HAZARDOUS WASTE AND HAZARDOUS WASTE CONSTITUENTS RELEASES FROM SOLID WASTE MANAGEMENT UNITS (SWMUs) AT SITES MANAGED UNDER RCRA PERMITTING

RECEIVED
JUL 29 1985
NYSDEC
New Paltz

1. Reviewer's Name, Office and Telephone Number James Reidy
White Plains
(914) 761-6660

2. DEC Region Number 3

3. Facility Name, Location and I.D. Number IBM Corp., East Fishkill
Route 52, Hopewell Junction NY 12533
NYD000707901

4. County Dutchess

5. Code Number 14

6. Has the applicant properly responded to all questions? For example, if question one indicates that the site has SWMUs, are questions 2-4 addressed?

Yes

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7. Types of SWMUs, number of units and waste previously stored in each as reported by applicant.

Unit Type & Volume	Number of Units	Waste Stored in Unit (Type)
Tanks	17	[illegible], Freon, waste solv[illegible] etc
Landfill	1	Construction debris - haz & non-haz
Leach Field/Pit	1	Inadequate data supplied

8. Any additional information on SWMUs existing at the facility that was discovered during the record review, but not reported by applicant. (Record review includes: Community Right to Know, Solid and Hazardous Waste, Legal, Water (spill), Registry of Inactive Sites and NPL lists).

Unit Type & Volume	Number of Unit	Waste Stored
None		

9. a. Describe any release from a SWMU reported by applicant. Include: 1) unit type; 2) volume; 3) waste type; 4) release duration; 5) time periods; 6) volume of release; 7) nature of release; 8) extent of release and 9) how applicant has determined volume and extent of release. If the applicant has not determined any of the above, please indicate so.

See attached photocopied sheets

b. Include any information on items 1-8 above that you discovered during the record review, but not reported by applicant.

No additional information found.

c. If the information in (b) is found in Regional files, indicate if it is located in:

1. Solid and hazardous waste file
2. Legal file
3. Water (spill) file
4. Other, specify

10. If the facility is contained in the Community-Right-to-Know report, is it:

a) Listed in appendix J K L M N

Not listed in appendix (Circle One)

b) If listed, indicate:

1. I.D. Number GO 308698

2. Waste description freon, precious metals, PCB capacitors/ballast, waste solvents

11. Is site found on Registry of Inactive Hazardous Waste Disposal Sites

Listed: Yes No

Give: a. site code 314054

b. site type open dump

c. waste type volatile halogenated organics

12. Was applicant's submittal properly certified: No

13. Comments and recommendations

There is documented on site and some off-site GW contamination at this site. Remedial investigation at site has identified 4 areas of known GW contamination and the applicant and NYSDEC have entered into Order on Consent to begin DEC approved Remedial Work Plans for each site. Present status of Remedial Work should be evaluated to determine if it meets RCRA requirements for corrective action

Reviewer's Signature

Supervisor's Signature

1	TANK NO. 53	05/13/85	WS	FOUND CRACK IN TOP OF UNDERGROUND STORAGE TANK	OBSERVATION DURING INVESTIGATION INTO HIGH WATER CONTENT IN TANK	GREATER THAN 5 GAL	SOLVENTS PRIMARILY ACETONE AND ISOPROPYL ALCOHOL
2	TANK NO. 123	05/15/85	WS	OVERFLOW OF TANK DUE TO BACKFLOW DURING MAINTENANCE OPERATIONS	OBSERVATION	EST. LESS THAN 25 GAL	WATER 85-95% N-BUTYL ACETATE 1.3-3.8% ISOPROPYL ALCOHOL 1.0-3.2% ACETONE 2.4-7.8% ETHYL CELLOSOLVE 0.1-0.2%
3	TANK NO. 157	01/06/84	WS	TANK OVERFLOW DUE TO INSTRUMENT MALFUNCTION	OBSERVATION	EST. 200-300 GAL	N-BUTYL ACETATE 50% ISOPROPYL ALCOHOL 21% FREON 5% ACETONE 5% WATER 10%
4	TANK NO. 157	01/21/85	WS	TANK OVERFLOW	ALARM/ OBSERVATION	EST. 100 GAL	PRIMARILY ISOPROPYL ALCOHOL
5	TANK NO. 168/86	01/12/81	WS	DISCHARGE DURING CHECK OF ELECTRICAL CONNECTION TO TRANSFER PUMP	OBSERVATION	EST 200 GAL	PERCHLOROETHYLENE 88% N-METHYL PYRROLIDONE 6% CELLOSOLVE ACETATE 3% ALCOHOLS TRACE XYLENES TRACE
6	TANK NO. 148	02/9/84	WS	TANK OVERFLOW THROUGH STAND PIPE	OBSERVATION	EST 100 GAL	WATER 60% SOLVENT (PRIMARILY NMP) 40%

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7	TANK NO. 169	02/16/81	WS	LEVEL INSTRUMENTATION MALFUNCTION; OPERATING ERROR	OBSERVATION	EST 1 GAL MAX	WATER 96.58% ACETONE 0.23% METHYL ALCOHOL 3.19%
8	TANK NO. 169	12/10/81	WS	LEVEL ALARM FAILURE	OBSERVATION	UNKNOWN	WATER 90% SOLVENTS 10% (METHYL CELLOSOLVE, ETHYL CELLOSOLVE, CYCLOHEXANONE, ACETONE, ISOPROPYL ALCOHOL. TRICHLOROETHYLENE)
9	TANK NO. 169	09/22/82	WS	TANK OVERFLOW DUE TO FAULTY HIGH LEVEL ALARM	OBSERVATION	EST 10-15 GAL	PRIMARILY METHANOL. SOME ACETONE
10	TANK NO. 169	06/12/85	WS	TANK OVERFLOW DUE TO ALARM PROBLEMS	ALARM/ OBSERVATION	EST 120 GAL (80 GAL CONTAINED; 40 GAL TO GROUND)	CELLOSOLVE ACETATE 44% TOLUENE 24% ACETONE 9% N-BUTYL ACETATE 8% FREON 5% CYCLOHEXANONE < 2% WATER 3%
11	FORMER CON-STRUCTION DEBRIS LANDFILL ([illegible] PARKING LOT)	07/31/84	CCM	DISCOVERY OF CONTAMINATED CONSTRUCTION DEBRIS	OBSERVATION DURING EXCAVATION	50 TONS (HAZARDOUS) 6530 TONS (NON-HAZARDOUS)	SEE TABLE 1 (ATTACHED)

* WS = WASTE SOLVENT
CCM = CONTAMINATCONSTRUCTION DEBRIS

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[illegible]   [illegible]

SAMPLE PTS.	Sb	As	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Tl	Zn	TOTAL CYANIDE	TOTAL PHENOLICS
LIQUID	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
GMMW #43	ND	11.0	ND	ND	ND	20.0	ND	ND	[illegible]	ND	ND	ND	ND	96.0	ND
HOLE #2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	60.0
HOLE #11	ND	32.0	ND	ND	30.0	190.0	190.0	ND	[illegible]	ND	ND	ND	310.0	ND	130.0
HOLE #18	ND	5.0	ND	ND	ND	40.0	ND	ND	ND	ND	ND	ND	60.0	ND	<50.0
SOILS	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
NR 2799	ND	4.0	0.7	ND	19.0	32.0	20.0	ND	24.0	0.8	ND	ND	96.0	ND	0.1
NR 2800	ND	5.7	0.6	ND	23.0	29.0	26.0	ND	26.0	0.8	ND	0.6	120.0	ND	0.1
NR 2801	ND	6.1	ND	ND	18.0	24.0	19.0	0.1	21.0	0.8	ND	0.6	110.0	ND	ND
NR 2802	ND	5.9	0.6	ND	19.0	28.0	20.0	ND	22.0	1.2	ND	0.5	120.0	ND	0.1
NR 2803	ND	5.7	0.6	ND	18.0	27.0	21.0	ND	21.0	0.7	ND	ND	95.0	ND	ND
NR 2804	ND	5.5	0.6	ND	17.0	33.0	25.0	ND	29.0	0.9	ND	0.6	170.0	ND	0.3
NR 2805	ND	6.6	0.9	ND	18.0	22.0	14.0	ND	22.0	1.2	ND	0.5	65.0	ND	ND
NR 2806	ND	4.8	0.8	ND	19.0	29.0	23.0	ND	21.0	1.3	ND	0.6	130.0	ND	ND
NR 2807	ND	5.4	0.6	ND	18.0	31.0	23.0	ND	22.0	1.2	ND	0.8	110.0	ND	ND
NR 2808	ND	5.4	0.3	ND	17.0	14.0	13.0	ND	20.0	0.7	ND	ND	61.0	ND	ND
NR 2809	ND	5.0	0.6	ND	15.0	25.0	23.0	ND	22.0	0.7	ND	ND	84.0	ND	ND
NR 2810	ND	4.4	0.8	ND	24.0	13.0	30.0	0.1	12.0	1.0	ND	ND	90.0	ND	0.6
LAB BLANKS															
F 2811	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F 2940	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

SAMPLE PTS.	ACID EXTRACTABLE	BASE-NEUTRAL EXTRACTABLES (PHTHALATES) BIS(2-ETHYLHEXYL)	BUTYL BENZYL	DI-n-BUTYL	V.O.C. MECL2	TCE	CHLOROFORM	TOLUENE	PESTICIDES PCB	T.O.C.
LIQUID	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l			ug/l	mg/l
GMMW #43	ND	ND	ND	ND	6 COMPOUNDS TOTAL =17.0				ND	34.0
HOLE #2	ND	ND	ND	ND	6 COMPOUNDS TOTAL =29.0				ND	13.0
HOLE #11	ND	16.0	ND	ND	2 COMPOUNDS TOTAL = 5.0				ND	37.0
HOLE #18	ND	ND	ND	ND	10 COMPOUNDS TOTAL =29.0				ND	32.0
SOILS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	
NR 2799	ND	ND	ND	ND	169.0	ND	ND	ND	ND	NA
NR 2800	ND	ND	11600.0	ND	90.0	ND	ND	ND	ND	NA
NR 2801	ND	ND	ND	ND	145.0	ND	ND	ND	ND	NA
NR 2802	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
NR 2803	ND	ND	ND	ND	75.0	ND	ND	ND	ND	NA
NR 2804	ND	ND	ND	ND	163.0	92.0	ND	ND	ND	NA
NR 2805	ND	634.0	ND	684.0	147.0	60.0	ND	ND	ND	NA
NR 2806	ND	ND	ND	ND	196.0	ND	ND	ND	ND	NA
NR 2807	ND	ND	ND	ND	183.0	84.0	ND	ND	ND	NA
NR 2808	ND	ND	ND	ND	103.0	ND	ND	ND	ND	NA
NR 2809	ND	ND	ND	ND	138.0	ND	ND	ND	ND	NA
NR 2810	ND	ND	ND	ND	163.0	ND	ND	ND	ND	NA
LAB BLANKS										
F 2811	NA	NA	NA		3.0		1.0	ND	NA	NA
F 2940	NA	NA	NA		2.0		1.0	1.0	NA	NA

DETAIL OF V.O.C.

LIQUID	CHLOROBENZENE	CHLOROETHANE	MECL2	1,2-TRANS-DCE	TRICHLORETHYLENE	VINYL CHLORIDE	TCE	TOLUENE	TRICHLOROFLUOROMETHANE	ET.CL2	EHTYL BENZ
GMMW #43	1.0	1.0	2.0	6.0	4.0	3.0	ND	ND	ND	ND	ND
HOLE #2	ND	2.0	2.0	15.0	5.0	2.0	3.0	ND	ND	ND	ND
HOLE #11	ND	ND	2.0	ND	ND	ND	ND	3.0	ND	ND	ND
HOLE #18	ND	1.0	3.0	6.0	2.0	1.0	2.0	5.0	3.0	4.0	2.0

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International Business Machines Corporation

East Fishkill Facility, Route 52
Hopewell Junction, New York 12533-0999
914/894-2121

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Attn.: J. M. Hogan
D/92C, B/300, Z/4A1

June 25, 1985

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JUL 02 1985
HAZARDOUS ... TECHNOLOGY ... AND ... WASTE

Mr. Richard M. Walka
Acting Chief, Solid Waste Branch
Room 905
United States Environmental Protection
Agency, Region II
26 Federal Plaza
New York, NY 10278

SUBJECT: Section 3004(u) RCRA Amendments of 1984

REFERENCE: 1) Letter from Conrad Simon, USEPA, Region II, dated 3/22/85
2) IBM letter dated 5/20/85, to James J. Cleary, USEPA, Region II.

Dear Mr. Walka,

As requested in the 3/22/85 EPA letter, the following documents pertaining to solid waste management units at IBM's East Fishkill Site are herewith enclosed:

1. Solid waste management units questionnaire duly completed

2. IBM East Fishkill Site map

3. Groundwater investigation reports

As required by applicable regulation, IBM reports all hazardous waste releases to the appropriate agencies, such as the National Response Center, the EPA, the U.S. Coast Guard and New York State Environmental Conservation. The response to questions 3 and 4 include those releases from hazardous waste units mentioned in question 2 or listed in the Part B application.

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Since February 1978, IBM East Fishkill has had a groundwater monitoring program. Presence of organic compounds in the groundwater monitoring wells and production wells was discovered during February 1979. In March of 1979, the New York State Department of Health (NYSDOH) was informed of these findings. The New York State Department of Environmental Conservation (NYSDEC) was also notified of our groundwater sampling

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results. NYSDEC and IBM signed a Consent Order in April, 1981 which formally instituted our Groundwater Remedial Action Plans. The IBM East Fishkill Groundwater Reports(Enclosures 2, 3, 4) identified four area of known groundwater contamination. Remedial Action Plans for each area have been submitted and approved by NYSDEC (Enclosures 8, 9, 10) with periodic updates presented to and approved by NYSDEC.(Enclosures 11, 12, 13, 14, 15)

Site investigations are being conducted on an ongoing basis. Currently available data has revealed that groundwater contamination is contained within the boundaries of IBM East Fishkill.(Enclosures 5, 6)

The enclosed reports and letters to New York State Department of Environmental Conservation address groundwater contamination from all identified sources (inactive landfills, underground storage tanks and pipes) and also describe the efforts being made by IBM East Fishkill to minimize their environmental impact.

Please call me or N. Ayengar (914 - 892-1624) if you have any questions.

Sincerely yours

Joseph M. Hogan

Joseph M. Hogan
Site Chemical/Environmental Services

gp

c NYSDEC - Albany
New Paltz

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Enclosures

Questionnaire

1. Completed Solid Waste Management Unit Questionnaire

Reports

2. Groundwater Status Report - January 1981
3. IBM East Fishkill Groundwater Report - March 1981
4. Groundwater Report NO. 2 IBM East Fishkill Facility - May 1982
5. Source Identification of Trace Organics in Groundwater Shenandoah Road and Route 52
Phase I - Summary Report January 1982
6. Trace Organics in Groundwater Shenandoah Road and Route 52 Phase II Report November 1982

Consent Order

7. Order on Consent: State of New York Department of Environmental Conservation April 1981

Correspondence

8. NYSDEC Letter dated February 1, 1982
9. NYSDEC Letter dated February 5, 1982
10. NYSDEC Letter dated July 26, 1982
11. IBM Letter dated March 8, 1983
12. IBM Letter dated April 19, 1983
13. IBM Letter dated December 13, 1983
14. IBM Letter dated December 19, 1983
15. NYSDEC Letter dated January 31,1984

Location Plan

16. IBM East Fishkill Site Map

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Information Regarding Potential Hazardous Waste and Hazardous Waste Constituent Releases From Solid Waste Management Units

Facility Name: IBM Corporation, East Fishkill

EPA I.D. No.: NYD 000707901

Location: Street Route 52

City & State Hopewell Junction, NY

Check: owner x operator x

Please review the following definitions prior to proceeding to page 2.

I. Under the Resource Conservation and Recovery Act (RCRA) amendments of 1984, the term "solid waste" means any garbage, refuse, sludge, from a waste treatment plant, water supply treatment plant, or air pollution control facility and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations, and from community activities, but does not include solid or dissolved material in domestic sewage, or solid or dissolved materials in irrigation return flows or industrial discharges which are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, or byproduct material as defined by the Atomic Energy Act of 1954.

II. A hazardous waste is a solid waste that is either listed in 40 CFR; Part 261 Subpart D ("List of Hazardous Wastes") or possesses one or more of the characteristics identified in 40 CFR; Part 261; Subpart C ("Characteristics of Hazardous Waste") and is not excluded in 40 CFR 261.4.

III. A Hazardous Waste Constituent represents the basis for a specific hazardous waste being listed in 40 CFR; Part 261; Subpart D. The Hazardous Waste Constituents are listed in 40 CFR; Part 261; Appendix VIII (Hazardous Waste Constituents).

IV. The term "solid waste management unit" (SWMU) applies to any landfill, surface impoundment, land farm, waste pile, incinerator, tank, injection well, transfer station, waste recycling operation, tank or container storage area that currently or formerly was used to manage a solid waste.

V. Under the requirements of the Hazardous and Solid Waste Act Amendments of 1984, Section 3004U of the RCRA amendments mandates that EPA address contamination caused by prior releases of hazardous wastes and hazardous waste constituents from solid waste management units, regardless of the time when the waste was placed in the unit or when the unit was closed.

VI. The term "tank" includes wastewater treatment units, elementary neutralization units and short-term accumulation units that are exempted from RCRA permit requirements.

VII. The term "release" includes any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping or disposing into the environment, but excluding releases otherwise permitted under law (e.g., NPDES permitted discharges).

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SPECIFIC INFORMATION

1. Are there any of the following solid waste management units existing or closed at your facility? Include any units you are aware of that were used by previous owners. Do not include hazardous waste units currently shown in your B application.

	Yes	No
• Landfill	x	
• Surface Impoundment		x
• Dump-pit or Leach Field	x	
• Land Farm		x
• Waste Pile		x
• Incinerator		x
• Storage Tank (above ground)	x	
• Storage Tank (below ground)	x	
• Container Storage Area	x	
• Injection Wells, Sink Holes		x
• Wastewater Treatment Units		x
• Transfer Stations		x
• Waste Recycling Operations	x	
• Other (specify)		x

(For items 2-4, if the space provided is not sufficient, use additional sheets as necessary and specify the item being answered.)

2.) If there are "Yes" answers to any of the items in number one above, please provide the following:

A. A description of the wastes that were stored, treated or disposed of in each unit.

See attached response to Question 2.

B. Determine, as best you can, if the particular waste would be considered a hazardous waste or hazardous waste constituent under RCRA (See definitions on page one)

See attached response to Question 2.

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C. A description of each unit including its capacity, dimensions, period of operation, location at facility including a site plan if available.

See attached response to Question 2.

3.) For each unit noted in number one and also those hazardous waste units identified in your Part B application, please provide the following information on any prior or current release of hazardous waste or hazardous waste constituents.

source of information that has led to the possibility that a release has occured (i.e. discoloration of surrounding soil)
date(s) of release
groundwater monitoring data for units not identified in your Part B
type of waste/material released
quantity or volume of waste/material released
nature of release (i.e., spill, overflow, ruptured tank or pipeline, leachate from landfill or surface impoundment, etc.)

See enclosed reports.

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IBM-EF-888

IBM-EF-600

4.) In regard to the prior releases described in number three above, please provide (for each unit) any analytical data that may be available which would describe the nature and/or extent of environmental contamination that exists as a result of such releases. In addition, any information on the concentration of hazardous waste or hazardous waste constituents present in contaminated soil, groundwater or surface water should be attached. Include any information/data (including groundwater monitoring data) submitted to EPA and the State under any other regulatory programs (i.e. Superfund, In place-toxics, etc.) that concerns prior or continuing releases as described above.

See enclosed reports.

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5.) If you do not have any record of a SWMU on your site, is there any evidence from soil borings, drilling of groundwater wells, groundwater monitoring results, exploratory pits or any excavations that would indicate the presence of a SWMU or that a release of hazardous waste or hazardous waste constituent has occured (Please describe the type of activity and observations that led to the discovery)?

Not applicable.

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QUESTION 2.
HAZARDOUS WASTE MANAGEMENT UNIT

NO.	SWMU	CONTENTS	INSTALL DATE	CAPACITY	* CONFIGURATION	TANK MATERIAL	DIMENSIONS	LOCATION
1	TANK NO. 79	FLUORIDE WASTE	1973	5,000	H,B,1	FRP	6'6"D X 20'	SW 308
2	TANK NO. 142	FREON WASTE	1975	1,000	H,B,1	STEEL	5'D X 6'	NW 309
3	TANK NO. 169	WASTE SOLVENT-MIXED	1980	5,000	H,B,2	STEEL	6'8"D X 19'	E 330C
4	TANK NO. 204	WASTE SOLVENT-MIXED	1983	5,000	H,B,1	STEEL	8'D X 13'	E 322
5	TANK NO. 205	WASTE NBA	1983	5,000	H,B,1	STEEL	8'D X 13'	E 322
6	TANK NO. 206	WASTE IPA	1983	5,000	H,B,1	STEEL	8'D X 13'	E 322
7	TANK NO. 207	WASTE FREON TF	1983	5,000	H,B,1	STEEL	8'D X 13'	E 322
8	LANDFILL (INACTIVE) **	SEE ENCLOSED REPORTS						
9	DUMP PIT/ LEACH/FIELD **	SEE ENCLOSED REPORTS						

* Configuration Codes: H - Horizontal B - Below Ground
1 - Single Wall 2 - Double Wall

** These Solid Waste Management Units refer to known areas of groundwater contamination on the IBM East Fishkill main site. A Consent Order between NYSDEC and IBM (Enclosure 7) addresses remedial action programs in place to clean up contaminated groundwater and minimize further impact. Reports submitted subsequent to the Consent Order use the following designations:
Landfill - Area "C"
Dump Pit/Leach Field - Area "A", "B", "D"

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QUESTION 3 AND 4

NO.	SWMU	DATE	MATERIAL	NATURE OF RELEASE	SOURCE/ INDICATION	QUANTITY	ANALYSIS
1	TANK NO. 53	05/13/85	WS	FOUND CRACK IN TOP OF UNDERGROUND STORAGE TANK	OBSERVATION DURING IN-VESTIGATION INTO HIGH WATER CON-TENT IN TANK	GREATER THAN 5 GAL	SOLVENTS PRIMARILY ACETONE AND ISOPROPYL ALCOHOL
2	TANK NO. 123	05/15/85	WS	OVERFLOW OF TANK DUE TO BACKFLOW DURING MAINTENANCE OPERATIONS	OBSERVATION	EST. LESS THAN 25 GAL	WATER 85-95% N-BUTYL ACETATE 1.3-3.8% ISOPROPYL ALCOHOL 1.0-3.2% ACETONE 2.4-7.8% ETHYL CELLOSOLVE 0.1-0.2%
3	TANK NO. 157	01/06/84	WS	TANK OVERFLOW DUE TO INSTRUMENT MALFUNCTION	OBSERVATION	EST. 200-300 GAL	N-BUTYL ACETATE 50% ISOPROPYL ALCOHOL 21% FREON 5% ACETONE 5% WATER 10%
4	TANK NO. 157	01/21/85	WS	TANK OVERFLOW	ALARM/ OBSERVATION	EST. 100 GAL	PRIMARILY ISOPROPYL ALCOHOL
5	TANK NO. 168/86	01/12/81	WS	DISCHARGE DURING CHECK OF ELECTRICAL CONNECTION TO TRANSFER PUMP	OBSERVATION	EST 200 GAL	PERCHLOROETHYLENE 88% N-METHYL PYRROLIDONE 6% CELLOSOLVE ACETATE 3% ALCOHOLS TRACE XYLENES TRACE
6	TANK NO. 168	02/9/84	WS	TANK OVERFLOW THROUGH STAND PIPE	OBSERVATION	EST 100 GAL	WATER 60% SOLVENT (PRIMARILY NMP) 40%

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QUESTION 3 AND 4
(CONTINUED)

NO.	SWMU	DATE	* MATERIAL	NATURE OF RELEASE	SOURCE/ INDICATION	QUANTITY	ANALYSIS
7	TANK NO. 169	02/16/81	WS	LEVEL INSTRUMENTATION MALFUNCTION; OPERATING ERROR	OBSERVATION	EST 1 GAL MAX	WATER 96.58% ACETONE 0.23% METHYL ALCOHOL 3.19%
8	TANK NO. 169	12/10/81	WS	LEVEL ALARM FAILURE	OBSERVATION	UNKNOWN	WATER 90% SOLVENTS 10% (METHYL CELLOSOLVE, ETHYL CELLOSOLVE, CYCLOHEXANONE, ACETONE, ISOPROPYL ALCOHOL. TRICHLOROETHYLENE)
9	TANK NO. 169	09/22/82	WS	TANK OVERFLOW DUE TO FAULTY HIGH LEVEL ALARM	OBSERVATION	EST 10-15 GAL	PRIMARILY METHANOL. SOME ACETONE
10	TANK NO. 169	06/12/85	WS	TANK OVERFLOW DUE TO ALARM PROBLEMS	ALARM/ OBSERVATION	EST 120 GAL (80 GAL CONTAINED; 40 GAL TO GROUND)	CELLOSOLVE ACETATE 44% TOLUENE 24% ACETONE 9% N-BUTYL ACETATE 8% FREON 5% CYCLOHEXANONE < 2% WATER 3%
11	FORMER CON-STRUCTION DEBRIS LANDFILL (B/334 PARKING LOT)	07/31/84	CCM	DISCOVERY OF CONTAMINATED CONSTRUCTION DEBRIS	OBSERVATION DURING EXCAVATION	50 TONS (HAZARDOUS) 6530 TONS (NON-HAZARDOUS)	SEE TABLE 1 (ATTACHED)

* WS = WASTE SOLVENT
CCM = CONTAMINATCONSTRUCTION DEBRIS

TABLE 1

INORGANIC ASSAYS

SAMPLE PTS.	Sb	As	Be	Cd	Cr	Cu	Pb	Hg	Ni	Se	Ag	Tl	Zn	TOTAL CYANIDE	TOTAL PHENOLICS
LIQUID	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
GWMW #43	ND	11.0	ND	ND	ND	20.0	ND	ND	10.0	ND	ND	ND	ND	96.0	ND
HOLE #2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	60.0
HOLE #11	ND	32.0	ND	ND	30.0	190.0	190.0	ND	70.0	ND	ND	ND	310.0	ND	130.0
HOLE #18	ND	5.0	ND	ND	ND	40.0	ND	ND	ND	ND	ND	ND	60.0	ND	<50.0
SOILS	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg	mg/Kg
NR 2799	ND	4.0	0.7	ND	19.0	32.0	20.0	ND	24.0	0.8	ND	ND	96.0	ND	0.1
NR 2800	ND	5.7	0.6	ND	23.0	29.0	26.0	ND	26.0	0.8	ND	0.6	120.0	ND	0.1
NR 2801	ND	6.1	ND	ND	18.0	24.0	19.0	0.1	21.0	0.8	ND	0.6	110.0	ND	ND
NR 2802	ND	5.9	0.6	ND	19.0	28.0	20.0	ND	22.0	1.2	ND	0.5	120.0	ND	0.1
NR 2803	ND	5.7	0.6	ND	18.0	27.0	21.0	ND	21.0	0.7	ND	ND	95.0	ND	ND
NR 2804	ND	5.5	0.6	ND	17.0	33.0	25.0	ND	28.0	0.9	ND	0.6	170.0	ND	0.3
NR 2805	ND	6.6	0.9	ND	18.0	22.0	14.0	ND	22.0	1.2	ND	0.5	65.0	ND	ND
NR 2806	ND	4.8	0.8	ND	19.0	29.0	23.0	ND	21.0	1.3	ND	0.6	130.0	ND	ND
NR 2807	ND	5.4	0.6	ND	18.0	31.0	23.0	ND	22.0	1.2	ND	0.8	110.0	ND	ND
NR 2808	ND	5.4	0.8	ND	17.0	14.0	13.0	ND	20.0	0.7	ND	ND	61.0	ND	ND
NR 2809	ND	5.0	0.6	ND	15.0	25.0	23.0	ND	22.0	0.7	ND	ND	84.0	ND	ND
NR 2810	ND	4.4	0.8	ND	24.0	13.0	30.0	0.1	12.0	1.0	ND	ND	90.0	ND	0.6
LAB BLANKS															
F 2811	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F 2840	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

ORGANIC ASSAYS

SAMPLE PTS.	ACID EXTRACTABLE	BASE/NEUTRAL EXTRACTABLES (PHTHALATE) bis(2-ETHYLHEXYL)	BUTYL BENZYL	DI-n-BUTYL	V.O.C. MECL2	TCE	CHLOROFORM	TOLUENE	PESTICIDES PCB	T.O.C.
LIQUID	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l			ug/l	mg/l
GWMW #43	ND	ND	ND	ND	6 COMPOUNDS		TOTAL =17.0		ND	34.0
HOLE #2	ND	ND	ND	ND	6 COMPOUNDS		TOTAL =29.0		ND	13.0
HOLE #11	ND	16.0	ND	ND	2 COMPUNDS		TOTAL = 5.0		ND	37.0
HOLE #18	ND	ND	ND	ND	10 COMPOUNDS		TOTAL =29.0		ND	32.0
SOILS	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	ug/Kg	
NR 2799	ND	ND	ND	ND	169.0	ND	ND	ND	ND	NA
NR 2800	ND	ND	11600.0	ND	90.0	ND	ND	ND	ND	NA
NR 2801	ND	ND	ND	ND	145.0	ND	ND	ND	ND	NA
NR 2802	ND	ND	ND	ND	ND	ND	ND	ND	ND	NA
NR 2803	ND	ND	ND	ND	75.0	ND	ND	ND	ND	NA
NR 2804	ND	ND	ND	ND	163.0	92.0	ND	ND	ND	NA
NR 2805	ND	634.0	ND	684.0	147.0	60.0	ND	ND	ND	NA
NR 2806	ND	ND	ND	ND	196.0	ND	ND	ND	ND	NA
NR 2807	ND	ND	ND	ND	183.0	84.0	ND	ND	ND	NA
NR 2808	ND	ND	ND	ND	103.0	ND	ND	ND	ND	NA
NR 2809	ND	ND	ND	ND	138.0	ND	ND	ND	ND	NA
NR 2810	ND	ND	ND	ND	163.0	ND	ND	ND	ND	NA
LAB BLANKS										
F 2811	NA	NA	NA		3.0		1.0	ND	NA	NA
F 2840	NA	NA	NA		2.0		1.0	1.0	NA	NA

DETAIL OF V.O.C.

LIQUID	CHLOROBENZENE	CHLOROETHANE	MECL2	1,2-TRANS-DCE	TRICHLORETHYLENE	VINYL CHLORIDE	TCE	TOLUENE	TRICHLOROFLUOROMETHANE	ET.CL2	EHTYL BENZ
GWMW #43	1.0	1.0	2.0	6.0	4.0	3.0	ND	ND	ND	ND	ND
HOLE #2	ND	2.0	2.0	15.0	5.0	2.0	3.0	ND	ND	ND	ND
HOLE #11	ND	ND	2.0	ND	ND	ND	ND	3.0	ND	ND	ND
HOLE #18	ND	1.0	3.0	6.0	2.0	1.0	2.0	5.0	3.0	4.0	2.0

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GROUND-WATER STATUS REPORT

International Business Machines Corporation
East Fishkill Facility
Dutchess County, New York

January 1981

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I. INTRODUCTION

The purpose of the report is to present a brief, but thorough, summary of the ground-water situation at the IBM Corporation's East Fishkill Facility as of January 1, 1981.

For background purposes the report first describes the geologic and hydrologic conditions pertinent to the ground-water system underlying the facility. The next section contains a summary of investigations conducted through the end of 1980. Later sections describe progress to date and plans for future work.

II. GENERAL REGIONAL HYDROGEOLOGY

The principal geologic formations pertinent to the ground-water system underlying the IBM East Fishkill Facility are unconsolidated surficial glacial deposits of Pleistocene Age and the underlying carbonate bedrock (limestone and dolomite) of Ordovician age.

The glacial deposits vary greatly in both thickness and texture. Where sufficient saturated thickness and permeability exist, the glacial deposits provide water to wells in the vicinity. These are generally small-capacity domestic and livestock wells, although yields of several hundred gallons per minute from sand and gravel deposits may be obtained in valley areas.

The bedrock, geologically known as the Stockbridge limestone, is the principal aquifer supplying water to large-capacity wells--including the IBM production wells at the East Fishkill Facility. The unit of this formation underlying the facility extends under the Fishkill Creek valley from Beacon northeastward to the headwaters of the creek.

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Joints, fractures and bedding planes in the bedrock provide the principal means for storage and movement of water. In fact, the yield of wells can vary from essentially zero to several hundred gallons per minute depending upon the amount and sizes of such openings encountered. The major fractures in the Stockbridge limestone are probably associated with faults. Several northeasterly trending faults have been mapped in the East Fishill area.

The source of ground water found in both the glacial and bedrock formations is derived from that portion of precipitation which falls on the overlying land that percolates downward to the ground-water system. Obviously, the portion of the precipitation that recharges the ground water is dependent upon many factors such as soil texture, soil moisture, type of cover, land slope and rainfall intensity. A general estimate of the average annual recharge is 13 inches--or about one-third of the average annual precipitation of 42 inches. The other two-thirds leaves the area as surface runoff in streams and evapotranspiration to the atmosphere.

Ground-water levels in the area normally are highest in the spring and lowest in the fall in response to the relative intensity of precipitation and evapotranspiration. Also, long-term records of ground-water levels not influenced by pumping show a strong correspondence with rainfall patterns, indicating essentially immediate recharge response to precipitation events.

III. SUMMARY OF GROUND-WATER QUALITY INVESTIGATIONS

A. Chronology of investigations

Test drilling has been conducted, and monitor wells installed, for the purposes of obtaining site-specific information on the physical properties of the glacial deposits and bedrock as well as to provide means for monitoring water levels and water quality. The following sections summarize results obtained from the drilling and monitoring as of December 1980.

The ground-water monitoring program began in February 1978 as the result of a request by the Real Estate and Construction Division of IBM for each IBM site to investigate the quality of their ground water. In addition to beginning a ground-water survey, the IBM East Fishkill site also examined the quality of the water being drawn from the bedrock production wells. These wells are a source of water for industrial and domestic purposes. A series of samples were collected and analyzed from the production well system in

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July of 1978. The results of these samples were received in September 1978 and indicated a satisfactory quality for the production wells (1, 2, 4 and 5) on the site.

In the fall of 1978 the ground-water situation was assessed on the site through the installation of a series of shallow and deep monitoring wells. During the planning and installation phase of the ground-water well network a further series of complete analyses were carried out on the production wells in December 1978. In addition to this set of analyses, the U. S. Environmental Protection Agency in early January 1979, carried out a complete analysis on the mixed raw-water supply of the East Fishkill site as part of an effluent guidelines survey. The results of the EPA and the IBM analyses became available in early February 1979. Both sets of analyses indicated the presence of trace organic compounds (chlorinated hydrocarbons) in the ground-water system. During this time frame the installation of a ground-water monitor-well network was finalized primarily in regions where chemicals were stored and/or handled. Sampling of water from these monitor wells began in March 1979.

Based on the results of the IBM survey and the EPA survey, it was decided to carry out a confirmatory analysis on the production wells. The use of production wells #2 and #4 (in which organic solvents were found) was minimized to prevent these materials from entering the potable water supply of the site. The results of this particular survey were received during the first week of March 1979 confirming the presence of organics in the production well system. Based on these results it was decided to minimize the use of the two particular wells involved until such a time that a granular activated carbon system could be installed. In the second week of April 1979 a Calgon granular activated carbon system was installed on production well #2. The design parameters for this system and other details were forwarded to the New York State Department of Health. A representative of the State Health Department visited the IBM site in May 1979 to discuss the potable water situation and made suggestions with respect to operating the granular activated carbon system. During the remainder of 1979 and the early part of 1980, IBM reported the results for organics in the production wells to the State Department of Health on a monthly basis to demonstrate the effectiveness of the carbon adsorbers.

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Table 1. Water-Quality Monitoring Parameters

Organic solvents	Metals	
Tetrachloroethylene	Antimony	Mercury
Trichloroethylene	Chromium	Selenium
cis-1, 2-dichloroethylene	Cobalt	Iron
Methylene chloride	Copper	Manganese
Trichloroethane	Nickel	Calcium
Freon TF	Silver	Aluminum
Toluene	Zinc	Magnesium
Benzene	Arsenic	Sodium
Isopropanol	Cadmium	Potassium
Dichloroethane	Lead	Hardness
Carbon tetrachloride		
Chloroform		

Non-metals	Physical parameters	Special organics
Fluoride	pH	Tetrahydorfuran
Nitrate	Conductance	Phenols
Sulfate		Total Organic Carbon (TOC)
Chloride		
Alkalinity		
Ammonia		
Cyanide		

Table 2. Levels of Organics[1/] in Ground Water

Area	Geometric mean (ppb)	Maximum concentration (ppb)
A	760	297,000[2/]
B	600	29,700
C	140	2,000
D	70	700

[1/] Includes those organic solvents listed in Table 1.

[2/] One well has had a separate solvent phase at various times.

Recent data on the quality of water in the bedrock production wells is summarized in Table 3.

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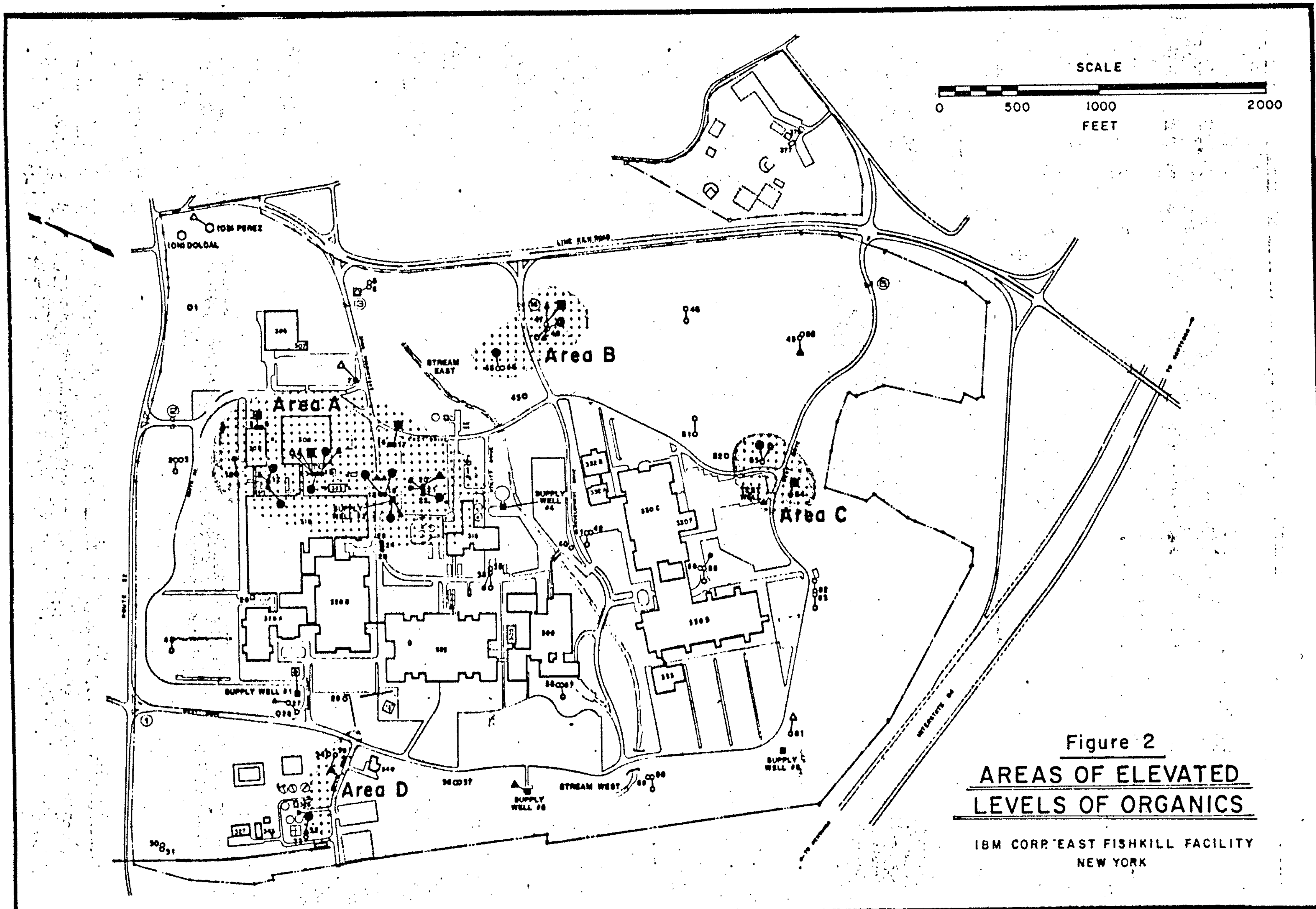

Figure 2

AREAS OF ELEVATED LEVELS OF ORGANICS

IBM CORP. EAST FISHKILL FACILITY
NEW YORK

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Table 3. Production Well Water Quality[1/]

Well No.	Average concentrations (ppb)[2/]
1	< 2
2	10,400
4	12
5	< 2
6	< 2
7	9
Recreation Center (Lime Kiln Road and Shenandoah Road)	< 2

The quality of water (after G.A.C. treatment of wells 2 and 4) entering the domestic system is less than 2 parts per billion of the organic compounds listed in Table 1.

[1/] Prior to treatment with Activated Carbon, October 1980.

[2/] For compounds listed in Table 1, Organic Solvents.

The ground-water quality at the site perimeters has been monitored, and the findings are summarized in Table 4.

Table 4. Ground-Water Quality[1/]

Site perimeter	Geometric mean (ppb)	Maximum concentration (ppb)
North	7	300
East	14	1,400
South	16	4,000
West	11	900

[1/] Includes organic solvents listed in Table 1.

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A number of monitoring wells installed in the second well construction program were found to contain levels of tetrahydrofuran. This compound was traced to the solvent cement used to join the PVC well casings. This material had been used in the past without difficulty and its presence in these wells was attributed to lack of curing time prior to installation of the casings. The level of this compound is declining rapidly as a result of well purging and possible biological degradation during the time period of the sampling program (9 months).

C. <u>Ground-water quality summary--inorganics</u>

All site production wells are analyzed for the parameters listed in Table 1 twice a year. In addition, a series of key inorganic species are analyzed twice a month. The results of these analyses have demonstrated that all production wells meet U. S. EPA primary and secondary drinking water standards.

A series of analyses for inorganics were carried out on ground-water samples for a period of 6 months as part of the routine sampling program. Based on an evaluation of the results, these analyses will be carried out on a quarterly basis in the future. The results of analyses of ground-water samples were quite good with only two areas of concern. Some monitor wells (shallow) have high levels of salts, such as chlorides and sulfates. These materials are attributed to the use of de-icing chemicals and general surface runoff. There does not appear to be a pattern of migration of those compounds into the bedrock aquifer at the present time. A second area of concern is the presence of elevated fluoride levels (2 to 10 ppm) in the area of Buildings 308 and 310. It is presumed that these levels are the result of processing fluoride wastes in the vicinity of the wells. There is no evidence that the fluorides have moved into the bedrock aquifer since production wells on site show non-detectable fluoride levels.

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D. <u>Potential sources of chemicals in ground water</u>

Information from previous studies highlights areas of concern on the East Fishkill site which indicated ground water containing various levels of organic compounds. These areas are shown in Fig. 2. The primary source of organics appears to be the chemical and waste solvent tank farm. Secondary sources such as spills, pipeline leaks and incidental discharges probably

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existed area wide because elevated levels occur in several areas of the plant that are hydraulically unexplainable if we assume only one source.

Unlike the findings obtained for the organic compounds, there is a less distinct pattern of degraded ground water by inorganic chemicals which appear to be much more widespread. These may be the accumulated results of incidental discharges, sporadic spills, leaks and de-icing compounds over the years.

E. Site-specific ground-water hydraulic characteristics

As of the end of 1980, over 100 holes have been drilled with monitor wells and piezometers installed on the IBM East Fishkill site. Fig. 3 (in pocket) is a geologic fence diagram which helps visualize the three-dimensional geometry and heterogeniety of the site. A summary of the physical information obtained to date follows:

1. Fill and glacial overburden deposits range in thickness from less than 1 foot to over 80 feet.

2. The bedrock surface is uneven with well defined depressions and high areas. Bedrock surface elevations under the site range from less than 50 feet to over 250 feet above mean sea level.

3. The exposed bedrock dips 30 to 40 degrees eastward. Folding and faulting in the area is evident.

4. The glacial deposits are heterogeneous, both horizontally and vertically. Permeabilities range from a few feet per day to 200 feet per day.

5. The degree of fracturing in the bedrock varies significantly. The permeability is essentially zero in those areas with no fracturing to 120 feet per day (or more) in localized areas where fracturing is extensive.

6. The natural water-table configuration in the glacial deposits probably conformed to the general topography of the area prior to construction on the facility. Thus, ground-water flow was to the low areas, such as streams and swamps, that served as outlets. Measurements of water levels in the monitor wells, however, show that a strong vertical gradient now exists because of pumping from the bedrock.

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7. The flow of ground water in the bedrock is controlled by the fracture patterns as well as relative potentiometric heads in the formation. The general flow direction across the site was probably southwesterly before the IBM wells were put into production. Recent measurements show pronounced influence of the production wells causing the direction of bedrock ground-water flow under much of the site to be towards the pumped wells.

8. Although the vertical permeability of the glacial deposits is very low, chlorinated hydrocarbons have been found at the base of the deposits indicating vertical percolation of the organics.

IV. PRESENT ABATEMENT AND PROTECTION PROGRAMS

A. Spill prevention, control and countermeasures (SPCC)

A ground-water protection program has been in effect since January 1978. The primary purpose of the program is to prevent future spills, control and abate existing situations, and establish a series of countermeasures in the event of an accidental spill episode. The main features of the program are as follows:

1. A formal SPCC Plan for petroleum and for hazardous materials.
2. Diking of all above-ground storage tanks or hazardous materials.
3. Truck loading/unloading spill control facilities at all hazardous waste transfer areas.
4. Site-wide ground-water monitoring program.
5. New specifications covering all new hazardous waste pipe and tank installations.
6. Training of key personnel in spill prevention and cleanup procedures.
7. Onsite specialized emergency equipment for use on hazardous waste spills.
8. Long-term replacement program of storage tanks and pipes conveying hazardous materials.

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9. Pilot plant for ground-water extraction and treatment of organics and inorganics.

10. Site-wide leak testing program of hazardous material storage tanks and piping systems.

B. Granular activated carbon systems

When the presence of organic compounds was confirmed in production wells #2 and #4, a number of potential treatment systems for organics removal were considered. Granular activated carbon (GAC) was chosen because the technology had been successfully applied to the removal of materials similar to those which existed in the ground water on the East Fishkill site. In addition to being capable of removing the particular organics, a system (CALGON, INC.) was available for delivery and installation on short notice. Two weeks after confirmation of the presence of organics, the GAC system was installed on well #2 and was fully operational by April 1979. The unit consists of two tanks, each containing 10,000 pounds of Calgon GAC, operated in series at a flow rate of 250 gpm. Water-quality into the system between the two tanks, and the output of the system is monitored on a weekly basis. Adsorption isotherm data from Calgon, Inc., indicated the material in the water which would break through (exhaust) the carbon most rapidly was cis-1, 2-dichloroethylene. When the level of this compound exceeds 10 ppb at the between sample point, the first GAC bed is replaced with virgin carbon and the flow pattern of the system is reversed which assures that the freshest carbon is on the output of the system at all times. The spent carbon is reactivated by Calgon for industrial use.

The design, the operating and maintenance procedures, and the analysis and reporting schedules were discussed with and approved by the New York State Department of Health in Albany and the Dutchess County Department of Health.

The pumping of production well #2 (with the GAC in place) resulted in a significant drop in the levels of organics in production well #4 which is hydraulically downgradient of #2.

A similar GAC system has been installed on production well #4 (August 1980) in order to further improve the quality of water from this source and the overall quality of the mixed raw-water supply for the site.

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The GAC system on production well #2, in addition to removing organics from the site raw-water supply, is acting as an extraction and treatment facility for organics in the ground water in the vicinity of Buildings 308 and 310. During the course of operation from April 1979 through December 1980, this system has processed in excess of 130 million gallons of ground water.

C. Treatment of areas containing elevated levels of organic/solvents

There are four areas on the East Fishkill site which have been identified as regions in which the ground water contains elevated levels of organics (Fig. 2). These findings are based on the results of the various hydrogeologic studies and the site-wide ground-water monitoring program.

A number of procedures have been implemented to extract, treat, and contain the ground water in these areas. A detailed program has been established to detect and correct any spills or leaks from the site chemical handling systems. The abatement procedures discussed below were implemented on a priority basis to contain the areas of interest, remove organics where possible, and study long-term concepts for the extraction and treatment of organics from ground water on a site-wide basis.

Area A. Pilot plant studies were conducted between June and November 1980 to investigate the feasibility and advisability of implementing a suitable process for ground-water extraction and treatment under the chemical and waste solvent storage area near Buildings 308, 309, and 310. Alternative treatment technologies for removal of organics, inorganics, and heavy metals at the levels occuring in ground water pumped from the shallow unconsolidated sediments and the underlying upper bedrock aquifer in this area, were investigated to develop detailed design parameters.

The purpose of the study was threefold--to determine a suitable and effective treatment procedure to permit sizing and costing of a full-sized system; to initiate early treatment of shallow ground water from a group of selected small-diameter monitoring wells; and to study the feasibility of recharging ground water. The project was grouped into five work categories:

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1. Initial laboratory study and design of pilot plant (Bench Scale).
2. Furnishing and installation of the pilot plant.
3. Operation of the pilot plant.
4. Performance of a recharge feasibility test.
5. Study and report

The pilot plant design was based on five unit operations: separation, equalization and storage, air stripping, coagulation and filtration, and adsorption. A continuous and fairly constant low volume stream of ground water was provided to the individual unit treatment processes making up the pilot plant by the conversion of several selected monitoring wells of varying depths into a connected and pumping extraction well network. Approximately 110,000 gallons per month was recovered, tested, and processed through the well network. Results indicated that special consideration must be given to design and selection of compatible materials and construction practices in the event very high concentrations, or separate phase organics, are encountered.

Results from operating the recovery well network confirm previously collected data and indicate complex hydrogeologic conditions. Over a 4-month period, approximately 6-7 gpm of ground water was successfully pumped on a semi-continuous basis and processed through the system.

Results from the pilot plant operations served to confirm basic assumptions regarding the appropriate methodology that should be considered for extracting of ground water pumped from the chemical and waste solvent storage area. The information that was evaluated on extracted ground water (analysis and treatment parameters) resulted in the design of an abatement program. The major conclusions from the pilot treatment plant investigation area as follows:

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1. Variable well production and analysis requires equalization/ storage prior to treatment.
2. Presence of iron and managanese in the water as well as possible suspended solids requires clarification with chemical treatment followed by filtration, prior to further treatment.

3. While cooling tower type air stripping is effective in removal of organics, a flooded, packed tower air stripping design is much more efficient.

4. The various activated carbons were more effective than had been calculated, although the synthetic resin type, Ambersorb XE 340, did not perform as predicted by the manufacturer. Steam stripping of the carbon after exhaustion, while extremely effective, did not return it to its original efficiency. This fact, together with capital and operating cost analysis, suggests the use and subsequent discard of virgin carbon for the project operating conditions.

Based on the results of the pilot plant/extraction field study, a number of design options for a full-scale project are in progress.

In addition to the construction and operation of a full-scale system, plans are underway to reinstall a modified pilot plant system for operation during the May 1981-November 1981 time frame. This will allow continued treatment of ground water in this area during the construction phase of the full-scale system.

Area B. The presence of particular species (i.e., methylene chloride) and their relative ratio with respect to other compounds suggests an isolated area of high organic levels shown as Area B on Fig. 2. The treatment of this area of ground water is being addressed in the studies presently underway (site hydraulic modeling). As an interim measure, a temporary system consisting of a submersible pump with level controls is being installed to pump water from this area into a storage trailer which will then be treated at a permitted waste disposal facility.

Areas C & D. As shown on Fig. 2, two additional areas (C & D) with elevated levels of organics have been identified. A study of ground-water flow patterns and data from the water-quality monitoring program suggests that additional monitoring is called for at the present time (see the data summary, Table 4). In addition, the stream which runs along the site western boundary may act as a natural barrier to the organics in the shallow unconsolidated zone.

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D. Development of site-specific hydraulic model

The complexity of the ground-water system as influenced by geometry, heterogeneous hydraulic characteristics, pumping, etc., requires that rather sophisticated analysis and prediction techniques be used. The analysis and prediction needed to evaluate proposed abatement plans can best be accomplished using a mathematical model of the system. Development of such a model requires sufficient knowledge of the system to adequately simulate its responses to pumping and recharge.

A program directed at obtaining the necessary information for developing such a model was begun in mid-October 1980. The work has included installation of a network of piezometers for measuring potentiometric head at specific elevations, additional definition of bedrock fracturing and an aquifer pumping test.

The aquifer pumping test, which included periodic measurement of water levels in monitor wells and piezometers, provides a base for calibrating a model so that simulated responses correspond with the field measurements. The aquifer pumping test was performed December 26-29, 1980.

V. FUTURE PLANS AND TIME SCHEDULES

Ongoing and planned future work are scheduled over a 12-month period as shown in Fig. 4. The data and information programs, and the abatement facilities for Area A, have been discussed in earlier sections of this report. The plan of work related to the development and use of an hydraulic model is discussed in more detail below.

A. Phase I, Data collection and preliminary analysis

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As shown in Fig. 4, Phase I is estimated to require 4 months and contain 6 major tasks. Because of the field work involved, the progress of the work is particularly vulnerable to adverse weather conditions.

Task IA--Hydraulic investigations. The work to be accomplished under this task is the most time consuming of all the Phase I tasks. It is anticipated that as many as 64 dual piezometers (two piezometers per hole) may

DATA & INFORMATION PROGRAMS

A. Water-quality data (monthly throughout year)
B. Water-level data (monthly throughout year)
C. Leakage information
D. Water-use data (historical)
E. Water need projections

SITE - SPECIFIC HYDRAULIC MODEL TASKS

Phase I, Data Collection and Preliminary Analysis

A. Hydraulic investigations
B. Geologic investigations
C. Initial migration evaluations
D. Initial water-supply evaluations
E. Model selection
F. Development of conceptual abatement plans

Phase II, Model Verification and Analysis

A. Model verification
B. Model analysis of abatement plans
C. Model analysis of water supply
D. Model analysis of migration situation
E. Continued data analysis

Phase III, Design Phase

A. Design site-wide abatement facilities
B. Supervise construction of abatement facilities
C. Continued data analysis
D. Prepare plan of work for monitoring and evaluating the progress of abatement

ABATEMENT FACILITIES

A. Design of abatement facilities for area of highest concentration of organics

B. Construction of abatement facility

1	2	3	4	5	6	7	8	9	10	11	12

MONTHS FROM BEGINNING OF PROJECT

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Fig. 4, PLAN OF WORK

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be required to adequately define ground-water flow conditions in the shallow and bedrock formations. Task IA can be further subdivided into subtasks which need to be performed sequentially as follows:

1. Design piezometer layout and construction details.
2. Determine which of the existing monitor wells can be converted to the piezometer network and how the conversion can be accomplished.
3. Engage a contractor(s) to install piezometers.
4. Supervise construction assuring satisfactory work.
5. Conduct pumping tests on production wells.
6. Analyze data for use in model.

As of January 1, items 1, 2, 3 and 5 have been completed; item 4 is near completion; and item 6 is yet to be done.

Task IB--Geologic investigations. Geologic investigations will be conducted to supplement data and information already available so as to better define the location and orientation of bedrock fractures. Specific subtasks include:

1. Make detailed inspection and measurements of bedrock outcrops.
2. Study aerial photographs, including satellite imagery.
3. Do TV survey in existing wells and new holes prior to installation of piezometers.
4. Acquire and study well logs available in area.
5. Analyze data for use in model.

As of January 1981, items 1 and 2 have been partially completed; item 3 has been accomplished; and items 4 and 5 have yet to be done.

Task IC--Initial migration evaluations. As data on quality analyses of ground-water samples taken from existing monitor wells become available, trend analyses and evaluations of potential migration will be made. The ultimate analyses will be made after the model is verified (Phase II), but preliminary evaluations will be made as soon as sufficient data are available.

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Task ID--Initial water-supply evaluations. As additional geologic and hydraulic data are developed during Phase I, preliminary evaluations of the facility water supply will be made--including recommendations for new production wells, if possible. However, ultimate analyses will be made after the model is verified (Phase II).

Task IE--Model selection. Existing ground-water models will be evaluated for applicability to the East Fishkill Facility and one or more will be selected for use.

Task IF--Development of conceptual abatement plans. Using preliminary data on ground-water flow conditions and quality, alternative abatement plans will be developed. It is anticipated that these will be in the form of ground-water pumping and recharge installations at alternate locations, numbers and sizes.

B. Phase II, Model verification and analysis

The modeling phase is expected to require 5 months to complete its five major tasks. The first task, model verification and calibration, must be completed before the next three are started.

Task IIA--Model verification and calibration. An important part of model development is the testing of the model against known field conditions and responses to verify that it truly simulates the system. During the calibration and verification process important decisions often must be made in adjusting model components. Data from piezometer and monitor-well measurements will be used in the verification process. Additional data from the ongoing leak-testing program for use in the modeling endeavor, as well as information on production well pumping, will be provided.

Task IIB--Model analysis of abatement plans. Alternative abatement plans will be tested with the model. The principal objective will be to identify the plan that will provide the most efficient and fail-safe operational abatement program. Plans for an abatement program for the area of highest concentration will be available by this stage of the work and will therefore be incorporated in the model.

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Task IIC--Model analysis of water supply. Using the model, the proposed abatement plan and the projected water needs will be imposed on the system to evaluate the quantity and quality problems expected to impact future water supplies. Programs will be implemented to assure adequacy of supply.

Task IID--Model analysis of migration situation. The model will be used to evaluate the potential migration. Control methods will be tested and implemented, if necessary.

Task IIE--Continued data analysis. Monthly trend analyses on quality and water-level data will continue through Phase II. These will be particularly scrutinized for changes near the facility boundaries.

C. Phase III, Design phase

After the alternate abatement plans have been tested and approved, the following tasks will be pursued.

Task IIIA--Design of abatement facilities. Plans and specifications for construction of the abatement facilities will be prepared, along with cost estimate of same.

Task IIIB--Supervision of construction of abatement facilities. Construction of the facilities in conformance with specifications will be quite closely supervised.

Task IIIC--Continued data analysis. Monthly trend analyses on quality and water-level data will continue through Phase III.

Task IIID--Preparation of plan of work. A plan of work for monitoring and evaluating the progress of abatement will be prepared prior to the completion of Phase III.

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IBM EAST FISHKILL

GROUNDWATER REPORT

INTERNATIONAL BUSINESS MACHINES CORPORATION
EAST FISHKILL FACILITY
ROUTE 52
HOPEWELL JUNCTION, NEW YORK 12533

MARCH, 1981

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I. INTRODUCTION

The purpose of this report is to present a brief, but thorough, summary of the groundwater situation at the IBM Corporation's East Fishkill Facility as of April 1, 1981 and to present the proposed groundwater treatment plans.

For background purposes the report first describes the geologic and hydrologic conditions pertinent to the groundwater system underlying the facility. The next section contains a summary of investigations conducted through the end of March, 1981. Later sections describe progress to date and plans (schedules) for future work.

II. GENERAL REGIONAL HYDROGEOLOGY

The principal geologic formations pertinent to the groundwater system underlying the IBM East Fishkill Facility are unconsolidated surficial glacial deposits of Pleistocene Age and the underlying carbonate bedrock (limestone and dolomite) of Ordovician age.

The glacial deposits vary greatly in both thickness and texture. Where sufficient saturated thickness and permeability exist, the glacial deposits provide water to wells in the vicinity. These are generally small-capacity domestic and livestock wells, although yields of several hundred gallons per minute from sand and gravel deposits may be obtained in valley areas.

The bedrock, geologically known as the Stockbridge limestone, is the principal aquifer supplying water to large-capacity wells, including the IBM production wells at the East Fishkill Facility. The unit of this formation underlying the facility extends under the Fishkill Creek valley from Beacon northeastward to the headwaters of the creek.

Joints, fractures and bedding planes in the bedrock provide the principal means for storage and movement of water. In fact, the yield of wells can vary from essentially zero to several

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hundred gallons per minute depending upon the amount and sizes of such openings encountered. The major fractures in the Stockbridge limestone are probably associated with faults. Several northeasterly trending faults have been mapped in the East Fishkill area.

The source of groundwater found in both the glacial and bedrock formations is derived from that portion of precipitation which falls on the overlying land that percolates downward to the groundwater system. Obviously, the portion of the precipitation that recharges the groundwater is dependent upon many factors such as soil texture, soil moisture, type of cover, land slope and rainfall intensity. A general estimate of the average annual recharge is 13 inches--or about one-third of the average annual precipitation of 42 inches. The other two-thirds leaves the area as surface runoff in streams and evapotranspiration to the atmosphere.

Groundwater levels in the area normally are highest in the spring and lowest in the fall in response to the relative intensity of precipitation and evapotranspiration. Also, long-term records of groundwater levels not influenced by pumping show a strong correspondence with rainfall patterns, indicating essentially immediate recharge response to precipitation events.

III. SUMMARY OF GROUNDWATER QUALITY INVESTIGATIONS

A. ON-SITE

A groundwater quality monitoring program has been carried out at the East Fishkill Facility. A series of monitoring wells (Fig. 1) provide groundwater quality samples which are analyzed for the parameters listed in Table 1.

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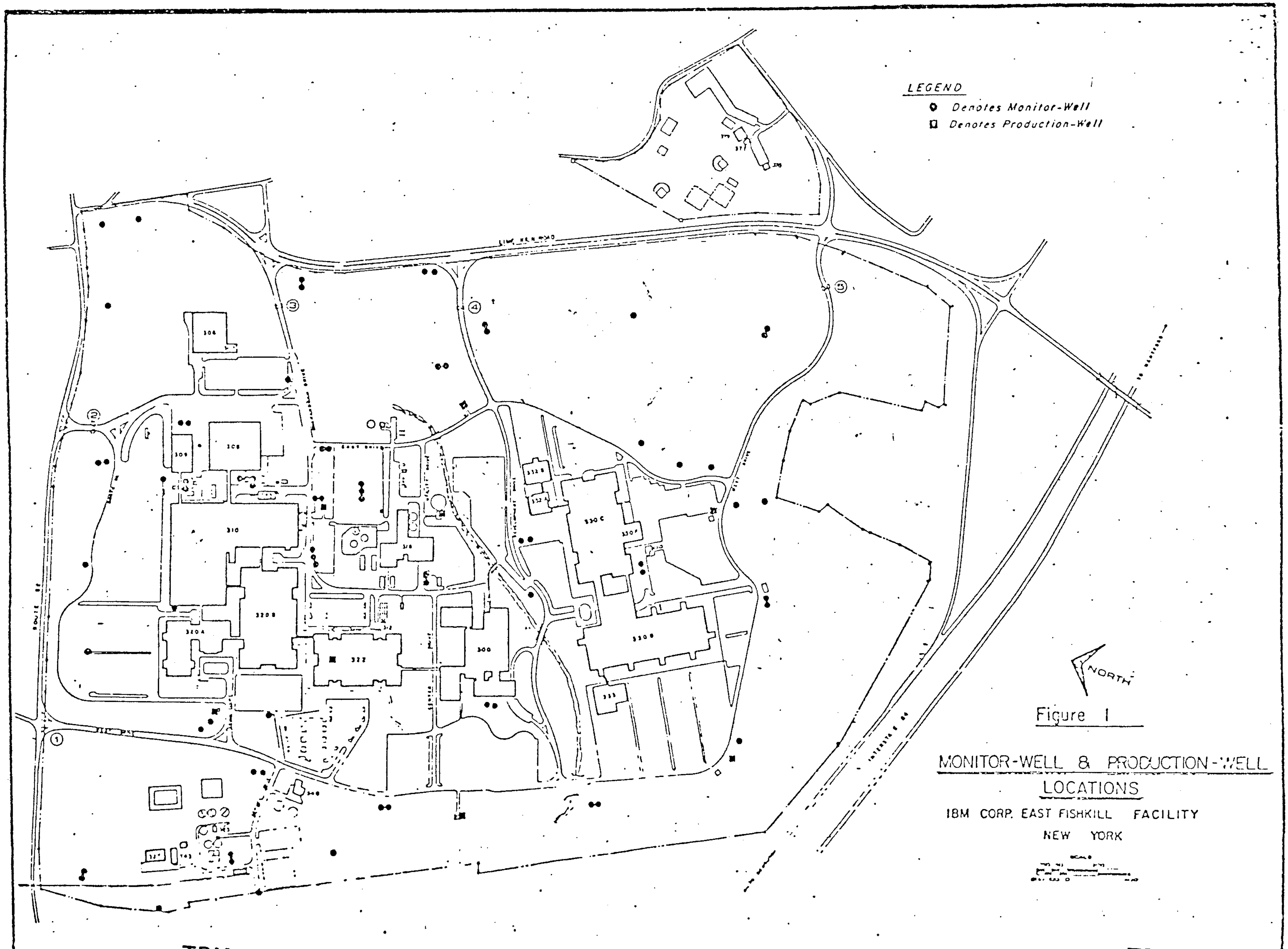

Figure 1

MONITOR-WELL & PRODUCTION-WELL LOCATIONS

IBM CORP. EAST FISHKILL FACILITY

NEW YORK

Table 1. Water-Quality Monitoring Parameters

Organic solvents

- Tetrachloroethylene
- Trichloroethylene
- cis-1, 2-dichloroethylene
- Methylene chloride
- Trichloroethane
- Freon TF
- Toluene
- Benzene
- Isopropanol
- Dichloroethane
- Carbon tetrachloride
- Chloroform

Metals

Antimony	Mercury
Chromium	Selenium
Cobalt	Iron
Copper	Manganese
Nickel	Calcium
Silver	Aluminum
Zinc	Magnesium
Arsenic	Sodium
Cadmium	Potassium
Lead	Hardness

Non-metals

- Fluoride
- Nitrate
- Sulfate
- Chloride
- Alkalinity
- Ammonia
- Cyanide

Physical parameters

- pH
- Conductance

Special organics

- Tetrahydo furan
- Phenols
- Total Organic Carbon (TOC)

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1. Groundwater Quality Summary--Organics

The groundwater studies confirm the presence of four main organic compounds in the shallow and deep aquifer systems. The materials are:

1,1,2,2 - tetrachloroethylene (Perchloroethylene)
1,1,2 - trichloroethylene
Methylene chloride
cis-1,2 - dichloroethylene

The organic species are concentrated in the four areas shown in Fig. 2 and Table 2. The largest concentrations are centered in the areas of Buildings 308/310.

A number of monitoring wells installed in the second well construction program were found to contain levels of tetrahydrofuran. This compound was traced to the solvent cement used to join the PVC well casings. This material had been used in the past without difficulty and its presence in these wells was attributed to lack of curing time prior to installation of the casings. The level of this compound is declining as a result of well purging and possible biological degradation during the time period of the sampling program (9 months).

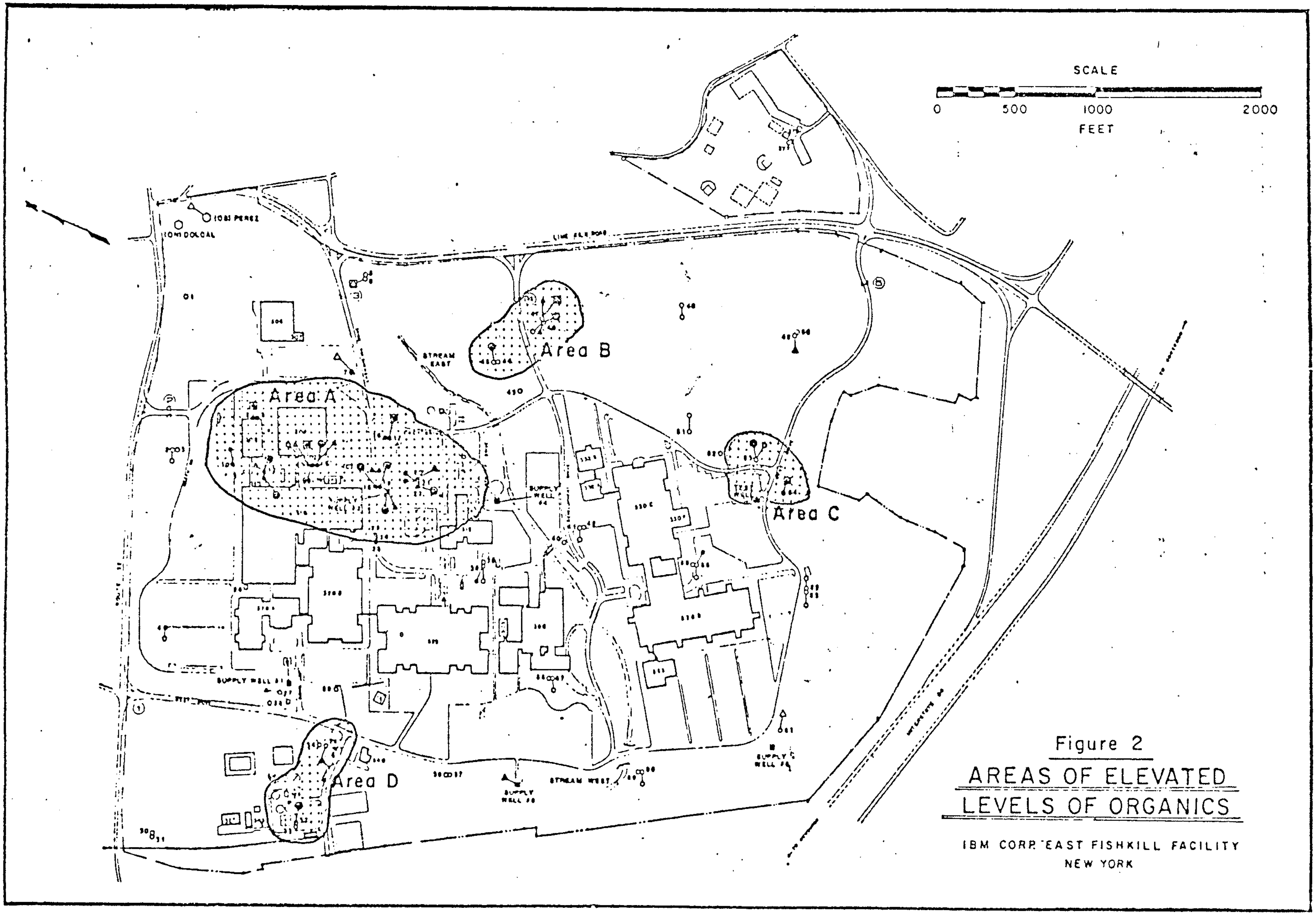

Figure 2

AREAS OF ELEVATED LEVELS OF ORGANICS

IBM CORP. EAST FISHKILL FACILITY
NEW YORK

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Recent data on the quality of water in the bedrock production wells is summarized in Table 3.

Table 3. Production Well Water Quality 1/

Well No.	Average Concentrations 2/ (ppb)
1	< 2
2	< 2
4	< 2
5	< 2
6	< 2
Recreation Center (Lime Kiln Road and Shenandoah Road)	< 2

The quality of water (after activated carbon treatment of wells 2 and 4) entering the domestic system is less than 2 parts per billion of the organic compounds listed in Table 1. Well 7 is on standby and not being used. Well 7 has an average concentration of 9 ppb. An activated carbon unit is being installed on Well 7, and an additional carbon unit is being added to Well 4 for increased flow capacity.

1/ Water from wells 2 and 4 is treated with activated carbon. Prior to treatment, average concentration for well 2 is 10,400 ppb and for well 4 is 12 ppb.

2/ For compounds listed in Table 1, Organic Solvents.

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Table 2. Levels of Organics[1/] in Ground Water

Area	Geometric mean (ppb)	Maximum concentration (ppb)
A	760	297,000[2/]
B	600	29,700
C	140	2,000
D	70	700

[1/] Includes those organic solvents listed in Table 1.

[2/] One well has had a separate solvent phase at various times.

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The groundwater quality at the site perimeters is summarized in Table 4.

Table 4. Groundwater Quality 1/

Site Perimeter	Geometric Mean (ppb) 2nd & 3rd quarters 1980	Geometric Mean (ppb) 4th quarter 1980	Maximum Concentration (ppb) 2nd & 3rd quarters 1980	Maximum Concentration (ppb) 4th quarter 1980
North	7	1	300	3
East	14	6	1,400	20
South	16	5	4,000	170
West	11	2	900	3

1/ Includes organic solvents listed in Table 1.

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2. Groundwater Quality Summary--Inorganics

All site production wells are analyzed for all the inorganic parameters listed in Table 1 twice a year. In addition, a series of key inorganic species are analyzed twice a month. The results of these analyses have demonstrated that all production wells meet U.S. EPA primary and secondary drinking water standards.

A series of analyses for inorganics were carried out on groundwater samples for a period of 6 months as part of the routine sampling program. Based on an evaluation of the results, these analyses will be carried out on a quarterly basis in the future. The results of analyses of groundwater samples were quite good. Some monitor wells (shallow) have salts, such as chlorides and sulfates above background levels. There does not appear to be a pattern of migration of these compounds into the bedrock aquifer. There are also elevated fluoride levels (2 to 10 ppm) in the area of Buildings 308 and 310. There is no evidence that the fluorides have moved into the bedrock aquifer.

3. Site Specific Groundwater Hydraulic Characteristics

As of April 1, 1981, a series of monitor wells and piezometers have been installed on the IBM East Fishkill site. Fig. 3 is a geologic fence diagram which helps visualize the three-dimensional geometry and heterogeniety of the site. A summary of the physical information obtained to date follows:

a. Fill and glacial overburden deposits range in thickness from less than 1 foot to over 80 feet.

b. The bedrock surface is uneven with well defined depressions and high areas. Bedrock surface elevations under the site range from less than 50 feet to over 250 feet above mean sea level.

c. The exposed bedrock dips 30 to 40 degrees eastward. Folding and faulting in the area is evident.

d. The glacial deposits are heterogeneous, both horizontally and vertically. Permeabilities range from a few feet per day to 200 feet per day.

e. The degree of fracturing in the bedrock varies significantly. The permeability is essentially zero in those areas with no fracturing to 120 feet per day (or more) in localized areas where fracturing is extensive.

f. The natural water-table configuration in the glacial deposits probably conformed to the general topography of the area prior to construction on the facility. Thus, groundwater flow was to the low areas, such as streams and swamps, that served as outlets. Measurements of water levels in the monitor wells, however, show that a strong vertical gradient now exists because of pumping from the bedrock.

g. The flow of groundwater in the bedrock is controlled by the fracture patterns as well as relative potentiometric heads in the formation. The general flow direction across the site was probably southwesterly before the IBM wells were put into production. Measurements show pronounced influence of the production wells causing the direction of bedrock groundwater flow to be towards the pumped wells in the center of the site.

h. The analysis of water-level measurements in the piezometer network, when converted to horizontal flow vectors, indicates that the groundwater flow in the glacial overburden and the bedrock aquifer is generally from the northerly, easterly and southerly boundaries toward the interior of the plant site.

B. OFF-SITE

An off-site study of groundwater quality was carried out in February, 1981. This effort was coordinated with the Dutchess County Department of Health and the New York State Department of Health.

Samples were taken by DCDH at homes chosen by DCDH (Fig. 4) and were analyzed by a private laboratory, with quality control samples being run by NYSDH in Albany. The results of this study are shown on Tables 5 and 6.

IBM has installed and has agreed that for a period of one year from the date of installation, it will fund the maintenance of granular activated carbon units on each of the five homes shown on Table 6 to have traces of organics in their water. Further, the DCDH/NYSDH have arranged for the sampling and analysis of water from designated homes adjacent to the IBM site (which IBM will also fund) for a one year period, now estimated to begin in March 1981. With permission of the homeowner, the DCDH will conduct studies throughout this one year period to help IBM and its neighbors identify the source of organics in the five wells. A memo from the DCDH discussing this matter is attached to this report.

TABLE 5

OFF-SITE GROUNDWATER MONITORING

Activity	
Perimeter Homes Sampled	59
Perimeter Homes Analyzed*	59
Results	
Home Wells with Organics	6**
Actions	
GAC Filter Units Installed	5

* Analysis by Independent Lab (EPA Methods)

** One had no Chlorinated Hydrocarbons - Petroleum Products Only - Referred to NYSDOT

TABLE 6
OFF-SITE WELL WATER ANALYSIS*

Compound	Concentration (ppb) 1/ Location 2/				
	#33	#19	#45	#35	#2
1,1,1-Trichloroethane	51/65	7/13	-	10/10	-
Perchloroethylene	-	10/24	-	-	-
Chloroform	-	-	15/ND	-	-
Methylene Chloride	-	-	-	-	5/13

* John Jay High School is monitored twice a week. No chlorinated solvents have been detected.

1/ Results are from two samples (different sample dates)

2/ Figure 4. - Dutchess County Tax Map.

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IBM has held an open meeting with the adjacent homeowners and will continue to do so periodically when there is new or changed information which is relevant to the homeowners' concerns. The purpose of these meetings is to review the findings of the monitoring programs and the hydrogeologic studies.

The chemical and hydrologic data available to IBM at the present time suggests that IBM is not the source of the organics found in the off-site wells. Studies on this matter are continuing.

C. LANDFILL INVESTIGATION

An allegation was made that a number of buried tanks and/or drums containing "toxic wastes" were located in two specific areas of the IBM site. IBM has no knowledge of any such tanks or drums. A search of the areas in question were made by the New York State Department of Environmental Conservation, using metal detectors and excavating equipment. The person making the allegation and IBM personnel were in attendance. The search did not reveal the presence of any tanks or drums or any similar containers.

By letter dated March 16, 1981, NYSDEC suggested IBM make a groundwater quality investigation in these two areas to finalize this matter. Arrangements for this study have been completed. (See Future Plans). (Letter attached)

IV. PRESENT ABATEMENT & PROTECTION PROGRAMS

A. SPILL PREVENTION, CONTROL AND COUNTERMEASURES (SPCC)

The primary purpose of the SPCC program is to prevent spills, control and abate existing situations, and establish a series of countermeasures in the event of an accidental spill episode. The main features of the program are as follows:

1. A formal SPCC plan for petroleum and for hazardous materials.
2. Diking of all above-ground storage tanks for hazardous materials.
3. Construction of truck loading/unloading spill control facilities at all hazardous waste transfer areas.
4. Site-wide groundwater monitoring program.

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5. New specifications covering all new hazardous waste pipe and tank installations.
6. Ongoing training of key personnel in spill prevention and cleanup procedures.
7. On-site specialized emergency equipment for use on hazardous waste spills.
8. Long-term replacement program of storage tanks and pipes conveying hazardous materials.
9. Pilot plant for groundwater extraction and treatment of organics and inorganics.
10. On-going site-wide testing program of hazardous material storage tanks and piping systems.

B. GRANULAR ACTIVATED CARBON SYSTEMS

Granular activated carbon (GAC) was chosen as the treatment technology for the removal of organics from the production well water. In addition to being capable of removing the particular organics, a system (CALGON, INC.) was available for delivery and intallation on short notice. The GAC unit consists of two tanks, each containing 10,000 pounds of Calgon GAC, operated in series at a flow rate of 250 gpm. Water quality into the system, between the two tanks, and the output of the system is monitored on a weekly basis. Adsorption isotherm data from Calgon, Inc., indicated the material in the water which would break through (exhaust) the carbon most rapidly was cis-1, 2-dichloroethylene. When the level of this compound exceeds 10 ppb at the "between" sample point, the first GAC bed is replaced with virgin carbon and the flow pattern of the system is reversed which assures that the freshest carbon is on the output of the system at all times.

The design, the operating and maintenance procedures, and the analysis and reporting schedules were discussed with and approved by the New York State Department of Health in Albany and the Dutchess County Department of Health.

The GAC system, in addition to removing organics from the site raw water supply, is acting as an extraction and treatment facility for organics in the groundwater in the vicinity of Buildings 308 and 310.

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C. TREATMENT OF AREAS CONTAINING ELEVATED LEVELS OF ORGANIC SOLVENTS

There are four areas on the East Fishkill site which have been identified as regions in which the groundwater contains elevated levels of organics (Fig. 2). These findings are based on the results of the various hydrogeologic studies and the site-wide groundwater monitoring program.

A number of procedures have been implemented to extract, treat and contain the groundwater in these areas. The abatement procedures discussed below were implemented on a priority basis to contain the areas of interest, remove organics where possible, and study long-term concepts for the extraction and treatment of organics from groundwater on a site wide basis.

Area A - Pilot plant studies were conducted between June and November 1980 to investigate the feasibility of implementing a suitable process for groundwater extraction and treatment. Technologies for the removal of organics from groundwater were investigated to develop detailed design parameters.

The purpose of the study was threefold - to determine a suitable and effective treatment procedure to permit sizing of a full-sized system; to initiate early treatment of shallow groundwater from a group of selected small-diameter monitoring wells; and to study the feasibility of recharging groundwater. The project was grouped into five work categories:

1. Initial laboratory study and design of pilot plant (Bench Scale).
2. Furnishing and installation of the pilot plant.
3. Operation of the pilot plant.
4. Performance of a recharge feasibility test.
5. Study and report.

The pilot plant design was based on five unit operations: Separation, equalization and storage, air stripping, coagulation and filtration, and adsorption. A continuous and fairly constant low volume stream of groundwater was provided to the individual

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unit treatment processes making up the pilot plant by the conversion of several selected monitoring wells of varying depths into a connected and pumping extraction well network. Results indicated that special consideration must be given to design and selection of compatible materials and construction practices in the event high concentrations, or separate phase organics, are encountered.

Results from operating the recovery well network confirm previously collected data and indicate complex hydrogeologic conditions. Over a 4-month period, approximately 6-7 gpm of groundwater was successfully pumped on a semi-continuous basis and processed through the system.

Results from the pilot plant operations served to confirm basic assumptions regarding the appropriate methodology that should be considered for treating groundwater. The information that was evaluated on extracted groundwater (analysis and treatment parameters) resulted in the design of a conceptual program. The major conclusions from the pilot treatment plan are as follows:

1. Variable well production and analysis requires equalization/storage prior to treatment.
2. Presence of iron and managanese in the water as well as possible suspended solids requires clarification with chemical treatment followed by filtration, prior to further treatment.
3. While cooling tower type air stripping is effective in removal of organics, a flooded, packed tower air stripping design is much more efficient.
4. The various activated carbons were more effective than had been expected. Steam stripping of the carbon after exhaustion, while effective, did not return it to its original efficiency. This fact suggests that only virgin carbon be used for the project operating conditions.

Based on the results of the pilot plant/extraction field study, a number of design options for a full-scale project will be evaluated with a mathematical model. The continued treatment of groundwater in this area of the site during the design and construction phases of the full-scale system will be carried out with production wells 2 and 4.

<u>Area B</u> - The presence of particular compounds (i.e., methylene chloride) and their relative ratio with respect to other compounds suggests a isolated area of organics shown as Area B on Fig. 2. The treatment of this area of groundwater is being addressed in the studies presently underway (site hydraulic modeling). As an interim measure, a system consisting of a submersible pump with level controls has been installed to pump water from this area into a storage trailer which will then be treated at a permitted waste disposal facility.

<u>Areas C & D</u> - As shown on Fig. 2, two additional areas (C & D) with organics have been identified. A study of groundwater flow patterns and data from the water quality monitoring program suggests that additional monitoring is called for at the present time (see the data summary, Table 4). In addition, the stream which runs along the site western boundary may act as a natural barrier to the organics in the shallow unconsolidated zone.

D. <u>DEVELOPMENT OF SITE SPECIFIC HYDRAULIC MODEL</u>

The complexity of the groundwater system as influenced by geometry, heterogeneous hydraulic characteristics, pumping, etc. requires that rather sophisticated analysis and prediction techniques be used. The analysis and prediction needed to evaluate proposed extraction and treatment plans can best be accomplished using a mathematical model of the system. Development of such a model requires sufficient knowledge of the system to adequately simulate its response to pumping and recharge.

A program directed at obtaining the necessary information for developing such a model was begun in mid-October 1980. The work has included installation of a network of piezometers for measuring potentiometric head at specific elevations, additional definition of bedrock fracturing and an aquifer pumping test.

The aquifer pumping test, which included periodic measurement of water levels in monitor wells and piezometers, provided a base for calibrating a mathematical model so that simulated responses correspond with the field measurements. The aquifer pumping was performed December, 1980.

Phase I contained five major tasks.

Task IA - Hydraulic Investigations - A series of dual piezometers (two piezometers per hole) were installed to adequately define groundwater flow conditions in the shallow and bedrock formations. Task IA was subdivided into subtasks which were performed sequentially as follows:

1. Design piezometer layout and construction details.
2. Determine which of the existing monitor wells can be converted to the piezometer network and how the conversion can be accomplished.
3. Engage a contractor(s) to install piezometers.
4. Supervise construction assuring satisfactory work.
5. Conduct pumping tests on production wells.
6. Analyze data for use in model.

As of April 1, 1981, all items have been completed.

Task IB - Geologic Investigations - Geologic investigations were conducted to supplement data and information already available so as to better define the location and orientation of bedrock fractures. Specific subtasks included:

1. Make detailed inspection and measurements of bedrock outcrops.
2. Study aerial photographs, including satellite imagery.
3. Do TV survey in exisitng wells and new holes prior to installation to piezometers.

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4. Acquire and study well logs available in area.
5. Analyze data for use in model.

As of April, 1981 all items have been completed.

Task IC - Initial Water Supply Evaluations - As additional geologic and hydraulic data became available during Phase I, preliminary evaluations of the facility water supply were made. Ultimate analyses will be made after the model is verified (Phase II).

Task ID - Model Selection - Alternative mathematical models have been selected that are capable of describing the movement and distribution of fluids in an aquifer such as the IBM site. Two-dimensional models of the glacial and bedrock aquifers will be used. The possible need to use a three-dimensional model has not been ruled out at this time.

Task IE - Development of Conceptual Plans - Using preliminary data on groundwater flow conditions and quality, conceptual plans for extraction/treatment have been developed. These are in the form of groundwater pumping and recharge installations in the bedrock aquifer, based on the reasonably uniform and predictable response of the aquifer system observed to date.

The plan for the glacial overburden will necessarily be more complex because of the variability of the system. The studies have demonstrated to IBM that the glacial materials have a low permeability and that only low horizontal hydraulic gradients may be imposed on this system by a conventional well field. A series of concepts will be evaluated with the hydraulic model.

V. FUTURE PLANS

Ongoing and planned future work is scheduled for on-site and off-site. The data and information programs and the extraction/treatment facilities for Area A have been discussed in earlier sections of this report. The plan of work related to the development and use of a hydraulic model and for an off-site "source identification" study are discussed in more detail below.

A. ON-SITE

Phase II - Model Verification and Analysis - As a result of Phase I, this phase was modified to include additional tasks required to gather data and information to meet the ultimate objectives of this study. Phase II now contains eight major tasks, the first three of which have been added to the five set forth in IBM's Groundwater Status Report dated January 1981.

Task IIA - Installation of Boundary Piezometers - Installation of up to seven additional piezometer groups (up to four piezometers in each group) to help define groundwater flow conditions across the westerly and easterly boundaries more accurately.

Task IIB - Installation of Additional Shallow Piezometers - Installation of up to six additional shallow piezometers for better definition of the upper saturated zone.

Task IIC - Neutron Meter Work - Installation of access tubing and measurement of soil moisture contents with neutron meter in both the access tubing and selected piezometers.

Task IID - Model Verification and Calibration - An important part of model development is the testing of the model against field conditions and responses to verify that it truly simulates the system. During the calibration and verification process important decisions often must be made in adjusting model components. Data from piezometer and monitor well measurements will be used in the verification process. Additional data from the ongoing SPCC program for use in the modeling endeavor, as well as information on production well pumping, will be provided.

Task IIE - Model Analysis of Plans - Alternative extraction/treatment plans will be tested with the model. The principal objective will be to identify the plan that will provide the most efficient and fail-safe operational program. Conceptual plans for a program for Area A will be available to us at this stage of the work and will therefore be evaluated by use of the model. Areas B, C & D will also be evaluated by use of the model to insure integration into an overall site plan.

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Task IIF - Model Analysis of Water Supply - Using the model, the proposed extraction/treatment plan and the projected water needs will be imposed on the system to evaluate the quantity and the quality problems expected to impact future water supplies. Programs will be implemented to assure adequacy of supply.

Task IIG - Model Analysis of Off-Site Migration - The model will be used to verify IBM's initial determination that chemicals found on IBM's site are contained within its boundary line. Existing containment methods will be evaluated and alternate methods may be tested and recommendations made for implementation, if necessary. The findings resulting from the installation of the piezometers (Task IIA) will influence the importance of, and possible need for, this task.

Task IIH - Continued Data Analysis - Monthly trend analysis on quality and water level data will continue through Phase II. These will be particularly scrutinized for changes near the facility boundary line.

PHASE III, DESIGN PHASE

After the alternate extraction/treatment plans have been tested and a plan is approved, the following tasks will be pursued:

Task IIIA - Design of Facilities - Plans and specifications for construction of the extraction/treatment facilities will be prepared.

Task IIIB - Supervision of Construction of Facilities - Construction of the extraction/treatment facilities in conformance with specifications will be closely supervised.

Task IIIC - Continued Data Analysis - Monthly trend analyses on quality and water level data will continue through Phase III.

Task IIID - Preparation of Plan of Work - A plan of work for monitoring and evaluating the progress of extraction/treatment will be prepared prior to the completion of Phase III.

B. OFF-SITE SOURCE IDENTIFICATION

This investigation is an attempt to assist the homeowner to identify the source or sources of trace organics in some private resident wells at the perimeter of the IBM East Fishkill Facility. The investigation will require prior written approval from each homeowner who desires to participate in the program. The project will be subdivided into three phases. This program is a voluntary effort on the part of IBM and, not withstanding anything in this plan to the contrary, IBM may at its option, modify or terminate any portion or all of this off-site source identification program.

Phase I - Scope of Work

Task IA - Prepare and execute a "Scope of Work" for the project.

Task IB- Select a consultant with expertise and familiarity with this type of investigation and award contract.

Phase II - Basic Data Gathering

This phase will include all work tasks associated with basic data gathering.

Task IIA - An aerial survey of the study area will be performed. The acreage to be mapped will be approximately 500' north of Route 52 and approximately 500' east and west of Shenandoah Road in the vicinity of IBM's East Fishkill Facility.

Task IIB - Review of the one year sampling program mentioned above, including sample site selections to assure that the sampling points are representative of well water quality.

Task IIC - A literature search will be conducted and include: SOC* soil transport, SOC soil attenuation, leaching of SOC's from non-metallic pipe and household and other SOC uses.

Task IID - Review reasonably available records of groundwater development within the study area, homeowners and well driller interviews, water quality data, fill areas, subsurface disposal systems, soil and geologic data.

* SOC - Synthetic Organic Chemicals

Task IIE - Investigation of each of the five homeowner wells that contain traces of organics, as well as wells immediately adjacent to these five wells will be conducted to determine parameters pertinent to this type of investigation. Initially, only static water levels and total depth will be determined at all other wells in the study area.

Phase III - Data Evaluation

All data obtained in Phase II will be evaluated and summarized. A detailed scope of service for Phase III will be prepared based on review of this preliminary information.

C. LANDFILL INVESTIGATION

At the request of NYSDEC, further investigation of the landfill area, to the extent mentioned in Article IIIC, will be conducted as follows:

Task IIA - Sample specified monitoring wells on site and some resident wells heretofore designated by NYSDEC in letter dated March 16, 1981.

Task IIB - Analyze well samples for heavy metals, cyanides, phenols, hydrocarbons, pH and chlorides.

Task IIC - Report results to NYSDEC.

D. SUMMARY STATEMENT

Based on data presently available, IBM has concluded that the chemicals discovered under the IBM site are being contained on the site and effectively removed by use of production wells. By use of the hydrogeologic model, IBM intends to develop a plan for a more sophisticated extraction and treatment system, using the best technology available to it. It is recognized that the complete removal of organics in the groundwater may not be practical or feasible. The extent of practical removal, using length of time of extraction and treatment and concentration

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as parameters, cannot be determined until after sufficient operating experience of the extraction and treatment system adopted by IBM has been evaluated. In determining a finite time period during which such extraction and treatment will continue (based on concentration levels to be attained), ~~it is proposed~~ ~~tha~~t NYSDEC, NYSDH and IBM be guided by the following draft policy statement issued by NYSDEC and the policy statement published by the U. S. Environmental Protection Agency:

From NYSDEC

<u>Development of a Groundwater Strategy</u> - April 15, 1980 - Draft

"Where groundwaters are contaminated beyond present and foreseeable technical and financial capabilities for reclamation, accept the fact that little can be done about the existing conditions and invest available resources in programs designed to prevent further contamination from occurring and to protect users of the groundwater."

"While the accepted strategy for surface water management entails cleaning up a polluted water body by reducing the input of pollutants through wastewater treatment and nonpoint source controls, there is often no practical corresponding approach for groundwater.

Once a pollutant enters the groundwater aquifer it is generally impractical to remove that pollution. Reductions in waste loading through wastewater treatment have little immediate impact except to prevent further degradation."

From Federal EPA

<u>Proposed Groundwater Protection Strategy</u> - November, 1980

"<u>Restoration or Cleanup</u>

If a large area of contamination is found, it may be extremely difficult and expensive to institute an aquifer clean-up program. While elimination of the original pollutant source material is essential and will be the purpose of Superfund efforts, cleanup of the groundwater itself is difficult. This is because of problems in defining the area of contamination; because of the large amounts of water that have to be removed, treated, and returned to the aquifer; or because of the difficulty of changing hydraulic gradients to control the direction in which the unwanted contaminants are moving. In contrast, surface waters move quite rapidly and can flush an area clean in a relatively short time once the discharge of pollution has stopped."

ESTIMATED SCHEDULE

TASK	DESCRIPTION	COMPLETION DATE
ON-SITE		
II-A	Installation of Boundary Piezometers	June, 1981
II-B	Installation of Additional Shallow Piezometers	June, 1981
II-C	Neutron Meter Work	June, 1981
II-D	Model Calibration	3 months after completion of II-A & II-B
II-E	Model Analysis of Extraction/ Treatment Plans	1 months after completion of II-D
II-F	Model Analysis of Water Supply	1 months after completion of II-E
II-G	Model Analysis of Off-Site Migration Potential	1 months after completion of II-E
II-H	Continued Data Analysis	Periodic
NYSDEC	MEETING/REPORT/PLAN APPROVAL BY NYSDEC AND NYSDOH	1 month after completion of II-G
III-A	Design of Extraction/Treatment Facilities	4 months after NYSDEC & NYSDOH approval of IBM Facilities
III-B	Construction of Facilities	Negotiated at time of NYSDEC & NYSDOH approval
III-C	Continued Monitoring	Periodic
III-D	Plan of Work to Evaluate Progress of Extraction/Treatment	Dependent on III-B

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OFF-SITE	DESCRIPTION	COMPLETION DATE
I	Develop Scope of Work	May, 1981
II	Data Gathering	3 months after completion of I
III	Data Evaluation	1 month after completion of II

LANDFILL INVESTIGATION		
I	Sampling and Analysis	April, 1981
II	Report to NYSDEC	1 month after completion of I

SPCC PROGRAMS

- Pipe and Tank Testing
- Pipe and Tank Replacements
- Tank Diking
- Truck Loading/Unloading Areas
- Personnel Training

All items on-going - Refer to Article 4A

GROUNDWATER REPORT NO. 2

IBM EAST FISHKILL FACILITY

MAY, 1982

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GROUND-WATER REPORT NO. 2
IBM EAST FISHKILL FACILITY
MAY 1982

Outline

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GROUND-WATER REPORT NO. 2
IBM EAST FISHKILL FACILITY
MAY 1982

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INTRODUCTION

This report regarding the ground-water situation at the IBM Corporation's East Fishkill Facility in Dutchess County, New York, is sequential to an earlier report dated March 1981 and entitled "IBM East Fishkill Ground-Water Report." The earlier report presented a summary of the ground-water situation as of April 1, 1981, and covered the regional hydrogeology, summarized the ground-water quality investigations, and discussed the abatement and protection programs underway at that time. The report also set forth a plan of work identified as "Phase II--Model Verification and Analysis" which began immediately after the completion of the work discussed in the March 1981 report.

The following report summarizes the investigations, results and conclusions derived from the Phase II onsite work. Because of differences in conditions and resulting recommendations for remedial action programs, much of this report is directed toward specific areas within the plant site. These zones are defined as areas A, B, C, and D as shown on Fig. 1.

SUMMARY OF FIELD INVESTIGATIONS

A number of field investigations were conducted from April 1981 through April 1982. These included additional borings and installation of additional piezometers and monitor wells as well as aquifer pumping tests.

Installation of Boundary Piezometers

In order to provide better information on the hydraulic conditions along the east and west boundaries of the plant site, seven additional piezometer sets were installed. Three locations were chosen along the east side of the plant site--one, east of Lime Kiln Road on IBM's recreation area; the second, along the right-of-way of Lime Kiln Road; and the third, on IBM property near gate 4.

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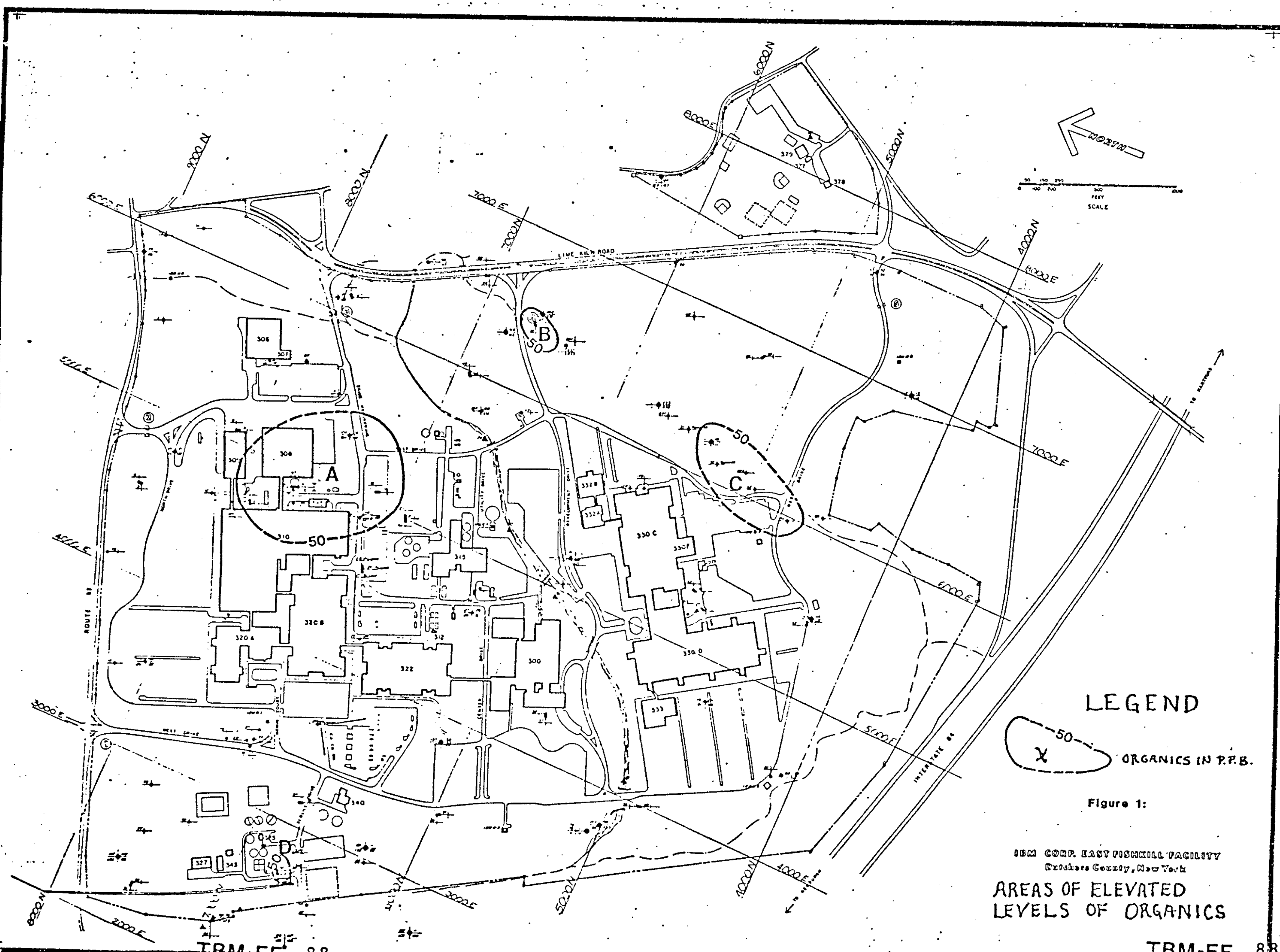

Figure 1:

IBM CORP. EAST FISHKILL FACILITY
Dutchess County, New York

AREAS OF ELEVATED LEVELS OF ORGANICS

Of the four sets of piezometers installed along the west boundary, only one was installed on IBM property. The other three sets were installed on public utility right-of-way. Because of the time required to obtain permission for installing these piezometers, they were not completed until November 1981. Since that time water levels have been measured on a monthly basis in the new boundary piezometers as well as the previously installed piezometers on the plant site for use in preparing potentiometric surface maps and evaluating ground-water flow directions.

Installation of Additional Shallow Piezometers

Based on an evaluation of existing data, additional drilling was done in five selected locations to determine if different placement of the bottoms of shallow piezometers would indicate perched water tables in the glacial materials. Holes were drilled at these five locations to predetermined depths and slotted PVC pipes were installed in the holes to keep them open. The holes were allowed to remain open for 48 hours to determine if any water zones were indicated. At three of the locations no shallow water zones were indicated. At two locations, shallow water zones were indicated and piezometers were installed.

Neutron Meter Work

A neutron meter was tried in a number of the existing 2-inch diameter piezometer pipes which penetrate the entire glacial overburden. The purpose of this work was to determine if the neutron meter provides a reliable technique for identifying perched water tables in the glacial material. Although quite significant differences in readings with depth were obtained in the piezometers measured, the differences appeared to be caused by something other than saturated versus unsaturated materials. Little or no correlation could be found between the measurements obtained and soil samples taken nearby. Because of this, the neutron meter was discarded as a viable technique for identifying perched saturated zones within the glacial overburden.

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Pumping Tests

To develop additional information on the hydraulic characteristics of the aquifers in specific areas, two pumping tests were conducted. IBM production well #8 was pumped for about 2½ days to obtain information on the aquifer in the southeast portion of the plant site. As is discussed in more detail in later sections, this test showed that production well #8 has little, if any, influence on potentiometric levels to the west of the major bedrock ridge which lies between production wells #8 and #7, therefore indicating little hydraulic communication with area C. The location of area C is shown in Fig. 1. The test also showed that pumping of production well #8 can be a method of assuring inward flow of ground water across the eastern boundary in the area of the lowlands between gates 5 and 4 along Lime Kiln Road.

Monitor well #32, near the facility's waste-water treatment plant, was test pumped for several hours to determine the hydraulic characteristics of a thin saturated zone lying above a clay layer in that area. The results of this pumping test and its significance are discussed in a later section concerning the remedial action plan for area D.

Borings, Areas A, B, C and D

Eighteen holes were drilled in area A, which is in the vicinity of buildings 308 and 310 as shown in Fig. 1, to better define hydrolgeologic and water-quality conditions. Monitor wells were installed in 12 of the 18 locations for purposes of measuring water levels and water quality of a saturated zone existing above a well defined clay layer in the area.

Three sets of piezometers and one monitor well were installed in area B to monitor water levels and quality before and after initiation of remedial action planned for that area.

Two shallow monitor wells were installed adjacent to the excavated portion of area C to monitor water quality.

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Nine holes were drilled and soil samples were collected for quality analysis in area D. The purposes were to help define the extent of the elevated levels of organics and provide information on the clay layer found in area D. Two shallow monitor wells were installed.

SUMMARY OF GROUNDWATER QUALITY INVESTIGATIONS

On-Site

The East Fishkill Facility groundwater monitoring program continues to operate on a schedule as described [1] previously. No additional quality monitoring wells have been added to the facility during the period March 1981 through May 1982.

Many wells, particularly those with trace levels of organics show a trend towards lower levels. This is due to the removal of materials introduced during the drilling and casing installation process.

Based on 24 months of monitoring data, the size of the areas with elevated levels of organics is significantly smaller than was previously believed. Figure 1 shows the four areas on the East Fishkill Facility in terms of 50 parts per billion contour lines. The contours for areas A, B and C indicate that the organics are moving to and being collected by production wells 2, 4 and 7. There is no evidence of any movement off-site in these areas. Area D has been determined to be almost stagnant with respect to water flow. Stream water quality measurements below area D have consistently been non-detected. This is to be expected in view of the low concentrations in area D and the lack of water flow from this region. No new compounds have been found in any of the areas discussed and the list (page 5 [1]) of major organics in the groundwater remains the same.

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Groundwater Quality Summary - Organics

The concentration of organic solvents in areas A, B, C and D has not changed significantly in the past year. Analytical data from the wells adjacent to these zones demonstrates that the pumping of production wells #2, 4 and 7 has prevented the migration of materials from areas A, B and C.

The level of organics in production wells #2, 4 and 7 has not changed in the last 12 months. Organic solvents have not been detected in any other (#1, 5, 6, 9) production wells. This is further evidence of a lack of migration from areas A, B, C and D. Production well #7 was brought on line in 1981 to contain migration from area C. This well is pumped on a continuous basis and all water from the well is treated with granular activated carbon.

The site perimeter wells have shown a marked decrease in the level of organic solvents since 1980. The median values on the geographical boundaries of the site have dropped from 2 - 6 ppb to $<$2 ppb (limit of detection).

No organic solvents have been detected downstream of area D which is consistent with the hydrogeologic data indicating no appreciable, if any, flow from area "D" toward the swamp. Core borings west of area "D" were also clean.

Off-Site

In cooperation with the Dutchess County Department of Health, IBM has voluntarily funded a water quality monitoring program in homes surrounding the East Fishkill Facility. John Jay High School was also included in this study. Granular activated carbon units were installed in five homes which had organic solvents confirmed in their well water. This program was extended from 12 months to 18 months to allow completion of studies of groundwater conditions in the area.

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Solvents have not been confirmed in any homes other than the original five (Feb. 1981). The level of organic solvents has decreased steadily since Feb. 1981 in the homes that originally were found to have solvents in their wellwater. There does not appear to be any seasonal trend to the data; however, a one year period is probably short, in most cases, to determine seasonality. The level of chemicals in the five off-site wells where detectable levels were originally found is now significantly below the New York State Department of Health guidelines of 50 and 100 ppb.

A series of observations/comments are appropriate with respect to the presence of low levels of organics in the off-site wells: (See Figure 2)

a) The finding of chloroform in a groundwater sample which has not been chlorinated is unusual. DCDH investigated the water supply situation at tax map location #45 [1] after chloroform was identified in the sample and the home was reported to have a dry well. Since the time of the original sample, the water table has risen sufficiently for the well at location 45 to be used routinely. Organic solvents have not been detected in any of these samples. IBM concludes that this well was and remains clean.

b) Samples taken at tax map locations #33 and #35 contained 1,1,1-Trichloroethane. Inorganic analysis [2] of the well water at location #35 indicates a connection between the well (in consolidated material) and the unconsolidated shallow zone. This is based on the presence of large amounts of ions such as chloride which is not found in high concentrations in bedrock water in this region. This fact suggests that this well could and may be contaminated as the result of intrusion of surface waters (road

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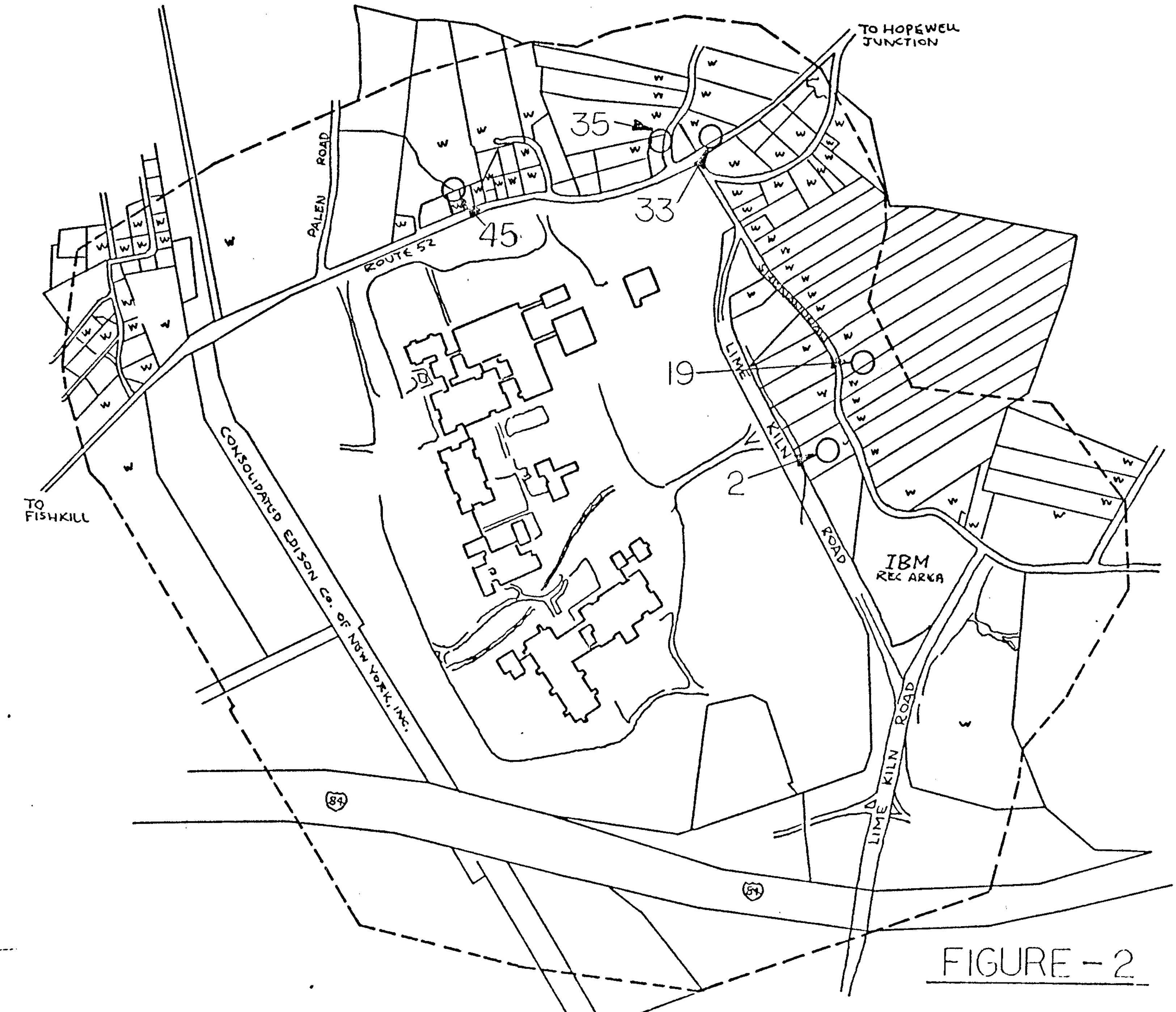

FIGURE - 2

OFF-SITE HOMEOWNER WELL LOCATIONS

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salts) and/or subsurface discharges from area septic systems. Groundwater flow directions in this area are towards the South (towards IBM).

c) Studies carried out as part of IBM's voluntary effort to aid off-site identification [2] at location #19 demonstrated a very rapid response between the homeowner's well and the homeowner's septic disposal system. Bacterial contamination of the well quickly followed pumping of the well and disposal of the water in the septic system. The well did not have a proper sanitary seal and was down gradient from a barnyard. Surface runoff from this area easily entered the well. Any chemicals used in the household or used for maintaining the septic system could easily have entered the well.

d) The DCDH found that the remaining well (location #2) in which chemicals were found was associated with a homeowner who had an autobody refinishing work area in his house [2]. Numerous solvents were stored and used in this house and it was difficult to sample water in the basement of the house due to the high concentrations of solvents in the air which contaminated the water samples. Analysis of water samples taken directly from the well revealed the presence of both gasoline and oil in the well water. Based on the usage of chemicals in the house and the need to dispose of them, it is fair to assume that the chemicals in the well most likely originated in the house.

e) Dispersive forces in the groundwater system result in horizontal and vertical spreading of chemicals as they move away from a point source. Since only four widely separated home wells have had chemicals confirmed in them and the wells in adjacent properties have remained clean, the source of chemicals appears to be localized to the immediate vicinity of each of the individual

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homes involved. Home subsurface disposal systems are the most likely source of chemicals in the groundwater in these areas.

f) The predominant type of chemical found off-site (1,1,1-Trichloroethane) is not the chemical which predominates in groundwater on the East Fishkill Facility (1,1,2,2-Tetrachloroethylene).

Site Specific Groundwater Hydraulic Characteristics

As part of IBM's groundwater investigations, additional piezometers have been added to the existing (as of March 1981) network. These piezometers provide water elevation data for use in assessing flow direction in the unconsolidated and consolidated zones. In addition, this data was and is used as input to the site groundwater mathematical models. Piezometers were installed off-site on Lime Kiln Road (east of the facility) and on the property of Consolidated Edison Corporation which is west of the facility (between IBM and John Jay High School). A summary of flow information follows:

1) North side (Route 52) water is flowing towards IBM from North to South.
2) South side (Route 84) water is flowing towards IBM.
3) East side (Lime Kiln Road) flow direction is seasonal. It approximately follows Lime Kiln Road swinging East and West depending on the water table. The bedrock hydraulic gradient in this area is very low and is probably strongly influenced in the vicinity of IBM Gate #4 by IBM's on-site pumping.
4) West side (John Jay High School) bedrock flow direction is strongly influenced by IBM production wells (from West to East). Large hydraulic gradients exist in this region, towards the IBM site. Water in the unconsolidated zone flows to the swampy area on the facility's western side. Water moves from the East and West to the swamp which is drained by a small stream flowing North from the site and eventually emptying into the Fishkill Creek. The water in the unconsolidated zone shows no appreciable movement.

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5) Evaluation of existing data, geology and modeling of the aquifers in the region indicates that flow patterns prior to IBM pumping (1963) were very much as they are today. The primary difference is the large gradient which now exists due to IBM's on-site pumping. The vertical gradients which now exist also have increased the drainage from the upper aquifer to the lower aquifer and have resulted in less movement in the upper aquifer system.

After careful review of all existing data (on and off-site), surface/subsurface hydrogeology and aquifer model runs, IBM concludes the following:

1) Chemicals in the groundwater in areas A, B and C are being contained, collected and treated by production wells #2, 4, 7 and their GAC units.

2) There is no evidence that chemicals may have migrated from area D to the swampy area West of area D.

3) Based on monitoring data (on and off-site), there does not appear to be any migration of chlorinated hydrocarbons off the IBM East Fishkill Facility.

4) IBM is not the source of the chlorinated hydrocarbons found off-site in private wells.

5) The most likely source of chlorinated hydrocarbons (such as 1,1,1-Trichloroethane) in off-site wells is subsurface disposal via home septic systems, through the use of any of numerous household products containing chlorinated hydrocarbons.

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DESCRIPTION OF MODELING WORK

As set forth in the original work plan, modeling of the ground-water system had three principal objectives: (1) evaluation of potential abatement or remedial action plans, (2) evaluation of water-supply needs in conjunction with ground-water quality remedial action programs and (3) evaluation of any possible offsite migration of ground water containing organics. As these objectives were investigated more closely, it became apparent that separate modeling endeavors were required for the solute transport simulation versus water-supply studies. Therefore, transport models were developed for the plant site (both glacial and bedrock aquifers), and a water-supply model was developed for a larger area (bedrock aquifer only). These are described below.

Solute Transport Model

Resource Consultants, Inc., conducted the modeling of the solute transport of the dissolved materials in the ground water using ISOQUAD, a two-dimensional areal finite-element dispersion model written by Dr. George Pinder of Princeton University. Because of the complex hydrogeology, the model was used to simulate two different aquifers--a relatively shallow glacial aquifer overlying a much thicker bedrock aquifer. The glacial aquifer consists of saturated silts, sands, and gravels in the glacial till that are above one or more clay layers. The clay layers restrict deep percolation to the bedrock aquifer below. The bedrock aquifer consists primarily of fractured limestone and dolomite. In some areas, IBM pumping from the bedrock aquifer has lowered the potentiometric surface in the bedrock aquifer below the bottom elevation of the clay layers. These clay layers have such low hydraulic conductivity that, in some cases, the material below them is unsaturated, thus creating a hydraulically separate glacial aquifer over a large area of the site.

The model was calibrated for both ground-water flow and solute transport for each aquifer. This process was a tedious trial-and-error procedure requiring a great deal of time and effort. One input parameter which was required during both calibration and predictive runs was the flow

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across the boundary of the model. This quantity came from results derived from the water-supply model, described below, which modeled a much larger area than the plant site alone.

The solute transport model focused principally on the situation in area A. Although the other areas were considered for modeling, this action was not pursued because the areal spread of organics in the other areas was too small relative to the model's nodal point spacing to accurately simulate the transport of solutes.

Water-Supply Model

One of the primary purposes for the water-supply model was to provide flux (ground-water flow) boundary conditions for the bedrock portion of the solute transport model. Ground-water models are quite sensitive to the boundary conditions used. Since the boundaries of the solute model correspond to property lines rather than well defined hydrogeologic boundaries, it was necessary to utilize a flux boundary condition for the most part. The water-supply model covered a much larger area than the solute model and, as such, could utilize constant head or impermeable boundaries where appropriate for its boundary conditions. The study area for the water-supply modeling extended approximately 1 mile to the south, west, and north of the plant site and about ½ mile to the east.

The model used was a relatively simple two-dimensional finite-difference flow model known as GRWATER developed by the staff at Colorado State University. Most of the effort in the modeling study was directed towards calibrating the model such that head contours generated by the model matched estimated contours from actual field data. The calibration process required a major work effort due to the large areal variation in transmissivity in the fractured limestone aquifer. Also, outside of the plant area little field information was available to assist in the calibration process.

The water-supply model appears to give reasonable results and utilizes hydrogeologic parameters that are reasonable when compared to known information from pumping tests, recharge rates from base stream-flow studies, etc. The model also simulates with reasonably good accuracy head

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southeast. Borings made between area D and the westerly boundary indicate that glacial materials with a much lower hydraulic conductivity exist in this area and are probably the reason for the formation of a swamp along this boundary. The westerly movement of ground water in the glacial aquifer is therefore very slow, and any ground water that could percolate through the clay layer and reach the bedrock aquifer would be directed towards the southeast and towards plant property. Since all borings and monitor wells between area D and the western boundary are free of organic solvents, it is believed that no migration has occurred offsite.

Ground-water flow directions in the bedrock aquifer are strongly influenced by pumping from the IBM production wells. Potentiometric contour maps, prepared using water-level data from the bedrock piezometers and production wells, indicate that the flow of ground water is inward across plant boundaries. Further, the results of the water-supply modeling analysis indicate that the area of influence due to pumping from the production wells covers a larger area than just that area within the plant boundaries. A portion of the recharge to the bedrock aquifer outside of the plant boundaries is also being intercepted and directed towards the production wells with a resulting inward ground-water flow direction along the plant boundaries.

On a local scale there is minor exception to the inward flow pattern and that is for an area along the eastern boundary. The southeastern corner of the plant site, including the low-lying area along Lime Kiln Road between gates 4 and 5, is somewhat isolated hydraulically from the rest of the plant site because of the less permeable zone manifested by the bedrock outcropping and topographic ridge extending southward from gate 4. For an area approximately 1,000 feet southeast of gate 4, ground water may be flowing in a generally northerly direction and offsite for a short distance before flowing in a westerly direction back towards the plant property. The extent of this offsite flow is apparently small, but plans are to install additional piezometers in this area to better determine actual flow directions.

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Results of the pumping test on IBM production well #8 indicate that this well could be used to effectively assure inward flow of ground water across Lime Kiln Road in the questionable area. Production well #8 has heretofore not been used as a water-supply well because of its relatively low yield.

REMEDIAL ACTION CONCEPTS AND ANALYSES--AREA A

Hydrogeology and Water Quality

Earlier water-quality analyses indicated organic solvents existing as a separate phase near the west side of building 308. The additional borings made during the past year indicate that the separate phase exists within a silt zone overlying a clay layer at a depth of approximately 20 feet below the ground surface, generally between buildings 308 and 310. This corresponds to the location of five underground tanks which have been used for storage of solvents in the past. These tanks have been cleaned and taken out of service.

A perched water table also exists on the clay layer mentioned above and the slope of the water table indicates flow easterly under building 308. Materials under the clay layer appear to be drained, for the most part, by the influence of pumping the bedrock production wells, particularly production well #2. The gradient of the potentiometric surface in the bedrock is relatively steep under this area with a southwesterly flow direction towards production well #2. Since borings to bedrock east of building 308 did not encounter the clay layer found between buildings 308 and 310, it appears that the perched water is flowing easterly to the discontinuous clay layer and then downward to the bedrock system and then back southwesterly to production well #2. The ground water in the glacial aquifer flowing over the separate phase solvent and taking some of the solvent into solution and then flowing into the bedrock aquifer is probably the principal source of organics being measured in water pumped from production well #2. This concentration level has stayed quite constant at 10 parts per million while the well is pumped at a constant rate of 150 gallons per minute.

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Solute Transport Modeling

Assumptions

As stated earlier, it was assumed that the hydrogeologic system could be divided into two different aquifers. The leakage out of the glacial aquifer was used as deep percolation input into the bedrock aquifer. Part of this assumption is that the glacial aquifer is continuous over the site. Actually, the glacial material is quite heterogeneous, and the water-bearing zones are not completely continuous. However, this assumption was conservative in that the spread of ground water containing organics in the numerical model will be more extensive than that observed in the field.

A second assumption was in the use of a constant source of organic solvents during both calibration runs and predictive runs. This assumption, though somewhat conservative, was necessary even if all leaks in pipelines and tanks have presumably been stopped. That is because the materials already underground as a separate phase will slowly dissolve as recharge water contacts it and acts as a source of organics for a long period of time, unless, of course, all of the separate phase could somehow be removed.

Glacial aquifer

The results of the calibration procedure for the glacial aquifer indicated the leak or leaks of organic solvents began approximately 10 years ago. The leak or leaks may have begun earlier, though, because the glacial aquifer model showed that the system had nearly reached the point where the compounds entering at the source was offset by the dilution from precipitation recharge and leakage down to the bedrock. This means no further spread was occurring. Once that point has been reached, one can only set the minimum length of time required for the system to reach its present state.

Once both hydraulic heads and concentrations had been calibrated, a run was made of the glacial aquifer model with no change in present operating conditions. This run confirmed the fact that the solute is not

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spreading beyond its present limits. The results after 20 years were not noticeably different from the initial conditions.

Another run incorporated a change in the hydraulic conditions near the source. The heads in the source area were set at a lower level and held constant in the model to induce flow back toward the source. This would be similar to installing some type of drainage system in the source area. This run showed that a reduction in the affected area occurs for about 5 years, after which there is little change in the size of the area.

Bedrock aquifer

The calibration of the organic levels in the bedrock aquifer indicated that the problem in the bedrock aquifer is more recent than in the glacial aquifer. The model showed that the materials had to have begun entering the bedrock aquifer in significant quantities approximately 4 years ago for the levels of organics in the monitor wells and production well #2 to reach their presently measured concentrations. Apparently, there was a time lag between solvents affecting the glacial aquifer and solvents affecting the bedrock aquifer.

The predictive runs of the bedrock aquifer model consisted of four different operating schemes. The first run was a continuation of present operating conditions. Under these conditions the affected area spread somewhat to the south for the next 10 years whereupon the plume stabilized and no further spread was observed. Most of the spread occurred in the fringe of the plume--between 1 and 5 percent of the maximum concentration. The higher concentrations remained fairly stable from the start between the source under building 308 and production well #2.

The second run investigated the changes associated with increasing the pumping rate for production well #2 by 100 gpm. The pumping rates for the other production wells remained at their present levels. The results of this run showed a decrease in the affected area over the first 5 years after which the size stabilized. There was also a slight decrease in the levels of organics within the plume.

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The next model run showed very similar results to the previous one. It depicted the effects of installing a new production well near the source area and pumping this well at 100 gallons per minute while all the other wells were maintained at their present rates. Again, the area decreased over the first 5 years, then stabilized. Also, this run showed a more significant drop in the levels of organics within the plume than the previous run.

A fourth run of the bedrock aquifer model was made to examine the consequences of pumping IBM production well #9 at 250 gallons per minute (gpm) while the rest of the production wells were held constant at their present rates. While the affected area southwest of the source decreased, the area northeast of the source, toward production well #9, increased slightly before stabilizing within 5 years. Also, this pumping caused the piezometric head gradient between the source area and production well #2 to decline. Hence, the solutes were not carried away as rapidly as in the other runs, so the concentration levels within the plume increased.

Conclusions

From the modeling results, it is apparent that under present conditions and with continued pumping by IBM, there is no danger of offsite migration of dissolved organics solvents from area A either in the glacial or bedrock aquifers. The pumping in the bedrock aquifer near the center of the plant site has induced enough flow towards the wells to insure

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containment of the organics, even if the source of is considered continuous. In the glacial aquifer, the dilution due to recharge from precipitation and the losses due to deep percolation prevent any contaminant from migrating offsite.

Either pumping production well #2 at a higher rate or installing a new production well near the source is an effective means of limiting the spread of organics. Although pumping a new well shows greater reduction in the levels of organics than pumping production well #2 more heavily, the reduced area is about the same for either scheme. Because the capability to pump and treat water already exists at production well #2, that is the action deemed most appropriate.

Separate Phase Remedial Action Concepts

As mentioned above, borings made between buildings 308 and 310 indicate that separate phase solvents exist in this area. The separate phase appears to exist in a silt layer which is found immediately above a dense, gray clay layer in this vicinity. The gray clay layer dips to the east under building 308 and apparently terminates under that building. The separate phase solvent probably tends to flow along the clay layer but quite slowly because of the low permeability of the silt and the low gradient.

The solute transport modeling efforts described above pertain only to the movement of ground water and any dissolved solvents they may contain. All indications are that the separate phase area will remain essentially stable but will continuously provide a source of dissolved organics to the ground-water system. Although the separate phase solvents can be wholly contained and controlled so that there is no risk to others, the Corporation wishes to do what it can to remove as much of the separate phase as is feasible. The most obvious first step in this endeavor is to remove all the old storage tanks which had previously been taken out of service and are suspected to have contributed to this situation, along with any separate phase solvents found in the soil adjacent to or under those tanks. By extending these excavations into the clay layer, installing drainage sumps and backfilling with clean permeable

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material, an additional amount of organics could be collected in the sumps over time.

Additional excavation (over and above that required for the removal of the storage tanks and installation of the sumps) has been considered, but because of a large number of underground utilities and above-ground structures that would have to be removed and relocated, other methods of capturing the separate phase solvents appear to be more practical and equally effective.

A network of drainage sumps could be installed throughout the separate phase area, but in order to be effective in capturing a significant portion of the separate phase, the drainage sumps would have to be spaced very closely together. Under any closely spaced configuration, the same obstructions that would interfere with total excavation would also present problems in constructing the drainage sumps at the most ideal locations.

Interception of the separate phase organics with a horizontal drainage line running approximately under the west face of building 308 is a method which deserves consideration. Installation of the drainage line would have to be accomplished by horizontal boring or tunneling, and to be most effective it would need to lie on the clay layer. Because the clay layer surface is uneven, the diameter of the drainage line should be fairly large in order to assure interception of the maximum amount of organics. However, before such a line is designed and installed, it would be wise to learn more about the hydraulics of this 2-phase flow system--probably with laboratory experiments in which the hydraulic conductivity and gradient are duplicated.

REMEDIAL ACTION--AREA B

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The proposed remedial action for area B was presented to the New York State Department of Environmental Conservation (NYSDEC) on January 8, 1982, and approval was received by letter dated Feb. 1, 1982. The basic plan is to pump ground water from monitor well #47, treat the water with activated carbon filters and return the clean water to the ground-water system through a recharge facility. The system is currently under design and construction is expected this summer.

Analytical studies were made to predict the amount of mounding that would be caused by the recharge of this water and the flow directions of the water after it enters the ground-water system. To help monitor the effects of the remedial action on water levels and water quality, three sets of piezometers and one monitor well have been installed during recent months.

REMEDIAL ACTION--AREA C

The proposed remedial action for area C was also presented to NYSDEC personnel on January 8, 1982, and was subsequently approved by letter from NYSDEC dated Feb. 5, 1982. The plan consisted of excavation of an old construction debris landfill suspected of being the cause of degraded ground-water quality in that area. After the plan was approved, the excavation was accomplished with the removal of about 20,000 cubic yards of material. The excavation was backfilled with clean soil, and a clay cap to minimize infiltration was placed over the top. It is believed that this action has effectively removed the source and that any remaining organics in the ground water surrounding the excavated area will be effectively contained and removed by continued pumping of IBM production well #7.

REMEDIAL ACTION CONCEPTS AND ANALYSES--AREA D

Hydrogeology and Water Quality

Additional borings in the area D vicinity during March and April 1982 revealed that the extent of the degraded ground water is very limited and apparently centered around monitor well #32. Further, the ground water is within a perched saturated zone above a clay layer with no direct evidence that the material has migrated below the clay layer. The potentiometric surface in the bedrock is considerably below the clay layer, thus providing a strong vertical gradient for such migration, but no organics have been measured in monitor wells, piezometers, or pumped wells tapping the bedrock in the area D vicinity.

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Approximately 10 feet of saturation exists above the clay layer in the monitor well #32 vicinity. The water table slopes westerly at about 0.5 percent, but no organics were found to the west of monitor well #32.

Monitor Well #32 Pumping Test

An 8-hour pumping test of monitor well #32 was conducted utilizing a pumping rate of 7 gpm. Water levels were routinely measured in the pumping well and at two other monitor well locations. Analysis of the data indicated a reasonable hydraulic conductivity that would be expected for the silty sands and gravels overlying the clay layer. Water levels responded quickly to the imposed pumping which was more representative of a confined aquifer situation rather than an unconfined situation that would have otherwise been expected. A drawdown contour map for conditions existing after 8 hours of pumping was also prepared. The estimated area of influence extended approximately 200 feet to the west, north, and east of the pumped well and approximately 400 feet to the south of the well. Within this area, ground water was being directed towards monitor well #32 where eventually it would be removed by pumping.

From the pumping test of monitor well #32, it is estimated that the safe continuous yield of the well is around 5 gpm. A relatively large cone of depression surrounded the well and any degraded ground water within this area would flow towards and be discharged by pumping. The area of influence covers all suspected sources of organics within area D.

Conclusions

The logical remedial action scheme for area D is to pump monitor well #32 and maintain a cone of depression that will assure the containment and removal of the organics. Disposal of the pumped water can be accomplished through the aeration process in the nearby waste-water treatment plant.

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CONCLUSIONS AND RECOMMENDATIONS

The following summarizes the conclusions and recommendations (or already approved actions) for remedial action in areas A, B, C and D.

Area A

Dissolved organics in the ground water in area A can be effectively controlled through pumping of production well #2. In that production well #2 has a capability of producing at least 250 gallons per minute, it is recommended that the production rate be increased to that level to further assure containment.

The IBM Corporation further intends to take steps to remove as much of the separate phase organics as feasible in the building 308-310 area. The first action to be taken will be the removal of all old unused buried storage tanks in that area, along with any separate phase existing, adjacent to or under those tanks. Where possible, the excavation will proceed to the clay layer which has been identified approximately 20 feet below the land surface. All soil from this excavation will be disposed of at a permitted hazardous waste disposal facility. A drainage sump will be installed which has a perforated zone through the silt layer containing the separate phase organics. The remaining portion of each excavation will be backfilled with permeable materials.

In addition, studies will be initiated to help evaluate the possible effectiveness of a horizontal drain for collecting separate phase solvents. If such a drain is determined to be reasonably effective and can be constructed with proven techniques without endangering buildings and utilities, the plans for same will be presented to NYSDEC for review.

Area B

Design work on remedial action for area B is underway as set forth in a meeting with NYSDEC held on January 8, 1982, and described further in an attachment to a letter to Mr. G. Burns dated January 20, 1982. Completed construction and implementation of the plan is expected by August, 1982.

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Area C

Completion of the excavation and backfill of the old landfill has been completed as presented previously to NYSDEC. The clay cap will be finished in June 1982. New monitor wells have also been installed. IBM production well #7 will be pumped as necessary to remove the remaining organic solvents ground water in area C.

Area D

Pumping of monitor well #32 will provide an effective containment and removal of materials found in a saturated zone above the clay layer in area D. It is recommended that monitor well #32 be pumped at a constant rate of about 5 gallons per minute and that the pumped water be piped to the existing waste-water treatment plant for disposal.

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REFERENCES

1. IBM Corporation, IBM East Fishkill Groundwater Report, March, 1981

2. M. Chazen Associates, Source Identification of Trace Organics in Groundwater - Shenandoah Road & Route 52 East Fishkill, NY, January, 1982

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SOURCE IDENTIFICATION OF TRACE ORGANICS IN GROUNDWATER

SHENANDOAH ROAD AND ROUTE 52

EAST FISHKILL, NEW YORK

PHASE I - SUMMARY REPORT

Milton Chazen Associates
Consulting Engineers
One Overocker Road
Poughkeepsie, New York

January - 1982

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PHASE I - SUMMARY REPORT

Purpose

The overall purpose of this investigation is to identify the source or sources of organic chemicals found in several privately owned individual households drinking water wells located north and east of IBM's East Fishkill facility.

As a result of the lack of available information regarding the study area it was necessary to divide the investigation into two fundamental parts: Phase I and Phase II.

Phase I had two major objectives

1. Obtain basic information regarding the site.
2. Use the obtained information to design a logical Phase II program that would home in on the source or sources of contamination.

Phase II will have the primary objective of identifying the source or sources of organic chemicals.

This Report provides the results of the Phase I program and makes recommendations for a Phase II continuation of the study.

Methods

Phase I was divided into five major information gathering components:

1. Mapping
2. Sampling Program Review
3. Literature Search
4. Review of Existing Records
5. Evaluation of Existing Wells

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The data so obtained would be summarized, evaluated, used to draw conclusions and used to develop a second phase program.

Literature Search - Organic Chemical Movement in Groundwater

Many investigators of organic chemicals in groundwater were identified during the literature search. They have reported that these chemicals can travel long distances underground without significant reduction in concentrations due to biological, chemical or physical activity. Investigators have also reported that when dissolved, contaminant plumes conform remarkably well with groundwater flow patterns. All of the solvents of concern in the present study are more dense than water and have water solubilities ranging between 150,000 and 20,000,000 parts per billion. It is noted that the highest concentration of any of these chemicals found in wells in this Study Area is 65 parts per billion. It can be concluded therefore, that in this Study Area the chemicals are dissolved in the groundwater and they will therefore tend to migrate with the groundwater. This is important because if groundwater velocity (speed and direction) is known, then, predictions can be made of the direction, and to a lesser extent the distance, a source of contamination is from an area known to be contaminated. Also, predictions of future areas of contamination can be made.

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Groundwater will move from areas of higher groundwater level to areas of lower groundwater level. The velocity of groundwater will be a function of the difference in groundwater elevation between two points and the resistance to flow within the waterbearing formation (known as the permeability).

The principles of organic solvent movement in the ground are illustrated in Figure 1 which shows an area where the groundwater surface slopes from left to right. Consequently, the groundwater is moving from left to right. The Figure also shows an impervious formation (aquilude) sloping from right to left. An organic solvent that is more dense than water and only slightly soluble is released on the ground surface at point A. The solvent then percolates through the unsaturated zone to the water table. After reaching the water table, the undissolved solvent is carried to the right (zone C) by the groundwater movement and vertically by gravity. Some of the solvent becomes dissolved in the water and is carried further to the right (zone D). After the undissolved solvent reaches the impervious formation ,it continues to flow under the influence of gravity to the left.

Sources of Organic Solvents

Organic solvents have been used for a myriad of commercial, industrial and domestic purposes. The more commonly reported sources of organic solvents in groundwater are: industrial spills, sloppy housekeeping by industry, leaching from dumps, landfills or lagoons, use of septic tank cleaners and improper disposal of household or other products. Table 1 provides more detailed information regarding uses of organic solvents.

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FIGURE 1

ILLUSTRATION OF RELATIVELY INSOLUBLE AND DENSE
CHEMICAL RELEASE TO GROUND SURFACE

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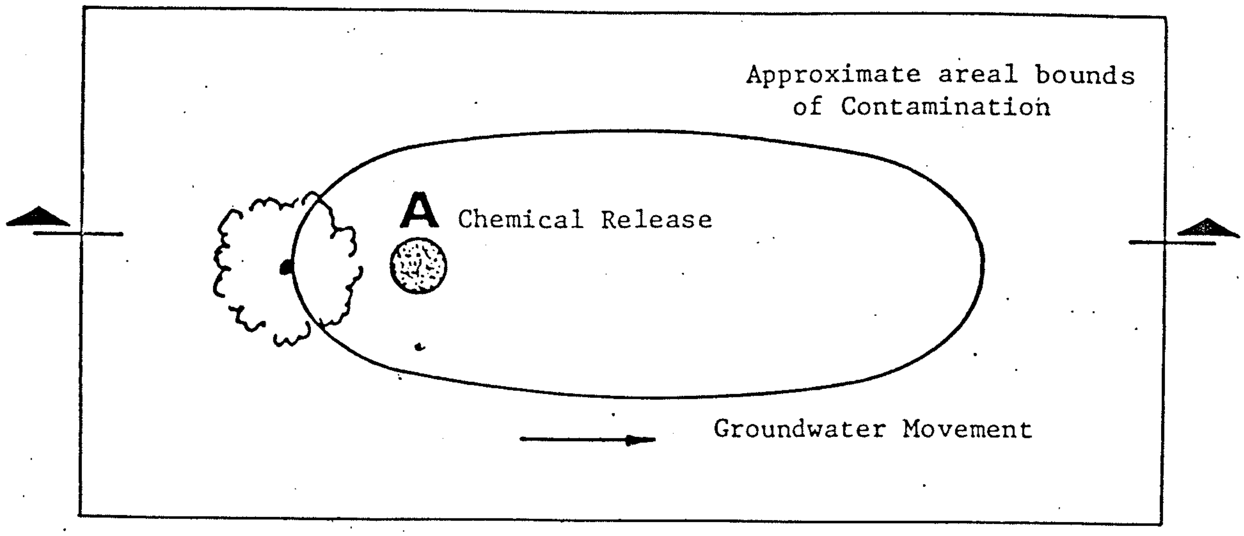
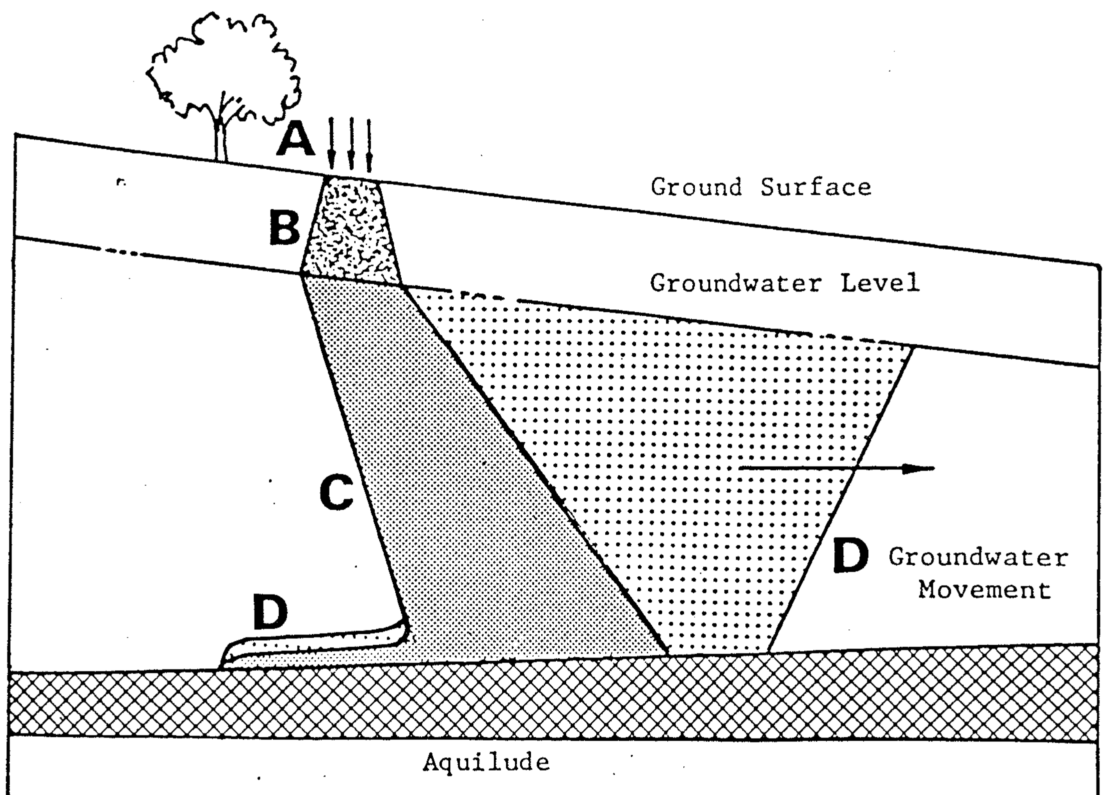


PLAN



SECTION

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A - Location of chemical release

B - Percolation of chemical in unsaturated zone

C. - Skewed vertical percolation of undissolved chemical through saturated zone and movement upgradient because of aquilude

D - Dissolved chemical in groundwater

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During the investigation, homeowners were asked if they knew of any nearby roadside dumping areas and any buildings within the Study Area that were used for "other than domestic" purposes. With the exception of the Smith property, which was reported at one time to be used as a part-time autobody repair shop, no "other than domestic uses" were reported. No one reported the existence of any roadside dumps.

County and Town Highway Departments were contacted to determine if they knew of the existence of any roadside dumping areas. The County Public Works Department responded that when work was performed on Lime Kiln Road in 1968, no dump sites were found.

The County Health Department did not identify any in-place toxic substance sites near this Study Area when it recently made an extensive survey of the County.

The map that was made as part of Phase I (to a scale of 1" = 50' and with a contour interval of two feet) has been carefully reviewed for fill areas that might have been used for illegal dumping. No such areas were identified.

Three additional potential sources of contamination cannot be overlooked. 1) migration of chemicals from the IBM site, 2) illegal discharge of these solvents by waste haulers and 3) contamination through residential use of the solvents. As indicated in the Purpose, Phase I was designed as a basic data gathering program from which a Phase II program, aimed more specifically at identifying the source or sources of contamination could be developed. For this reason, there

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	Trichloro ethylene	111 trichloro ethane	tetr ethy	bon chloride	chloroform	toluene
Metal washing & degreasing	x	x	x	x	–	–
Dry Cleaning	x	–	x	x	x	–
Cleaning & drying electronic parts	x	x	x	–	–	–
Paint Varnish & finish remover	x	–	–	–	–	x
Extraction of fats	x	x	x	–	–	–
Septic Tank Cleaners	x	x	x	–	–	–
Refrigerant and heat exchange	x	–	x	–	–	–
Pesticides	–	x	–	–	–	–
Adhesives	–	x	–	–	–	–
Textile processing	x	–	x	–	–	–
Joint compound or liner adhesive	x	–	x	–	–	–
Spot removers	x	–	–	–	–	–
Air fresheners	x	–	–	–	–	–
Printing ink	x	x	–	–	–	–
Shoe polish	–	x	–	–	–	–
Fermentation Retardant	–	–	–	–	–	–
Pharmaceuticals	x	–	x	–	x	–
Organic synthesis	x	x	x	x	x	x
Cellulose ester & ether solvent	x	–	x	–	–	–
Heat transfer medium	–	–	x	–	–	–
Dyeing	x	–	–	–	–	x
Lacquers	x	–	–	–	x	x
Leather Tanning	x	–	–	–	–	–
Fumigant	x	–	–	x	–	–
Anesthetic	–	–	–	–	–	–
Herbicide	–	–	–	–	–	–
Cleaning plastic molds	–	x	–	–	–	–
Perfumes	–	–	–	–	–	–
Rubber Solvent	–	–	–	x	x	–
Gasoline	–	–	–	–	–	x
Plastics	–	–	–	–	x	–
Fire Extinguishers	–	–	–	x	x	–
Floor Polishes	–	–	–	–	x	–

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is insufficient data presently available to incriminate or exonerate any of these potential sources.

Soils and Geology

Soils in the Study Area are sufficiently pervious to allow percolation of surface water and contaminants. In most of the Study Area bedrock is shallow and consists of folded, faulted and cracked dolostone that has been dissolved extensively along faults. Groundwater will move with relative ease along solution channels and faults.

Groundwater Quality

Tables 2 through 6 provide the results of the on-going organic chemical sampling program. These data indicate that the highest concentrations of organic solvents were found during January and February 1981. Generally, organic solvent concentrations decreased during the summer. Concentrations in well water along Shenandoah Road has remained low through September. The Perez well however, showed increases in organic solvents during September. There is insufficient data available to conclude if this is a seasonal variation that may be caused by changes in precipitation and groundwater levels or if some other reason exists for this fluctuation.

These data clearly show two distinct areas where groundwater contains organic solvents. One area is located north of Route 52 near Binnewater Road. To date, two household drinking water wells in this area have been shown to contain organic solvents. The other area is located on the southern part of Shenandoah Road. In this area, five wells have, on occasion shown the presence of organic solvents.

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Table 2

MILTON CHAZEN ASSOCIATES

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING
(All Results in ug/l)

	Detection Limit	PEREZ RESIDENCE																												
LABORATORY		G	G	G	HD	G	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W				
RAW, FILTERED OR BAILED		R	R	F	R	R	R	F	R	F	R	F	R	F	R	F	F	R	F	R	F	R	F	F	R	F				
DATE SAMPLED		2/5	1/28	2/11	2/5	2/5	4/7	4/7	5/12	5/12	6/23	6/23	7/21	7/21	8/4	8/4	8/4	9/16	9/16	10/20	10/20	11/10	11/10	11/10	12/1	12/1				
1,1,1 Trichloroethane	1	51	65	nd	58	51	20	nd	6.7	nd	nd	nd	9.2	nd	12	nd	nd	19	nd	9.4	nd	12	nd	nd	5.8	nd				
Tetrachloroethylene	1	nd									→	1.6	nd	1.6	nd	1.8	nd									→				
Methylene Chloride 1	1	nd																								→				
CIS-1,2 Dichloroethylene	1	nd																								→				
1,2 Dichloroethane 2	1	nd																								→				
Carbon Tetrachloride	1	nd																								→				
Trichloroethylene	1	nd																								→				
Freon	5	nd																								→				
Benzene	1	nd																								→				
Toluene	1	nd																								→				
M, P Xylene	1	nd																								→				
O, Xylene	1	nd																								→				
Chloroform	1	nd														→	1.3	nd								→				

1 Some samples were reported to have a detection limit of 2 ug/l
2 Some samples were reported to have a detection limit of 3 ug/l
G Gollob Analytical Service
HD New York State Department of Health Lab
W Westchester County Environmental Laboratory
B Bailed from well

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TABLE 3

MILTON CHAZEN ASSOCIATES

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING
(All Results in ug/l)

LABORATORY	Detection Limit	STONE RESIDENCE																								
		G	G	G	G	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
RAW, FILTERED OR BAILED		R	R	F	F	R	F	R	F	R	F	R	F	R	F	F	R	F	B	R	F	R	F	F	R	F
DATE SAMPLED		2/3	2/1	2/17	2/19	4/21	4/21	5/12	5/12	6/30	6/30	7/28	7/28	8/11	8/11	8/11	9/22	9/22	10/15	10/27	10/27	11/10	11/10	11/10	12/8	12/8
1,1,1 Trichloroethane	1	10	10	nd										1.7	nd											
Tetrachloroethylene	1	nd													1.3	nd										
Methylene Chloride [1]	1	nd																								
CIS-1,2 Dichloroethylene	1	nd																								
1,2 Dichloroethane [2]	1	nd																								
Carbon Tetrachloride	1	nd																								
Trichloroethylene	1	nd																								
Freon	5	nd																								
Benzene	1	nd																								
Toluene	1	nd																								
M, P Xylene	1	nd																								
O, Xylene	1	nd																								
Chloroform	1	nd														1.3	nd									

1 Some samples were reported to have a detection limit of 2 ug/l
2 Some samples were reported to have a detection limit of 3 ug/l
G Collob Analytical Service
HD New York State Department of Health Lab
W Westchester County Environmental Laboratory
B Bailed from well

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TABLE 4

MILTON CHAZEN ASSOCIATES

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING
(All Results in ug/l)

LABORATORY RAW, FILTERED OR BAILED DATE SAMPLED	Detection Limit	DIMATTEO RESIDENCE G R 1/29	HD R 1/29	W R 4/7	W R 5/5	W R 6/2	W R 7/7	W R 8/25	W R 9/8	W R 10/27	W R 11/10	W R 12/1
1,1,1 Trichloroethane	1	nd										
Tetrachloroethylene	1	nd										
Methylene Chloride [1]	1	nd										
CIS-1,2 Dichloroethylene	1	nd										
1,2 Dichloroethane [2]	1	nd										
Carbon Tetrachloride	1	nd										
Trichloroethylene	1	nd										
Freon	5	nd										
Benzene	1	nd										
Toluene	1	nd										
M, P Xylene	1	nd										
O, Xylene	1	nd										
Chloroform	1	nd										

1 Some samples were reported to have a detection limit of 2 ug/l
2 Some samples were reported to have a detection limit of 3 ug/l
G Gollob Analytical Service
HD New York State Department of Health Lab
W Westchester County Environmental Laboratory
B Bailed from well

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TABLE 5

MILTON CHAZEN ASSOCIATES

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING
(All Results in ug/l)

		FRANK RESIDENCE																												
LABORATORY	Detection Limit	G	G	G	HD	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
RAW, FILTERED OR BAILED		R	R	F	R	R	F	R	F	R	F	R	F	R	F	R	F	R	F	F	R	F	B	R	F	R	F	F	R	F
DATE SAMPLED		1/29	2/5	2/11	2/5	4/14	4/14	5/19	5/19	5/20	5/20	5/20	5/20	6/2	6/2	7/7	7/7	8/11	8/11	8/11	9/1	9/1	10/15	10/6	10/6	11/3	11/3	11/3	11/23	11/23
1,1,1 Trichloroethane	1	7	nd	nd	13	2.8	nd	1.8	nd	1.3	nd	1.7	nd	nd	nd	1.1	nd													→
Tetrachloroethylene	1	10	24	nd	25	nd	nd	2.8	60	3.4	65	3.8	nd	3.0	nd	8.6	nd	2.6	nd	nd	nd	nd	2.2	nd	nd	2.4	nd	nd	3.0	nd
Methylene Chloride 1	1	nd																												→
CIS-1,2 Dichloroethylene	1	nd																												→
1,2 Dichloroethane 2	1	nd																												→
Carbon Tetrachloride	1	nd																												→
Trichloroethylene	1	nd																												→
Freon	5	nd																												→
Benzene	1	nd																												→
Toluene	1	nd																												→
M, P Xylene	1	nd																												→
O, Xylene	1	nd																												→
Chloroform	1	nd					→	2.1	nd	1.6	nd																→	2.0	nd

1 Some samples were reported to have a detection limit of 2 ug/l
2 Some samples were reported to have a detection limit of 3 ug/l
G Gollob Analytical Service
HD New York State Department of Health Lab
W Westchester County Environmental Laboratory
B Bailed from well

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TABLE 6

MILTON CHAZEN ASSOCIATES

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING
(All Results in ug/l)

LABORATORY	Detection Limit	SMITH RESIDENCE G	G	W	W	GRASSO RESIDENCE G	W	W	W	YEOMANS RESIDENCE G	W	W	W	W	W	W	W	W
RAW, FILTERED OR BAILED DATE SAMPLED		R 2/17	R 2/29	B* 10/16	R 11/10	R 1/28	R 4/28	R 6/16	R 9/8	R 1/28	R 4/28	R 5/15	R 6/30	R 7/28	R 8/25	R 9/29	R 10/20	R 11/23
1,1,1 Trichloroethane	1	nd	nd	1.6	nd	nd	nd	nd	nd	nd								
Tetrachloroethylene	1	nd	nd	nd	nd	nd	nd	nd	nd	nd								
Methylene Chloride [1]	1	5	13	nd	nd	nd	nd	1.5	nd	nd								
CIS-1,2 Dichloroethylene	1	nd	nd	nd	nd	nd	nd	nd	2.8	nd								
1,2 Dichloroethane [2]	1	nd	nd	nd	nd	nd	1.8	3.5	nd	nd								
Carbon Tetrachloride	1	nd	nd	nd	nd	nd	nd	nd	nd	nd								
Trichloroethylene	1	nd	nd	nd	nd	nd	nd	nd	nd	nd								
Freon	5	nd	nd	nd	nd	nd	nd	nd	nd	nd								
Benzene	1	nd	nd	nd	nd	nd	nd	nd	nd	nd								
Toluene	1	nd	nd	nd	nd	nd	nd	nd	nd	nd								
M, P Xylene	1	nd	nd	nd	nd	nd	nd	nd	nd	nd								
O, Xylene	1	nd	nd	nd	nd	nd	nd	nd	nd	nd								
Chloroform	1	nd	nd	nd	nd	nd	nd	nd	nd	nd								

1 Some samples were reported to have a detection limit of 2 ug/l
2 Some samples were reported to have a detection limit of 3 ug/l
G Collob Analytical Service
HD New York State Department of Health Lab
W Westchester County Environmental Laboratory
B Bailed from well
* Gasoline and high molecular weight oil also present

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It is noted that water from two of the five wells in this area was found to contain an organic solvent on only one sampling day. In both cases, follow-up samples have not confirmed the original result. Despite the lack of confirmation of the original sample result, the data is included on Figure 2 which shows the approximate location of these wells and the month in which an organic solvent was first identified. Based on the available data, it is impossible to conclude if the groundwater organic chemical concentrations are: 1) in the case of Matheson and Picano wells, true indications of groundwater quality or the result of errors inherent in the sampling and analytical procedures and 2) the result of multiple sources of contamination or the result of a single release of solvents to the environment. The existing data can be used to support or refute either argument. For example, one could make an argument that the incidents are unrelated because:

1). the same organic solvents don't always appear in samples from different wells, also

2). there are currently wells that have never shown the presence of organic solvents located in between wells that have and

3) results from the Matheson and Picano wells should be discarded because they were not confirmed.

Comment:

If a single incident was responsible, one would expect all wells downgradient of the contaminant release to show the presence of the contaminant and the same compounds to be present in each case. Also, one would expect results to be reproducible and investigators should be allowed the flexibility to question results that are not.

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The opposite argument can also be made as follows:

1). all of the wells with organic solvents are in the same general geographic area,

2). the presence of different compounds in different wells can be explained because during the manufacture of these solvents, it is common to produce smaller quantities of many other solvents and

3). the development characteristics of the presently uncontaminated wells are unknown, consequently they may be developed into another water bearing formation or a fracture or solution channel that is unrelated to nearby contaminated fracture or solution channels.

Obviously, additional investigations that have the purpose of clarifying the hydraulic and groundwater quality characteristics of this area are warranted.

Organic solvent samples collected after groundwater recovery from the Stone, Frank and Smith wells indicated tetrachloroethylene present in the Frank well at 2.2 ug/l and 1,1,1-trichloroethane present in the Smith well at 1.6 ug/l, all other analyses for organic solvents were less than the detection limit. The Smith well water also produced a petroleum like sheen which was observed floating on the intermediate pumping tank. (The intermediate pumping tank was a receiving tank for metered water pumped from the well.) Water in this tank was subsequently pumped into a tank truck and removed from the site. The material causing the petroleum like sheen was sampled. The Smith well was also bail sampled at the end of the recovery test. The Westchester County Environmental Laboratory reported the presence of a "high molecular weight oil" and 0.35 parts per million (350. ppb) gasoline in the

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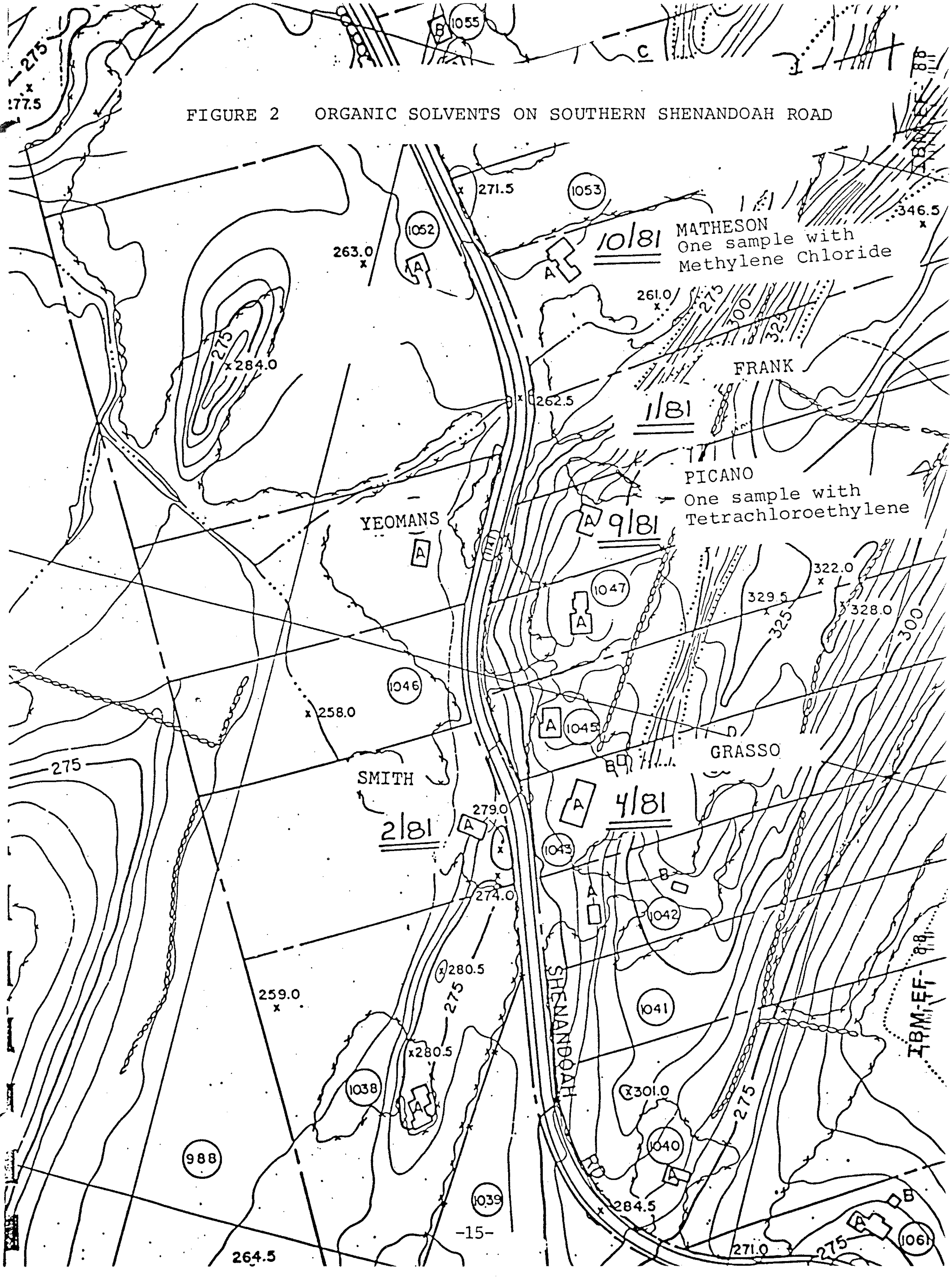
FIGURE 2 ORGANIC SOLVENTS ON SOUTHERN SHENANDOAH ROAD



intermediate pumping tank sample and ten times less "high molecular weight oil" and less than .2 parts per million (200. ppb) gasoline in the sample bailed from the well. It is noted that the well water level was drawn down to the bottom of the pump during the pump test and presumably most of the petroleum floating on top of the water column was discharged to the intermediate pumping tank. The results of these analyses are provided in Table 7. Each sample was also analyzed for fourteen inorganic chemical parameters, pH, coliform organisms, conductance and total organic carbon. The inorganic chemical characteristics of the Frank and Smith well water are very similar. The water from the Stone well showed much higher concentrations of alkalinity, sodium, chloride, and sulfate. These dissolved constituents may be due, in part, to the influences of deicing salt use on Route 52 and the interaction between surface activity and groundwater quality in a fractured dolostone aquifer. These variations in inorganic constituents provide the possibility that dissolved inorganic compounds which are already present in the groundwater may be used as an indicator for groundwater movement.

The Frank well also showed 22 coliform organisms per 100 ml after the pump test was completed and prior to disinfection of the well. Subsequent resampling by the Dutchess County Health Department showed total coliform levels in excess of 150 colonies per 100 ml. The Frank well was again disinfected between November 12 and November 14. During this period, fecal and total coliform levels were significantly lower in the

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TABLE 7

MILTON CHAZEN ASSOCIATES

ANALYTICAL RESULTS OF PUMPED WELLS

PARAMETER	Detection Limit	UNITS	WELL TESTED		
			FRANK	SMITH *	STONE
ORGANIC					
1,1,1 - Trichloroethane	1	ug/l	nd	1.6	nd
Tetrachloroethylene	1	ug/l	2.2	nd	nd
Methylene Chloride	1	ug/l	nd	nd	nd
CIS - 1,2 Dichloroethylene	1	ug/l	nd	nd	nd
1,2 Dichloroethane	1	ug/l	nd	nd	nd
Carbontetrachloride	1	ug/l	nd	nd	nd
Trichloroethylene	1	ug/l	nd	nd	nd
Freon	5	ug/l	nd	nd	nd
Benzene	1	ug/l	nd	nd	nd
Toluene	1	ug/l	nd	nd	nd
M.P Xylene	1	ug/l	nd	nd	nd
O,Xylene	1	ug/l	nd	nd	nd
Chloroform	1	ug/l	nd	nd	nd
INORGANIC					
Alkalinity					
Carbonate	-	mg/l	< 1	< 1	< 1
BiCarbonate	-	mg/l	250.	260.	330.
Ca Hardness	-	mg/l	340.	350.	520.
Chloride	-	mg/l	42.	51.	390.
Sodium	-	mg/l	28.	25.	210.
Manganese	-	mg/l	< 0.01	< 0.01	0.03
Magnesium	-	mg/l	40.	43.	50.
Iron	-	mg/l	< 0.02	.1	0.04
Potassium	-	mg/l	0.68	.84	1.4
Sulfate	-	mg/l	25.	30.	68.
Fluoride	-	mg/l	< .1	< .1	0.1
Nitrate	-	mg/l	1.6	0.6	0.6
Nitrite	-	mg/l	< 0.01	< 0.01	< 0.01
Ammonia	-	mg/l	< 0.05	< 0.05	< 0.05
OTHER					
pH	-	-	7.3	7.3	7.4
Coliform	-	-	2 2	< 1	< 1
Conductance	-	umhos/cm	580.	630.	1500.
TOC or COD	-	mg/l	1.3	5.0	5.7

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*During the Smith test a petroleum like sheen was observed floating on water in the pump tank. The water in the tank was sampled and water was bailed directly from the well. The bailed sample contained < .2 ppm gasoline and a high molecular weight oil. The sample from the tank contained 0.35 ppm gasoline and 10 times more oil than the bailed sample.

samples collected prior to disinfection than those collected after disinfection. The same trend of deterioration in raw water bacteriological quality was repeated on November 20 when the household piping system was disinfected prior to installation of an ultraviolet light disinfection unit. These data are provided in Table 8.

It is believed that the deterioration in the bacteriological water quality can be explained by short circuiting of the Frank's subsurface disposal system discharge to their own water supply well. During the pump test, the pumped water was contained and removed from the Frank property causing no increase in hydraulic loading to the Frank subsurface disposal system. After disinfection of the well on November 12, the well was pumped to purge it of chlorine. The pumped water was treated via carbon filtration and then discharged to the subsurface disposal system causing an increased hydraulic loading. No evidence of surface out-cropping of water from the subsurface disposal system was observed during this period. It is believed that the increased hydraulic loading caused an out-wash of bacteria from the subsurface disposal system and that these bacteria migrated very quickly to the Frank water supply well. Table 5 also shows that nitrate levels are higher than normally expected in groundwater. This supports the thesis that a hydraulic interconnection between the subsurface disposal system and the well exists. Two possible locations for the short circuiting exist:

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TABLE 8

FRANK RESIDENCE - SAMPLE RESULTS

Parameter	Location / Date / Time	PreDisinfection 11/12/81 8:10 A.M.	Post Disinfection 11/14/81 10:00 A.M.	Pre UV 11/20/81 12:30 PM	Post UV 11/20/81 12:30 PM	Pre UV 11/20/81 3:00 PM	Post UV 11/20/81 3:00 PM	Kitchen Tap 11/20/81 3:00 PM	Raw Tap 11/20/81 8:30 AM	Raw Tap 11/20/81 3:00 PM
Total Coliform (MF)		>120*	293*	15*	1*	>695*	<1*	<1*	--	--
Total Coliform (MPN)		920	350	17	<2	540	<2	<2	--	--
Fecal Coliform (MF)		4*	33*	2*	<1*	121*	<1*	<1*	--	--
Fecal Coliform (MPN)		2	110	2	<2	540	<2	<2	--	--
AGAR Plate Count		838*	330*	340*	8*	TNTC*	1*	<1*	--	--
Chloride ma/l		NA	NA	NA	NA	NA	NA	NA	71	51
Ammonia mg/l		NA	NA	NA	NA	NA	NA	NA	0.50	0.50
Nitrite mg/l		NA	NA	NA	NA	NA	NA	NA	<.04	<.04
Nitrate mg/l		NA	NA	NA	NA	NA	NA	NA	9.10	4.75

* Results are average of three analyses

UV - Ultraviolet Disinfection
MF - Membrane filter methods, colonies per 100 ml
MPN - multiple tube method, colonies per 100 ml
Agar Plate Count - Colonies per ml
NA - not analyzed
TNTC - Too numerous to count

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1). wastewater leakage from the normally sealed household discharge pipe, septic tank or septic tank discharge pipe or

2). improper filtration of bacteria after discharge from the leach device due to insufficient soil depth.

This information is of interest to the present study because it demonstrates that in a fractured dolostone area, activity near the ground surface can quickly affect groundwater quality.

Static Groundwater Levels and Pump Tests

Table 9 provides static groundwater elevations for the five homeowner wells, and the five IBM wells that were monitored during the pump tests. These data are plotted on Figures 3 and 4 and show probable groundwater contours for the Route 52 area and the southern Shenandoah Road area.

It is noted that all of the homeowner wells are cased into rock and then consist of open hole construction (uncased) for the remainder of the depth. Use of this type of well to ascertain groundwater level elevations can result in misleading information because more than one water bearing formation with different groundwater levels may be intercepted by the open hole. The resultant composite groundwater profile may not represent hydraulic conditions in any one formation.

It is further noted that all of the groundwater elevation data used in this Report was generated during a single day for the Binnewater Road area and over a two day period for the southern Shenandoah Road area. More data, collected over a

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TABLE 9

STATIC GROUNDWATER LEVELS

Date	Homeowner Wells			IBM Wells		
	Frank	Yeomans	Smith	164	89	166
10/13/81	252.65	--	--	--	--	--
10/14/81	--	252.11	251.96	--	--	--
10/15/81	252.54	252.21	253.30	253.60	255.42	241.24
10/16/81	252.07	252.15	253.55	253.60	255.37	241.17

STATIC WATER LEVELS

Date	Homeowner Wells		IBM Wells	
	Stone	DiMatteo	Prod. #9	85
10/12/81	--	245.11	--	--
10/13/81	233.79	--	--	--
10/14/81	235.49	244.87	208.41	232.40

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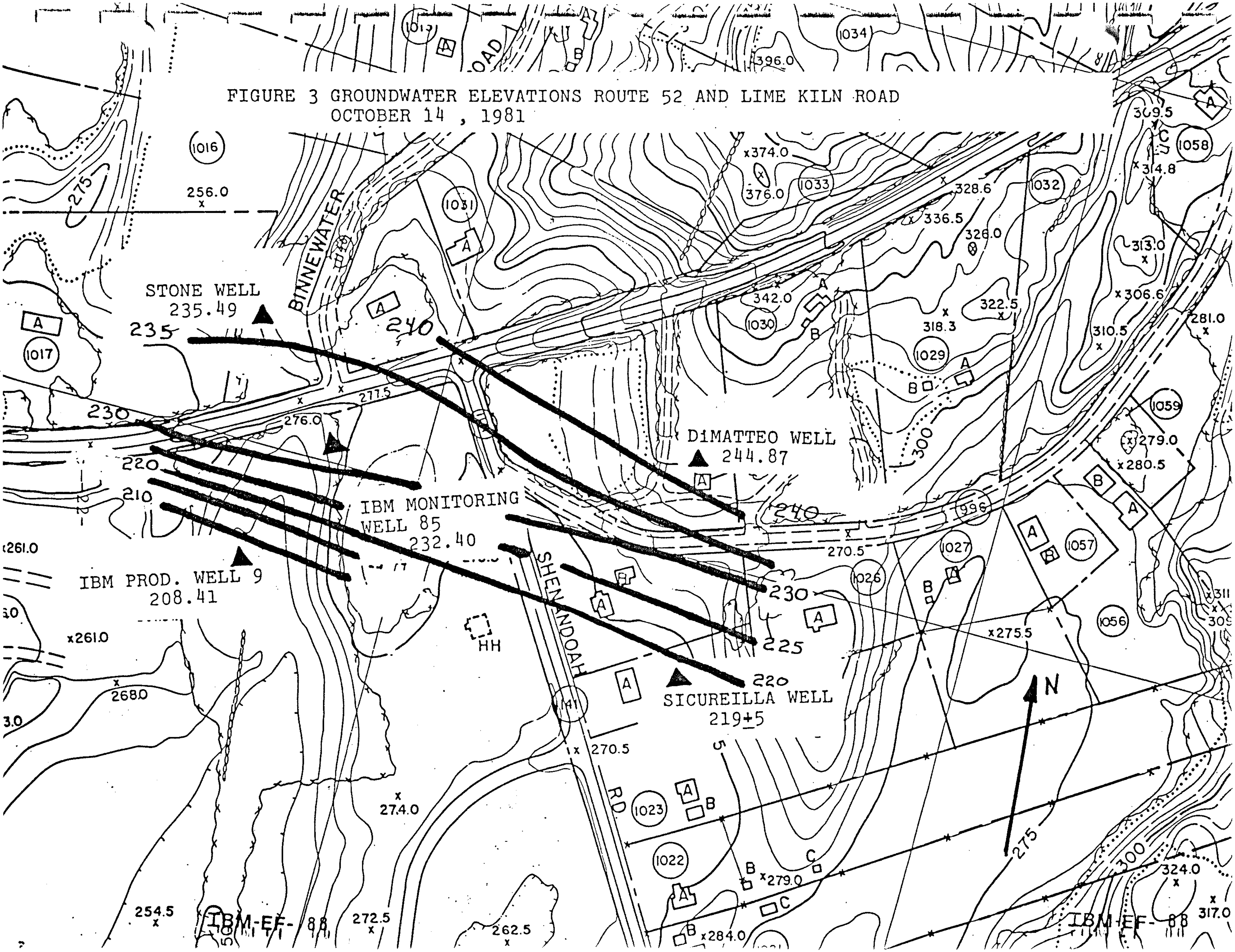
FIGURE 3 GROUNDWATER ELEVATIONS ROUTE 52 AND LIME KILN ROAD
OCTOBER 14 , 1981



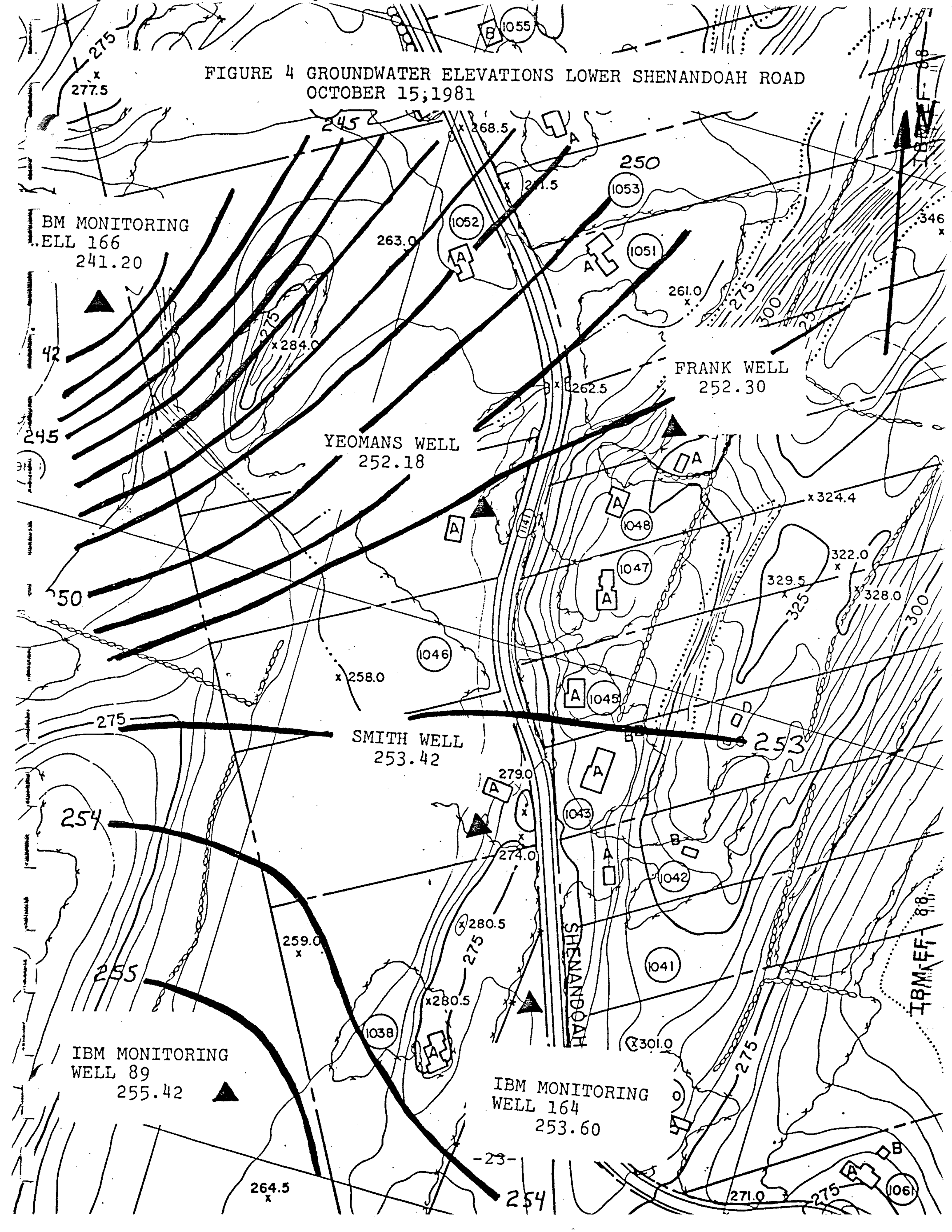


FIGURE 4 GROUNDWATER ELEVATIONS LOWER SHENANDOAH ROAD
OCTOBER 15, 1981
BM MONITORING
.ELL 166
241.20
YEOMANS WELL
252.18
FRANK WELL
252.30
SMITH WELL
253.42
IBM MONITORING
WELL 89
255.42
IBM MONITORING
WELL 164
253.60
245
250
253
254
255
SHENANDOAH
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longer period of time is needed prior to use of the data in predicting seasonal or longer term groundwater flow patterns. Recommendations are included in this report for the establishment and monitoring of a network of carefully located and constructed piezometers in both the Binnewater Road and southern Shenandoah Road areas. The installed piezometers will be used to gather data that will allow the formulation of conclusions regarding groundwater flow in which there is a high degree of confidence.

The data collected during Phase I yields the preliminary and tentative observation (for the above reasons) that groundwater in the Binnewater Road area may be moving in a southerly direction and that groundwater in the southern Shenandoah Road area may be moving in a northerly direction.

PUMP TESTS

A discussion of each of the three pump tests is provided in the main report.

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CONCLUSIONS

This section of the Summary Report provides conclusions that have been generated as a result of the Phase I investigation. In each case, when a conclusion is made that additional information is needed, a companion recommendation has been included in the next section of this Summary Report.

1). Organic solvent concentrations found in wells in the Study Area are dissolved and will move with groundwater essentially unimpeded by physical, chemical or biological processes. This indicates that if one can determine groundwater flow characteristics, then one can predict areas from which chemicals have migrated or to which they will migrate.

2). Groundwater will move from areas of higher piezometric head to areas of lower piezometric head (water flows downhill). Methods are available to measure the velocity (speed and direction) of groundwater flow.

3). The organic solvents found in wells in the Study Area are commonly used by industries and are also found in many household products.

4). Neither homeowners nor County and local officials reported the existence of any roadside dumps or in-place toxic substance sites located within this Study Area that might contribute to the groundwater

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organic solvent concentrations. The Smith residence was the only property identified as formerly being used for "other than domestic" purposes.

5). There are two areas where groundwater has been shown to contain organic solvents. One area is located near the intersection of Binnewater Road and Route 52. The other area is located on southern Shenandoah Road. Data from carefully located and constructed piezometers is needed prior to the formulation of conclusions regarding groundwater flow in which there is a high degree of confidence. The data collected during Phase I yields the preliminary and tentative observation that groundwater in the Binnewater Road area may be moving in a southerly direction and that groundwater in the southern Shenandoah Road area may be moving in a northerly direction.

6). Organic solvent concentrations in groundwater wells were highest during January and February 1981. Levels generally decreased during the spring and summer of 1981. Wells near Shenandoah Road showed that organic solvent levels remained low into the early Fall. The Perez well showed increased levels during September. There is insufficient data to conclude if this will be a recurring seasonal trend.

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7). There is insufficient data available to conclude if the organic solvents present in wells on southern Shenandoah Road are the result of a common environmental release or separate unrelated releases.

8). Water samples collected for organic chemical analyses during this study showed no detectable concentration of solvents in the Stone well, 2.2 ug/l tetrachloroethylene in the Frank well and 1.6 ug/l 1,1,1-trichloroethane in the Smith well. The Smith well also showed the presence of gasoline and "high molecular weight oil". These samples were all bailed directly from the well thereby eliminating any influences that the household piping system might have had on water quality. It is concluded, therefore, that these solvents were actually present in the groundwater in these wells.

9). There is a significant difference in the inorganic water quality (calcium, sodium, chloride and sulfate) of water from the Stone well and water from the wells sampled on southern Shenandoah Road. It may be possible to use this dissimilarity to trace groundwater flow by sampling and measuring these parameters at various locations within the Study Area.

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10). The rapid deterioration in bacteriological quality of the Frank well water due to increased hydraulic loading of the subsurface disposal system demonstrated that in a fractured dolostone area, activity near the ground surface can quickly affect groundwater quality.

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PHASE II RECOMMENDATIONS

This section of the Report provides recommendations for continuation of this investigation. The recommendations are provided in three distinct groupings as they apply to the 1) southern Shenandoah Road area, 2) the Binnewater Road area, and finally 3) the overall Study Area.

Recommendations are characterized as "need" or "possibly needed" according to their perceived overall importance in facilitating the successful completion of this study. Recommendations labeled "need" are important and should be undertaken. Recommendations labeled "possibly needed" should be considered as logical adjuncts to this study.

1). <u>SOUTHERN SHENANDOAH ROAD</u>

A. <u>Need:</u>

Accurately and reliably determine groundwater flow characteristics for the area shown in Figure 4 . It is noted that the data included in this Report was based on low volume,short duration pump tests and observation well water level monitoring from partially cased wells. Although the data is useful in the formulation of preliminary observations, accurate water elevation data from controlled observation points is needed to achieve a greater degree of confidence in projected groundwater flow patterns.

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Method

Plan and implement a systematic piezometric network for this part of the Study Area. To the extent feasible place piezometers on public land. If piezometers need to be placed on private land, secure permission from landowners for their placement. Plan a high rate, extended duration, pump test to obtain field measurements of the hydraulic characteristics of the aquifer. This may be accomplished by temporarily installing a high yield pump in one of the existing residential wells or installing a new well specifically for this purpose. Monitor groundwater levels in the piezometers during the test. Also monitor groundwater levels for an extended period.

Product:

Use the obtained data to develop a model of groundwater flow in which there is a high degree of confidence.

B. Need:

Obtain accurate information regarding groundwater development characteristics of additional wells in the southern Shenandoah Road area. This information will be used to predict if the homeowners are using water from the same waterbearing formation, and if appropriate, as additional groundwater level monitoring points. Wells on property owned by the following residents will be included if permission from the homeowner is secured: Grasso, Vrouvas, Picano, Baker, Mosca, Livingston and Matheson.

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Method:

On-site measurements of each well will be made by removing the sanitary seal and determining the depth of the casing, the pump depth, the elevation of the bottom of the well and the static water level. It is advisable that bacteriological samples be collected prior to the on-site measurements.

Product:

A tabulation of the obtained data, conclusions regarding development similarities and conclusions regarding the water source formation for each well will result from this segment of the investigation.

C. Need:

Collect and analyze septage from household septic tanks in the southern Shenandoah Road area. As indicated in the Report, there remain three potential sources of organic solvents in the southern Shenandoah Road area:

1). Migration from the IBM site,

2). household use of solvents and

3). illegal discharges by waste haulers.

A possible transport vehicle of household solvents to the groundwater is the individual subsurface disposal system. (See the discussion of the Frank well results in Section V). Analysis of septage from household septic tanks will provide valuable information regarding this potential source.

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Method:

With the permission of the homeowners, samples of septage will be obtained from the following properties: Grasso, Vrouvas, Picano, Baker, Mosca, Livingston and Matheson.

Product:

A tabulation of obtained data and conclusions regarding the likelihood that these potential sources of organic solvents are contributing to groundwater, organic solvent concentrations will result from this segment of the investigation.

D. Need:

As indicated, a preliminary and tentative observation is that groundwater, at least in mid-October 1981, may be migrating in a northerly direction in the area shown in Figure 4. There is a need to obtain additional groundwater quality data for this area to determine if there are any notable trends or correlations with groundwater flow predictions.

Method:

Use the piezometers referred to in (A) above for monitoring purposes if it is determined that groundwater from the piezometer is representative of local groundwater quality. If needed, install monitoring wells in appropriate number and locations to insure representative sampling.

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Initiate a program to obtain samples from the monitoring wells. Analysis will be made of the organic and inorganic chemical quality of the sampled water.

Product:

Tabulation and evaluation of the data will be made to determine if groundwater flow and groundwater quality can be correlated.

2. BINNEWATER ROAD AREA

A. Need:

Accurately and reliably determine groundwater flow characteristics for the area shown in Figure 3. It is noted that the data included in this Report was based on a low volume,short duration pump test and observation well water level monitoring from partially cased wells. Although the data is useful in the formulation of preliminary observations, accurate water elevation data from controlled observation points is needed to achieve a greater degree of confidence in projected groundwater flow patterns.

Method:

Plan and implement a systematic piezometric network for this area placing piezometers on public land along Binnewater Road, Route 52 and Old State Road. Plan a high rate, extended duration pump test to obtain field measurements of the hydraulic characteristics of the

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aquifer (IBM's production well No. 9 will probably serve this purpose). Monitor groundwater levels in the piezometers during the pump test. Also monitor groundwater levels for an extended period to observe seasonal trends.

Product:

Use the obtained data to develop a mathematical model of groundwater flow for this part of the Study Area.

B. Possible Need:

Collect and analyze septage from household septic tanks in the Binnewater Road area. As indicated in the Report, there remain three potential sources of organic solvents in the Binnewater Road area:

1). migration from the IBM site,

2). household use of solvents and

3). illegal discharges by waste haulers.

A possible transport vehicle of household solvents to the groundwater is the individual subsurface disposal system. (See the discussion of the Frank well results in Section V). Analysis of septage from household septic tanks will provide valuable information regarding this potential source.

Method:

With permission of the homeowners, it is recommended that samples of septage be obtained from the following properties: Stone, Stephens, Eaton and Perez.

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Product:

A tabulation of obtained data and conclusions regarding the likelihood that these potential sources of organics are contributing to groundwater organic solvent concentrations will result from this segment of the investigation.

3. OVERALL STUDY AREA

A. Possible Need:

Recommendations 1A and 2A above provide for detailed groundwater flow modeling of the southern Shenandoah Road and the Binnewater Road areas. It is of interest, although not critical to Phase II of this study, that a groundwater flow model also be developed to include that portion of the Phase I Study Area located in between the two areas recommended for modeling.

Method:

Plan and implement a systematic piezometric network for this portion of the Study Area. To the extent feasible, place piezometers on public land. If piezometers need to be placed on private land, secure permission from landowners for their placement. Include these observation points in the high rate, extended duration, pump tests described in 1A and 2A above.

Product:

The obtained data will be used to generate a mathematical model of groundwater flow for this area.

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B. Possible Need:

Significant variations in inorganic groundwater quality were noted between the Binnewater Road area and the southern Shenandoah Road area. These inorganic chemicals may be used as in-place chemical tracers of groundwater flow characteristics.

Method:

Measurement of those parameters in groundwater at various locations within the Study Area will provide the data needed to plot isopleths (lines connecting points of equal concentration analogus to topographic map contour lines of equal ground levels) of inorganic chemical concentrations. One would expect that these chemicals will move with groundwater thereby providing a method of tracing groundwater movement by measurement of inorganic chemical concentrations at various locations within the Study Area.

Product:

A map of inorganic chemical isopleths will be prepared and evaluated. Concentration changes are expected to reveal groundwater movement characteristics.

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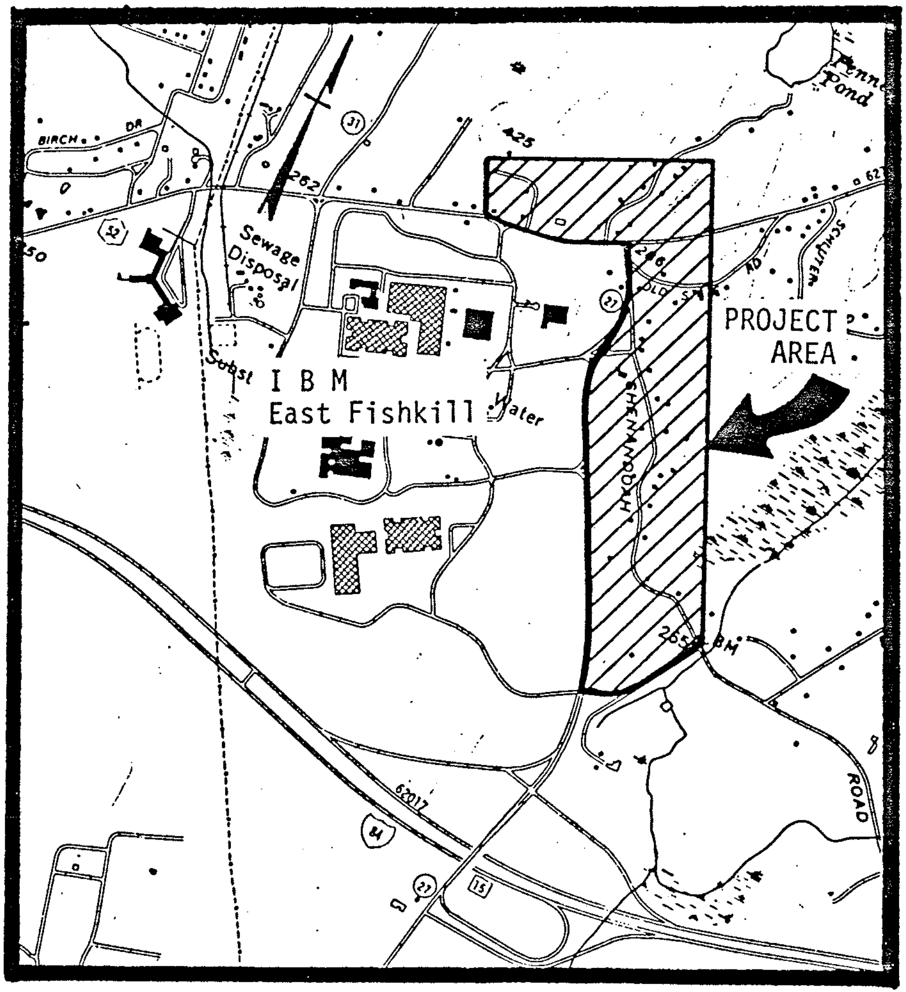
TRACE ORGANICS IN GROUNDWATER

SHENANDOAH ROAD AND ROUTE 52

EAST FISHKILL, NEW YORK

PHASE II REPORT



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November - 1982

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GLOSSARY OF TERMS AND ABBREVIATIONS

Aquifer - A saturated bed, formation or group of formations that yield water.

Groundwater Table - The levels at which water stands in wells that penetrate an unconfined water body.

Piezometer - A tightly cased non-pumping well, generally of small diameter, which is used to measure the static pore-water pressure only at the depth of the screened (or open) portion of the hole.

ppb - Part per billion approximates microgram per liter.

ppm - Part per million approximates milligram per liter.

Subsurface Disposal System - All pipes, septic tank and leaching devices used to discharge sewage into the ground.

ug/kg - Microgram per kilogram approximates part per billion.

Study Area - Approximately 38 private lots located along Route 52 and Shenandoah Road on the northern and eastern borders of IBM's East Fishkill facility.

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I. EXECUTIVE SUMMARY

This Report provides the results of the second phase of a two part project aimed at determining whether or not IBM is the source of the organic chemicals that were found in four homeowner wells that are located north and east of IBM's East Fishkill facility. The Study Area is comprised of approximately 38 private lots that are located along Route 52 and Shenandoah Road on the northern and eastern borders of IBM's East Fishkill facility.

The Phase I investigation concluded that the organic chemicals that have been found in wells in the Study Area are dissolved in groundwater and therefore groundwater flow is the principle means of organic chemical transport. The Phase I report recommended that additional piezometers be installed in the Study Area to provide data from which an accurate groundwater flow regime for the Study Area could be developed.

The piezometers were completed during July of 1982. An aquifer pump test resulted in a determination that the piezometers in the Study Area are hydraulically interconnected. This was critical because it allows use of the piezometric surface elevation data to develop a groundwater flow regime for the Study Area. Data from the piezometers for August, September and October have been used to develop groundwater flow regimes in which there is a high degree of confidence. Throughout this period, and for the entire Study Area, the predominant direction of groundwater flow has been toward IBM's East Fishkill facility. Also, groundwater was not found to be flowing from IBM's East Fishkill site into the Study Area.

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A review of the organic chemical water quality data from the Health Department coordinated sampling program that was sponsored by IBM, and data from samples collected from each of the piezometers installed during Phase II indicates that:

a). the concentrations of organic chemicals in the homeowner wells decreased between the winter of 1981 and September of 1982;

b). not all of the wells contain the same organic chemicals;

c). uncontaminated wells are located in between wells in which organic chemicals have been identified; and,

d). none of the piezometers contained detectable concentrations of the organic chemicals for which they were analyzed.

These data support a conclusion that the organic chemicals that have been found in all of the homeowner wells did not result from a single release of organic chemicals to the environment.

The Phase I Report concluded that subsurface disposal systems are a possible means of transport of contaminants into the groundwater of the Study Area. During Phase II, sludge samples from two septic tanks were collected and analyzed for the same organic chemicals for which homeowner wells were analyzed under the Health Department coordinated sampling program. Each of these samples confirmed the presence of organic chemicals.

This investigation leads to the conclusions that:

a). the IBM East Fishkill facility's on-site groundwater problems are not the cause of the organic chemicals that have been found in four wells in the Study Area and,

b). the most likely source of the organic chemicals that have been found in homeowner well water is some on premises use or disposal of common household products that contain these compounds.

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II. INTRODUCTION

A. The Study Area is comprised of approximately 38 private lots located along Route 52 and Shenandoah Road on the northern and eastern borders of IBM's East Fishkill facility. A map of the Study Area showing the locations of each private lot is provided in Appendix A.

B. PHASE I REVIEW

Phase I was designed to gather background information regarding the Study Area and to use this information to formulate a logical Phase II continuation of the Study. The following specific tasks were included in Phase I.

* A sanitary survey of the area was conducted to identify any likely sources of organic chemicals.

* A literature search was undertaken to catalogue the experiences of other investigators of organic chemical transport in groundwater.

* The construction characteristics of homeowner wells were measured to identify similarities and dissimilarities of wells with and without organic chemicals.

* Three homeowner wells that were shown to contain organic chemicals were pump tested to ascertain their hydraulic characteristics and to identify any possible hydraulic interconnections between various homeowner wells.

* The static groundwater levels found at homeowner wells and nearby piezometers were measured and used to make preliminary observations of the groundwater flow regime within the Study Area.

* The organic chemical water quality data that was generated as a result of the Health Department coordinated sampling program was reviewed and interpreted.

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Completion of the above work items resulted in the following conclusions.

1. The sanitary survey did not reveal the presence of any roadside dumps or other overt sources of organic chemicals within the Study Area.

Neither homeowners, County nor local officials reported the existence of any roadside dumps or in-place toxic substance sites located within the Study Area that might contribute to the organic solvent concentrations of groundwater in this Study Area. The Smith/Tomasi residence was the only property identified as formerly being used for "other than domestic" purposes.

2. The literature search revealed that:

a). the solubilities in water of the solvents found in the Study Area range between 150,000 and 20,000,000 parts per billion (ppb) and that dissolved solvents can be transported long distances by groundwater. The highest concentrations found in any well in the Study Area was 65 ppb. Therefore it was concluded that the solvents in groundwater in the Study Area are dissolved and that the primary transport mechanism is the movement of groundwater.

b). groundwater will move from areas of higher groundwater level to areas of lower groundwater level.

c). the solvents found in wells in the Study Area have been used for many commercial, industrial and domestic purposes. The more commonly reported sources

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of organic solvents in groundwater are: industrial spills, sloppy housekeeping by industry, leaching from dumps, landfills or lagoons, use of septic tank cleaners and disposal of household or other products.

3. The evaluation of homeowner wells showed that:

a). for the southern Shenandoah Road area, the Frank, Yeomans and Smith/Tomasi wells were completed at about the same elevation as IBM's shallow bedrock piezometer network. Because of this, it was possible to use groundwater elevation data generated from these wells and nearby shallow bedrock piezometers to make preliminary estimates of the groundwater flow regime for southern Shenandoah Road.

b). for the Route 52 and Binnewater Road area, the DiMatteo and Stone wells were completed at slightly higher elevations than IBM's shallow bedrock piezometers. It was judged, dispite these differences in elevation, that preliminary estimates of the groundwater flow regime for the Route 52 and Binnewater Road area could be generated from groundwater elevation data from these wells.

4. During October 1981, short duration low volume pump tests were performed on the Stone, Frank and Smith/Tomasi wells. During these tests, the groundwater elevation of nearby homeowner wells was monitored. The Stone well pump test confirmed

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a hydraulic interconnection between the Stone and DiMatteo wells in the Route 52 and Binnewater Road area. The tests on southern Shenandoah Road confirmed a hydraulic interconnection between the Frank and Smith/Tomasi wells.

These findings were important because they demonstrated the appropriateness of using groundwater elevation data from these wells to make preliminary estimates of the groundwater flow regimes for these areas.

5. During the Frank well pump test, and subsequent attempts to disinfect the well, it was discovered that the Frank's subsurface disposal system was "short circuiting" to their well. This showed that in a fractured dolostone area, subsurface disposal systems are a possible means of transporting contaminants into the groundwater system.

6. The static groundwater elevations obtained during October 1981 led to the preliminary conclusion that groundwater in the southern Shenandoah Road area was moving northeasterly across Lime Kiln Road then northerly parallel to Shenandoah Road and finally northwesterly back onto the IBM site. Data obtained during this same period for the Route 52 and Binnewater Road area, led to the preliminary conclusion that groundwater was moving generally in a southwesterly direction across Route 52 and onto IBM's site. It was further concluded that groundwater elevation data over a longer time frame should be obtained to help formulate conclusions in which there is a high degree of confidence.

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7. The organic chemical water quality data that was generated as a result of the Health Department coordinated sampling program indicated, in general, a decrease in the organic chemical levels of water from homeowner wells between the beginning and end of 1981.

8. Finally, the Phase I Report concluded that there were three potential sources of the organic solvents that were found in the homeowner wells: 1) migration of chemicals from the IBM site, 2) illegal discharge of these solvents by waste haulers and 3) contamination through residential use of the solvents. The Report further concluded that a Phase II continuation of the Study was needed to clarify the preliminary conclusions that were generated in Phase I and to resolve whether IBM was the source of the organic chemicals found in homeowner wells.

C. PHASE II PURPOSE AND WORKPLAN

1. PURPOSE

The purpose of Phase II was to clarify the preliminary conclusions that were generated during Phase I and to determine whether or not IBM was the source of the organic chemicals found in four homeowner wells (Frank, Perez, Stone, Smith/Tomas) in the Study Area.

2. WORKPLAN

A Workplan was developed to accomplish the purposes of Phase II. The Workplan consisted of the following elements:

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a). Water Quality

i. The organic chemical water quality data that was generated during the Health Department coordinated sampling program was to be reviewed and interpreted. In particular, any identifiable trends in the water quality of individual wells were to be noted. An overall review of these data and the water quality data to be generated from the Phase II piezometers was to be performed to determine continuity or discontinuity of the organic chemical water quality from one sampling point to another.

ii. Water samples were to be obtained from a number of homeowner wells and analyzed for inorganic chemicals. These data were to be used to determine if inorganic chemical water quality concentration gradients exist within the Study Area. If gradients were found to exist, these data were to be used as in-place chemical tracers of groundwater movement.

b). Septage Sampling

The Phase I Report identified subsurface sewage disposal systems as a possible source of the organic chemicals that have been found in homeowner wells within the Study Area. The Phase I literature search did not identify any reports of the organic chemical quality of septage. Septage samples were to be obtained from a septic tank within the Study Area to determine if the sludge contained the types of organic chemicals that have been found in homeowner wells within the Study Area.

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c). <u>Groundwater Flow Direction</u>

The primary means of transport of dissolved organic chemicals in groundwater is groundwater flow. Therefore an accurate determination of the groundwater flow direction within the Study Area is prerequisite to a determination of whether or not IBM is the source of the organic chemicals that have been found in wells in the Study Area. Three work elements were to be accomplished that would allow formulation of a groundwater flow regime for the Study Area in which there is a high degree of confidence.

i. A review of the surfacial geology of the Study Area was to be made to determine the location of any structural disconformities that would influence groundwater movement.

ii. A longer duration and higher yield pump test was to be performed in the southern Shenandoah Road area to identify the presence of hydraulic interconnections between piezometers within the area. Confirmation of the presence of hydraulic interconnections between piezometers within the Study Area is necessary for proper interpretation of piezometric surface data and subsequent development of the groundwater flow regime.

iii. The piezometric surface, as determined by the piezometers that were to be installed during Phase II and the nearby piezometers on IBM's property, would be used to generate a groundwater flow regime for the Study Area in which there is a high degree of confidence.

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III INVESTIGATION RESULTS AND DISCUSSION

A. Water Quality

1. Health Department Coordinated Organic Chemical Sampling Program

The organic chemical water quality data that was generated as a result of the Health Department coordinated sampling program is provided in Tables B-1 through B-6 of Appendix B. Water Quality data from the Perez, Frank, Stone and Smith/Tomasi wells are also provided in Figure 1. This Figure shows that the organic chemical content of water from these wells generally decreased between early 1981 and the fall of 1982.

Water from the Perez well had cumulative solvent concentrations of 65 ug/l and 58 ug/l respectively in January and February 1981. Eight of the nine samples that were collected during the remainder of 1981 had detectable concentrations of organic solvents ranging between 5.8 and 20 ug/l. Only two of nine samples that were collected between January and September of 1982, had detectable concentrations of organic solvents. In these two samples, 1,1,1-trichloroethane was detected at 1.6 and 1.2 ug/l.

Water from the Frank well had cumulative solvent concentrations of 17 ug/l and 38 ug/l respectively in January and February of 1981. Ten of the thirteen samples that were collected during the remainder of 1981 had detectable concentrations of organic solvents ranging between 2.3 and 9.7 ug/l. Only three

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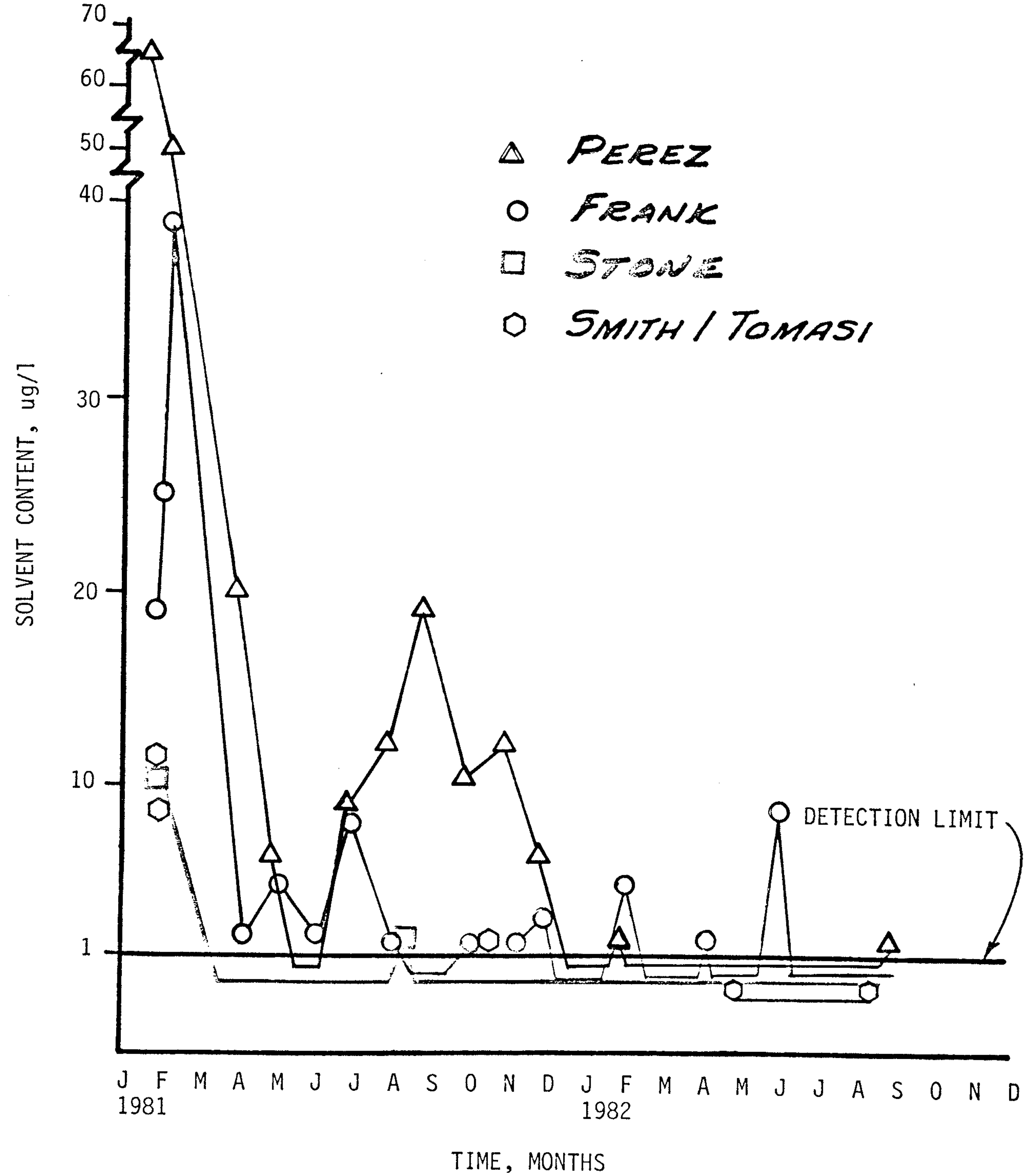
FIGURE 1

HOMEOWNER WELL SOLVENT CONTENT

(The Sum of all Species Detected)



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of eight samples that were collected between January and August of 1982 had detectable concentrations of organic solvents. In these samples the tetrachloroethylene concentrations were 1.3, 1.7 and 5 ug/l. 1,1,1 Trichloroethane was also found in one of these samples at a concentration of 2.0 ug/l, Finally, p-Dichlorobenzene was found in the sample that was collected during June 1982.

During the entire sampling period, only three of twenty-two raw samples from the Stone well had detectable organic solvent concentrations. Two of these samples, that were collected during February 1981, had concentrations of 10 ug/l, 1,1,1 trichloroethane. One sample collected during August 1981 had a concentration of 1.7 ug/l 1,1,1 trichloroethane. None of the raw samples that were collected during 1982 had detectable concentrations of organic chemicals.

Two samples that were collected from the Smith/Tomasi residence during February 1981 had methylene chloride concentrations of 5 and 13 ug/l. A sample that was collected during October 1981 had 1.6 ug/l of 1,1,1 trichloroethane. No detectable concentrations of solvents were found in samples that were collected from this well during May, June, July or August of 1982.

During 1981 the Grasso well occasionally showed the presence of methylene chloride, CIS - 1, 2 dichloroethylene and 1,2 dichloroethane at levels that were slightly above the analytical detection limit. No detectable concentrations of solvents were found in the four samples that were collected from this well between December 1981 and September 1982.

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The data contained in Appendix B also shows that different organic chemicals have been found in different homeowner wells. Table 1 is a list of the names of the chemicals that have been found in water from the Frank, Grasso, Smith/Tomasi and Yeomans wells.

TABLE 1

ORGANIC CHEMICALS FOUND IN WELLS ON SOUTHERN SHENANDOAH ROAD

	Frank	Smith/Tomasi	Grasso	Yeomans
1,1,1 Trichloroethane	yes	yes	no	no
Tetrachloroethlyene	yes	no	no	no
Methylene Chloride	no	yes	yes	no
CIS-1,2 Dichloroethylene	no	no	yes	no
1,2 Dichloroethane	no	no	yes	no
p-Dichlorobenzene	yes	no	no	no

Table 2 provides data regarding the completion of nine homeowner wells within the Study Area. These data show that the Frank, Yeomans, Smith/Tomasi and Grasso wells are completed at approximately the same elevation. One would therefore expect that these wells take water from the same aquifer.

The data from Tables 1 and 2 support a conclusion that a common release of contaminants to the environment is not responsible for the organic chemicals that have been found in these wells. This conclusion has been reached because one would expect that each well that has been affected by a common release to contain the same chemicals. Furthermore, one would also expect all of the wells that are downgradient of the

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TABLE 2

HOMEOWNER WELL COMPLETION DATA

Homeowner	ELEVATION *, FEET								
	Stone	Perez**	DiMatteo	Sicurella***	Baker****	Frank	Yeomans	Smith/Tomasi	Grasso
Date of Measurement	10/14/81	5/27/82	19/14/81	5/27/82	5/27/82	10/15/81	10/15/81	10/15/81	5/27/82
Top of Casing	281.37	297.52	302.36	266.76	263.96	299.60	261.19	262.21	279.43
Bottom of Casing	274.04	277	291.36	--	--	--	--	--	266
Static Water Level	235.49	250.22	244.87	254.46	258.96	252.54	252.21	253.30	255.93
Pump Setting	181.37	--	--	236	--	194.85	--	218.96	216
Bottom of Boring	160.21	198.02	197.36	228	233	178.77	186.03	176.71	174

*Elevations based on IBM bench mark 19 at elevation 257.90

**This well was reported to be 20' lower. An obstruction was encountered at elevation 198 that may have been the bottom of the well or may have been the pump.

***This Sicurella well has been abandoned. It reportedly went dry during October 1981.

****This Baker well has been abandoned. It reportedly went dry during October 1981.

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contaminant release point to be contaminated. Within this Study Area neither of these expectations are realized.

2. Organic Chemical Water Quality Data from Piezometers

Water samples were collected from the eight piezometers that were installed in the Study Area. These samples were analyzed for the same organic chemicals for which homeowner water supplies were analyzed under the Health Department coordinated sampling program. The shallower bedrock piezometers were screened at approximately the same elevation as the Frank, Smith/Tomasi, Yeomans and Grasso wells. The deeper bedrock piezometers were screened at an elevation that is approximately 50 feet deeper than the shallow bedrock piezometers. The data that is provided in Table 3 shows that no detectable concentrations of solvents were found in samples that were taken from these piezometers during August, September or October, 1982. For the same reasons that were stated in the previous section of this Report, these data support the conclusion that a common release of contaminants to the environment is not responsible for the organic chemicals that have been found in all of the homeowner wells.

3. Inorganic Chemical Water Quality Data

Table 4 provides the inorganic chemical water quality data that was obtained from homeowner water supply wells within the Study Area during 1981 and 1982. These data were obtained because the Phase I Study indicated that there was a possibility of a large variation in the inorganic chemical water quality

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TABLE 3

RESULTS OF ORGANIC CHEMICAL ANALYSIS OF WATER FROM PIEZOMETERS

(All Results in ug/l, All Samples Collected in 1982)

		WELL 855			WELL 856			WELL 857			WELL 858			WELL 859			WELL 860			WELL 861			WELL 862		
LABORATORY	Detection Limit	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
RAW, FILTERED OR BAILED		B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B
DATE SAMPLED		8/11	9/10	10/4	8/11	9/10	10/4	8/11	9/10	10/4	8/11	9/10	10/4	8/11	9/10	10/4	8/11	9/10	10/4	8/11	9/10	10/4	8/11	9/10	10/4
1,1,1 Trichloroethane	1	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→
Tetrachloroethylene	1	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→
Methylene Chloride	1	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→
CIS-1,2 Dichloroethylene	1	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→
1,2 Dichloroethane	1	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→
Carbon Tetrachloride	1	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→
Trichloroethylene	1	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→
Freon	5	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→
Benzene	1	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→
Toluene	1	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→
M, P Xylene	1	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→
O, Xylene	1	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→
Chloroform	1	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→	nd		→

W - Westchester County Environmental Laboratory
B - Bailed from well
nd - Not detected at specified detection limit

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TABLE 4

RESULTS OF INORGANIC WATER QUALITY ANALYSES
(All Results in mg/l Except pH)

Sample Location	RUSSELL	STONE			PEREZ			DIMATTEO		SICURELLA	
Date	5-10-82	10-81	8-9-82	9-8-82	5-10-82	8-9-82	9-8-82	8-9-82	9-9-82	5-10-82	8-9-82
Laboratory	Nanco	W	W	W	Nanco	W	W	W	W	Nanco	W
Inorganic Parameters											
Aluminum	NA	NA	NA	< 0.05	NA	NA	< 0.05	NA	< 0.05	NA	NA
Alkalinity											
Carbonate	< 1.	< 1.	< 1.	< 1.	< 1.	< 1.	< 1.	< 1.	< 1.	< 1.	< 1.
Bicarbonate	326.	330.	330.	390.	375.	260.	350.	310.	340.	307.	280.
Total	326.	330.	330.	390.	375.	260.	350.	310.	340.	307.	280.
CA Hardness	247.	NA	260.	240.	221.	220.	210.	210.	203.	212.	210.
Total Hardness	408.	520.	*465.	520.	420.	*409.	580.	*415.	460.	364.	360.
Chloride	5.	390.	170.	240.	17.	33.	32.	44.	50.	47.	53.
Sodium	2.30	210.	130.	160.	13.4	20.	13.	24.	25.	23.9	26.
Manganese	0.05	0.03	0.02	0.03	0.06	0.01	0.02	0.01	< 0.01	0.15	0.02
Magnesium	52.5	50.	50.	53.	54.	46.	54.	50.	52.	43.5	3[illegible].
Iron	0.20	0.04	0.16	0.05	0.20	0.12	0.06	0.12	0.03	< 0.20	0.46
Potassium	0.59	1.4	1.3	1.4	1.2	1.2	1.0	0.64	0.5	1.50	1.2
Sulfate	34.	68.	84.	70.	33.	47.	38.	36.	41.	32.	39.
Fluoride	< 0.10	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Nitrate	7.60	0.6	1.0	1.7	0.2	0.6	1.8	2.6	1.7	2.39	1.6
Nitrite	< 0.04	< 0.01	< 0.01	< 0.01	< 0.04	< 0.01	< 0.01	< 0.01	< 0.01	< 0.04	< 0.01
Ammonia	< 0.01	< 0.05	< 0.05	< 0.05	< 0.10	< 0.05	< 0.05	< 0.05	< 0.05	< 0.10	< 0.05
Other:											
pH	7.36	7.4	6.9	7.0	7.6	7.1	7.0	6.9	6.9	7.55	7.1
TDS	NA	NA	NA	890.	NA	NA	470.	NA	490.	NA	NA

W - Westchester County Environmental Lab.
Nanco - NANCO Laboratory, Hopewell Jct., NY
NA - Not Analyzed
* - Calculated from calcium and magnesium concentrations reported as $CaCo_3$

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TABLE 4 - Cont'd.

RESULTS OF INORGANIC WATER QUALITY ANALYSES
(All Results in mg/l Except pH)

SAMPLE LOCATION	PICANO		FRANK	YEOMANS		GRASSO			TOMASI		STIBBENS		BAKER			MATHLSON	
Date	8-9-82	9-10-82	10-81	8-11-82	9-8-82	5-10-81	8-9-82	9-8-82	10-81	9-8-82	8-9-82	9-8-82	5-10-82	8-9-82	9-9-82	8-9-81	9-9-82
Laboratory	W	W	W	W	W	Nanco	W	W	W	W	W	W	Nanco	W	W	W	W
Inorganic Parameters																	
Aluminum	NA	< 0.05	NA	NA	< 0.05	NA	NA	< 0.05	NA	< 0.05	NA	< 0.05	NA	NA	< 0.05	NA	NA
Alkalinity																	
Carbonate	< 1.	< 1.	< 1.	< 1.	< 1.	< 1.	< 1.	< 1.	< 1.	< 1.	1.	< 1.	< 1.	< 1.	< 1.	< 1.	< 1.
Bicarbonate	280.	290.	250.	200.	250.	314.	330.	310.	260.	300.	220.	250.	282.	210.	260.	200.	190.
Total	280.	290.	250.	200.	250.	314.	330.	310.	260.	300.	220.	250.	282.	210.	260.	200.	190.
CA Hardness	190.	200.	NA	140.	160.	188.	170.	200.	NA	180	180	170.	194.	180.	180.	150.	140.
Total Hardness	340.	360.	340.	250.	320.	368.	330.	380.	350.	420.	280.	340.	339.	320.	360.	250.	280.
Chloride	27.	30.	42.	33.	23.	10.	11.	23.	51.	52.	19.	29.	23.	33.	24.	8.	12.
Sodium	13.	13.	28.	11.	11.	12.8	12.	17.	25.	19.	11.	10.	7.4	11.	9.3	5.8	4.9
Manganese	0.02	0.01	0.01	0.01	0.02	0.09	0.01	0.02	< 0.01	0.02	0.02	0.02	< 0.05	0.02	< 0.01	0.01	0.01
Magnesium	34.	43.	40.	34.	40.	41.5	35.	44.	43.	46.	29.	38.	44.5	41.	28.	30.	30.
Iron	0.09	0.03	0.02	0.15	0.10	< 0.2	0.18	0.08	0.1	0.09	0.11	0.05	< 0.02	0.78	0.21	0.12	0.11
Potassium	1.0	0.8	0.68	0.7	0.7	1.18	1.1	1.0	0.84	1.0	1.3	1.2	1.5	1.5	1.1	0.76	0.5
Sulfate	35.	36.	25.	36.	31.	26.	29.	31.	30.	36.	33.	37.	31.	39.	41.	40.	32.
Fluoride	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
Nitrate	3.7	2.5	1.6	1.5	2.0	3.7	5.0	3.7	0.6	2.1	1.2	1.1	< 0.04	0.1	< 0.1	1.3	1.6
Nitrite	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.04	< 0.01	< 0.01	< 0.01	< 0.01	0.01	< 0.01	0.20	< 0.01	< 0.01	< 0.01	< 0.01
Ammonia	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.1	< 0.05	< 0.05	< 0.05	< 0.05	0.05	< 0.05	< 0.10	< 0.05	< 0.05	< 0.05	< 0.05
Other:																	
pH	7.0	7.2	7.3	6.9	8.0	7.96	6.9	7.1	7.3	7.1	7.3	7.3	7.53	6.9	7.4	7.4	7.3
TDS	NA	420	NA	NA	330.	NA	NA	410.	NA	440.	NA	380.	NA	NA	390	NA	270.

W - Westchester County Environmental Lab.
Nanco - NANCO Laboratory, Hopewell Jct., NY
NA - Not Analyzed

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of water from several homeowner wells. It was anticipated that if this variation was confirmed, it could be used as an in-place tracer of groundwater movement. Unfortunately, a review of the data did not reveal any definitive inorganic chemical water quality gradients and therefore this data could not be used for the intended purpose. It is provided in this Report for general information purposes and any benefit that may be derived by the owners of the sampled wells.

B. Septage Sampling

The Phase I Report identified subsurface sewage disposal systems as a possible means of conveyance of contaminants into the groundwater system. The Phase I literature search did not reveal any organic chemical analytical results for septic tank sludge. Therefore, to obtain some data regarding this possibility, sludge from a septic tank in the Study Area was sampled and analyzed for the same organic chemicals for which homeowner water supplies were analyzed under the Health Department coordinated sampling program. A second septic tank, that is located in the Town of Fishkill, was also sampled.

It was theorized that the highest concentrations of organics would be found near the bottom of the septic tank because the organic solvents are heavier than water and only slightly soluble in water. Also, the affinity of organic solvents for the natural organic material found in septic tank sludge suggested that the higher density of solids near the bottom of the tank would lend to greater mass of organic solvents near the bottom of the tank. To test these theories, two samples were collected from a septic tank in the Study Area. One of these was an undisturbed sample from the

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bottom of the tank and the other sample was from the top of the tank after it had been completely mixed. The results of these samples are provided in Table 5. It is noted that the bottom sample contained higher concentrations of each identified organic chemical than the sample that was collected after mixing.

A second septic tank was also sampled. In this case, a sample was collected near the surface of the tank and then a second sample was collected after the tank had been completely mixed. This sampling technique was chosen because it took less equipment and much less time than the technique used at the Smith/Tomasi residence resulting in less inconvenience to the homeowner and the cooperating septic tank hauler. The results of these analyses are also provided in Table 5. They show that higher concentrations of two dichlorobenzene compounds were found in the mixed sample than were found in the surface sampling. These data support the initial thesis that, if present, higher concentrations of organic solvents will be found near the bottom of the septic tank.

These data are limited because only two septic tanks were sampled. For this reason it is impossible to predict the organic chemical quality of sludge from a "typical" septic tank. The data are useful because they show that some septic tanks contain the same compounds that have been found in water supply wells in the "Study Area". In this sense, these data support the findings of the literature search that subsurface disposal systems are a possible means of conveyance of organic chemicals into the groundwater system.

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TABLE 5

SEPTAGE SAMPLE RESULTS

SMITH/TOMASI RESIDENCE	CONCENTRATION, ug/kg (wet weight)	
Organic Chemical	Bottom Sample	Mixed Sample
Chloroform	4.2	< 1.
Trichloroethylene	1.1	< 1.
Tetrachloroethylene	4.2	1.1
Methylene Chloride	47.	42.
1,1 Dichloroethane	92.	39.

HOUSEHOLD IN TOWN OF FISHKILL	CONCENTRATION, ug/kg (wet weight)	
Organic Chemical	Top Sampling	Mixed Sample
m-Dichlorobenzene	< 10.	105,000.
o,p'-Dichlorobenzene	< 10.	180,000.
Toluene	13.	410.

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C. Groundwater Flow Regime

The Phase I Report concluded that the organic chemicals that have been found in water supplies in the Study Area are dissolved in the groundwater. The report also concluded that the primary transport mechanism of these compounds is groundwater flow. It is logical then, that definition of the groundwater flow regime is prerequisite to a determination of whether or not IBM's East Fishkill facility is the source of the organic chemicals that have been found in the homeowner wells in the Study Area.

Groundwater will always move from areas of higher groundwater elevation to areas of lower groundwater elevation. The rate of groundwater movement is dependent on the slope of the groundwater table (or piezometric surface) and the physical characteristics of the soil or rock through which the groundwater moves. Three different types of data have been used to define the groundwater flow regime for the Study Area - a review of the geology of the area was made, a pump test of the Frank well was performed and finally, the groundwater piezometric surface of the Study Area was established and interpreted.

1. Surfacial Geology

A geological review of the Study Area was made to identify any geological characteristics that would influence groundwater flow. This evaluation revealed:

a). no geologic structural features that directly influence groundwater movement from IBM's site to the east.

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b). that the principle lines of structural disconformity (faults, bedding plane strike or major joint sets) trend between north 10° east and north 20° east.

c). that the most common bedding plane dip is to the east.

d). that the bedrock is complexly folded and faulted.

2. Frank Well Pump Test

Piezometers were installed to generate data that would allow development of a flow regime for the Study Area in which there is a high degree of confidence. The surfacial geological survey and the data from the Phase I Report were used to select the locations of the piezometers that were installed during Phase II. One piezometer set was installed on Lime Kiln Road, two sets were installed on Shenandoah Road and a fourth piezometer set was installed on IBM's recreational center property.

Proper interpretation of the data and development of the flow regime for the Study Area is made by evaluating data from piezometers that are known to be hydraulically interconnected. Hydraulic interconnections are established by evaluating the response of the piezometric surface of several piezometers to a pump test. For example, the lowering of the piezometric surface of a piezometer as a result of pumping a nearby well is evidence of a hydraulic interconnection. Similarly, the lowering of the piezometric surfaces of two wells as a result of pumping a third nearby well is evidence that all three are hydraulically interconnected. Other evidence of hydraulic

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interconnection is similar piezometer response to aquifer wide phenomena. For example, similar elevation trends in the piezometric surface within an area due to seasonal or other variations in in groundwater level are also evidence of hydraulic interconnections.

The Frank homeowner well was pumped for a period of 48 hours to establish identifiable hydraulic interconnection within the Study Area. A pump rate of 40.8 gpm was maintained during the first 24 hours resulting in a drawdown within the Frank's well of 4.75 feet. The pump rate was increased after approximately 24 hours to 59.0 gpm resulting in a total drawdown of 9.08 feet after 48 hours of pumping. Throughout the pump test, the water elevation in 14 piezometers was measured. Additionally, the water level in two nearby homeowner wells was monitored during the pump test to make sure that pumping the Frank well did not jepordize domestic supplies.

Based on the results of this pump test, a review of the piezometric surface data and a review of the surfacial geology of the Study Area, it is concluded that the piezometers in the Study Area are hydraulically interconnected. Tables 6 and 7 provide the rationale for making this determination for each of the piezometers listed. The strongest evidence of a hydraulic interconnection is a piezometric surface response to a pump test. There is greater uncertainty in the determination when it is based on piezometric surface elevation trends or solely on a review of the surfacial geology. Therefore, the piezometric surface data that has been

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generated from the piezometers within the "Study Area" is comparable and usable in formulating a reliable groundwater flow regime.

3. Piezometric Surface and Flow Regime

The piezometric surface within the Study Area was established for August, September and October by measuring the water level in piezometers within the Study Area. The elevation of water in each piezometer was plotted on a map of the Study Area. Contour lines of equal piezometric surface elevations were then constructed on this map resulting in a "contour map" of the piezometric surface of the Study Area. The direction of groundwater flow within the Study Area was developed from this "contour map" by constructing flow direction arrows that are normal to the contours. These data are provided in Figure 2, 3, 4, 5, 6 and 7.

These Figures also show the location of the piezometers that were installed during Phase II and the other piezometers that were used to generate these flow regimes. In these Figures, Route 52 is at the top of the page, Lime Kiln Road is in the center of the page and IBM's recreational facility is shown in the lower right hand corner. Finally, the relative locations of the Frank, Perez, Stone and DiMatteo residences are shown.

Figures 2, 3 and 4 show respectively the piezometric surface maps for August, September and October, 1982 for the shallow aquifer. As discussed earlier in this report, the shallow aquifer piezometers are screened at approximately

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TABLE 6

SHALLOW PIEZOMETERS BELIEVED TO BE HYDRAULICALLY INTERCONNECTED

Piezometer		Reason for Determination		
Number	Location	Frank Pump Test	Piezometric Surface Data	Surfacial Geology
89	Lime Kiln Road (South)	yes	yes	yes
164	IBM Rec Center	yes	yes	yes
166	Lime Kiln Road (north)	no	yes	yes
855	IBM Rec Center	no	yes	yes
857	Lime Kiln Road (Middle)	yes	yes	yes
859	Shenandoah Road (Picano)	yes	yes	yes
861	Shenandoah Road (Baker)	yes	yes	yes

TABLE 7

DEEP PIEZOMETERS BELIEVED TO BE HYDRAULICALLY INTERCONNECTED

Piezometer		Reason for Determination		
Number	Location	Frank Pump Test	Piezometric Surface Data	Surfacial Geology
90	Lime Kiln Road (South)	no	yes	yes
165	IBM Rec Center	yes	yes	yes
167	Lime Kiln Road (north)	no	yes	yes
856	IBM Rec Center	no	yes	yes
858	Lime Kiln Road (Middle)	no	no	yes
860	Shenandoah Road (Picano)	yes	yes	yes
862	Shenandoah Road (Baker)	yes	yes	yes

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the same elevation as the homeowner wells that are located on south Shenandoah Road (see Table 2). This is important because the flow of groundwater to those individual wells is likely to be predicted from the shallow piezometer data.

Figure 2 shows that the lowest piezometric surface elevations are on IBM's East Fishkill site. Piezometric surface elevations increase as one proceeds south from the IBM facility. A "mound" in the piezometric surface was also observed in the vicinity of piezometer 857 near Gate 4 (Intersection of Lime Kiln Road and Development Drive).

The red arrows show the flow regime that was developed using the previously described technique. North of gate 4, all of the groundwater in the Study Area was determined to be moving onto the IBM facility. Along Route 52, groundwater was determined to be moving southward across Route 52 and in the east, groundwater was determined to be moving westward across Lime Kiln Road. South of Gate 4, a groundwater divide was observed in the vicinity of Lime Kiln Road. In a general sense, groundwater east of Lime Kiln Road was determined to be moving to the east or northeast and groundwater west of Lime Kiln Road was determined to be moving to the west or northwest.

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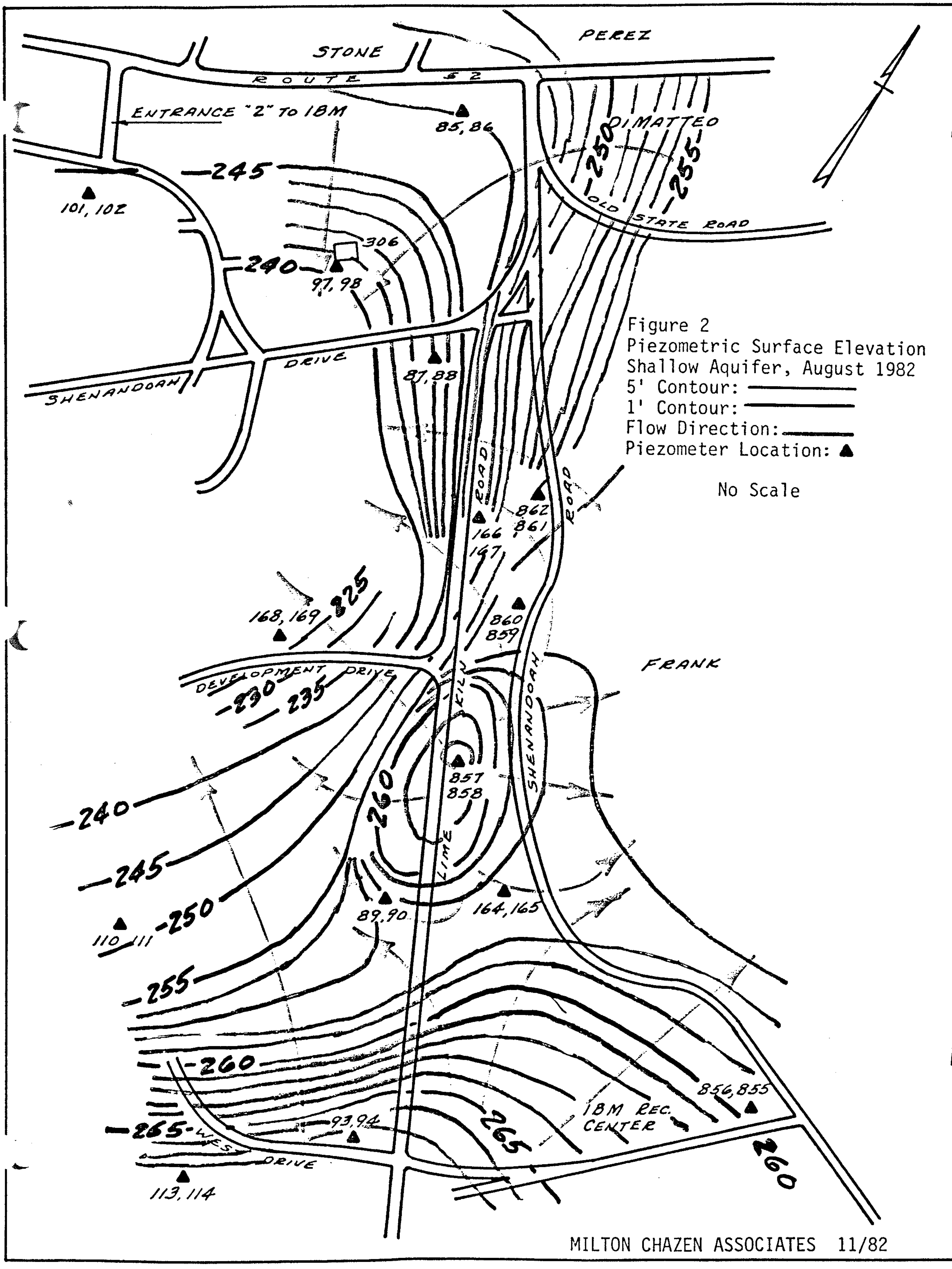

Figure 2
Piezometric Surface Elevation
Shallow Aquifer, August 1982
5' Contour:
1' Contour:
Flow Direction:
Piezometer Location: ▲

No Scale

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Figure 3 shows a general decline in the piezometric surface at each of the piezometers that were used to establish the groundwater flow regime. The decrease in the piezometric surface for the Phase II piezometers ranged between 0.3 feet and 2.2 feet between August and September. Despite this decrease in the piezometric surface, the flow regime in September was the same as the flow regime that was observed for August. Notably, south of Gate 4, the groundwater divide continued to exist in the vicinity of Lime Kiln Road.

Figure 4 shows a continued decline in the piezometric surface at each of the piezometers that were used to establish the groundwater flow regime. Of the Phase II piezometers, the greatest decrease in the piezometric surface elevations occurred in piezometers 857 and 859 with decreases of 4.5 feet and 3.6 feet respectively. Decreases of 0.9 feet and 1.8 feet were observed in piezometers 855 and 861 respectively. These differential decreases caused a different flow regime to evolve south of Gate 4 during October. The Figure shows the absence of the divide that previously existed in the vicinity of southern Lime Kiln Road. From this Figure, groundwater flow north of gate 4 was determined to be moving southward and westward onto the IBM facility. South of Gate 4 most of the groundwater was determined to be moving north and northwestward onto the IBM site. In the extreme east, near piezometers

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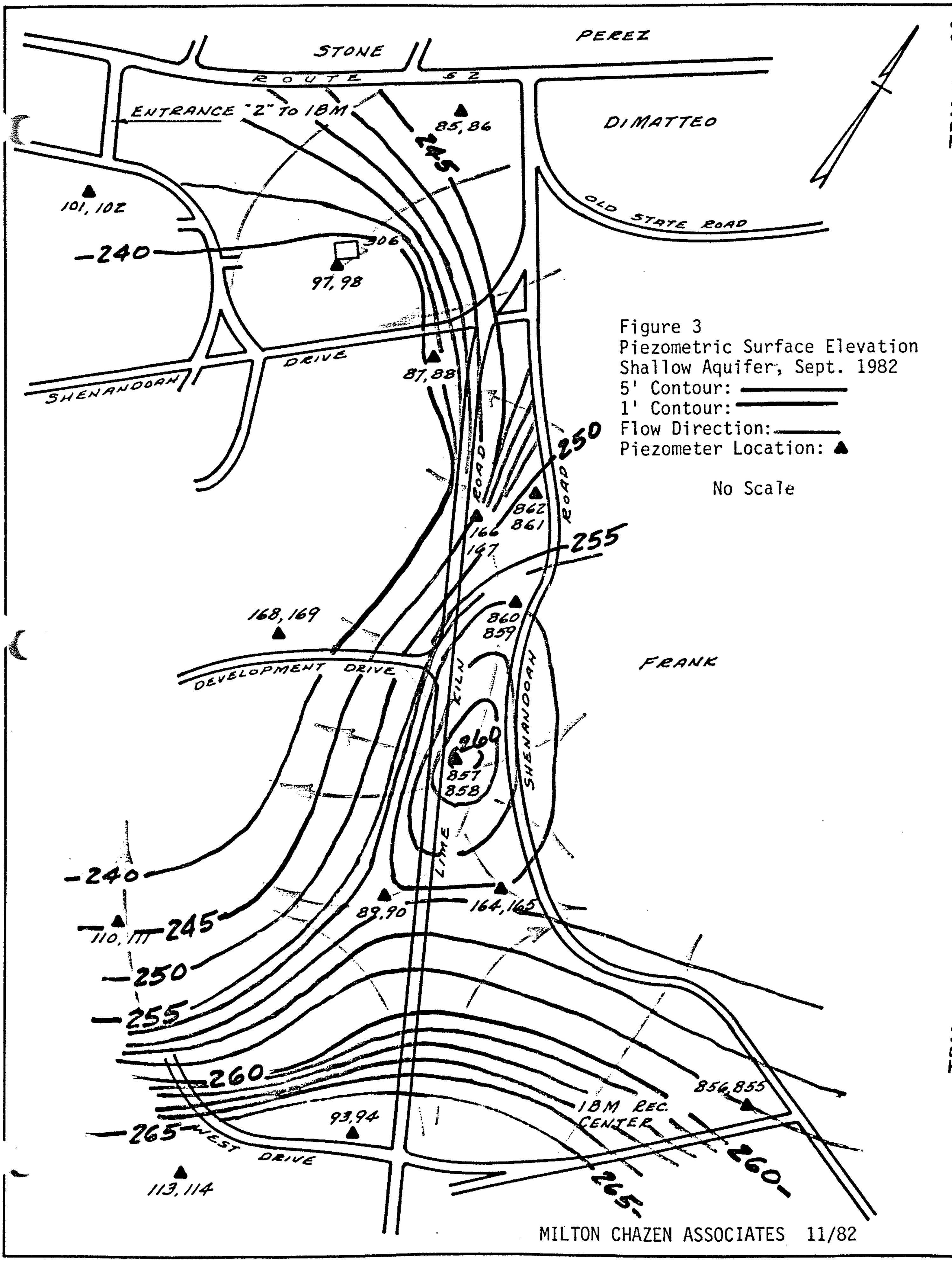

Figure 3
Piezometric Surface Elevation
Shallow Aquifer, Sept. 1982
5' Contour:
1' Contour:
Flow Direction:
Piezometer Location: ▲

No Scale

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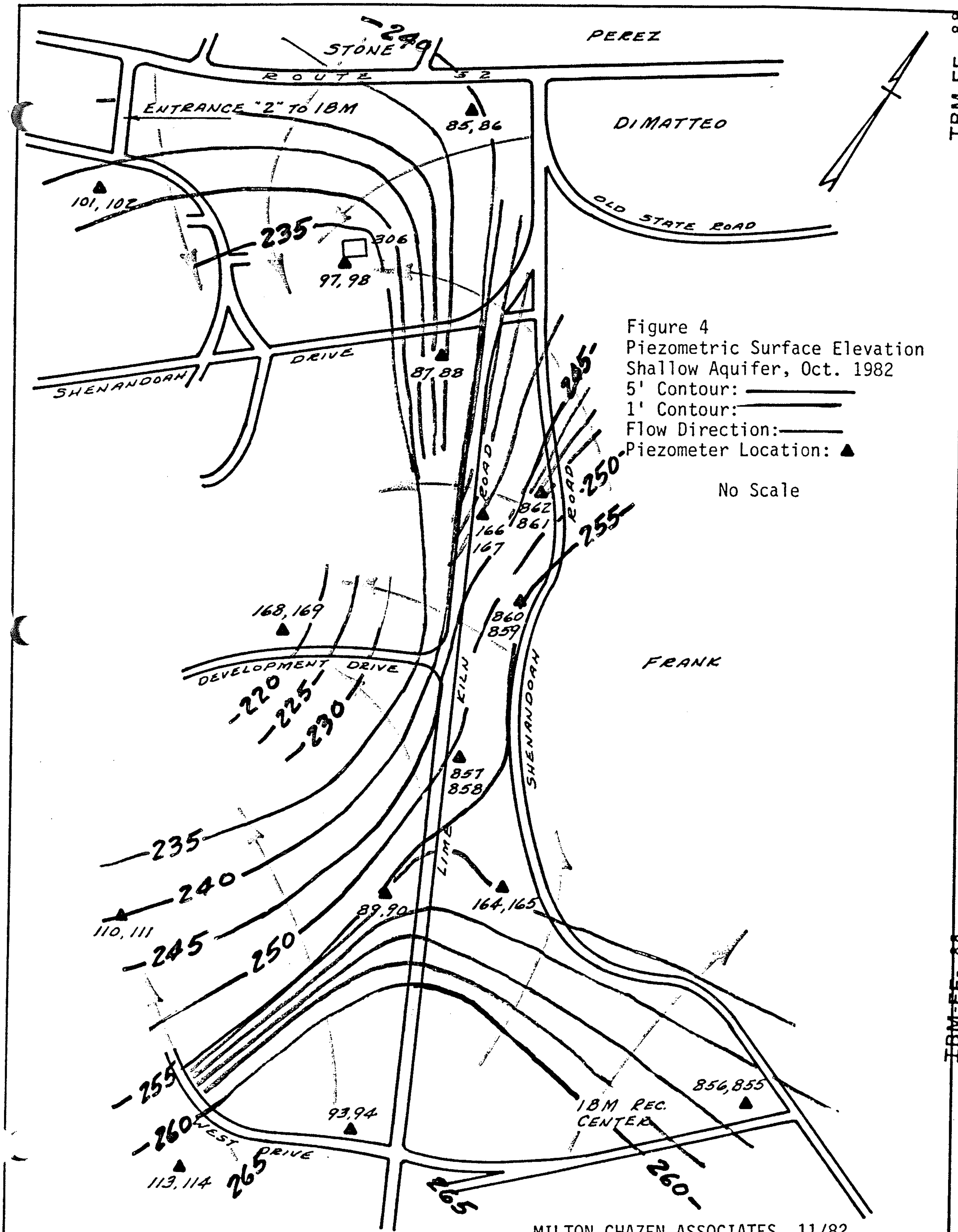

Figure 4
Piezometric Surface Elevation
Shallow Aquifer, Oct. 1982
5' Contour:
1' Contour:
Flow Direction:
Piezometer Location: ▲

No Scale

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855 and 856, groundwater flow is believed to be moving to the northeast. Consequently the groundwater divide that existed during August and September along Lime Kiln Road shifted eastward onto the recreation center property during October.

Figure C-1, which is provided in Appendix C, shows the changes that occurred in the piezometric surface elevations between March and October 1982 for all of the shallow bedrock piezometers that were used to generate Figures 2,3,and 4. This Figure shows that the same general trends of rising and lowering of the piezometric surface occurred in each of the piezometers within the Study Area throughout this period.

Figures 5,6 and 7 show the groundwater flow regimes for the deep aquifer for August, September and October 1982. These Figures were developed using the same technique that was previously described. Figure 5 shows groundwater north of Gate 4 to be moving onto the IBM facility from the north and northwest across Route 52 and from the east across Lime Kiln Road. A groundwater "mound" was identified near piezometer 858 in the vicinity of Gate 4. Groundwater moves westward from this "mound" onto the IBM site and eastward toward Shenandoah Road. Further south along Lime Kiln Road, flow is generally northwestward west of Lime Kiln Road and northeastward east of Lime Kiln Road.

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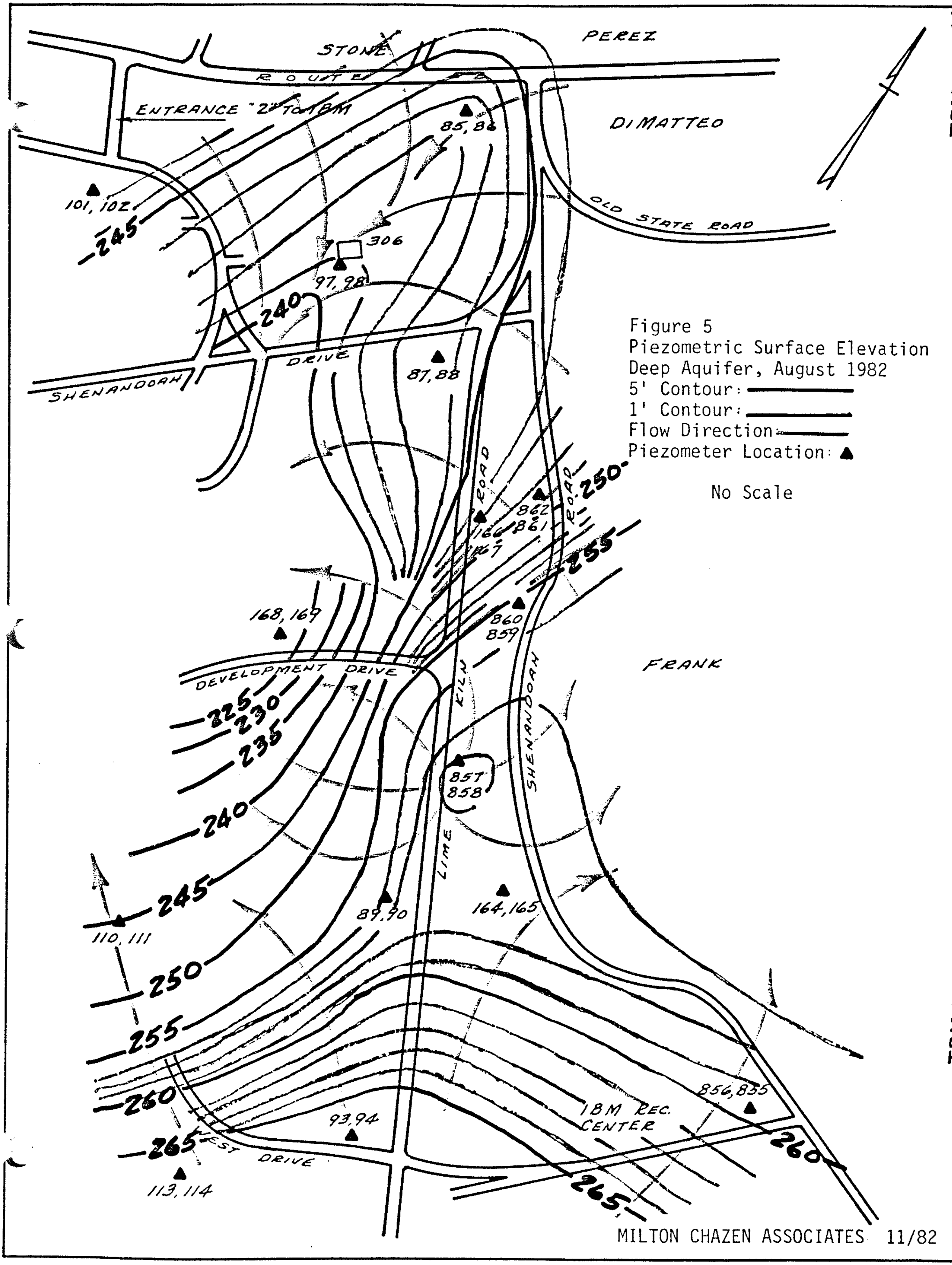

Figure 5
Piezometric Surface Elevation
Deep Aquifer, August 1982

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Figure 6 shows a general decline in the piezometric surface between August and September. Of the Phase II piezometers, the greatest decrease in the piezometric surface elevation occurred in piezometer 858 with a lowering of 1.6 feet. Decreases of 0.7 and 0.4 feet were observed in piezometer 856 and 860 respectively. The piezometric surface elevation of piezometer 862 increased 0.3 feet. These differentials in elevation change caused a different flow regime to evolve south of Gate 4 for September. Figure 6 shows the absence of the divide that previously existed in the vicinity of southern Shenandoah Road. From this Figure, groundwater flow north of Gate 4 was determined to be moving southward and westward onto the IBM facility. South of Gate 4, the groundwater was determined to be moving north and northwestward onto the IBM Site.

Figure 7 shows a continued decline in the piezometric surface during October at each of the piezometers that were used to establish the groundwater flow regime. The decrease in the piezometric surface for the Phase II piezometers ranged between 1.0 and 3.5 feet between September and October. Despite this decrease in the piezometric surface, the flow regime in October was the same as the flow regime that was observed for September. Notably, south of Gate 4, groundwater was determined to be moving north and northwestward onto the IBM site. North of Gate 4, groundwater was determined to be moving southward across Route 52 and westward across Lime Kiln Road onto the IBM site.

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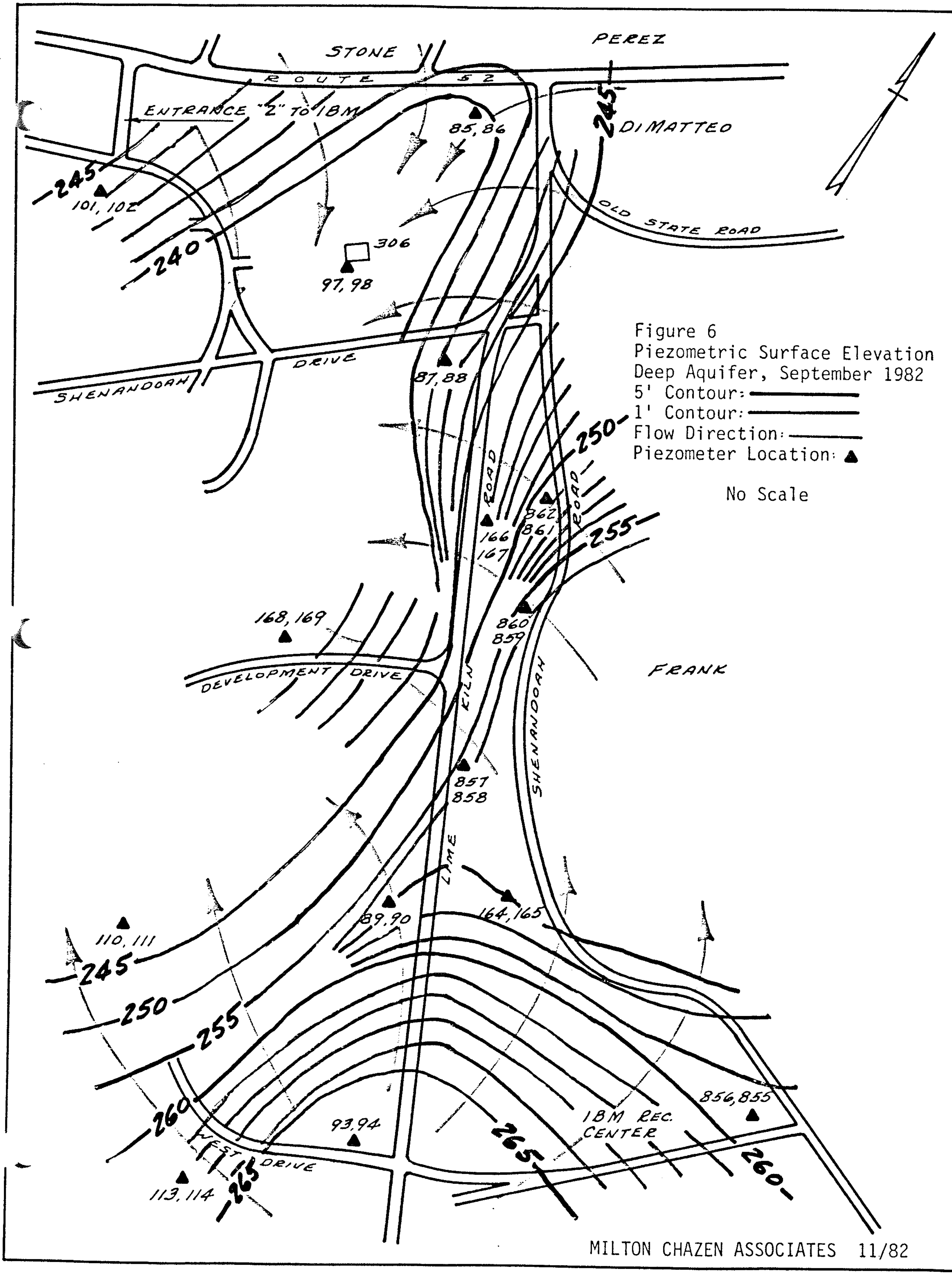

Figure 6
Piezometric Surface Elevation
Deep Aquifer, September 1982
5' Contour:
1' Contour:
Flow Direction:
Piezometer Location: ▲

No Scale

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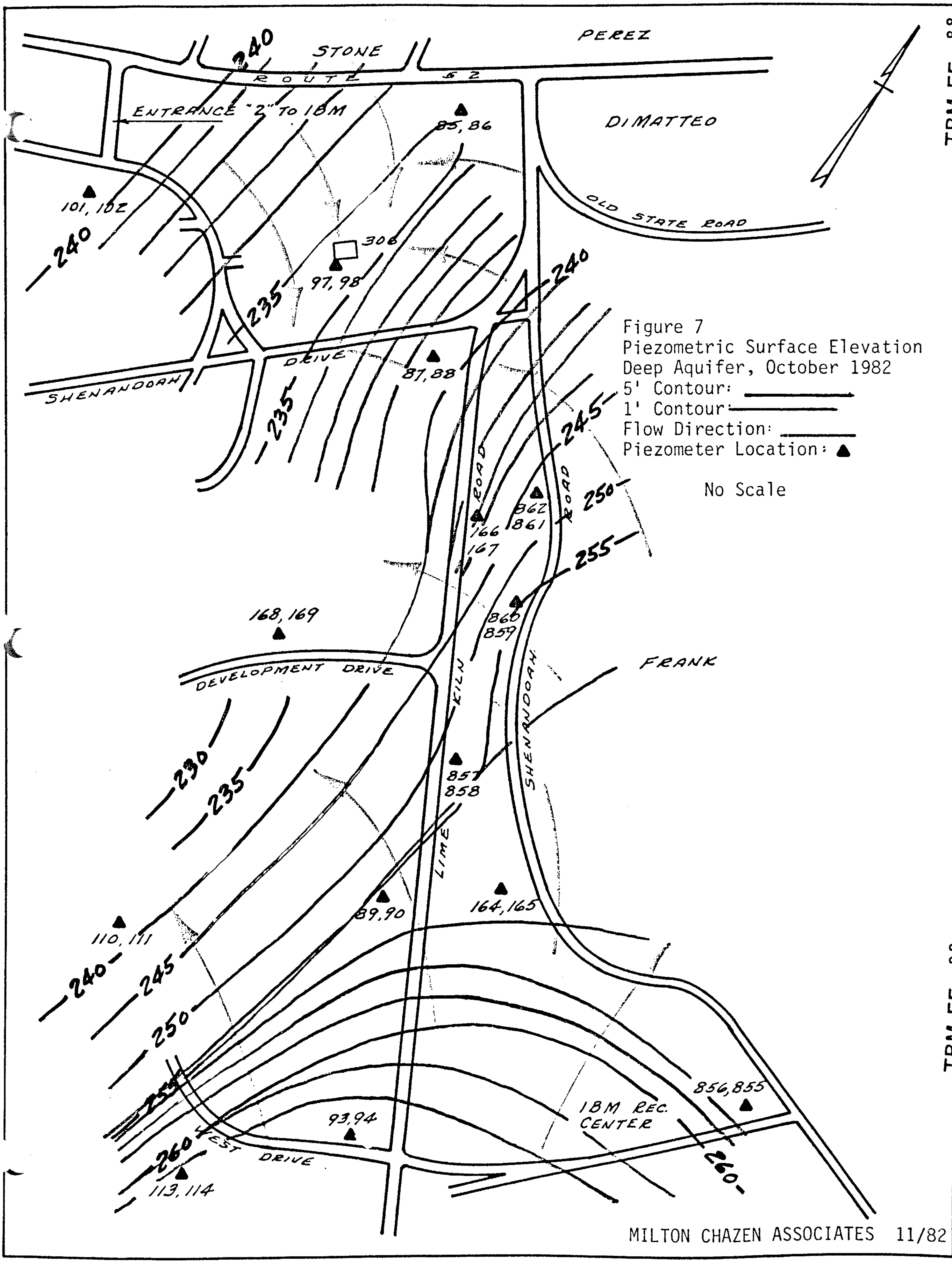

Figure 7
Piezometric Surface Elevation
Deep Aquifer, October 1982
5' Contour:
1' Contour:
Flow Direction:
Piezometer Location: ▲

No Scale

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Figure C-2 of Appendix C, shows the changes that occurred in the piezometric surface elevations between March and October 1982 for all of the deep bedrock piezometers that were used to generate Figures 5, 6 and 7. This Figure shows that the same general trends of rising and lowering of the piezometric surface occurred in each of the piezometers within the Study Area during this period.

The groundwater flow data presented in this section of the report supports the conclusion that the predominant direction of groundwater flow within the Study Area is toward IBM's East Fishkill facility. Also, groundwater was not found to be flowing from IBM's East Fishkill site into the Study Area. These conclusions have been reached for both the shallow and deep aquifers.

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IV. OVERALL REPORT CONCLUSIONS

The following conclusions regarding the organic chemicals that have been found in homeowner wells within the Study Area have resulted from this investigation.

1. The concentrations of organic chemicals that have been found in homeowner wells in the Study Area have decreased between early 1981 and the fall of 1982. A discussion of the data that supports this conclusion is provided in Section III.A.1. of this Report.

2. The organic chemicals that have been found in the Smith/Tomasi, Grasso and Frank wells are not the result of a single release of organic chemicals to the environment because:

   a). The same chemicals are not found in each contaminated well and

   b). all of the wells and piezometers that are downgradient of a contaminated well are not contaminated. This indicates that there is no widespread contaminant plume in the Study Area.

3. Groundwater movement is the major transport mechanism for the organic chemicals that have been found in homeowner wells in the Study Area because the concentrations of chemicals that have been found are far below the saturation concentrations. Based on this, an accurate development of the groundwater flow regime for the Study Area can be used to determine whether or not IBM's onsite groundwater problems are the cause of the organic chemicals that have been found in homeowner wells in the Study Area.

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4. The predominant direction of groundwater flow in the Study Area in both the shallow bedrock and the deep bedrock aquifers is toward IBM's East Fishkill facility. Additionally, throughout the Study period, groundwater was not found to be flowing from IBM's East Fishkill site into the Study Area.

a). In the Binnewater Road and Route 52 area for August, September and October 1982, groundwater flowed from the north across Route 52 and from the east across Lime Kiln Road toward IBM's East Fishkill facility. A discussion of the data that supports this conclusion is provided in Section III. C.3. of this Report.

b). In the southern Shenandoah Road area for August and September 1982, a groundwater divide existed along Lime Kiln Road in the shallow bedrock aquifer. During this period, groundwater flow west of Lime Kiln Road was moving to the west and groundwater flow east of Lime Kiln Road was flowing to the east. For August 1982 a similar divide existed along Lime Kiln Road in the deep bedrock aquifer. During October 1982 for the shallow bedrock aquifer and during September and October 1982 for the deep bedrock aquifer, the groundwater divide did not exist. During this period, flow throughout the Study Area was toward IBM's East Fishkill facility.

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5. The types of chemicals that have been found in wells within the Study Area were also found in septage samples from two septic tanks. In each case, higher concentrations of chemicals were determined to be nearer the bottom of the tank than the top.

6. IBM's on-site groundwater problems are not the cause of the organic chemicals that have been found in homeowner wells in the Study Area because:

a). groundwater was not found to be flowing from IBM's East Fishkill site into the Study Area and

b). the organic chemicals that have been found in all of the homeowner wells are not the result of a single release of chemicals to the environment.

7. The sanitary survey that was conducted during Phase I and the interviews of homeowners and County and local officials did not reveal the existence of any roadside dumps or illegal discharge points by waste haulers within the Study Area.

8. Based on all of the above; it is concluded that the most likely sources of the organic chemicals that have been found in homeowner wells are on premises use or disposal of common household products that contain these compounds.

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APPENDIX A

HOMEOWNER LOCATION MAP

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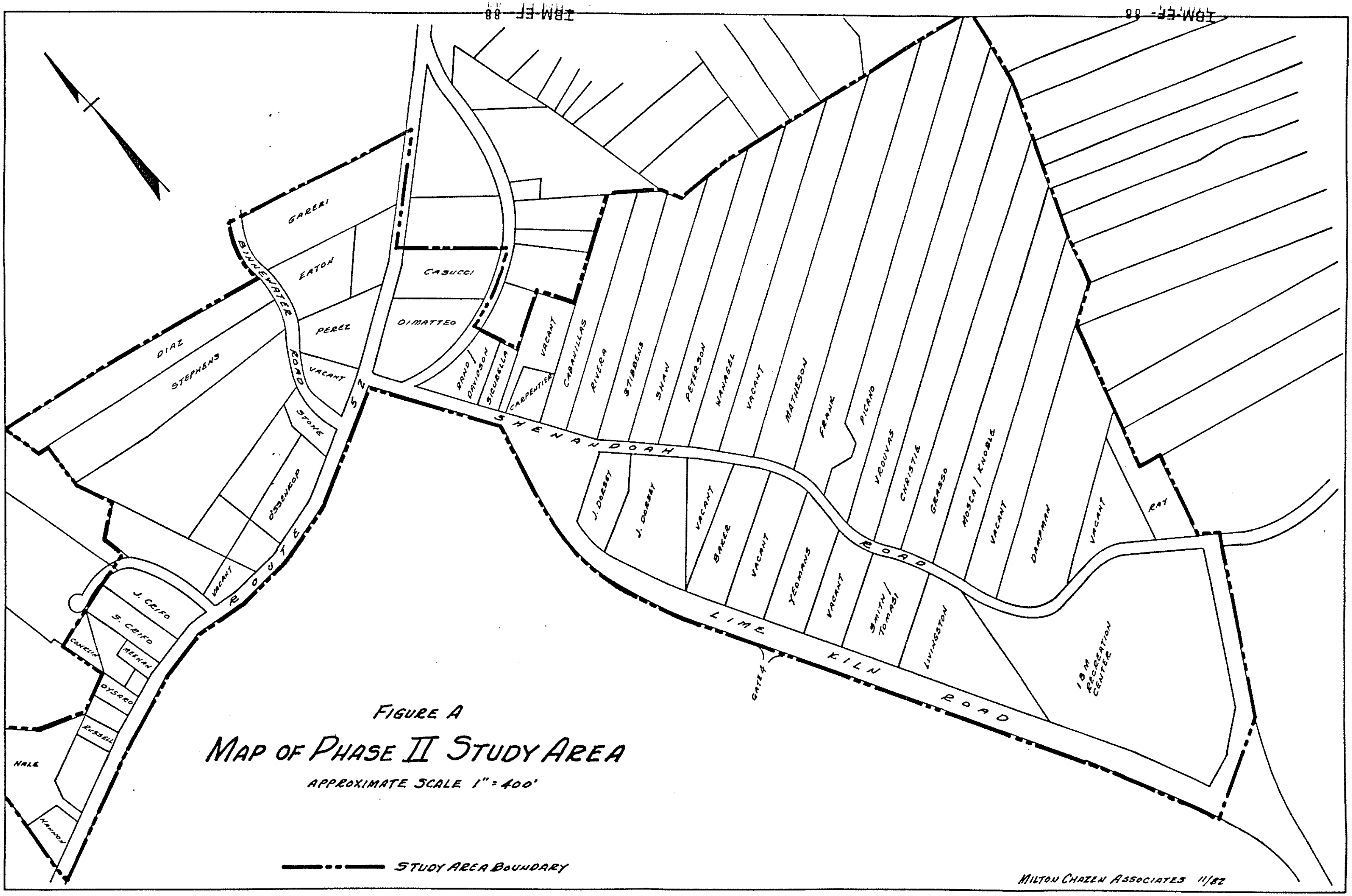

FIGURE A

MAP OF PHASE II STUDY AREA

APPROXIMATE SCALE 1" = 400'

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APPENDIX B

RESULTS OF THE HEALTH DEPARTMENT COORDINATED SAMPLING PROGRAM

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Appendix B-1

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RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING
(All Results in ug/l)

(Sample Collected in 1981)

LABORATORY	Detection Limit	G	G	G	HD	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
		FRANK RESIDENCE																												
RAW, FILTERED OR BAILED		R	R	F	R	R	F	R	F	R	F	R	F	R	F	R	F	R	F	F	R	F	B	R	F	R	F	F	R	F
DATE SAMPLED		1/29	2/5	2/11	2/5	4/14	4/14	5/19	5/19	5/20	5/20	5/20	5/20	6/2	6/2	7/7	7/7	8/11	8/11	8/11	9/1	9/1	10/15	10/6	10/6	11/3	11/3	11/3	11/2	11/23
1,1,1 Trichloroethane	1	7	nd	nd	13	2.8	nd	1.8	nd	1.3	nd	1.7	nd	nd	nd	1.1	nd	→												
Tetrachloroethylene	1	10	24	nd	25	nd	nd	2.8	60	3.4	65	3.8	nd	3.0	nd	8.6	nd	2.6	nd	nd	nd	nd	2.2	nd	nd	2.4	nd	nd	3.0	nd
Methylene Chloride 1	1	nd	→																											
CIS-1,2 Dichloroethylene 2	1	nd	→																											
1,2 Dichloroethane	1	nd	→																											
Carbon Tetrachloride	1	nd	→																											
Trichloroethylene	1	nd	→																											
Freon 3	5	nd	→																											
Benzene	1	nd	→																											
Toluene	1	nd	→																											
M, P Xylene	1	nd	→																											
O, Xylene	1	nd	→																											
Chloroform	1	nd	→						2.1	nd	1.6	nd	→																2.0	nd

1 Some samples were reported to have a detection limit of 2 ug/l
2 Some samples were reported to have a detection limit of 3 ug/l
3 Some samples were reported to have a detection limit of 10 ug/l
G Gollob Analytical Service
HD New York State Department of Health Lab
W Westchester County Environmental Laboratory
B Bailed from well

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APPRNDIX B-1 Cont'd

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING
(All Results in ug/l)

FRANK RESIDENCE

LABORATORY	Detection Limit	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
RAW, FILTERED OR BAILED DATE SAMPLED		R 12/81	F 12/81	R 1/82	F 1/82	R 2/82	F 2/82	R 3/82	F 3/82	R 4/82	F 4/82	R 5/82	F 5/82	R 6/82	F 6/82	R 7/82	F 7/82	R 8/82	F 8/82
1,1,1 Trichloroethane	1	1.2	nd	2.0	nd														
Tetrachloroethylene	1	nd	nd	1.7	nd	5	nd	nd	nd	1.3	nd								
Methylene Chloride	1	nd											4.8	nd					
CIS-1,2 Dichloroethylene	1	nd																	
1,2 Dichloroethane	1	nd																	
Carbon Tetrachloride	1	nd																	
Trichloroethylene	1	nd																	
Freon	5	nd																	
Benzene	1	nd												*	nd				
Toluene	1	nd																	
M, P Xylene	1	nd																	
O, Xylene	1	nd																	
Chloroform	1	10.0	nJ																

W - Westchester County Environmental Laboratory
nd - Not detected at specified detection limit
* - p-Dichlorobenzene found at 9 and 4.1 ug/l respectively in duplicate samples

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Appendix B-2

MILTON CHAZEN ASSOCIATES

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING
(All Results in ug/l)

(Sample Collected in 1981)

LABORATORY		PEREZ RESIDENCE																								
	Detection Limit	G	G	G	HD	G	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
RAW, FILTERED OR BAILED		R	R	F	R	R	R	F	R	F	R	F	R	F	R	F	F	R	F	R	F	R	F	F	R	F
DATE SAMPLED		2/5	1/28	2/11	2/5	2/5	4/7	4/7	5/12	5/12	6/23	6/23	7/21	7/21	8/4	8/4	8/4	9/16	9/16	10/20	10/20	11/10	11/10	11/10	12/1	12/1
1,1,1 Trichloroethane	1	51	65	nd	58	51	20	nd	6.7	nd	nd	nd	9.2	nd	12	nd	nd	19	nd	9.4	nd	12	nd	nd	5.8	nd
Tetrachloroethylene	1	nd	→	→	→	→	→	→	→	→	→	1.6	nd	1.6	nd	1.8	nd	→	→	→	→	→	→	→	→	→
Methylene Chloride [1]	1	nd	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
CIS-1,2 Dichloroethylene	1	nd	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
1,2 Dichloroethane	1	nd	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Carbon Tetrachloride	1	nd	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Trichloroethylene	1	nd	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Freon [3]	5	nd	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Benzene	1	nd	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Toluene	1	nd	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
M, P Xylene	1	nd	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
O, Xylene	1	nd	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→	→
Chloroform	1	nd	→	→	→	→	→	→	→	→	→	→	→	→	→	1.3	nd	→	→	→	→	→	→	→	→	→

1 Some samples were reported to have a detection limit of 2 ug/l
2 Some samples were reported to have a detection limit of 3 ug/l
3 Some samples were reported to have a detection limit of 10 ug/l
G Gollob Analytical Service
HD New York State Department of Health Lab
W Westchester County Environmental Laboratory
B Bailed from well

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APPENDIX B-2 Cont'd

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING
(All Results in ug/l)

PEREZ RESIDENCE

LABORATORY	Detection Limit	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
RAW, FILTERED OR BAILED		R	F	R	F	R	F	R	F	R	F	R	F	R	F	R	F	R	F
DATE SAMPLED		1/82	1/82	2/82	2/82	3/82	3/82	4/82	4/82	5/82	5/82	6/82	6/82	7/82	7/82	8/82	8/82	9/82	9/82
1,1,1 Trichloroethane	1	nd	nd	1.6	nd													1.2	nd
Tetrachloroethylene	1	nd																	
Methylene Chloride	1	nd																	
CIS-1,2 Dichloroethylene	1	nd																	
1,2 Dichloroethane	1	nd																	
Carbon Tetrachloride	1	nd																	
Trichloroethylene	1	nd																	
Freon	5	nd																	
Benzene	1	nd																	
Toluene	1	nd																	
M, P Xylene	1	nd																	
O, Xylene	1	nd																	
Chloroform	1	nd																	

W - Westchester County Environmental Laboratory
nd - Not detected at specified detection limit

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Appendix B-3

MILTON CHAZEN ASSOCIATES

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING
(All Results in ug/l)

(Sample Collected in 1981)

LABORATORY	Detection Limit	STONE RESIDENCE																								
		G	G	G	G	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
RAW, FILTERED OR BAILED		R	R	F	F	R	F	R	F	R	F	R	F	R	F	F	R	F	B	R	F	R	F	F	R	F
DATE SAMPLED		2/3	2/1	2/17	2/19	4/21	4/21	5/12	5/12	6/30	6/30	7/28	7/28	8/11	8/11	8/11	9/22	9/22	10/15	10/27	10/27	11/10	11/10	11/10	12/8	12/8
1,1,1 Trichloroethane	1	10	10	nd										1.7	nd											
Tetrachloroethylene	1	nd													1.3	nd										
Methylene Chloride 1	1	nd																								
CIS-1,2 Dichloroethylene 2	1	nd																								
1,2 Dichloroethane	1	nd																								
Carbon Tetrachloride	1	nd																								
Trichloroethylene	1	nd																								
Freon 3	5	nd																								
Benzene	1	nd																								
Toluene	1	nd																								
M, P Xylene	1	nd																								
O, Xylene	1	nd																								
Chloroform	1	nd															1.3	nd								

1 Some samples were reported to have a detection limit of 2 ug/l
2 Some samples were reported to have a detection limit of 3 ug/l
3 Some samples were reported to have a detection limit of 10 ug/l
G Gollob Analytical Service
HD New York State Department of Health Lab
W Westchester County Environmental Laboratory
B Bailed from well

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APPENDIX B-3 Cont'd

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING

(All Results in ug/l, Sample Collected in 1982)

STONE RESIDENCE

		W R 1/82	W F 1/82	W R 2/9	W F 2/9	W F* 2/9	W R 2/10	W F 2/10	W F* 2/10	W R 2/16	W F 2/16	W R 3/82	W F 3/82	W R 4/82	W F 4/82	W R 5/82	W F 5/82	W R 6/82	W F 6/82	W R 7/82	W F 7/82	W R 8/82	W F 8/82
1,1,1 Trichloroethane	1	nd																					
Tetrachloroethylene	1	nd																					
Methylene Chloride	1	nd				18	nd	nd	1.2	nd													
CIS-1,2 Dichloroethylene	1	nd																					
1,2 Dichloroethane	1	nd																					
Carbon Tetrachloride	1	nd																					
Trichloroethylene	1	nd																					
Freon	5	nd																					
Benzene	1	nd																					
Toluene	1	nd																					
M, P Xylene	1	nd																					
O, Xylene	1	nd																					
Chloroform	1	nd																					

W - Westchester County Environmental Laboratory
nd - Not detected as specified detection limit
* - New filter installed

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APPENDIX B-4

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING
(All Results in ug/l)

(Sample Collected in 1981)

LABORATORY	Detection Limit	DIMATTEO RESIDENCE G	HD	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
RAW, FILTERED OR BAILED		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
DATE SAMPLED		1/29/81	1/29/81	4/7/81	5/5/81	6/2/81	7/7/81	8/25/81	9/8/81	10/27/81	11/10/81	12/1/81	1/82	2/82	3/82	4/82	5/82	6/82	7/82	8/82	9/82
1,1,1 Trichloroethane	1	nd																			
Tetrachloroethylene	1	nd																			
Methylene Chloride [1]	1	nd																			
CIS-1,2 Dichloroethylene	1	nd																			
1,2 Dichloroethane	1	nd																			
Carbon Tetrachloride	1	nd																			
Trichloroethylene	1	nd																			
Freon [3]	5	nd																			
Benzene	1	nd																			
Toluene	1	nd																			
M, P Xylene	1	nd																			
O, Xylene	1	nd																			
Chloroform	1	nd																			

1 Some samples were reported to have a detection limit of 2 ug/l
2 Some samples were reported to have a detection limit of 3 ug/l
3 Some samples were reported to have a detection limit of 10 ug/l
G Gollob Analytical Service
HD New York State Department of Health Lab
W Westchester County Environmental Laboratory
B Bailed from well
nd Not detected at specified detection limit

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MILTON CHAZEN ASSOCIATES 11/82

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APPENDIX B-5

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING
(All Results in ug/l)

(Sample Collected in 1981)

		YEOMANS RESIDENCE															
LABORATORY	Detection Limit	G	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W
RAW, FILTERED OR BAILED		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
DATE SAMPLED		1/28/81	4/28/81	5/15/81	6/30/81	7/28/81	8/25/81	9/29/81	10/20/81	11/23/81	12/81	1/82	2/82	3/82	4/82	5/82	9/82
1,1,1 Trichloroethane	1	nd															
Tetrachloroethylene	1	nd															
Methylene Chloride [1]	1	nd															
CIS-1,2 Dichloroethylene [2]	1	nd															
1,2 Dichloroethane	1	nd															
Carbon Tetrachloride	1	nd															
Trichloroethylene	1	nd															
Freon [3]	5	nd															
Benzene	1	nd															
Toluene	1	nd															
M, P Xylene	1	nd															
O, Xylene	1	nd															
Chloroform	1	nd															

1 Some samples were reported to have a detection limit of 2 ug/l
2 Some samples were reported to have a detection limit of 3 ug/l
3 Some samples were reported to have a detection limit of 10 ug/l
G Gollob Analytical Service
HD New York State Department of Health Lab
W Westchester County Environmental Laboratory
B Bailed from well
nd Not detected at specified detection limit

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APPENDIX B-6

RESULTS OF HEALTH DEPARTMENT COORDINATED SAMPLING

(All Results in ug/l)

(Sample Collected in 1981)

LABORATORY RAW, FILTERED OR BAILED DATE SAMPLED	Detection Limit	SMITH/TOMASI RESIDENCE G R 2/17/81	G R 2/29/81	W B* 10/16/81	W R 11/10/81	W R 5/82	W R 6/82	W R 7/82	W R 8/82	GRASSO RESIDENCE G R 1/28/81	W R 4/28/81	W R 6/16/81	W R 9/8/81	W R 12/81	W R 3/82	W R 6/82	W R 9/82
1,1,1 Trichloroethane	1	nd	nd	1.6	nd				→	nd							→
Tetrachloroethylene	1	nd							→	nd							→
Methylene Chloride [1]	1	5	13	nd	nd				→	nd	nd	1.5	nd	nd			→
CIS-1,2 Dichloroethylene	1	nd							→	nd	nd	nd	2.8	nd			→
1,2 Dichloroethane	1	nd							→	nd	1.8	3.5	nd	nd			→
Carbon Tetrachloride	1	nd							→	nd							→
Trichloroethylene	1	nd							→	nd							→
Freon [3]	5	nd							→	nd							→
Benzene	1	nd							→	nd							→
Toluene	1	nd							→	nd							→
M, P Xylene	1	nd							→	nd							→
O, Xylene	1	nd							→	nd							→
Chloroform	1	nd							→	nd							→

1 Some samples were reported to have a detection limit of 2 ug/l
2 Some samples were reported to have a detection limit of 3 ug/l
3 Some samples were reported to have a detection limit of 10 ug/l
G Gollob Analytical Service
HD New York State Department of Health Lab
W Westchester County Environmental Laboratory
B Bailed from well
* Gasoline and high molecular weight oil also present
nd Not detected at specified detection limit

MILTON CHAZEN ASSOCIATES 11/82

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APPENDIX C

TRENDS IN THE PIEZOMETRIC SURFACE ELEVATIONS
MARCH - OCTOBER 1982

IBM-EF-88

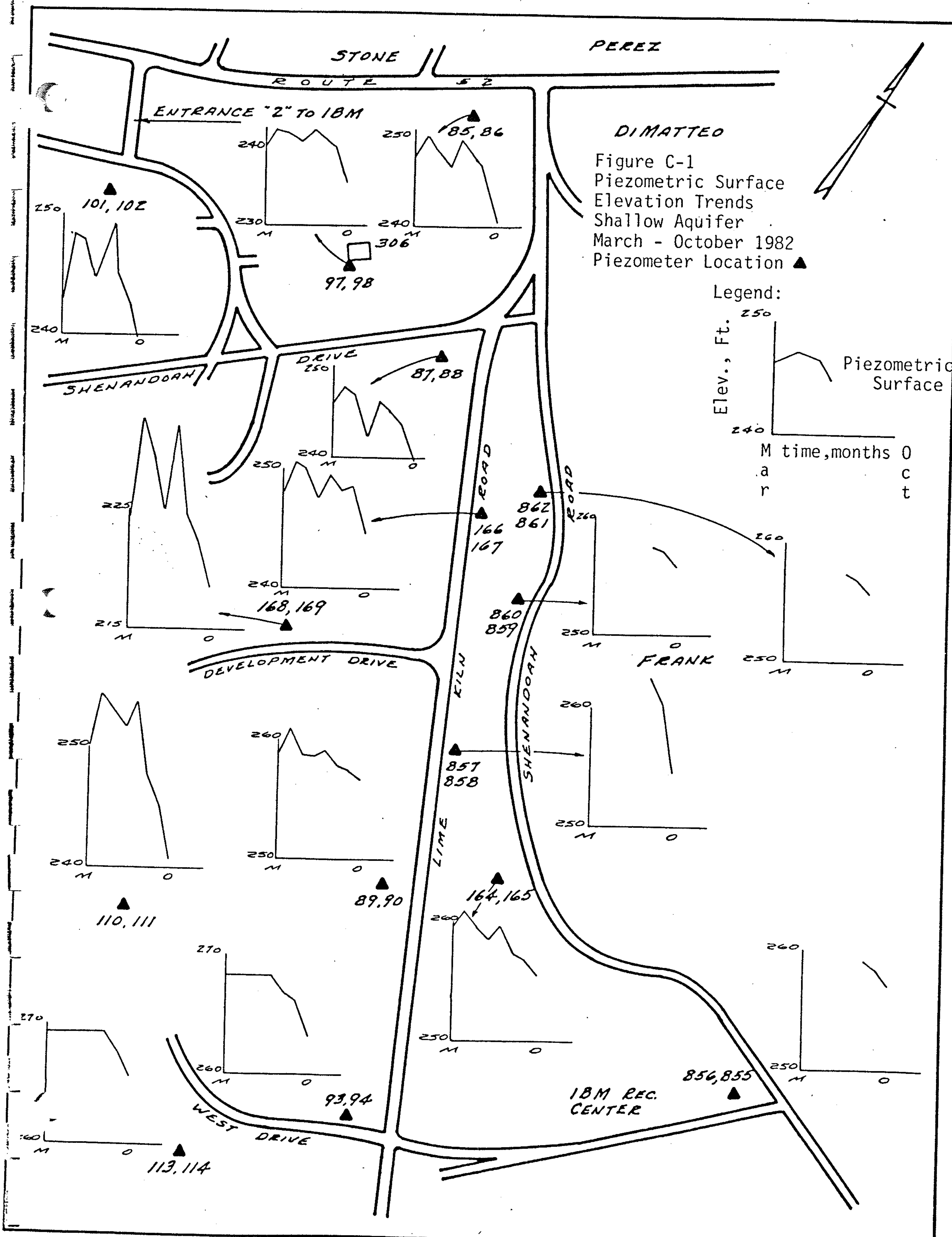
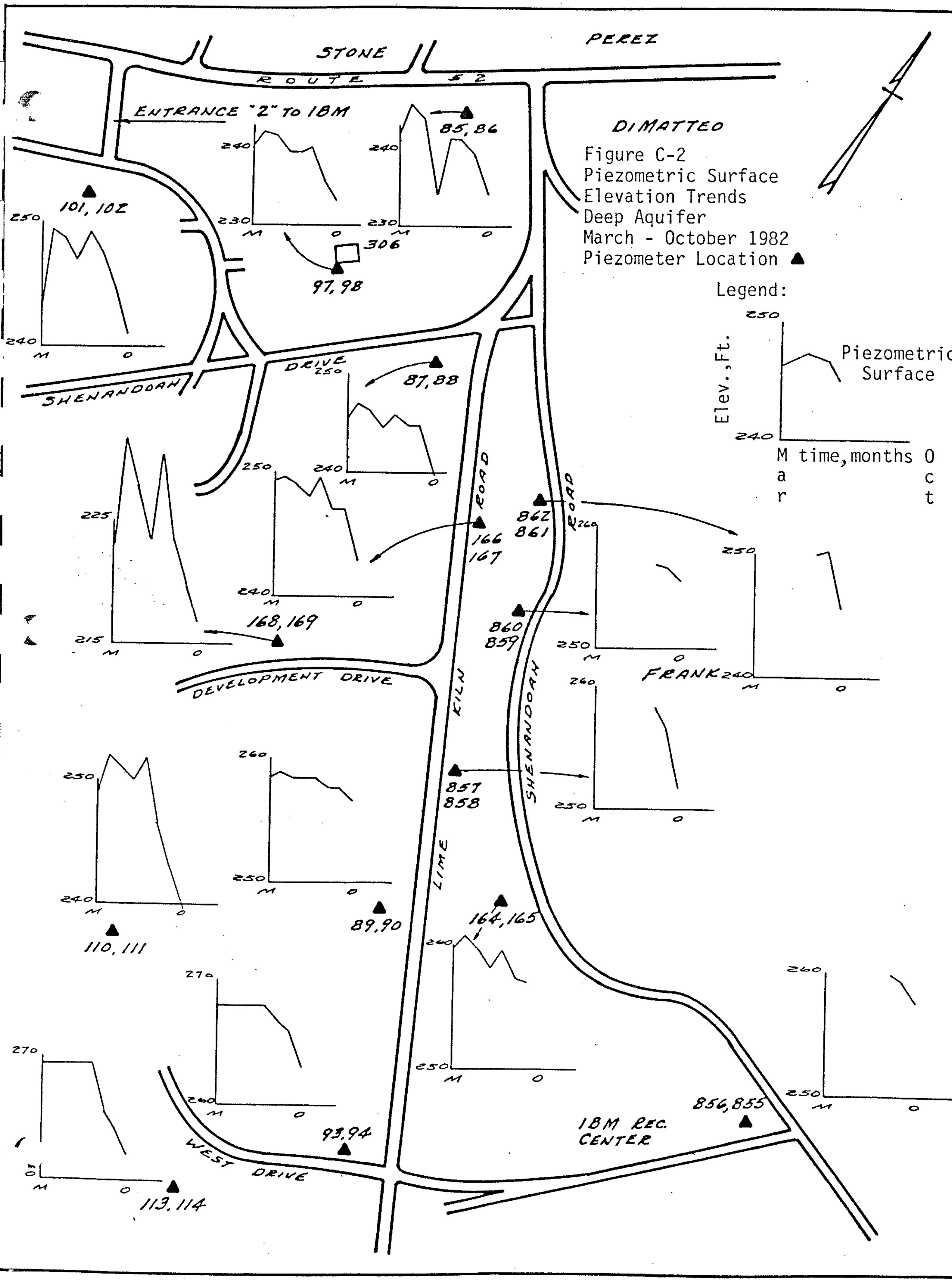


Figure C-1
Piezometric Surface
Elevation Trends
Shallow Aquifer
March - October 1982
Piezometer Location ▲

IBM-EF- 88


STONE
PEREZ
ROUTE 52
ENTRANCE "2" TO IBM
DIMATTEO
Figure C-2
Piezometric Surface
Elevation Trends
Deep Aquifer
March - October 1982
Piezometer Location ▲
Legend:
Elev.,Ft.
Piezometric Surface
M a r time, months O c t
101, 102
85, 86
306
97, 98
87, 88
SHENANDOAH
DRIVE
168, 169
166
167
862
861
860
859
DEVELOPMENT DRIVE
FRANK
LIME KILN ROAD
SHENANDOAH ROAD
857
858
110, 111
89,90
164,165
93,94
113,114
WEST DRIVE
IBM REC. CENTER
856,855

IBM-EF-88

STATE OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL CONSERSATION

In the Matter of Compliance with Section 27-1313 of the Environmental Conservation Law ("ECL") by:

INTERNATIONAL BUSINESS MACHINES CORPORATION (I.B.M.),

Respondent.

ORDER
ON
CONSENT

WHEREAS:

1. IBM has heretofore reported to the Department of Environmental Conservation (the "Department") and the New York State Department of Health that, based upon analyses of samples removed from IBM's monitoring wells (which had previously been installed by IBM as part of its water protection program) IBM had discovered that chemicals were present in the groundwater beneath IBM's facility located off Route 52, in the Town of East Fishkill, County of Dutchess, State of New York (the "Facility").

2. IBM commenced a voluntary investigation of the Facility in an effort to determine the concentration and location of these chemicals and to establish the reason for their presence in the groundwater; that investigation is continuing. IBM also took voluntary remedial actions to contain these chemicals and to extract and treat them and, further, to monitor the groundwater at several locations within and outside the boundary line of the Facility. A Ground Water Status Report dated January, 1981, submitted to the Department, summarizes such activity to that date.

3. On January 23, 1981, the Department placed the Facility on the registry of Inactive Hazardous Waste Disposal Sites as a result of the discovery of chemicals in the groundwater at such Facility.

4. Pursuant to Section 27-1313 of the ECL, the Commissioner of Environmental Conservation may order the owner of an inactive hazardous waste disposal site, after notice and an opportunity for a hearing, (a) to develop an inactive hazardous waste disposal site remedial program, subject to the approval of the Department, at such site, and (b) to implement such program within reasonable time limits specified in the Order.

5. The Department has requested IBM to submit a written plan (the "Plan") to the Department for approval, setting forth those actions heretofore taken and those hereafter to be implemented by IBM. Further, the Department has requested that IBM bind itself to the provisions of the Plan by consenting to the issuing and entering of this Order and that IBM agree to be bound by the terms, provisions and conditions herein contained.

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IBM-EF-88

6. By consenting to the form and entry of this Order, IBM does not admit that the Facility is an inactive hazardous waste disposal site subject to Title 13 of Article 27 of the New York State Environmental Conservation Law ("ECL"), denies the applicability of such Law and does not admit to any violation of any other provision of the ECL or any other State or Federal Law. However, IBM joins with the Department in its desire to resolve this matter amicably and does hereby agree to continue its investigation and the implementation of the activities more fully described in the Plan.

NOW, having considered this matter and being duly advised, it is ORDERED that:

I. IBM hereby affirmatively waives its right to notice and opportunity for a hearing granted under provision of the laws of the State of New York; provided that the waiver shall not be applicable and shall be considered null and void if the Department or the New York State Department of Health propose to raise new matters or impose new obligations on IBM not covered by the Plan or propose to modify the Plan in any respect, and, provided further that such waiver applies only to those obligations IBM has assumed herein.

II. The Department acknowledges that IBM has submitted the Plan for extraction and treatment of chemicals in the groundwater at the Facility for review and approval by the Department. Such Plan provides timetables for all proposed actions.

III. Within ten (10) days of approval by the Department of the Plan, IBM shall submit the Plan in final form to the Department. The Department shall have 30 days from service of this Order and following any resubmittals by IBM in which to review such proposed plan, and if the Department has expressed neither approval or disapproval of the Plan within such 30 days, the Plan shall be deemed approved as proposed and shall be deemed a final Plan. In the event that reviews by the Department have been timely and IBM has not submitted an approvable Plan by July 1, 1981, or such later date as agreed to by the parties, this Order may, on five days written notice to IBM, be declared null and void and the Department shall initiate a formal enforcement proceeding to finally resolve the subject matter of this Order.

IV. The Plan, in final form, shall be appended to this Order, thereby incorporated herein and made a part hereof as a Schedule of Compliance .

IBM-EF-88

V. IBM agrees to comply with each of the requirements set forth in the Plan in accordance with the approved timetable therein specified. If IBM fails to comply with the provisions of this Order, the Order shall be fully enforceable by a civil action in the Supreme Court of the State of New York and IBM hereby waives any right to assert that it is not obligated to comply with each and every provision of this Order. However, IBM's consent to this Order shall not be construed to bar or estop IBM from asserting any other defense in such civil action or in any litigation or proceeding that might hereafter arise.

VI. The Department agrees that this Order is the appropriate remedy to address the matters contained in this Order. However, this Order shall not preclude the Department's use of other remedies available to it; provided, however, that so long as IBM is in compliance with this Order, the Department agrees that it will not pursue any other remedy.

VII. IBM shall not be in default in compliance with this Order if IBM is unable to comply with any provision of this Order because of the actions of a national or local government body or courts, acts of God, war, refusal, non-cooperation, or adversary status of third parties (such as John Jay High School authorities or adjacent homeowners) prohibiting IBM from implementing offsite proposals, strikes, riots or catastrophes or other causes not within the control of IBM as to any of which the negligence or willful misconduct on the part of IBM was not the proximate cause. IBM shall apply in writing to the Department immediately upon obtaining knowledge of such event and the parties shall make an appropriate modification to the schedule contained in the Plan to the extent made necessary by such cause or causes.

VIII. Subject to Article VII if, for any reason, IBM desires that any provision of this Order be changed, IBM shall make timely written application therefore to the Department's Commissioner or his designated representative setting forth reasonable grounds for the relief sought. No change or modification to this Order shall be made or be effective except as may be specifically set forth in writing by such Commissioner or Commissioner's representative upon timely written application by IBM for the relief sought.

IX. All reports and submissions herein required shall be made to the Region 3 sub-office, New York State Department of Environmental Conservation, 202 Mamaroneck Avenue, White Plains, New York 10601 Attention: Gil Burns, Regional Engineer. All communication to IBM shall be made to IBM, Manager, Environmental Engineering Dept. 77-D, building 306-31A, East Fishkill, Route 52, Hopewell Junction, New York 12533.

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X. For the purpose of insuring compliance with this Order, duly authorized representatives of the Department shall be permitted access to the Facility during reasonable business hours, in order to inspect and/or require such tests as may be deemed necessary to determine the status of IBM's compliance herewith.

XI. The provisions of this Order shall be deemed to bind IBM, its officers, directors, agents, employees, successors and assigns, and all persons, firms and corporations acting under or for it.

DATED: New Paltz, New York
April 27, 1981

ROBERT F. FLACKE, Commissioner
New York State Department of
Environmental Conservation

BY: Paul D. Keller
PAUL D. KELLER
Regional Director, Region 3

TO: I.B.M.
East Fishkill Facility
Route 52
Hopewell Junction, New York 12533

CONSENT BY RESPONDENT

Respondent hereby consents to the issuing and entering of this Order, waives its rights to notice and hearing herein and agrees to be bound by the provisions, terms and conditions contained herein.

INTERNATIONAL BUSINESS MACHINES (I.B.M.)

BY: Paul R Low

TITLE: East Fishkill General Manager

DATE: April 23, 1981

STATE OF New York)
) ss:
COUNTY OF Westchester)

On this 23rd day of April, 1981, before me personally came P. R. Low, to me known, who being by me duly sworn did depose and say that he resides in Greenwich, Connecticut, that he is General Manager, East Fishkil of International Business Machines Corp. the Corporation described in and which executed the foregoing instrument, and that he signed his name as authorized by said Corporation.

Alan R. Wolfert

Notary Public

ALAN R. WOLFERT
Notary Public, State of New York
No. 4502278
Qualified in Westchester County
Commission Expires March 30, 1983

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FEB 0 2 1982

Rec'd 2/17/82

IBM-EF-

New York State Department of Environmental Conservation
202 Mamaroneck Avenue, White Plains, New York 10601

Robert F. Flacke
Commissioner

February 1, 1982

cc -
Alan W
Harry B
Bill Shim...

Mr. Robert Estabrooke
Manager, Site Environment Program
Department 92A, Building 300-44X
IBM - East Fishkill Facility
Route 52
Hopewell Junction, New York 12533

Re: IBM - East Fishkill Facility
In-Place Toxic Site No. 314054

Dear Mr. Estabrooke:

The Department has reviewed the Remedial Work Program proposed for Area B and Area C. The Remedial Plan for Area B is acceptable and can commence immediately. However, additional information is required before the Department can approve the Remedial Plan for Area C. Listed below are the Items that must be addressed:

1. An analytical procedure must be developed to determine when material in place is clean enough to leave in place. Does Exhibit IX (off-site Project Analytical Flow Chart and Scheme) describe this procedure?

2. A Department approved site-specific health and safety plan must be in place before any work begins at Area C. This plan must include such items as:
   1) Personal safety equipment and protective clothing
      a) Who is required to wear what in which situation?
      b) How will clothing be disposed of and/or decontaminated?
   2) Site Security
      a) Will the site be fenced during construction?
      b) Will there be a guard on-site during non-working hours?
   3) Restriction of contamination to the work site
      a) What specific procedures will be followed to minimize dispersion of contaminants?
      b) How will airborne particulates be controlled?
      c) How will heavy equipment be decontaminated?
      d) What restrictions will be placed on personnel as to their ingress and egress from the site?

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4) Air Monitoring
   a) Procedures for air monitoring of particulates, organics, explosivity, etc., must be developed so that any hazard in the work area can be rapidly determined and contingencies put in place.
   b) Air monitoring between the site and any nearby population must be maintained at appropriate intervals, depending on what air contaminants are being detected in the work area and depending on wind direction and speed.

If you have any questions concerning the above, please contact Mr. Dick Dana of the Bureau of Hazardous Site Control at (518) 457-4343 or me.

Very truly yours,

Richard A. Gardineer

Richard A. Gardineer, P.E.
Senior Sanitary Engineer

RAG/vg

cc: Regional Attorney
Bob McCarty
Dick Dana
Jack Hill

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Rec'd 2/19/82

FEB - 8 1982

IBM-EF- 88

New York State Department of Environmental Conservation
202 Mamaroneck Avenue, White Plains, New York 10601

Robert F. Flacke
Commissioner

February 5, 1982

Mr. Robert G. Estabrooke
Manager, Site Environmental Programs
Dept. 92A - Building 300-44X
IBM - East Fishkill Facility
Hopewell Junction, New York 12533

Re: IBM - East Fishkill Facility
In-Place Toxic Site No. 314054
Remedial Work Plan - Area C

Dear Mr. Estabrooke:

The Department has reviewed the proposed Remedial Work Plan for Area C and has found it acceptable. This Plan consists of material submitted to the Department dated January 20, 1982 and February 2, 1982 and a verbal agreement to amend one part of the February 2, 1982 submittal. This agreement reached by you with Mr. Dick Dania of the Bureau of Hazardous Site Control adds a procedure to be followed if the TLV valves are exceeded at the excavation site boundaries as delineated by the temporary fencing used for site access control. The agreement is that when the TLV valves are exceeded during the work day, the excavation working fence shall be covered with clean soil at the end of the work day.

If you have any questions, please contact me immediately.

Very truly yours,

Richard A. Gardineer

Richard A. Gardineer, P.E.
Senior Sanitary Engineer

RAG/vg

cc: Dick Dania
Jack Hill
Regional Attorney

IBM-EF- 88

810

JUL 2 7 1982

HARRY B.

IBM-EF- 88

New York State Department of Environmental Conservation
202 Mamaroneck Avenue, White Plains, New York 10601

Robert F. Flacke
Commissioner

July 26, 1982

Mr. Robert Estabrooke
Manager, Site Environmental Programs
Department 92A
Building 300 - 44X
IBM - East Fishkill Facility
Route 52
Hopewell Junction, New York 12533

July 27, 1982

H. F. Bell

For your information.

R. G. Estabrooke

Re: Remedial Work Programs
Site No. 314054
East Fishkill (T); Dutchess County

Dear Mr. Estabrooke:

The proposed Remedial Work Programs for Areas A and D have been reviewed by the Department and have been found to be acceptable. This means that all four (4) areas previously listed as effected by separate sources of hazardous waste have approved Remedial Work Programs for the purpose of removing the hazardous waste from the environment.

Please note that the Department requires periodic updating of the status of the remedial work activities. Please notify the Department prior to any excavation so that a representative of the Department or the County Health Department can observe. Department observance of all activities is not mandatory, but periodic inspections of construction activities by the Department or the Health Department will be beneficial to all parties.

Very truly yours,

Richard A. Gardineer

Richard A. Gardineer, P.E.
Regional Solid Waste Engineer

RAG:bz
cc: Regional Attorney
Dutchess County Department of Health
Bureau of Hazardous Site Control

IBM-EF- 88

B-51

International Business Machines Corporation

East Fishkill Facility, Route 52
Hopewell Junction, New York 12533
914/897-2121

D/92A, B/300, Z/44X
March 8, 1983

New York State Department of
Environmental Conservation
21 South Putt Corners Road
New Paltz, New York 12561

Att: Mr. R. Gardineer

Subject: IBM East Fishkill Remedial Action Plans

Gentlemen:

The following is a summary of the current status of the remedial action plans at the IBM East Fishkill site.

Two programs have been approved by NYSDEC for Area A by letter dated July 26, 1982 to Mr. R. Estabrooke. The first consisted of increasing the pumping rate in IBM Production Well No. 2 to 250 gallons/minute. This was accomplished on October 20, 1982. The pumping rate was temporarily decreased to 150 gallons/minute on January 19, 1983. We plan to return the pumping rate to 250 gallons/minute as soon as possible. The second program was the removal of several storage tanks and the installation of sumps to collect contaminated groundwater. The final design package for the sumps and groundwater treatment facility is expected to be completed in Spring 1983.

The construction of the extraction/treatment facilities in Area B and D has been completed. The systems were put into operation on December 8, 1982, and December 1, 1982, respectively.

Please contact Joe Hogan at 897-9273 if you have any questions regarding the implementation of the remedial action plans at the East Fishkill site.

Sincerely,

International Business
Machines Corporation

R G Estabrooke

R. G. Estabrooke, Manager
Site Environmental
Programs/Security Services

RGE/pm

cc: J. M. Hogan

IBM-EF-88
IBM-EF-88
IBM-EF-0
IBM-EF-0

IBM-EF- 888

International Business Machines Corporation

East Fishkill Facility, Route 52
Hopewell Junction, New York 12533
914/897-2121

D/92A, B/300, Z/44X
April 19, 1983

New York State Department
of Environmental Conservation
21 South Putt Corners Road
New Paltz, New York 12561

Att: M. R. Gardineer

Subject: IBM East Fishkill Production Well No. 2

Reference: (1) My letter dated March 8, 1983
(2) Telephone conversation with J. Hogan on April 15, 1983

Gentlemen:

As discussed in the above referenced communications, the pumping rate for Production Well No. 2 has been temporarily decreased to approximately 150 gallons/minutes due to a degradation in microbiological raw water quality. Monitoring of the effluent from the activated carbon units has not indicated a breakthrough by coliform of the second unit. Investigations are being conducted to determine possible causes of the degradation and remedial actions.

Telephone discussions were also held on April 15, 1983 with Messrs. J. Sansalone of NYSDEC, P. Chiefari of NYSDOH, and J. Napoli of DCDOH regarding options currently available to the site. Based on the concurrence of all regulatory agencies contacted, the pumping rate for Production Well No. 2 will be approximately 150 - 250 gallons/minute, activated carbon treatment will continue to remove organics, and the treated water will be discharged to the stormwater drainage system. Monitoring of the treated discharged water will continue. This was commenced at approximately 5:30 P.M. on 4/18/83. It is expected that the discharge may continue for several months.

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Your office will be kept informed of the situation as required. Please contact J. Hogan on (914) 894-9273 if you have any questions.

Sincerely,

International Business Machines Corporation

R. G. Estabrooke, Manager
Site Environmental
Programs/Security Svces.

RGE/pm

cc: P. Chiefari, NYSDOH
J. Hogan
J. Napoli, DCDOH
J. Sansalone, NYSDEC

IBM-EF-888
IBM-EF-888

Bill

IBM-EF- 88

International Business Machines Corporation

East Fishkill Facility, Route 52
Hopewell Junction, New York 12533
914/897-2121

December 13, 1983
D/92A, B/300, Z/44X

New York State Department of
Environmental Conservation
21 South Putt Corners Road
New Paltz, New York 12561

Attention: Mr. W. Sullivan

Subject: Area "A" Groundwater Treatment Facility

Reference: (1) IBM Groundwater Report No. 2, May 1982.
(2) Meeting with NYSDEC May 26, 1982.

Gentlemen:

Enclosed for your review is the design of the Area "A" groundwater treatment facility. The proposed schedule for commencement of construction is first quarter 1984, with operation of the facility beginning first quarter 1985. As shown in the attached process schematic, the facility will consist of a collection sump, separator, packed tower air stripper, and associated storage tanks and pumps.

The purpose of the remedial actions in Area "A" is to remove as much of the separate phase organics as feasible in the building 308-310 area. There are five decommissioned buried storage tanks in the area. Two of these will be removed, along with any separate phase existing adjacent to or under those tanks. A drainage sump will be installed which has a perforated zone into the silt layer containing the separate phase organics. Water/solvents collected from the sump will be pumped to the treatment facility.

The treatment facility is designed to process 30 gallons per minute of groundwater. The treatment building will be a 40 ft. x 50 ft. pre-engineered metal building, diked to contain any leaks or spills that may occur. Groundwater will be pumped to a solvent separator tank, where the solvent and silt will be settled out and drained into drums for disposal by a licensed/approved vendor. The groundwater overflows to an influent storage tank and will be pumped to an air stripping tower. The stripping tower is designed to remove in excess of 99% of the organic solvents from the groundwater. The treated groundwater will be transferred to a storage tank prior to discharge to our Industrial Waste Neutralization/Treatment Plant.

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IBM-EF- 88

IBM-EF- 88

IBM-EF- 88

A review of the utilities in Area A has revealed an above-ground high-temperature hot-water line in close proximity to two of the underground storage tanks north of the Building 310-308 linkway (tanks nos. 16 and 17). Also, one tank (no. 14) is located under the linkway. Concern has been raised regarding the safety exposures and the impact to manufacturing of undermining the pipeline and building foundations during excavation activity. We are presently considering relocating the high-temperature hot-water line prior to excavation or other technical options which could result in a clean-up equivalent to tank removal without the necessity of physically removing them. We will discuss our findings with your office when we have reached a decision.

Concurrent with investigating the previously discussed options, we plan to proceed with tank removal (nos. 23 and 24) south of the linkway and treatment facility construction, after review by your office. This will allow construction to proceed and treatment to begin as soon as possible.

A permit to construct has been received from NYSDEC for the air stripper (Air Emission Source No. 1328000095SGWIT1). Discharge of treated groundwater to the industrial wastewater treatment system will not have any impact on the receiving stream for the site's final effluent. Furthermore, consultant studies have shown that total failure of the treatment process for 24 hours will not result in any significant changes to final effluent water quality. Safeguards have been incorporated into the design to shutdown the transfer pumps in the event of a failure in the packed tower air handling equipment. Also intensive water quality monitoring will occur during operation of the facility.

We will be happy to answer any questions you may have at the meeting with your people on December 29, 1983, or you may call Joseph Hogan on (914) 894-9273.

Sincerely,

International Business
Machines Corporation

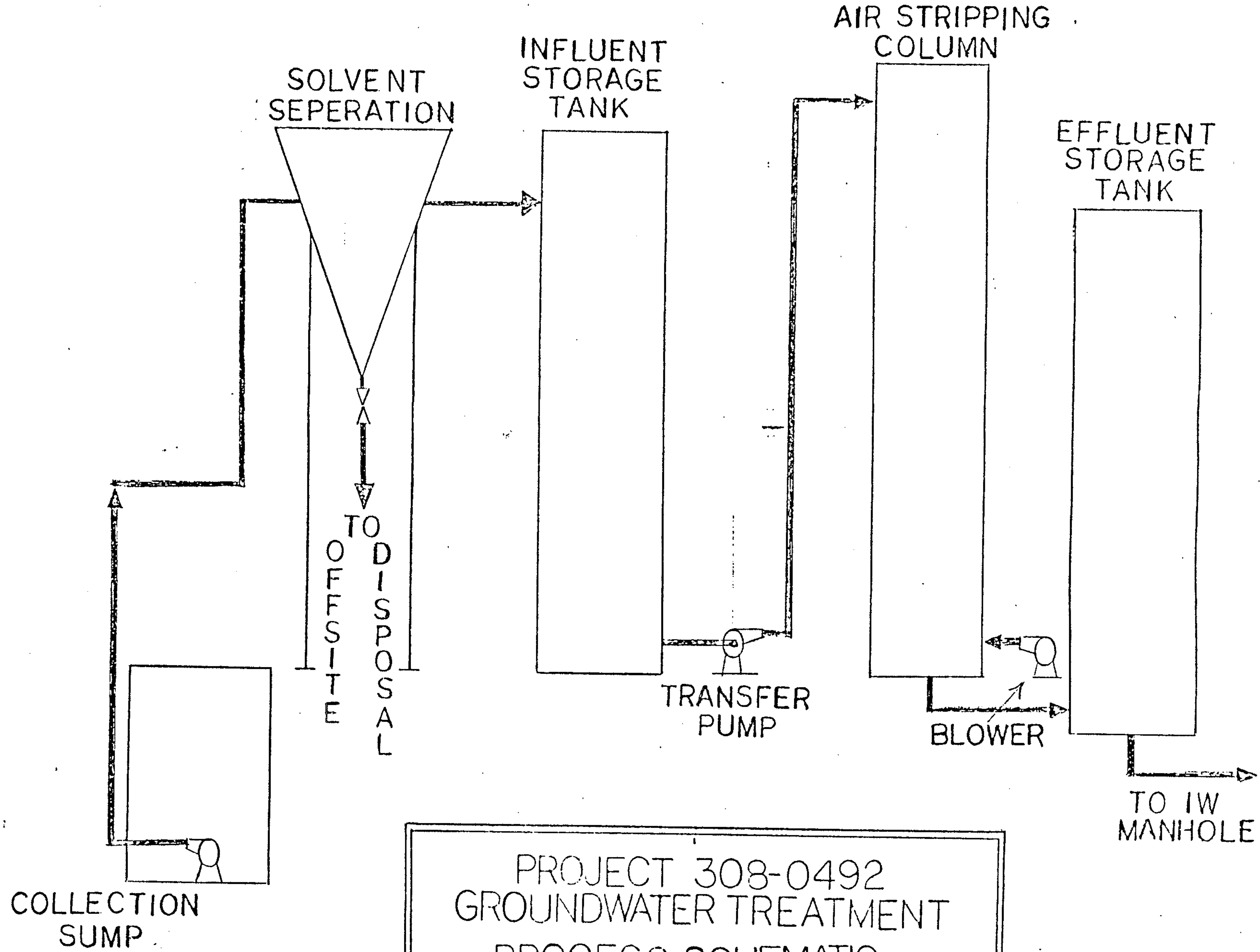
R. G. Estabrooke

R. G. Estabrooke, Manager
Site Environmental
Programs/Security Services

RGE/ls

cc: R. Gardineer, NYSDEC (w/o attachment)
J. Hogan 4A1 (w/o attachment)
J. Iannotti (with attachment)

IBM-EF- 88



PROJECT 308-0492
GROUNDWATER TREATMENT
PROCESS SCHEMATIC

IBM-EF- 88

International Business Machines Corporation

East Fishkill Facility, Route 52
Hopewell Junction, New York 12533
914/897-2121

IBM-EF- 88

December 19, 1983
D/92A, B/300, Z/44X

New York State Department of
Environmental Conservation
21 South Putt Corners Road
New Paltz, New York 12561

Attention: Mr. W. Sullivan

Subject: IBM East Fishkill Remedial Action Plans

Reference: My letters dated March 8, 1983, and April 19, 1983

Gentlemen:

Following is an update of the IBM East Fishkill remedial action plans since our referenced correspondence.

We have completed an evaluation of our groundwater monitoring network so as to optimize the statistical significance of the data collected.

The design of the groundwater treatment facility for Area "A" is complete and information regarding this design is being forwarded for your review under separate cover. The Production Well No. 2 pumping rate is 250 gallons/minute with the water being carbon treated and discharged to the stormwater drainage system.

IBM-EF- 60

Additional monitoring wells have been installed in the vicinity of Area "C" and Production Well No. 7. This activity, as well as other hydrogeological investigations, including a production well recovery pump test, have been performed to better understand the cause of increased organic chemical concentrations in Production Well No. 7. The data is still under review.

The Area "B" extraction/treatment/recharge facility has been in operation since December 1982. Downtime due to siltation of the well screen and disruption of electrical service has occurred periodically. The remedial action facility at Area "D" has been operational since December 1982 with no major service interruptions. A cone of depression has been established extending beyond the area of contamination. The documentation of preventative maintenance and operating procedures has been initiated for these areas.

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Also,we have engaged a consultant to determine the optimal pumping rate for Areas "B" and "D" in order to maximize the removal of organic chemicals. Data for this study is being collected at Area "D"; however, the study will not begin at Area "B" until the siltation problem is resolved to our satisfaction.

Please contact Joseph Hogan on (914) 894-9273 if you have any questions regarding the implementation of remedial action plans at the East Fishkill site.

Sincerely,

International Business
Machines Corporation

R. G. Estabrooke

R. G. Estabrooke, Manager
Site Environmental Program/
Security Services

RGE/ls

cc: R. Gardineer, NYSDEC (w/o attachment)
J. Hogan Z/4A1 (w/o attachment)
J. Iannotti, NYSDEC (with attachment)

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J Braungart

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New York State Department of Environmental Conservation
21 South Putt Corners Road, New Paltz, N.Y. 12561-1696
(914) 255-5453

Henry G. Williams
Commissioner

January 31, 1984

IBM-EF-36

IBM
East Fishkill Facility
Route 52
Hopewell Junction, New York 12533

Attn: Mr. H.W. Shimmin
Site Environmental Engineering

Re: IBM East Fishkill Area "A"
314 054

Dear Mr. Shimmin:

The remedial plans outlined in your letters of December 13 and 19, and in our meeting of December 29, 1983, have been reviewed by this Department. In general, the proposal is acceptable.

Specifically, the Department concurs with:

1) the proposed design and schedule for the Groundwater Collection and Treatment System;
2) removal of tanks 23 and 24, south of the linkway;
3) additional investigation of the area north of the linkway (including a study of the removal of tanks 14, 16 and 17 which the Department favors if feasible);
4) continued monitoring of the Area "A" wells.

Also, the Department is not opposed to the optimization of the pumping rates in Areas B and D as long as the intent of the program is not jeopardized. Please submit a record of these modifications, along with conclusions on the impact of these changes on the groundwater flow regime.

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Other points which should be addressed:

1) A permit to operate the air stripping unit is required from the DEC's Division of Air. Please contact Mr. Neil Isabelle, Regional Air Engineer at this office in this regard. Also, the question of fugitive air emissions from the treatment facility should be discussed.

2) Since the treated groundwater will be discharged to your industrial wastewater treatment system, the Department's Division of Water has determined that the discharge will constitute a change in the waste characteristics and

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and therefore necessitate a review of your facility's SPDES permit. A formal request by IBM is required. Please contact Mr. John Sansalone of this office for specific requirements. In addition, the Division of Water must review the plans for the proposed air stripping system. Mr. Sansalone will also advise you in this matter.

Please contact me if you have any questions.

Very truly yours,

William G. Sullivan
Assistant Sanitary Engineer
Region 3

WGS/di

cc: R. Gardineer
M. Malinoski
N. Isabelle
J. Sansalone
J. Hill, D.C.H.D.

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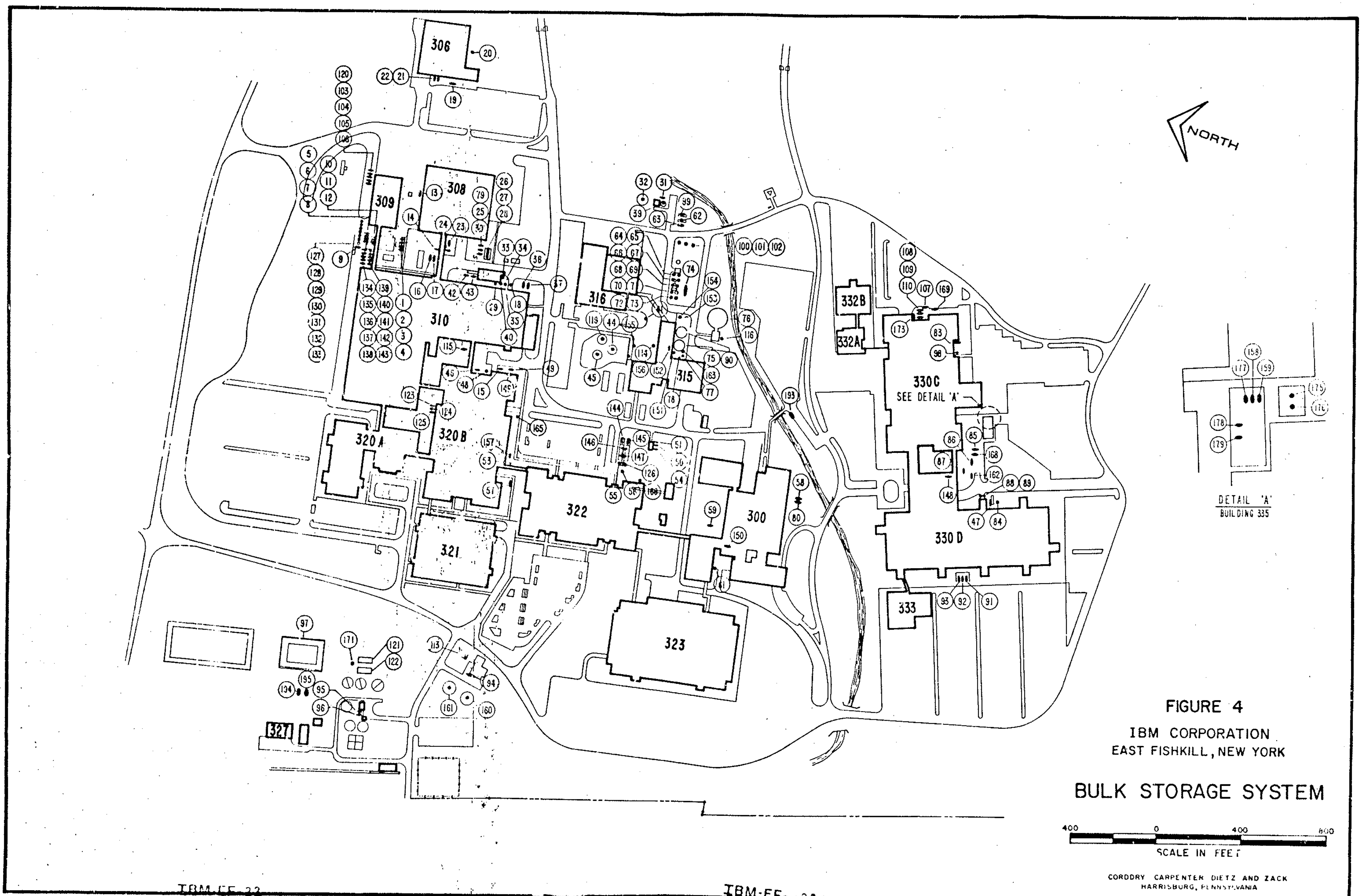

FIGURE 4

IBM CORPORATION
EAST FISHKILL, NEW YORK

BULK STORAGE SYSTEM

CORDDRY CARPENTER DIETZ AND ZACK
HARRISBURG, PENNSYLVANIA