weights in lbs/hr for the following processes (For Part 212, if the process is not listed, process weight does not apply, and the question should be left blank):

A - Stone driers (asphalt concrete plants)
B - Expanded aggregate kilns (lightweight aggregate plants)
C - Continuous process material dryers emitting solid particulates and water only
D - Brass and bronze melting furnaces
E - Ferroalloy production furnaces
F - Lime kilns
G - Glass production furnaces
H - Graphitizing and silicon carbide furnaces
I - Gypsum driers
J - Primary aluminum reduction furnaces

Part 214 - Tons/day of coal charged into oven
Part 220 - Tons/hr of kiln feed
Part 223 - Lbs/hr of regenerator coke burn-off or million Btu/hr heat input of incinerator waste heat boiler fuel
Part 224 - Ton/hr of acid produced
Part 228 - Gallons/hr or gallons/day of coating applied
Part 229 - Gallons of storage capacity or gallons/day or gallons/yr of throughput

57. Unit

Enter the appropriate code number indicating the units in which the input (production rate or capacity) presented in previous question is expressed:

1 - lbs/hr
13 - tons/hr

30 - gallons
31 - gallons/hr
32 - gallons/day
33 - gallons/yr

60 - megawatts (MW)
61 - Btu x 10^6/hr

58. Environmental Rating

Leave blank (See Sections D and E, pages 5 - 7) of instructions regarding applicablity of 6 NYCRR 212 for how the environmental rating is determined). No environmental rating is assigned for sulfur dioxide emissions originating solely from sulfur contained in fuel used in a process.

59. Actual Emissions

If application is for a Permit to Construct, enter the anticipated emissions in units prescribed below, by Part number, based on stack tests performed on pilot or similar full scale installations or reliable material balance. If application is for a Certificate to Operate, specify actual emissions in units prescribed below, by Part number based on accepted stack test(s) of this installation.

Part 205 - lbs/hr or lbs/day
212 - lb/hr or grains/DSCF
213 - lbs/hr
214 - grains/DSCF or lbs/ton
216 - grains/DSCF
220 - lbs/ton, lb/hr or grains/DSCF
223 - grains/DSCF, lbs/1000(input), lbs, grains/100 DSCF, lbs/10^6 Btu or % (vol)
228 - lbs/gal

The actual emissions will be compared to permissible emissions; therefore, it must be verifiable.

60. Unit

Enter the code to indicate the units in which the actual emissions in the previous question are presented:

1 - lbs/hr
2 - lbs/hr x10^{-3}
3 - lbs/hr x10^{-6}
4 - lbs/day

5 - lbs/1000 lbs (input)
6 - (lbs/1000 lbs) x 10^{-3} (input)

9 - lbs/gallon
10 - lbs/ton
11 - lbs/million Btu
12 - lbs/mw-hr
13 - tons/hr
14 - lbs/100 lbs input (refuse charged)

20 - grains/DSCF
21 - grains/100 DSCF

30 - gallons
31 - gallons/hr
32 - gallons/day
33 - gallons/year

40 - micro curies/ml
41 - 10^{-3} micro curies/ml
42 - 10^{-6} micro curies/ml
43 - 10^{-9} micro curies/ml(pico curies/ml)
44 - 10^{-12} micro curies/ml
45 - 10^{-15} micro curies/ml
46 - 10^{-18} micro curies/ml
47 - 10^{-21} micro curies/ml

50 - % vol
51 - ppm (vol)
52 - ppb (vol)

90 - % control
92 - % opacity

94 - Trace
98 - Not applicable

61.	How Determined	Use code to designate how the actual emissions are determined. 1 - Stack test of emissions from this process or unit 2 - Stack test of emissions from identical process or unit 3 - Stack test of emissions from geometrically similar process or unit 4 - Manufacturer's guarantee 5 - Published emission factors 6 - Material balance calculations 7 - Continuous stack monitoring 9 - Other
62.	Permissible Emissions	Leave blank.
63.	% Control Efficiency	Enter actual efficiency of emission control equipment specified in Section D for each contaminant.
64.	Emission Rate Potential (ERP)	Enter the emission rate potential in lbs/hr (See NYCRR 200.1(s) for definition). If conversion of units is required from units specified in the applicable rule which are other than pounds per hour, show calculations in Section E.
65.	Actual Hourly Emissions	Enter the actual hourly emission in lbs/hr based on normal daily operation of the process.
66.	Actual Annual Emissions	Enter the actual annual emissions in lbs/yr. For radioactive air contaminants enter curies/yr.
67.	10^x	For very large or very small annual emissions utilize the exponent of 10 to specify the correct magnitude. Enter the exponent (x) and indicate whether plus (+) or minus (-). If exponent is not needed, enter zero.
68.	Permissible Annual Emissions	Leave blank.

69-83. For other air contaminants emitted, complete these questions in accordance with instructions for questions 54-68.

84-98. " " " " " " "

99-113. " " " " " " "

114-128. " " " " " " "

129-143. " " " " " " "

SECTION G

Summarize the total amount(s) and type(s) of fuel used in all the processes or units where the products of combustion are vented to the same emission point specified in Section B.

144.	Solid Fuel Type	Specify the code for the type of solid fuel burned: 01 - Anthractie coal 04 - Bituminous coal 08 - Sub-bituminous coal 12 - Lignite 19 - Coal (other) 29 - Coke 80 - Wood 84 - Refuse derived fuel (RDF) 86 - Refuse 99 - Other
145.	Solid Fuel (Tons/Yr)	Average quantity of solid fuel burned in all processes described in this application (tons/yr).
146.	Solid Fuel (%S)	Percent (%) sulfur content by weight.
147.	Oil Type	Enter the code for the type of oil burned: 31 - #1 32 - #2 34 - #4 35 - #5 36 - #6 40 - Diesel 49 - Oil (other) 92 - Liquid waste 96 - Sludge 99 - Other
148.	Oil (Thousands of Gal/Yr)	Average quantity of oil burned in all processes and emission control equipment described in this application (thousands of gal/yr).
149.	Oil (%S)	Percent (%) sulfur content by weight.
150.	Gas Type	Enter the code for type of gas burned: 52 - Natural gas 56 - Blast furnace gas 58 - Coke oven gas 60 - Manufactured gas 62 - Producer gas 64 - Refinery gas 68 - Sewage gas 72 - L.P. gas 79 - Gas (other) 94 - Gaseous waste 99 - Other
151.	Gas (Thousands of Ft^3/Yr)	Quantity of gas burned in all processes and emission control equipment described in this application (thousands of ft^3/yr).
152.	Gas (Btu/Ft^3)	Heating value of gas (Btu/ft^3).

153-154.	Applicable Rule	Leave blank.
155.	Signature of Authorized Representative or Agent and Date	Signature of owner's representative or authorized agent must be affixed when applying for a Certificate to Operate, or the application will not be processed. Leave blank when applying for a Permit to Construct. Enter date at time of signature.

Instructions for Completing Form 76-19-4

COMPLETE FORM 76-19-4 ONLY IF MORE THAN ONE PROCESS OR UNIT VENTS TO THE SAME EMISSION POINT. COMPLETE A FORM 76-19-4 FOR EACH PROCESS. WRITE THE NUMBER OF 76-19-4 FORMS USED (e.g., 8 FORMS 76-19-4) IN SECTION E OF FORM 76-19-3.

SECTION H

175.	Emission Point I.D.	Enter the emission point I.D. from question 29 of form 76-19-3.
176.	Unit I.D.	Number consecutively when more than one 76-19-4 form is required.
177.	Source Code	Leave blank.
178.	Hrs/Day	Number of hrs/day this unit is or will be in operation.
179.	Days/Year	Number of days/yr this unit is or will be operation.
180.	% Operation By Season	Indicate this percentage of time the process is or will be in operation by season. Total of four percentages listed must equal 100. Winter: January - March, Spring: April - June, etc.
181.	Describe Process/Unit	Describe process of unit emitting contaminants through the emission point specified in question 175. One form 76-19-4 must be completed for each non-identical process or unit venting to the emission point.

SECTION J

Complete this Section only if the emissions from each process (unit) are directed to separate emission control equipment.

182.	Emission Control Equipment I.D. No.	Number assigned to each emission control device being reported. Each emission control device connected to the same stack must be assigned a different number not to exceed two digits. Control equipment must be numbered on the plot plans and/or drawings submitted (See Figure 1).
183.	Control Type	Enter the code to designate the type of emission control equipment used:

02 - Settling chamber
03 - Louver collector
04 - Baffle chamber
06 - Centrifugal (dry)
07 - Centrifugal (wet)
08 - Fabric collector
09 - Electrostatic precipitator
10 - Thermal afterburner
11 - Spray tower
12 - Impingement plate scrubber
13 - Venturi scrubber
14 - Demister
15 - Packed tower
16 - Ejector condenser
17 - Activated bed adsorber
18 - Silica gel adsorber
19 - Catalytic unit
20 - Vapor condenser
21 - Control for VOC storage and transfer
22 - Filter
23 - Absolute filter
98 - Other
99 - None

184.	Manufacturer's Name and Model Number	Specify the manufacturer and model number of the emission control type specified in the previous question.
185.	Disposal Method	Specify method of disposal of collected contaminants by entering code: 1 - Landfill - on-site 2 - Land fill - off-site 3 - Recycled in the process 4 - Recycled on-site 6 - Sold 7 - Public sewer 8 - Private sewer 9 - Other, explain in process description
186.	Date Installed	Actual or expected date of installation of control equipment (month and year).
187.	Useful Life	Expected years of useful life of emission control equipment.

188-193. If additional emission control equipment is used, complete these questions. Refer to instructions for questions 182-187.

SECTION K

Show calculations used to determine input or production input, emission rate potential and actual emissions and annual emissions. Where appropriate, include, pressure, temperature, % moisture (by weight) and gas flow rate. Calculations must be legible. If additional space is necessary, use additional paper and submit original and three copies.

SECTION L

194.	Contaminant Name	Specify the air contaminants emitted by complete name. List other contaminants under questions 206, 218, 230, etc., including sulfur dioxide derived from combustion of fuel used in process. Do not abbreviate or use chemical formual.
195.	Contaminant CAS Number	Specify the contaminant Chemical Abstract Series Number.
196.	Input or Production	Enter input or production rate in units which are specified in the applicable regulations (e.g., 40 CFR 60 Subparts D through HH for Federal Regulations and 6 NYCRR parts 200 through 259 for State Regulatins). Do not insert the Federal Subpart letter or the State Part number. 40 CFR 60 Subpart O - Lbs/hr of sludge charged Subpart S - Tons/hr of aluminum or aluminum equivalent produced per hour Subpart Z - Megawatts of furnace power input Subpart BB - Lbs/hr of black liquor solids entering recovery furnace Subpart HH - Tons/hr of limestone feed per hour Part 212 and 213 - Process weights in lbs/hr for the following processes (For Part 212, if the process is not listed, process weight does not apply, and the question should be left blank): A - Stone driers (asphalt concrete plants) B - Expanded aggregate kilns (lightweight aggregate plants) C - Continuous process material dryers emitting solid particulates and water only D - Brass and bronze melting furnaces E - Ferroalloy production furnaces F - Lime kilns G - Glass production furnaces H - Graphitizing and silicon carbide furnaces I - Gypsum driers J - Primary aluminum reduction furnaces Part 214 - Tons/day of coal charged into oven Part 220 - Tons/hr of kiln feed

1-800-642-6501

Send to
Al Klaus

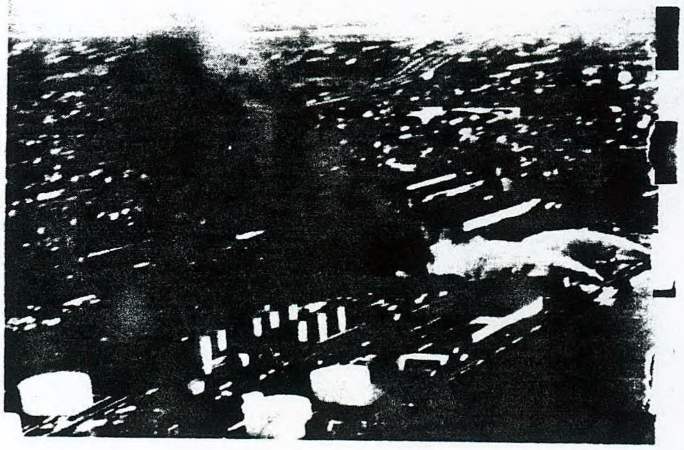
9/16/88

Shakti

ENVIRONMENTAL
ENGINEERING
SERVICES

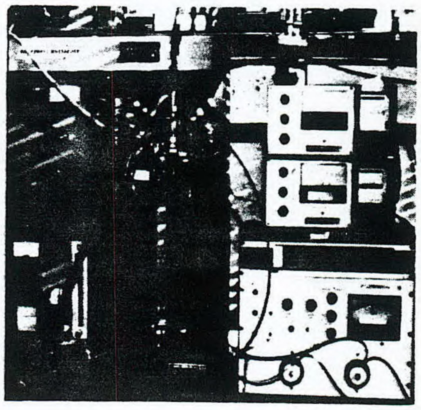
About the Firm

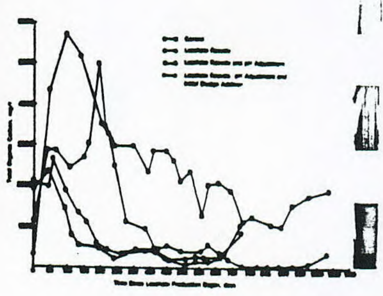
Shakti Consultants, Inc. is an independently owned, private consulting firm with demonstrated capabilities in reducing the risks and liabilities associated with handling hazardous materials. It is dedicated to assisting Industry in complying with complex environmental laws.



Risk Control Services

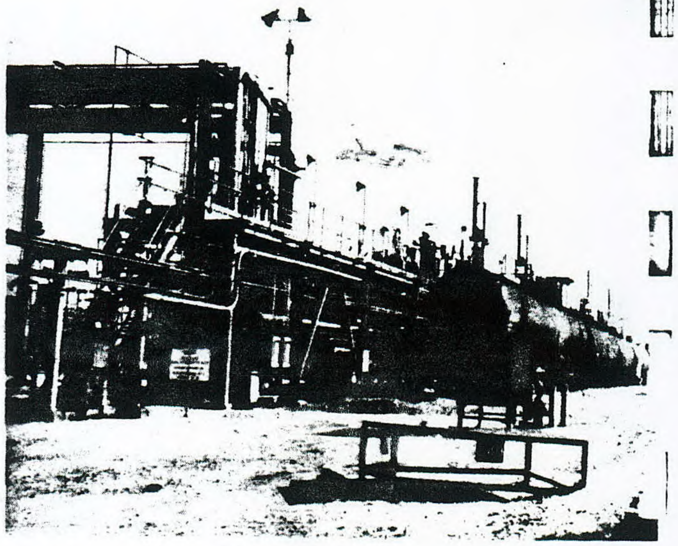
- Experienced in Spill Prevention and Hazardous Materials Management
- Providing Environmental Audits of compliance and liability
- Offering Risk Control and Training programs.





Emergency Spill Response and Project Management Services

- Available 24 hours a day. Experienced in Spill Responses and Project Management of Federal and Industrial resources at numerous hazardous materials spills and clean-up actions.
- Disaster Response: damage assessment and cost control, disaster management and public health risk assessment.
- Knowledgeable of the engineering geology, civil engineering, waste disposal and treatment methods used in Site Remedial Actions.



For more information please contact

Shakti Consultants, Inc.

[illegible]
[illegible]
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SHAKTI CONSULTANTS INC.

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September 16, 1988

Mr Walter Stern
General Switch Co.
Wallkill, New York 10940

Martin Baker, Esq.
Rosenman & Colin
575 Madison Avenue
New York, New York 10022

Re: U.S.A. v. General Switch
87 Civ. 8789 (RJW)

Dear Mr. Gil Sandberg,

We have prepared a reply to the June 9, 1988 letter from The U.S. Attorney, Helen Toor, in light of our discussions with Robert Cobiella, Mel Hauptman, Betty Martinovich and Bernice Corman of the USEPA.

Sincerely,

John Bee

John Bee
President, Shakti Consultants, Inc.
Certified Professional Geologist # 6173
American Institute of Professional Geologists

FEASIBILITY STUDY & PROPOSAL FOR FINAL CLEANUP

WALLKILL NEW YORK

SEPTEMBER 1988

by

ENVIRONMENTAL TECHNOLOGY SERVICES
SHAKTI CONSULTANTS, INC.
JAMESBURG, NEW JERSEY - CHARLESTON, WEST VIRGINIA

John Bee
Senior Geologist, Shakti Consultants, Inc.
CPG#6173 American Institute of
Professional Geologists

FEASIBILITY STUDY & PROPOSAL FOR FINAL CLEANUP

WALLKILL NEW YORK

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FEASIBILITY STUDY & PROPOSAL FOR FINAL CLEANUP

WALLKILL NEW YORK

1.0 Introduction

Shakti Consultants has been retained by General Switch to review the field work conducted in Washington Heights and the General Switch Property in the last four years and to devise a cost effective program to remedy the soil and groundwater contamination at the site. (Figure 1)

This submission is a proposal for final cleanup that is acceptable to General Switch pending the results of the review and detailed design of alternatives. The final feasibility study report will be available on December 1, 1988.

The proposed program is a follows:

- *The groundwater from the Parella well will be pumped through a merry-go-round air stripper and a secondary biological reactor that will reduce the contaminant concentration from 250 ppm in the influent water to below 5 ppb in the effluent. The water will then be infiltrated into the tetrachloroethylene contaminated soils on site to induce cleaning of the soils and leaching of the contaminants that will be intercepted by the cone of depression of the Parella well. In addition, contaminants will be drawn from the vapor space in the well above the the water level to collect soil vapors.*
- *Treatment of the soil by leaching in the areas detailed in the attached site map Figure 9. Leaching of the soil will be enhanced by dispersion of the treated groundwater through a leaching field in each of the three areas of soil contamination.*
- *Groundwater interception using the Parella well that controls the water resources of the area and will intercept the flow of contaminants to downstream receptors*
- *Air stripping the groundwater of the volatile contaminants so that the groundwater is below the proposed water quality criteria for tetrachloroethylene effective at the time of pumping and the air flow leaving the air stripper is below acceptable air criteria effective at that time.*

The remedial investigation begun by the Technical Assistance Team and continued by Fred C. Hart was designed to define the extent of contamination and exposure and supply data to support the assessment of remedial alternatives in the feasibility study. General Switch is committed to moving this program ahead to address remedial action.

A review of site data developed during the remedial investigation stage was requested by the Technical Staff of the USEPA. Shakti is prepared to demonstrate that the major tasks of the remedial investigation are completed and we propose to move on to the feasibility study and remedial design following review and approval by USEPA of the remedial investigation summary and a finding that no additional soil sampling is required to define soil contamination.

In a letter to Rosenman and Colin the attorneys for General Switch, the U.S. Attorney proposed that the following tasks are required:

Item 1. Definition of the nature and extent of soil and groundwater contamination, including investigation of tetrachloroethylene ("PCE") degradation products in both soil and groundwater;

During our recent discussion with the USEPA, Shakti Consultants was able to present additional data defining the extent of groundwater contamination and the hydrogeology of the site that included various pump tests conducted at the site. This information was not included in the Fred C. Hart reports and was obtained during the initial response to Wallkill beginning on October 15, 1983, and during the ensuing site investigation to April 1984 conducted by John Bee as a member of the Technical Assistance Team supporting the USEPA Emergency Response Branch, Region II. John Bee is employed by Shakti Consultants as the project hydrogeologist for this feasibility study and remedial action. At the request of the technical staff of the USEPA assigned to this case, this data is presented in the attached remedial investigation summary.

It is our conclusion after reviewing the site data that there is not a significant exposure to degradation products of tetrachloroethylene. Tetrachloroethylene does not decay quickly in groundwater. Research by Woods et al. 1980 that indicated a 2-year half life, used organic-rich sludge and was significantly flawed. We propose to monitor for tetrachloroethylene as the principal indicator of the extent of contamination and exposure, with occasional quality control sample analysis for trichloroethylene, 1,1-dichloroethylene, and vinyl chloride.

Item 2. Aquifer restoration to 5 ppb of PCE, 5 ppb of trichloroethylene, 7 ppb of 1,1-dichloroethylene, and 2 ppb of vinyl chloride.

We can undertake to treat the groundwater to the Safe Drinking Water MCLs effective at the time of the groundwater clean-up operation.

Item 3. Soil cleanup until the danger of further leachate into the ground water is eliminated; method of soil cleanup to be determined based on results of investigations, e.g. incineration or in-situ treatment;

We propose to reduce leachate generation by soil treatment in combination with groundwater interception as being the cost effective method for clean-up and off site control. Incineration is too costly.

Item 4. Cleanup of groundwater by air stripper at 99.9% efficiency if levels of vinyl chloride concentration in all exhaust gas discharged to the atmosphere do not exceed 10 ppm.

The vinyl chloride exhaust gas criteria is irrelevant to this site. We will ensure that the exhaust gas concentrations meets the air criteria that is effective during the operation.

Item 5. Provision of alternate water to any persons whom investigations indicate are currently receiving water contaminated with more than 5 ppb of PCE.

It is understood that any resident whom investigations indicate is currently receiving water contaminated with more than the current drinking water standard of tetrachloroethylene will be provided with alternate water in the form of a hook-up to the Wallkill drinking water supply system.

Apart from these broad undertaking there are additional needs for refinement of the cost estimates, detailed assessment of the feasibility of the alternatives and final design:

1.1 Feasibility Study Tasks

The outstanding tasks that are required in the feasibility stage of the program are:

- *Retest selected wells in the Washington Heights Community to check that no additional well contamination has occurred. Review groundwater analyses results. The retesting will concentrate on the residences that are not yet hooked up to municipal supply.*

- *Measure the water levels in the wells in Washington Heights and produce a groundwater contour map indicating the present groundwater flow directions.*

- *Pump test the Parella well to define its present sustained contaminant strength and capability to intercept the contaminant plume in the shale, to provide a "safety net" under the site to collect future infiltration of contaminants percolating out of the till.*

- *Refine the cost estimates for the alternatives and complete the final design specifications.*

1.2 Description of Present Situation

A contaminant plume of tetrachloroethylene has been identified in the groundwater in the Washington Heights Section of Wallkill. The majority of the residents are supplied with municipal drinking water supply. Municipal drinking water supply is available to all the residents. Individual home owners have chosen not to use the available municipal supply.

1.3 Remedial Investigation Summary

Site Hydrogeology

The stratigraphy of the site is a silty glacial till overlaying a sandstone and shale formation: the Austin Glen Series. The building of General Switch sits upon fill and the the parking lot to the south east of the facility is composed of fill that contains some metal objects and is in part reworked till that contains cobbles. There is approximately 40 feet of unconsolidated material under the building. The bedrock in general slopes to the southeast (Figure 2).

Glacial Till

There are several exposures of the soils and underlying shale to be found along the railway track located 4,000 feet north of the Parella Property (320 Highland Avenue) and massive sandstone and shale is found to outcrop at the surface on the northern end of Watkins Avenue and near Lubricants, Inc.

From profiles of the soils at these locations, it can be noted that the soils horizons of the Washington Heights section of the Town of Wallkill belong to the Mardin gravelly silt loam series. The Mardin soils are formed from a gravelly, sandy silt glacial till which in turn is derived from the sandstone, shale and slate of the bedrock of this area. The till lies unconformably on the Austin Glen Grit and Shales.

Permeability in the till is described in the literature as moderate in the surficial layer and upper part of the subsoil and is slow or very slow in the underlying substratum. The till is generally unsorted and unstratified and consists primarily of clay, silt and boulders. The permeability of the till is very low and the values range from 1.3 x 10^{-7} cm/sec to 6.4 x 10^{-7} cm/sec.

Available water capacity in the till is low and runoff is slow to medium. A perched water table has been observed in the spring in the till. This perched water table was noted in the till that is tapped by poorly yielding dug wells: on the Continental Telephone property (abandoned) on the Stout Property (abandoned) and at 208 Watkins Ave (used for watering vegetables).

Transmission of water and contaminants through the glacial till is likely to be retarded by the slow percolation rate operating in the surficial soils. Thus, during wet seasons a perched water table is noted close to the surface. The water in the glacial till is found in the soil pores between the unconsolidated soil grains. Contouring of the water table elevations in 1984 indicated a flow direction from north to south, generally following the ground level elevations.

When the Technical Assistance Team first arrived on-site on October 15, 1983, a survey of wells was made nearby to the Parella Well. Two shallow dug wells were noted on the property belonging to Janice Stout (Stout Lot #4). The two wells were 11 feet and 16 feet deep, were dug into the glacial till soils, and were dry to the bottom. Following a major storm event, the water levels were measured on December 16, 1983. Water, within a 2 day period, had reached to within 1 foot of the ground surface. The water levels in these wells then continued to hold a level within 2 feet from the surface through November, December and January. Water was found consistently through these winter months to be close to the ground surface in the shallow dug wells on Commonwealth, Watkins and Highland Avenues as well as in sumps and depressions along Industrial Place Extension. It is this perched water in the till that is assisting in the mobilization of the solvents in the soil and will be addressed by soil treatment and capping the areas of soil contamination.

It is noted from questioning local residents that the original wells in this area were dug to a maximum of 30 feet into the glacial till, were approximately 3 feet wide and were lined with stones. These wells had a history of running dry in August each year. With increased use of this surficial aquifer, the water levels, according to local residents, dropped. Problems experienced with biological contamination of the shallow wells from septic systems that predate the municipal sewers, in addition to the depletion of the perched water reserves caused many of the wells to be abandoned. In 1984 it was noted that 4 shallow wells were being used consistently for drinking water (291 Highland, 175 Watkins and 177 and 193 Commonwealth) and 4 other wells are used only for flushing toilets, washing clothes and watering the garden (208 and 217 Watkins and 216 and 233 Commonwealth). None of the shallow wells indicated contamination with tetrachloroethylene.

From the plot of water table levels in shallow dug wells (Figure 3) and in depressions throughout the site area, the water table contours in the till follow the topography of the site. The general lateral direction of groundwater flow in the till is from north to south in contrast to the groundwater flow direction in the shale that was influenced by the overpumping of the groundwater reserves on Highland Avenue. Fred C. Hart has provided water contours in the glacial till specifically on the General Switch property (Figure 4).

Austin Glen Grit and Shale

The Austin Glen Grit and Shale consists of interbedded massive sandstones grading with increasing micaceous minerals through to thinly-bedded fissile shales. The fissile weathered shale members are observed along the railroad grade while the more massive sandstone, fractured with regional fissures, is seen immediately north of Lubricants, Inc. The trend of the regional fissures at this outcrop is predominantly northeast-southwest. The strike of bedding for the Austin Glen Series is northeast-southwest as can be seen from the Goshen Quadrangle Map (Figure 5) and the regional dip is 26-40° NW. From the cross section included with the quadrangle, the site is located on the northeast limb of a major anticline.

A second aquifer is found in the Austin Glen Series. In the sandstone and shale, the groundwater is not found between the mineral grains but is found in the secondary fissures cutting through the rock. These secondary fissures influence the abundance and direction of flow of the groundwater under the motive force of the difference in potentiometric head from one point to another. Following weathering and erosion of the overlying soil and rock, there has been a pressure release in the Austin Glen Series and fractures in the rock have opened as the overburden (the amount of rock above) has been reduced. Groundwater will pass more slowly through rock with tight joints. Permeability and well yields in the Austin Glen Series can vary greatly within a short distance. This is determined in part by the degree of fracturing and openness of the joints and also by the interconnection of joints.

Shale Aquifer

The groundwater in the shale is contained in a fractured bedrock aquifer. The following data obtained in 1984 is presented to indicate how the fractured bedrock aquifer responds to pumping.

The potentiometric pressures in the shale represented by the composite groundwater contours plotted for the shale in 1984 indicated drawdown due to over pumping along Highland Avenue, a groundwater divide between Highland and Watkins Avenue and a groundwater mound in the vicinity of the Electra Manufacturing, General Switch and Pitt properties from which water moves away in a radial pattern westward to Cosmo Optic, southeastward along Highland Avenue and southward towards Guild Molders (Figure 6).

Between November 15, 1983 and February 3, 1984 water levels were taken by the Technical Assistance Team in wells that supply residents with drinking water in the Washington Heights section of the Town of Wallkill and from Industrial Place in the City of Middletown.

Water levels were taken under the following conditions: Water levels used for plotting the regional groundwater flow pattern were taken only when whole streets and city blocks had stopped pumping their wells for at least 12 hours. The highest elevation of the groundwater found in the wells was taken as that most nearly approaching static. These water levels were contoured and plotted on February 18, 1983 and represented the static water levels of the Washington Heights section for the semi-confined aquifer in the shale during a period of aquifer use for drinking water.

Composite static groundwater levels: The composite water levels plotted for this site are taken from wells open along a large portion of their saturated profile. This composite water level may differ from the true water level if the well penetrates a zone of rock in which the hydraulic potential changes with depth. The resultant water level is a function of the head differential, the permeabilities and the rate of recharge to the system. The true groundwater table can be determined by constructing piezometers screened no more than 5 feet in length and penetrating the aquifer only sufficiently to be below the dry season water level.

In interpreting the water contour map attached, it should be noted that in a recharge area, a deep open hole will show an anomolously lower water level reading than that found in a shallower comparable borehole. It is only in areas of lateral flow that data from deep and shallow holes, and open and cased holes (piezometers) can be plotted on the same groundwater level map.

Any contaminants located in the shale near General Switch would tend to move towards the Parella well if a suitable fissure was available. The force moving the contaminants would be the difference in head between the General Switch well 624.77' (static) and the Parella well 615.61' (static). Note that even moderate (4 gpm) pumping of wells in the shale causes large drawdowns as much as 50 feet in the Parella well and 77 feet in the Pitt well. The General Switch well had not been pumped since it was drilled, as reported by John Braghirol, the Plant Engineer. Thus, the potentiometric head around General Switch would maintain its elevated position. Pumping of the surrounding wells such as Osbourne, Lobb, Parella and Pitt greatly change the potentiometric contours as shown in the pump tests conducted at the site, greatly increasing the potentiometric head difference between the General Switch Well and the pumped wells.

Since 1962 when municipal sewers were constructed, the discharge of well water pumped from this aquifer into the municipal treatment plants has reduced the overall potentiometric head in the shale by about 20 feet throughout the area, according to local well drillers. There appears to be correlation between areas of extensive pumping and long-term drawdown of water wells. Although the water levels plotted are static conditions for individual wells, the groundwater elevations in the shale show long-term anomalies where extensive pumping has occurred. There has been extensive pumping of water from the aquifer under Highland Avenue. Thus in the 1984 plot of groundwater levels, the 620 and 610 feet groundwater contours crossing Highland Avenue between the Knapp (317 Highland Avenue) and Merle (331 Highland Avenue) residences show drawdown of the water levels in this location. As indicated by the composite groundwater contour map, groundwater was moving away from the groundwater mound near Electra Manufacturing properties and curving to the south, running along the line of Highland Avenue. A groundwater divide was located in the vicinity of Van Pelt and Gilbert where potentiometric head decreased to the east towards Highland Avenue and west towards the 590 foot contour observed along Watkins and Commonwealth Avenues. Little water is extracted from the aquifer along most portions of Watkins Avenue; many residences in 1984 were provided with municipal water supply. In general, groundwater flowed from Watkins Avenue towards Commonwealth Avenue in a north-westerly direction under residences located north of Electric Avenue (between numbers 208-251 on Watkins and numbers 200-244 on Commonwealth).

Groundwater, as interpreted from the 600 foot contour flowed from the vicinity of the Van Pelt residence towards the Hebrew School (195 Watkins) and from Wegenroth (168 Watkins) towards the Hebrew School, converging in a groundwater "valley", or low, running northwest-southeast through the Hebrew School. A potentiometric low towards which water flowed was noted in the vicinity of the Winner and Morse residences (186 and 190 Watkins).

The tight concentric contours centered on the Morse and Perry residences reflects local drawdown in the potentiometric surface by overpumping of these two wells in a formation that is of limited extraction capacity and limited communication with major fractures. These wells did not recovered to static levels within 12 hours. While groundwater data is scarse in the area immediately northwest of the Industrial Place Extension, the potentiometric head difference between General Switch elevation (624.77 feet) and Guild Molders (594.81 feet) would mean that groundwater would tend to flow from General Switch towards Guild Molders.

The pumping of individual wells has a great effect upon potentiometric heads in the shale and hence groundwater movements. While pumping of the Parella, Stout, Lobb and Osbourne wells will tend to increase the potential for groundwater flow from the Electra Manufacturing/General Switch groundwater mound, the fact that the well at Guild Molders had not been extensively used, according to information supplied by the facility, would tend to minimize the flow of groundwater from General Switch to Guild Molders. The mobilizing force for the groundwater flow would have been the difference in static head between the wells.

Pumping Tests

Pumping of the Parella Well

Between November 15 and December 26, 1983, the Parella well at 320 Highland Avenue, was pumped at between 1/2 to 4 gpm. The Parella well was the most contaminated well at that time and was employed as an extraction well to remove contaminants from the bedrock aquifer, in an attempt to limit the spread of the plume and to prevent the contamination of clean wells in the vicinity of the Parella well.

From the plot of concentration of the effluent pumped between November 15 and December 26 there is an indication that pumping at 1/2 gpm to 1 gpm recovered the most contaminated groundwater. Figure 7. There seemed to be a general lowering of tetrachloroethylene levels with time in the water being recovered, after a peak of 260,000 ppb on November 15, 1983. The concentration of tetrachloroethylene from the Parella well pumping at 4 gpm after 3 months was at 95,000 ppb. There also appears to be a recovery and increase in concentration of tetrachloroethylene in samples taken during pumping after the well was rested without pumping for one day as observed on November 26, 1983.

Pumping the Parella well from November 15 to December 25, 1983, extracted 33,400 gallons of contaminated water from the bedrock aquifer. At an average of 74,500 ppb tetrachloroethylene, this recovered 20.75 lbs. of tetrachloroethylene or 1.55 gallons of pure product extracted during the pumping. It is unfortunate that this pumping was not continued.

Parella Well Pump Test #1

The following data is presented as it indicates how the Parella well operates and is interconnected to some of the nearby wells. On December 21, 1983, a pump test was conducted on the Parella well. The well had not been pumped for the previous 30 hours. At 1445 hours, a static level was taken in the Osbourne, Lobb, Fiore, Electra Manufacturing and Continental Telephone wells. At that time, these wells were abandoned: the residences were either supplied by a temporary municipal water line or the wells were previously abandoned. It was assumed after 30 hours that the water levels in the shale had time to return to the static conditions. At 1500 hours, the Parella well was pumped at 12 gpm. At 1505 hours, the pump rate was reduced to 6 gpm as the well was loosing suction. At 1535 hours, the pump rate was further cut back and held at 4 gpm for the duration of the test (3.5 hours).

Figure 8 and Table 1 presents a summary of the data collected during the pump test. From the data plotted, the effect that pumping the Parella well had on other wells can be observed. The water level in the Parella well was pulled down an estimated 50 feet, and the water levels in three of the surrounding wells belonging to the Osbourne, Lobb and Fiore families were pulled down appreciably.

The water level in the Lobb well after approximately 2 1/2 hours was pulled down 23.49 ft., Fiore 11.7 ft., and Osbourne over 6 ft. Thus the Lobb, Fiore, and Osbourne wells are in intimate hydraulic connection with the Parella well, probably being fed by the same fissure in the shale. It should be noted that the Lobb and Osbourne wells are highly contaminated, but that the Fiore well contains only a trace of tetrachlcroethylene contamination. The drawdown in the Fiore well may have been the result of homeowner water withdrawal during the pump test. A time/concentration pump test for the Fiore well was not completed. The abandoned well at Electric Manufacturing did not respond in this 2.5 hour pump test and is judged not be in direct and intimate connection with the Parella well fissure system. The Continental Telephone well water level dropped .18 feet during this test.

Thus, the zone of influence of pumping the Parella well does not propagate in all directions equally, but follows preferred flow paths through fissures in the shale. This zone has a general effective radius of influence of 350 ft. (based on .18 ft. drop at a distance of 350 ft. for the Continental Telephone Well).

General Switch Pump Test #1

The General Switch well is not a candidate for a groundwater recovery well. On February 2, 1984, the General Switch well was pumped at 2 gpm. At or before 1213 hours, a static water level was taken in the General Switch well and neighboring wells which had been rested for at least 12 hours. After 1 hour 49 minutes of pumping at 2 gpm the drawdown in the General Switch well was measured at more than 287' below the static water level, deeper than the maximum depth that could be measured using an M-scope water indicator. The specific capacity (gallons per minute/foot of drawdown) of the General Switch well is very small. The well yields very little water. It is estimated that the General Switch well delivers only 1/2 gpm, although it is 480 feet deep. During the pumping test, water levels in nearby wells were recorded. There appear from the test to be hydraulic connection between the Parella and Osbourne wells and the General Switch well (Table 2).

Pumping the General Switch well appreciably drew down the water levels in the Parella and Osbourne wells. The Guild Molders, Perez and Pitt wells were unaffected. Water levels in the Electra Manufacturing, Perry and Wand wells rose during the test.

Ruppert Well Pump Test #1

The Ruppert well was pumped on February 3, 1984, at a flow rate of 11 gpm. This flow rate was sufficient after one hour to break suction on the pump set at 180' depth (147' below the static water level). One hour into the test the pump lost suction at 11 gpm and was then throttled back to 6 gpm. The pump again lost suction 1 hr. 23 minutes into the test @ 6 gpm. At this point the pump was throttled back to 2 gpm and drawdown continued in the Barry (neighbor's) well. The drawdown in neighboring wells during 3 hours of pumping the Ruppert well is noted in Table 3.

Pumping the Ruppert well drew down the water levels appreciably in the Ruppert and Barry wells. Water levels in the Knapp, Van Pelt, Morse, Winner and Palermo wells rose during the test indicating that the wells were recovering to static level during the test that these wells were not in intimate hydraulic connection with the Ruppert well, and any drawdown due to pumping was masked by this recovery.

The pumping data generated during the initial well contamination period is subject to interference from individual well use during the test. However, there is indication that pumping the Parella well will have a substantial effect of plume capture and intercept the flow of contaminated groundwater flowing to downgradient wells.

Definition of Extent of Contamination

The soil contamination on the General Switch property has been defined in various reports by the NYDEC, USEPA and Fred C. Hart. The US Attorney has proposed that the definition of nature and extent of soil and groundwater contamination, including investigation of tetrachloroethylene ("PCE") degradation products in both soil and groundwater. That can be addressed during ongoing monitoring. The tetrachloroethylene is the principal contaminant of concern and will be used as the indicator of the extent of contamination and exposure.

Extent of Soil Contamination

In December 1983, the NYSDEC sampled soil from 0-2.5 feet at a site just south of the plant building. The results of the chemical analyses showed relatively low concentrations of tetrachloroethylene at the top and bottom of the hole and higher concentrations (100 ppm) at depths of one to two feet.

A second round of soil samples was taken from within a 100 foot radius of the plant in March, 1984. The most contaminated sample (1,000 ppm tetrachloroethylene) was found on the northwest side of the plant. Two other samples from the southwestern corner of the plant contained 95 and 400 ppm tetrachloroethylene, while the other soil samples contained only 10 ppm.

The Fred C. Hart reports define the extent of contamination and contaminant transport in the glacial till. The additional data from the TAT studies fills a gap in the knowledge of the hydrogeology of the area and the nature and extent of groundwater contamination in the shale and allows us to proceed with the Feasibility Study - see exposure assessment section.

Extent of Groundwater Contamination

From October 17, 1983 to March 16, 1984 water samples from potable wells within a one-mile radius of the General Switch plant were analyzed for tetrachloroethylene. The data generated from over 300 ground water samples indicated that twenty wells on Highland and Watkins Avenues had detectable concentrations of tetrachloroethylene. Seven domestic wells and one industrial well at General Switch contained concentrations of tetrachloroethylene that exceeded the NYSDOH 1984 maximum permissible concentration (50 ppb) for any single synthetic organic chemical.

In 1984, the tetrachloroethylene contamination of wells in the Washington Heights Section of the Town of Wallkill was restricted to wells drawing water from the Austin Glen Series and not in the shallow dug wells in the area. Permeability in this formation is determined by the degree of fracturing, openness of joints and bedding planes, and the interconnection of joints. The distribution of contaminants in the area indicate transmission of the contaminants are along regional fractures. Those wells that obtain the highest level of contaminant concentration were/are on a regional fracture that connects to the source of contaminants.

2.0 Institutional Requirements

Regulations under th the Resource Conservation and Recovery Act (RCRA), the Safe Drinking Water Act (SDWA), and the Federal Water Pollution Control Act (Clean Water Act or CWA), have the broadest applications to remedial action alternatives. These regulations, advisories, and guidance are considered in developing remedies. If federal regulations are not followed, the reasons for not using them must be stated and recorded in the record of decision documents (RODs) issued by the USEPA.

Results of the institutional analysis are presented, in the feasibility study as part of the non-cost criteria analysis of the remedial action alternatives.

2.1 Permits

Permits that may be required for this site include:

- *Injection into an underground formation requires an Underground Injection Control permit. This may be needed if groundwater is returned to the Shale once it is treated*
- *Transportation of hazardous waste to an off-site treatment, storage, or disposal facility (TSDF) requires RCRA manifests and TSDF permits.*
- *Discharge of pollutants or contaminants from a point source into U.S. waters requires a National Pollutant Discharge Elimination System (NPDES) permit pursuant to CWA section 402.*
- *Discharge of pollutant contaminants into a publicly owned treatment works (POTW) may require permits issued by the local POTW.*
- *Emissions of pollutants to the air may require Clean Air Act (CAA) permits, depending on the substance emitted, its quantity, and the classification of the area.*

2.2 Applicable and Relevant Standards

It is EPA policy that, in selecting remedial actions, primary consideration be given to remedies that attain applicable or relevant Federal environmental and public health standards (ARARs). The ARARs are presented in the section addressing exposure assessment.

State standards that are more stringent than Federal standards may form the basis for a remedy only if the standards have been promulgated and the result is consistent with the cost-effective remedy based on Federal standards.

The USEPA will consider all of the alternatives arrayed in the feasibility study and will give primary consideration to remedies that attain or exceed applicable or relevant Federal public health and environmental standards.

An on-site alternative may be accepted that does not attain applicable or relevant standards in one or more of the circumstances discussed below.

- The selected alternative is not the final or total remedy and will become part of a more comprehensive remedy;

  Soil treatment is not the total remedy for the site but will reduce soil contamination and is complemented by the groundwater interception at the Parella well.

- Technical impracticability - that it is technically impracticable from an engineering perspective to achieve the standard at the specific site in question;

  It is technically impractical to remove all the tetrachloroethylene from the soil. Alternatives are presented that will mitigate the environmental impact of the product remaining in the soil.

- Unacceptable environmental impacts - All alternatives that attain or exceed standards would cause unacceptable damage to the environment; Not Applicable

- Where the remedy is to be carried out pursuant to CERCLA section 106; the Hazardous Response Trust Fund is unavailable, or would not be used; there is a strong public interest in expedited cleanup; and the litigation probably would not result in the desired remedy.

It is unlikely that the Hazardous Response Trust Fund will be available for this site. Now that the municipal drinking water supply has been provided to the community, there is not the drinking water exposure to the community that would trigger a high exposure score and inclusion in the National Priority List.

The New York DEC has funds to effect cleanup in addition to the Hazardous Response Trust Fund. If the New York DEC took over the site and cleaned up to the DEC's demanding environmental standards, it is likely that during cost recovery, those costs that attained cleanup to higher than federal standards would be disallowed by the courts.

There is public sentiment as voiced by the Orange County Health Department that there has been sufficient study of the site and that a remedy is long overdue. In light of the fact that General Switch is probably not the only industry in the area that is contributing tetrachloroethylene to the groundwater according to information in our possession and that the regulatory agencies have not actively pursued other PRPs, this offer from General Switch would seem a reasonable discharge of their responsibilities in this matter.

2.3 Qualitative Exposure Assessment

The remedial action selected must adequately protect public health, welfare, and the environment. This requires documenting that the action minimizes the long-term effects of any residual contamination and protects the public both during and after the action. In accordance with current procedures, the public health evaluation may be done by EPA Regions, the State, a responsible party, or their consultants.

The public health evaluation has several steps (though not all apply to all remedial sites):

- *Baseline site evaluation: Preliminary evaluation and classification.*

The information collected included site background data, disposal history, extent of contamination data, site environmental data (e.g., topography and hydrogeology), contaminant mobility and migration, information on the local community, and information on human health effects.

Definition of Extent of Contamination

The definition of soil contamination on the General Switch property has been defined in various reports by the NYDEC, USEPA and Fred C. Hart. The US Attorney has proposed as a task that the definition of nature and extent of soil and groundwater contamination, including investigation of tetrachloroethylene ("PCE") degradation products in both soil and groundwater. This task can be addressed during ongoing monitoring. The tetrachloroethylene is the principal contaminant of concern and will be used as the indicator of the extent of contamination and exposure.

- *Exposure assessment: at a minimum, a qualitative exposure analysis is required to evaluate the types, amounts, and concentrations of chemicals at the site, their toxic effects, the proximity of target populations, the likelihood of chemical release and migration from the site, and the potential for exposure.*

At a minimum, the public health evaluation should establish the potential health and environmental impact.

The potential health and environmental impact of the site is:

Soil Contamination

Contamination of soils with solvents including tetrachloroethylene have been detected in soils in the facility yard and in a remote cul-de-sac at the northern side of the plant. Access to these areas is restricted. Exposure of the general public is unlikely. Site workers do have access to these areas and walk across the areas close to the building, near the loading docks.

In December 1983, the NYSDEC sampled soil from 0-2.5 feet at a site just south of the plant building. The results of the chemical analyses showed relatively low concentrations of Tterachloroethylene at the top and bottom of the hole and higher concentrations (100 ppm) at depths of one to two feet. A second round of soil samples was taken from within a 100 foot radius of the plant in March, 1984. The most contaminated sample (1,000 ppm tetrachloroethylene) was found on the northwest side of the plant. Two other samples from the southwestern corner of the plant contained 95 and 400 ppm tetrachloroethylene, while the other soil samples contained only 10 ppm.

The Fred C. Hart reports define the extent of contamination and contaminant transport in the unconsolidated soils on the General Switch property as shown in Figures 9, 10, 11, 12, and 13.

Depth and Lateral Extent for Soil Treatment

Fred C. Hart has conducted a program to define the lateral and vertical extent of contamination of the unconsolidated soils and fill material at General Switch.

A correlation was developed between the laboratory data compared to data produced using a Photovac, a portable gas chromatograph with a photoionization detector and data generated using the portable OVA, a gas chromatograph using a flame ionization detector. It appears that the instruments were not calibrated to the same standards.

The results in Table 1 indicated that the concentrations of tetrachloroethylene in the headspace as identified through the Photovac analysis was approximately one order of magnitude greater than the actual concentration of tetrachloroethylene in the soil as identified by the standard laboratory method. Based on this correlation a conservative relationship between the Photovac analysis and the laboratory analysis was established as follows:

Tetrachloroethylene Photovac Analysis (ppm)		***Corresponding Lab Analysis in the Soil (ppm)***
>1000	*significant contamination*	*#100*
100-1000	*moderate contamination*	*10-100*
1-10	*low contamination*	*<1*

The OVA data produced poor correlation with soil laboratory data except to indicate high level soil contamination. When the OVA scan of the split spoon indicated a high concentration of total volatile organics (greater than 1000 ppm) it was assumed that the sample was highly contaminated and a Photovac analysis was not performed. Based on the OVA results from this study and laboratory analytical results from previous studies, tetrachloroethylene concentrations in the soil around TPA and TPD are known to be higher than 200 ppm.

The Photovac results are the most numerous and we propose to use this data along with the OVA data to establish the horizontal and vertical extent of soil that requires treatment.

The following discussion addresses only the Photovac results which, based on the laboratory correlation, showed concentrations of 200 ppm or less. There are three areas of soil contamination indicated by previous investigations that are displayed in Figure 9: Soil around TP6, TPA and TPD.

TP6

Soil samples taken from the area around TP6, which included Test Borings T-1 through T-4, showed tetrachloroethylene concentrations in the range of less than 1 to approximately 20 ppm.

With respect to contamination in the vertical direction, the higher concentrations were found at depths of 2 to 7 feet, as indicated in Test Borings T-2, T-3, and T-4. The tetrachloroethylene contamination that was found below a depth of 10 feet extends to a depth of 17 feet at the range of 1 to 5 ppm for all samples analyzed in this area. If the soil solidification alternative is adopted, soil will be treated to 4 feet depth in this area as defined by Cross Section A-A'.

With respect to the lateral extent of tetrachloroethylene contamination in this area, all four test borings generally showed the same degree of contamination. It appears that tetrachloroethylene contamination at concentrations of less than 20 ppm extends laterally beyond the area investigated with Test Borings T-1 through T-4. It is proposed to treat the area detailed on Figures 10-13 that include locations T-1, T-4 and TP6.

TPD

Soil samples taken from the area around TPD, which included Test Borings T-5 through T-11, showed tetrachloroethylene contamination in the range of less than 1 ppm to approximately 200 ppm.

With respect to contamination in the vertical direction in this area, the higher concentrations were found at depths of 0 to 12 feet, with the highest concentrations generally at depths of less than 10 feet. Concentrations in samples taken at depths of 12 to 17 feet were in the range of approximately 5 to 16 ppm.

With respect to the lateral extent of tetrachloroethylene contamination in this area, the highest concentrations were found in Test Borings T-7, T-8, T-9, T-10 and T-11, at levels of up to approximately 200 ppm with the Photovac and greater than 1000 ppm with the OVA. The lowest concentrations were found in Test Borings T-5, T-8, T-12, T-13 and T-11, in a range of less than 1 ppm to approximately 20 ppm. It appears that these test borings roughly define the lateral extent of tetrachloroethylene contamination in this area. For the solidification alternative, soil will be treated to 4 feet depth in T-5, T-6, to 6 feet depth near T-7, T-8, T-9 and T-10 and 2 feet near T-12, T-13.

TPA

Soil samples taken from the area around TPA, which included Test Borings T-15 through T-20, showed tetrachloroethylene contamination in a range of less than 1 ppm to approximately 200 ppm.

It appears that there is significant contamination in the vertical direction in this area to at least a depth of 10 to 12 feet. The highest concentrations were found in Test Borings T-15, T-18, T-17, and T-20, at levels of up to approximately 200 ppm with the Photovac and greater than 1000 ppm with the OVA. However, Test Boring T-19 had a maximum concentration of approximately 5 ppm and all three concentrations in T-18 were less than 1 ppm. It appears that Test Boring T-19 roughly defines the lateral extent of tetrachloroethylene contamination parallel to the building in this area. The area at the side of the General Switch building is a cul-de-sac, a depression that is lower than the neighboring slope from Highland Avenue and is bounded on the north by a property boundary. For the soil solidification alternative the depth of soil treatment in this area will be to 6 feet and extend from T-15 to T20, bounded by the property boundary. The foundations of the building will be undermined if excavation proceeds below the footings.

TABLE 1

Photovac and Laboratory PCE Concentrations

Test Boring	Depth (ft.)	Photovac (ppm)	Laboratory (ppm)
T-1	2.5- 4.0	27	
T-1	5.0- 7.0	45	
T-1	10.0-11.0	48	
T-2	0.0- 1.0		
T-2	2.5- 4.5	100-125	
T-2	5.0- 7.0	50-70	
T-2	10.0-12.0	4	
T-2	15.0-17.0	2	
T-3	0.0- 1.0		
T-3	2.5- 4.5	104	
T-3	5.0- 7.0	50-70	
T-3	10.0-12.0	21	3.08
T-3	15.0-17.0	31	
T-4	2.5- 4.5	81	
T-4	5.0- 7.0	179	
T-4	10.0-12.0	18-23	
T-4	15.0-17.0	13	
T-5	0.0- 2.0		
T-5	2.5- 4.5	121	
T-5	5.0- 7.0	72	4.68
T-5	15.0-17.0	38	
T-6	0.0- 2.0	*	
T-6	2.5- 4.5	32	
T-6	5.0- 7.0	100-125	
T-6	10.0-12.0	19	
T-6	15.0-17.0	148	
T-7	0.0- 2.0	*	
T-7	2.5- 4.5	*	
T-7	5.0- 7.0	1692	92.2
T-7	10.0-12.0	19	
T-7	14.0-15.0	83	
T-8	0.0- 2.0		
T-8	2.5- 4.5	*	
T-8	5.0- 7.0	1871	132.4
T-8	8.5-10.5	>500	
T-9	0.0- 2.0		
T-9	2.5- 4.5	*	
T-9	5.0- 7.0	*	
T-9	10.0-12.0	>500	

TABLE 1 (continued)

Photovac and Laboratory PCE Concentrations

Test Boring	Depth (ft.)	Photovac (ppm)	Laboratory (ppm)
T-10	0.0- 2.0	*	
T-10	2.5- 4.5	>1000	
T-10	5.0- 7.0	*	
T-10	10.0-10.5		
T-11	0.0- 2.0	*	
T-11	2.5- 4.5	*	
T-11	5.0- 7.0	*	
T-11	7.0- 9.0		
T-12	0.0- 1.0	>203	
T-12	2.5- 4.5	40	
T-12	5.0- 7.0	8	
T-12	9.0-11.0	2	
T-13	0.0- 2.0		
T-13	2.5- 4.5	38	
T-13	5.0- 7.0	45	
T-13	10.0-12.0	1	
T-13	15.0-17.0	24	
T-14	2.5- 4.5		
T-14	5.0- 7.0	150-200	
T-14	10.0-12.0	40	
T-15	0.0- 2.0	1524	
T-15	5.0- 7.0		
T-15	7.0- 9.0		
T-16	2.0- 4.0	1640	
T-16	6.0- 8.0	*	
T-16	8.0- 9.2	*	
T-17	0.0- 2.0	*	
T-17	4.0- 6.0	*	
T-17	8.0-10.0	>1000	
T-17	10.0-12.0	*	
T-17	12.0-13.3	121	
T-18	0.0- 2.0	2	
T-18	4.0- 6.0	3	
T-18	8.0- 9.0	4	
T-19	0.0- 2.0	<1	
T-19	2.0- 4.0	44	
T-19	4.0- 6.0	1	
T-20	0.0- 2.0	*	
T-20	2.0- 4.0	2098	
T-20	8.0-10.0	>1000	

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* OVA scan showed greater than 1000 ppm of total volatile organics.

Groundwater Contamination

From October 17, 1983 to March 16, 1984 water samples from potable wells within a one-mile radius of the General Switch plant were analyzed for tetrachloroethylene. The data generated from over 300 ground water samples indicated that twenty wells on Highland and Watkins Avenues had detectable concentrations of tetrachloroethylene. Seven domestic wells and one industrial well (at General Switch) contained concentrations of tetrachloroethylene that exceeded the NYSDOH 1984 maximum permissible concentration (50 ppb) for any single synthetic organic chemical as shown on Figure 14.

In 1984, the tetrachloroethylene contamination of wells in the Washington Heights Section of the Town of Wallkill was restricted to wells drawing water from the Austin Glen Series and not in the shallow dug wells in the area. Permeability in this formation is determined by the degree of fracturing, openness of joints and bedding planes, and the interconnection of joints. The distribution of contaminants in the area indicate transmission of the contaminants are along regional fractures. Those wells that obtain the highest level of contaminant concentration were/are on a regional fracture that connects to the source of contaminants.

Many of the residences on Highland Avenue have been supplied with municipal water, as noted in Figure 14, and have abandoned their wells including all those residences with greater than 50 ug/l tetrachloroethylene. As of July 1988, the nearest residences to General Switch that use the aquifer as a drinking water source are:

The Perry residence that has historically been unaffected by the groundwater contamination and the Ogden (now Wood), Seeley and Gilbert residences at 319, 321 and 323 Highland Avenue. These wells in November 1983 to April 1984 received 1 to non-detected concentrations of tetrachloroethylene, indicating that their well was not on a major fissure carrying the contaminants.

In November 1983 to April 1984 the residences on Watkins that were supplied from wells were Hammerquist, Wegenroth, Rassmussen, Morse, Winner, Prior King Press, Cosmo Optics, Radivoy, Campbell, Jehovahs Witness, Wand and Saxton. All the other residences on Watkins Avenue were supplied with municipal water from Middletown. In November 1983 to April 1984 all the wells on Watkins Avenue were free from tetrachloroethylene contamination except Prior King Press (ND, 2 and 3), Winner (ND and 1.1), Rassmussen (12 and ND), Morse (4 and ND) and Wand (2 and ND).

All the wells tested in 1983-1984 on Commonwealth Avenue were <1 or non-detected for tetrachloroethylene.

Water well testing was conducted by Fred C. Hart between June and September 1984. The results of potable water analysis are presented in the Appendix. During the four months of sampling by Fred C. Hart, the most contaminated wells encountered were at the homes of: Ruppert, Liska, Barry, Stout, Parella. General Switch and Lewis. With the exception of Liska and Lewis, all the other wells had previously been identified as contaminated with over 50 ppb of tetrachloroethylene. Tetrachloroethylene concentrations in excess of 50 ppb were first noticed in the Lewis and Liska wells on July 17, 1984. Another set of samples were taken on August 28, 1984 to confirm the previous results.

When the results of the August 28, 1984 sampling trip were received, the Liska and Lewis homes were put on alternate water. Aside from the wells mentioned above, all the other wells in the General Switch vicinity remained uncontaminated.

In general, the concentrations and distribution of tetrachloroethylene had changed very little since EPA's last samples were taken in March of 1984. The trend of tetrachloroethylene distribution had remained in a northwest-southeast orientation and the contamination found in the Liska and Lewis wells conformed to this pattern.

The additional data from the TAT studies fills a gap in the knowledge of the hydrogeology of the area and the nature and extent of groundwater contamination in the shale and allows us to proceed with the Feasibility Study.

No potable water samples have been taken since 1984. Retesting of selected wells is included in the proposal to continue monitoring of the site along with a commitment by General Switch to provide municipal water to any residence with a well containing more than the Safe Drinking Water Act MCL.

Based on the available data, the Baseline Site Evaluation and Exposure Assessment have been completed.

The remaining tasks include an analysis of the extent and duration of human exposure to site contaminants in the absence of remedial action.

Exposure Following No Remedial Action

In the absence or any remedial action addressing on-site cleanup or off-site plume capture, over the last four years, two additional wells were contaminated to above Drinking Water Standards and the residents were provided with municipal water supply. Most of the residents of Washington Heights have been removed from dependence upon groundwater drinking supply. It is General Switch's intent to offer municipal drinking water to the remaining houses on Highland and Watkins Avenue. Without a remedial action there will be continued exposure of site workers to the contaminated soil on the General Switch property.

The following tasks remain to be completed:

o Standards analysis: Comparison of projected environmental concentrations to appropriate ambient standards or criteria.

o Develop and evaluate remedial alternatives: Evaluation of short- and long-term effects of remedial alternatives to remove or mitigate exposures of concern identified during the exposure assessment.

2.4 Standards Analysis

There is no existing federal MCL for tetrachloroethylene, trichloroethylene, 1,2-dichloroethane and vinyl chloride. The remaining standards are non-enforceable criteria and guidance. These standards are presented in Table 2. There is discussion inside the USEPA of proposing 5 ppb for tetrachloroethylene as the proposed drinking water standard.

The agreement between General Switch and the Justice Department can be worded so that General Switch will abide by the accepted criteria in effect at the time of the remedial work.

The end of cleanup will be:

o When the soil treatment, using a specific method has processed a preagreed finite volume of soil, the work is completed. For instance, when the volume of soil (750 tons) deliniated by Figures 9 to 13 is rotor tilled, solidified and capped, the work is complete.

or When the soil has been leached such that soil contaminants have been reduced to less than 50 ppm and

o When the groundwater at the Parella well for a period of three months has attained the accepted MCL criteria in effect at that time.

TABLE 2

Applicable or Relevant Requirements

Other Criteria, Advisories and Guidance

HUMAN HEALTH CRITERIA
DRINKING WATER STANDARDS - TABLE I

ALL VALUES ARE IN ug/l UNLESS NOTED OTHERWISE	SAFE DRINKING WATER ACT MCL		PROPOSED WATER QUALITY CRITERIA INITIAL CANCER RISK		FINAL CANCER RISK		EPA SNARLS			NAS SNARLS (mg/l)			NAS ADI (mg/kg) /DAY)	NEW YORK STATE
MATERIAL OR CHARACTERISTIC	PRIM.	SEC.	10-6	TOX	10-6	TOX	1-DAY	10-DAY	CHRON	1-DAY	7-DAY	CHRON	/DAY)	GWS
1,2-Dichloroethane (P)			0.7		0.94									
Tetrachloroethylene (P)			.2		.8		2300	175	20	172	24.5			
Trichloroethylene (P)			2.1		2.7		2000	200	75	105	15			10
Vinyl Chloride (P)			51.7		2.0									5

CRITERIA LEVELS - TETRACHLOROETHYLENE

WATER	5 ppb	PROPOSED MCL, DRINKING WATER STANDARD*. MEANS EXTENDED GROUNDWATER TREATMENT
	0.67 ppb	HEALTH BASED STANDARD FOR CLEAN-UP. CARCINOGENIC ASSESSMENT GROUP - EPA WASHINGTON
		TECHNICAL OPERATING GUIDANCE -NY STATE (TOGS) NOT ARARs
SOIL	50 ppb	PROPOSED - EPA REGION II.
	200 ppb	HEALTH BASED STANDARD FOR CLEAN-UP. CARCINOGENIC ASSESSMENT GROUP - EPA WASHINGTON
		TECHNICAL OPERATING GUIDANCE -NY STATE (TOGS) NOT ARARs

3.0 Identification of Applicable Technologies

The goals of this remedial action are to restore the underlying aquifer to its potential for full use and to protect against endangerment to human health or the environment arising from the soil contamination at General Switch.

Based on previous experience with contaminated soil and groundwaters, several technologies were identified for minimizing the impact of on-site soil contamination and to address groundwater recovery and treatment. These alternatives are listed in Table 3. The purpose of this section is to describe each technology and to assess the feasibility of the alternative.

Description of the Alternative

The methods and goals of the alternative were described as they relate to the site requirements.

Feasibility

The feasibility of the alternative is a judgment based on previous experience as to whether a given process is capable of performing effectively. The general applicability of each technology in terms of the classes of organic contaminants effectively treated and interferences were noted. For instance, the groundwater treatment method will reduce the contaminants to within drinking water standards or below MCL's. The designation "very good-excellent" means that the technology will achieve 80 to 100 percent removal consistently. The Water Quality Criteria are health goals which may or may not be technically and/or economically feasible. In the case of contaminants not governed by Drinking Water Regulations, if a process has been shown to be capable of good removal (more than 40 to 50 percent), then the performance of that process can be said to be effective. "Fair" removal implies that the process is capable of moderate removals (20 to 40 percent), and the Drinking Water Regulation or some reasonable criterion is often exceeded. "Poor" removal implies that the process rarely provides treatment to within standards, regardless of the initial concentration.

Advantages and Disadvantages

The advantages and disadvantages of the methods were reviewed.

Technology Assessment

Each technology that was identified was further assessed with respect to the following criteria:

- Residual problems
- Secondary environmental impacts.
- Commercial availability & previous applications with contaminated soil and groundwater.
- Operation and maintenance requirements.
- Capital cost.
- Annual operating cost.

Residuals Problems

The alternatives were assessed in term of residual or intractable problems that the methods generated or did not address. Residual waste solids were a disposal problem with some of the treatment processes identified. The remedial methods such as in soil removal or solidification may leave residual problems unaddressed by the method.

Secondary Environmental Impacts

The secondary environmental impacts include such considerations as odors and land use were evaluated.

Commercial Availability & Previous Applications

Both air stripping and carbon adsorption have been used for many years to treat water. Design procedures and operating parameters are well established. A cost saving can be realized if the equipment is purchased from a primary manufacturer. Lease purchase agreements are available. The high cost of rental of the remedial equipment means that rental costs quickly pay for the equipment.

O&M Requirements

The costs of operation and maintenance are often a major consideration in site clean-up. The ideal site operation would require only minimal supervision and be readily monitored for efficiency.

Capital and Annual Operating Cost

Capital costs were estimated for each treatment method and are summarized in Table 13. It should be kept in mind that these estimates are not based on a detailed design.

TABLE 3. ALTERNATIVES DISCUSSED:

SOIL CLEAN-UP

o SOIL REMOVAL	EFFECT OF LAND BAN ON LANDFILL DISPOSAL
o INCINERATION OF SOIL	REJECTED AS TOO COSTLY
o SOIL SOLIDIFICATION	CLOSURE IN PLACE. CEMENT/LIME KILN DUST/MODIFIED PROCTOR COMPRESSION
o PARTIAL SOIL TREATMENT	TREAT SOIL TO 4 FEET, TO 6 FEET IN HEAVILY CONTAMINATED AREAS.
o CAPPING	RCRA CAP / SOLIDIFIED SOIL / CEMENT PAD
o VAPOR EXTRACTION	USE OF THE PARELLA WELL TO EXTRACT VAPORS

GROUNDWATER CAPTURE

o PUMP PARELLA WELL	FOR GROUNDWATER PLUME CAPTURE
o PUMP ADDITIONAL WELLS	IF REQUIRED TO CAPTURE THE PLUME

GROUNDWATER TREATMENT

o PUMP GROUNDWATER TO SEWER	VERBAL AGREEMENT WITH WALLKILL ALREADY OBTAINED
o TREAT GROUNDWATER WITH AIR STRIPPER	
o TREAT GROUNDWATER WITH CARBON ADSORPTION	

DRAINAGE DIVERSION

- COLLECT ROOF DRAINS
- PROVIDE RUN-OFF DIVERSION

Annual operating costs were estimated for each alternative and are summarized in Table 13, along with groundwater treatment cost per 1,000 gallons. Power costs were estimated at $0.05/kWh and maintenance at 4 percent of the total capital cost. Labor and chemical requirements were obtained from vendors (assuming $15/hr).

General Estimating Criteria

The alternatives were evaluated and costed using standard general assumptions:

Soil Alternatives
- *The soil volume for treatment was estimated to be 750 tons from the cross-sections and areas defined by the boreholes and noted on Figure 9.*
- *Local equipment will be used*

Groundwater Alternatives
- *Treatment flow: 20 gpm. Includes an allowance for polishing of the final effluent or serial operation of units.*
- *Treatment levels: to drinking water criteria*
- *Feed sump, feed pumps, flow meter, and pipes, valves, and specialties are required for each system.*
- *Electrical work, piping, instrumentation, and site work are each 12 percent, 8 percent, 5 percent, and 5 percent, respectively, of the total equipment capital cost.*
- *The cost for engineering and contingency is 25 percent of capital costs.*

ALTERNATIVE NO ACTION

The alternative of No Action is rejected based on the fact that contamination in nine private wells has been discovered above the 50 ppb drinking water criteria previously established by NYSDOH. No action would increase the potential for future contamination of additional private wells and the long-term impact of the contamination on the environment.

3.1 SOIL CLEAN-UP

o	*SOIL REMOVAL*	*EFFECT OF LAND BAN ON LANDFILL DISPOSAL*
	LANDFILL DISPOSAL OF SOIL	
	a.	*SOIL REMOVAL BASED ON SOIL CONCENTRATION*
	b.	*SOIL REMOVAL BASED ON PREAGREED DEPTH BASED ON PRESENT EXTENT OF SOIL CONTAMINATION DATA*
o	*INCINERATION OF SOIL*	*DISMISSED AS TOO COSTLY*
o	*SOIL SOLIDIFICATION*	*CLOSURE IN PLACE. CEMENT/LIME KILN DUST/MODIFIED PROCTOR COMPRESSION*
o	*TOTAL SOIL SOLIDIFICATION*	*TREAT ALL SOIL TO EPA/DEC STANDARD*
o	*PARTIAL SOIL SOLIDIFICATION*	*TREAT SOIL TO 4 FEET, WITH EXCAVATION TO 6 FEET IN HEAVILY CONTAMINATED AREAS.*
o	*CAPPING*	*RCRA CAP / SOLIDIFIED SOIL / CEMENT PAD*
o	*VAPOR EXTRACTION*	*VAPOR RECOVERY FROM SOIL*

ALTERNATIVE CONTAMINATED SOIL REMOVAL AND OFF-SITE DISPOSAL

It appears that off-site disposal of solvent contaminated soil is not a viable option.

Land Disposal Ban Under RCRA

In the Hazardous and Solid Waste Amendments of 1984, Congress created a statutory policy against the land disposal of hazardous wastes. In order to implement this statutory policy, the land disposal of hazardous wastes will be banned pursuant to statutory schedules unless EPA determines otherwise ("hammer provisions"). EPA has already taken final action on F catagory wastes that include tetrachloroethylene and dioxin wastes and has proposed a rule for a group of wastes known as the "California list".

In February, 1986 regulations were promulgated banning the landfilling of containerized hazardous liquids and of liquids absorbed in materials that biodegrade or release liquids when compressed.

November 8, 1986 - The land disposal of solvents (codes F001 through F005) and dioxins (codes F020 through F023) - the California List was prohibited unless human health and the environment will not be endangered. Wastes generated by Superfund and RCRA enforcement actions were given a two year excemption.

November 8, 1988 Wastes generated by Superfund and RCRA enforcement actions are now banned from landfills. Limited exemptions exist for parties who can prove that their disposal unit will not allow any hazardous waste or constituents to migrate from the disposal site.

While the tetrachloroethylene contaminated soil is unlikely to release a liquid, this waste comes under the Land Ban for F001 waste:- tetrachloroethylene used as a solvent. According to the proposed regulations, landfilling of solvent contaminated soil in such facilities as SCA Model City in Buffalo and Cecos in Niagara Falls is prohibited.

Costs

TABLE 4. CAPITAL COST FOR SOIL DISPOSAL

Equipment		
Excavation (Backhoe -10 days @$500)	*$5,000*	
(Bulldozer -10 days @$320)	*3,200*	
Transportation to Model City (38 Loads @ $1450/load)	*55,100*	
Disposal ($132/ton)	*99,000*	
Backfill (750 tons @$3.5)	*2,500*	
Subtotal	*$164,800*	*$164,800*
Contingency and Engineering at 25%		*41,000*
TOTAL CAPITAL COST		*$205,000*

ALTERNATIVE IN-SITU SOIL SOLIDIFICATION

The remedy of in-situ soil treatment appears to be forced upon us by the Land Ban.

Description of Alternative

The steps that will be completed to address remedial action for soil contamination on-site using this alternative are:

- *Excavation and mounding of the contaminated soils inside the limits of the contaminated soil area. The excavation will extend down to 4 feet, except in areas of high-level contamination of the soil where the soil will be excavated to 6 feet depth..*
- *The soil during soil solidification will then be replaced in 8" lifts. The soil lifts will be spread across the floor of the excavation and rotor tilled, during which a large proportion of the volatiles will escape into the air. Rotor tilling will be used to mix lime kiln dust or cement dust into the soil, forming a cement like soil that will bind up the remaining solvents on the soil particles, resist erosion and form a cap over the solvent that has leached further down into the surficial soils.*
- *Physical testing of the solidified material will be completed*
- *There will be a final quality control inspection and certification*

The contaminated soil areas will be closed in a manner that minimizes the need for further maintenance and controls. The finished closure of stabilized soil to the south of the truck yard will be seeded to minimize erosion. The area of solidified soil in the cul-de-sac will be provided with a concrete cap that will collect precipitation and shed the run-off so as to minimize infiltration through the cap. The nature of the stabilized soil will provide relative impermeability to water by its very nature. The stabilized soil will not require extensive maintenance and controls. The system will be essentially a passive system that requires periodic inspection.

Data Needs

For the final design of the solidification procedures the correct mix of cement, lime kiln dust and native clay is required along with the method and degree of compaction and hyration.

Advantages:

The site will be closed in a manner that:

- *Minimizes or eliminates threats to human health and the environment*
- *Avoids post-closure release of: hazardous materials and leachate, contaminated run-off and waste decomposition products to ground waters of the state or atmosphere. Once the driving force of continued infiltration of precipitation is removed, leachate production will be minimized and the impact on the groundwater resources of the area reduced.*
- *Reduces the concentration of contaminants to an acceptable level in the upper soil horizons and binds the contaminants up in a pozzolanic reaction.*
- *Protects public health and the environment through control of transport pathways.*

Table 5 presents elements that are believed essential to include in a comprehensive approach to an in-situ treatment program. These goals address the concerns of public health by reducing the infiltration of contaminants into the groundwater from contaminated soil.

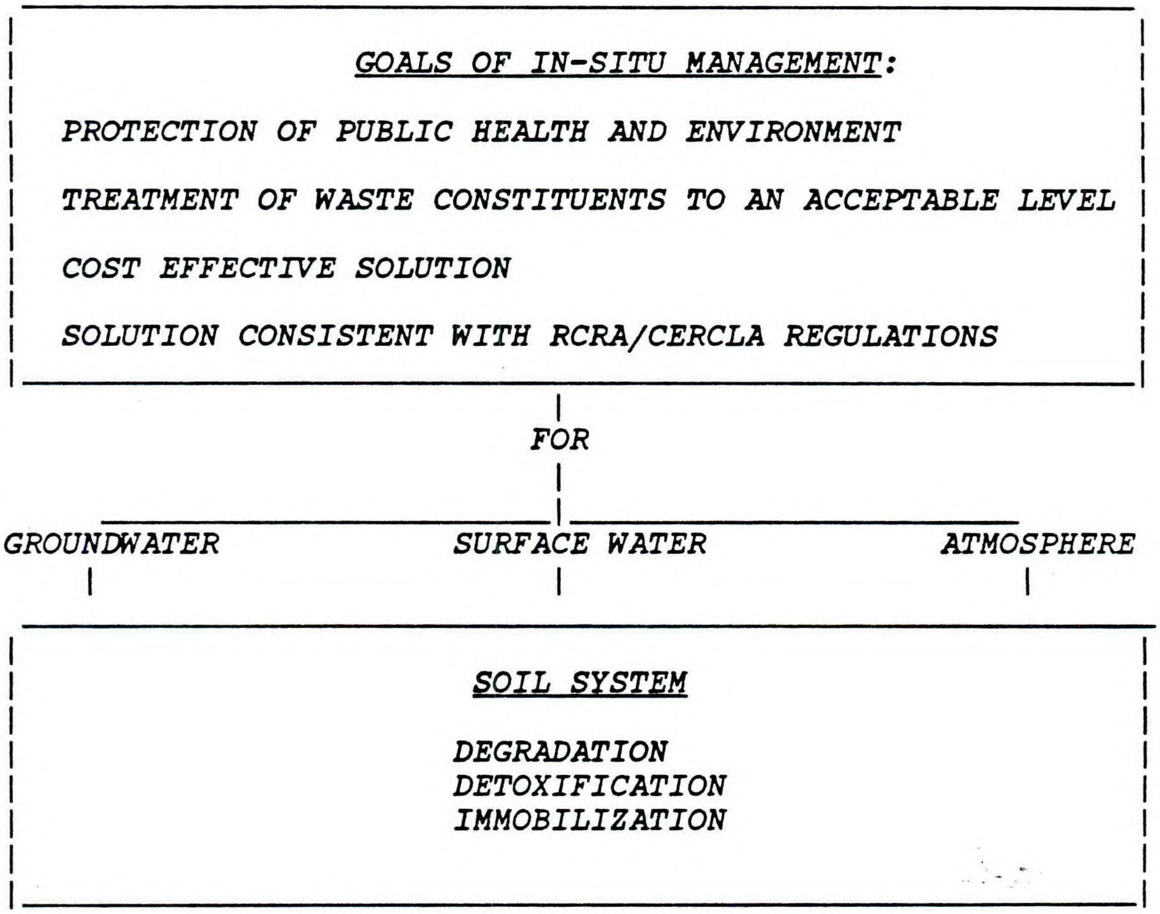
Pathways of Dispersion at the Site

The major pathways of dispersion of contaminants at this site are by production of leachate that infiltrates the groundwater and air dispersion by volatilization. Contaminants in the soil can represent a potential long-term threat in the soil environment and groundwater quality, but this threat can be reduced considerably if the contaminants can be immobilized at the point of contamination by either physical or chemical methods.

Erosion and Surface-Water Run-Off

The use of soil solidification envisaged in this alternative will minimize contaminant erosion. Drainage interception will minimize run-on.

Table 5



GOALS OF IN-SITU MANAGEMENT:

- PROTECTION OF PUBLIC HEALTH AND ENVIRONMENT
- TREATMENT OF WASTE CONSTITUENTS TO AN ACCEPTABLE LEVEL
- COST EFFECTIVE SOLUTION
- SOLUTION CONSISTENT WITH RCRA/CERCLA REGULATIONS

FOR

GROUNDWATER | SURFACE WATER | ATMOSPHERE

SOIL SYSTEM

- DEGRADATION
- DETOXIFICATION
- IMMOBILIZATION

Goals of In-Situ Treatment

Infiltration of Contaminants to the Groundwater

Infiltration of contaminants to the groundwater is considered to be the prime potential impact of the contaminants in the soil at General Switch. At present the soil is surcharged with run-off water from the site, a seasonal perched water condition is observed and the resultant leachate production is infiltrating the groundwater beneath the site.

Laboratory studies and previous experience of the fate and toxicology of the contaminants, support the contention that if the soil is bound up in a pozzolanic reaction, the contaminants will not have any significant impact on public health and the environment through control of the transport pathways.

Once the soil contamination area is capped with solidified soil, leachate production and the impact of downward percolation of leachate into this contaminated aquifer from this soil will be minimized.

Disadvantages

Air Emissions: The loss of contaminants from the soil during treatment via vapor phase transport will be significant as shown by information obtained from ambient air measurements of the Love Canal area and from the Hudson River basin (Shen and Tofflemire 1980). Toxic materials released from these landfills and dump sites were much greater than emission via water transport, and concerns over the air impacts of some uncontrolled hazardous waste sites are warranted. Protective respirators will be used by remedial workers during soil solidification. The sites in the parking area are remote from residential dwellings. Access to the sites will be restricted during soil tilling. The area near TPA is adjacent to a residential dwelling.

The emplaced cap of solidified soil to the site for the purposes of reducing infiltration will act as an odor and vapor barrier and reduce vapor release and transport.

Potential Receptors

Once the soil is solidified and a cap placed upon the remaining contaminants, the remaining significant pathway of dispersion would be infiltration of any contaminant to the groundwater and groundwater flow to a receptor.

The groundwater is reported to flow to the Parella well under the influence of pumping and will be captured by pumping that well to treatment.

Residuals Problems

At this site the anticipated leaching from contaminants that are not treated or removed are to be captured by the groundwater recovery operation. Thus, the methods may complement each other to address the overall site remedy.

An undefined amount of vaporization of the solvents from the soil will occur.

Secondary Environmental Impact

Volatilization of the solvents contained in the treated soil will occur

Commercial Availability & Previous Applications

Soil solidification has been used extensively in civil engineering for the stabilization of swelling and shrinking clays and in the foundations for airport runways. Articles and reports addressing in-situ solidification are presented in the Appendix.

Costs

TABLE 6. CAPITAL COST FOR SOIL SOLIDIFICATION

Ingredients of Solidification			
1 part soil			
1 part clay	*(750 tons @$3.5)*	*$2,600*	
1 part Kemical	*(750 tons @$35*	*26,250*	
Equipment			
Excavation	*(Backhoe -10 days @$500)*	*5,000*	
	(Bulldozer -20 days @$320)	*6,400*	
Mixing	*(Farm Tiller -10 days @500)*	*5,000*	
Compaction	*(Roller -20 day @$175)*	*3,500*	
Soil Testing		*4,000*	
QA/QC Final Inspection		*4,000*	
Subtotal		*$56,750*	*$56,750*
Contingency and Engineering at 25%			*14,000*
TOTAL CAPITAL COST			*$70,750*

TABLE 6A. ANNUAL COST ESTIMATE - SOIL SOLIDIFICATION

Maintenance at 4% of Capital Cost	*2,500*
TOTAL ANNUAL COST	*$2,500*

ALTERNATIVE **VACUUM EXTRACTION OF VAPOR FROM SOIL**

Description of Method

Wells screened in the unsaturated zone can be used to collect soil vapor. A vacuum pump is connected to a drain or wells screened above the water table.

Feasibility

Heavier-than-air vapors such as tetrachloroethylene are best collected at the top of the water table. Vapor extraction has been successful in Puerto Rico under the Upjohn Consent Order in the recovery of carbon tetrachloride and at the American Thermostat site, NY. At the Upjohn site, three pounds by weight per day of carbon tetrachloride was obtained from wells screened in the contaminated residual soils in an underground tank farm above a valuable limestone aquifer.

Advantages

The contaminated soil is purged of solvent vapor and cannot act as a reservoir for continued leaching of contaminants into the aquifer. The system can be fabricated on site with local labor.

In a adaptation of this method used at the American Thermostat site, the Parella well will be connected to a vacuum pump and the vapors exhausted.

3.2 GROUNDWATER CAPTURE

- *PUMP PARELLA WELL FOR GROUNDWATER PLUME CAPTURE*
- *PUMP ADDITIONAL WELLS IF REQUIRED TO CAPTURE THE PLUME*

ALTERNATIVE INTERCEPTOR WELL FOR GROUNDWATER CAPTURE

Description of Alternative

The Parella well pumping at 4 gpm has a radius of influence of at least 350 feet and controls the hydrology of the area. Pumping the Parella well will pull down the potentiometric head in the shale 40 feet (allowing for 80% efficient well). The well is situated upon a major fracture in the area and will intercept the flow of groundwater contaminants flowing past to Highland Avenue.

Data Needs

A pump test is required to define the zone of influence of the well and define the effect of pumping for an extended period of time on the hydrology of the site in order to provide reliable drawdown predictions as portyayed in Figure 15. A pump test using an electropiezometer system is scheduled for the Parella well to demonstrate the zone of influence of the well (Figure 16). The transmissivity and storativity of the fractured bedrock aquifer will be obtained along with the concentration of contaminants in the effluent required for treatment design.

Feasibility

The method proved successful in 1984 under the removal action of USEPA during which an estimated 20.7 pounds of tetrachloroethylene were removed from the aquifer. The well has proven to be the most prolific well in terms of yield and has been consistently contaminated.

Advantages

The well will act as an interceptor well for contaminants flowing southwards along Highland Avenue and minimize contamination of supply wells downgradient. The plume will be captured by physically altering the potentiometric pressure in the aquifer, altering the regional direction of groundwater flow and providing a drawdown cone under the site. According to data presented by Fred C. Hart, the aquifer in the fractured bedrock may affect the water levels in wells in the base of the glacial till. Within the zone of influence of the pumping well, the contaminated groundwater flows to the well where it is permanently removed from the aquifer.

Disadvantages

Additional wells may need to be pumped if the Parella well is not sufficient to speed up the aquifer rehabilitation.

Time Frame

The Parella well is already drilled.

Further information and costs will be presented about this alternative following the pump test.

TABLE 7. CAPITAL COST FOR WELL PUMPING

Well Construction	*$ 0*	
Well rehabilitation	*1,000*	
Easement for well use	*2,000*	
Excavation	*2,000*	
Centrifugal pump for 4"-diameter	*750*	
Replacement pump	*750*	
Electrical at 12%	*1250*	
Piping and controls	*4,000*	
Site Work	*2,250*	
Subtotal	*$14,000*	*$14,000*
Contingency and Engineering at 25%		*3,500*
TOTAL CAPITAL COST		*$17,500*

TABLE 7A. ANNUAL COST ESTIMATE - WELL PUMPING

Labor	*$3,000*
Power at $0.05/kWh	*1,000*
Chemicals	*0*
Maintenance at 4% of Capital Cost	*2500*
TOTAL ANNUAL COST	*$6,500*

(Costs are not inclusive of treatment: see treatment alternatives)

3.3 GROUNDWATER TREATMENT

o	*PUMP GROUNDWATER TO SEWER*	*VERBAL AGREEMENT WITH WALLKILL ALREADY OBTAINED*
o	*TREAT GROUNDWATER WITH AIR STRIPPER*	
o	*TREAT GROUNDWATER WITH CARBON ADSORPTION*	

ALTERNATIVE — ***PUMP PARELLA WELL TO WALLKILL SEWER***

Description of Alternative

The groundwater from the Parella well will be pumped into the sewer system and treated at the Wallkill Treatment Plant.

The sewer system running down Highland Avenue is at present collected by the City of Middletown Sewage Treatment Plant. On several occasions the USEPA and NYDEC has indicated that the City of Middletown is not in compliance with the City's surface water discharge permit limitations for tetrachloroethylene imposed under the Clean Water's Act.

The NYDEC is at present reviewing an application that Wallkill Township will intercept the sewer line running down Highland Avenue and take over the function of sewer treatment for Highland Avenue. This work is scheduled for the fall of 1988. Shakti Consultants in July 1988 confirmed with the Town Supervisor, Dennis Cosgrove, that the Wallkill Treatment Plant is willing to treat the effluent from the Parella well and other contaminated wells in Washington Heights in return for a sum of between $50,000 and $100,000 initial cost and 50 cents per 1000 gallons for treatment.

Feasibility

This alternative only requires hook-up of the pump discharge to the sewer on Highland Avenue, a distance of 40 feet away and permission and permits from the USEPA, NY DEC and Wallkill. The system was used during the removal action by the USEPA in 1983-84.

From November 15, 1983 to December 26, 1983 the Parella well water was pumped into a tank truck to help contain the spread of the tetrachloroethylene plume under Highland Avenue. Parella well water was brought to the surface by a jet pump and discharged into a 2,000 gallon tank truck. The Town of Wallkill Public Works personnel emptied the truck as required. The tank truck was driven approximately 3 miles to a Town of Wallkill sanitary sewer line on Mud Mills Road. Prior to the shut down the rate was 4 gpm into the sanitary sewer.

TABLE 8

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

Collection Date	Lab Number	Tetrachloroethylene Concentration (ppb)	Analysis Date	Laboratory
* 320 Highland Avenue, Parella				
10/17/83	34292	120000	11/15/83	NYSLOAC
11/15/83	63940	260000	11/17/83	USEPA/ESD
11/22/83	68501	76000	12/02/83	USEPA/ERT
11/23/83	68535	1900	12/06/83	CLAYTON
11/26/83	69105	>37000	12/06/83	USEPA/ERT
11/28/83	69114	160000	12/06/83	USEPA/ERT
11/29/83	68548	126000	12/06/83	USEPA/ERT
11/29/83		87000	12/06/83	NYSDEC
11/30/83	69138	96480	12/15/83	TAT/PHOTOVAC
12/01/83	69124	79766	12/15/83	TAT/PHOTOVAC
12/02/83	69142	83000	12/08/83	USEPA/ERT
12/03/83	69146	140122	12/15/83	TAT/PHOTOVAC
12/06/83	69150	73000	12/29/83	USEPA/ERT
12/07/83	69157	70300	12/08/83	USEPA/ERT
12/08/83		72000	12/15/83	NYSDEC
12/09/83	69165	61400	12/29/83	USEPA/ERT
12/29/83	69152	95000	12/29/83	USEPA/ERT
01/06/84	68568	56000	01/12/84	USEPA/ESD
* STP EFFLUENT				
11/23/83	68520	FAILED QC	12/06/83	CLAYTON
11/24/83	68547	11	12/06/83	CLAYTON
11/29/83		10	12/03/83	NYSDEC
12/01/83	69140	1	12/15/83	TAT/PHOTOVAC
12/02/83	69144	2	12/06/83	USEPA/ERT
12/03/83	69148	5	12/15/83	TAT/PHOTOVAC
12/05/83	69155	3.7	12/15/83	USEPA/ERT
12/07/83	69162	2.3	12/20/83	USEPA/ERT
11/23/83	68522	3	12/06/83	CLAYTON
* STP INFLUENT				
11/23/83	68514	ND	12/02/83	USEPA/ERT
11/23/83	68519	ND	12/02/83	USEPA/ERT
11/23/83	68521	FAILED QC	12/06/83	CLAYTON
11/24/83	68546	3	12/06/83	USEPA/ERT
12/01/83	69139	29	12/15/83	TAT/PHOTOVAC
* STP INFLUENT				
12/02/83	69143	50	12/06/83	USEPA/ERT
12/03/83	69147	12	12/16/83	USEPA/ERT
12/05/83	69154	39	12/16/83	USEPA/ERT
12/07/83	69160	26	12/20/83	USEPA/ERT

TABLE B

WALLKILL, NEW YORK
TETRACHLOROETHYLENE SAMPLE RESULTS

Collection Date	Lab Number	Tetrachloroethylene Concentration (ppb)	Analysis Date	Laboratory
* TANK TO SEWER				
11/23/83	68545	>12000	12/06/83	CLAYTON
11/26/83	69108	38900	12/06/83	USEPA/ERT
11/27/83	69110	16300	12/06/83	USEPA/ERT
11/28/83	69113	7000	12/06/83	USEPA/ERT
11/29/83	68549	5300	12/06/83	USEPA/ERT
11/29/83		2300	12/03/83	NYSDEC
12/01/83	69125	29023	12/15/83	TAT/PHOTOVAC
12/01/83	69141	44798	12/15/83	TAT/PHOTOVAC
12/03/83	69145	25979	12/15/83	TAT/PHOTOVAC
12/05/83	69153	53000	12/16/83	USEPA/ERT
12/06/83	69176	48000	12/19/83	USEPA/ERT
12/07/83		33000	12/19/83	NYSDEC
11/25/83	69103	34000		USEPA/ERT
* WALLKILL RIVER - DOWNSTREAM OF STP OUTFALL				
12/07/83	69164	ND	12/20/83	USEPA/ERT
* WALLKILL RIVER - UPSTREAM OF STP OUTFALL				
11/23/83	68537	ND	12/06/83	USEPA/ERT
12/07/83	69163	ND	12/20/83	USEPA/ERT

From the point of discharge into the sanitary sewer line, the contaminated well water flowed approximately three miles down to the Town of Wallkill wastewater treatment plant (Figure 17). It is estimated that this took approximately three hours to reach the treatment plant. It took approximately eight hours for this wastewater to be processed through the treatment plant, after which the wastewater was discharged to the Wallkill River.

EPA/TAT and the NYDEC sampled the Parella well, the stationary sewer tank discharge, and the influent and effluent at the town of Wallkill Wastewater Treatment Plant, as well as upstream and downstream of the plant in the Wallkill River. This sampling effort was to determine what effect, if any, the operation had on the Wallkill treatment plant and Wallkill River. Results can be found in Table 8.

These limited sets of results indicate that pumping tetrachloroethylene contaminated water into the Town of Wallkill wastewater treatment plant, at these low flows, had an insignificant impact on the plant's operation and on impact on the Wallkill River water's quality. The Wallkill plant treats on the average approximately 1.5 million gallons per day (mgd) and discharges this water into the Wallkill River. The river flows at an average of 350 mgd. The total flow from the tank truck was 5760 gallons per day or 0.0057 mgd

Discharge from the Parella Well

The option of discharging the groundwater from the Parella well into the sewer line is contingent upon Wallkill taking over operation of the system in the Fall of 1988. This alternative will not address the soil contamination on the General Switch site.

TABLE 9. CAPITAL COST FOR PUMPING INTO SEWER

Sump	$1,000	
Flow meter	6,000	
Electrical at 12%	1,000	
Piping and controls at 8%	500	
Site Work	1,000	
Subtotal	$9,500	$9,500
Contingency and Engineering at 25%		2,500
TOTAL CAPITAL COST		$12,000

TABLE 9A. ANNUAL COST ESTIMATE - PUMPING INTO SEWER

Treatment Cost - Wallkill*	$2,000
Labor	3,000
Power at $0.05/kWh	1,000
Chemicals	0
Maintenance at 4% of Capital Cost	500
TOTAL ANNUAL COST	$6,500

(4 gpm @ 50c/1000 gallons)

3.4 GROUNDWATER TREATMENT OPTIONS

Aquifer Restoration

The US Attorney has proposed the following requirements with regard to aquifer restoration

- *Aquifer restoration to 5 ppb of tetrachloroethylene (PCE), 5 ppb of trichloroethylene, 7 ppb of 1,1-dichloroethylene, and 2 ppb of vinyl chloride.*
- *Cleanup of groundwater by air stripper at 99.9% efficiency if levels of vinyl chloride concentration in all exhaust gas discharged to the atmosphere do not exceed 10 ppm.*

Organic Contaminant Removal

ALTERNATIVE AIR STRIPPING OF VOLATILE ORGANIC COMPOUNDS

Description of the Alternative

Employing this alternative, the Parella well will be pumped through an air stripper. In a packed column air stripper, as shown in Figure 18, contaminated groundwater is pumped to the top of the packed column where it is dispersed over the column packing. The packing provides the large surface area required for efficient volatilization. At the same time a counter current of forced air is forced up the column from the column base. The volatile-organic laden air exits the upper column through a demister.

The treated water will be returned to the ground or piped to the sewer system. Removal efficiencies for a packed column air stripper of 95 to 99.9+% have been demonstrated.

Air stripping efficiency depends on the transfer rate of the contaminant from water to air. A measure of the resistance to mass transfer from water to air is the Henry's Law Constant, H (Mackay, et al, 1979). The larger the Henry's Law Constant, the greater will be the equilibrium concentration of the contaminant in the air. Thus, contaminants with large Henry's Law Constants are more easily removed by air stripping (Kavanaugh and Trussell, 1980).

The Henry's Law Constants for each of the organic contaminants identified by the U.S Attorney is presented in Table 10. Also included in this table are vapor pressure and water solubility for each compound. Mackay and Wolkoff (1973) and Mackay and Leinonen (1975) suggested that these two parameters be combined to give an effective Henry's Law Constant for organic materials in water:

Data Needs

Data needed to design an air stripper include the influent water concentration and temperature, the air criteria and water criteria to be met and the vaporization characteristics reflected in the Henry's constant.

Feasibility

In general, it can be said that the combination of high Henry's Law Constant, high vapor pressure, and low solubility indicate a potential for successful air stripping. McCarty, et al (1979) noted that those compounds such as tetrachloroethylene, with a Henry's Constant value greater than 10-3 atm m3/mole would be good candidates for removal by air stripping (Figure 19).

Such systems have been demonstrated to achieve 99+ % removal efficiency with tetrachloroethylene. Even with 99+ % removal efficiency two passes through the column or two columns in series may be required to reach drinking water criteria levels in the effluent from an anticipated influent concentrations of 95,000 ppb that were noted in the November-December 1984 pump test. Existing abandoned wells will be used to demonstrate sufficient drawdown to capture the contaminant plume.

A wide variety of air stripping devices are available, including diffused aeration, the coke tray aerator, the countercurrent packed tower, multistage strippers and the cross-flow tower.

In diffused aeration, air is bubbled into a contact chamber through a diffuser. Diffused aeration is ideally conducted counterflow, with the untreated water entering at the top, the treated water exiting through the bottom, the fresh air entering at the bottom, and the exhausted air leaving through the top.

A coke tray aerator is a simple, low-maintenance design without air blowers. The water being treated trickles through several layers of trays, producing a large amount of surface area for gas transfer. It is difficult to model the gas transfer efficiency of coke tray aerators because the air-to-water ratio is not controlled.

In countercurrent packed towers detailed in Figure 18, packing materials are used which provide high void volumes and high surface area. The water flows downward by gravity and air is forced upward. The untreated water is usually distributed on the top of the packing with sprays or distribution trays, and the air is blown through the tower in forced or induced draft. This design results in continuous and thorough contact of the liquid with the gas and minimizes the thickness of the water layer on the packing, promoting efficient mass transfer.

The evaluation row in Table 10 summarizes the Henry's Law Constant, vapor pressure, solubility of the compounds of concern at the site to indicate the amenability of each compound to removal by air stripping. The evaluations for the compounds presented range from Excellent to Very Good and indicate that air stripping is feasible for these compounds.

TABLE 10. HENRY'S CONSTANT

	Tetrachloro ethylene (PCE)	*Trichloro ethylene*	*1,1-Dichloro ethylene*	*Vinyl chloride.*
Henry's Law Constant (atm:m3/mole)	28.7 x 10^3	11.7 x 10^{-3}	15 x 10^{-3}	640 x 10^{-3}
Vapor Pressure (torr,25%C)	14	57.9	591	2660
Solubility in Water (mg/l, 25%C)	150	100	5000	1.1
Effective Henry's Law Constant	10^2	10^{-2}	10^{-2}	10_{-1}
Evaluation of Stripping Efficiency	*Very Good*	*Very Good*	*Very Good*	*Excellent*

Residuals Generated

No solids are generated as a result of air stripping of volatile organics.

Secondary Environmental Impact

Air stripping has a potential air pollution problem associated with it. Existence of an actual problem depends on the geographical location (state, air quality region, etc.) of the stripper, the efficiencies of the stripper and the expected concentration of contaminant(s) in the influent water.

Previous Applications

Applications of the air stripping to removal of organic pollutants are numerous. Although treatment of contaminated groundwaters is a relatively new use for this technology, many groundwater treatment systems are now in full-scale operation.

O&M Requirements

Air stripping requires minimal operator attention, maintenance, and electricity. The tower itself contains no moving parts. Attention to mineral deposition and biological matting of the column packing will be required.

Interferences

It is improbable that any substance would interfere with air stripping of volatile organics. Reliability of air stripper operation can be a problem for installations where cold weather operation is required. Cold weather would decrease the driving force for volatilization. Heating the influent water may be required for winter operation or a shut down for the months of January, February and March may be considered.

Advantages

Volatile organic compounds such as trichloroethylene are efficiently removed by this process.

Disadvantages

State regulatory authorities may require air emission source registration and permitting. Requirement for vapor recovery may be imposed adding additional capital and operating expense. Based on the current groundwater concentration of volatile organics in the groundwater the concentration of tetrachloroethylene in stack may be of concern with an efficient stripper.

Time Frame

Delivery of a unit is possible after 90 days from the date of the purchase order. The equipqment could be operational within a further 150 days.

We propose to explore the option of treating the groundwater and returning it to the aquifer by obtaining the required permission from the USEPA to treat groundwater by air stripping to below the acceptable drinking water criteria and discharge that groundwater into the ground. We request that the USEPA define the terms under which infiltration of treated water will be allowed.

Cost

TABLE 11. CAPITAL COST ESTIMATE - AIR STRIPPING

Stripping Tower (Packed Tower)	*$30,000*	
Sumps	*6,000*	
Flow Meter	*6,000*	
Pipes, Valves, Specialties	*3,000*	
Feed Pumps	*9,000*	
Electrical at 12%	*5,400*	
Piping at 8%	*3,600*	
Instrumentation at 5%	*2,250*	
Site Work at 5%	*2,250*	
Excavation	*3,000*	
Subtotal	*$70,500*	*$70,500*
Contingency and Engineering at 25%		*18,000*
TOTAL CAPITAL COST		*$88,500*

TABLE 11A. ANNUAL COST ESTIMATE - AIR STRIPPING

Labor	*$3,000*	
Power at $0.05/kWh	*1,000*	
Chemicals	*0*	
Maintenance at 4% of Capital Cost	*2,500*	
TOTAL ANNUAL COST	*$6,500*	
$/1,000 gallons		*$0.15*

Suppliers

Groundwater Technology
Baron-Blakeslee, Inc.
Nepco-IT
Hydro Group. Inc.

ALTERNATIVE *MERRY-GO-ROUND AIR STRIPPER*

Description of Alternative

The groundwater from the Parella well will be pumped through a merry-go-round air stripper and a secondary biological reactor that will reduce the contaminant concentration from 250 ppm in the influent to below 5 ppb in the effluent. The water will then be infiltrated into the tetrachloroethylene contaminated soils on site to induce cleaning of the soils and leaching of the contaminants that will be intercepted by the cone of depression of the Parella well. In addition, there is the added opportunity to draw contaminants from the vapor space in the well - particularly if the well is not cased (open hole) above the the water level.

Data Needs

The data required to design and size the equipment is available.

Feasibility

The system has been operated with success at Pompey, New York at a National Priority Listed (NPL) site by the USEPA Emergency Response Division, Site Mitigation Section, Edison, New Jersey. The system was moved after two years upon completion of this groundwater cleanup and is now operating at American Thermostat NPL site in South Cairo, New York about 1 hours drive from the Wallkill site. The system is operating in the same fractured bedrock type of aquifer. The innovative system, designed by Robert Cobiella, the on-scene-coordinator (OSC) for the site, will in many respects supersede the conventional packed column. The packed column air stripper is a single air lift while the merry-go-round air stripper is a series of air stripping lifts. At each air stripping lift, air is entrained into the water stream and volatilizes the contaminant at a rate proportional to the Henry's Constant of the volatile contaminant and the temperature of the air and water.

The proposed system will consist of a series of 15 air lifts (Figure 20) that in series air strip the volatile contaminants in the well water. The yield of influent water from the Parella well is no more than 4 gpm and based on past sampling is expected to be initially at 250 ppm tetrachloroethylene, stabilizing at 95 ppm. However, as the the contribution from soil leaching begins to affect the groundwater captured the contaminant strength may increase to its initial value.

The air lift units will be piped in a merry-go-round arrangement that will take water from the well and from two 12,000 gallon central storage tanks. The water will be circulated through the series of air lifts and at each air lift experiences air stripping at approximately 65% removal efficiency. The air stripping lifts sum up to 99.8% removal of the volatile contaminant from the groundwater.

The removal percent follows a diminishing return curve, while the removal efficiency remains the same, the amount of contaminant removed decreases in proportion to the reduced total concentration to be treated such that the largest expense is incurred in reducing the concentration below 65% of the initial concentration.

Number of Air Lifts	*Summed Removal Percentage*	*Concentration*
1	*67.75%*	*250,000 ppb*
2	*71.54*	
3	*82.15*	
4	*88.39*	
5	*92.46*	
6	*95,10*	
7	*96.82*	
8	*97.93*	
9	*99.125*	
10	*99.43*	
11	*99.64*	
12	*99.76*	
13	*99.84*	
14	*99.9*	
15	*99.93*	*17.5 ppb*

In iron-rich shale formations above 0.5% iron, a practical limit of removal of 99.8% removal is determined by the entrainment of tetrachloroethylene upon iron flocculate that forms and fouls the system, but which can be overcome by allowing the iron floc to settle out and steep in the central storage tanks. The central storage tank is pH adjusted to pH 4. This adjustment will affect iron components of the pumps necessitating the purchase of more expensive acid resistant components made of aluminum and stainless steel. An alternative is to use a centrifugal impeller system in the flow system. Nutrients of basal salts and glucose in the form of Epsom salts at 0.1% Karo Syrup and pellet fertilizer at 1% of the flow are added to the central tank. The central tanks will be seeded with treatment plant sludge. The microbes in turn assimilate the tetrachloroethylene and iron and precipitate magnesium salts that will be filtered out with two down-draining sand filters arranged in parallel to allow for cleaning and maintenance.

Once the biological activity is established the bacteria will digest the remaining tetrachloroethylene and be disseminated into the contaminated soil. The glacial till is only moderately to poorly permeable. A simple french drain leaching field will be employed to disseminate the leaching water. This established nutrified and aerated bacterial colony will infiltrate into the soil in the same manner that the solvent did and will digest the tetrachloroethylene in the soil. The thrust of this method is to treat the contaminated soils on site by leaching and biological activity. A cap on the site will not be employed and surface water infiltration will be encouraged during treatment.

To operate the merry-go-round air stripper with 15 lifts, a 60 scfm air supply is required.

Lifts (gpm)	Water Flow scfm	Air Flow
1	4	4
2	4	8
3	4	12
4	4	16
•		
15	4	60

The airlift stripping system at American Thermostat has been fully operational since February 24, 1987. The current operation is unattended, running at a flow rate of about 3000 gpd. (The proposed Wallkill project will treat groundwater at 5700 gpd). Flows, pressures and vacuum controls are in a manually set balance. An automatic shutoff is operative to prevent overflow in the event of transfer pump failure. The system is checked twice a week by the Technical Assistance Team (TAT) or the OSC. Samples are taken periodically and analyzed by a commercial laboratory through a TAT special project fund. The latest available data shows raw water at 10,300 ppb tetrachloroethylene, and effluent water treated with a seven stage air stripper averaging 48 ppb, for a removal rate of 99.53%. Removal rates have ranged from 99.5 to 99.86% during the operation to date. With this system the influent groundwater concentration was reduced from 144,500 ppb to 2,000 ppb in 15 months. This system was not provided with the added enhancement of the secondary biological reactor.

To reach an effluent criteria of 5 ppb is a matter of increasing the number of air lifts to 15 employing biological polishing and incurring slightly higher power costs. Multistage airlift stripping can easily be scaled up to meet the needs of any groundwater/surface water/aquifer cleanup action. These multistage air strippers can be sized for flow rates up into the millions of gallons per day, and costs per gallon can reasonably be expected to be lower for larger systems than for the smaller ones, and also lower for longer remedial actions than for short term projects as the initial capital investment is offset by more gallons treated. Throughput capacities for multistage systems are slightly lower than the calculated flow capacity of a single airlift (12 to 15 times the cross-sectional area of the riser pipe in square inches = gpm), at least in the smaller size strippers. This system can be operated at about 10 gpm per square inch of riser pipe area. Air flow capacity per stage operates at about 1 scfm per gpm, yielding an air to water ratio per stage of 7.48 to 1. Laboratory reported removal rates for single lifts at this ratio were about 62-68%.

Robert Cobiella is available for clarification of the feasibility of the method. George Zachos, Section Chief of the Site Mitigation Section has offered their assistance to Mel Hauptman and Betty Martinovich, the technical staff on this project, monitoring the remedial effort.

Advantages

A full scale model has already been proven to be effective and has completed the treatment operation at an NPL site during which many design refinements were incorporated. We do not need to go to an established air-stripper manufacturer to have the system designed and fabricated. The air stripper can be fabricated on-site using plumbing supply plastic piping and shipper blowers and pumps. We may propose to build the Wallkill air stripper alongside the American Thermostat stripper so that this technology may be replicated easily. The system will be cheaper to construct than a packed-column air stripper and operates unattended for long periods of time. An Air 100 Permit was already obtained for the American Thermostat system and meeting the air discharge criteria were not a problem.

Sufficient information is in hand at this time to evaluate the field performance of the multistage airlift stripping technology. It is a high efficiency, low cost technique for purging volatile organic chemicals from water. It is effective, practical, operable, flexible, reliable, amenable to fabrication in the field at a scale tailored to the problem of the site and simple enough to be fabricated by readily available construction-level skilled tradesmen anywhere in this country. It can be fabricated of materials capable of withstanding high or low pH liquids. It will readily move viscous liquids or high solid content liquids. It has no moving parts in contact with the liquid being stripped and so is relatively free from the effects of abrasive materials.

Costs

The system is not an expensive proposition. At American Thermostat the cost as of April 1, 1987 for the groundwater treatment was $55,000 for the construction, fabrication, running-in and operation of the airlift system for the first month. The cost included a shelter building and all its internal and external component items. Total treated throughput in the first month as of April 1, 1987 was over 150,000 gallons of contaminated groundwater. The cost of the airlift stripping was 36¢ per gallon at this time. Projected system shut-down will be at the 300,000 gallons treated, and the cost at that time is forecast at $60,000 attributable to airlift stripping. Final cost per gallon for the completed action is thus expected to be about 20¢ per gallon.

For comparison purposes, the purification of 5.7 million gallons of groundwater at the Hicksville, L.I., New York site by a heated-feed, packed-column air stripper, admittedly a much more difficult to strip material (MEK), but also a much larger system, cost about 18¢ per gallon.

TABLE 11B. CAPITAL COST ESTIMATE
MERRY-GO-ROUND AIR STRIPPING

Multistage Stripper	*$15,000*	
Insulated Building/Sumps	*6,000*	
Flow Meter	*3,000*	
Pipes, Valves, Specialties	*1,000*	
Feed Pumps (2 blowers, 1 vac, 1 turbine)*	*7,000*	
Electrical at 12%	*2,500*	
Piping at 8%	*2,000*	
Instrumentation at 5%	*1,000*	
Site Work at 5%	*1,000*	
Excavation	*3,000*	
Subtotal	*$41,500*	*$41,500*
Contingency and Engineering at 25%		*8,000*
TOTAL CAPITAL COST		*$49,500*

TABLE 11A. ANNUAL COST ESTIMATE - AIR STRIPPING

Labor	*$3,000*	
Power at $0.10/kWh	*1,000*	
Chemicals	*0*	
Maintenance at 4% of Capital Cost	*2,500*	
TOTAL ANNUAL COST	*$6,500*	
$/gallons		*$0.15*

Suppliers

Fabrication - Local
Pumps - Fugi, NJ
Impeller - Wright-Austin, Detroit, Michigan
(dealer Koechlein, NJ 201 652-6274

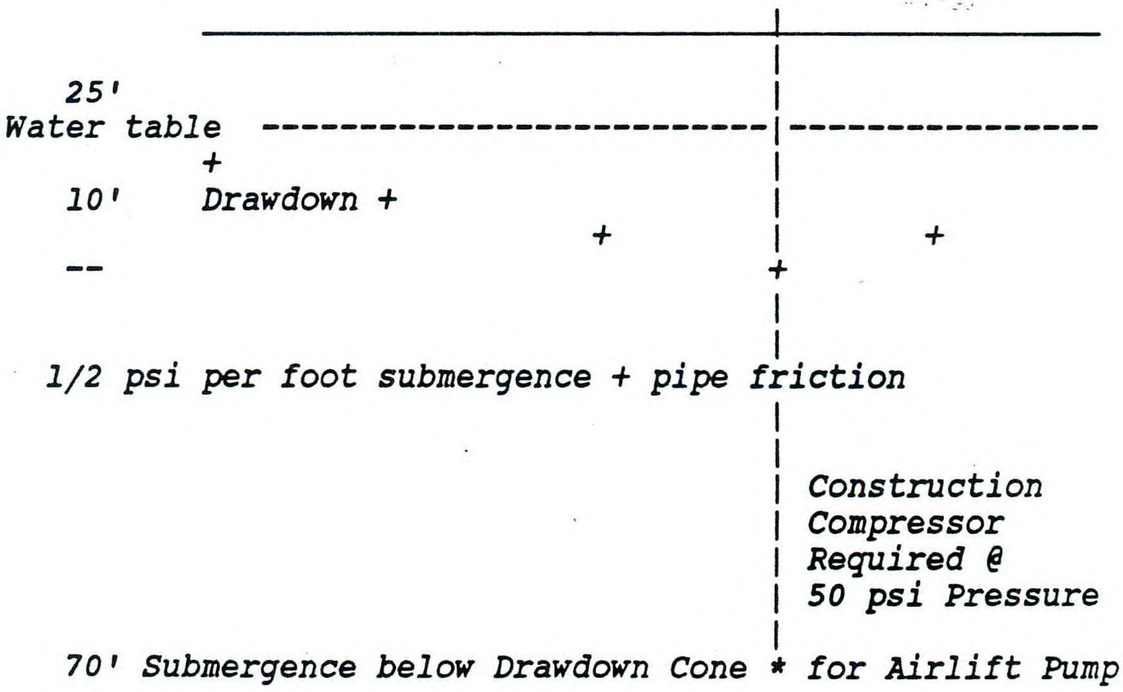
Appendix

Single Lift Capacities

	Flow gpm			
Diam "	*Max*	*Stable*	*3 lift*	*10 lifts*
.75	*6*	*4*	*3.5*	*1.8*
1	*8*	*6*		*7 lifts*
1.5	*12*	*8*	*6*	*6*
3	*50*			

The alternative of using an air lift pump to effect groundwater capture and lift the contaminated groundwater from the Parella well is rejected. A normal turbine pump will be used. While air lifting the groundwater will effect an initial 35% removal of volatiles the power cost of using an airlift pump is twice that for a turbine pump. The cost of air compression to lift water is expensive incurred in the loss of energy through heat production during compression. Air lift pumps are only 35% efficient per kwh compared to 70% efficiency for deep well turbine pumps.

Air lift pumps require a specific submergence to operate that is twice the drawdown depth from the surface below the bottom of the drawdown cone developed during pumping.



```
                                                                                  I Vapor out
                                                                                |
                                                                                |
                                          _____________Vapor Collection Header__|
                                          |         |         |         |
                                          |         |         |         |
              Air pump                    |         |         |         |
              a+++++++++++++++++++++++++++|+++++++++|+++++++++|+++++++++|++
                       Air lift series  _a| +     _a| +     _a| +     _a| +
                                        | | +     | | +     | | +     | | +
                                        | | +     | | +     | | +     | | +
                                        | | +     | | +     | | +     | | +
                                        | |<b     | |<b     | |<b     | |<b Air injection         General Switch
                                        | |_______| |_______| |_______| |__________Treated Water to injection >_|
Ground surface__________________________|_______________________________________________________________________|_______
                    Contaminated Water  |                                                                       |
          25'                 from well |                                                     |||||||||||||||||||
Water table  ---------------------------|---------------------------------------------------  \\Leaching Field\\\+
               +                        |                                + Contaminated soil ///////////////////
          20' Drawdown +                |                 +                                \\\\\\\\\\\\\\\\\\\\
                                 +      |       +                              /////////////////////////////
          --                            +        \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
                                        |     /////////////////Plume Capture/////////////////////////
                                        a \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
          10' Submergence below Drawdown Cone for Turbine Pump
```

Figure 20: Multistage Airlift System (without central storage tanks)

AIR STRIPPER DESIGN CRITERIA QUESTIONAIRE

SOURCE OF WATER: ______________________________
CONTAMINANT(S) ______________________________
CONCENTRATION ______________________________ *ug/l*
SUSPENDED SOLIDS ______________________________
IN WATER? ______________________________
CONCENTRATION? ______________________________
BATCH/CONTINUOUS ______________________________
VOLUME REQUIRED? ______________________________
PACKING PREFERENCE: ______________________________
STAINLESS STEEL, ______ *PLASTIC,* ______
NEED RECOMMENDATION ______________________________
FOLLOWING ANALYSIS ______________________________
WATER SAMPLES ______________________________
DISCHARGE LEVEL ______________________________ *PPB/PPM*
PROPOSED LOCATION ______________________________
HEATED/AT CONSTANT ______________________________
TEMPERATURE? ______________________________
PRESSURIZED AIR ______________________________
AVAILABLE? ______________________________
WHAT PSI AT ______________________________
WHAT CFM? ______________________________
ELECTRICAL POWER __________ *VAC,* __________ *AMPS AT 60 HZ*
SPACE AVAILABLE ______________________________
OVERHEAD CLEARANCE ______________________________
FOOTINGS AVAILABLE ______________________________

3.4 DRAINAGE DIVERSION

- *COLLECT ROOF DRAINS*
- *PROVIDE RUN-OFF DIVERSION*

ALTERNATIVE *REROUT YARD DRAINAGE AND COLLECT ROOF DRAINS OF GENERAL SWITCH*

Description of Alternative

In this alternative, the roof drains from the General Switch property will be totally rerouted so as to prevent surcharging of the areas of soil contamination. This alternative will only be employed to complement soil solidification. The down spouts of the roof drains will be collected in a inclined header pipe tied to the side of the building that carries the rainwater to the end of the building to discharge in an area where there is no soil contamination. Yard drainage will be directed away from these areas by using swales in the topography of the yard.

Feasibility

This alternative is a low-cost method of reducing the potential for leachate generation caused by percolation of water in the perched water system through the contaminated soil.

Costs

TABLE 12. CAPITAL COST FOR ROOF DRAIN INTERCEPTION

Piping	*$3,600*
Site Work	*2,250*
Excavation	*3,000*
TOTAL CAPITAL COST	*$8,850*

TABLE 13. SUMMARY COSTS

SOIL SOLIDIFICATION/PUMPING TO POTW

o	CONDUCT PUMP TEST ON PARELLA WELL	$4,000
o	CONDUCT SOLIDIFICATION TESTING	$2,000
o	OBTAIN FINAL COSTS / PROVIDE EPA/NYDEC FEASIBILITY ASSESSMENT REPORT	$7,000
o	SOLIDIFY TOP 4-6 FEET OF SOIL TO PROVIDE CAP FOR HOT-SPOTS	$70,750
o	IMPLEMENT PUMPING OF PARELLA WELL TO POTW	$17,500
o	REROUTE ROOF DRAINS & PROVIDE RUN-OFF CONTROL	$8,500
	TOTAL CAPITAL COST	$109,750
	TOTAL ANNUAL COSTS	
o	SOIL SOLIDIFICATION	$2,500
o	WELL PUMPING	$6,500
o	PUMPING INTO SEWER	$6,500
	TOTAL ANNUAL COST	$15,500

TABLE 14. SUMMARY COSTS

MERRY-GO-ROUND AIR STRIPPER & ACTIVE SOIL LEACHING

o	*CONDUCT PUMP TEST ON PARELLA WELL*	*$4,000*
o	*OBTAIN FINAL COSTS / PROVIDE EPA/NYDEC FEASIBILITY ASSESSMENT REPORT*	*$7,000*
o	*PUMP PARELLA WELL THROUGH MERRY-GO-ROUND AIR STRIPPER*	*$49,500*
	INFILTRATE TREATED WATER INTO SOIL HOT SPOTS	*$6000*
	TOTAL CAPITAL COST	*$66,500*
	TOTAL ANNUAL COSTS	
o	*WELL PUMPING*	*$6,500*
	AIR STRIPPING	*$6,500*
	TOTAL ANNUAL COST	*$13,000*

TABLE 15. SUMMARY COSTS

SOIL SOLIDIFICATION/PUMPING THROUGH AIR STRIPPER

o	CONDUCT PUMP TEST ON PARELLA WELL	$4,000
o	CONDUCT SOLIDIFICATION TESTING	$2,000
o	OBTAIN FINAL COSTS / PROVIDE EPA/NYDEC FEASIBILITY ASSESSMENT REPORT	$7,000
o	SOLIDIFY TOP 4-6 FEET OF SOIL TO PROVIDE CAP FOR HOT-SPOTS	$70,750
o	PUMP PARELLA WELL TO TREATMENT PLANT OR THROUGH AIR STRIPPER	$88,500
o	REROUTE ROOF DRAINS & PROVIDE RUN-OFF CONTROL	$8,500
	TOTAL CAPITAL COST	$180,750
	TOTAL ANNUAL COSTS	
o	SOIL SOLIDIFICATION	$2,500
o	WELL PUMPING	$6,500
o	AIR STRIPPING	$6,500
	TOTAL ANNUAL COST	$15,500

Shakti Consultants, Inc.

Figure 1. Site Location Map - General Switch

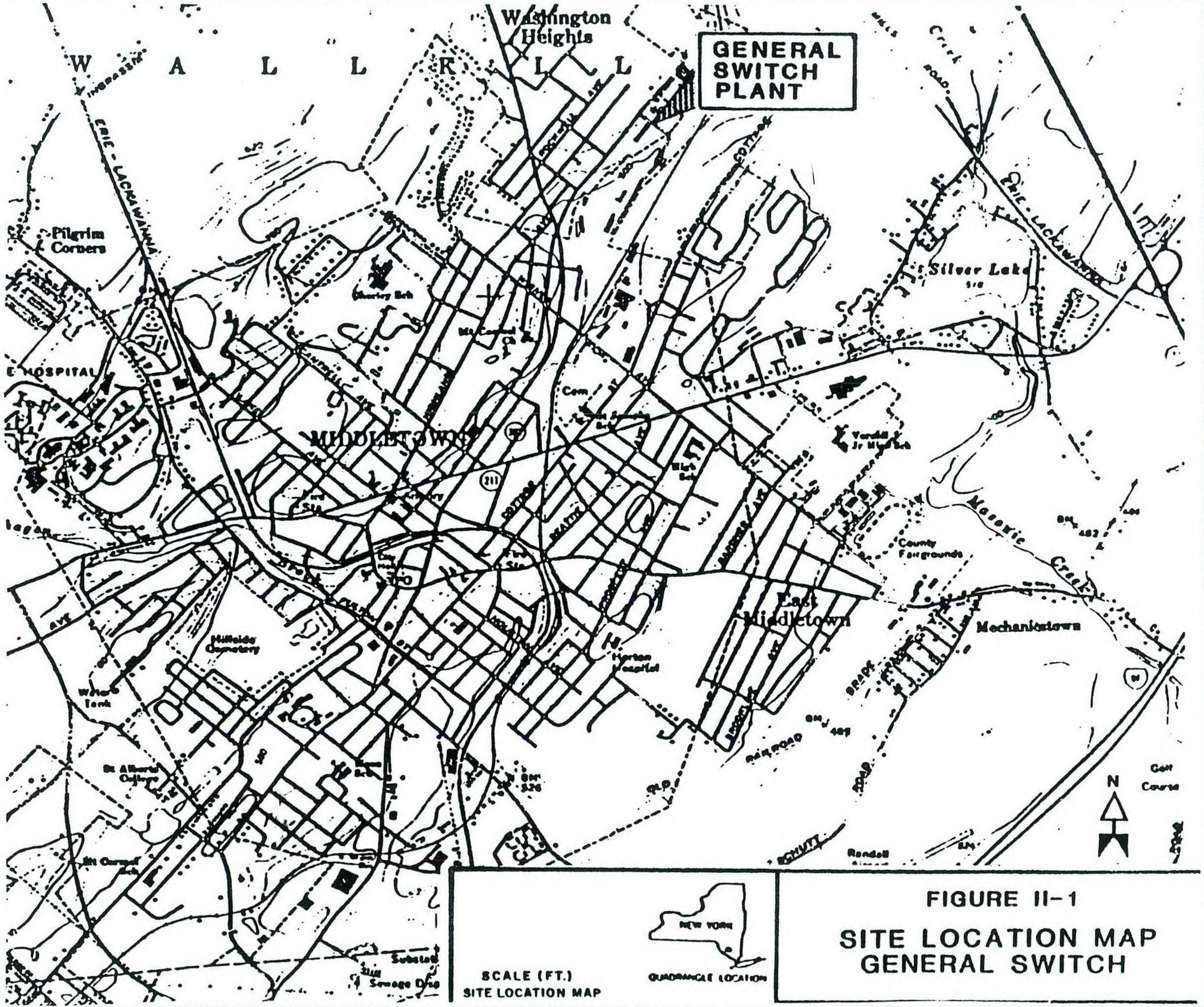
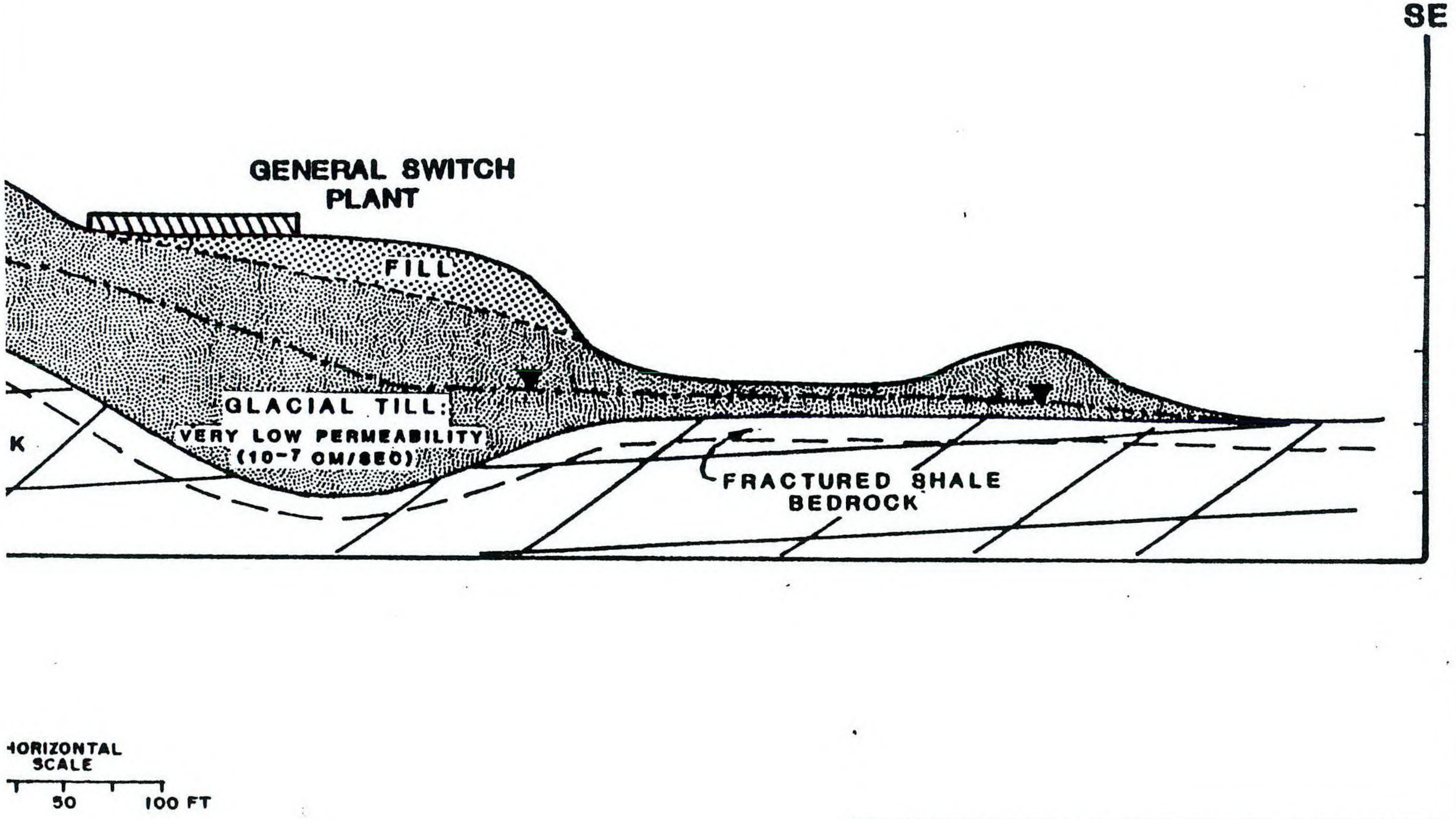


FIGURE II-1

SITE LOCATION MAP
GENERAL SWITCH

Figure 2. Generalized Cross Section - General Switch

Shakti Consultants, Inc.



N BEDROCK LIMITED TO
OOT CORE

FIGURE IV-1

GENERALIZED
GEOLOGIC CROSS-SECTION
GENERAL SWITCH

FRED C. HART ASSOCIATES, INC.

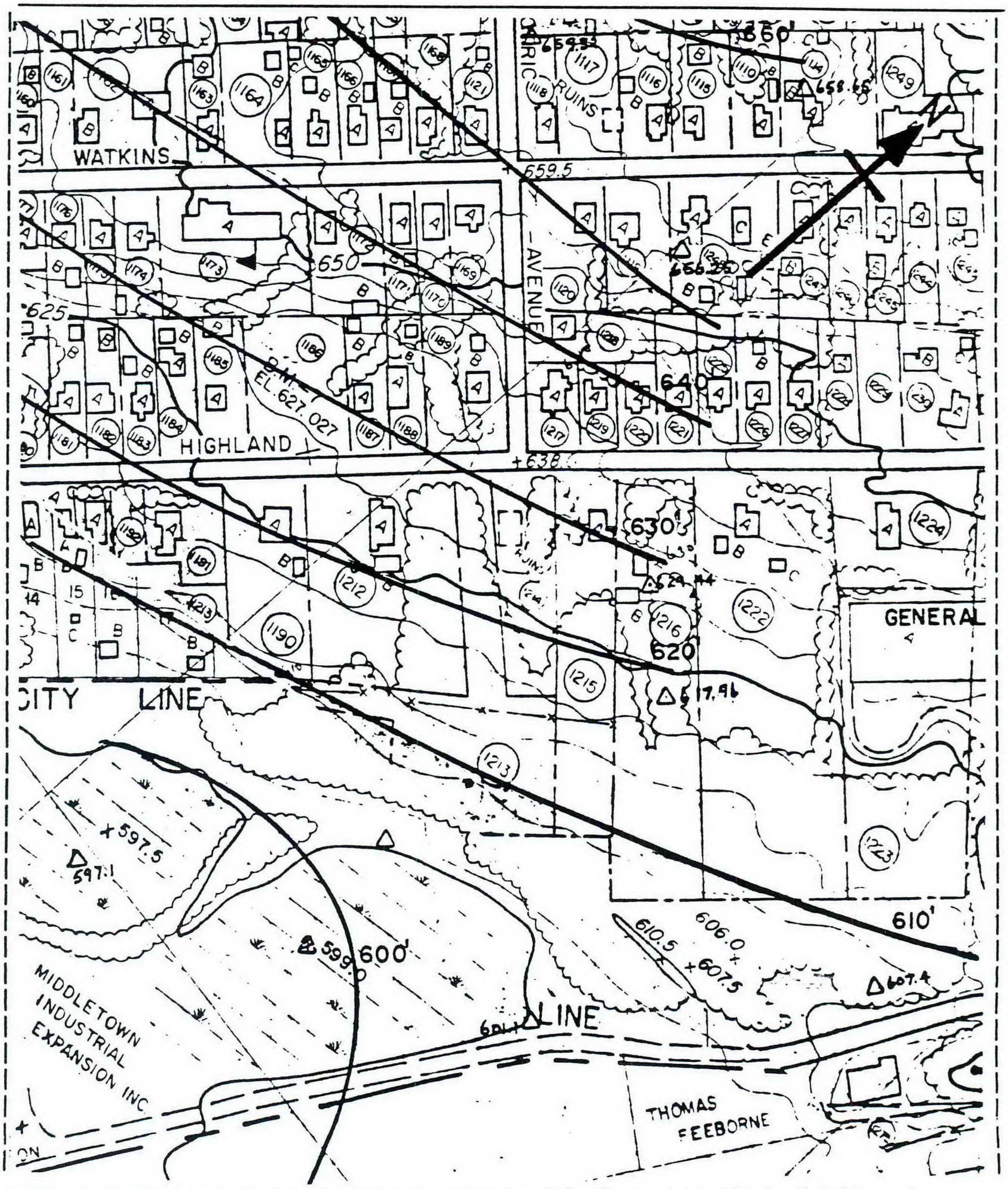


Figure 3. Water Table Elevations in the Glacial Till, Jan 1984

Shakti Consultants, Inc.

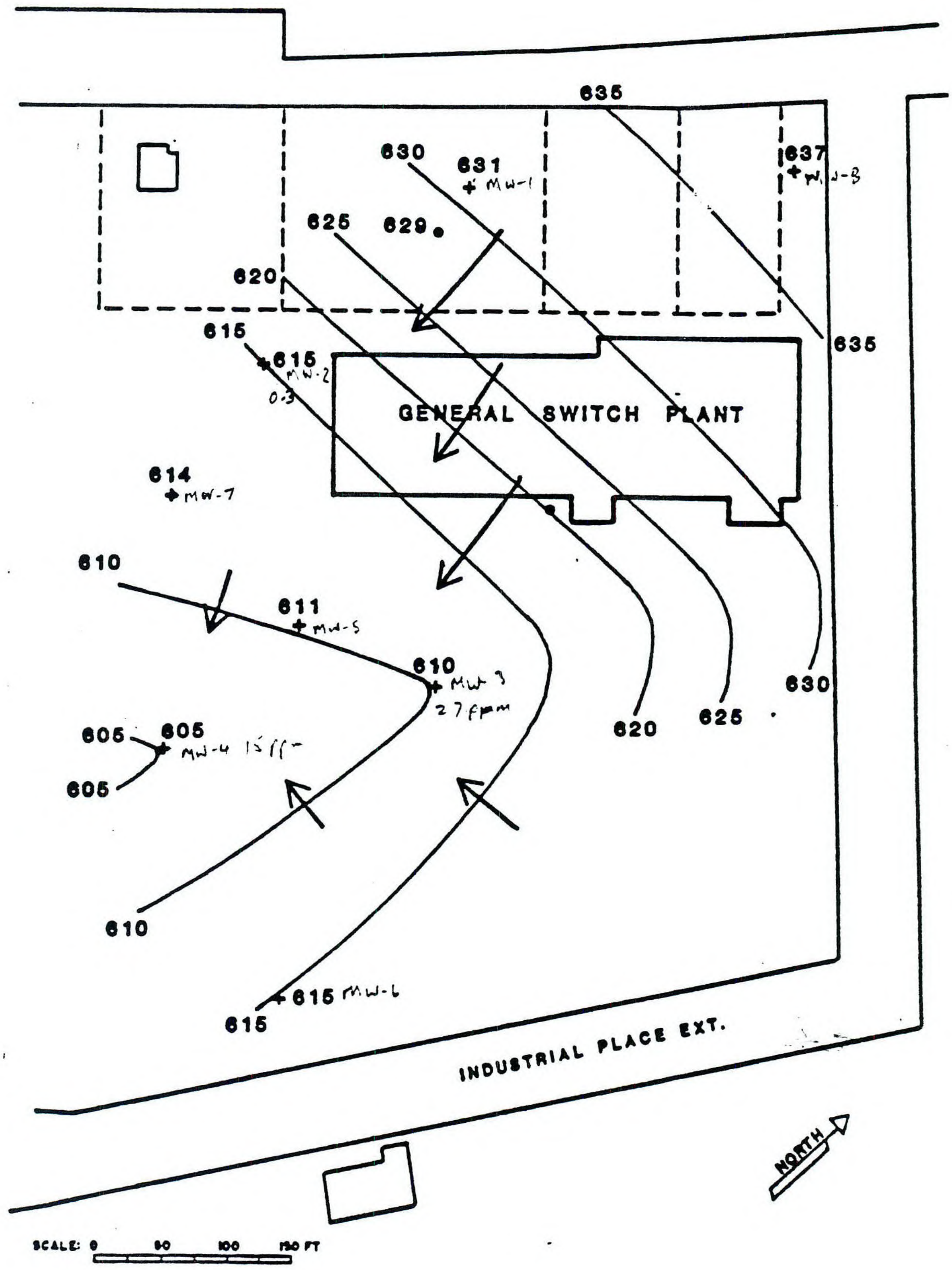


Figure 4. Contour Map of Water Levels - General Switch

Shakti Consultants, Inc.

LEGEND

●	WATER LEVELS MEASURED IN WELLS OPEN TO BASE OF SHALLOW TILL AND TOP OF SHALLOW BEDROCK
610 —— 610	CONTOUR OF WATER LEVELS MEASURED 9-14-84
→	POTENTIAL FLOW DIRECTION

CONTOUR INTERVAL = 5'

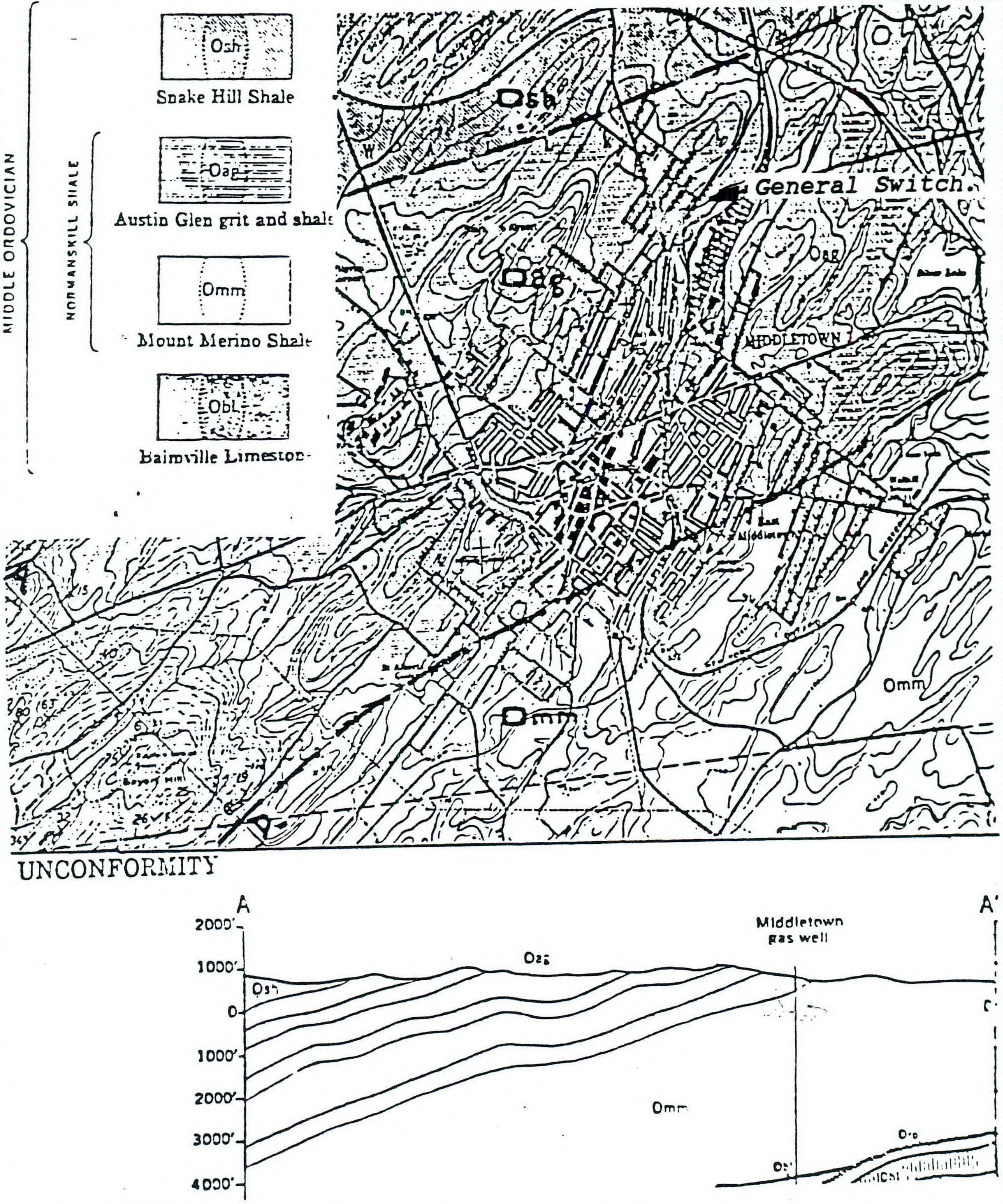


Figure 5. Geologic Map and Cross Section

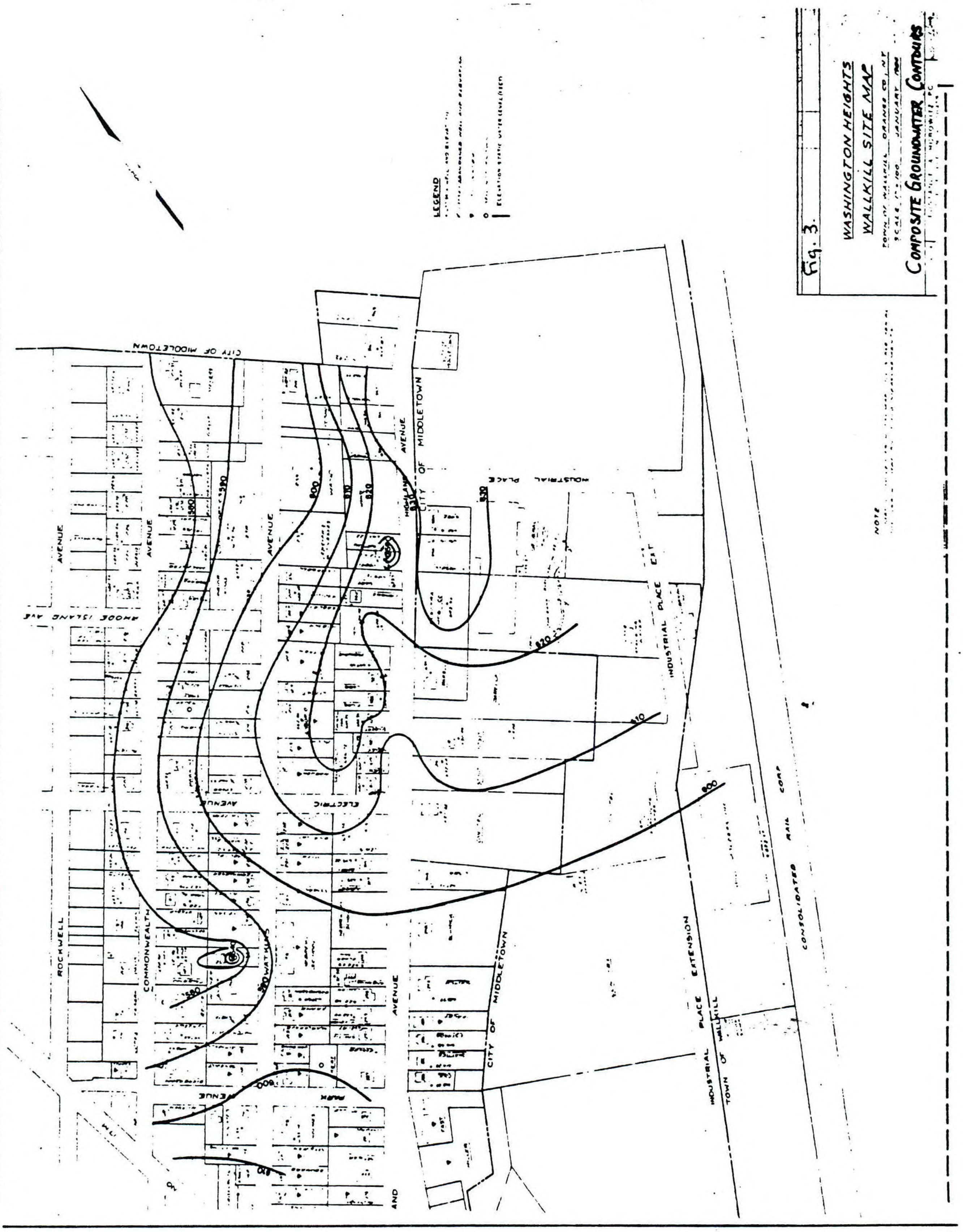


Figure 6. Composite Groundwater Contours - Washington Heights

Shakti Consultants, Inc.

Figure 1. Levels of Tetrachloroethylene (ppb) in the Parella Well during Pumping. Oct. 17-Dec. 26, 1983

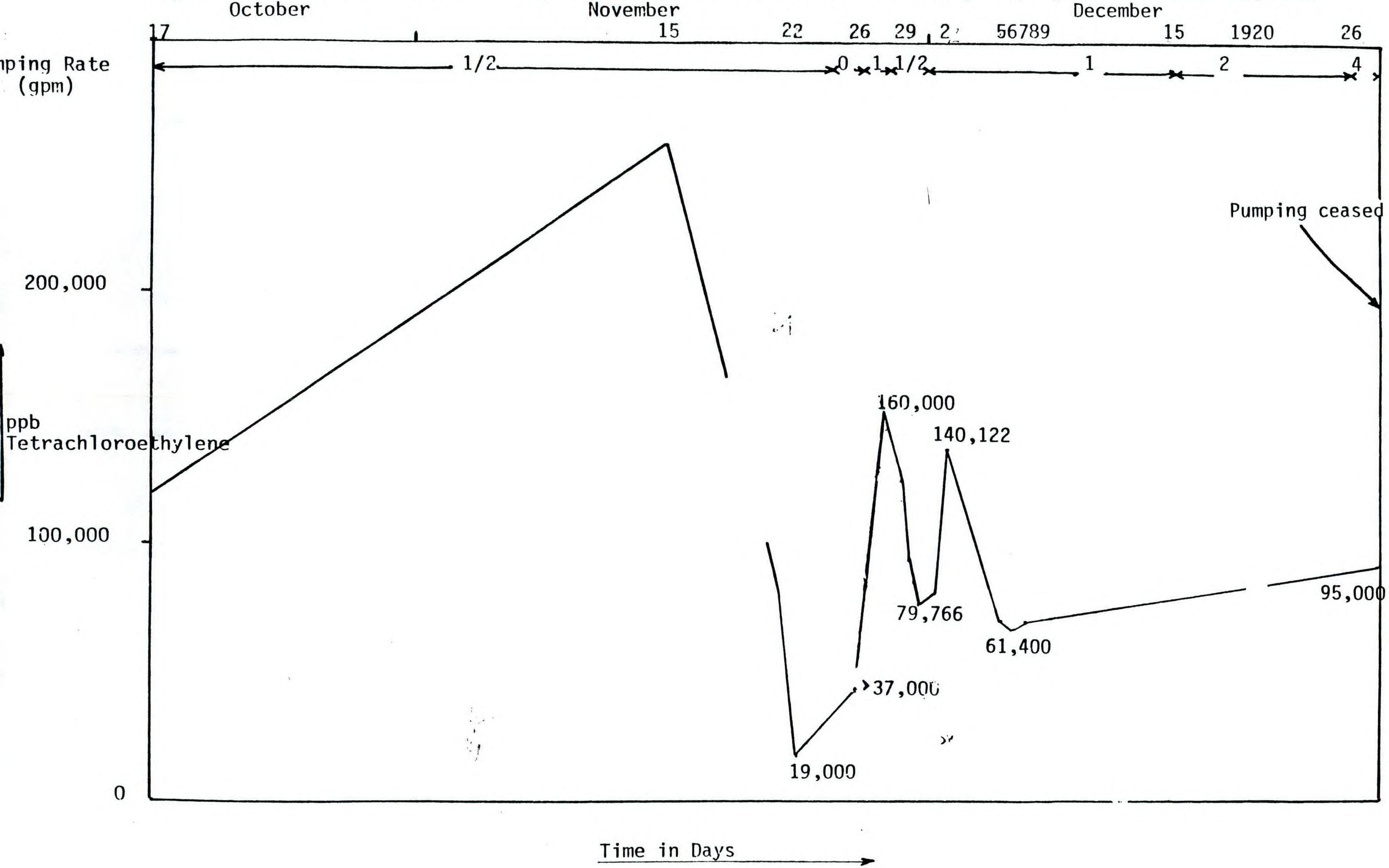
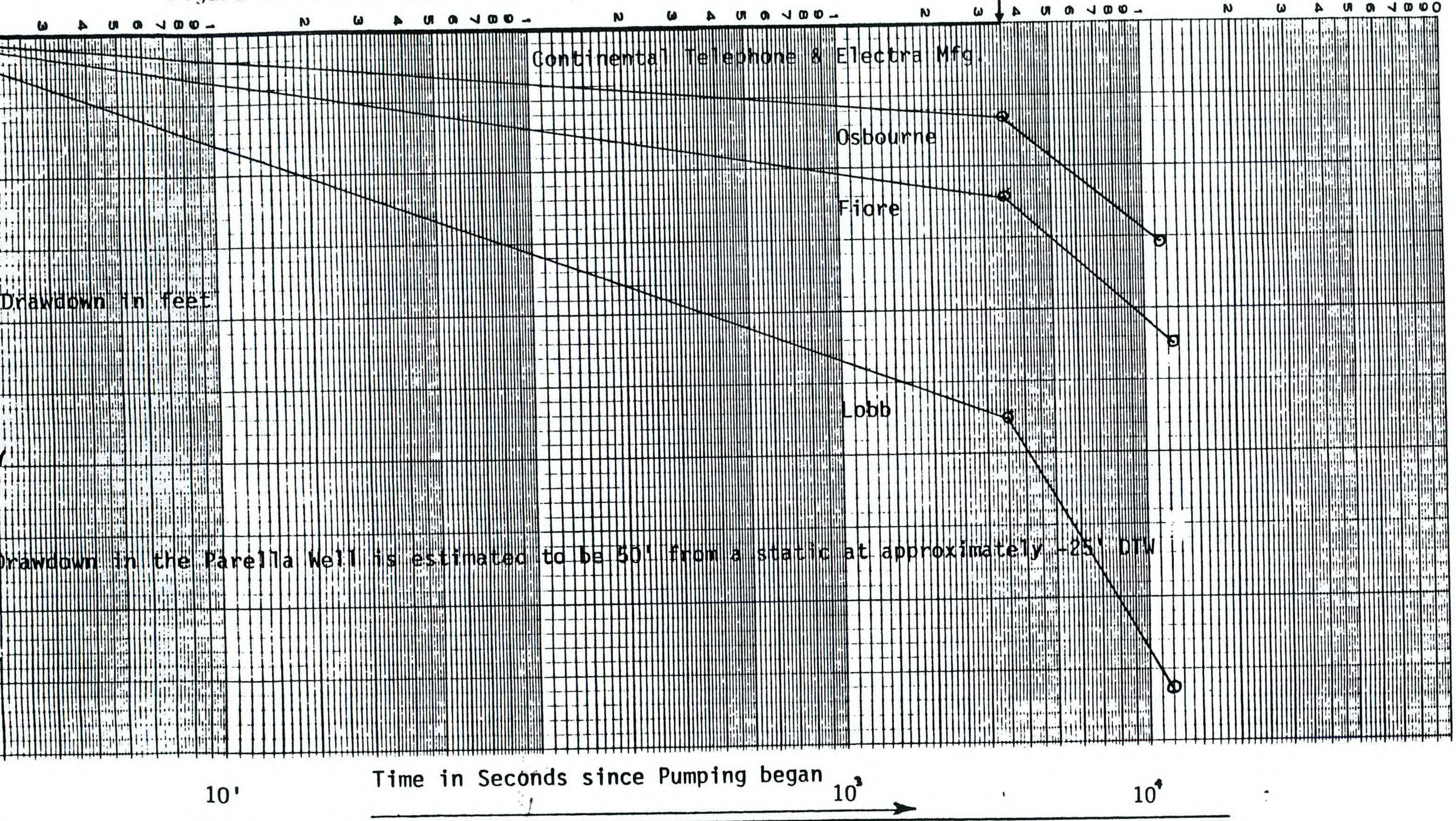


Figure 2. Plot of Data from Pump Test 1. Parella Well



rawdown in the Parella Well is estimated to be 50' from a static at approximately -25' DTW

Figure 8. Plot of Data from the Pump Test 1. Parella Well

Shakti Consultants, Inc.

Table 1: Parella Pump Test #1

Time Of Reading Flow Rate		1495-1500 hr. Static	1610-1630 hr. 4 gpm	1656-1730 hr. 4 gpm	End Of Test
Residences/Well	Distance In Feet From Parella Well	Water Levels Measured In Ft. From Top Of Casing			Total Draw-Down
Parella Well					50'*
Osbourne	185'	26.94'	30.33'	34.55'	7.61' = 34.55-26.94
Lobb	144'	25.81'	39.68'	49.00'	23.19' = 49.00-25.81
Fiore	150'	22.28'	28.37'	33.45'	11.17' = 33.45-22.28
Electra Mfg.	194'	10.38'	10.36'	10.40'	.02 = 10.40-10.38
Continental Telephone	350'	21.35'	21.37'	21.53'	.18 = 21.53-21.35

Table 2: General Switch Pump Test #1

2/2/8

Time Of Reading Flow Rate		Static t_o = 12:13 2 gpm	13:53 - 14:21 2 gpm	16:26 - 16:40 2 gpm	End Of Test
Residences/Well	Distance In Feet from General Switch	Water Level In Feet From Top Of Casing			Total Draw-Down
General Switch	0	13.79'	>300'	>300'	>286'
Parella	370'	23.58'	23.92'	26.16'	-2.58
Osbourne	490'	32.61'	32.94'	34.56'	-1.95
Electra Mfg.	210'	13.70'	13.61'	13.59'	+ .11**
Perry	370'	65.72'	62.04'	59.13'	+6.59
Continental Telephone	670'	23.13'	23.1'	23.13'	0
Ward	650'	79.97'	79.15'	78.83'	+1.14
Pitt	580'	33.98'	33.98'	34.05'	-.07
Perez	260'	15.82'	15.80'	16.02'	-.2
Guild Molders	1040'	7.96'	7.94'	7.94'	+.02

*Estimated at the elevation of the pump when the Parella well lost suction.

**Positive values indicate a well that is recovering.

Table 3: Ruppert Pump Test #1

		Static E0=11:15	12:00-12:35	13:46-14:18	End Of Test
Time Of Reading Flow Rate		11:05-11:15	11 gpm-6gpm	2 gpm	
Residences/Well	Distance In Feet From Ruppert Well		Water Level In Feet From Top Of Casing		Total Draw-Down
Ruppert	0	Approx 33'	180'	180'	-147'
Barry	50'	32.78'	37.95'	42.05'	-42.05'
Continental Telephone	290'	23.07'	23.55'	23.70'	-.63'
Knapp	250'	43.40'	42.32'	42.62'	+.78'
Van Pelt	310'	30.27'	29.2'	28.87'	+1.4'
Stout	400'	18.00'	18.00'	18.26'	-.26'
Robaina	270'	37.26'	37.55'	37.76'	-.5'
Estrada	480'	24.21'	24.21'	24.33'	-.12'
Morse	420'	111.13'	109.17'	107.94'	+3.19'
Rassmussen	360'	44.47'	44.50'	44.74'	-0.27'
Winner	480'	73.98'	70.16'	67.85'	+6.13'
Palermo	600'	81.53'	79.44'	77.94'	+3.59'

*Water levels at pump intake by assumption when pump broke suction: Well annulus blocked preventing direct water level measurement.

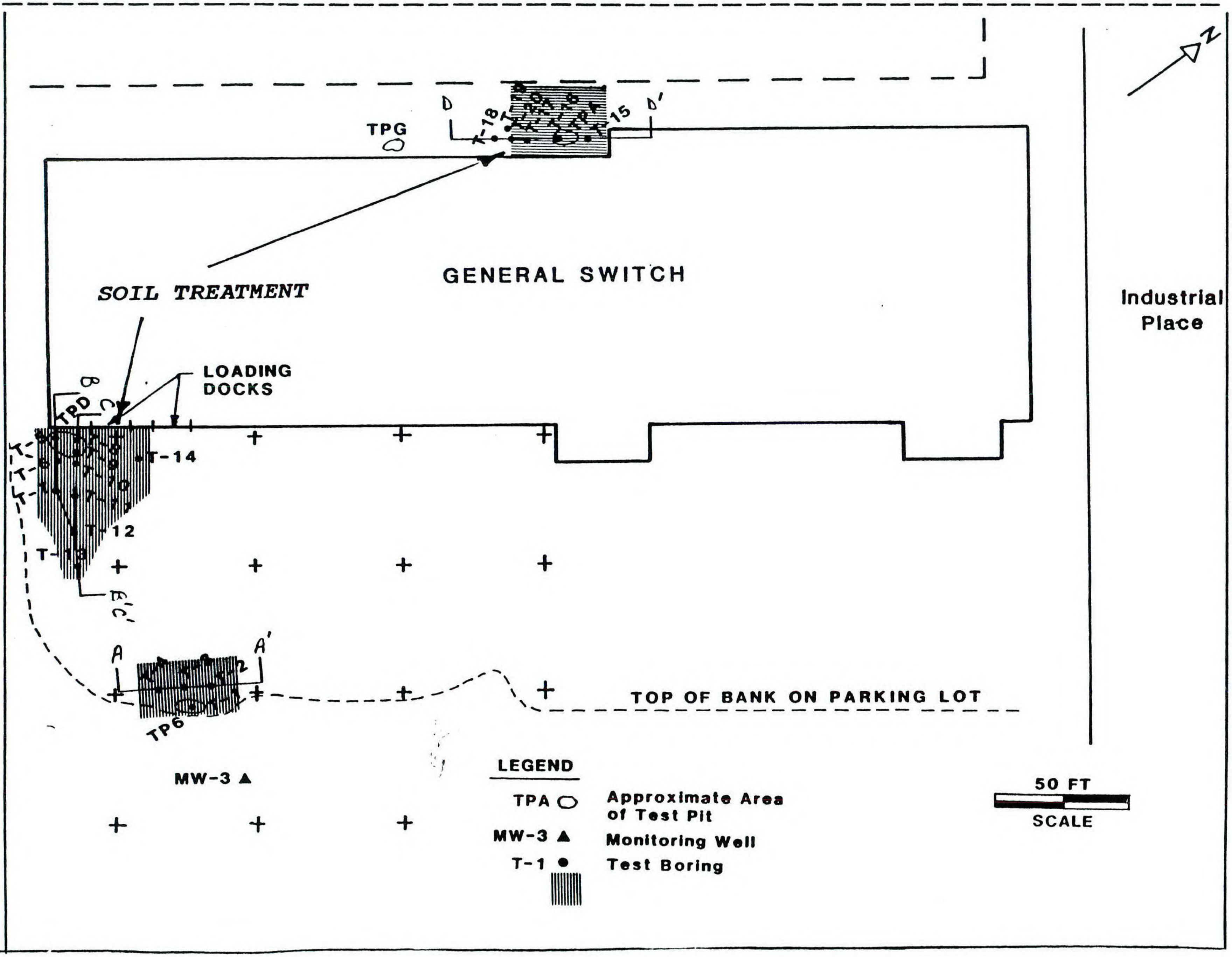


Figure 9. Location of Test Borings and Areas for Soil Treatment

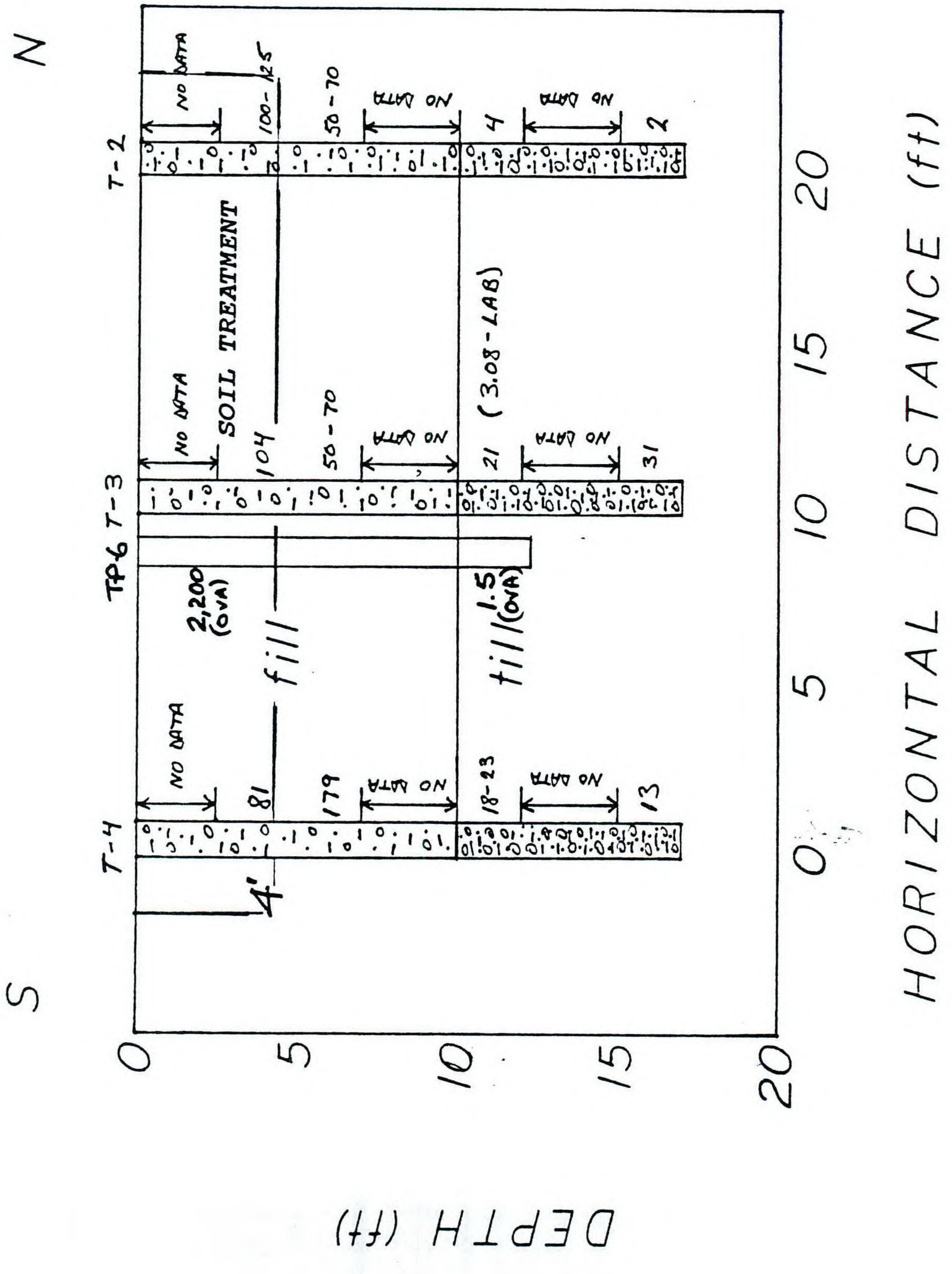


Figure 10. Cross-Section: Analytical Data & Depths for Soil Treatmen

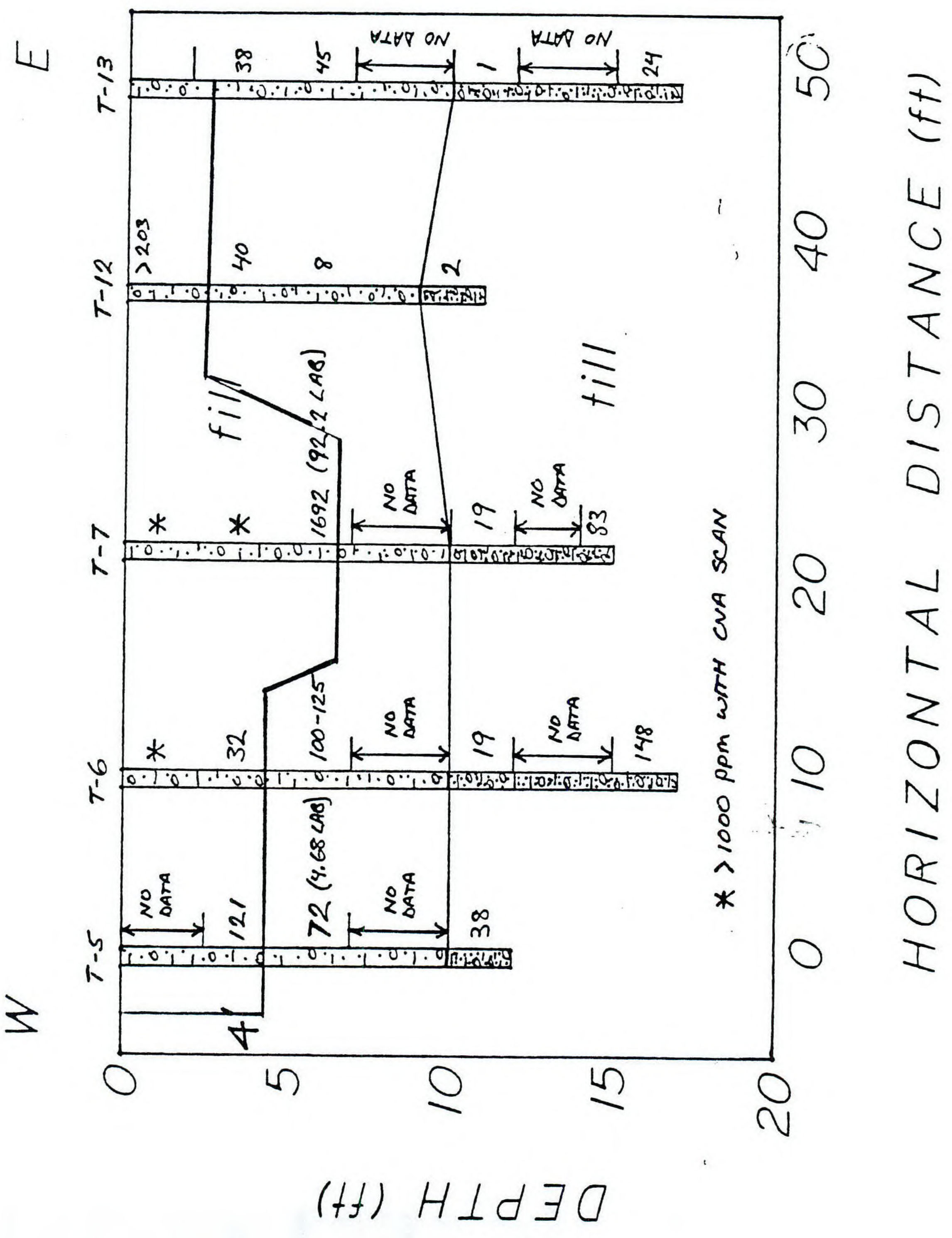


Figure 11. Cross-Section: Analytical Data & Depths for Soil Treatmen

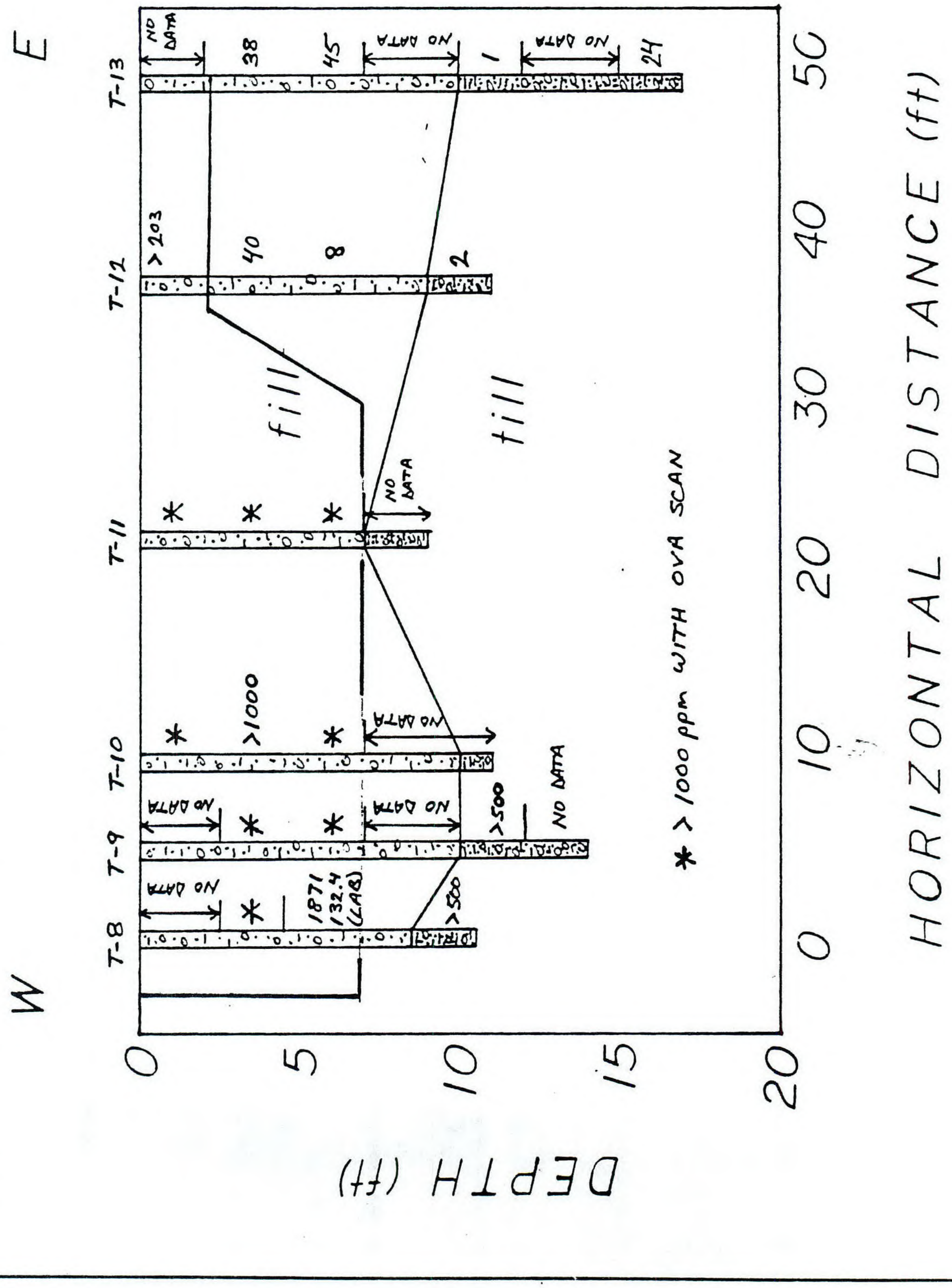
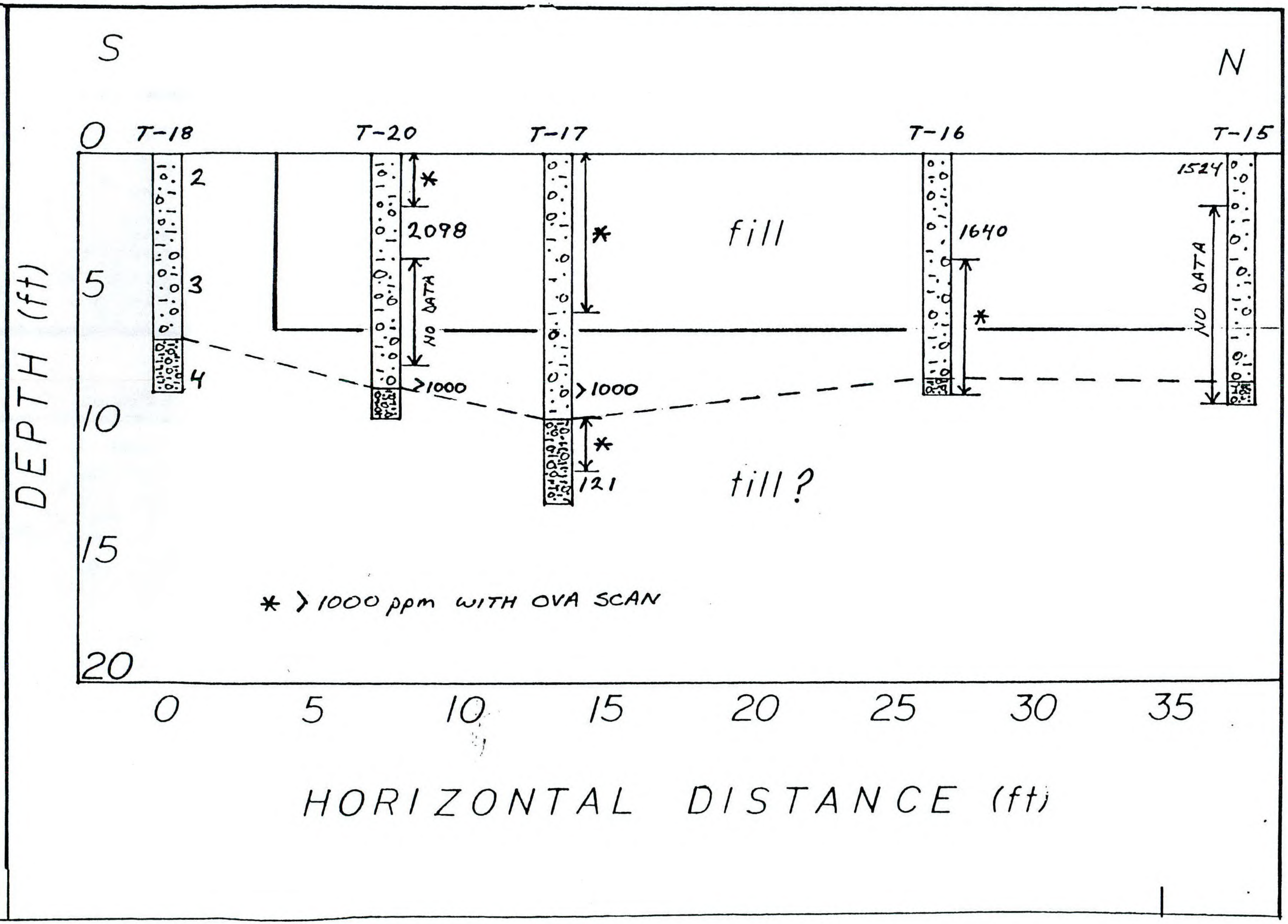


Figure 12. Cross-Section: Analytical Data & Depths for Soil Treatment


S
N
T-18
T-20
T-17
T-16
T-15
0
5
10
15
20
DEPTH (ft)
2
3
4
*
2098
NO DATA
>1000
*
>1000
*
121
fill
till?
1640
*
1524
NO DATA
* >1000 ppm WITH OVA SCAN
0
5
10
15
20
25
30
35
HORIZONTAL DISTANCE (ft)

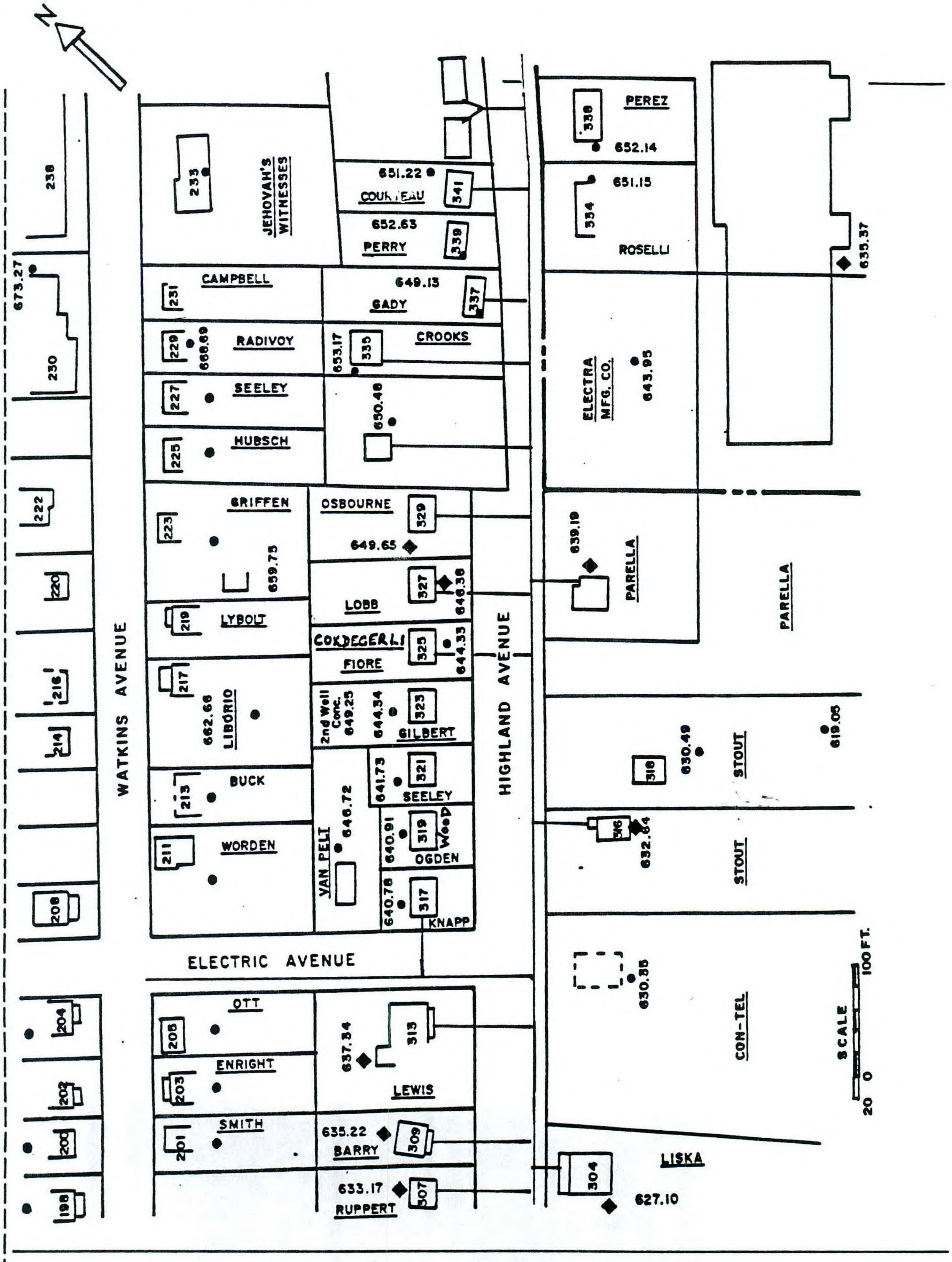
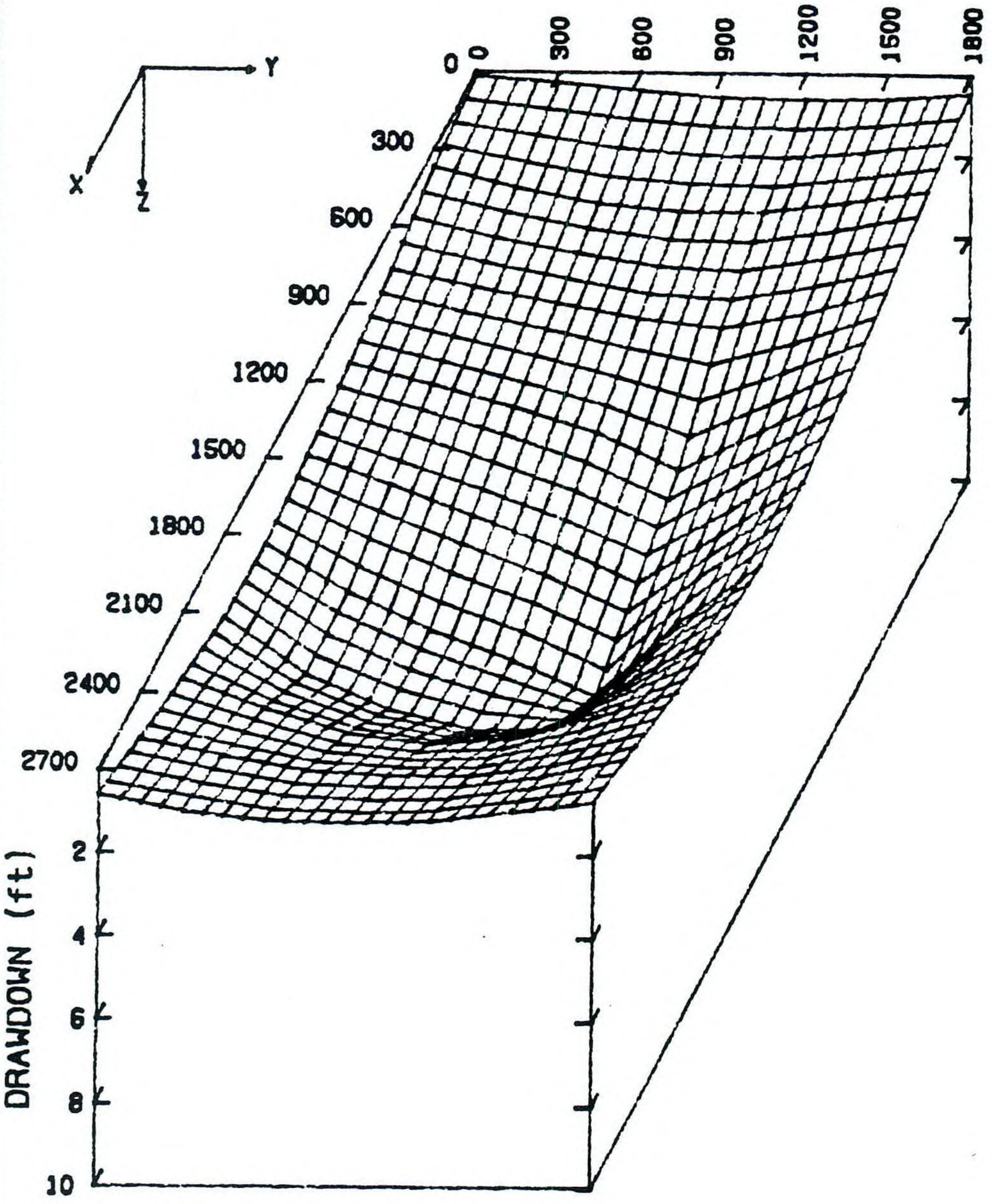
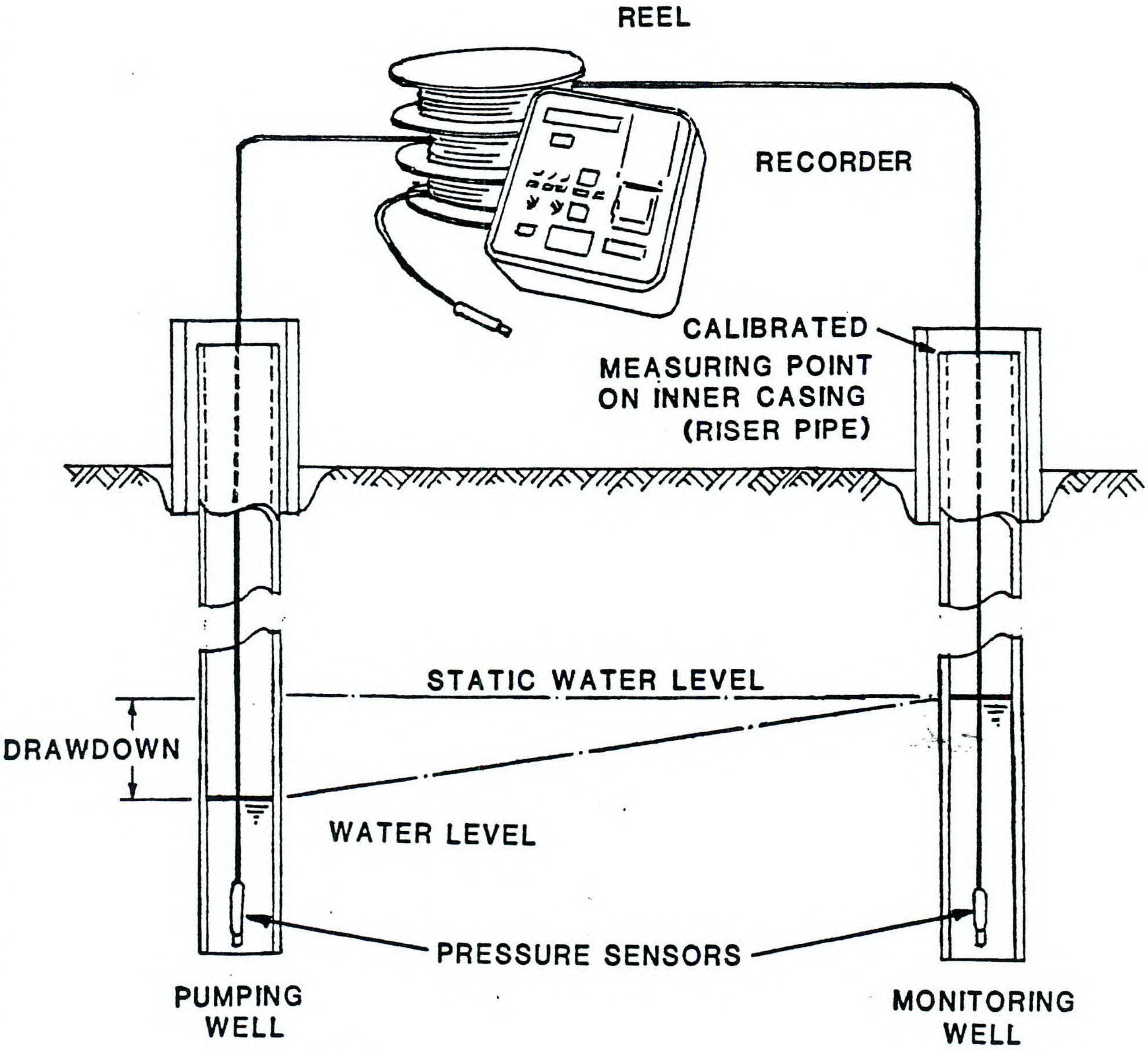


Figure 14. Location of Contaminated Wells & Water Supply Lines

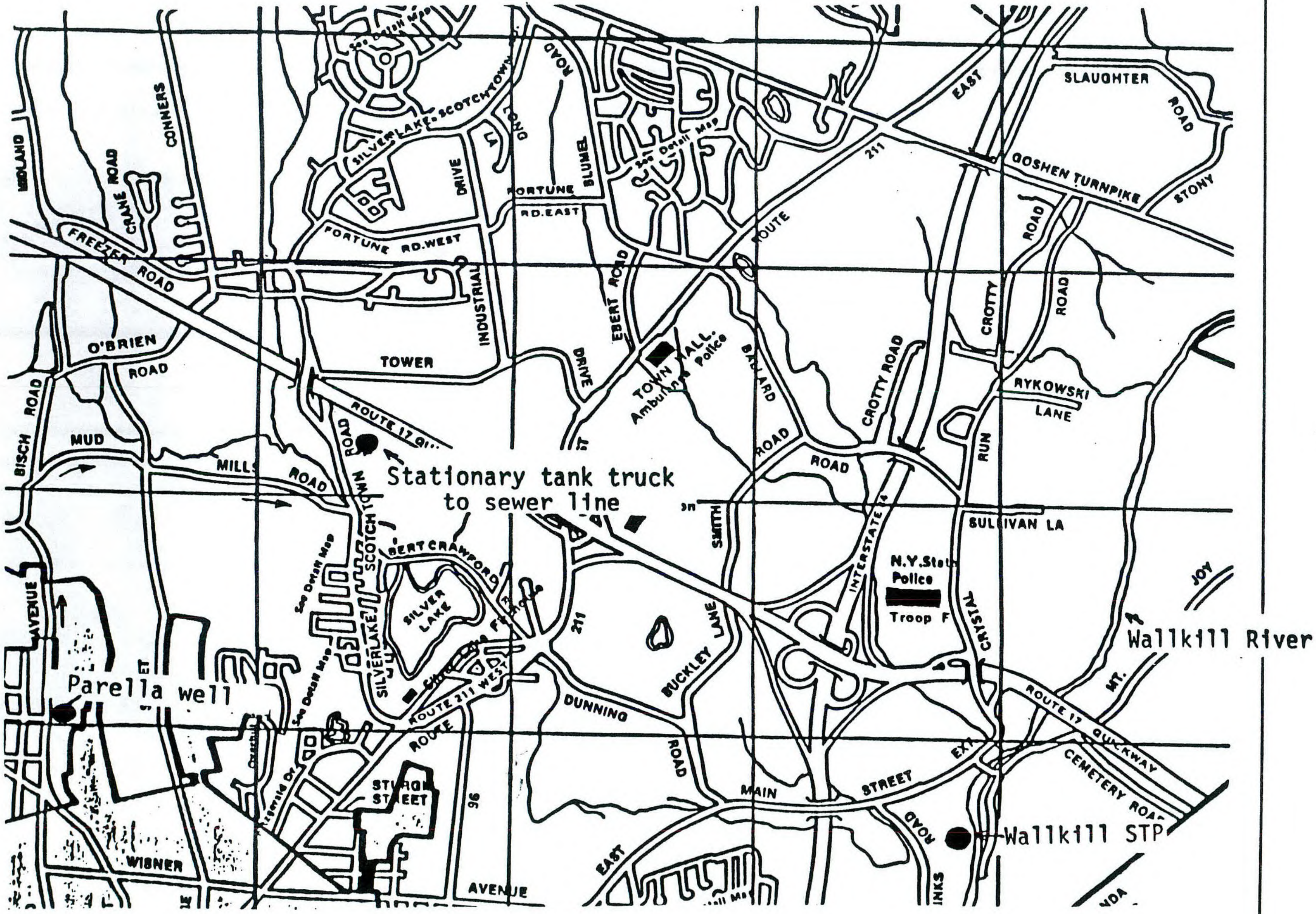


GROUNDWATER LEVEL AFTER 5 YEARS OF PUMPING

NOTE: SCALE OF X AND Y AXES DIFFERS
FROM THAT OF Z AXIS



PRESSURE TRANSDUCERS



Stationary tank truck to sewer line

Parella well

Wallkill River

Wallkill STP

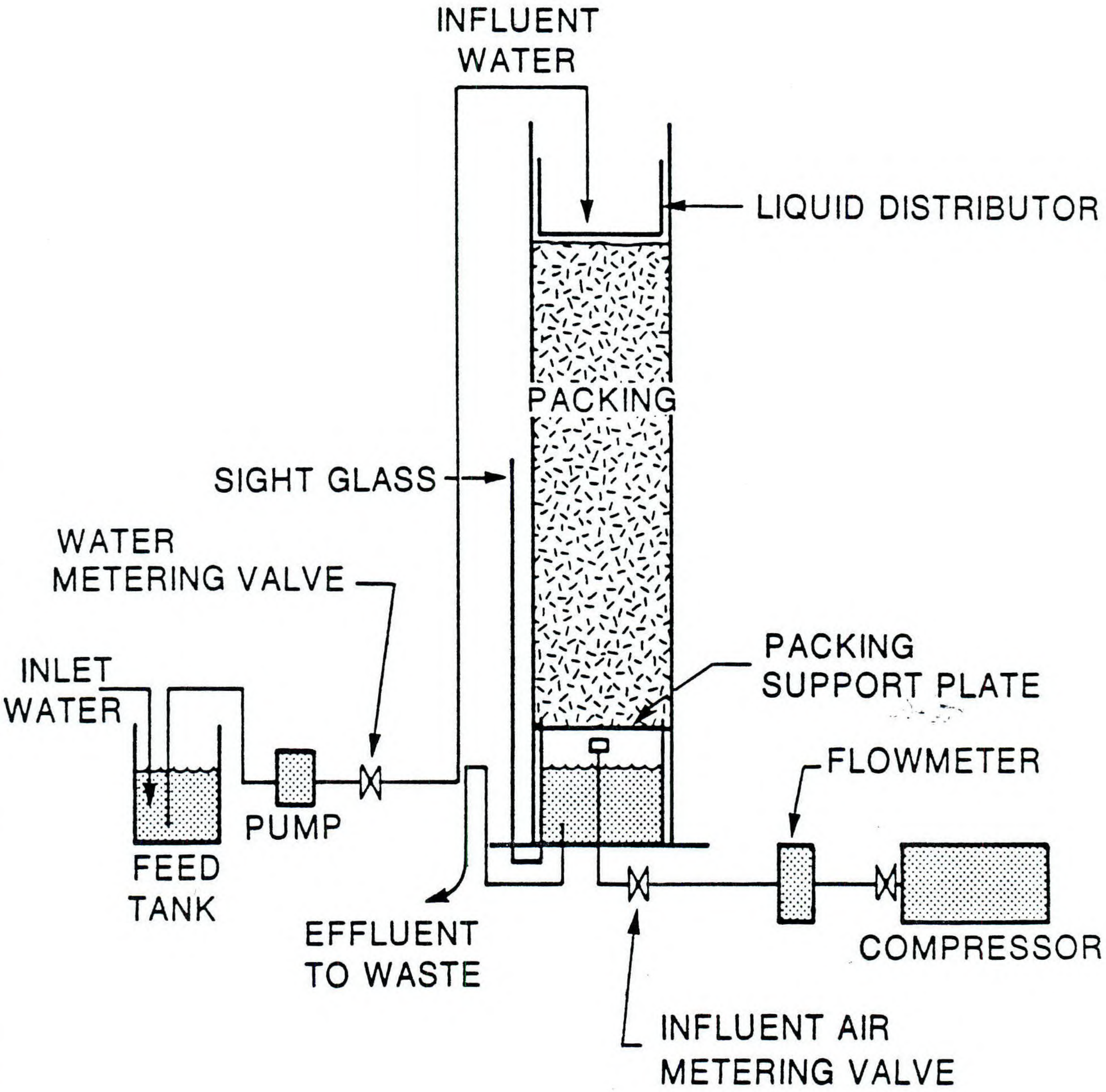
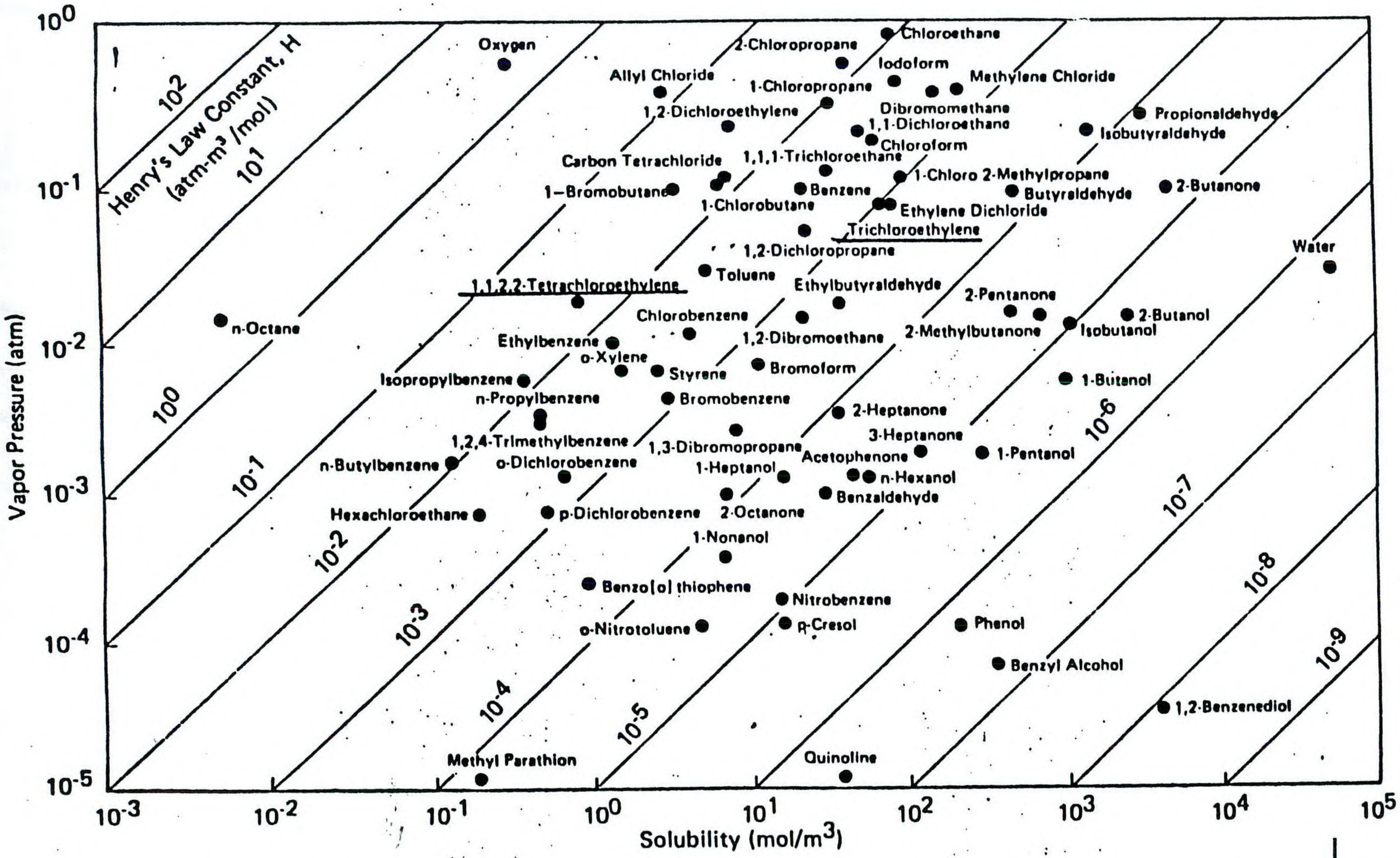

INFLUENT WATER
LIQUID DISTRIBUTOR
PACKING
SIGHT GLASS
WATER METERING VALVE
INLET WATER
PACKING SUPPORT PLATE
FLOWMETER
PUMP
FEED TANK
EFFLUENT TO WASTE
COMPRESSOR
INFLUENT AIR METERING VALVE

Figure 19



Source: Mackay and Yuen [15]. *(Reprinted with permission from the authors.)*

FIGURE 15–2 Solubility, Vapor Pressure and Henry's Law Constant for Selected Chemicals

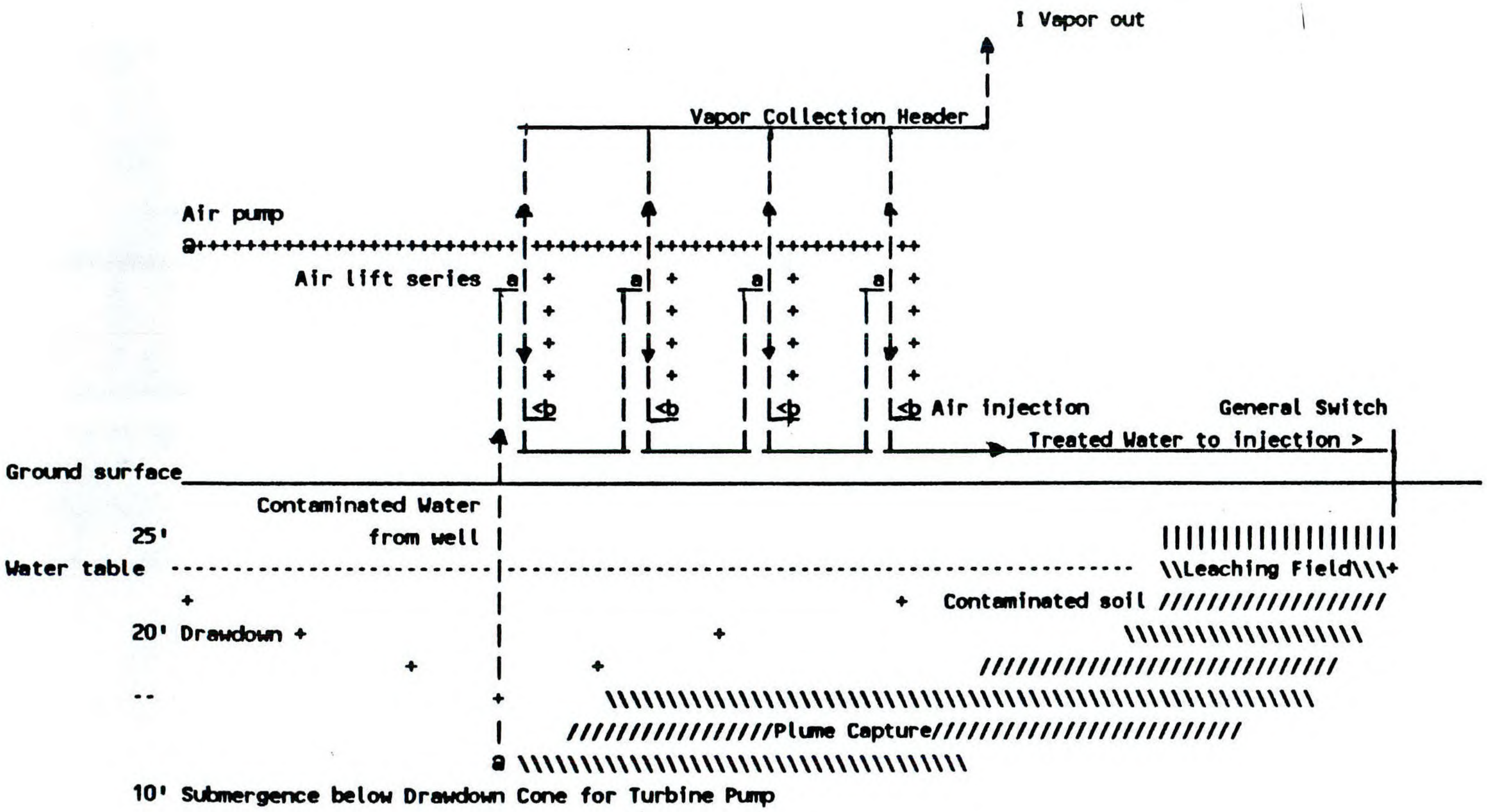
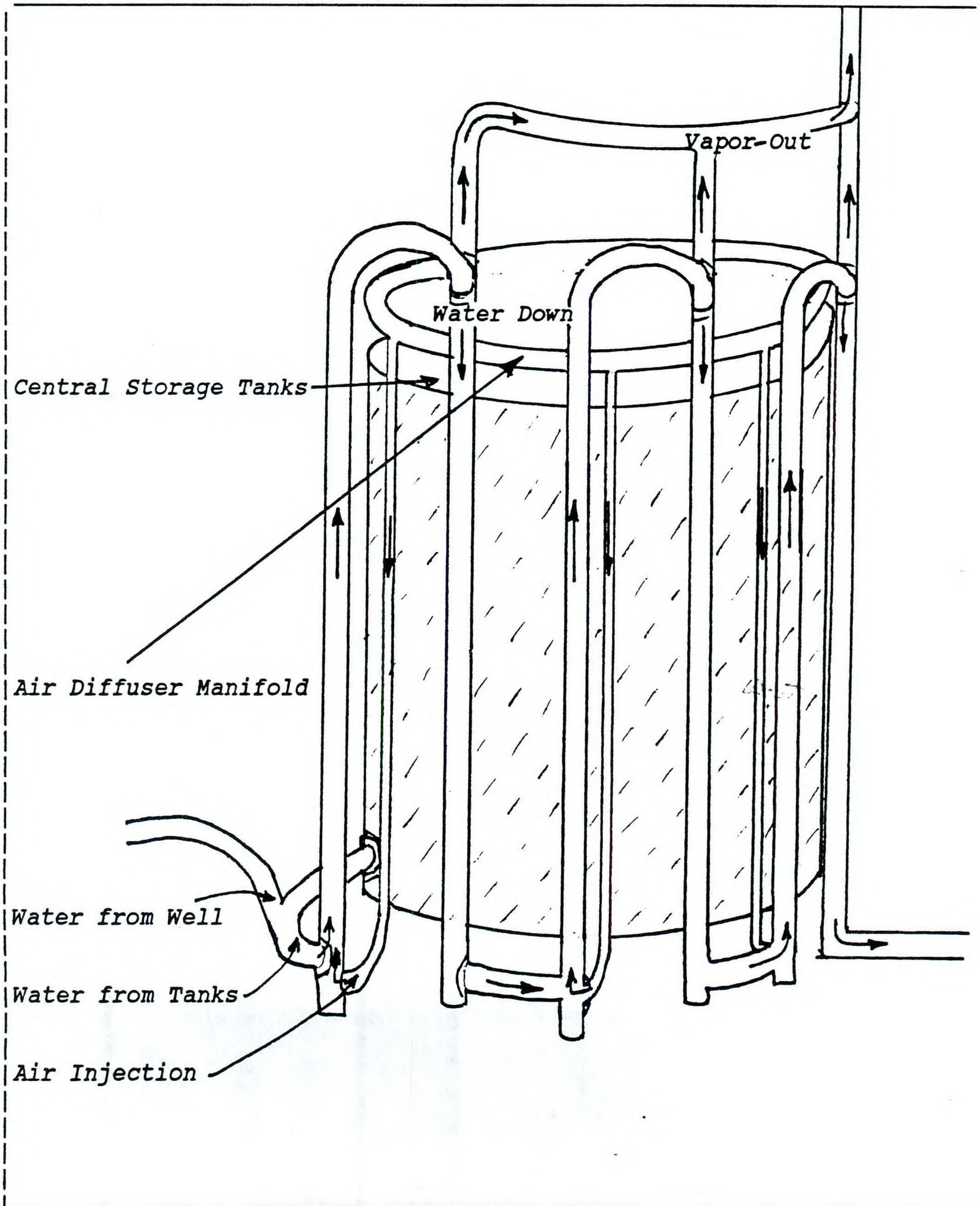


Figure 20: Multistage Airlift System (without central storage tanks)


Vapor-Out
Water Down
Central Storage Tanks
Air Diffuser Manifold
Water from Well
Water from Tanks
Air Injection

APPENDIX

SEMINAR ON ALTERNATIVE TECHNOLOGIES FOR REMOVAL ACTIONS , March 31 thru April 2, 1987

CASE STUDY: A Summary of the Application of Multistage Airlift Stripping at the
American Thermostat NPL Site in South Cairo, Greene County, New York.

OSC: Robert M. Cobiella, PE Telephone (201) 321-6646
Site Mitigation Section FTS 340-6646
Response and Prevention Branch
Emergency and Remedial Response Division
U.S.EPA Region II
Edison, New Jersey 08837

INTRODUCTION

The American Thermostat (AT) Site is located a few miles north of Catskill, the county seat of Greene County, New York. The surrounding area is a picturesque, hilly, wooded rural residential zone. Some of the homes in the South Cairo vicinity are summer homes, but most are occupied all year.

The strata underlying the contaminated area is fractured slate. The geology is accidented. Groundwater flow patterns are unpredictable, and groundwater veins are where you find them. Contaminant plume flow is likewise unpredictable, though generally a pattern can be developed from known data, and looks good on paper. The most reliable treatment planning, however, will be based on treatment of water from known contaminated existing wells. As a result, when removal action under CERCLA was requested, the OSC elected to base an aquifer remediation action on the treatment of water pumped from the most highly contaminated residential well. That this well was immediately adjacent to the original points of contaminant introduction into the ground was fortuitious and was used to advantage.

BACKGROUND

The AT factory reportedly began operating in South Cairo during the early 1950s, manufacturing thermostatic devices. Their operations required degreasing of metal parts. Their process and potable water was wellwater. Their industrial and sanitary wastewater was discharged into their septic system, and so, apparently, was their spent solvent, which was primarily tetrachloroethylene (perc). The factory operated for about 30 years.

A preliminary investigation of citizen's complaints was initiated by New York State Department of Environmental Conservation (DEC) in 1981. DEC found perc in residential wellwater, at the tap, at concentrations up to 47,000 ppb. The high value was in water from the Rath residence well, about 200 feet from the factory septic system. Initial mitigative action taken by AT, in 1983, in accord with a consent order, included the provision of bottled water to affected residents and the installation of five 2 column whole house activated carbon treatment systems. The Rath well was taken out of service and water for the Raths was provided through an activated carbon system installed inside the AT plant. By this time the Rath wellwater was showing perc at 98,000 ppb.

On May 7, 1985, AT filed for bankruptcy and ceased operating. DEC, on May 22, re-the untreated wellwater from six residential wells, at levels in excess of the EPA 10 Day Health Advisory Level of 175 ppb.

On August 19, 1985, funding was authorized to provide bottled water to the affected residents, to maintain existing systems, to monitor the site, to further define the plume and to install additional activated carbon treatment systems as required. One new system was installed. The removal action ended at the conclusion of the six-month CERCLA time limit. New York State resumed site monitoring and maintenance, the site was classified as Remedial, and the state enforcement organization retained the lead role.

During the following year, DEC monitoring revealed that perc levels in wellwater downgradient from the site continued to rise. Carbon column and system breakthrough began to occur more rapidly. One home (Rivenburg) was experiencing breakthrough in less time than the sampling cycle could cope with. The population was again at risk. In view of this unacceptable development, DEC once again requested that EPA take a removal action.

Since the prior OSC was no longer available, a new OSC was assigned, a new field investigation was made, alternative technologies were evaluated, a preferred approach was selected and an Action Memorandum submitted. This Action Memo was signed on August 23, 1986. EPA legal action, proceeding concurrently, resulted in the issuance of a Unilateral Administrative Order (UAO). A delivery Order was issued to the ERCS contractor during the period of grace of the UAO, in order to prepare for field action, but with the start-work date delayed until November 5, 1986, in order to give the PRP ample time to respond. No PRP action resulted and the removal began 11/5/86, as scheduled.

TREATMENT SYSTEM

The subject of this presentation is the multistage airlift stripping system that is operating on the Rath property, adjacent to the AT plant.

The treatment system has the following capabilities:

a) Pumping from the Rath well, at flow up to and beyond the stripping system capacity, in order to allow plenty of pressure availability and enable particulate filtration and
b) Spray-flash vaporization, with vacuum assist and air purge.
c) Airlift stripping through a ten stage series of lifts, with vacuum assist and manifold air purge, discharging to final tanks (2) equipped with their individual recirculating air lifts. These final tank lifts each have a flow capability double that of the main lift system, have vacuum assist on their spent air discharge and vents on the tank void spaces in order to minimize perc redissolution.
d) Capability for internal recirculation.
e) Capability for recirculation to the well, in order to be able to meet higher groundwater contaminant concentrations by dilution.
f) A supply system to serve treated water to the residence, through activated carbon (carbon units from the AT plant to be relocated into the home).
g) Pumping of the treated water to the plant septic system, to enable removal of perc from the aquifer under the plant.

A set of rough sketches illustrating the component systems is attached, along with early rough data from the running-in period to show how the performance was evaluated. The information gained was very useful in the tuning process, and in selection of a reliable stable pressure/vacuum/ flow rate adjustment for unattended operation

SYSTEM STATUS

The airlift stripping system has been fully operational since 2/24/87. The current operation is unattended, running at a flow rate of about 3000 GPD. Flows, pressures and vacuum are in a manually set balance. An automatic shutoff is operative to prevent overflow in the event of transfer pump failure. Flash tank level is maintained by the lifts themselves, since they have a capacity in excess of the set flow, and shut themselves down and restart unaided as the level falls and rises. The system is checked twice a week by the TAT or the OSC. Samples are taken periodically and analyzed by a commercial laboratory through a TAT special project. The latest available data sheet is attached, showing data from samples taken 3/12/87. This set shows raw water at 10,300 ppb, and treated water averaging 48 ppb, for a removal rate of 99.53%. Removal rates have ranged from 99.5 to 99.86% during the operation to date. A set of samples was taken 3/26/87, and verbally reported results may be available to include in the verbal presentation. Predicted values for this newest set are 3,000 ppb for the raw water and less than 30 ppb for the treated water (average of two samples from the Rath tap).

SCALING UP

Multistage airlift stripping can easily be scaled up to meet the needs of any groundwater/surface water/aquifer cleanup action. Airlifts can be sized for flow rates up into the millions of gallons per day, and costs per gallon can reasonably be expected to be lower for larger systems than for the smaller ones, and also lower for longer actions than for short term projects. Throughput capacities for multistage systems are slightly lower than the calculated flow capacity of a single airlift (12 to 15 times the crossectional area of the riser pipe in square inches = gpm), at least in the smaller size, if the Rath residence experience holds true. This system can be operated at about 10 gpm per square inch of riser pipe area. Airflow capacity per stage operates very well at about 1 SCFM per gpm. yielding an air to water ratio per stage of 7.48 to 1. Laboratory reported removal rates for single lifts at this ratio were about 62-64%. Field obtained removal rates are on the order of 45% per stage for a 10 stage system. The OSC speculates that the difference is probably due to three factors: the 50°F groundwater temperature inhibiting perc vaporization, the limited contact time available in the available indoor overhead space and the carry-over of minute air bubbles containing perc vapors from one stage to the next. Use of the configuration designed for the final tanks minimizes bubble carry-over, and will be part of the next system built. Higher overhead clearance and raised tank elevation will maximize removal contact times.

COSTS

Although the mitigation contract total cost to date for this removal action construction, fabrication, running-in and operation of the airlift system, including its shelter building (dubbed the "Taj Mahal") and all its internal and external component items. Total treated throughput as of April 1 is projected at over 150,000 gallons of contaminated groundwater. Cost of the airlift stripping can thus be seen to be approaching 36¢ per gallon at this time. Projected system shut-down is at the 300,000 gallon total throughput point, and cost at that time is forecast at $60,000 attributable to airlift stripping. Final cost per gallon for the completed action is thus expected to be about 20¢ per gallon. For comparison purposes, the purification of 5.7 million gallons of groundwater at the Hicksville, L.I., New York site by heated-feed packed-bed air stripper, admittedly a much more difficult to strip material (MEK), but also a much larger system, cost about 18¢ per gallon.

CLOSING SUMMATION

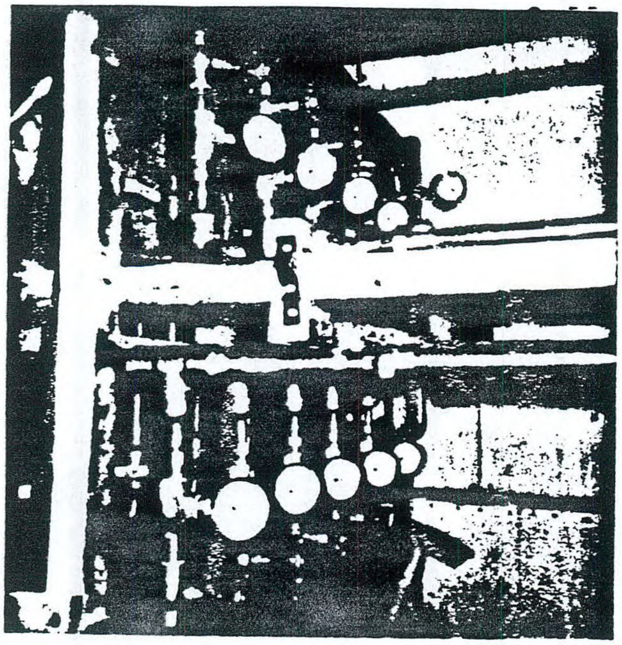
Sufficient information is in hand at this time to evaluate the field performance of the multistage airlift stripping technology. It is a high efficiency, low cost technique for removal of volatile organic chemicals from water. It is effective, practical, operable, flexible, reliable, amenable to fabrication in the field at a scale tailored to the problem or the site and simple enough to be fabricated by readily available construction level skilled tradesmen anywhere in this country. It can be fabricated of materials capable of withstanding high or low pH liquids. It will readily move viscous liquids or high solid content liquids. It has no moving parts in contact with the liquid being stripped and so is relatively free from the effects of abrasive materials. In effect, it is a modern adaptation of an old pumping method, and should be a useful tool in the hands of the OSC.

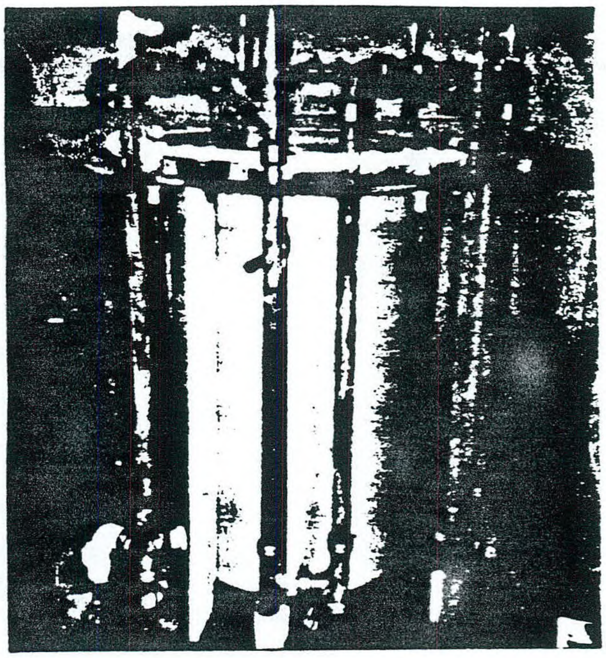
Robert M. Cobiella

Robert M. Cobiella, BSME, PE
On Scene Coordinator

Date April 1, 1987

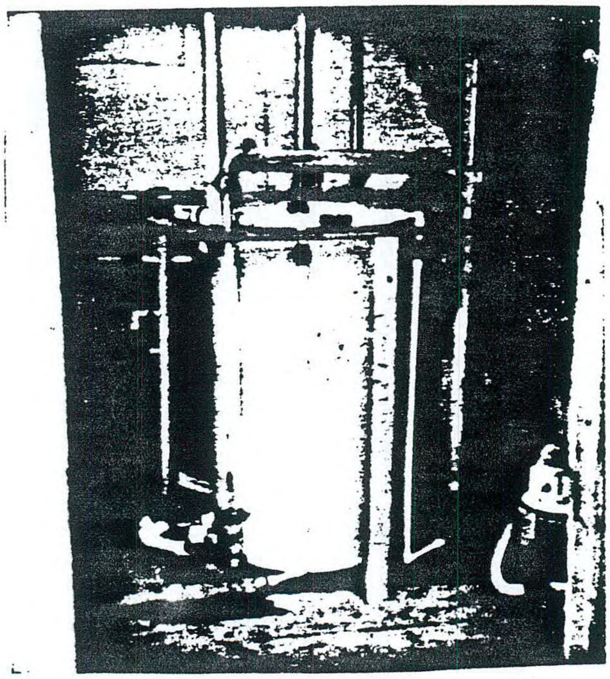
NOTE: Photographs of this system are available for viewing after the day's presentations are complete.

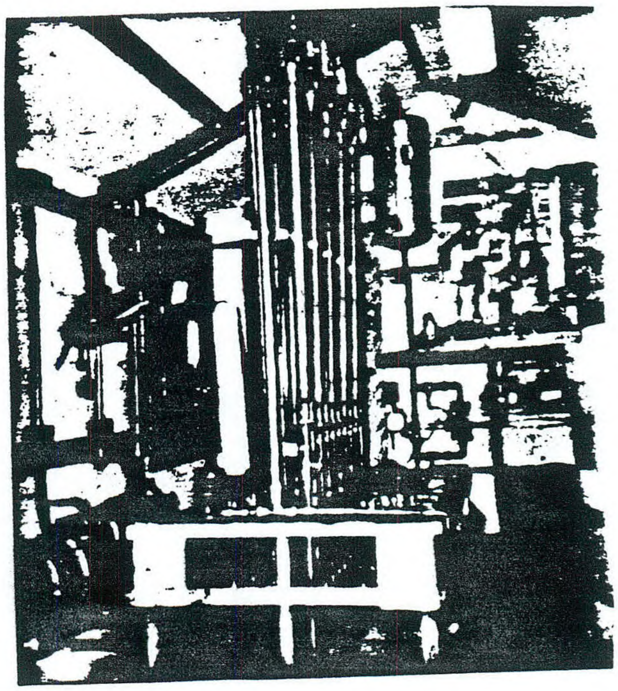




1. February 12, 1987. Ten-stage airlift stripper shows steady de-percing (99.9% removal)

2. August 2, 1987. Pompey, NY. 7-stage airlift pumping at 0.8 gpm. Merry-go-round style, 1/2" glass airlifts.





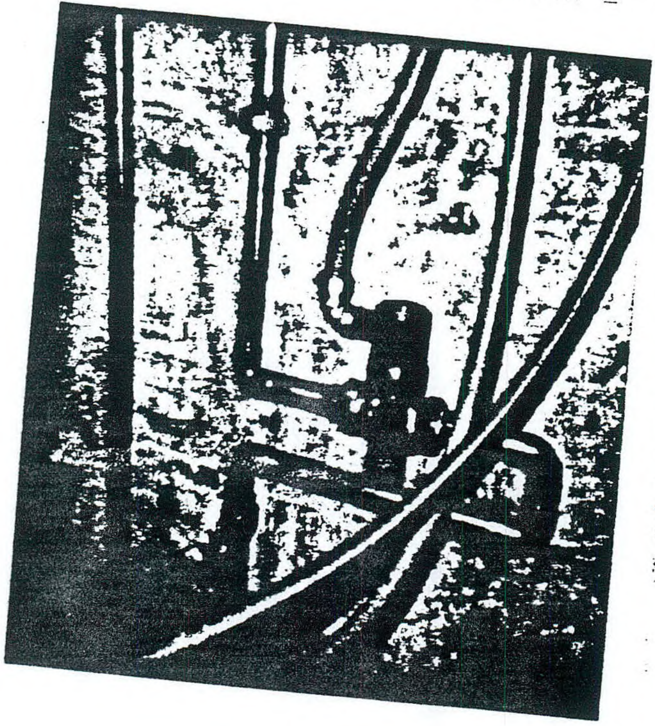
3. Pompey, NY 3 stage airlift at Bumpus, 0.8 gpm well, 10 gpm lifts.

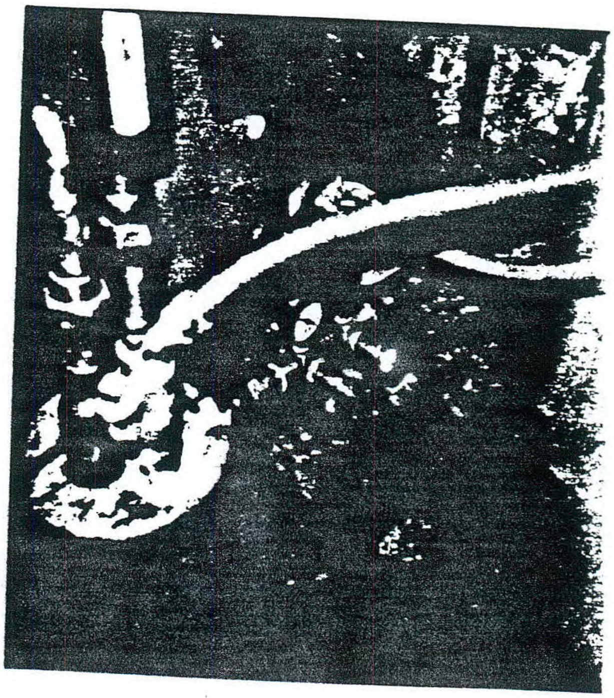
4. February 13, 1987. Flash tank with air and vacuum connected. Ten-stage serial airlift stripper in final configuration.

5. February 11, 1987. Granular activated carbon, new isolation valve on vacuum discharge system.

6. December 19, 1986. American Thermostat. Electrical power and controls to blower and vacuum pumps.

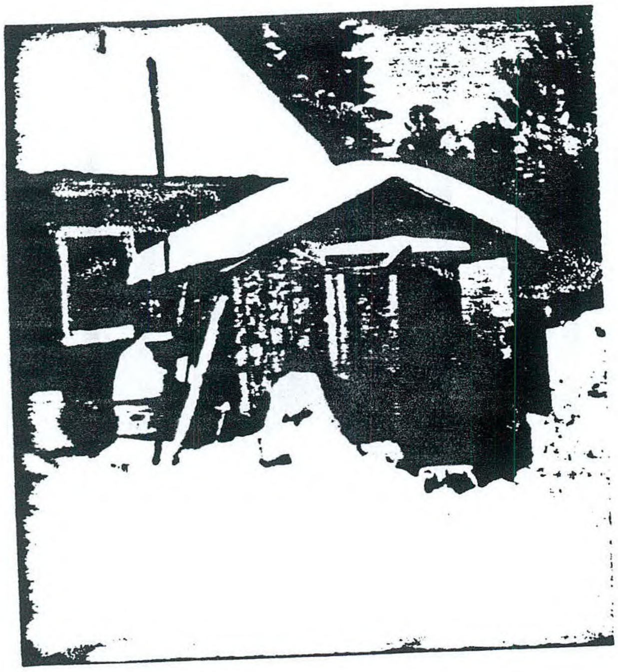
7. February 16, 1987. Flash tank removes 25-40%.

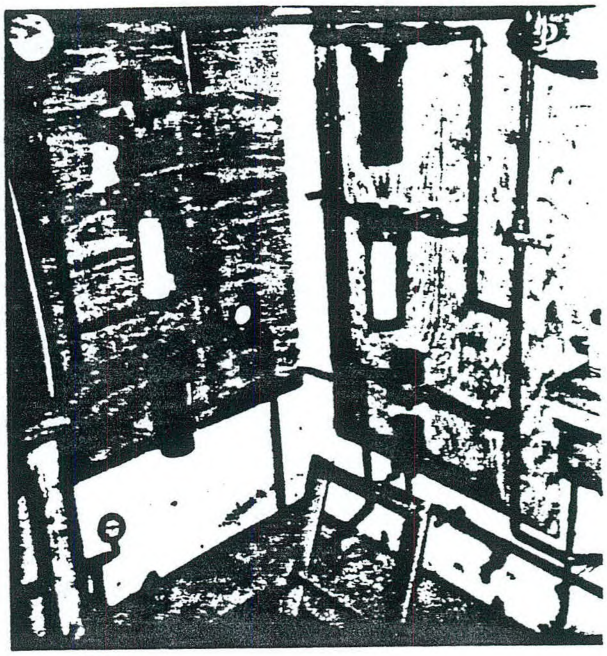




8. February 26, 1987. Automatic valving to provide water to Rath home; shuts off to flow to AT plant when Rath home needs water.

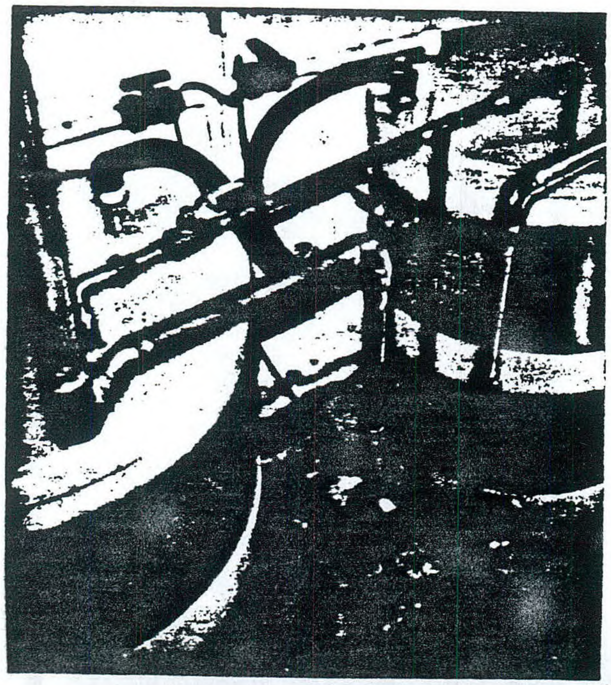
9. February 26, 1987. Well pit piping to show entry into Rath's Basement Closet.

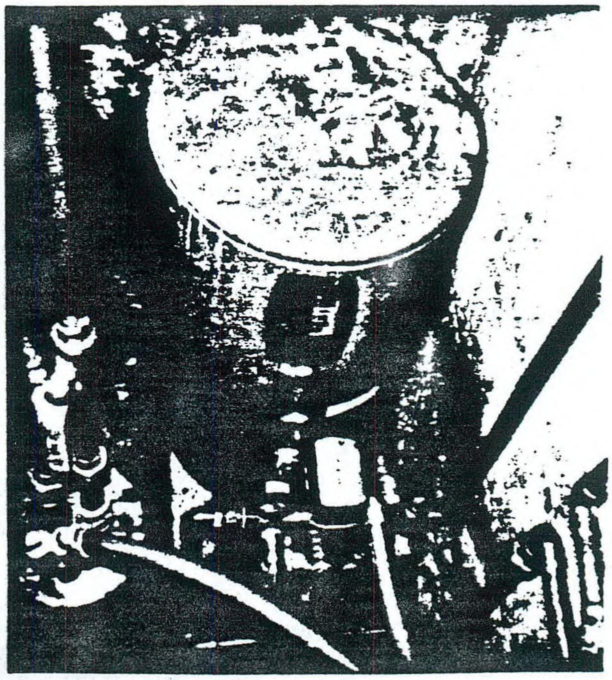




10. Building before modification with Calliope arrangement of venting.

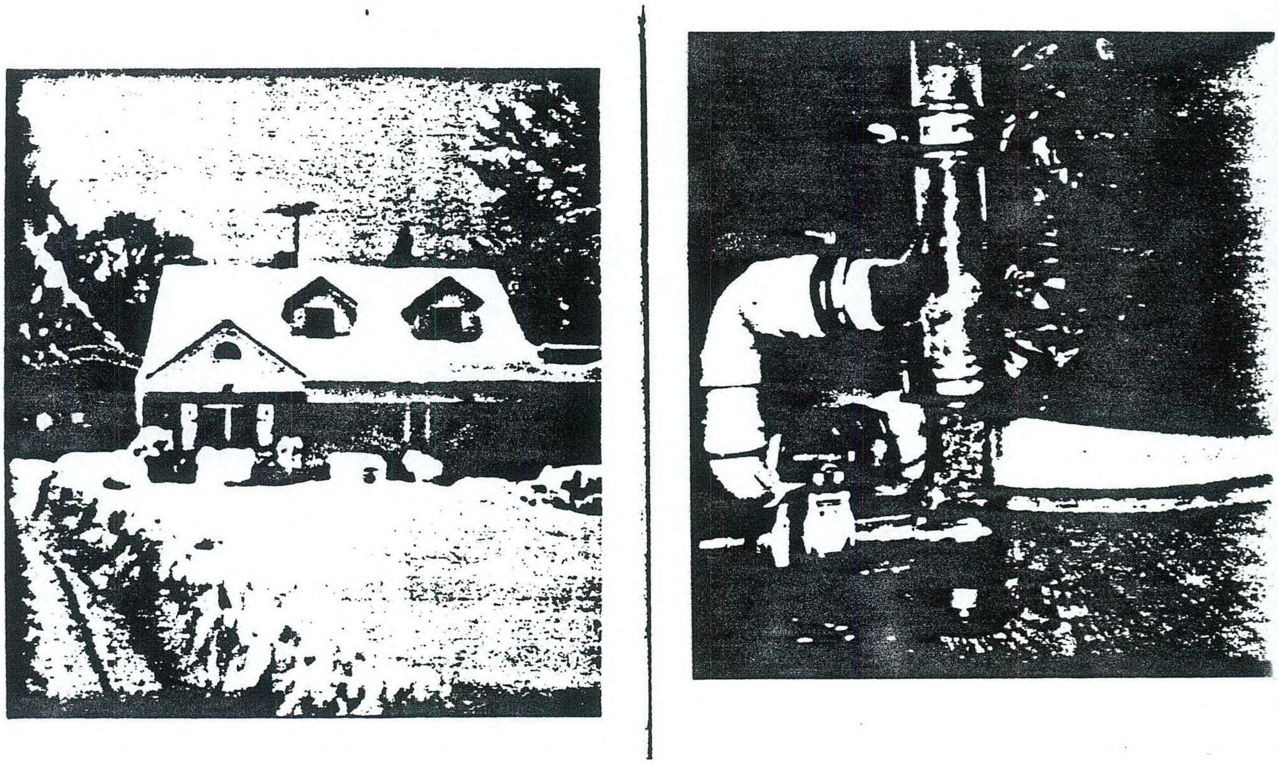
11. February 11, 1987. Filter and meter panels and top of ladder from well pit.





12. February 26, 1987. Vent Fan and final tank vapor hoses installed behind transfer pump.

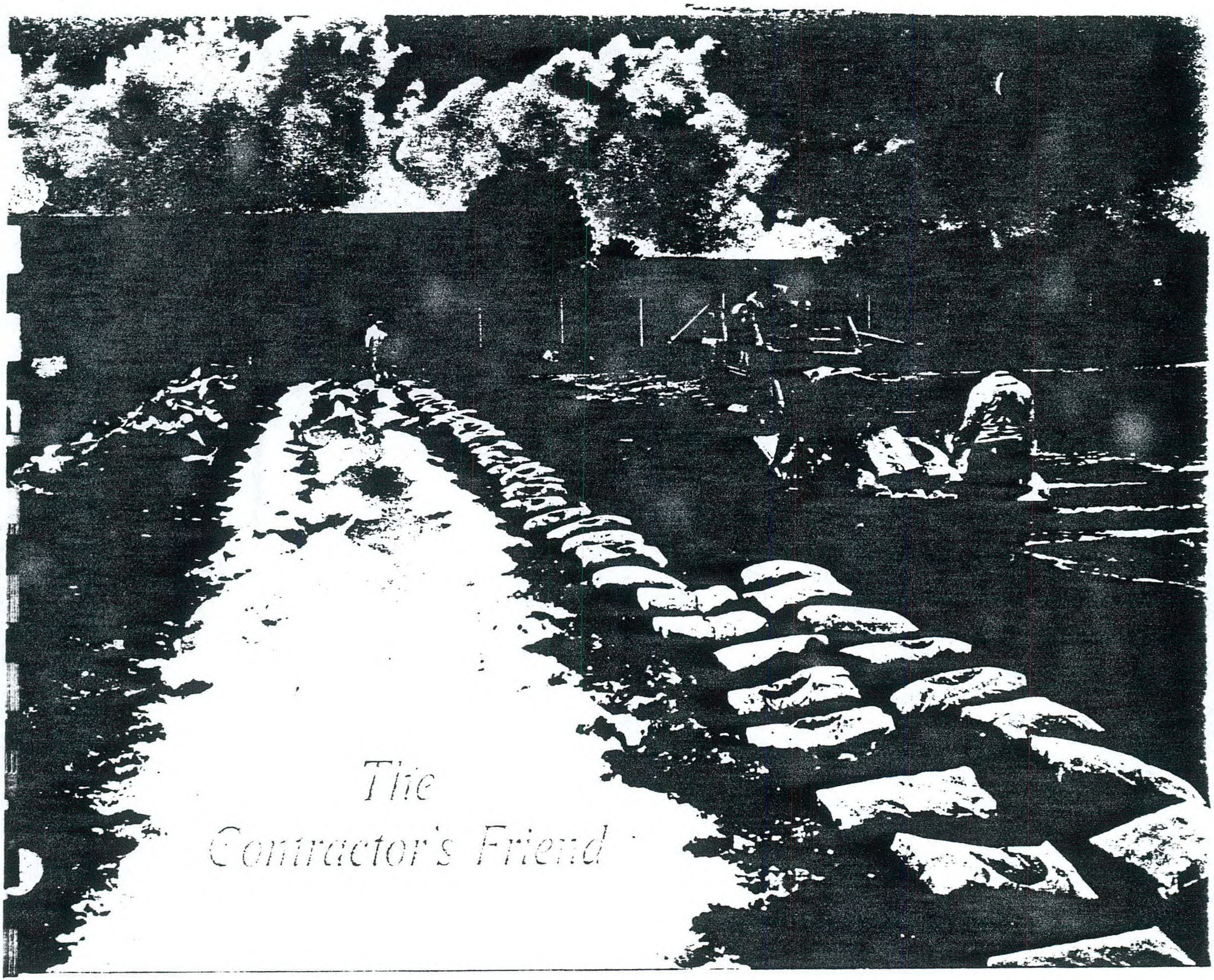
13. American Thermostat home hydropneumatic wellhead seal, vacuum and drain piping, discharge piping, etc. in the well pit.



14 Pompey, July 1, 1987. Shedlocks test column with screen diffuser (since removed to avoid clogging) running at 9 gpm.

Shakti Consultants, Inc.
Proposal for Final Cleanup - Wallkill, NY

ARTICLES ON SOLIDIFICATION

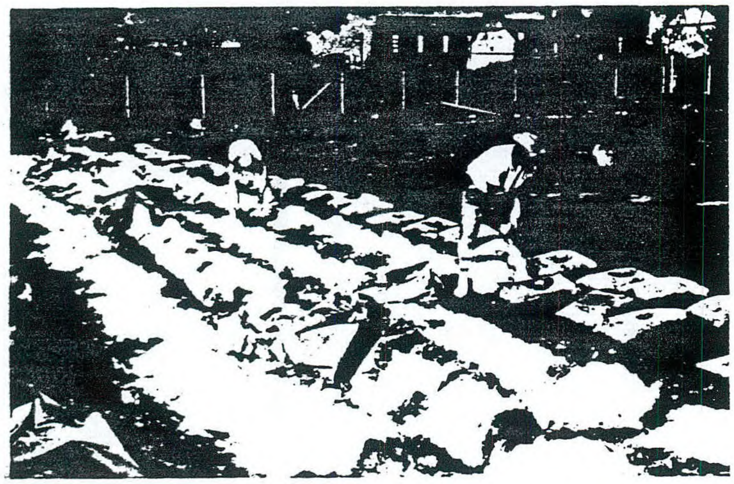


MUD

CONSTRUCTION SITES **FLOOR FOUNDATIONS**
WET SPOTS **HAULAGE ROADS**

Dries Up Mud Quickly *Prevents Delays*
Stabilizes Soil *No Subsequent Softening*

Countless construction jobs are bogged down by mud caused by spring thaws or rainy periods. Days, even weeks of valuable time—and money—are lost. Now, thanks to lime, this need not happen.



10 a.m.

Workers slit open bags and dump hydrated lime in piles at Texas Highway Department warehouse site, Bryan. Note how lime blots up moisture from saturated clay soil.

2 p.m.

Lime is mixed into soil with twin disc harrow pulled by crawler tractor. Mixing starts right after lunch.

Lime, either quick or hydrated, dries up the wet soil quickly so that it can be compacted readily, forming a working table that will be unaffected by subsequent rains ...thus, the job can proceed on schedule.

When a job is bogged down due to weather, it is usually too risky to wait for nature to dry up the mud. Improvement from partial drying may be lost after another deluge. That is why lime should be used at the first sign of a mud "bottleneck." The other alternative to lime treatment—excavating the mud, hauling it away, and replacing with dry fill—is usually more costly and time-consuming.

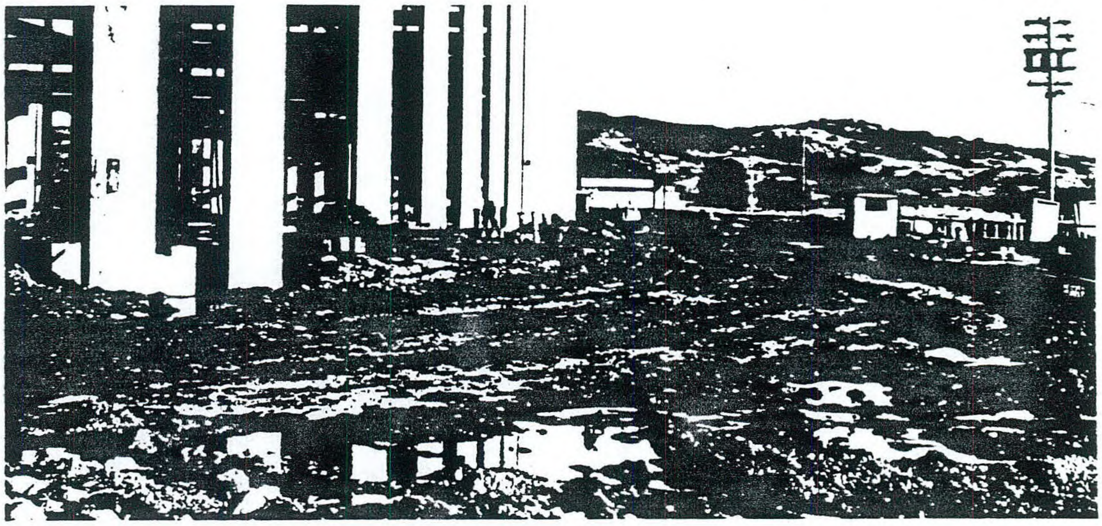
Quicklime and hydrated lime have a high affinity for moisture, producing a blotting action on wet clay and silt soils. Highway contractors were the first to learn this in road construction where lime-soil stabilization was specified. In roads lime is used primarily to stabilize and strengthen the subgrade, making it part of the pavement design; however, contractors soon found that it also expedited construction in rainy weather, due to its drying action, as well as forming a firm working table. This saved time and costly reworking—and it is now doing the same thing for building contractors, too.

Quick and hydrated lime should not be confused with pulverized limestone or agstone. The former ar chemical stabilizers; the latter is an inert, fine aggregate. Any type of hydrate (i.e., masons, chemical, agricultural, etc.) may be used for dry-up, provided in bulk or in 50 lb. bags. Quicklime may be in ground, granular or pebble form.

For most dry up applications 2 to 4% lime (based on dry weight of soil) is required, depending on degree of wetness. This is about 1 to 2 lbs./sq. ft. for 6 in. of compacted depth. At 3-5¢/lb., the lime material cost is generally 5-6¢/sq. ft., depending on whether bulk or bagged material is used, amount required, rate of application, etc.

In road stabilization construction steps are precise and demand specialized equipment in meeting strict specifications. But where lime is only used for drying and expediting construction, the procedure is less exact and simpler. Construction steps include: (1) lime spreading, (2) mixing lime and soil, and (3) compaction.

Lime spreading The most rapid lime spreading is achieved with pneumatic bulk trucks equipped with a spreader at rear. However, on wet spots, bulk spreading is usually impractical, necessitating use of bagged lime. Bags are generally loaded on a front-end loader an spotted in a uniform pattern by hand. A man following



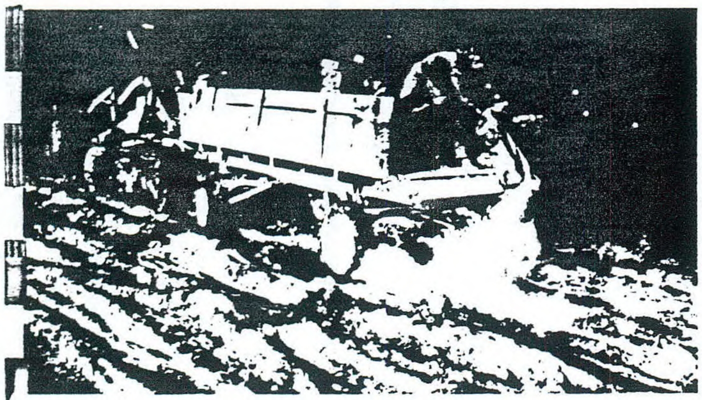
Construction site in California, where all work was stopped due to quagmire conditions. To expedite construction, the contractor mixed in lime to make all-weather access roads and work areas. The job then proceeded without delay.

Another technique recommended only for inside building enclosures is to transport the bags in a tractor-drawn wagon. Workmen open the bags on the wagon and dump the lime over the sides. Because of the drop, better distribution results than opening bags at ground level. If any wind is present, this method should not be used because of excessive dusting.

Before mixing, usually it is desirable to leave the lime that is spread for 1 to 2 hours to permit the lime to blot up excess water; otherwise, mixing equipment might bog down.

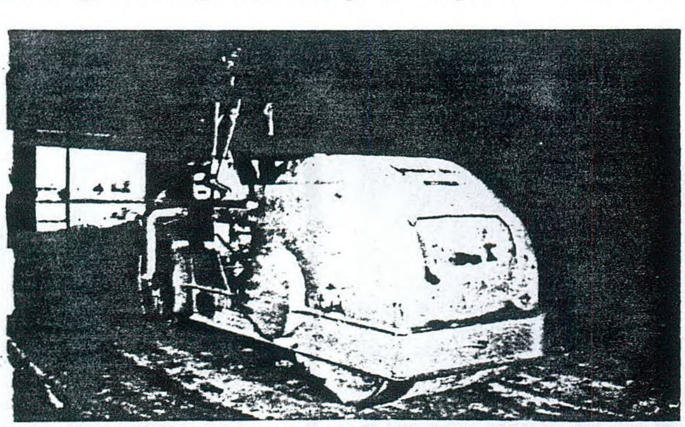
Mixing The lime and mud are then mixed by a disc harrow about 6 in. deep (in exceptional spongy spots, it may be necessary to go deeper). If a heavy duty construction disc is unavailable, a farm disc may suffice. Other equipment used for mixing includes: front-end loader equipped with bucket teeth, scarifiers, and rotary mixers. Several passes are made until the soil is dry enough for compaction. By mixing a small area first, it is possible to determine if the desired degree of drying is achieved. If not, the rate of application can be stepped up.

In many northern building projects, construction is started during the winter, and by spring the walls and roof are completed. Then, after the spring thaw, the building interior becomes a morass, and drying from the sun is out of the question. How lime solved this "mud" problem at two Midwestern projects is shown below:

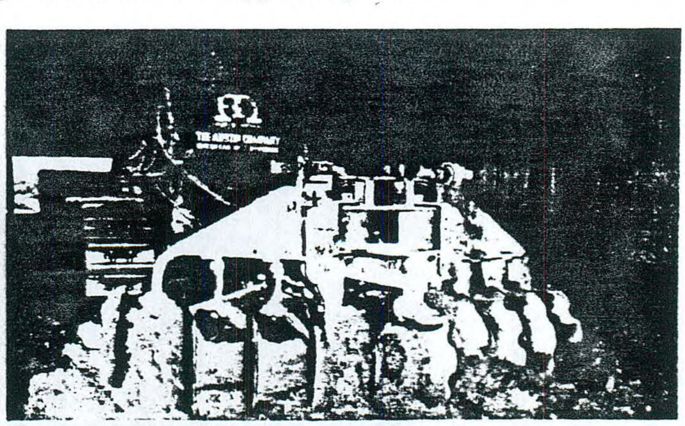


Spreading lime from wagon to dry up interior of K-Mart building, Indianapolis, Ind., prior to floor construction.

Farm disc is used to mix lime to depth of 6-8 in. After several passes, the area is ready for compaction.



Tandem steel roller finishes off stabilized section. Initial



Heavy duty disc harrow completes lime-soil mixing inside

Compaction Initial compaction is performed with a sheepsfoot roller, followed by a pneumatic or flat wheel roller. However, the lime-soil mixture may be dry enough for the latter rollers to do all compaction. For temporary haul roads, compaction with the sheepsfoot alone may only be necessary, since haulage trucks will provide additional compaction. If compaction is reasonably thorough, subsequent rains will not soften the treated subgrade; it does not revert to mud.

For spots that may be too small to justify the heavy equipment cited above, they can also be dried up with hand labor. Bags of lime are emptied by hand, and crudely mixed with rakes and hoes. Then compaction is achieved by hand tampers. Often only 5 to 20 bags of lime are needed for such dry up — a small price to pay to keep the job moving and eliminate costly rehandling of materials.

Since quicklime can cause burns, and hydrated lime can be caustic, a few precautions are advisable to protect skin and particularly eyes. Workmen, who handle, spread, and mix the lime, should wear tight fitting goggles, gauntlet gloves, long sleeves, and pants tucked into boots. Wash off all lime dust from skin as soon as practical, but in case of eyes flush out with clean water immediately and see a doctor. Protective cream is suggested for those with sensitive skin. Breathing lime dust is harmless; there is no odor. By following these few points, lime is perfectly safe to use.

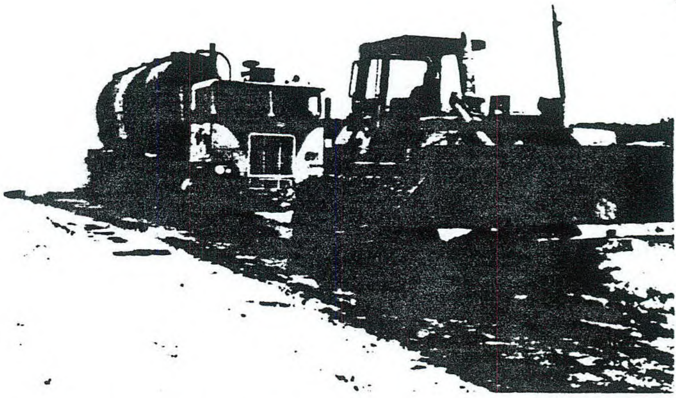
Because of its heat of hydration, quicklime has greater drying capacity and dries more rapidly than hydrate. This drying advantage is accentuated in cold weather; quicklime's heat also helps melt frozen soil.

An ideal solution to mud is to prevent it from occurring in the first place. This is being done by farsighted contractors. After initial grading of a building site, they will lime stabilize the whole area on which they work and haul and stock materials. Then, if rain occurs, equipment will not bog down in mud; they have an all-weather working table on which to build. There is no slipping and wheel spinning...and worker productivity and comfort are improved.

But in lieu of pre-treatment, be sure to have some lime bags on hand for emergency dry up use to avoid costly delays.

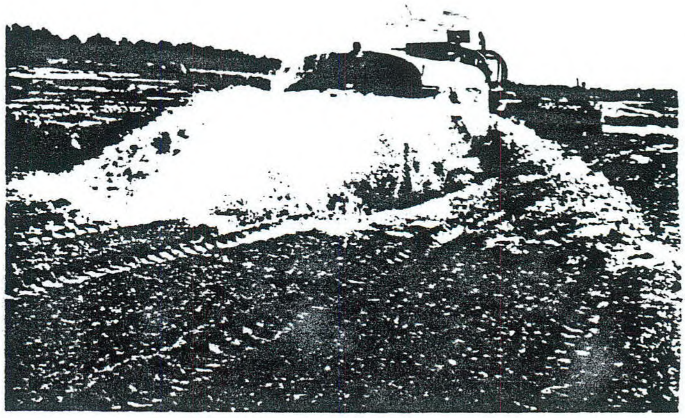
If it's used extensively on Interstate highways and jet airport runways, it can help you too.

Lime expedited construction of 10,000 ft. runway at Houston Intercontinental Airport by drying out clay subgrade following heavy rain.



Crawler tractor was used to pull bulk lime truck through wet subgrade clay during 1/2-in. rain.

Next morning, following discing, rotary mixers were used to mix lime with the wet clay.



By 10 a.m. the soil had dried out to the extent that water was needed for compaction. Following compaction the stabilized subgrade shed rain and remained hard.

For further information and free literature — write

NATIONAL LIME ASSOCIATION

Appendix C

SOLIDIFICATION OF SLUDGE

In-situ treatment of a waste that is not a characteristic waste is considered as the practical and economically acceptable approach to treatment, protection of health and environment, land reclamation, and ultimate disposal for the sludge.

We further believe that this waste, once it is solidified and capped should be treated as a non-hazardous landfill subject to inspection of the integrity of the cap and drainage system.

Various methods of in-situ treatment of these soils have been investigated, through literature review, analysis of current efforts of consulting, research and manufacturing organizations, and by laboratory testing as an alternative to excavation and disposal.

The methods were assessed according to the criteria of:

Protection of the Public Health and Environment

Treatment of the Waste to an Acceptable Level

Cost Effectiveness

The method chosen as meeting these criteria was in-situ treatment by solidification and immobilization of the contaminants by pozzolanic materials. Pilot testing of various ingredients for solidification was conducted with the sludge. These ingredients included Portland cement, high-CaO cement kiln dust and reactive flyash with and without the addition of soils.

Various recipes of the above listed materials were mixed with the sludge under controlled conditions. The resultant consolidated materials were tested for waste characteristics, strength and consolidation. Following these laboratory tests, we are in a position to recommend the appropriate mix and present the physical and chemical constitution of the final solidified materials.

In-Situ Treatment Techniques for Hazardous-Waste Contaminated Soils

Applicability of In-Situ Treatment Techniques

Two types of scenarios for uncontrolled hazardous waste sites may be addressed using in-situ treatment. These include:

(1) Low levels of contamination around the periphery or in the "transition zone" of a landfill, impoundment, etc.

(2) Low residual levels of contamination in the "hot" or contaminated zone which remain on site following the bulk of contaminant removal. (2)

The contaminant concentrations found in the sludge from the CST (Racetrack) Lagoon qualify the contents for consideration and treatment as a low-level source.

In-Situ Treatment Methods for Hazardous Organic Chemical Disposal

Two alternative treatment schemes may be considered for in-situ treatment:

(1) <u>Management of the soil system</u> to utilize natural soil reactions for degradation, detoxication, or immobilization of waste constituents; and/or

(2) <u>Addition of exogenous treatment agents</u> (physical, chemical, and/or biological) to the site to accomplish treatment (degradation, transformation to less toxic constituents, and/or immobilization).

The first scheme utilizes the natural soil/site attenuation capacity (SSAC) and techniques to increase the SSAC to accomplish the goals of treatment. The second scheme utilizes exogenous treatment (ET) agents to directly treat the constituents.

Soil treatments that require extensive or extreme modification from the original soil characteristics are more costly, are less likely to be successful in terms of Quality Control, and require longterm management.

Treatment techniques reviewed for in-situ immobilization and detoxification of hazardous constituents in soil systems are presented:

(1) Management of the soil system

ALTERNATIVE 1. IMMOBILIZATION BY SORPTION

The ability of a soil to hold a particular contaminant depends on such soil properties as texture, surface area, CEC, organic matter, percentage of free iron oxides, lime content and pH, and on the contaminant itself.

Soil sorption is perhaps the most important soil-waste process affecting immobilization of toxic and recalcitrant fractions of hazardous wastes. Conversely, leaching potential and residence time in soil for contaminants that may undergo biodegradation are directly affected by the extent of their immobilization.

Treatment techniques to enhance immobilization of constituents by controlling or augmenting the sorption process in soils have been developed based on fundamental principles and applied land-treatment techniques.

Such techniques as capping of waste piles, surface water diversion and lowering the water table are examples of methods used to reduce soil moisture in the waste pile and hence sorption by the site soils.

ALTERNATIVE 2. CONTROL OF SOIL MOISTURE

Controlling the moisture content of a soil by such methods as isolation or providing an impervious cap to the material represents a management tool to accomplish immobilization of a constituent in contaminated soils. It also allows for additional time to accomplish biological degradation for contaminants retained at the site.

Soil moisture management may or may not be compatible with anaerobic degradation. Where immobilization of constituents using this technique is to be followed by anaerobic decomposition in a treatment train, anaerobiosis must be achieved with techniques other than flooding, such as soil compaction. The proposal will employ Modified Proctor compaction.

Using the Freundlich isotherm, the percent of a hazardous waste constituent sorbed under natural moisture conditions can be estimated by:

$$\% \text{ sorbed} = \frac{1}{1 + (S/K)^{1/N} \, (1/S)\text{MC}} \qquad (1)$$

where MC is the moisture content (weight basis).
where Kd is the distribution coefficient of the chemical between soil and soil water.

A graph is presented (Simms, 1984) of the percent of sorption as a function of soil moisture and Kd, the distribution coefficient of a chemical between soil and soil pore water (2) Figure 1. - with lower moisture contents most of the chemical will be in an absorbed state on the soil. This is especially important for constituents with relatively small Kd values, i.e., constituents not strongly sorbed to soil.

The cap proposed for the site will control soil moisture in the stabilized wastes as a means to ensure contaminant immobilization. Precipitation/runon and runoff will be controlled by the cap and drainage system. It is anticipated that the volume increase of the solidified soil will cause the soils of the constructed landfill to be mounded. A peripheral ditch to collect the drainage from the cap will also prevent runon and reduce residence time for precipitation.

ALTERNATE 3. MECHANICAL STABILIZATION

Stabilized materials may be compacted using the modified Proctor compaction procedure, which provides greater compactive effort than the Standard Proctor procedure and produces a denser compacted specimen.

The increased compactive effort increases the dry unit weight and decreased the porosity. Compaction with the modified Proctor procedure caused only a modest reduction in the permeability to water: from 7 x 10-8 cm/sec for Standard Proctor to 5 x 10-8 for Modified Proctor.

The permeabilities for modified-Proctor-stabilized Kaolinite permeated with heptane and TCE are presented in Figures 5.1 and 5.2. from research conducted by Daniel and Broderick (20). The use of greater compactive effort caused such a large reduction in the permeability to the organic chemicals that the "stabilized" soils were practically impermeable to heptane and TCE. For example, kaolinite soil compacted with Standard Proctor effort had a permeability to heptane 1 x 10-4 cm/sec, but when kaolinite was compacted with modified Proctor effort the permeability to heptane dropped to less than 1 x 10-10 cm/sec, which is a million-fold difference. Clearly, compaction of soils to greater densities has potential for producing tremendous benefits for clay soils or stabilized materials that will be exposed to organic chemicals and for immobilizing contamianants in these soils.

The decrease in porosity achieved with modified Proctor compaction makes the soil more dense. Organic chemicals tend to cause clays to flocculate and crack, but if the particles are packed very densely, the particles may not be able to rearrange themselves to swell or crack.

Water-saturated clay has a finite heptane-entry pressure and TCE-entry pressure. In other words, there is a finite hydraulic gradient below which there is virtually no flow of a specific product into or through the soil.

By analogy to a capillary, the smaller the pores, the higher the entry pressure. Thus. the following hypothesis is suggested. With Standard Proctor effort a few relatively large pores were present, and heptane and TCE were able to displace the water in those pores and, ultimately, increase permeability. Modified Proctor compaction reduced the size of the largest pores such that the pores were small enough that the heptane and TCE did not displace the soil water.

Whatever the mechanism, the use of greater compactive effort shows tremendous potential for reducing the movement of selected contaminants through stabilized soils.

ALTERNATIVE 4. BIOLOGICAL DEGRADATION AND DETOXIFICATION

Biological methods for in-situ treatment of toxic and hazardous waste contaminated soils are directed toward enhancing biochemical mechanisms for decomposing or detoxifying the waste material. Since soil microorganisms (bacteria, actinomycetes, fungi) are important in these processes, treatments must be applied in a way that does not severely restrict microbial growth and/or biochemical activity. Physical boundaries of temperature (5-60 Degrees C), soil water potential (>-15 bars), pH(5-9), and oxidation-reduction potential (pe + pH 17.5 - 2.7) must be avoided to assure adequate microbial activity.

Biological treatment techniques were developed based primarily on information gained through research on degradation of natural materials, pesticides, and priority pollutants in agronomic settings. Optimum microbiological activity occurs at soil water potentials from 0.1 to -1.0 bars, to achieve this range irrigation is often practiced in agriculture. But this treatment is antagonistic to the efforts to minimize leaching or erosion.

Managing the soil physical and chemical processes, such as tilling and irrigation, to increase the biological activity for degradation require extensive management. The physical and chemical processes in soils that retain organics against leaching and downward movement may be exhausted by the high contaminant concentration in industrial wastes.

While soil moisture control and heavy compaction will be employed at the site, the more rigorous ET based techniques comprise the categories of in-situ treatment techniques that were further considered as fundamental to solidification of the waste.

(2) Addition of Exogenous Treatment Agents

ALTERNATIVE 5: ADJUSTMENT OF SOIL pH

Adjustment of Soil pH (liming) at the rates used in agricultural practice, enhances precipitation and sorption of cationic metals but has little beneficial effect on organic contaminants. Liming may increase biological activity and enhance degradation of organic wastes. Soils will tend to return to their original pH with time. Soil pH must be monitored and liming may be repeatedly required. For true stabilization a pozzolanic (cement-like) reaction is required: as described in the lime- and cement-based alternatives.

ALTERNATIVE 6: ADDITION OF NON-TOXIC ORGANIC MATERIALS

Addition of agricultural products and sewage sludge provides additional sites for metals adsorption and some organics but is not appropriate for sludge treatment.

ALTERNATIVE 7: ADDITION OF ACTIVATED CARBON or ZEOLITES

Addition of activated carbon and zeolites while providing additional sites for adsorption is extremely costly for soil treatment.

ALTERNATIVES INVOLVING SOIL SOLIDIFICATION

The treatment that was chosen for the sludge will consist of solidification of the sludge into a soil that restricts the leachability of the soil and the production of leachate. The soil will be into a cement-like form that restricts surface infiltration of water into the mass, reduces erosion of contaminants and restricts the movement of leachate, and hence contaminant movement, downward in the unsaturatated zone of the soil, in order to preserve groundwater quality.

Stabilization/solidification or fixation is a process for treating industrial solid wastes (primarily sludges) that contain hazardous constituents to prevent dissolution and loss of toxic materials into the environment. Most of these treatment processes are designed to produce a monolithic solid of low permeability.

Present solidification/stabilization systems can be grouped into seven classes of processes.

Alternative:

- Solidification through cement addition.
- Solidification through the addition of lime or other pozzolanic materials.
- Techniques involving embedding wastes in thermoplastic materials such as bitumen, paraffin or polyethylene.
- Solidification by addition of an organic polymer.
- Encapsulation of wastes in a inert coating.
- Treatment of the wastes to produce a cementitious product without major additions of other constituents.
- Formation of a glass by fusion of wastes with silica.

The advantages and disadvantages of each approach is discussed. Alternatives other than solidification by lime or cement addition were dismissed as too costly for a low level organic contaminant source.

Lime is commonly used in stabilizing highly plastic clays against the tendency to shrink and swell when the moisture content changes. Typically, lime is spread over the soil, is plowed or disced into the soil, and then the soil-lime mixture is compacted. For example. this procedure was used beneath nearly all the Dallas-Fort Worth Regional Airport to stabilize soils against shrink/swell tendencies. Lime also makes the soil less plastic, which makes the soil-lime mixture easy to work with during construction.

Portland cement is also often added to soil to form "soil cement." Portland cement is the type of cement used to make concrete. Soil cement is not as strong as concrete, but still provides a very strong material that is ideal for roads, airfields, and buildings. Lime and cement have been used to solidify several hazardous waste sites both for the USEPA and for private parties under order by the USEPA. Details of some of these sites is provided in Appendix I.

Asphalt has sometimes been mixed with sand to form a relatively impermeable material, e.g., in the floor of oil storage tanks. Asphalt has rarely been mixed with clay.

Two other additives include silica-based cement/sodium-silicate solution and another is synthetic polymer. Sodium silicate grout solutions are often injected into natural soils and rocks. The grout solution is literally forced into the voids of the soil or rock by high pressure, and when the sodium silicate gels, the grouted material has a lower permeability and a higher strength.

Research has been conducted on the permeability and leachability of stabilized soils by Green et al (28) since 1981 and Daniel and Broderic since 1985, (20). Green indicated that organic materials increase the permeability of clays. In the Daniel and Broderick research permeability tests were performed on variously stabilized (solidified) soils and the permeabilities were compared to the natural soil conditions. Details of this series of studies are presented in this Appendix. In each test, a baseline permeability to water was determined, and then various permeant organic chemical liquid were switched instead of water. This and other similar research is presented to discuss the effectiveness of lime and cement-based pozzolanic reactions in preventing leachate generation and thus protection of environmental quality impacted by runoff and downward percolation from solidified waste.

Permeant Liquids

The properties of the five representative organic liquids used in the reseach of Daniel and Broderick are given in Table 1. All tests were initiated using tap water as the permeant liquid to obtain a baseline permeability. The organic liquids were all reagent-grade (pure) chemicals.

Methanol was selected to represent a neutral-polar compound. Methanol's density, viscosity, and dipole moment are somewhat less than that of water. The dielectric constant is much lower than the dielectric constant of water, and methanol is miscible with water.

Heptane is a neutral, norpolar organic chemical with a very low dielectric constant. It is immiscible with water. The density and viscosity are somewhat lower than the values of water.

The acid and base selected for study were glacial acetic acid and ethanolamine, respectively. Acetic acid has a density and viscosity slightly greater than that of water. The dielectric constant is significantly lower, and the dipole moment is less than that of water.

Ethanolamine is slightly more dense and considerably more viscous than water. The dielectric constant is midway between values for water and heptane. Both acetic acid and ethanolamine are miscible with water.

Trichloroethylene (TCE) is a chlorinated hydrocarbon with a low dielectric constant. It has a higher density and lower viscosity when compared with water. As with heptane, TCE is practically insoluble in water and has a dipole moment that is much less than the value for water.

Untreated Soil Permeability to Organic Liquids

All the organic chemicals used in this study caused increases in the permeability of one group of soils tested, kaolinite, although the increases were small for acetic acid and methanol. With the natural soil the strong acid (acetic acid) and base (ethanolamine) caused large decreases in permeability.

The two compounds that increased the permeability of these soils the most were heptane and trichloroethylene (TCE). These are the compounds with the lowest dielectric constant and are the only immiscible compounds studied. It would be expected that, for neutral compounds, decreasing the polarity and dielectric constant of the permeant liquid would increase the permeability (Brown and Anderson, 1983).

It may be argued that reagent-grade chemicals are not relevant to field problems. However, the stabilization schemes that were investigated worked under these extreme conditions, and work in more realistic field conditions. Details of the results are discussed in subsequent sections relevant to each alternative.

ALTERNATIVE 8 SOLIDIFICATION OF THE CST LAGOON WITH CEMENT-BASED TECHNIQUES

Cement-based waste fixation techniques owe much of their development to the use of this system in disposal of low-level radioactive waste. The cement-waste radioactive products have been ruled as acceptable for permanent disposal by both U. S. Atomic Regulatory Agencies and the International Atomic Energy Agency (10).

Common cement or "Portland cement" is produced by firing a charge of limestone and clay or other silicates mixtures at a high temperature. The resulting clinker is ground to a fine powder to produce a cement that consists of about 50% tricalcium and 25% dicalcium silicates (also present are about 10% tricalcium aluminate and 10% calcium aluminoferrite). The ''cementation" process is brought about by the addition of water to the anhydrous cement powder. This first produces a colloidal calcium-silicate-hydrate gel of indefinite composition and structure. Hardening of the cement is a lengthy process brought about by the interlacing of thin, densely-packed, silicate fibrils growing from the individual cement particles. This fibrilliar matrix incorporates the added aggregates and/or wastes into a monolithic, rock-like mass. The success of the hardening process is affected by compounds such as sulfates, borates, salts of some metals, and a variety of organic compounds. Five types of portland cements are generally recognized based upon variations in their chemical composition and physical properties (10):

a) Type I is the "normal'' cement of the building trade as described above and constitutes over 90% of the cement manufactured in the USA.

b) Type II is used in the presence of moderate sulfate concentrations (150-1500 mg/kg).

c) Type III has a high early strength and is used where a rapid set is required.

d) Type IV develops a low heat of hydration and is used in large mass concrete work.

e) Type V is a special low-alumina, sulfate-resistant cement used with high sulfate concentrations (#1500 mg/kg).

The types which have been used for waste fixation are Type I and to a much lesser extent Types II and V.

Most hazardous wastes, slurried in water, can be mixed directly with the cement and the suspended solids will be incorporated into the rigid matrix of the hardened concrete. This procedure is especially effective for wastes with high levels of toxic metals since at the pH of the cement mixture most multivalent cations are converted to insoluble hydroxides or carbonates. Metal ions may also be taken into the crystal structure of the cement minerals that form. Materials in the waste such as sulfides, asbestos, latex, and solid plastic wastes may actually increase the strength and stability of the waste concrete. However, the presence of certain inorganic compounds in the hazardous waste and the mixing waters can be deleterious to the setting and curing of the waste-concrete mix (9).

Impurities such as organic materials, silt, clay, coal or lignite may delay setting and curing of common Portland cement for as long as several days. All insoluble materials passing through a No. 200 sieve (#74 micron particle size) are undesirable as they may be present as dust or may coat the larger particulates weakening the bond between the particles and the cement. Salts of manganese, tin, zinc, copper and lead may cause large variations in setting time and significant reductions in physical strength--salts of zinc, copper and lead being the most detrimental. Other compounds which are especially active as retarders of the setting of Portland cement include sodium salts of arsenate, borate, phosphate, iodate, sulfide-even at concentrations as low as a few tenths of a percent of the weight of the cement used. Products containing large amounts of sulfate (such as flue gas cleaning sludges) not only retard the setting of concrete but, by reacting to form calcium sulfoaluminate hydrate cause swelling and spalling in the solidified waste-concrete. The special low alumina (Type V) cement was developed for use in circumstances where high sulfate is encountered to prevent this reaction.

A number of additives have been developed for use with cement to improve the physical characteristics and decrease the leaching losses from the resulting fixed sludge. Many of the additives used in waste fixation are proprietary and cannot be discussed here; but experimental work on the fixation of radioactive waste has shown some improvement in cement-based fixation and retention of nuclear waste by adding clay or vermiculite as absorbents (6). Sodium silicate has reportedly been used to bind contaminants in cement fixation processes, but this additive causes an increase in volume to occur during the setting of the cement-waste mixture.

Test results for cement stabilized soils are summarized (20)

Permeabilities to Water. The addition of cement reduced the permeability of both soils to water. The average permeability of cement-treated soils to water was 20% of the average permeability of the untreated soil to water. Thus, the addition of cement to the soils provided a significant reduction in the baseline permeability to water.

With both soils, cement was a more effective additive than lime in reducing the permeability to water.

Permeabilities to Organic Chemicals. Typical plots of permeability versus pore volumes of flow for kaolinite are shown in Figs. 5.9 (acetic acid), 5.10 (ethanolamine), 5.11 (heptane), and 5.12 (TCE).

Except for one test, the cement-stabilized soils were less permeable to the organic chemicals than the untreated soils were to water. The permeability of the cement-treated soil to organic liquids was far less than the average for untreated soils. Cement worked slightly better for the natural soil group than for kaolinite. Cement stabilization worked better than lime for the soils at the mix proportions used in this study.

ADVANTAGES

Advantages of the cement-based fixing systems are:

a) Raw materials are plentiful and inexpensive.

b) The technology and management of cement mixing and handling is well known; and the equipment is commonplace. Specialized labor is not required.

c) Extensive drying or dewatering of waste is not required because cement mixtures require water and the amount of cement added can be adapted to wide range of water contents.

d) The system is very "tolerant" of chemical variation. The natural alkalinity of the cement used can neutralize acids. Cement is not effected by strong oxidizers such as nitrates or chlorates. Pretreatment is required only for materials that retard the setting reactions of cement.

e) Variation in the amount of cement used can produce very high bearing capacities making the waste concrete good

DISADVANTAGES

Disadvantages of cement-based systems are:

a) Relatively large amounts of cement are required for most fixing processes. However this may, in part, be off-set by the low cost of material. The weight and volume of the final product is normally about double that of other solidification processes.

b) Uncoated cement-based products may require a well-designed landfill for burial. Experience in radioactive waste disposal indicates that some wastes are leached from concrete, especially by mildly acidic leaching solutions.

c) Extensive pretreatment, high cement to soil volume ratios or higher cost cement types or additives may be necessary for wastes containing large amounts of impurities which effect the setting and curing of the waste-concrete (such as borates and sulfates).

d) The alkalinity of cement drives off ammonium ion as ammonia gas.

ALTERNATIVE 9 SOLIDIFYING CST LAGOON WASTE WITH LIME-BASED TECHNIQUES

Waste fixation techniques based on lime-products usually depend on the reaction of lime with a fine-grained siliceous (pozzolanic) material and water to produce a concrete-like material (sometimes referred to as a pozzolanic concrete). The most common pozzolanic-type materials used in waste treatment are flyash, ground blast-furnace slag or cement-kiln dust. All of these materials are themselves waste products with little or no commercial value. The use of these waste products to consolidate another waste often results in a cost saving.

The composition of flyash is very similar to that of Portland cement. The process of flyash solidification after addition of water is also like that of Portland cement in forming concrete. This solidification process involves a complex sequence of several steps including dissolution, diffusion, hydration, nucleation and crystal growth. These steps occur in series and also in parallel, and much of the water added or present in the waste becomes a part of the hydrate crystals. It has been established that, when mixed with Portland cement, the constituents of hazardous waste in water and/or sludge are fixed in the solid phase of Portland cement concrete through a variety of chemical and physical phenomena; these phenomena include chemical bonding, chelate formation, complexation, chemisorption, adsorption, entrapment in crystalline structure of concrete, and entrapment in micropores of the concrete.

The diameter of particles of flyash is substantially smaller than that of particles of Portland cement; the former is approximately 25 to 50% of the latter. Furthermore, the particles of flyash are far more spherical than those of Portland cement. In comparison with Portland cement, therefore, flyash possesses far greater reactive surface and volume, yields much denser concrete, and generates pores with substantially smaller diameters. The ability of flyash to react with or entrap the constituents of hazardous waste exceeds that of Portland cement.(1)

<u>Permeabilities to Water</u> The addition of lime reduces the permeability of soils to water. For example, untreated kaolinite soil has an average permeability to water of 7 x 10 -8 cm/sec, but lime-treated kaolinite is only about half as permeable to water (3 x 10-8 cm/sec).

<u>Permeabilities to Organic Liquids</u> The permeabilites of the lime-stabilized soils to the organic liquids are summarized. The highest permeability recorded on any of the lime treated soils reviewed was 4 x I0 -7 cm/sec, which is 250 times lower than the highest value 1 x 10-4 cm/sec recorded for any untreated soil. The addition of lime to the soils improved their resistance to permeability increases. Typical comparative plots of permeability versus pore volumes of flow through heptane are shown in Figs. 5.3 acetic acid, 5.4 ethanolamine, 5.5 heptane. and 5.6 TCE. The improvement provided by the lime is clearly seen.

While lime treatment did not prevent permeability increases for all liquids, it did make the soils much more resistant to large permeability increases. With untreated soil, the soil was up to 3,000 times more permeable to organic chemicals than to water. With lime treatment, the soils were no more than about 30 times more permeable to organic chemicals than the untreated soils were to water. For the organic liquids that caused large permeability increases in untreated soil, treatment of the soil with lime caused at least an order-of-magnitude reduction in permeability to that same chemical.

Lime treatment appears to offer significant enhancement of the ability of stabilized materials to resist attack by concentrated organic chemicals.

The reason why lime reduces the susceptibility of the soil to attack by concentrated organic chemicals is probably related to the cementing action of lime. Lime reacts with clay to form a pozzolanic cement. The cement binds the soil particles together, making the soil much stronger. When an organic chemical is introduced into soil, the liquid tends to cause the clay particles to flocculate. Flocculation can lead to formation of large pore spaces and cracks. However, if the particles are cemented together, they cannot undergo deleterious rearrangement i.e.. the particles cannot flocculate and the soil cannot crack.

In the proposed method, clay soil/lime kiln dust and sludge was mixed in various proportions. The mixture supplies the clay soil that binds the sludge and is itself bound up in the pozzolanic reaction.

ADVANTAGES

Advantages of lime-based techniques which produce pozzolan cements are several:

(a) The materials are often very low in costs and widely available.

b) Little specialized equipment is required for handling lime.

c) The chemistry of lime-pozzolanic reactions is relatively well-known.

d) Extensive dewatering is not necessary because water is required in the setting reaction.

DISADVANTAGES

The lime-based systems have many of the same potential disadvantages as cement-based techniques:

a) Lime and other additives add to the weight and bulk to be transported and/or landfilled unless the material is solidified in-situ.

b) Uncoated lime-fixed materials may require specially designed landfills to guarantee that the material does not lose potential pollutants by leaching.

(c) A portion of the constituents of hazardous waste and water remains unfixed and lodges in the macropores of Portland cement concrete. Some hazardous waste constituents tend to inhibit hydration of the components of cement, and may reduce the mechanical strength and impurity containment capacity of the concrete.

(d) Flyash tends to flash set especially when it is mixed with waste, and the relatively small amount of calcium in flyash inhibits the capacity of flyash to fix, solidify and contain the constituents of hazardous waste. Various additives are available to retard the flash setting of flyash.

ALTERNATIVE 10 SOLIDIFY THE CST LAGOON WASTE WITH REACTIVE FLYASH WITH THE AID OF ADDITIVES

Additives for concrete or flyash have been developed to eliminate the two factors deterring the use of flyash for fixation, solidification and containment of hazardous waste. The first major component of the additives delays flash setting of flyash when it is mixed with water or sludge, and an additional component enhances the mechanical strength of the resultant concrete. Proper procedure have been established to apply the additives. F2S is such a product marketed by Lindsay Liner, of Topeka, Kansas.

The additive chemical compounds are added to fly ash, Portland cement and other inorganic chemicals for the purpose of cross-linking the organic and inorganic particles of a matrix through a five phase cementation process that reduces the coefficient of permeability and reduces the matrix plasticity index while increasing its mechanical internal strength into a load bearing mass upon solidification. The process provides a micro encapsulation that surrounds and seals that portion of the matrix not chemically incorporated into the reaction. The cementitious products from the fly ash and other inorganic compounds of the mixture produce reactions that are thoroughly distributed over particulate surfaces throughout the mass (micro encapsulation).

In nearly all cases, the formulation of the ingredients of solidification needs to be modified to a specific waste, so that the waste material (chemistry permitting) takes an active role in the cementation phase of stabilization. Some waste materials will function as a chemical reagent in its own disposal, contributing to physical hardening and reducing or eliminating permeation and leaching characteristics. The permeability decreases exponentially with increasing mechanical strength development. The permeability and consequently the leaching rates decrease with decreasing pore volume.

Note: The alternatives that follow were dismissed as too costly.

ALTERNATIVE 11 THERMOPLASTIC TECHNIQUES (INCLUDING BITUMEN, PARAFFIN AND POLYETHYLENE)

Development of the use of thermoplastic fixation systems in radioactive waste disposal has led to a waste containment system that can be adapted to industrial wastes. In processing radioactive waste with bitumen, or other thermoplastic material, the waste is dried, heated and dispersed through a heated plastic matrix. The mixture is then cooled to solidify the mass, and is usually buried in a secondary containment system such as a steel drum, Variations of this fixation system can use other thermoplastic organic materials such as paraffin or polyethylene.

The principal disadvantages of thermoplastic-based disposal systems is that the technique is expensive. Complicated equipment is required and highly specialized labor is necessary for processing that makes the method inappropriate for low hazard sludges.

ALTERNATIVE 12: ORGANIC POLYMER TECHNIQUES

Organic polymer techniques were developed as a response to the requirement for solidification of radioactive waste for transportation. The most thoroughly tested organic polymer solidification technique is the urea-formaldehyde (UF) system. The polymer is generally formed in a batch process where the wet or dry wastes are blended with a prepolymer in a waste receptacle (steel drum) or in a specially designed mixer. When these two components are thoroughly mixed, a catalyst is added and mixing is continued until the catalyst is thoroughly dispersed. Mixing is terminated before the polymer has formed and the resin-waste mixture is transferred to a waste container if necessary. The polymerized material does not chemically combine with the waste; it forms a spongy mass that traps the solid particles. Any liquid associated with the waste will remain after polymerization. The polymer mass must often be dried before disposal.

The major disadvantages of the organic resin technique, especially the urea-formaldehyde resin system, is the high cost of this alternative. This method was rejected.

ALTERNATIVE 13: ENCAPSULATION TECHNIQUES

All fixation systems depend on binding particles of waste material together. To the extent to which the binder coats the waste particles, the wastes are encapsulated. The systems addressed under encapsulation are those in which waste that has been bonded together is inclosed in a coating or jacket of inert material. A number of systems for coating solidified industrial wastes have been examined by TRW Corporation (12). In most cases coated materials have suffered from lack of adhesion between coatings and bound wastes and lack of long-term integrity in the coating materials. After investigating many alternative binding and coating systems, TRW Corporation produced detailed plans for what it considered the optimum encapsulation system. The TRW-developed system has been thoroughly tested and published data on the process are available (16). The system is appropriate to highly hazardous materials.

ALTERNATIVE 14: SELF-CEMENTING TECHNIQUES

Some industrial wastes such as the flue gas cleaning or desulfurization sludges contain large amounts of calcium sulfate or calcium sulfite. A technology has been developed to treat these types of wastes so that they become self-cementing (17). Usually a small portion (8-10% by weight) of the dewatered waste sulfite/sulfate sludge is calcined under carefully controlled conditions to produce a partially dehydrated cementitious calcium sulfate or sulfite. This calcined waste is then reintroduced into the waste sludge along with proprietary additives. Flyash is added to adjust moisture content. The finished product is a hard, plaster-like material with good handling characteristics and low permeability.

The method is appropriate to high sulfate or high sulfite sludges.

ALTERNATIVE 15: GLASSIFICATION

Where material is extremely dangerous or radioactive, it is possible to combine the waste with silica and fuse the mixture into glass (18). Glasses are only very slowly leached by naturally-occurring water, so this approach is generally assumed to produce a safe, material for disposal without secondary containment. The major disadvantage of glassification is that the process is energy-intensive. A charge must be heated to 1350 degrees C to produce a satisfactory melt.

CONCLUSIONS

Soil Compaction Decreases the Permeability of Soils to Organic Chemicals

Compaction of soils with the modified Proctor compaction procedure produces denser soils that are slightly less permeable to water compared with samples of soil compacted with the standard proctor procedure. However, the soils compacted with the modified Proctor procedure were approximately 1,000,000 times less permeable to heptane and trichloroethylene (TCE) than the samples compacted following standard Proctor procedures. The samples compacted following the modified Proctor procedure were so impermeable to the organic chemicals that only a fraction of a pore volume of liquid could be forced through the clay; it is not known whether the permeabilities might eventually increase. However, mechanical stabilization of the clay soil that was studied produced a large improvement in the ability of the soil to resist attack by concentrated organic chemicals. Clays that are highly impermeable to concentrated organic chemicals might be obtained simply by compacting soil with bigger, heavier equipment than is commonly used today for clay compaction. Such equipment is available and is used, for example, in earthwork for airports, highways, and buildings.

Lime Stabilization of Soils Significantly Decreases Permeability

The addition of lime to soils significantly improves the ability of the soils to maintain low permeability when exposed to concentrated organic chemicals. Chemicals that produced large increases in the permeability of untreated soils produced 100-fold smaller permeabilities when the soils were treated with lime.

Cement Stabilization Significantly Reduces Soil Permeability

The addition of cement to clay soils significantly lowers the permeability of the soil both to water and to reagent-grade organic chemicals. The cement-treated soils are generally less permeable to the organic liquids than the untreated soils were to water.

The reason why lime, cement, and sodium silicate is so effective in stabilizing clay against attack by concentrated organic liquids is probably related to the cementing action of the additives. The mechanism by which organics attack clay is flocculation and dewatering of clay particles, which can cause formation of large pores and cracks. If particles are cemented together, they cannot undergo the deleterious rearrangement.

The reasons why modified Proctor compaction is so effective is not so obvious. However, the denser the soil particles are packed together, the more difficult flocculation of particles becomes

Methods for treating soil, using well established techniques, have been shown to be effective in stabilizing soils against attack by concentrated organic liquids. The stabilization schemes are also effective for more dilute waste sludges.

In experiments conducted by The PQ Corporation on the most effective way of solidifying an organic hazardous waste to meet the USEPA requirement of fifty (50) psi minimum compressive strength. In this study samples of a synthetic organic waste were treated for solidification using recipes that included a cement kiln dust, a lime kiln dust, two types of absorbant clay and sodium silicate. These treated samples were then evaluated for unconfined compressive strength, volume increase and for treatment cost. Based on the results of this study, the following recommendations were made on the best method to use for treating organic hazardous waste.

The lime kiln dust was found to be the most reactive of all the materials tested during this study. Samples prepared using this material had the lowest dust loading and the highest compressive strengths.

Results from this study indicate that the addition of clay improves the containment of an oily waste and increases the final strength of the solidified material. Clay was found to be superior to the clay dust for oily waste treatment.

The addition of small amounts of Portland cement Type I to a solidification formulation will increase the final strength of a solidified waste.

The addition of five percent (5%) N sodium silicate will increase the final compressive strength of a solidified waste by an average of seventeen percent (17%).

A treatment formulation based on the addition of lime kiln dust, clay product and N sodium silicate was found to be the least expensive method of achieving the fifty (50) psi minimum compressive strength requirement.

Based on reactivity and cost, lime kiln dust should be used as the major component in all organic waste solidification formulations.

Portland Cement Type I should only be used for treating problem wastes or if cost is not considered a major factor.

The addition of clay is recommended for all solidification formulations.

The addition of N sodium silicate is also recommended for all solidification formulations based on its performance and low cost.

These formulations and recommendations were based on the treatment of oily wastes only.

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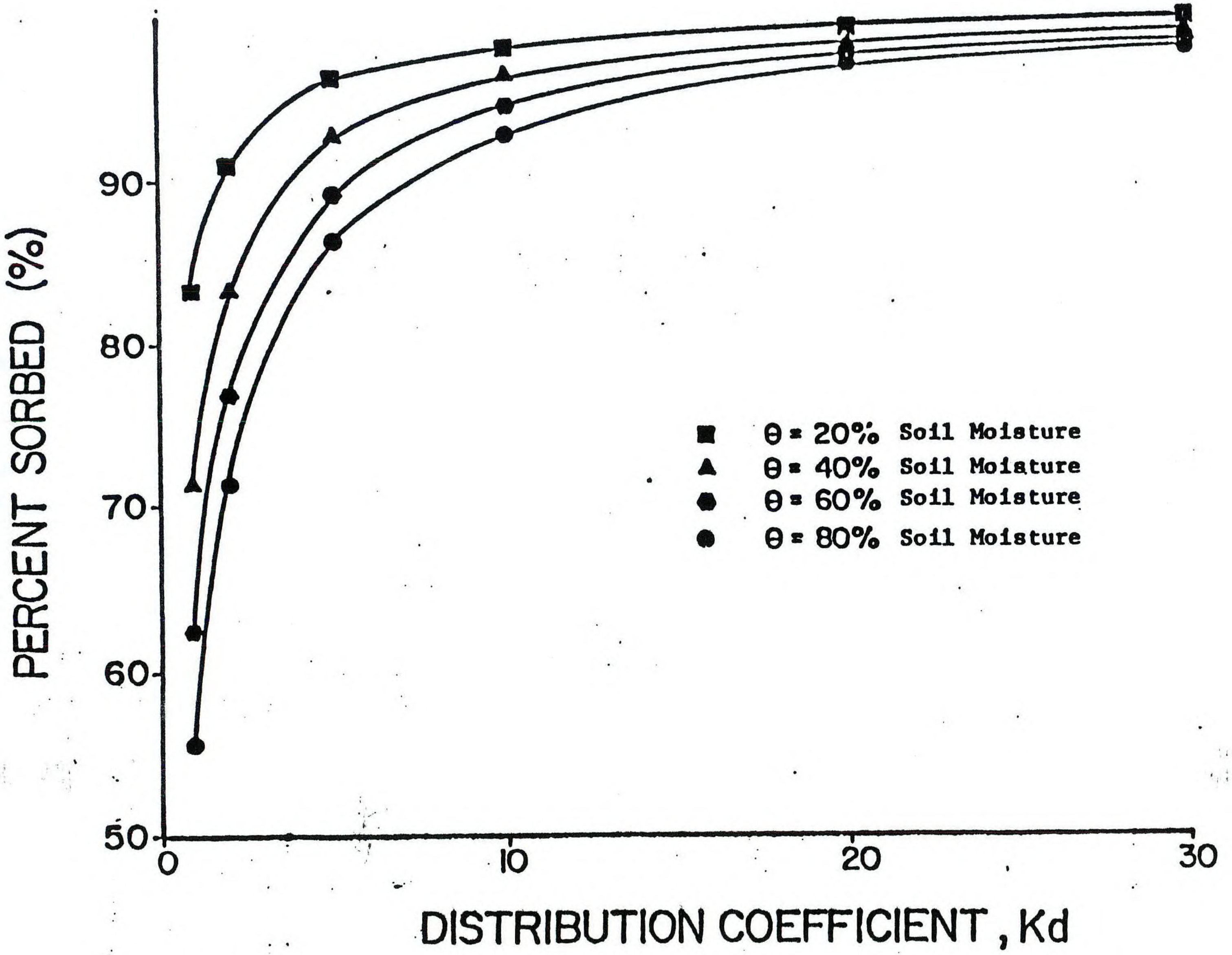

Figure 1: EXTENT OF SORPTION AS A FUNCTION OF SOIL MOISTURE θ AND Kd.

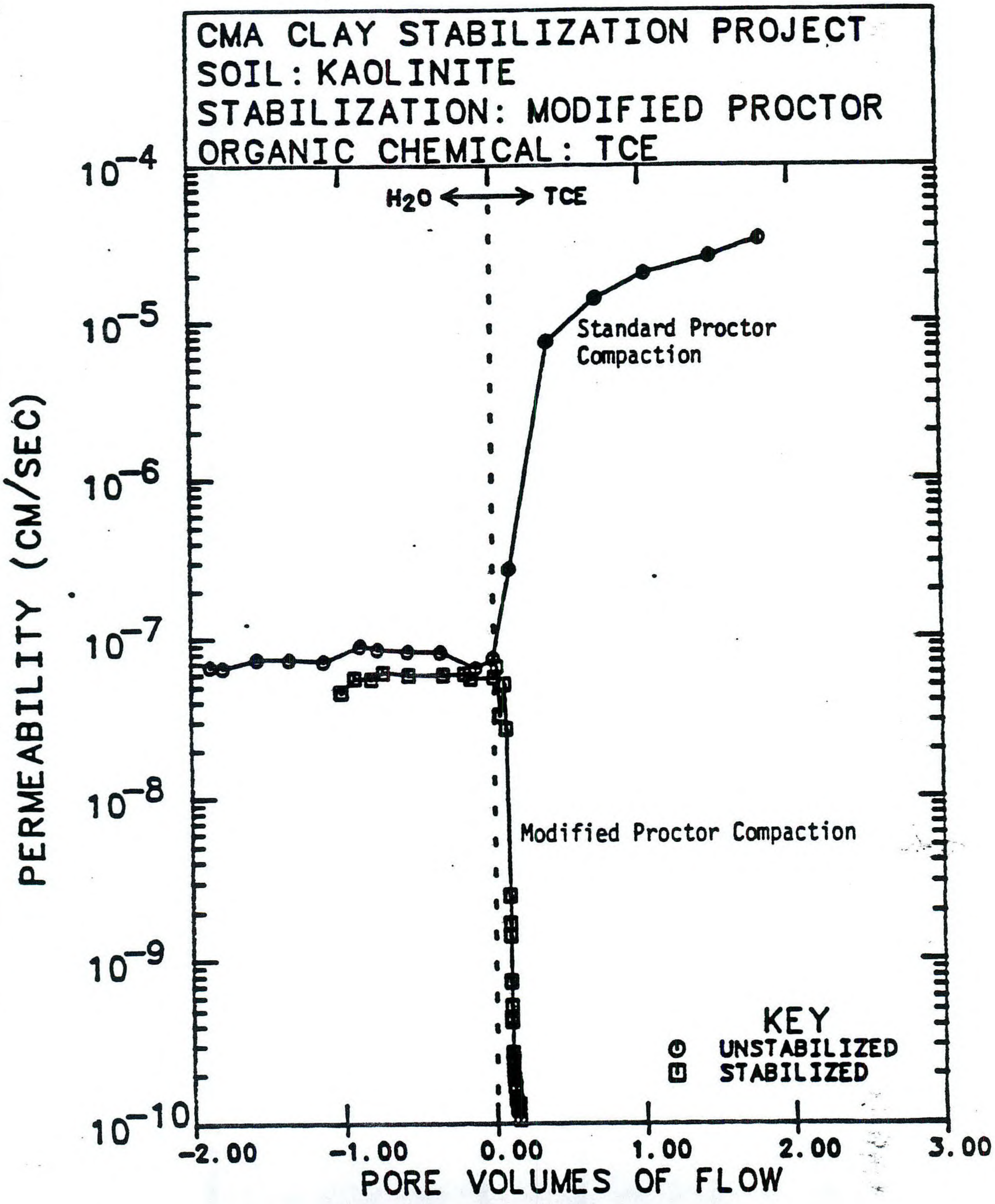

Figure 5.2 Effect of Modified Proctor Compaction on the Permeability of Kaolinite that Was Permeated with Water and then Trichloroethylene.

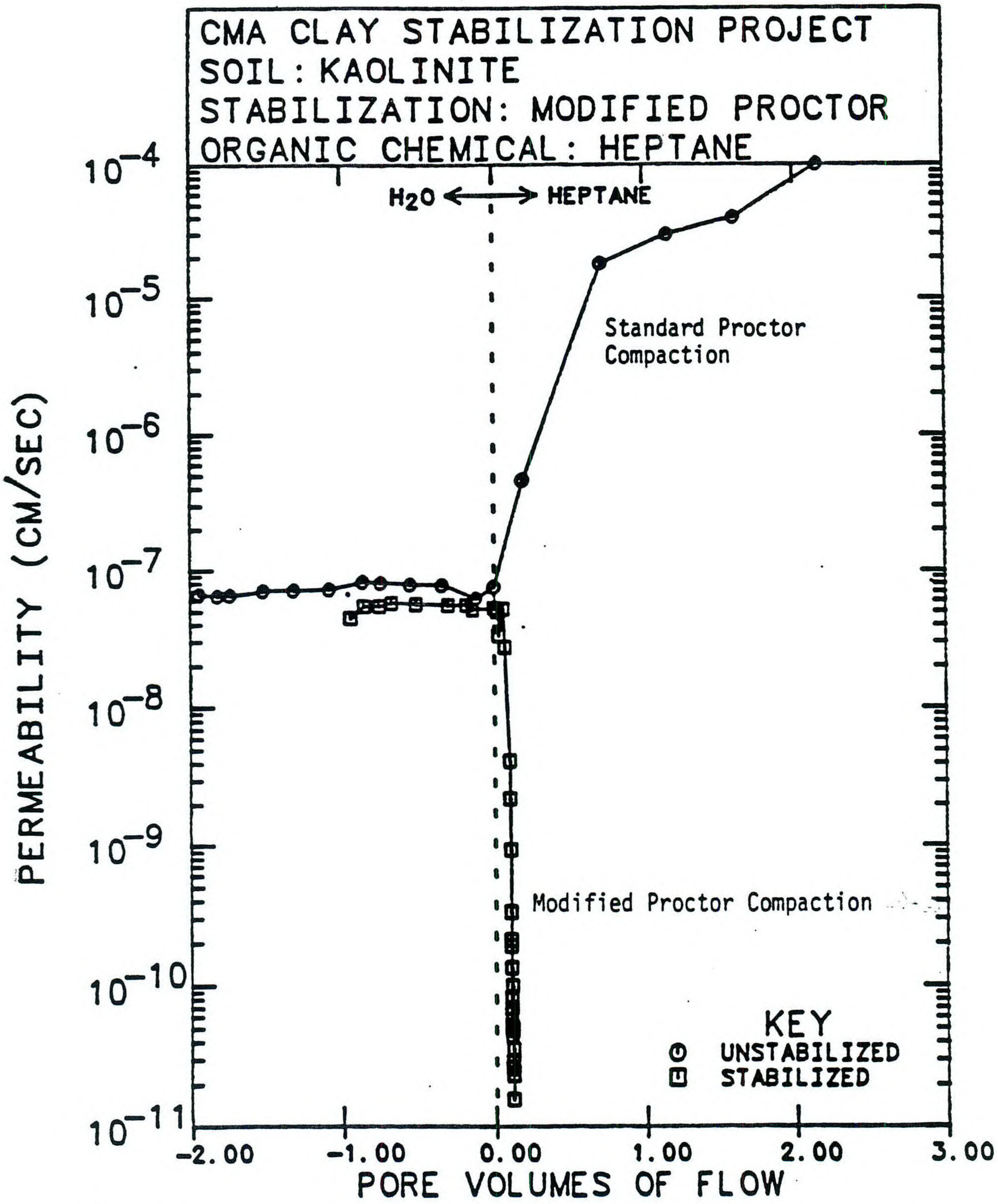

Figure 5.1 Effect of Modified Proctor Compaction on the Permeability of Kaolinite that Was permeated with Water and then Heptane.

Table 1

Properties of Permeant Liquids

Fluid	Type	Melting Pt °C	Boiling Pt °C	Density @20°C($^{gm}/cm^3$)	Viscosity @20°C (cps)	Dielectric Constant @20°C	Water Solubility at 20° C	Molecular Weight	Dipole Moment (debyes)
Acetic Acid $C_2H_4O_2$	Acid	17	118	1.05	1.28	6.2	miscible	60.1	1.04
Ethanolamine C_2H_7NO	Base	10	171	1.02	24.1	37.7	miscible	61.1	2.27
Heptane C_7H_{16}	Neutral Nonpolar	-91	98	0.68	0.41	2.0	52 ppm	100.2	0
Methanol CH_4O	Neutral Polar	-98	65	0.79	0.54	31.2	miscible	32.0	1.66
Trichloroethylene C_2HCl_3	Chlorinated	-73	87	1.47	0.58	3.4	1100ppm	131.4	0.90
Water H_2O	Neutral Polar	0	100	0.98	1.0	80.1		18.0	1.87

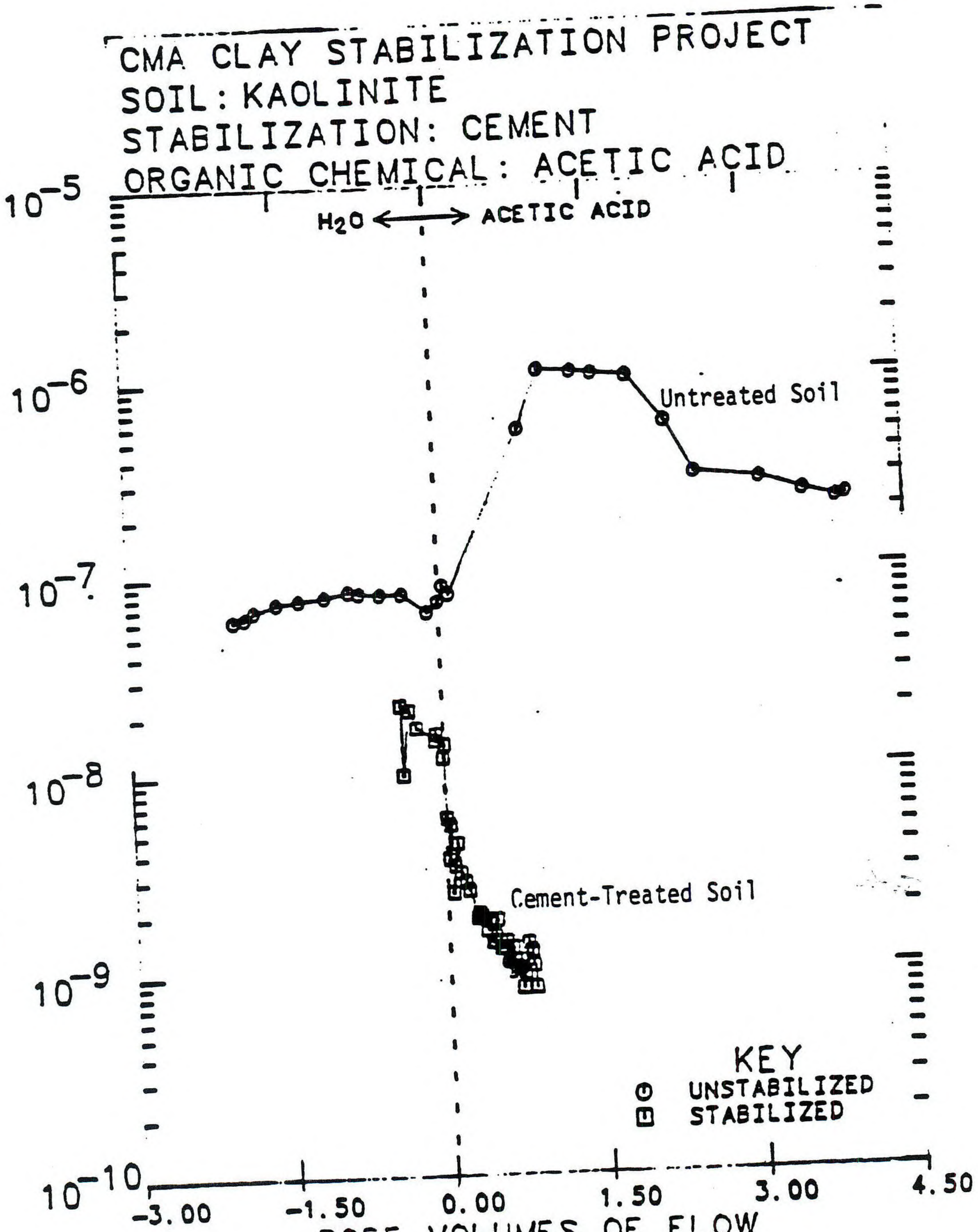

Figure 5.9 Effect of Cement Treatment on the Permeability of Kaolinite that Was Permeated with Water and then Acetic Acid.

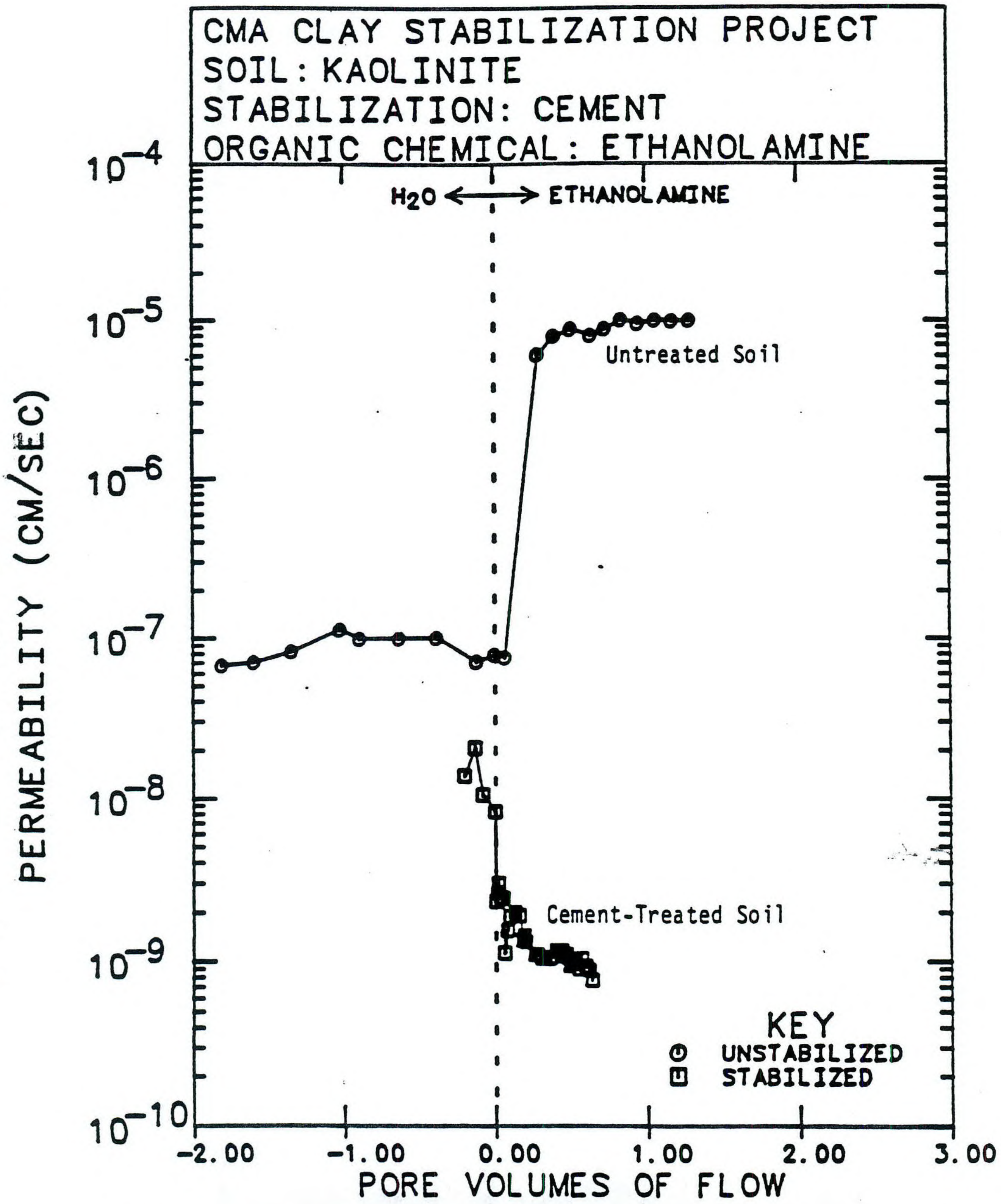

Figure 5.10 Effect of Cement Treatment on the Permeability of Kaolinite that Was Permeated with Water and then Ethanolamine.

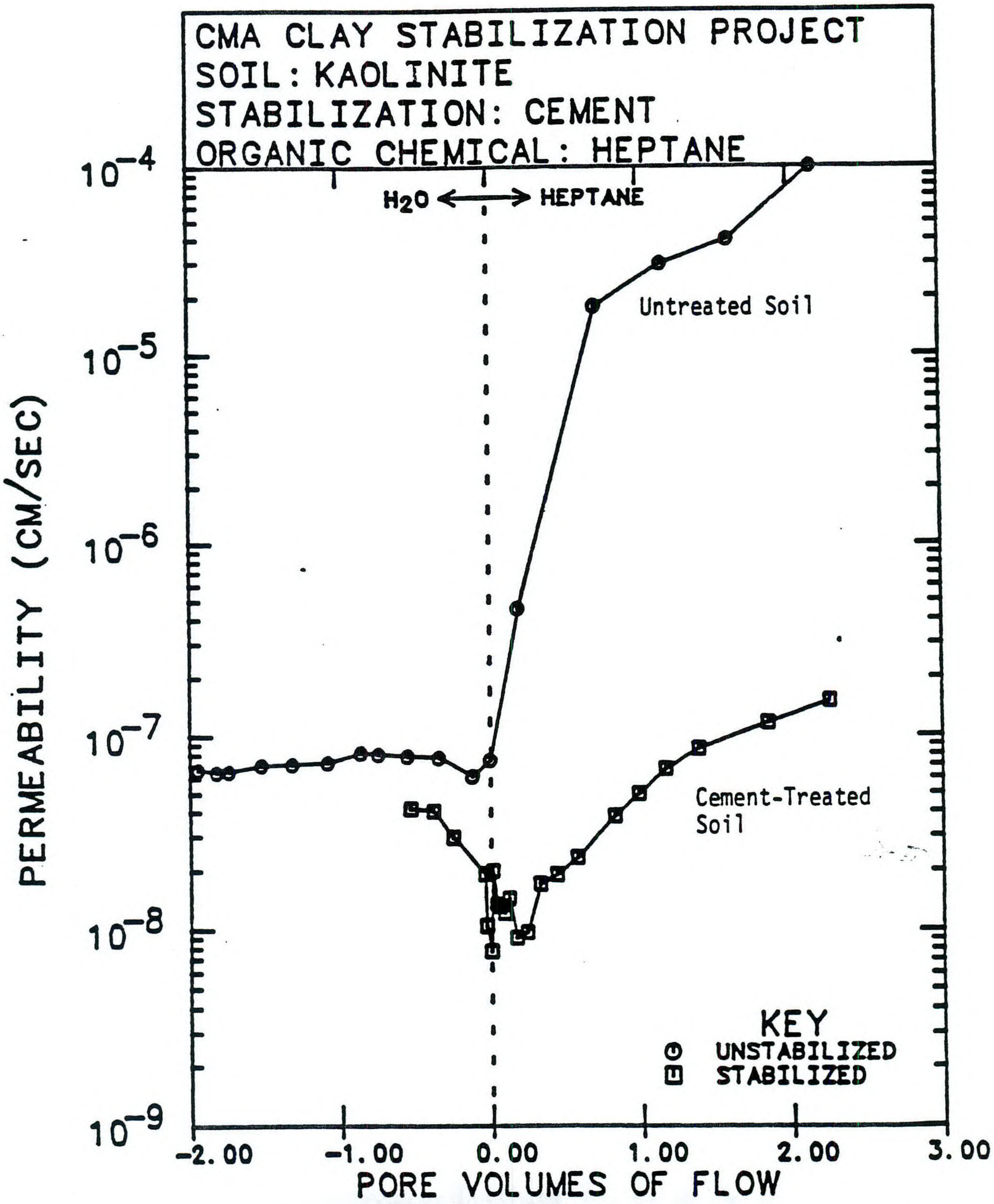

Figure 5.11 Effect of Cement Treatment on the Permeability of Kaolinite that Was Permeated with Water and then Heptane.

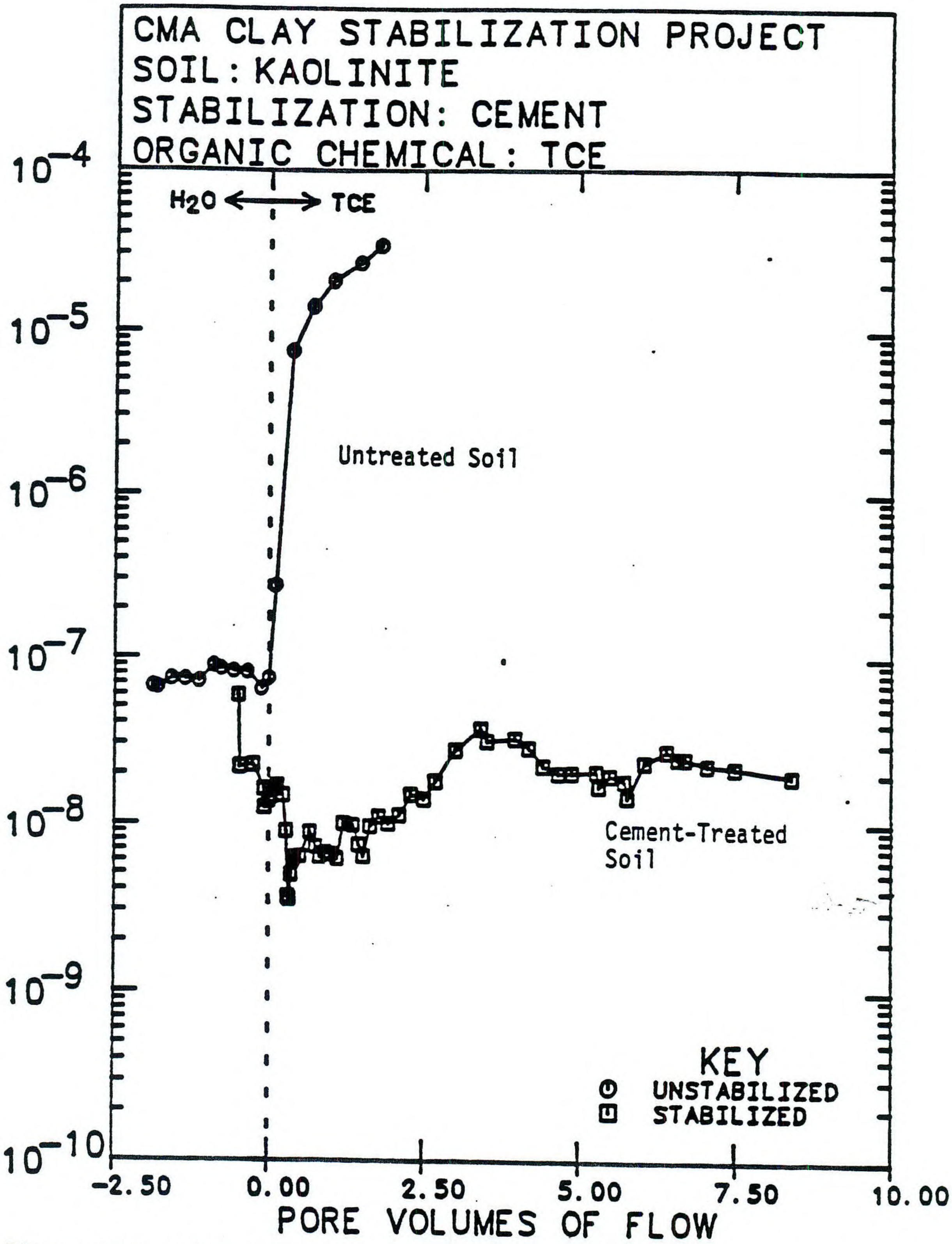

Figure 5.12 Effect of Cement Treatment on the Permeability of Kaolinite that was Permeated with Water and then Heptane.

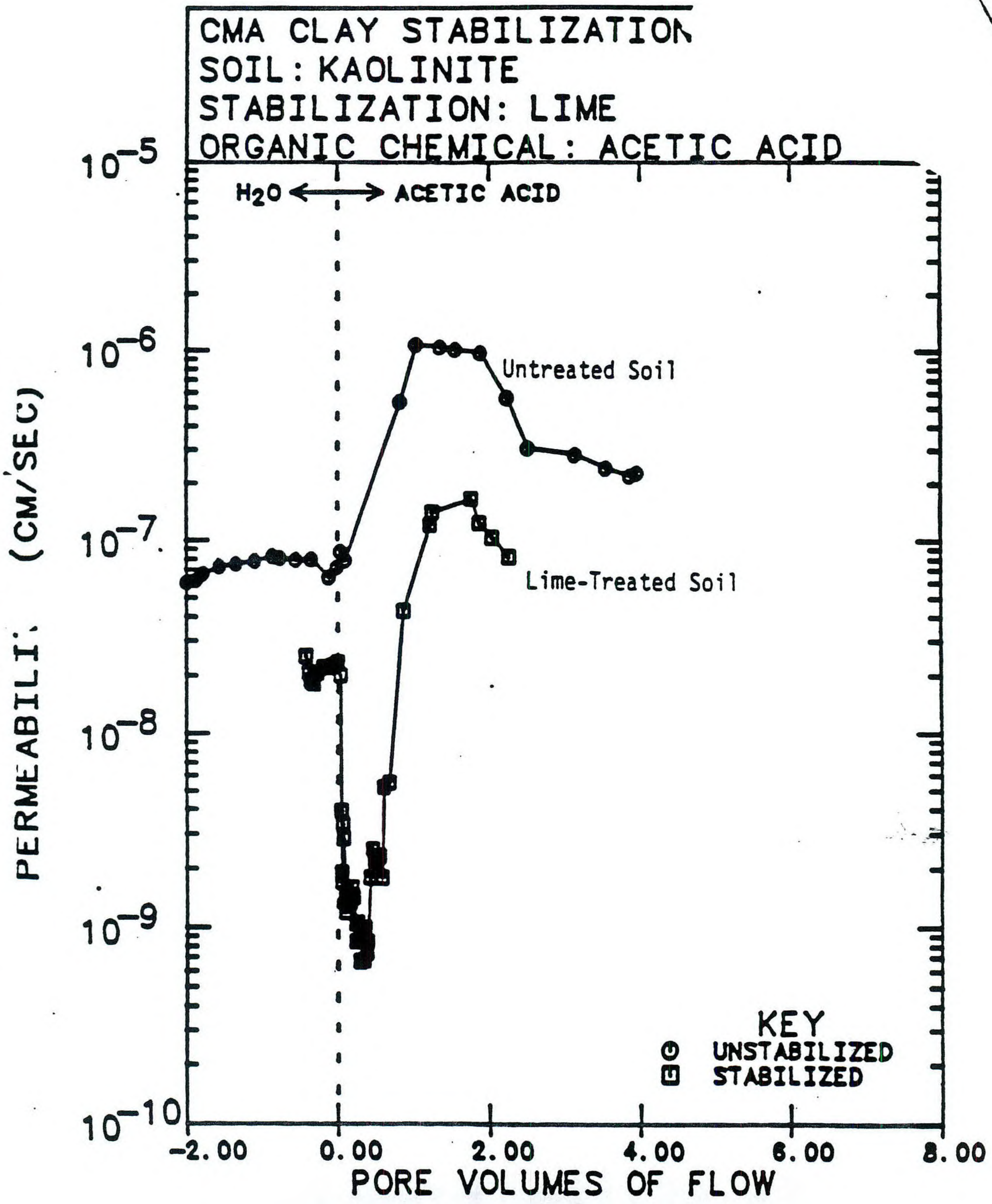

Figure 5.3 Effect of Lime Treatment on the Permeability of Kaolinite that Was Permeated with Water and then Acetic Acid.

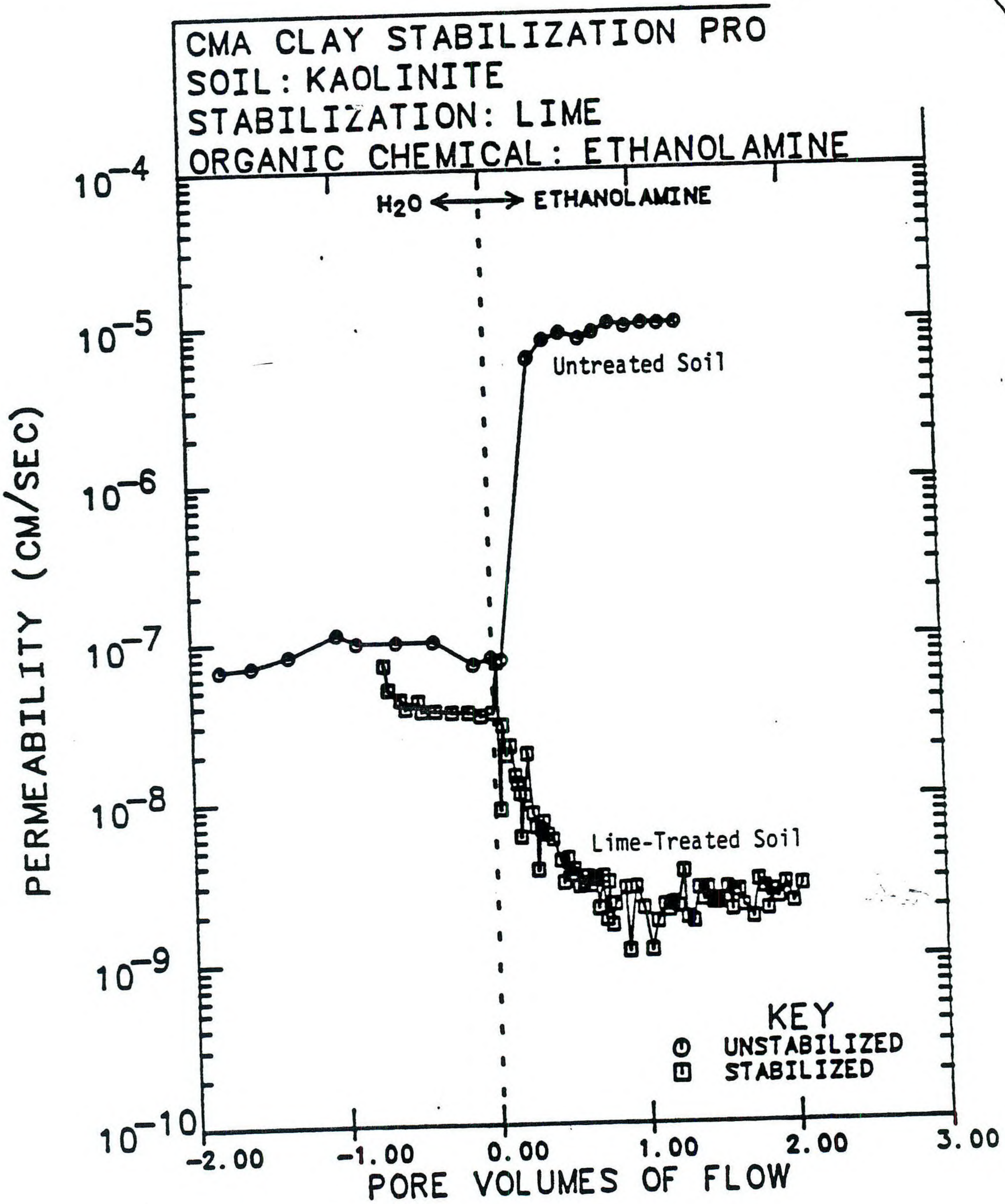

Figure 5.4 Effect of Lime Treatment on the Permeability of Kaolinite that Was Permeated with Water and then Ethanolamine.

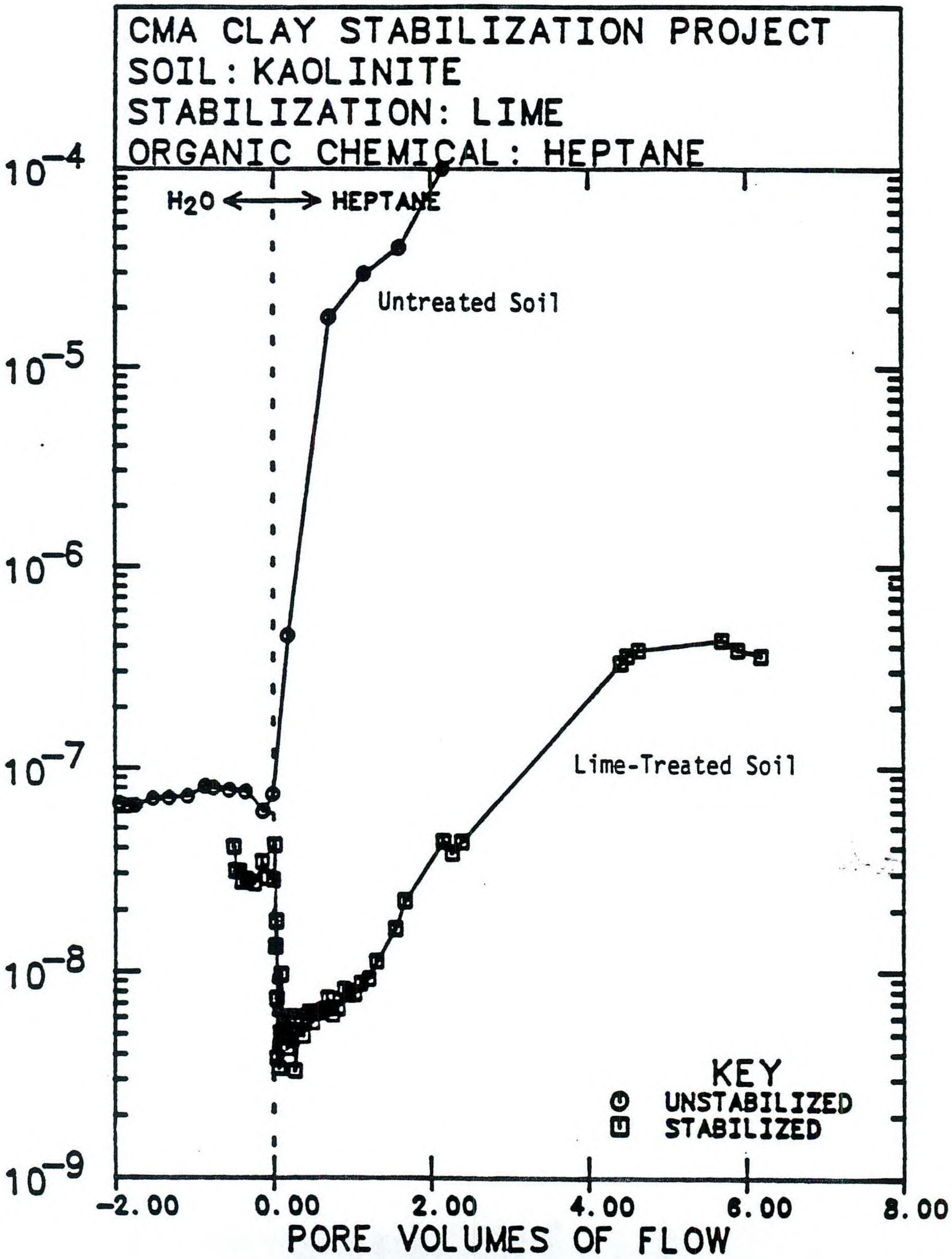

Figure 5.5 Effect of Lime Treatment on the Permeability of Kaolinite that Was Permeated with Water and then Heptane.

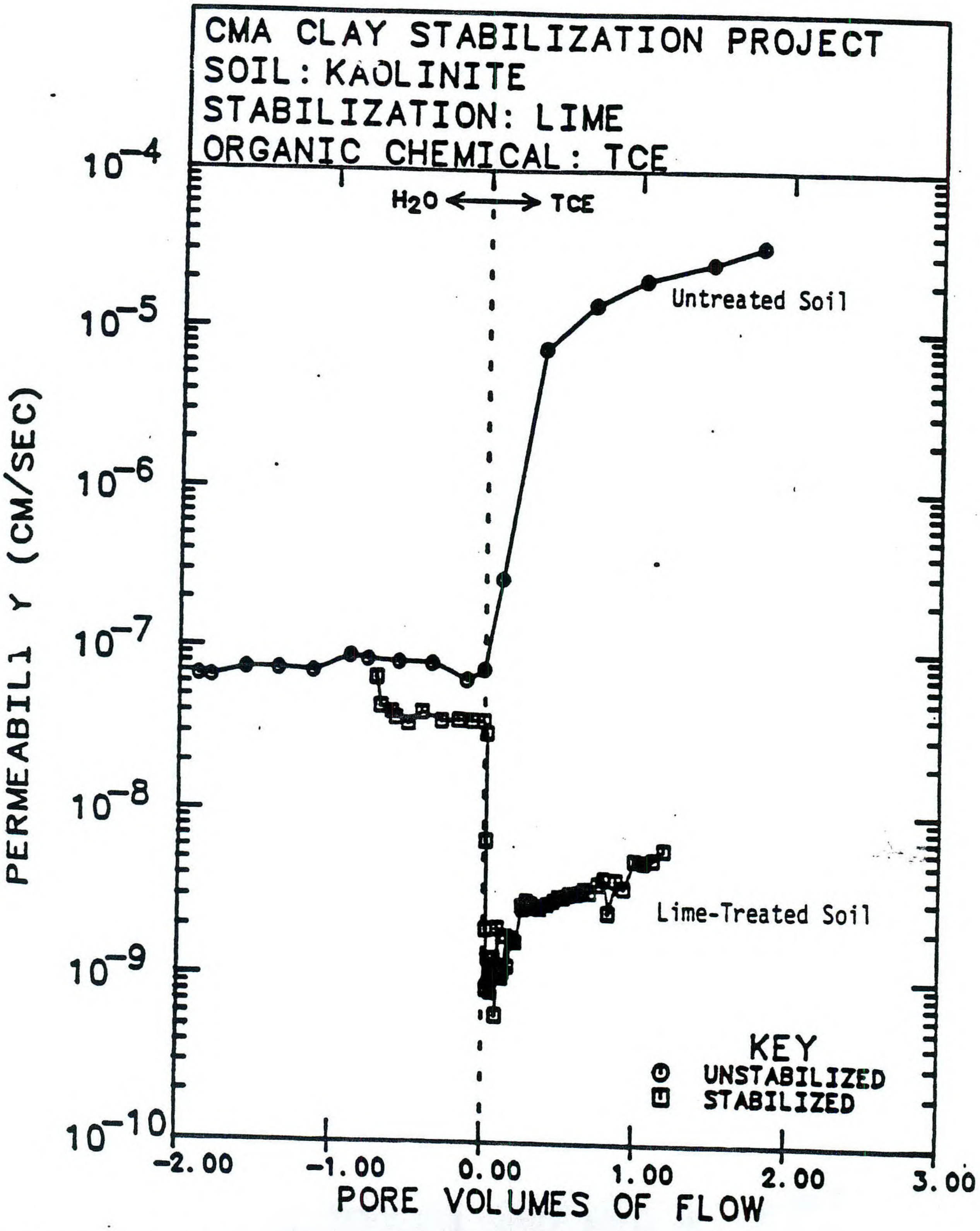

Figure 5.6 Effect of Lime Treatment on the Permeability of Kaolinite that Was Permeated with Water and then Trichloroethylene.

Fixation/Solidification of Hazardous Waste At Chemical Waste Management's Vickery, Ohio Facility

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ABSTRACT

Chemical Waste Management, Inc. is ceasing treatment of hazardous/toxic wastes in open surface impoundments at the Vickery, Ohio, Facility. The lagoons are being closed and wastes which are highly acidic are being neutralized and chemically fixed with dolomitic quicklime and cement kiln dust. This fixed material then will be placed in a secure landfill.

The paper describes the reagent selection and the procedures and methods used to solidify the toxic sludge which produced 250,000 yd of fixed material. The design of the landfill to hold the hazardous material also is described.

INTRODUCTION

The Chemical Waste Management site at Vickery, Ohio, is located six miles east of Fremont, Ohio, on State Route 412. The 248-acre site is bounded by the turnpike to the North, State Route 412 to the South, State Route 510 to the East, and County Road 244 to the West. Only about 97 acres are used for the waste disposal operations; the remaining land is farmed (Figure 1).

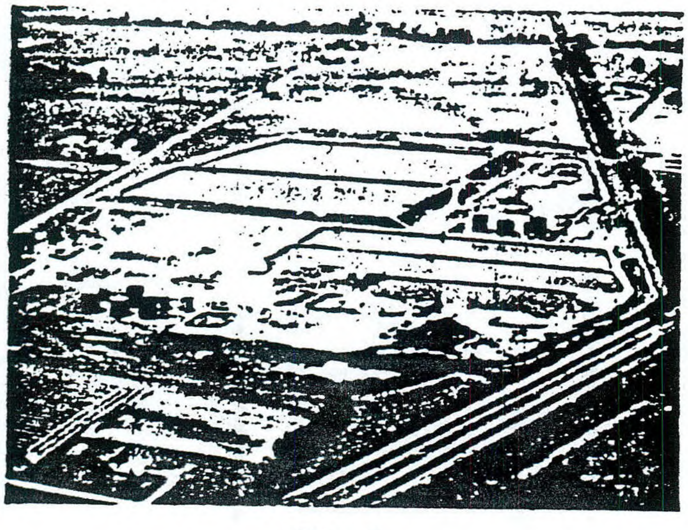


Figure 1
General View of Chemical Waste Management, Inc. Site, Vickery, Ohio, Showing Surface Impoundments to be Closed.

The Site originally was started by a local resident in 1964 for the purpose of oil recovery. In order to "crack" the oil emulsions, acid was required. For economic reasons, waste acid was used and this led to the construction of surface impoundments in 1970 to hold this material. From those early beginnings, the site developed. By 1971, five lagoons existed.

The first deep well permit was obtained in 1975, because disposal by evaporation was considered an unacceptable method of disposal by the authorities. Four deep wells had been permitted by the time Chemical Waste Management, Inc. purchased the site in 1978. Two further wells have been installed since that time.

In early 1983, PCBs (less than 500 ppm) and dioxins were found on-site in three of the surface impoundments. The Company, in negotiations with both the State of Ohio EPA and the U.S. EPA, decided to close all five surface impoundments that remained on-site. Because the controlling regulations for disposal would be the PCB regulations promulgated under TSCA, the available options permitted were limited to disposal in an approved landfill, incineration in a U.S. EPA-approved incinerator or disposal via some alternative methods approved by the U.S. EPA Regional Administrator. A risk assessment study was undertaken which showed that off-site disposal with the large volume of material and distance to an approved disposal site posed a greater risk than on-site disposal. It was, therefore, decided to develop a plan to stabilize and fix the material and dispose of it in an on-site closure cell, which would be acceptable to both the U.S. EPA and the Ohio Environmental Protection Agency (OEPA).

This proposal was further influenced by the natural soil condition of the area, which comprises a very low permeability clay. The area, which is rural, requires the installation of extensive land drainage systems by local farmers.

CLOSURE PLAN

The initial concept for closing the impoundments was fairly simple and straightforward. There was excess land on-site where a land cell could be constructed and site personnel had solidified pond sludges in the past utilizing a mixture of sugar beet tailings and lime kiln dust.

However, as discussions with the U.S. EPA developed, it became clear that a restriction on the closure cell was likely to be imposed. For a variety of reasons, the U.S. EPA required that any closure cell constructed at the site for the disposal of fixed material from the ponds should occupy the same location that initially was occupied by the three impoundments containing the PCBs.

Because of this, an additional restriction resulted: the volume of material the closure cell could hold was limited by the plan area of the three ponds and a restriction on the height to which the cell could be filled. Any reagents used for the fixation process would, therefore, have to keep "bulking" to a minimum.

SELECTION OF REAGENTS

Battelle-Columbus Laboratories were retained to evaluate a variety of solidification agents. Eight various combinations were used (Table 1), and evaluated on the basis of the Extraction Procedures toxicity test as described in the *Federal Register*, May 19, 1980; in addition priority pollutants PCBs, and 2, 3, 7, 8 tetrachlorodibenzo-*p*-dioxin (2, 3, 7, 8-TCDD) were measured. In addition to assessing the efficiency of fixation, "bulking" of the resultant fixed material also was assessed.

Samples of unfixed sludge and fixation materials were subjected to extraction and analysis for the contaminants mentioned above, using U.S. EPA protocols. For each system, the effectiveness of the stabilization alternatives were compared in what was the relative attenuation of the contaminants. Analyses of the samples were reviewed and compared.

None of the three contaminant compounds found in the pond sludges and deemed particularly important at the outset of the study, namely 2, 3, 7, 8, tetrachlorodibenzo-*p*-dioxin (dioxin), polychlorinated byphenyls (PCBs) and dichlorobenzidine (DCB) were detected in any of the leachates generated.

Table 1.
Composition of Sludge Fixation Alternatives
(All Parts on a Weight Basis)

System I

100 parts sludge
35 parts cement kiln dust
40 parts sugar beet tailings
15 parts steel pickle liquor

System II

100 parts sludge
20 parts cement kiln dust
60 parts clean site clay

System III

100 parts sludge
20 parts cement kiln dust
30 parts fly ash
30 parts calcium sulfate sludge

System IV

100 parts sludge
30 parts cement kiln dust
20 parts calcium sulfate sludge

System V

100 parts sludge
30 parts cement kiln dust
20 parts Portland cement

System VI

100 parts sludge
20 parts cement kiln dust
20 parts beet tailings
20 parts Portland cement

System VII

100 parts sludge
15 parts quickline (calcium oxide)

System VIII

100 parts sludge
15 parts quicklime
20 parts cement kiln dust

From a leachate quality standpoint, Fixation Systems I, II, VI, VII, and VIII generally produced very good and virtually equivalent results for the Vickery sludge [1]. System III leached significantly greater quantities of lead, while IV and V afforded the poorest performances of all the systems tested.

Volumetric tests on the various systems showed significant variations on fixation (Table 2).

With the restriction on volumetric capacity in the closure cell, clearly Systems VII and VIII had advantages over the other systems.

Another factor considered which influenced the final decision on system selection was the availability of reagent material. Sugar beet tailings which were utilized in System I and VI proved to have limited local supply and were very seasonal. This, in effect, eliminated these systems, while the bulking factor eliminated System II.

Material for Systems VII and VIII was then subjected to strength and consolidation tests [2]. These showed that with both samples there was a high initial compression and relatively low consolidation compression (Table 3).

Table 2.
Waste Volume Increase for Fixed Sludges

System	Volume Increase %
I	56
II	47
III	47
IV	(Not Tested)
V	19
VI	26
VII	9
VIII	21

Table 3.
Volume Changes with Single Load Increment of 3600 lb/ft²

Total Volume Decrease (%)	12.1	7.3
Volume Decrease Due To Initial Compression (%)	7.0	5.5
Fluid Drained (% of original weight)	5.9	0.8
Increase In Density (%)	7.1	7.1

Both materials exhibited measurable secondary compression but only equated to a settlement of 2-4 in. over a period of approximately 100 yr on a 45-ft high cell.

Because of the lesser bulking of the calcium oxide, it was decided to utilize this mix, but add limited cement kiln dust to reduce consolidation and fluid leachate. A mixture of 100 parts sludge to 15 parts calcium oxide and 5 parts cement kiln dust was selected.

FIELD EVALUATION

Having approved the constituents for the reagents and accept the results obtained in the laboratory for fixing the pond sludge the U.S. EPA required proof of the results in a field trial.

At the site, a small pond (approximately 180 ft x 85 ft) containing some 2000 yd of sludge, was designated to be treated as a pilot project.

This project was used to determine three things:

- Could the results obtained in the laboratory be reproduced in the field and would the fixed material have acceptable structural strength?
- How could the additives be applied to minimize dust generation?
- Could the material be mixed satisfactorily with back-hoes?

For the pilot project, super bags were filled from a silo with the

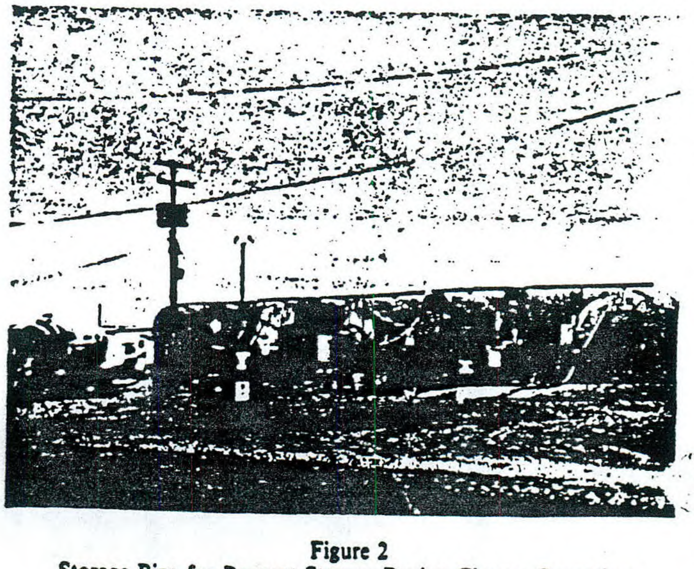


Figure 2
Storage Bins for Reagent Storage During Closure Operations with Dust Collectors in Position.

calcium oxide and cement kiln dust. The weight per bag varied from 1000 to 3000 lb, and these were placed on the sludge using a crane to support the bag approximately 6 to 12 in. above the surface. The pilot project showed that this method of dispensing the reagent was practical and that mixing with a back-hoe was possible and produced satisfactory results.

The pilot project took three weeks to complete working 12 hr/day. Based on the pilot project experience, it was decided that two shifts should be worked on the main project.

SITE PREPARATION

Because the U.S. EPA required the closure cell to be located in the same area occupied by the ponds, a temporary stockpile area for the fixed material had to be constructed.

This requirement meant that significant construction work had to be completed prior to the commencement of any operation. The stockpile area, approximately 6 acres in size immediately east of the ponds, had to be prepared by lining the area with a minimum of 3 ft of clay and providing a retention area to contain precipitation run-off from the stockpile. The capacity of the retention area was to accommodate a 24-hr, 25-yr storm. Three quarters of a mile of fence line was erected to isolate the operational area from the rest of the site. Separate areas were established for personal and equipment decontamination, both having their own water supply and wastewater disposal systems.

Because of concerns about dust (the reagent material was of 16 mesh and below), a dust collection system was installed at the point of discharge to the storage pigs. Storage pigs (Figure 2) were employed to ensure that any failure of transportation or factory production could be accommodated for up to 3 days.

In addition, lighting was installed on the entire 12-acre site, impoundment and stockpile areas to provide background lighting for the night shift who utilized mobile lighting sets for point lighting (work area lighting).

It already has been mentioned that, during the pilot project, super bags were used. Because these bags sustained damage and often were not reusable, it was decided to manufacture reusable dispensers to dispense the anticipated 20,000 tons of reagent. Each dispenser could hold approximately 4,500 lbs, could be loaded pneumatically, had a dust control facility and could be unloaded mechanically and remotely. Because of the volume of reagent, eight dispensers were manufactured and used throughout the project.

Prior to startup, two further tasks had to be accomplished. The first was the installation of weigh scales to control the weight of reagent dispensed. The second was to train all personnel in the use of self-contained breathing apparatus and all aspects of the safety rules, regulations and operating procedures.

POND CLOSURE

The three ponds to be closed (Ponds 4, 5 and 7) were each 200 ft wide and 800 ft long. The ponds had been surveyed in 1983 in an attempt and estimate the depth of sludge. The best estimate that could be obtained indicated that the depths were likely to be 3 ft in Pond 7, 8 ft in Pond 5 and 14 ft in Pond 4. A portion of Pond 4 had also been closed previously; included in the Closure Plan was the re-opening, excavation and fixation of the material in the previously closed section.

Because it was not known what problems were likely to be encountered, it was decided the fixation/solidification process should take place in Pond 7 first as it contained the least amount of sludge.

The supply of reagent was contracted with three different suppliers. Two quick lime suppliers were used, as a single supplier could not supply the total volume necessary. Use of two suppliers also provided an alternate source in case of factory breakdown. Only one supplier was used for the cement kiln dust. The additives were delivered in bulk, using tankers which discharged their loads pneumatically into the eight storage pigs, each of which held between 100 and 150 tons. Six pigs were reserved for the calcium oxide and two for the cement kiln dust.

From the storage pigs, the reagent material was pumped pneumatically into the reagent applicators. During this operation, the applicators were placed on scales so the reagent could be weighed as it was loaded. Weighing was necessary to determine and maintain the mixing rates in the pond.

The plan for the actual mixing operation utilized two cranes, each with a 100-ft boom. One crane sat on the East dike and one on the West dike to dispense the reagent. The cranes were rigged with double cables, one supporting the applicator and the second enabling the crane operator to activate the lever to operate the clam shell gate at the base of the unit and deposit the reagent.

As three back-hoes were used in the mixing operation, each crane served one and a half hoes. To simplify the reagent application, the applicators were numbered "1" through "8"; "1" through "6" were filled with quicklime and "7" and "8" with cement kiln dust. This mechanism maintained the 3:1 ratio for the fixation recipe. To make things even simpler, odd numbered applicators were used on the West dike and even numbered applicators on the East dike.

The applicators were pneumatically loaded while connected to both the pigs and a dust control system, which was located beside the scales. The weight of reagent in each applicator was recorded before the applicator was picked up and transferred by a forklift to the cranes. The cranes moved the applicators over the sludge and deposited the reagent, utilizing their second cables to control the quantity of material deposited (Figure 3). If the chemical

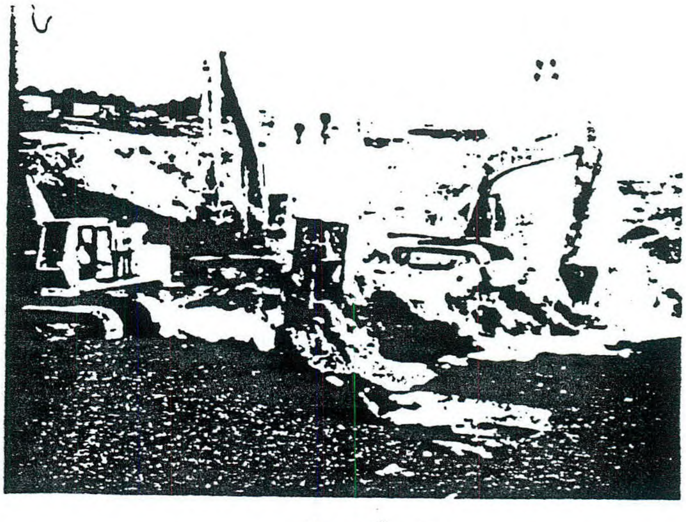


Figure 3
Crane Depositing Cement Kiln Dust on Sludge with Back-hoe on Right Mixing in Calcium Oxide.

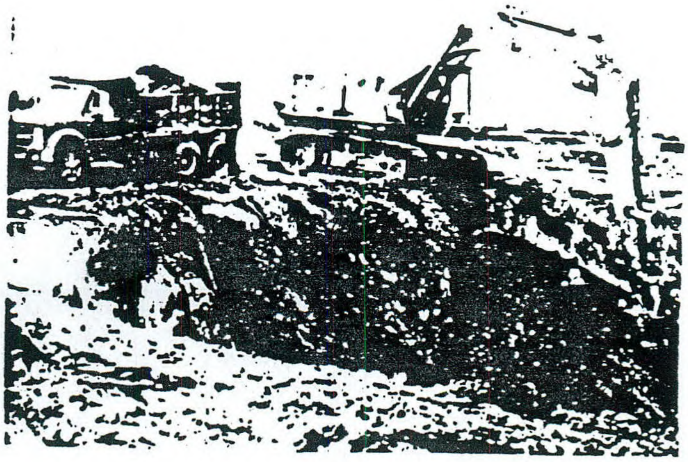


Figure 4

reaction between the sludge and reagent became strong, the quantity of reagent deposited was reduced. The crane operator varied the quantity of reagent applied as required by the prevailing conditions in order to control heat and dust generation.

Once the reagent was deposited, the back-hoes started mixing with a "kneading" action. As soon as solidification started, the solid material was used to form a dike around the mixing area. Additional reagent then was placed in the mixing area and mixing continued until solidification and fixation were completed. Completion of fixation was determined using the following criteria:

- Visual inspection (the material to be solid and earth-like)
- No free liquid
- Possible to excavate with back-hoe (material sitting in bucket and not flowing over edge)
- Holding angle of repose of 30–45° when stockpiled
- Maintain a ratio of reagent/fixed material of 1/6 or 0.13–0.16

The material then was excavated and cast to the rear of the back-hoes. The dike then was broken to permit an inflow of additional sludge. This process was repeated until sludge ceased to flow to the hoes. The back-hoes then moved out onto the fixed material using crane mats. This process was repeated until each pond was fixed.

Once the material had been fixed and cast behind the three mixing back-hoes, a fourth hoe on the dike loaded the materials into trucks (Figure 4) for transport to the stockpile area. As the back-hoes moved along the bottom of the pond, a bulldozer was used to feed the material to the fourth back-hoe which then loaded it onto trucks for disposal in the stockpile.

The sludges in all three ponds took just under 5 months to solidify and fix, utilized approximately 20,000 tons of reagent and produced about 170,000 yd³ of fixed material. Once all the sludges had been removed, the previously closed portion of Pond 4 was excavated material fixed where necessary and stockpiled. A further 70–80,000 yd³ of material were removed and 2,000 tons of reagent were used.

Once all the fixed material and the southern half of Pond 4 (i.e., the previously closed portion) had been excavated and stockpiled, there was a requirement to ensure the remaining clay was clean. This requirement was met by excavating at least 6 in. of clay and transporting it to the stockpile. Tests then were run on samples of soil, and excavation continued until the area was shown to be clean based on laboratory results. Depths of excavation varied by the time clean conditions were reached. These were generally between 6 and 18 in. but in one location reached 3 ft. The most difficult contaminants to remove were the heavy metals.

All the material excavated produced a stockpile approximately 46 ft high and measuring 620 ft x 460 ft (Figure 5). One plan requirement was that the pile should be covered. The initial concept was to utilize gunnite but because of the size of the stockpile a gunnite cover would have cracked extensively unless the cove had been constructed with significant thickness and included forcement. An asphalt cover also was considered. Fina polypropylene cover was selected and approved by the OEPA, but a restriction on the number of separate sheets utilized was impose by the U.S. EPA. The restriction was eight sheets. A cover wa placed on the stockpile using the required eight sheets, but these were lost in gale force winds of over 55 mi/hr. soon after installation. The cover has been redesigned utilizing 53 sheets—12 ft wid and of varying lengths. This construction has proved to be muc more satisfactory and has been in place for the last year.

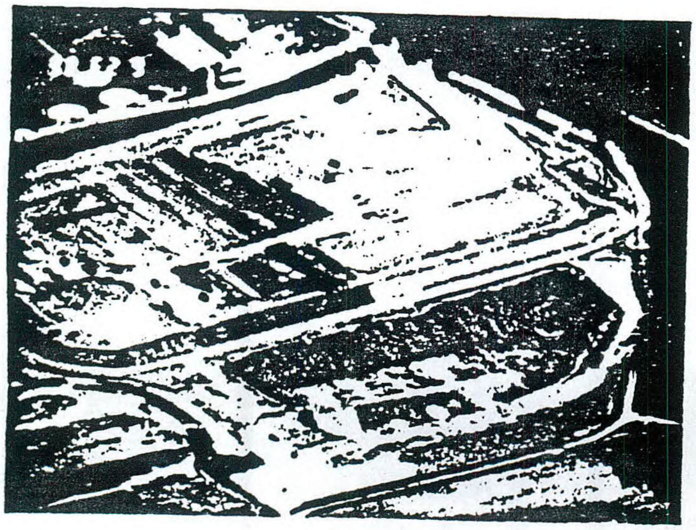


Figure 5
Stockpile (in upper picture) with Runoff Retention Area.
Call Construction Starting (in foreground).

The stockpile retention area contains all the runoff from the stockpile and has a capacity of approximately 1.5 million gal. In order to dispose of the volume of liquid in the retention area, pipeline was installed to discharge the liquid to the two remaining surface impoundments (Ponds 11 and 12).

SAFETY

Throughout the entire fixation process, safety was of the utmost importance. It already has been stated that a training course for personnel was held prior to the start of operations. In addition to instruction in the operation and use of breathing apparatu (Figure 6), instruction also was given on potential hazards, first aid, safety equipment locations, both project and site contingency plans and last, but by no means least, dressing, undressing and decontamination procedures.

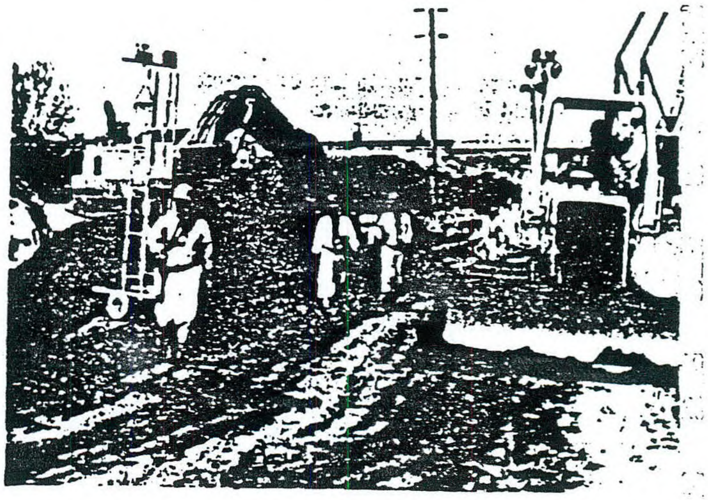


Figure 6
Workers Wearing Full Personnal Protective Equipment.

Apart from the personnel aspects of safety, both air monitoring and monitoring of decontamination procedures were undertaken extensively. With regard to air quality, three different aspects were monitored. These were:

- Perimeter monitoring; i.e., air at site boundary
- Organic vapor analyses monitoring within the operational area
- Monitoring of operational personnel

MONITORING

Perimeter Monitoring

Monitoring was undertaken to measure the air quality at the perimeter of the site and to see if there was any significant increase of contaminants in the air during mixing. In order to establish a base, air samples were taken prior to the commencement of any operation to measure the level of contamination existing in the a to determine what those contaminants were and to estab background readings.

Further samples were taken over weekly periods during the fixing operations in Ponds 4, 5 and 7. The results showed that there was a slight increase in air contaminant levels during the fixation process. These levels were well below a level, of concern, but did show an increase as the fixation process went from Pond 7 to Pond 5 to Pond 4. This increase was expected and would seem to indicate that the fixation of the remaining ponds will produce even less air-borne constituents than already have been experienced.

OVA Monitoring

The level of protection employed by the workers was determined by monitoring at 16 discrete locations within the operational area with an Organic Vapor Analyzer (OVA). This device was read at each location prior to start-up. Throughout the entire operation, which lasted approximately 6 months, readings on the OVA were taken twice per shift, every shift. By reviewing these readings, the level of protection to be afforded the men was determined after consultation between the Project Manager and Safety Officer and Industrial Hygienist.

Personal Monitoring

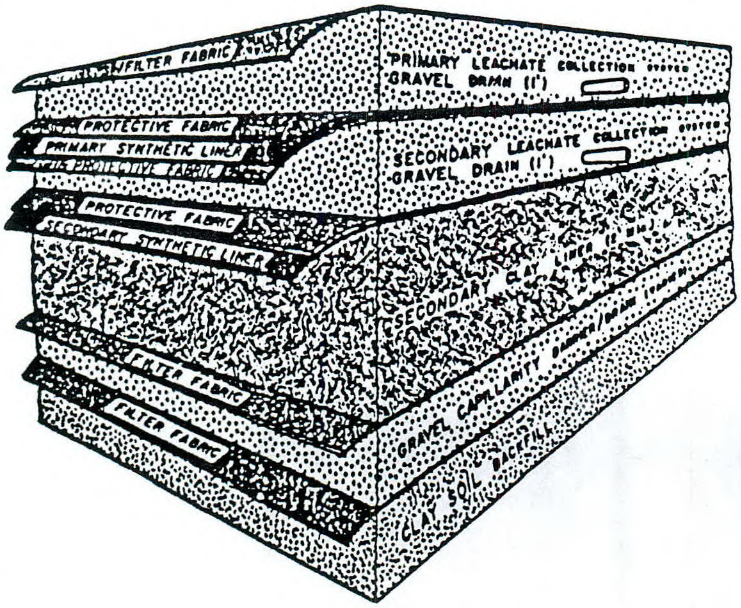
Finally, to supplement all of the above data, personal monitoring devices were worn by 20% of the work force during each shift. These devices monitored 16 constituents and gave an indication of the level of contamination in the work area. These results, in turn, could be correlated with the OVA readings. The collection tubes were analyzed on-site with a 24 hr turnaround time.

CLOSURE CELL

The basic TSCA requirments for a toxic landfill are fairly straightforward. There should be a 50-ft separation between the cell and groundwater, and the material should be sealed from the surrounding area by a clay liner with a minimum thickness of 3 ft and a maximum permeability of 10^{-7} cm/sec.

The TSCA land cell designed for Vickery is much more sophisticated than the requirements require and has been evolved over the past 2 yrs after considerable discussion between the U.S. EPA and the Company and redesign by our geological consultants.

The geology of the site is good, as was demonstrated by the depth of soil contaminated in the surface impoundments. Remembering that the impounded material was highly acidic and was present in the impoundments for some 15 yrs, the penetration was minimal. Any form of liquid penetration in the same area is difficult. The area always has significant ponding of water, and farmers have to employ extensive land drainage schemes. The main aquifer is also between 50 to 600 ft below ground surface. It was because of this geology that there was the possibility of building the land cell on-site. However, it was stipulated that the disposal area should be accommodated within the area previously occupied by the ponds.



The first problem encountered with the cell design was to obtain the 50 ft differential between the groundwater and the cell base. Because the area is flat and virtually non-permeable, groundwater is at-grade. It was requested that a variance from the 50-ft separation from the aquifer be granted and a 2-ft thick gravel capillarity barrier be installed below the cell in order to prevent any upward migration of the groundwater. Water entering this capillarity barrier or drain would be collected and pumped to a holding tank. Liquid collected in the tank would be tested and either disposed of through the deepwell system or discharged into the surface water system, depending on its quality.

A variety of designs for the cell were submitted, and these have been reviewed over the last 2 yrs. The final design (Figure 7) is probably the most advanced for any form of land cell.

Immediately above the capillarity drain or barrier, compacted clay will be placed and shaped for the gradients for the ultimate leachate collection systems. The gradients to be installed, which will create collection points at the north and south edges of the cell, are significant, being in excess of 2%. Because the cell length is just under 800 ft, 8 ft of clay need to be placed at the center of the cell to provide satisfactory gradients.

Above this contoured clay will be a 2-ft clay liner. QA/QC for installation will have a much tighter specification than for the contour clay, and routine field testing will be conducted to ensure a permeability of less than 10^{-7} cm/sec.

Above the clay liner will be two 60 mil HDPE liners. Each liner will have its own leachate collection system and sump (Figures 8 and 9) together with pumps and ancillary equipment to extract any leachate that may collect. Filter fabric will be used on either side of the liners to protect them during installation.

QA/QC procedures on the liner system will be strict and conducted by an outside consulting firm. QA/QC control for the liner will not be restricted to the installation process only, but will include both manufacture, storage and transportation. During the installation of the liners, inspection and non-destruction testing will be conducted on 100% of all joints. In addition, one destructive test will be conducted for every 500 ft of joints. These destructive tests will be accomplished in the field and confirmed in the laboratory.

Once the closure cell design was formulated and the specifications for liner and filter fabric evolved, testing was undertaken by the Battelle Laboratories in Columbus, Ohio, to determine the compatibility of the materials with the possible leachate. In the testing process, tests were conducted under the most stringent conditions, utilizing actual pond sludge. The tests were done in accordance with U.S. EPA Method 9090 and at elevated temperatures. No deterioration of either the liner material or the filter fabric was observed, and the lifetime expectancy of both is in excess of 30 yr.

Once the cell has been built, the fixed material from the stockpile will be placed in the cell, but only to a height ensuring that the side slope gradients do not exceed 1 in 5. A cover will be placed over the cell to encapsulate the material completely.

The cover, like the liner, has been upgraded (Figure 10). A double liner will be placed above the material. There will be a compacted 2-ft thick clay liner, laid to the same tight specifications as the bottom clay liner, followed by a 40 mil HDPE synthetic liner. Once again, the liner will be protected by filter fabric. Above the liner, there will be a one foot sand drainage layer followed by 18 in. of compacted clay and top soil. The final cover will be seeded with grass, and the whole area will be fenced.

MONITORING WELLS

Once the Closure Cell has been constructed and covered, it will be marked and the whole area will be monitored for a minimum

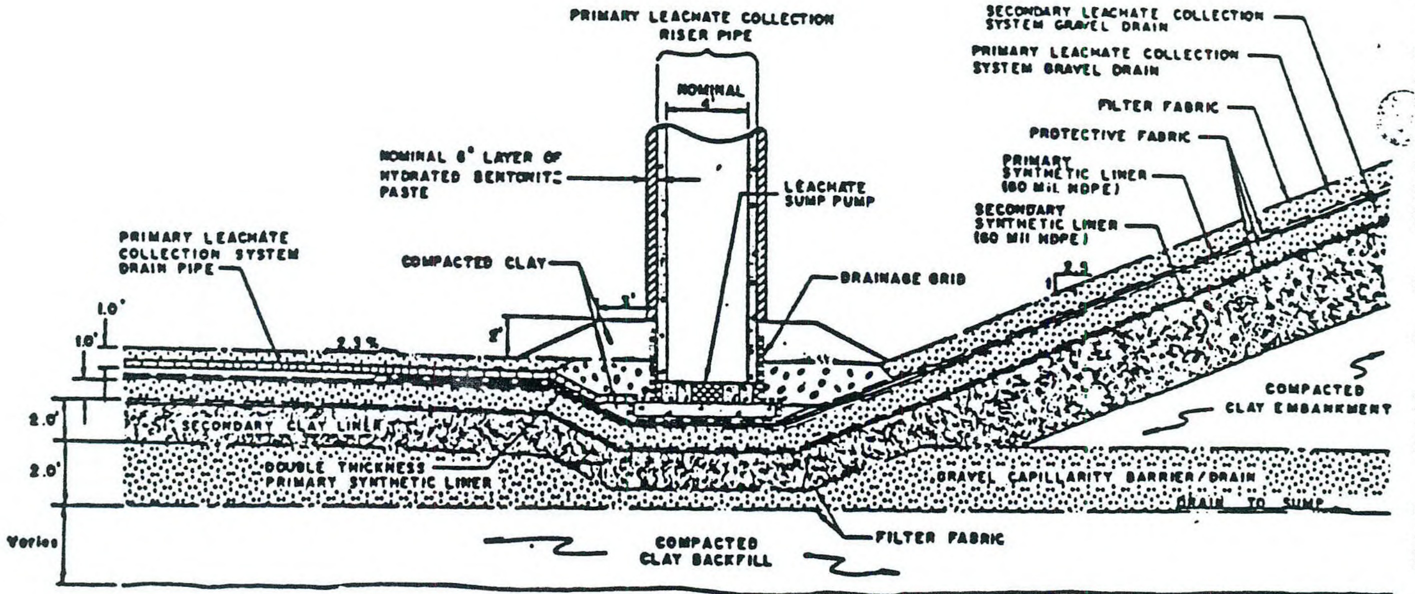


Figure 8
Primary Leachate Collection System Details

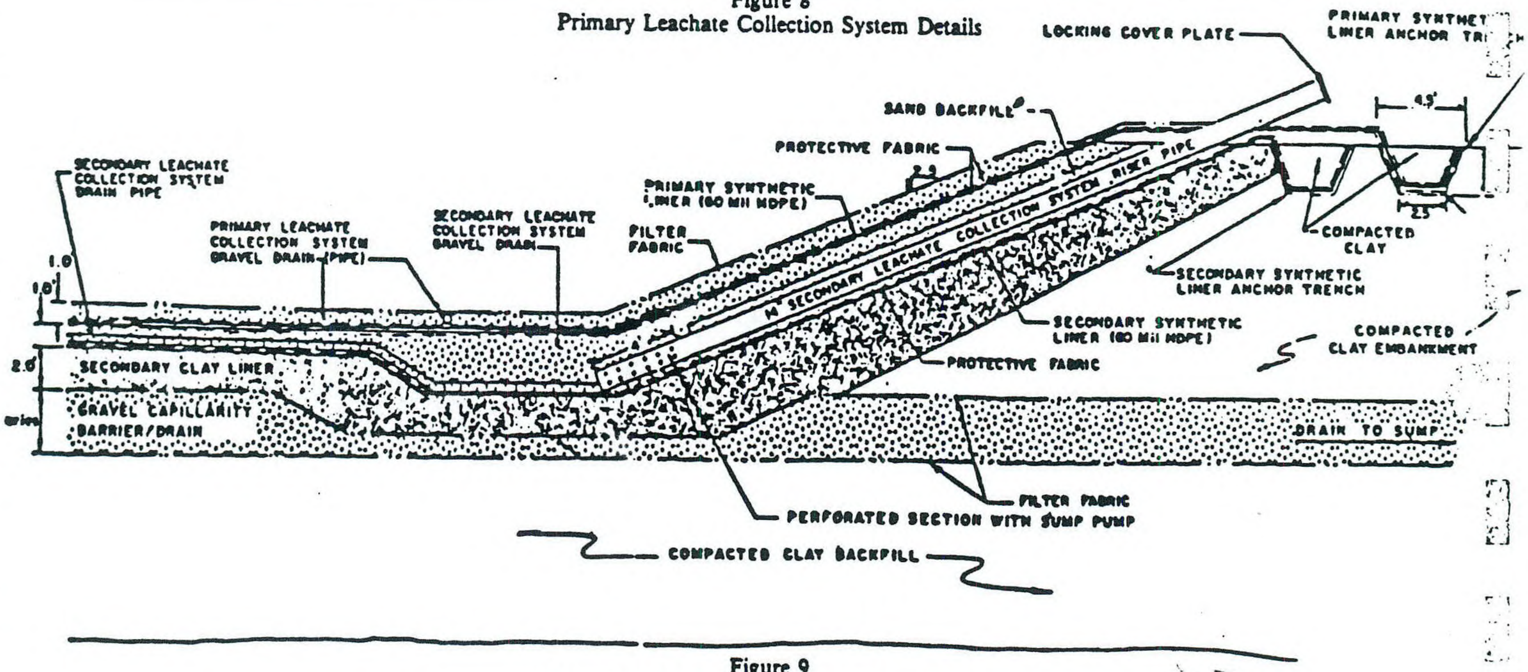


Figure 9
Secondary Leachate Collection System Details

site and a further six wells will be installed. These wells will monitor groundwater at various depths down to 165 ft. The distribution of wells will surround all the closed ponds, and test samples taken from these wells will be compared with samples from a number of up-gradient wells.

CONCLUSION

When the Closure Cell is completed, it will be a state-of-the-art landfill. Chemical Waste Management, Inc. is dedicated to developing and managing the most environmentally-sound disposal sites. The Company has demonstrated that, working in close cooperation with both the Federal and State regulatory agencies, any potential environmental problems can be solved in an efficient and practical manner.

REFERENCES

1. Vigon, B. W., and DeRoos, F. L., "Assessment of Waste Sludge Stabilization Alternatives," Final Report, Battelle (Columbus) Laboratory, July 13, 1984, and Addendum, Aug 1984.
2. Collison, G. H., "Physical Property Testing of Chemically Fixed Material, CWMI, Vickery, Ohio," Golder Associates Report, Aug, 1984.

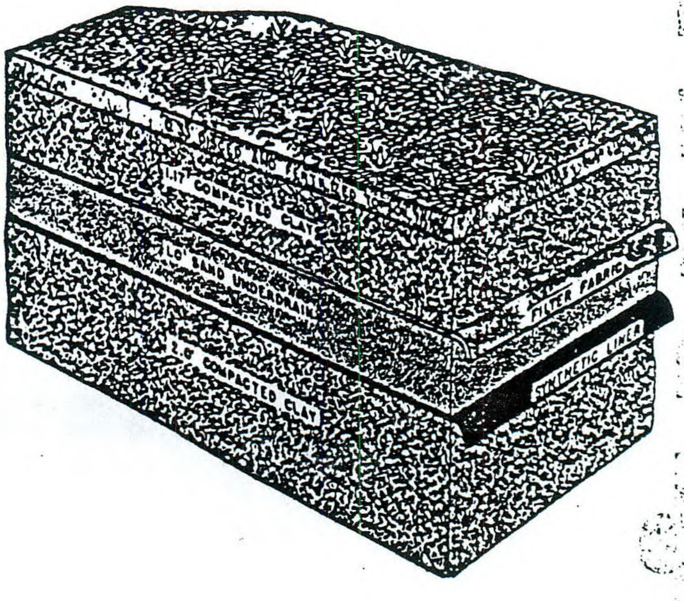


Figure 10

About the Founder

John Bee Shakti Consultants, Inc

Certified Professional Geologist
American Institute of Professional Geologists, #6173

Experience

John Bee's 15 years of professional experience have made him completely familiar with hazardous substance spill scenarios and cleanup operations. In addition, he has extensive experience in writing, editing and publication of professional reports and books.

As a Senior Geologist and Project Manager for Union Carbide, he directed the site investigations, spill responses and remedial actions at major Union Carbide sites and coordinated compliance with the hazardous materials spill and hazardous waste regulations facing this corporation.

As a consultant to the US Environmental Protection Agency his experience as a Senior Geologist and Project Manager included major sites involving air, surface water, groundwater and solid waste management. He directed the investigation and remedial action at over fifty hazardous material spills and hazardous waste sites.

As a Senior Emergency Response Team Member, his experience includes the management of responses to chemical fires, oil spills, hazardous materials transportation incidents and air pollution episodes in New York, New Jersey, Ohio, Louisiana, Texas and Puerto Rico. Areas of specific training and experience include geology, hydrology, analytical chemistry and toxicology, civil engineering, environmental monitoring, emergency response techniques, site safety supervision, the engineering and operation of groundwater cleanup equipment such as air strippers, hazardous waste treatment plants, the preparation of proposals and the accounting of multi-million dollar site operations. Skills used include an intimate knowledge of environmental law, regulations and enforcement policy.

As an Engineering Geologist in England and Canada, John Bee performed site investigations for civil and environmental engineering projects for power stations, docks, roads, dams, quarries, earth-retaining structures and slope stability, spoil tips, groundwater contamination, mapping and aerial photographic interpretation.

Instructor

Instructor to Emergency Response Branch, Region II U.S. EPA. Conducted the following courses:

Groundwater Pollution and Monitoring Course
Environmental Monitoring and Sampling Seminars
Site Costing and Accounting under the 311 Act and Superfund
Geophysics in Hazardous Material Investigation.
Emergency Response Management.

Author and Lecturer

Organized numerous conferences and presented seminars on Hazardous Materials Response and Hydrogeology; Geophysics; Environmental Law and Regulations.

Emergency Response

Union Carbide Emergency Response/Chronic Spills Study: For Union Carbide following the Bhopal disaster wrote procedures for the response to hazardous materials spills and the investigation of chronic environmental problems. These procedures were written to assist Divisional Environmental Managers in the management of environmental incidents, to respond effectively to the environmental imperatives of various spill situations and to provide timely, safe and effective site assessment, spill management and cleanup that included:

Measures to Contain a Spill Situation
The Site Assessment of a Spill
Health and Safety at Spill Sites
Standard Operating Procedures for Environmental Sampling
A Standard Tracking Procedure to Ensure Quality Analytical Results
Public Relations Efforts at a Spill Site

Geophysics

Trained and experienced in Geophysical Surveys such as resistivity surveys, terrain conductivity and magnetometer surveys used in hazardous materials site investigations.

Public Relations

Coordinated the public relations efforts at numerous environmentally sensitive sites.

Environmental Monitoring for Air, Soil, Surface Water and Groundwater

- Pollutant sampling and analysis methods to determine the Extent of Risk or Liability

Contaminant Geology

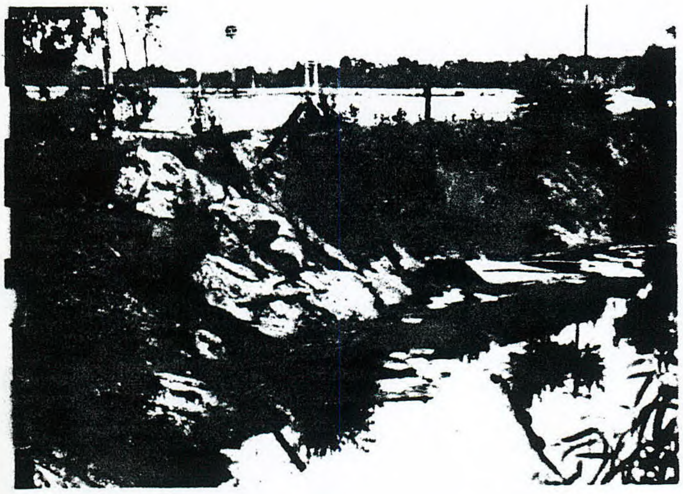
- Senior Hydrogeologist available for soil and groundwater investigations and the design and installation of abatement technology for hazardous materials spills; hazardous waste site investigations; for enforcement and remedial actions.

Environmental Compliance

- Determining Environmental Compliance. Expert witness and consultant on numerous enforcement cases for the United States Environmental Protection Agency.

Remedial Action

- Responding to accidental spills of hazardous materials, reducing health hazards from uncontrolled waste sites, and providing hazard assessment and cost effective cleanup.



Intergovernmental and Government - Industrial Negotiations

- Negotiator and coordinator representing Federal agencies and Industrial clients, as part of the project management for hazardous material spills and cleanup operations.