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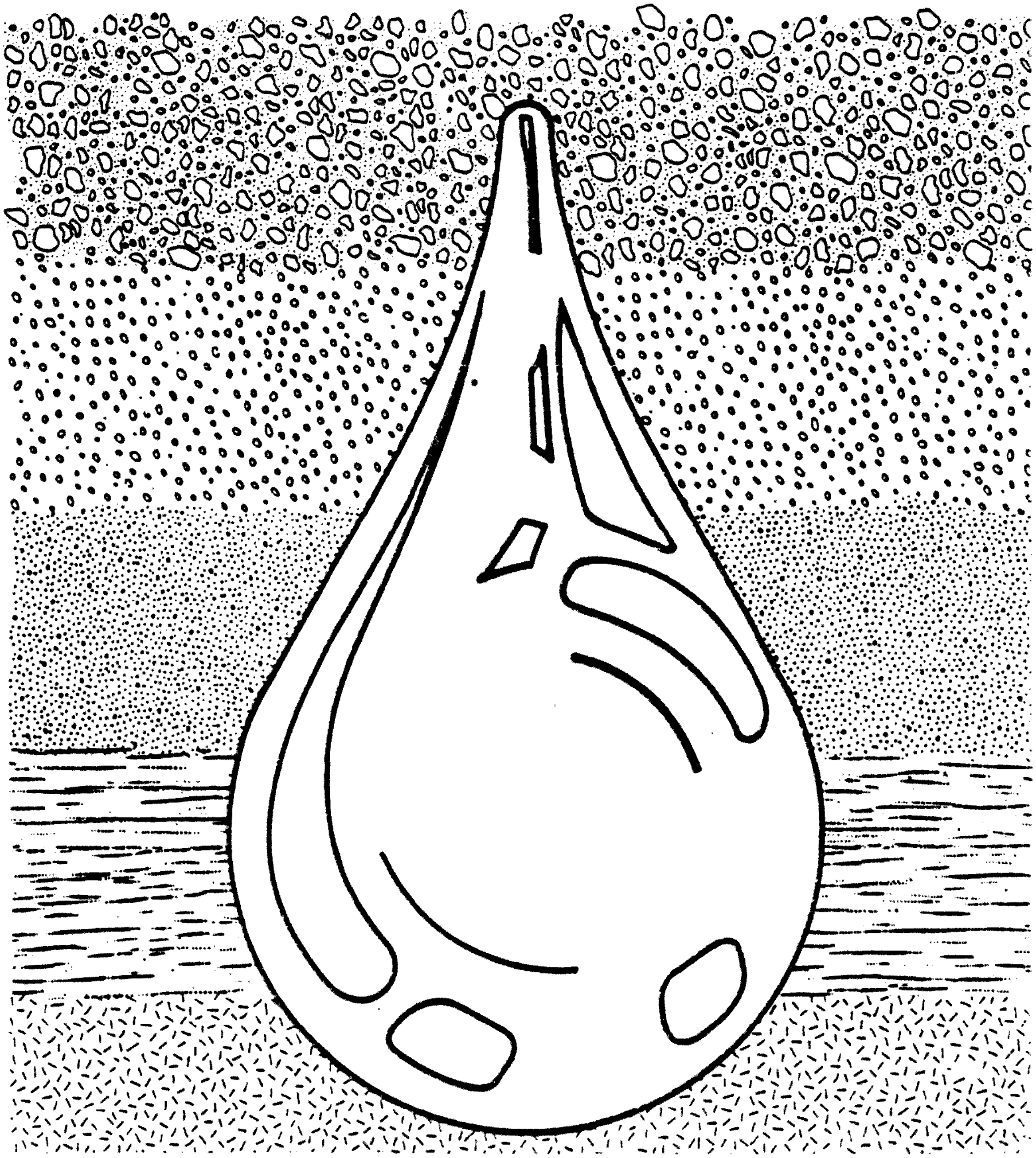
Report of the Preliminary Groundwater Contamination Investigation

Lakewood, Washington October—November, 1981



REPORT OF THE PRELIMINARY GROUND WATER CONTAMINATION INVESTIGATION, LAKEWOOD, WASHINGTON

OCTOBER - NOVEMBER 1981

By

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Fred Wolf

Kwasi Boateng

ABSTRACT

During the summer of 1980, organic solvents were discovered in the water produced by Lakewood Wells H-1 and H-2. Significantly higher concentrations were repeatedly detected in Well H-2. The drillers logs indicated that a tight hard pan (till) layer seperated the production aquifer from the unconfined semi-perched aquifer above. The annular space at H-2 was found to have been filled with pea gravel and it was hypothesisized that this could be a conduit for vertical migration of contaminent. This hypothesis would also account for the higher concentrations found in H-2. This preliminary investigation tests this hypothsis by the construction and monitoring of 10 observation wells. The study provides information which suggests hydrologic interconnections do exist between the semi-perched and the production aquifers, but does not suggest that the semi-perched zone is infact the source of the organic solvents.

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This report has been reviewed by the U.S. Environmental Protection Agency, and approved for public release. Approval does not signify that the contents necessarily reflect the views or policies of the U.S. Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorcement or recommendation for use.

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1-0. Introduction

This investigation of ground water contamination occuring at the Lakewood (Washington) Water District's Ponders Well Field was initiated to obtain more detailed hydrogeologic data concerning the site. Earlier sampling at this location has shown strong evidence that both production wells, H-1 and H-2 are contaminated by Trichloroethylene, Tetrachloroethylene and 1, 2 (trans) Dichlorethylene. (Littler et.al 1981). An examination of the "as constructed" well logs from the two production wells revealed that the annular space of H-2 had been filled with highly porous gravel pack having no cement seal to prevent vertical migration of contaminants from the surface. The logs also showed the occurrence of a confining layer of till at about 25-30 ft. from the surface. It was hypothosized that this till could act as a confining layer creating a perched water table. If grossely contaminated, such an aquifer could be the source of contamination reaching the deeper aquifer downward through the annular gravel pack. The concentrations of the organics were higher in H-2 than H-1 which reenforced this hypothesis.

The purpose of this study was to probe the upper, perched aquifer to attempt to define the direction of movement and levels of contaminants present. If possible, a direction to the source area of the contaminants would be obtained. A network of shallow observation wells using low cost, but adequate levels of technology and construction were installed. Their siting was "interactive" based on field data and chemical information obtained from the Century Systems Model 128 Organic Vapor Analyzer (OVA-128)gas chromatograph. The physical installation of wells occurred during the first half of October, 1981, and the gathering of samples and data from October to January, 1982.

This project was carried out under the direction of the Environmental Services Division, U.S. EPA, Region 10 with supporting professional services and contracting support from the Field Investigation Team, Region 10, Ecology and Environment, Inc., under TDD 10-810803.

2.0. Physical Description

2.1 Location

The Lakewood Water District contaminated wells are located within 200 feet N.E. of the intersection of I-5 and New York Ave. in Lakewood, Pierce County, Washington. The site is also located at N.W. 1/2 of the N.E. 1/4 of Section 14, Township 19N, Range 2E, and may also be located at ~~Longitude~~ 47° 08'30"N and ~~Latitude~~ 122° 31'15" W. The site is shown in Figure 1.

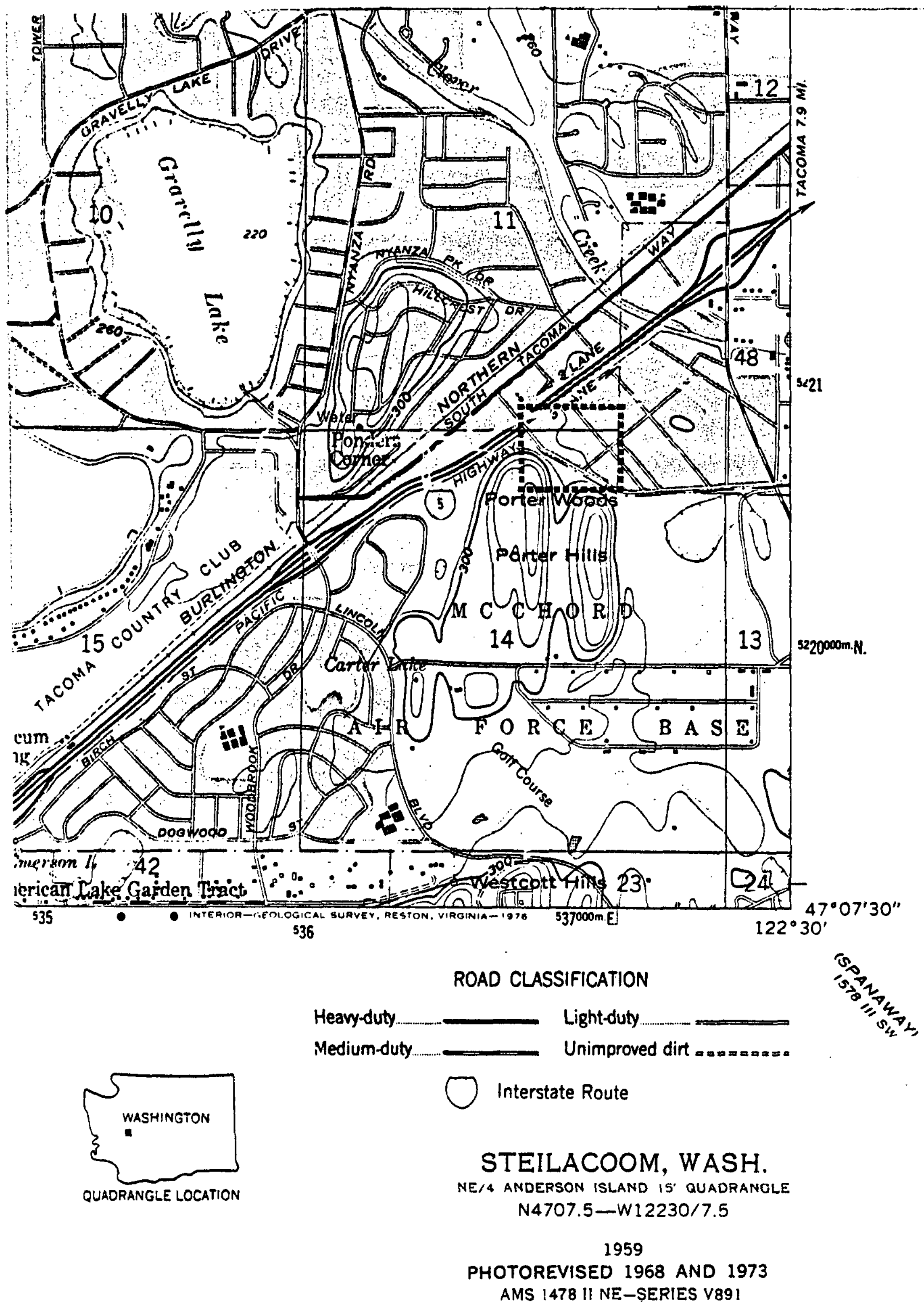


Figure 1

Location of Lakewood Study Area

2.2 Climate and Water Budget

The Lakewood-Tacoma general area has a temperate maritime climate with cool wet winters and warm dry summers. There is a marked deficit of actual transpiration over potential transpiration during the summer so that May-October are water deficit months, and November-April have excess precipitation.

Average annual precipitation for the area from 1945 to 1980 is 39.19 inches. Mean lake evaporation is about 23 inches per year (DOE 1981), leaving approximately 16 inches to infiltrate or run-off the site. The maximum 2-year precipitation expected in 24-hour period is 2 inches (Miller, et. al., 1973).

2.3 General Geology

The Lakewood-Tacoma general area is underlain by a great thickness of semiconsolidated and unconsolidated materials laid down in lakes or by streams during recent, Pleistocene and late tertiary time (Griffin, Sceva, et. al., 1962). These sediments include clay, silt, sand, and gravels, glacial till and peat. Water-bearing characteristics of the general area differ from place to place depending upon the rock type. The areas underlain by outwash sand and gravel deposits are the most productive aquifers, while in the till-capped areas, where permeability is low, aquifers are generally not productive and yield only small amounts of water to wells.

2.4 Site Geology

The study area is underlain by sand and gravels (see well logs), deposited by meltwater streams that flowed westward accross the general area during the Vashon glacietion in the late Pleistocene. These outwash deposits are highly permeable and yeild large quantities of water. One of the study wells, H-1 yields more than 2,000 gpm. with specific capacity of about 35 gpm. per foot of drawdown. (Griffin, Sceva, et. al., 1962).

Ground water was encountered between 20'-35' below ground elevation in all the observation wells.

3.0 Methodology

3.1 Description of Methodology and Drilling Site Selection

Drilling sites were preselected by the investigators allowing adaquate time to obtain permission to drill, and to ensure the location could be reached by the rig. A standardized permission form was developed and is presented in the appendix. A total of 17 potential drilling sites were located with permission for access and drilling obtained. Because the drilling program was interactive, individual sites selected for drilling based on field judgement and OVA data; each well site was chosen on the basis of information gathered in preceeding wells. The flexibility inherent in this approach permitted more data to be obtained using fewer drill sites. A map showing observation well locations is presented in Figure 2.

3.2 Well Construction

The observation wells were excavated to an average depth of 35 feet utilizing a truck-mounted hollow-stem auger drill rig (Mobile Drill D-61), to about 10 feet below the water table. The internal diameter of the auger was 4-inches.

A 2-1/2-inch ID ungalvanized steel casing (black iron pipe), was then installed. The perforated section of the casing was 10 feet (except observation wells #1 and 2 which were 20 and 15 feet long respectively). Since the formation material was coarse, it was not necessary to place gravel pack around the "screen" to serve as a filter media. Figures 3 and 4 show the slot being "cut" by torch and the finished slotted screen

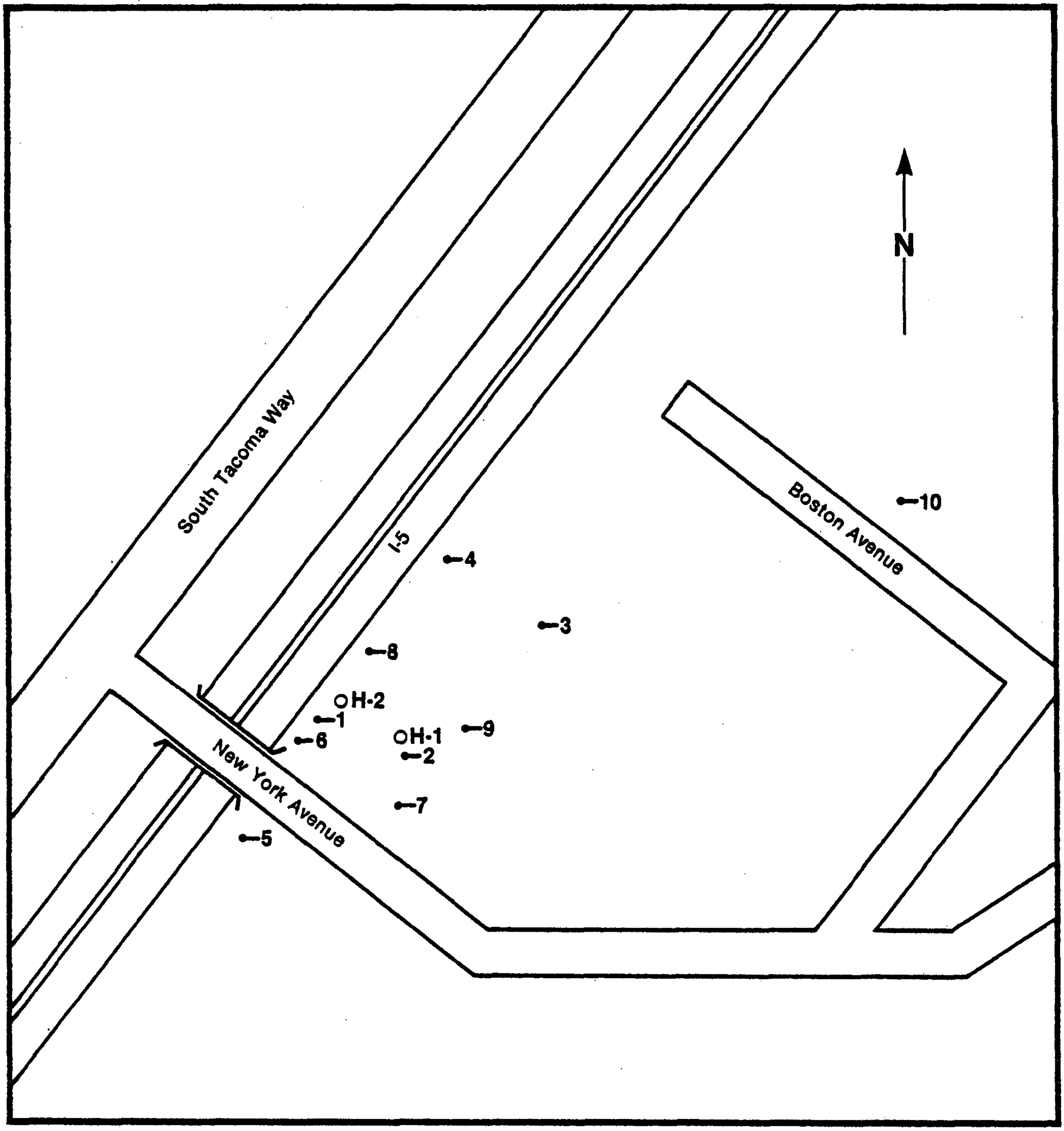
The annular space from the top of the screen (perforations) to 6 feet below ground surface was backfilled with drill cuttings. The annular space from the depth of 6 feet to ground surface was filled with a mixture of bentonite and fine sand in a ratio of one portion of fine sand and one portion bentonite in accordance of Washington State Department of Ecology (DOE) specifications. Details of well construction are illustrated in Figure 5.

3.3 Well Development

The completed wells were developed with compressed air to insure their utility as monitoring wells. This was done in a manner that did not cause any undue disturbance of the strata above the water table nor disturb the seal effected around the well casing and thereby reduce the sanitary protection. The development of the wells continued until the water pumped from the wells was clear and free of sand. This usually took 1-1/2 to 2 hours per well.

3.4 Pump Test

A pump test to establish the existance of the confining layer or significant difference in vertical permeability at the well field location was carried-out on 5 November 1981. The test was carried-out by pumping H-1 and H-2 for one hour each, while measuring drawdown in the pumping wells and water level changes in the observation wells. Measurements were carried out by two



*Not Drawn to Scale

Well Location Map*
Lakewood Washington

○ Lakewood Water District Production Well
•— Observation Well Installed by EPA

Figure 2

Observation Well Construction*
Lakewood Project

*Not Drawn to Scale

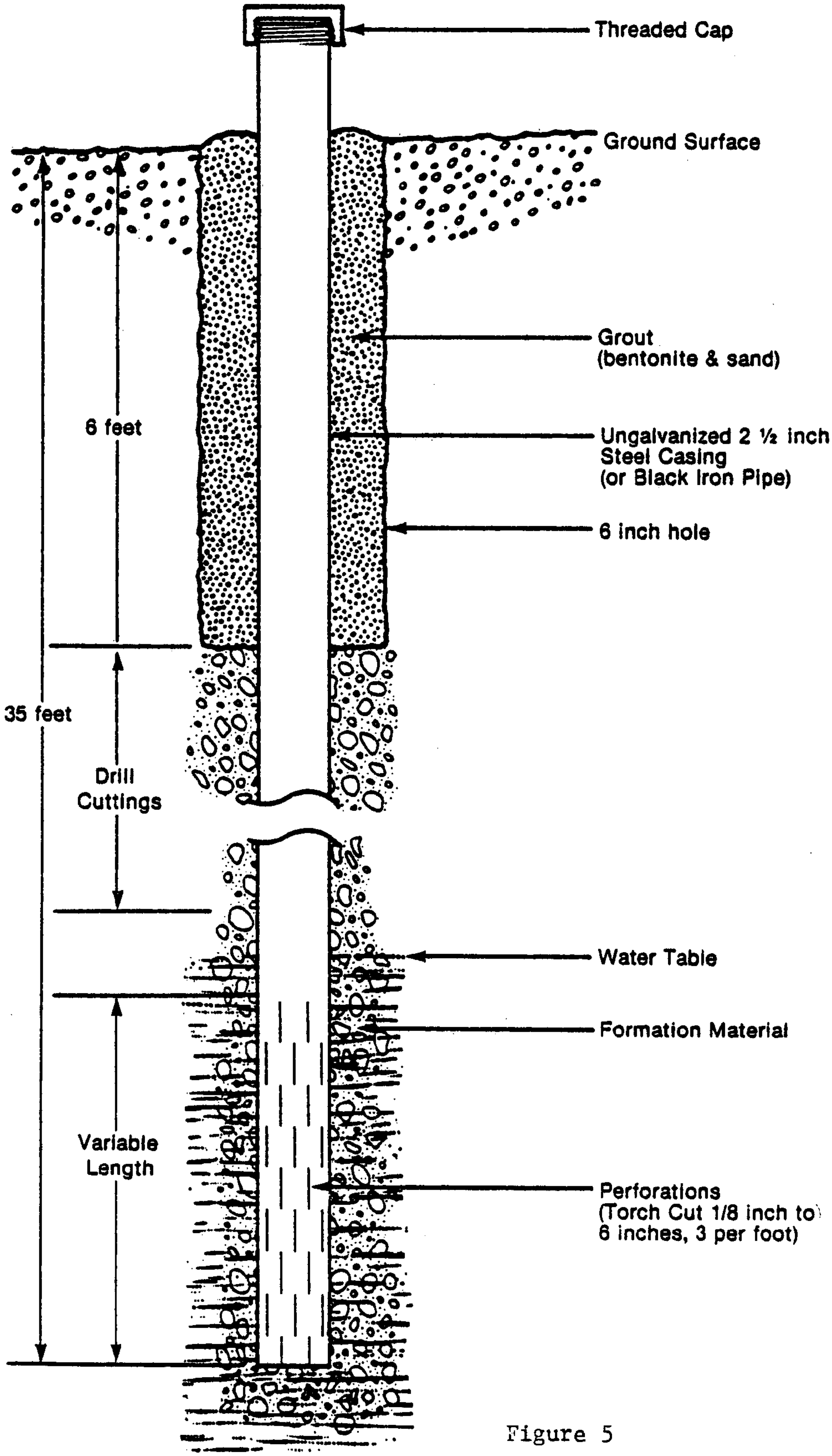
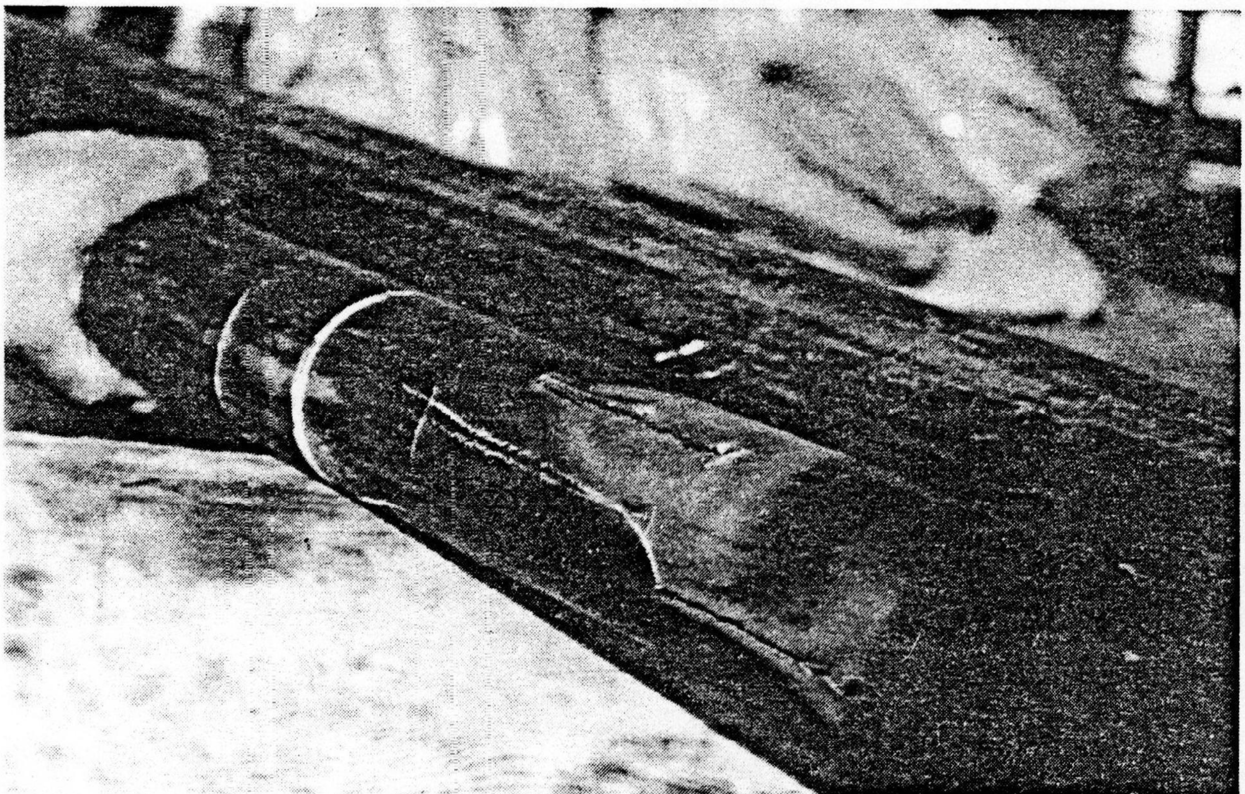


Figure 5

Driller's assistant cutting slots using a torch.


Torch-cut slots in black iron casing.

Figures 6 and 7

teams of two people, with one team using electric tape and the other, steel tape. Well H-1 was pumped from 1149 to 1249 at a flow rate initially of 1250 gallons per minute, H-2 was similarly pumped for one hour, 1400 to 1500, at an initial flow of 1000 gallons per minute.

Water level elevations are presented in Table 1 and their curves are presented in Figures 8 through 19 . During the pump test, water samples were obtained from the discharge pipe at the on-site discharge pit adjacent to H-2. The samples were taken at approximately 10 minute intervals and analyzed for tetrachloroethylene, trichloroethylene and 1, 2 (trans) Dichlorethylene.

3.5 Equipment Decontamination

The Lakewood project required us to use equipment decontamination procedures to insure that trace levels of volatile organic compounds were not the result of cross-contamination between drill sites nor resulting from sources outside the scope of the project area. Outside sources of contamination could include drilling water, contaminated truck surfaces used to haul auger sections or equipment in contact with contaminated surfaces. The drilling contractor was required to provide 2 complete 50 foot strings of auger. This permitted one string to be in use while the other was being cleaned and decontaminated off site. Prior to arrival on-site, the drill rig was steam cleaned. One technician and a driller's helper were responsible for operating the off-site decontamination station. Located at the Lakewood Water District's equipment and storage area, the station also served as a water source for the rig, where pre-analyzed water was available in adaquate supply. A steam cleaner was obtained by the contractor for this project. The tank of this cleaner was scrubbed with Alconox and water and thoroughly rinsed before it was used. The water tank on the rig was similarly rinsed followed by steam cleaning.

Equipment decontamination during the drilling phase occured as follows:

1. The truck carrying the augers and equipment was unloaded at the decontamination site, then scrubbed with Alconox and water followed by steam cleaning.

2. All drilling equipment and tools were scrubbed with Alconox and steam cleaned in the same manner and reloaded onto the truck without being set on the ground.

3. Since cleaning was carried out on a paved surface, drainage was controlled and directed to the sewer system.

Equipment used in the project was periodically checked by both the OVA-128 and HNU Vapor detector systems. No detection of organic vapors on tools or auger sections decontaminated by this procedure was observed.

3.6 Organic Vapor Analyzer (OVA)

A Century Systems Organic Vapor Analyzer (OVA) Model 128 was used to detect and monitor the presence of organic vapor during and after well installation. A twofold method was used. The survey mode was used to "sniff" the wells during drilling to determine if organic vapors were encountered. The G.C. mode was used to detect the type of organic compounds in the soil and water samples in the field (see appendix). HNU Model 101 Photoionization Analyzer was used to screen methane. Figures 6 and 7 illustrate the use of the HNU and the OVA to assess ambient vapor levels around the auger during drilling.

3.7 Survey

Elevations of the top of the well casings were surveyed to a common datum. This was necessary to determine the direction of ground water flow at the site.

The survey datum was an artificial plane 100 feet below the top of the cement monument located in the well house at H-1.

4.0 Sampling Program

A total of ten observation wells and two production wells were sampled.

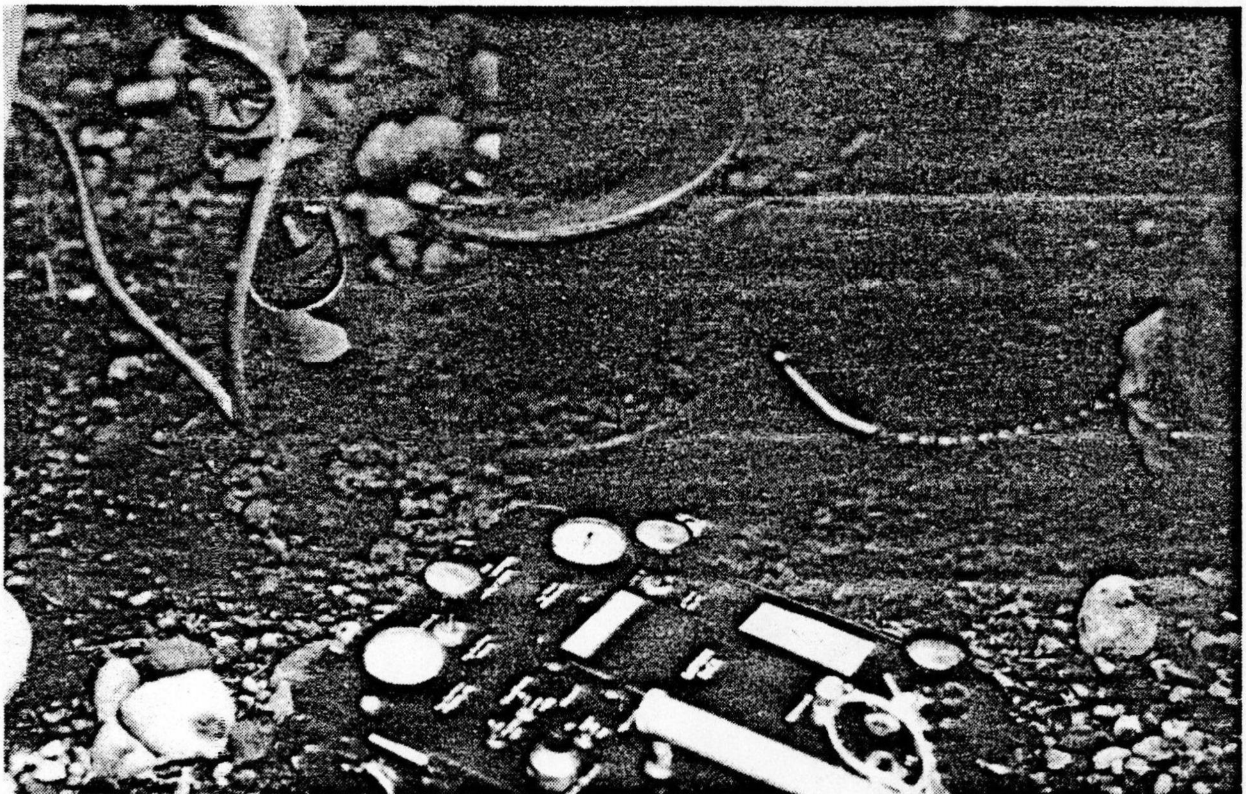
4.1 Observation Wells

At least three to five times the volume of water originally standing in the well was bailed out and the wells allowed to recharge before sampling. Samples were collected with a 1" stainless steel bailer lowered by a stainless steel wire. The bailer was cleaned with acetone, methylene chloride and dried with air before sampling each well.

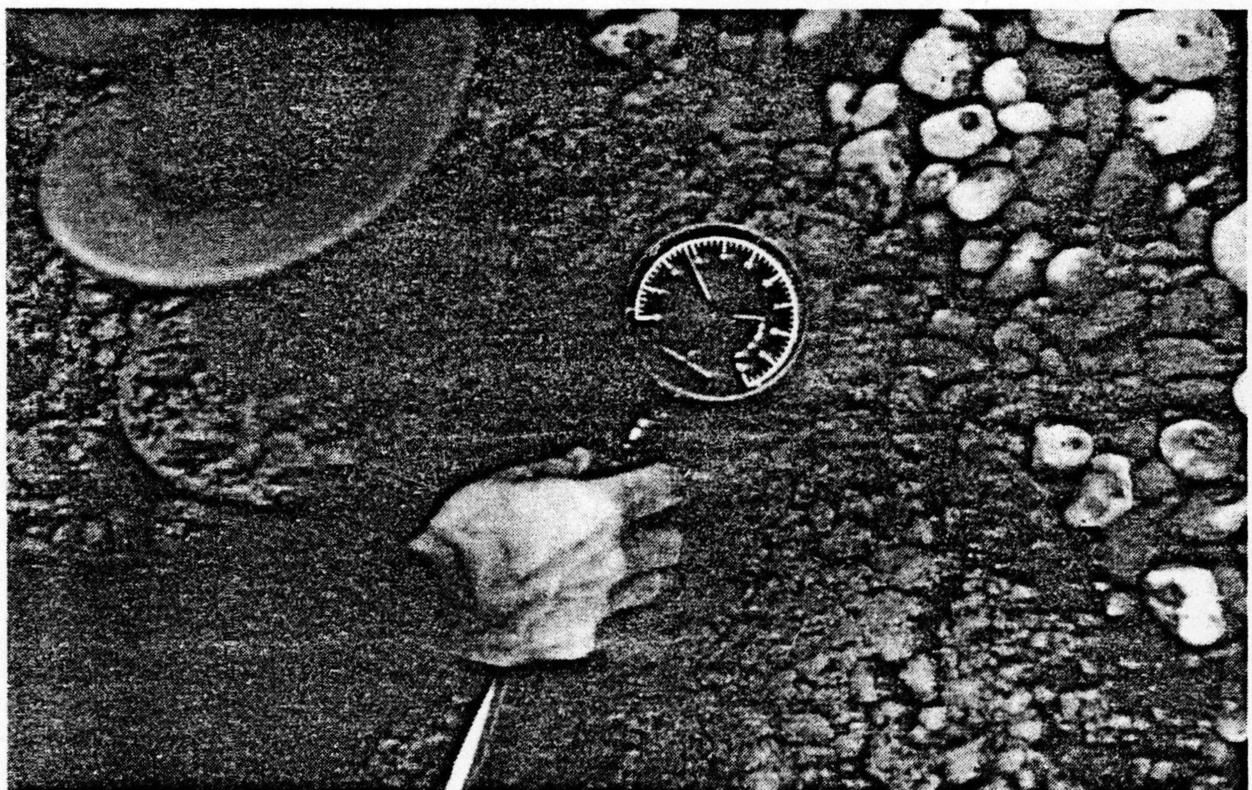
All sampling containers, the bailer and the sampler's gloves were rinsed two times with the media to be sampled. The gloves were changed between sampling each well to eliminate cross-contamination. The outside of the containers were rinsed with distilled water before the containers were placed in the ice chest.

4.2 Production Wells

Samples were collected from the production wells H-1 and H-2 with 1" stainless steel bailer.



OVA-128 and H-NU instruments being used to measure vapor levels during augering.



Direct read-out of vapor levels using the OVA-128.

Figures 8 and 9

4.3 Analytical Requirements

All samples obtained from the observation wells were analyzed by the EPA Region X Laboratory for heavy metals, pesticides, acid extractible, base/neutral extractible and volatiles on the priority pollutants list. The production wells were analyzed for Trichloroethylene, Tetrachloroethylene and 1, 2 (trans) - Dichloroethene. All the wells except H-1 were analyzed for hardness, specific conductance, alkalinity, total dissolved solids, pH, SO_4 and Cl. A list of priority pollutants analyzed during this study is provided in Table 1.

The following containers were used:

Extractable Organics	Two 1-gal. glass jars with teflon-lined lids.
Volatile Organics	Two 40-ml. vials with teflon-lined lids.
Pesticides	One 1/2 gal. glass jar with teflon-lined lids.
Heavy Metals and General Parameters	One 1-qt. polyethylene cubitainer.

4.4 Sampling Documentations

The sampling procedures were documented in a field log book. Samples were shipped to EPA Region X Laboratory, and were accompanied by a Field Sample Data Sheet, an Analysis Requirement Sheet and a white copy of the Chain-of-Custody Record. These forms were sealed in a ziplock plastic bag. Each container was labled with a sample number. A sample identification tag was tied around the container. The ice chest containing the samples was sealed with a Chain-of-Custody Seal before shipment in accordance with EPA procedures (MEIS, 1980).

4.5 Quality Assurance

Quality Assurance was maintained by use of analytical blanks, field transfer blanks and appropriate media samples as described in section 3.5. All samples shipped to the laboratory were accompanied by appropriate pre-analyzed organic-free water blanks, in containers of the type used for the environmental samples and/or field transfer blanks. Field transfer blanks were used to establish that trace levels of organic compounds in environmental samples did not result from field procedures. All analytical data obtained in this study has been reviewed by the Environmental Services Division for quality assurance acceptability.

Table 1

Priority Pollutant Analyses Request for Lakewood Observation Wells

METALS

ANTIMONY
ARSENIC
BERYLLIUM
CADMIUM
CHROMIUM
COPPER
LEAD
MERCURY
NICKEL
SELENIUM
SILVER
THALLIUM
ZINC

PESTICIDES

ALDRIN
CHLORDANE
DIELDRIN
4,4'DDT
4,4'DDE
4,4'DDD
ALPHA ENDOSULFAN
BETA ENDOSULFAN
ENDOSULFAN SULFATE
ENDRIN
ENDRIN ALDEHYDE
HEPTACHLOR
HEPTACHLOR EPOXIDE
ALPHA BHC
BETA BHC
GAMMA BHC (LINDANE)
DELTA BHC
TOXAPHENE
PCB 1016
PCB 1221
PCB 1232
PCB 1242
PCB 1248
PCB 1254
PCB 1260

BASE/NEUTRAL EXTRACTIBLES

. ACENAPHTHENE
. BENZIDINE
. 1,2,4-TRICHLOROBENZENE
. HEXACHLOROBENZENE
. HEXACHLOROETHANE
. BIS(2-CHLOROETHYL) ETHER
. 2-CHLORONAPHTHALENE
. 1,2-DICHLOROBENZENE
. 1,3-DICHLOROBENZENE
. 1,4-DICHLOROBENZENE
. 3,3-DICHLOROBENZIDINE
. 2,4-DINITROTOLUENE
. 2,6-DINITROTOLUENE
. 1,2-DIPHENYLHYDRAZINE
. FLUORANTHENE
. 4-CHLOROPHENYL PHENYL ETHER
. 4-BROMOPHENYL PHENYL ETHER
. BIS(2-CHLOROISOPROPYL)ETHER
BIS(2-CHLOROETHOXY) METHANE
HEXACHLOROBUTADIENE
HEXACHLOROCYCLOPENTADIENE
ISOPHORONE
NAPHTHALENE
NITROBENZENE
N-NITROSODIMETHYLAMINE
N-NITROSODI-N-PROPYLAMINE
N-NITROSODIPHENYLAMINE
BIS(2-ETHYLHEXYL) PHTHALATE
N-BUTYL BENZYL PHTHALATE
DI-N-BUTYL PHTHALATE
DI-N-OCTYL PHTHALATE
DIETHYL PHTHALATE
DIMETHYL PHTHALATE
BENZO(A)ANTHRACENE
BENZO(A)PYRENE
BENZO(B)FLUORANTHENE
BENZO(K)FLUORANTHENE
CHRYSENE
ACENAPHTHYLENE
ANTHRACENE
BENZO (GHI) PERYLENE
FLUORENE
PHENANTHRENE
1,2,5,6-DIBENZANTHRACENE
INDENO(1,2,3-CD)PYRENE
PYRENE
TCDD

ACID EXTRACTIBLES

2,4,6-TRICHLOROPHENOL
P-CHLORO-M-CRESOL
2-CHLOROPHENOL
2,4-DICHLOROPHENOL
2,4-DIMETHYLPHENOL
2-NITROPHENOL
4-NITROPHENOL
2,4-DINITROPHENOL
4,6-DINITRO-O-CRESOL
PENTACHLOROPHENOL
PHENOL

VOLATILE ORGANICS

ACROLEIN
ACRYLONITRILE
BENZENE
CARBON TETRACHLORIDE
CHLOROBENZENE
1,2-DICHLOROETHANE
1,1,1-TRICHLOROETHANE
1,1-DICHLOROETHANE
1,1,2-TRICHLOROETHANE
1,1,2,2-TETRACHLOROETHANE
CHLOROETHANE
CHLOROFORM
1,1-DICHLOROETHYLENE
1,2-TRANS-DICHLOROETHYLENE
1,2-DICHLOROPROPANE
CIS-1,3-DICHLOROPROPENE
TRANS-1,3-DICHLOROPROPENE
ETHYLBENZENE
METHYLENE CHLORIDE
METHYL CHLORIDE
METHYL BROMIDE
BROMOFORM
BROMODICHLOROMETHANE
TRICHLOROFLUOROMETHANE
DICHLORODIFLUOROMETHANE
DIBROMOCHLOROMETHANE
TETRACHLOROETHYLENE
TOLUENE
TRICHLOROETHYLENE
VINYL CHLORIDE
BIS(CHLOROMETHYL) ETHER
2-CHLOROETHYL VINYL ETHER

4.6 Site Safety Plan

A site safety plan was prepared by the Field Investigation Team, Region 10, Ecology and Environment, Inc. (FIT). This plan established the criteria for personnel protection as dictated by OVA-128 and HNU Model 101 analytical data. Since the level of organic vapors was expected to be very low in the respirable zone (breathing area of workers) respiratory protection was not required. Drillers were instructed to use disposable gloves, changing them on each well. The FIT provided a supply of MSA Ultra-twin respirators and Level D protective gear as a contingency. A copy of the Site Safety Plan is provided in the Appendix.

5.0 Results

5.1 Summary

This study generated a generous amount of hydrogeological and chemical data. These samplings were highly specific in purpose and the results should be interpreted with this in mind. Numerous samples were obtained prior to and during the course of drilling. These samples were either of a quality assurance nature or were exploratory, such as samples of aquifer material. All such samples were analyzed by the EPA Manchester lab for the Volatile Organics listed with the 129 priority pollutants, none were detected. The study produced physical data in terms of lithologic logs, which are presented in the Appendix, water level elevations and fluctuations, dynamic levels of chemical constituents during pumpage in waters from H-1 and H-2 and extensive background water quality data from the observation wells.

5.2 Data Obtained

The results of this study have been tabulated and plotted in the following Tables and Figures.

Table 2

Ground Water Elevations (in Feet) During Pumpage

November 5, 1981

WELL	TIME	ELEV	TIME	ELEV	TIME	ELEV	TIME	ELEV	TIME	ELEV	TIME	ELEV	TIME	ELEV
PRODUCTION WELL H-1	1030	68.0	1103	68.1	1149	67.9	1158	49.4	1207	49.2	1216	48.8	1225	48.6
PRODUCTION WELL H-2	1031	68.4	1105	68.4	1157	62.9	1205	62.3	1214	62.2	1223	62.5	1232	61.9
OBSERVATION WELL 1	1031	69.4	1105	69.4	1155	69.4	1204	69.5	1213	69.5	1222	69.5	1231	69.5
OBSERVATION WELL 2	1035	68.5	1101	68.4	1152	68.5	1159	68.4	1209	68.4	1217	68.4	1226	68.4
OBSERVATION WELL 3	1014	69.7	1037	69.7	1112	69.8	1200	69.8	1210	69.8	1223	69.8	1239	69.7
OBSERVATION WELL 4	1019	69.8	1041	69.8	1117	69.8	1203	69.7	1214	69.7	1227	69.7	1238	69.7
OBSERVATION WELL 5	1003	68.0	1032	68.0	1106	68.0	1126	68.0	1155	68.0	1206	67.9	1232	67.7
OBSERVATION WELL 6	1038	67.5	1109	67.1	1154	67.4	1203	67.8	1212	67.3	1220	66.9	1230	66.8
OBSERVATION WELL 7	1040	67.6	1059	57.5	1153	67.6	1202	67.6	1211	67.6	1219	67.6	1228	67.5
OBSERVATION WELL 8	1016	68.6	1039	68.6	1115	68.6	1202	68.6	1212	68.4	1225	68.3	1236	68.3
OBSERVATION WELL 9	1007	69.7	1036	69.7	1110	69.7	1158	69.7	1209	69.6	1229	69.6	1247	69.5
OBSERVATION WELL 10	1025	74.1	1046	74.1	1120	74.0	1218	74.0	1257	74.0	1430	74.0	1611	74.0

WELL	TIME	ELEV	TIME	ELEV	TIME	ELEV	TIME	ELEV	TIME	ELEV	TIME	ELEV	TIME	ELEV
PRODUCTION WELL H-1	1233	48.5	1241	67.7	1250	67.8	1310	67.7	1326	60.8	1340	60.6	1407	61.9
PRODUCTION WELL H-2	1240	61.8	1248	61.8	1323	67.8	1332	67.8	1346	68.0	1400	64.9	1402	22.2
OBSERVATION WELL 1	1238	69.5	1247	69.5	1321	69.5	1331	69.6	1345	69.8	1405	70.6	1418	70.8
OBSERVATION WELL 2	1235	68.4	1243	68.4	1315	68.4	1327	68.3	1341	68.3	1408	68.3	1420	68.3
OBSERVATION WELL 3	1248	69.7	1302	69.7	1320	69.7	1357	69.7	1410	69.7	1423	69.7	1439	69.7
OBSERVATION WELL 4	1252	69.6	1306	69.6	1325	69.7	1401	69.7	1408	69.6	1421	69.5	1437	69.5
OBSERVATION WELL 5	1243	67.6	1311	67.5	1313	67.5	1352	67.6	1443	67.4	1445	67.3	1501	67.2
OBSERVATION WELL 6	1238	66.7	1246	66.9	1320	66.8	1329	66.8	1344	68.9	1411	66.8	1424	66.7
OBSERVATION WELL 7	1237	67.5	1244	67.5	1318	67.4	1328	67.4	1342	67.5	1422	67.4	1429	67.4
OBSERVATION WELL 8	1250	68.2	1304	68.2	1322	68.4	1324	68.4	1359	68.4	1406	68.5	1419	68.3
OBSERVATION WELL 9	1308	69.5	1318	69.6	1355	69.6	1412	69.5	1425	69.5	1441	69.5	1454	69.4
OBSERVATION WELL 10														

Table 2

Ground Water Elevations (in Feet) During Pumping

November 5, 1981

WELL	TIME	ELEV	TIME	ELEV	TIME	ELEV	TIME	ELEV	TIME	ELEV	TIME	ELEV	TIME	ELEV
PRODUCTION WELL H-1	1419	60.8	1427	60.6	1434	60.5	1441	60.4	1448	60.2				
PRODUCTION WELL H-2	1546	66.0												
OBSERVATION WELL 1	1425	71.1	1432	71.3	1439	71.6	1447	71.8	1453	72.0	1545	73.3		
OBSERVATION WELL 2	1428	68.3	1435	68.3	1443	68.3	1451	68.3	1456	68.3	1546	68.0		
OBSERVATION WELL 3	1452	69.7												
OBSERVATION WELL 4	1450	69.5	1458	69.5										
OBSERVATION WELL 5	1546	67.2												
OBSERVATION WELL 6	1439	66.5	1445	66.7	1449	66.5	1458	66.4	1543	66.5				
OBSERVATION WELL 7	1437	67.5	1444	67.4	1450	67.4	1457	67.4	1553	67.2				
OBSERVATION WELL 8	1435	68.1	1449	68.0	1456	68.0	1606	68.2						
OBSERVATION WELL 9														
OBSERVATION WELL 10														

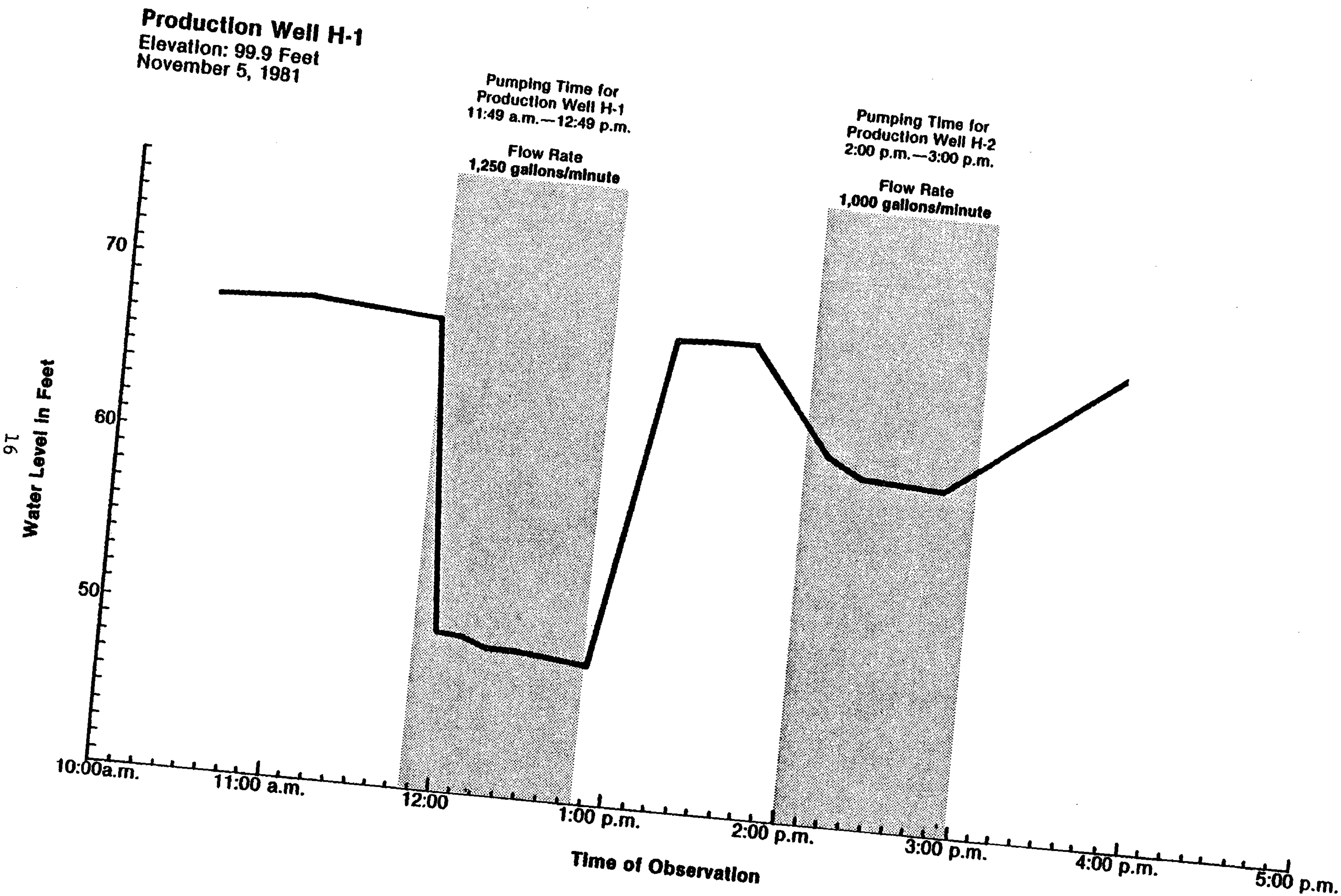

Production Well H-1
Elevation: 99.9 Feet
November 5, 1981
Pumping Time for
Production Well H-1
11:49 a.m.—12:49 p.m.
Flow Rate
1,250 gallons/minute
Pumping Time for
Production Well H-2
2:00 p.m.—3:00 p.m.
Flow Rate
1,000 gallons/minute
70
60
50
Water Level in Feet
10:00a.m.
11:00 a.m.
12:00
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
Time of Observation

Figure 8

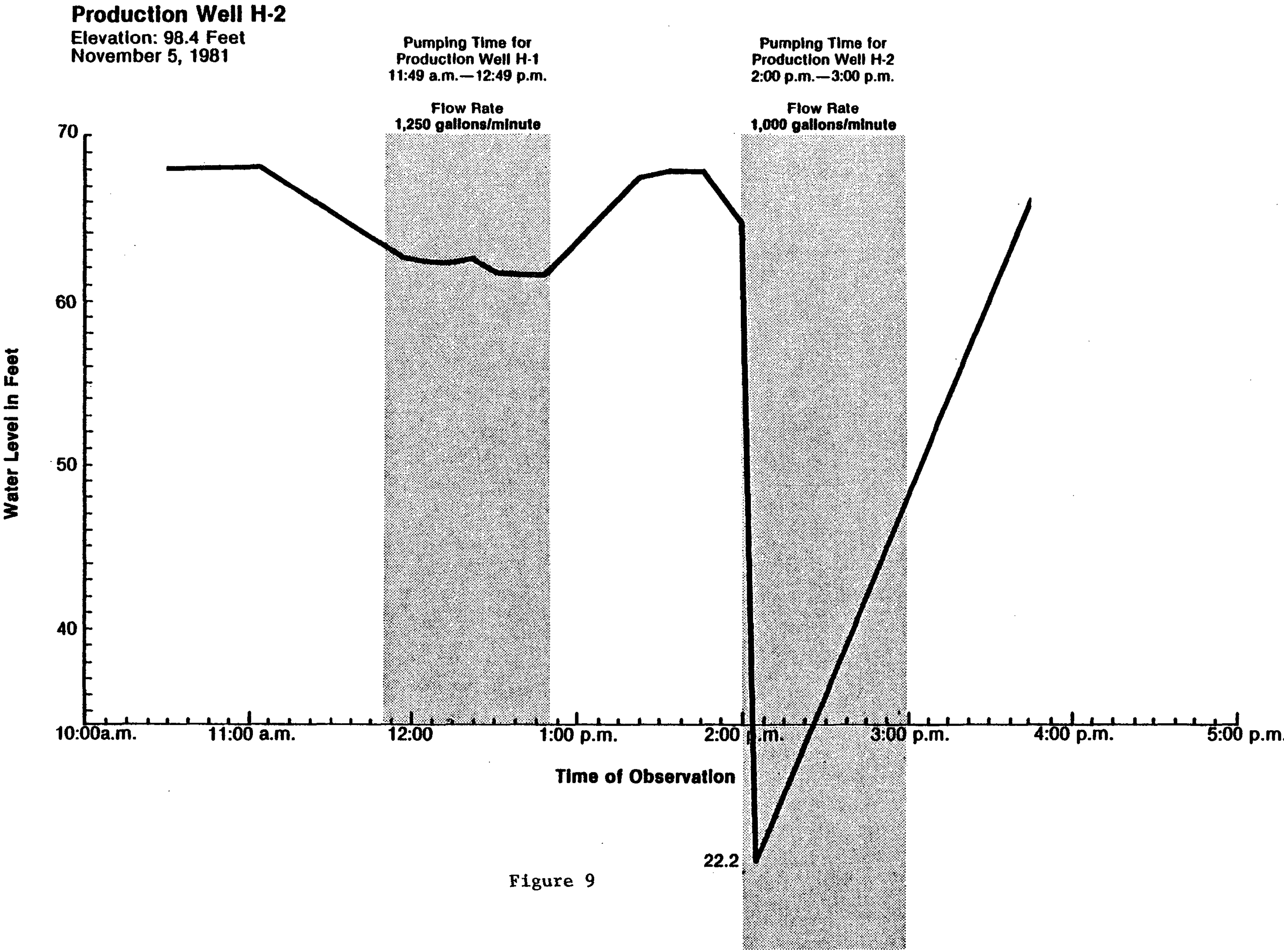

Production Well H-2
Elevation: 98.4 Feet
November 5, 1981
Pumping Time for
Production Well H-1
11:49 a.m.—12:49 p.m.
Flow Rate
1,250 gallons/minute
Pumping Time for
Production Well H-2
2:00 p.m.—3:00 p.m.
Flow Rate
1,000 gallons/minute
70
60
50
40
22.2
Water Level in Feet
10:00a.m.
11:00 a.m.
12:00
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
Time of Observation

Figure 9

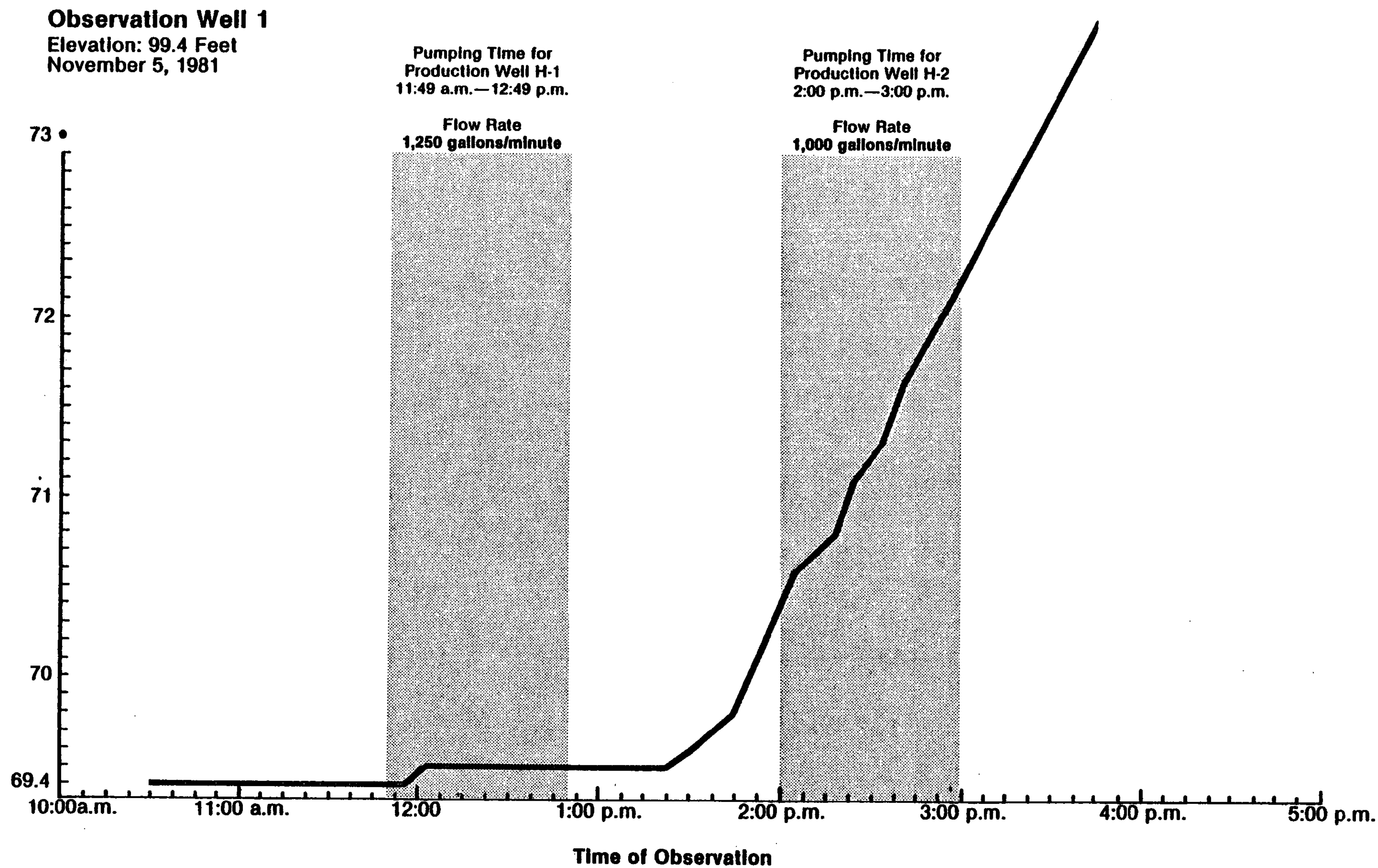

Observation Well 1
Elevation: 99.4 Feet
November 5, 1981
Pumping Time for
Production Well H-1
11:49 a.m.—12:49 p.m.
Flow Rate
1,250 gallons/minute
Pumping Time for
Production Well H-2
2:00 p.m.—3:00 p.m.
Flow Rate
1,000 gallons/minute
Water Level in Feet
73
72
71
70
69.4
10:00a.m.
11:00 a.m.
12:00
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
Time of Observation

Figure 10

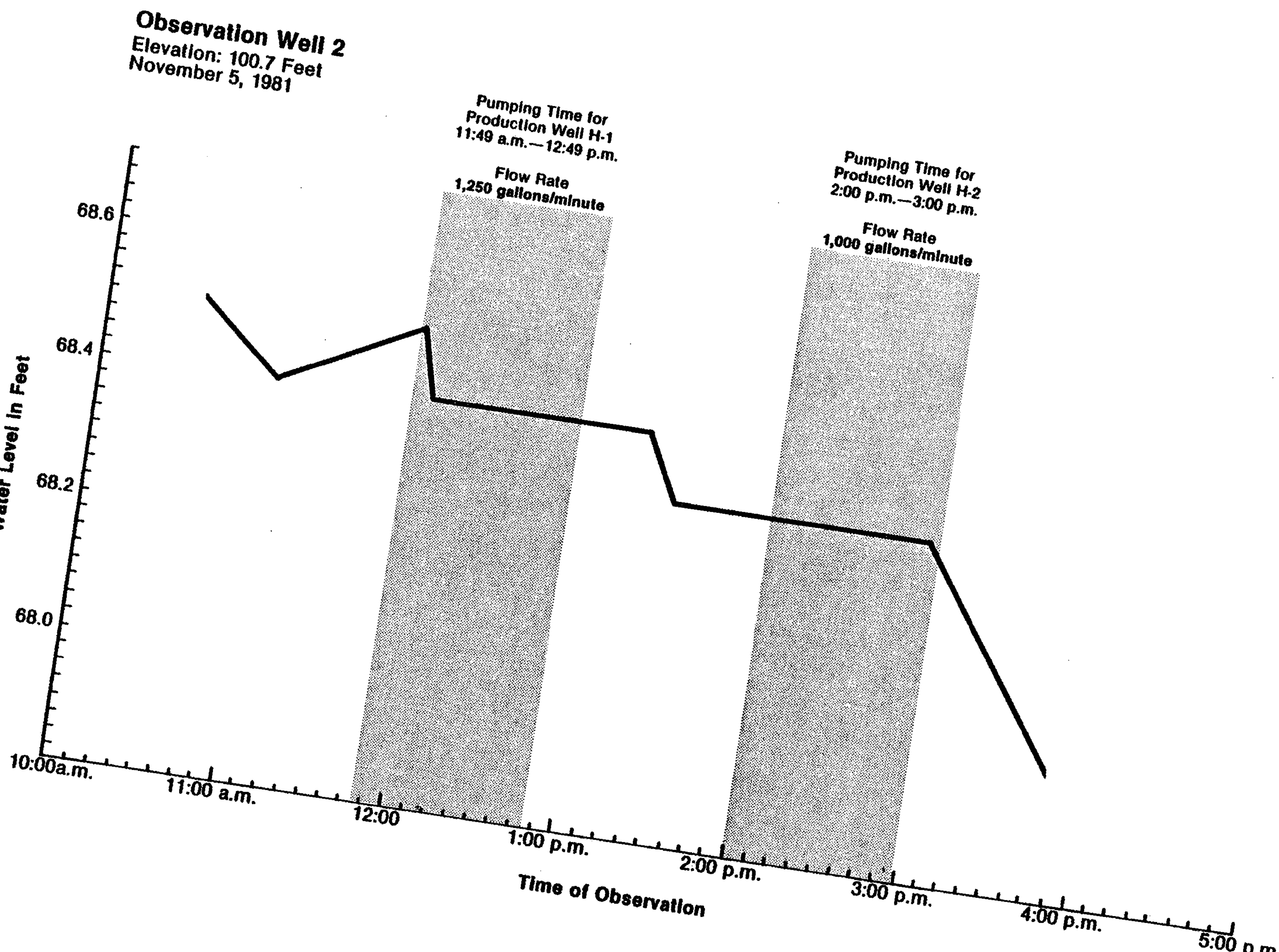

Observation Well 2
Elevation: 100.7 Feet
November 5, 1981
Pumping Time for
Production Well H-1
11:49 a.m.—12:49 p.m.
Flow Rate
1,250 gallons/minute
Pumping Time for
Production Well H-2
2:00 p.m.—3:00 p.m.
Flow Rate
1,000 gallons/minute
Water Level in Feet
68.6
68.4
68.2
68.0
10:00a.m.
11:00 a.m.
12:00
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
Time of Observation

Figure 11

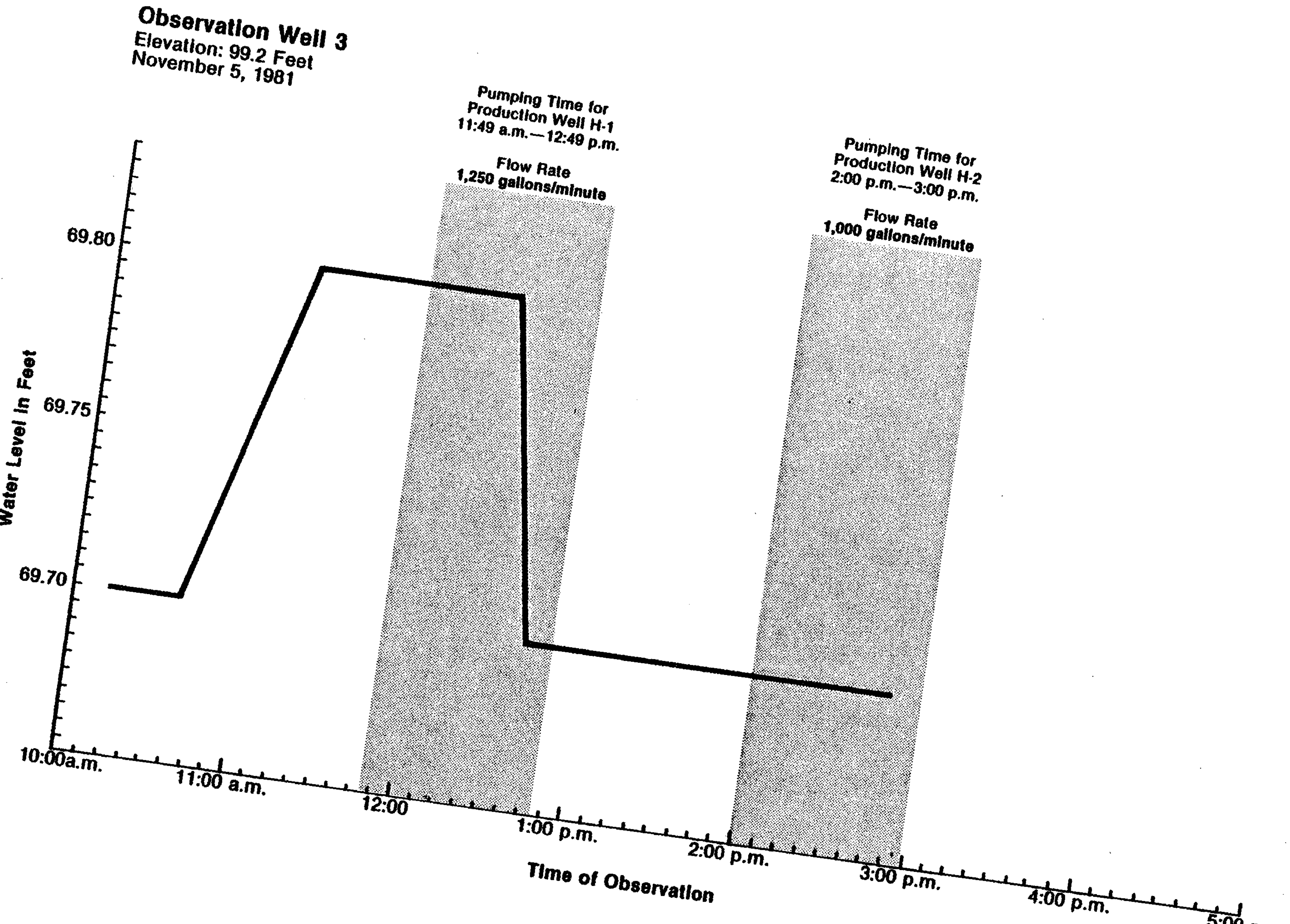
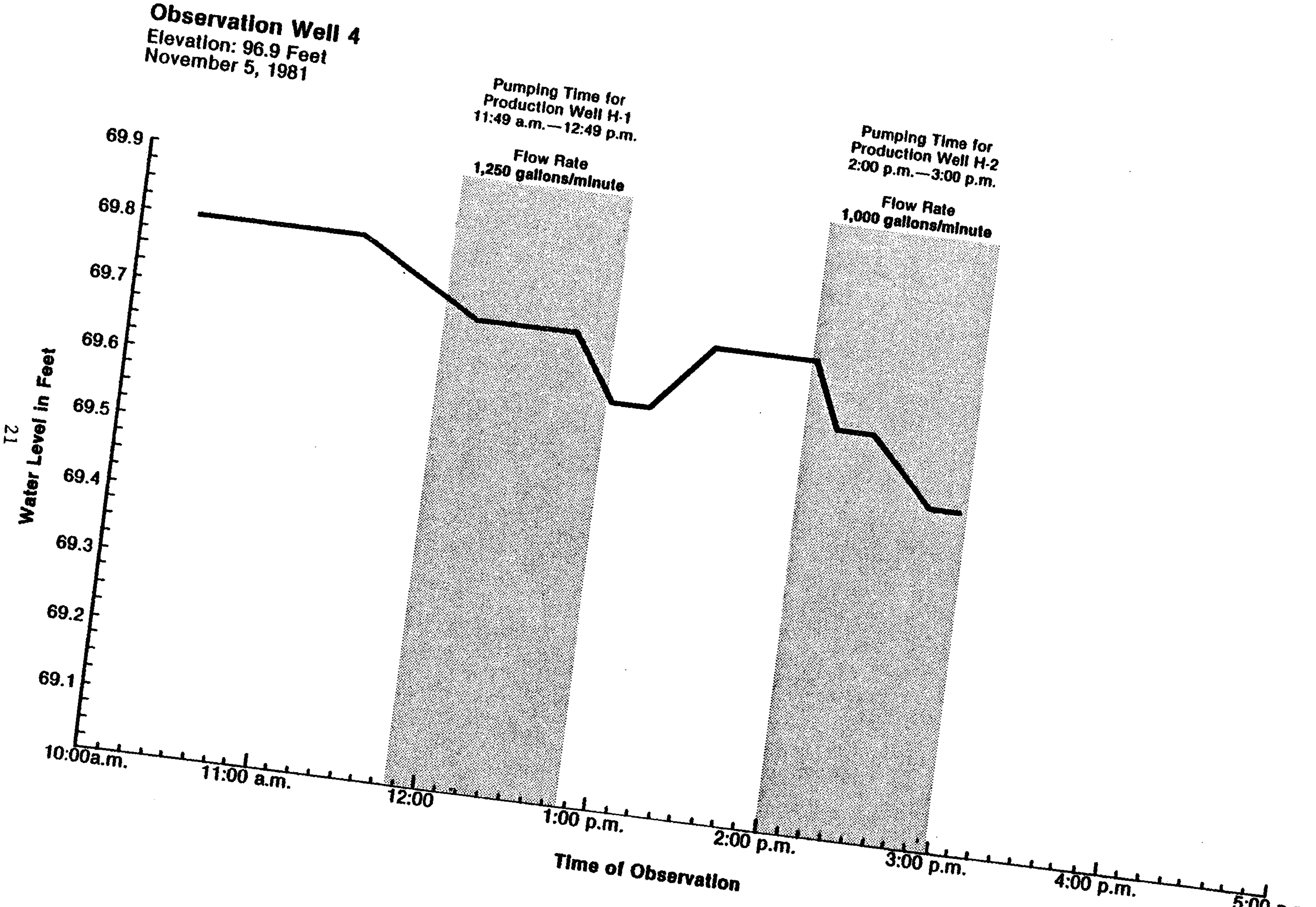

Observation Well 3
Elevation: 99.2 Feet
November 5, 1981
Pumping Time for
Production Well H-1
11:49 a.m.—12:49 p.m.
Flow Rate
1,250 gallons/minute
Pumping Time for
Production Well H-2
2:00 p.m.—3:00 p.m.
Flow Rate
1,000 gallons/minute
Water Level in Feet
69.80
69.75
69.70
10:00a.m.
11:00 a.m.
12:00
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
Time of Observation

Figure 12



Observation Well 4
Elevation: 96.9 Feet
November 5, 1981
Pumping Time for
Production Well H-1
11:49 a.m.—12:49 p.m.
Flow Rate
1,250 gallons/minute
Pumping Time for
Production Well H-2
2:00 p.m.—3:00 p.m.
Flow Rate
1,000 gallons/minute
69.9
69.8
69.7
69.6
69.5
69.4
69.3
69.2
69.1
Water Level in Feet
10:00a.m.
11:00 a.m.
12:00
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
Time of Observation

Figure 13

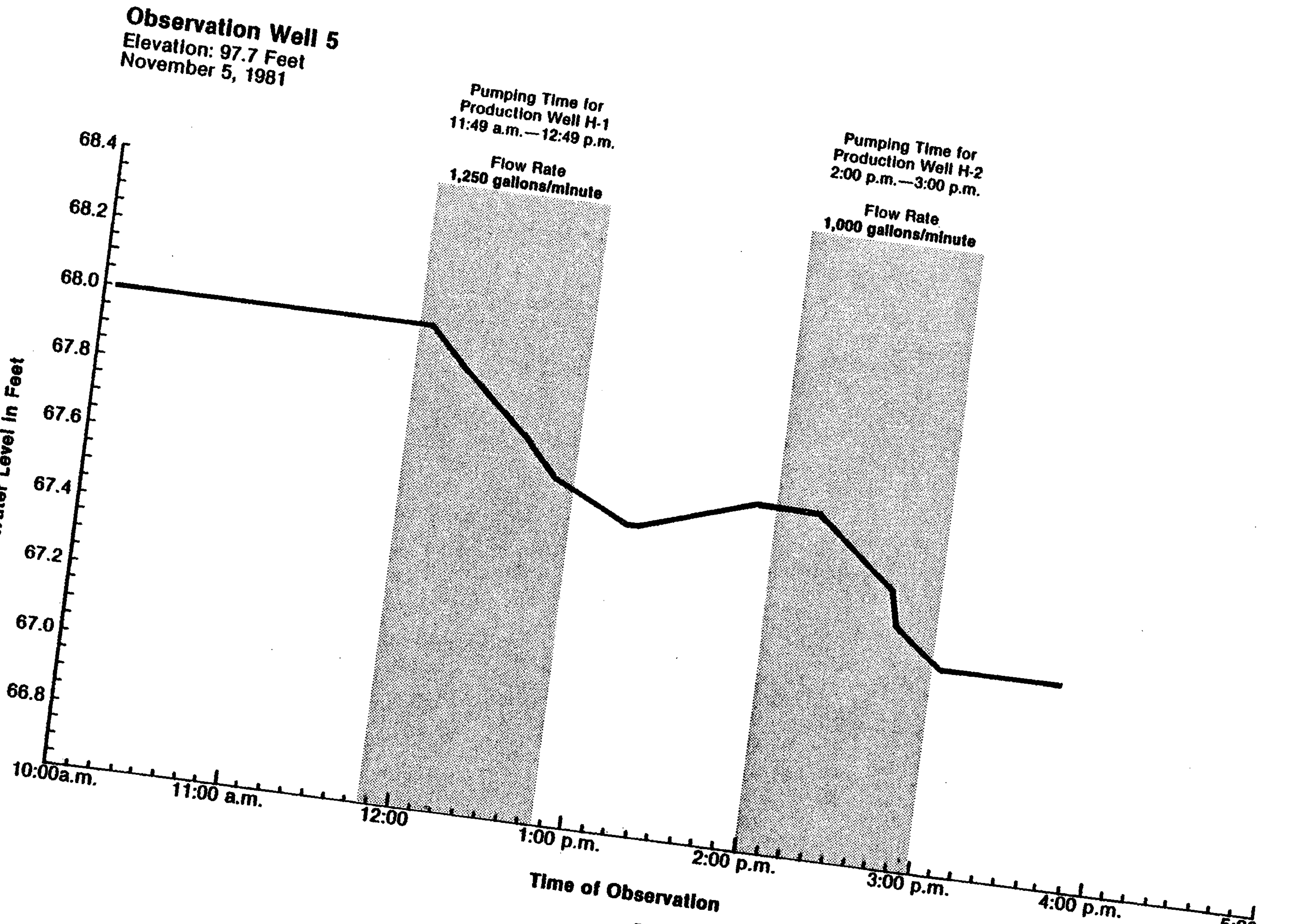

Observation Well 5
Elevation: 97.7 Feet
November 5, 1981
Pumping Time for
Production Well H-1
11:49 a.m.—12:49 p.m.
Flow Rate
1,250 gallons/minute
Pumping Time for
Production Well H-2
2:00 p.m.—3:00 p.m.
Flow Rate
1,000 gallons/minute
Water Level in Feet
68.4
68.2
68.0
67.8
67.6
67.4
67.2
67.0
66.8
10:00a.m.
11:00 a.m.
12:00
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
Time of Observation

Figure 14

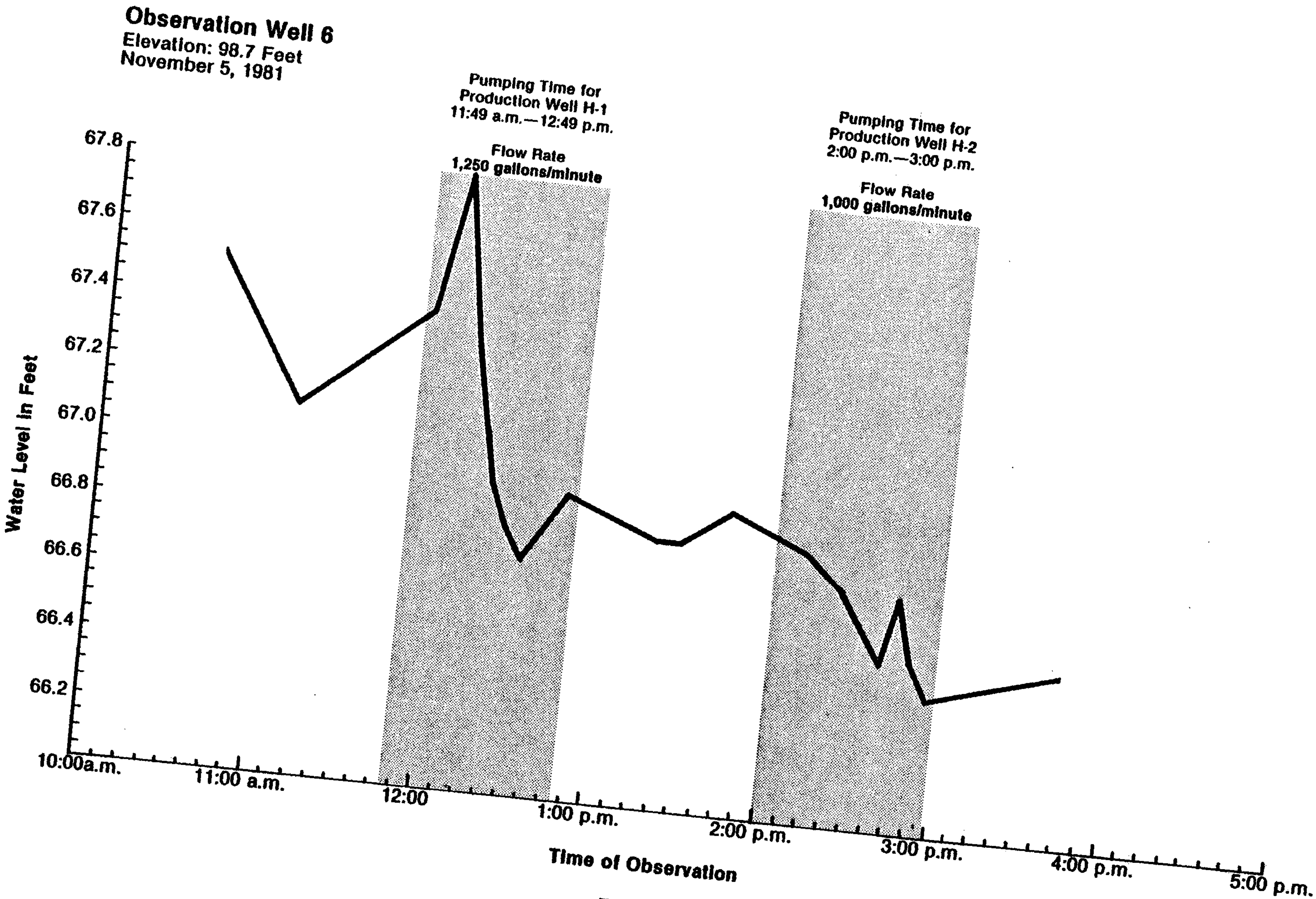
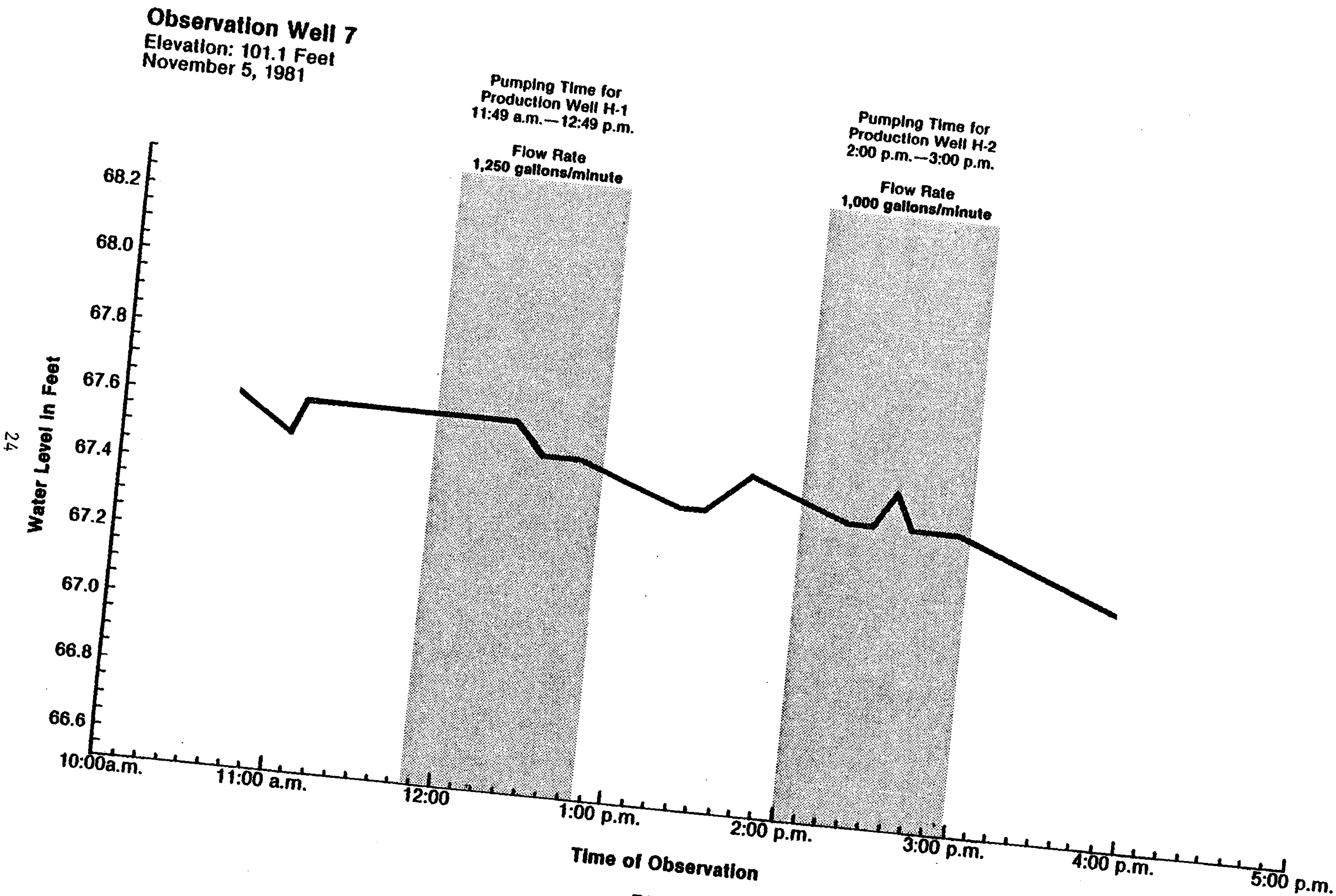

Observation Well 6
Elevation: 98.7 Feet
November 5, 1981
Pumping Time for
Production Well H-1
11:49 a.m.—12:49 p.m.
Flow Rate
1,250 gallons/minute
Pumping Time for
Production Well H-2
2:00 p.m.—3:00 p.m.
Flow Rate
1,000 gallons/minute
Water Level in Feet
67.8
67.6
67.4
67.2
67.0
66.8
66.6
66.4
66.2
10:00a.m.
11:00 a.m.
12:00
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
Time of Observation

Figure 15



Observation Well 7
Elevation: 101.1 Feet
November 5, 1981
Pumping Time for
Production Well H-1
11:49 a.m.—12:49 p.m.
Flow Rate
1,250 gallons/minute
Pumping Time for
Production Well H-2
2:00 p.m.—3:00 p.m.
Flow Rate
1,000 gallons/minute
Water Level in Feet
68.2
68.0
67.8
67.6
67.4
67.2
67.0
66.8
66.6
10:00a.m.
11:00 a.m.
12:00
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
Time of Observation

Figure 16

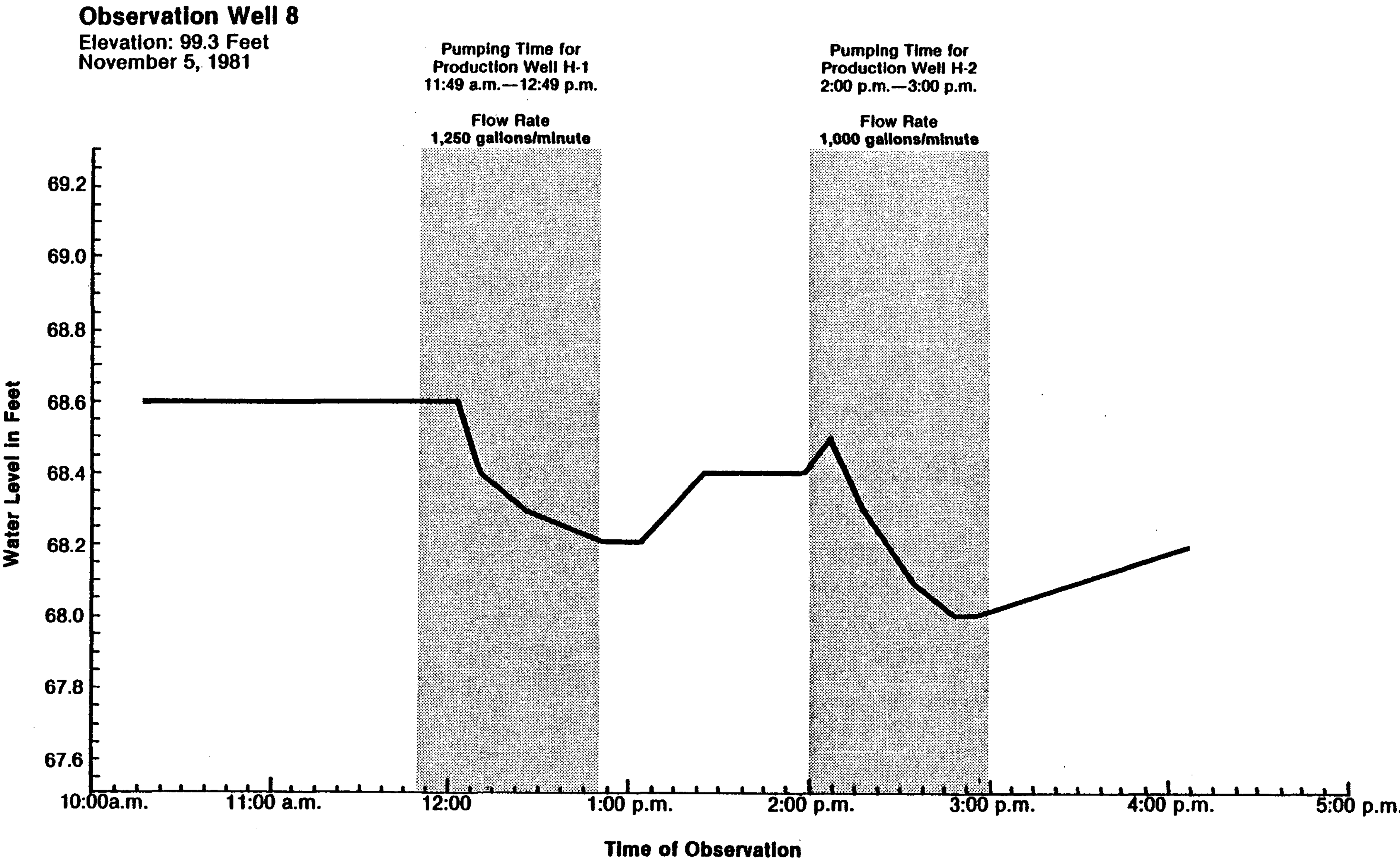

Observation Well 8
Elevation: 99.3 Feet
November 5, 1981
Pumping Time for
Production Well H-1
11:49 a.m.—12:49 p.m.
Flow Rate
1,250 gallons/minute
Pumping Time for
Production Well H-2
2:00 p.m.—3:00 p.m.
Flow Rate
1,000 gallons/minute
Water Level in Feet
69.2
69.0
68.8
68.6
68.4
68.2
68.0
67.8
67.6
10:00a.m.
11:00 a.m.
12:00
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
Time of Observation

Figure 17

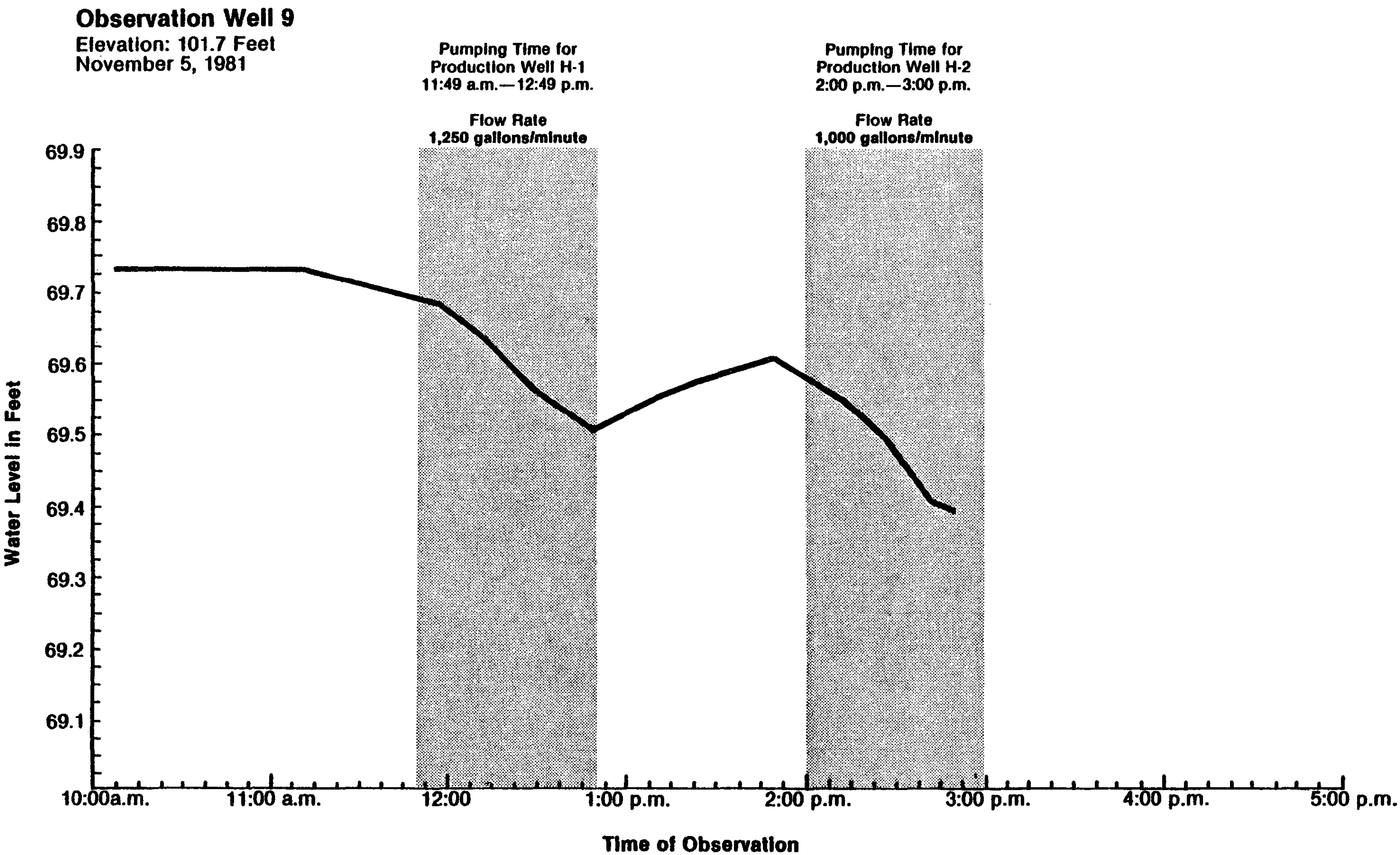

Observation Well 9
Elevation: 101.7 Feet
November 5, 1981
Pumping Time for
Production Well H-1
11:49 a.m.—12:49 p.m.
Flow Rate
1,250 gallons/minute
Pumping Time for
Production Well H-2
2:00 p.m.—3:00 p.m.
Flow Rate
1,000 gallons/minute
69.9
69.8
69.7
69.6
69.5
69.4
69.3
69.2
69.1
Water Level in Feet
10:00a.m.
11:00 a.m.
12:00
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
Time of Observation

Figure 18

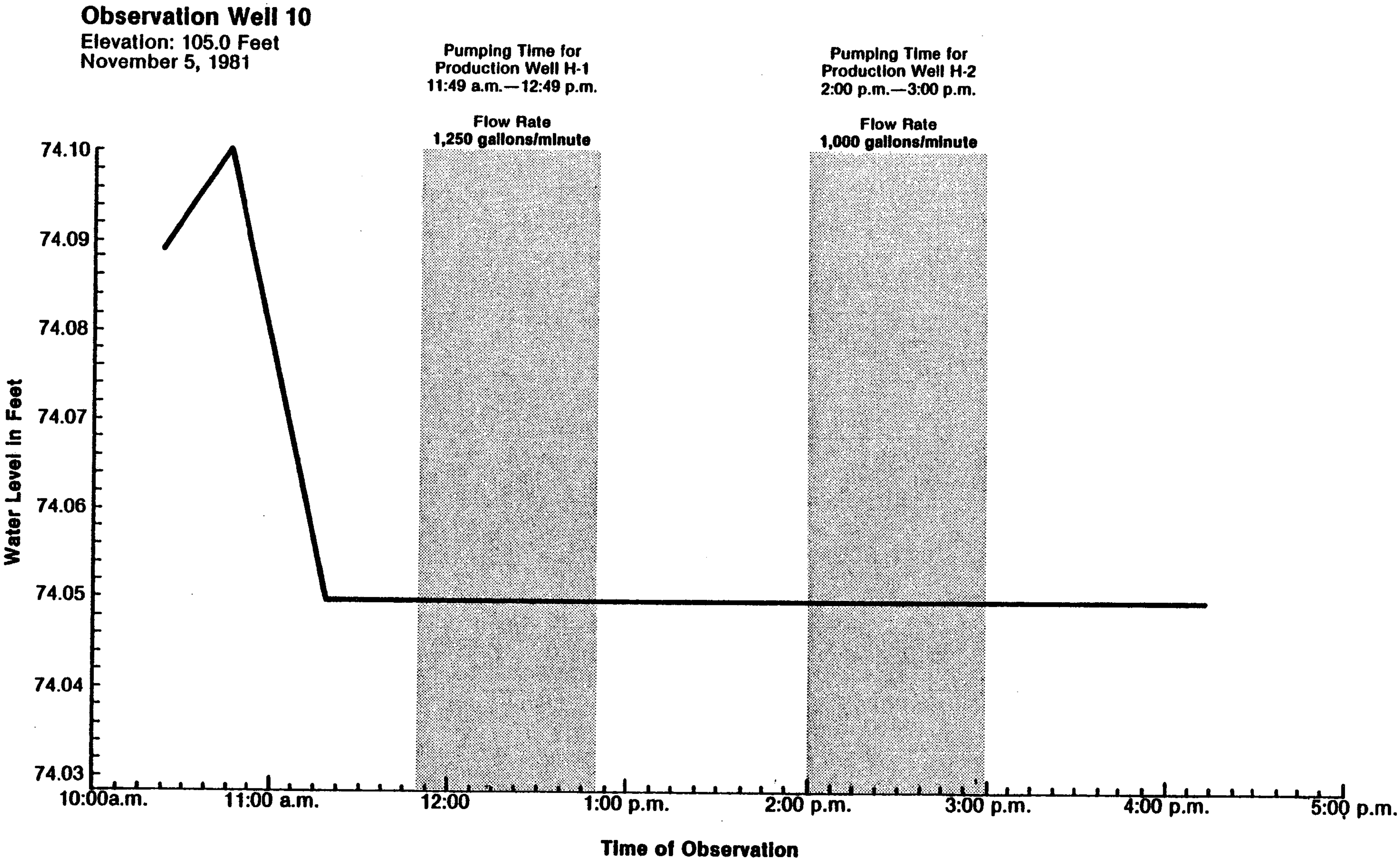

Observation Well 10
Elevation: 105.0 Feet
November 5, 1981
Pumping Time for
Production Well H-1
11:49 a.m.—12:49 p.m.
Flow Rate
1,250 gallons/minute
Pumping Time for
Production Well H-2
2:00 p.m.—3:00 p.m.
Flow Rate
1,000 gallons/minute
74.10
74.09
74.08
74.07
74.06
74.05
74.04
74.03
Water Level in Feet
10:00a.m.
11:00 a.m.
12:00
1:00 p.m.
2:00 p.m.
3:00 p.m.
4:00 p.m.
5:00 p.m.
Time of Observation

Figure 19

TABLE 3

CONTAMINANT CONCNETRATION V.S TIME DURING PUMPAGE

WELL - PRODUCTION WELL H-1
CONTAMINANT - TETRACHLOROETHYLENE

SAMPLE #	TIME (MIN FROM START OF PUMPING)	CONCENTRATION (UG/L)
44-364	1	5.6
44-365	11	23.0
44-366	23	23.0
44-367	35	26.0
44-368	47	29.0
44-369	60	29.0

TABLE 4

CONTAMINANT CONCNETRATION V.S TIME DURING PUMPAGE

WELL - PRODUCTION WELL H-1
CONTAMINANT - TRICHLOROETHYLENE

SAMPLE #	TIME (MIN FROM START OF PUMPING)	CONCENTRATION (UG/L)
44-364	1	1.9
44-365	11	6.6
44-366	23	3.0
44-367	35	3.2
44-368	47	4.2
44-369	60	3.8

TABLE 5

CONTAMINANT CONCNETRATION V.S TIME DURING PUMPAGE

WELL - PRODUCTION WELL H-1

CONTAMINANT - 1,2 TRANS DICHLOROETHYLENE

SAMPLE #	TIME (MIN FROM START OF PUMPING)	CONCENTRATION (UG/L)
44-364	1	9.8
44-365	11	34.0
44-366	23	34.0
44-367	35	32.0
44-368	47	37.0
44-369	60	34.0

TABLE 6

CONTAMINANT CONCNETRATION V.S TIME DURING PUMPAGE

WELL - PRODUCTION WELL H-2
CONTAMINANT - TETRACHLOROETHYLENE

SAMPLE #	TIME (MIN FROM START OF PUMPING)	CONCENTRATION (UG/L)
44-370	1	80
44-371	14	128
44-372	24	136
44-373	40	138
44-374	50	131
44-375	60	133

TABLE 7

CONTAMINANT CONCNETRATION V.S TIME DURING PUMPAGE

WELL - PRODUCTION WELL H-2
CONTAMINANT - TRICHLOROETHYLENE

SAMPLE #	TIME (MIN FROM START OF PUMPING)	CONCENTRATION (UG/L)
44-370	1	18.5
44-371	14	16.0
44-372	24	14.0
44-373	40	15.0
44-374	50	12.0
44-375	60	13.0

TABLE 8

CONTAMINANT CONCNETRATION V.S TIME DURING PUMPAGE

WELL - PRODUCTION WELL H-2
CONTAMINANT - 1,2 TRANS DICHLOROETHYLENE

SAMPLE #	TIME (MIN FROM START OF PUMPING)	CONCENTRATION (UG/L)
44-370	1	120
44-371	14	130
44-372	24	138
44-373	40	138
44-374	50	126
44-375	60	136

Concentration vs. Time During Well Pumpage
Lakewood Groundwater Study

Concentration of Tetrachloroethylene
Well H-1

November 5, 1981

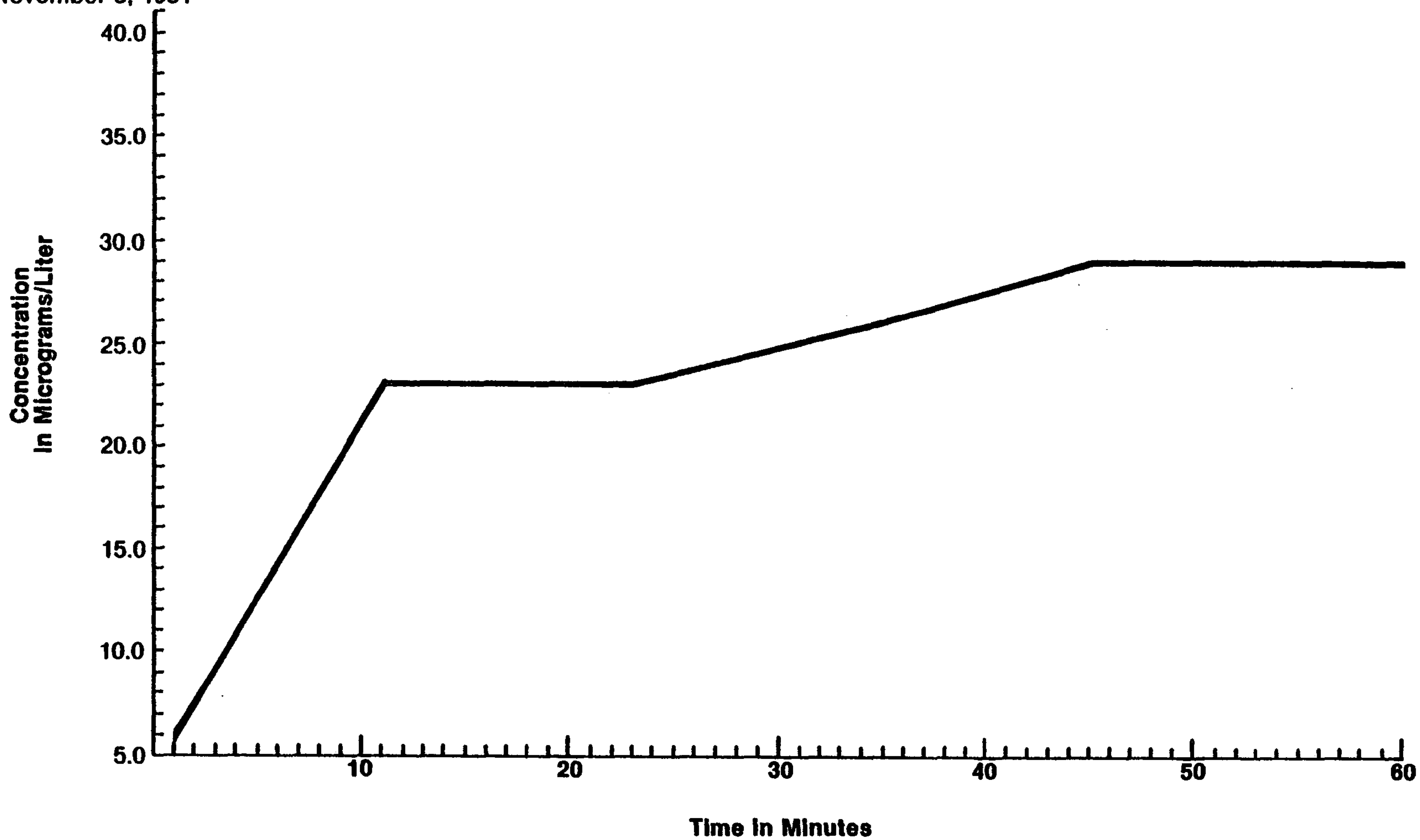


Figure 20

Concentration vs. Time During Well Pumpage
Lakewood Groundwater Study

Concentration of Trichloroethylene
Well H-1

November 5, 1981

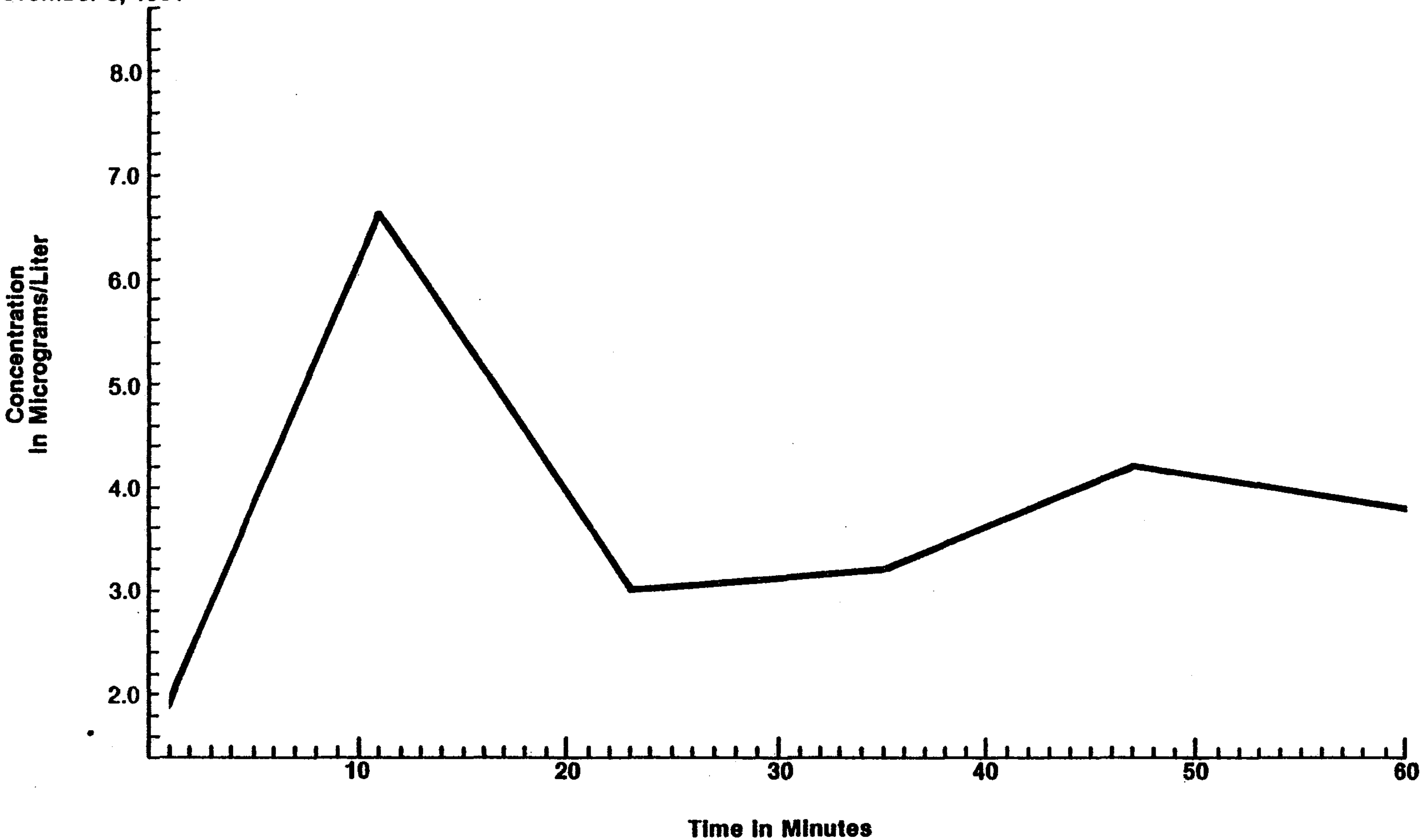


Figure 21

Concentration vs. Time During Well Pumpage
Lakewood Groundwater Study

Concentration of 1,2 (Trans)-Dichloroethylene
Well H-1

November 5, 1981

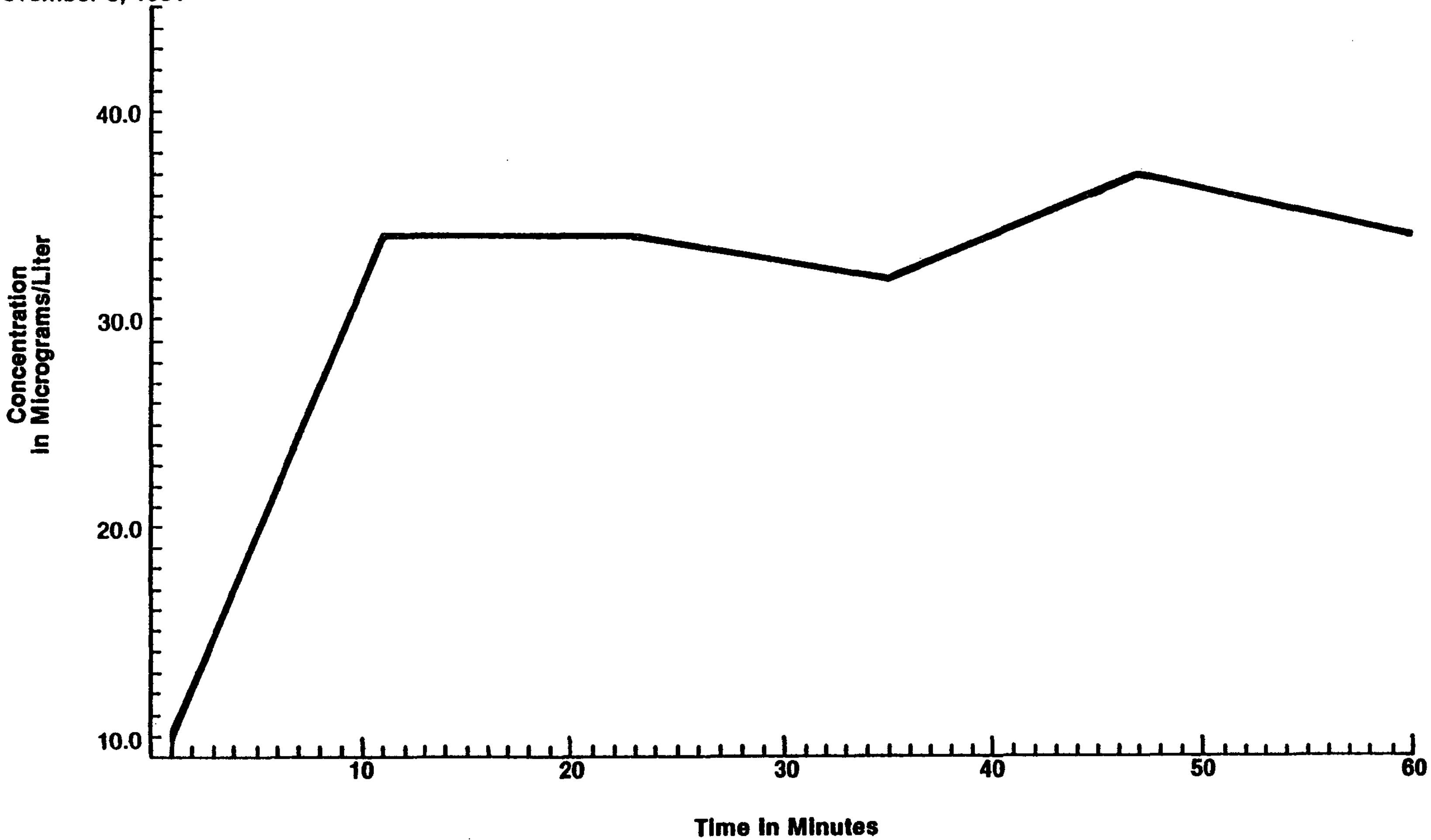


Figure 22

Concentration vs. Time During Well Pumpage
Lakewood Groundwater Study

Concentration of Tetrachloroethylene
Well H-2

November 5, 1981

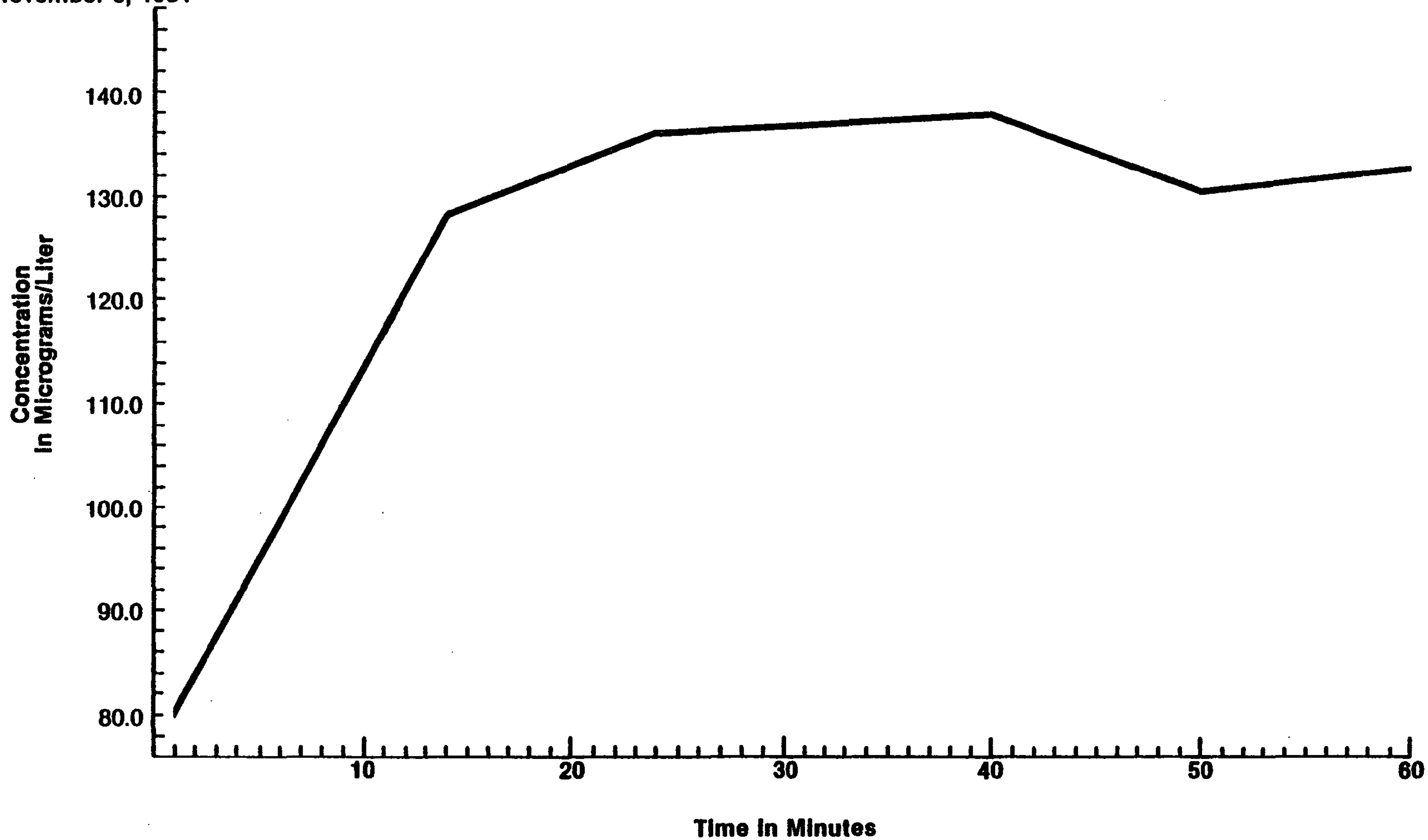


Figure 23

Concentration vs. Time During Well Pumpage
Lakewood Groundwater Study

Concentration of Trichloroethylene
Well H-2

November 5, 1981

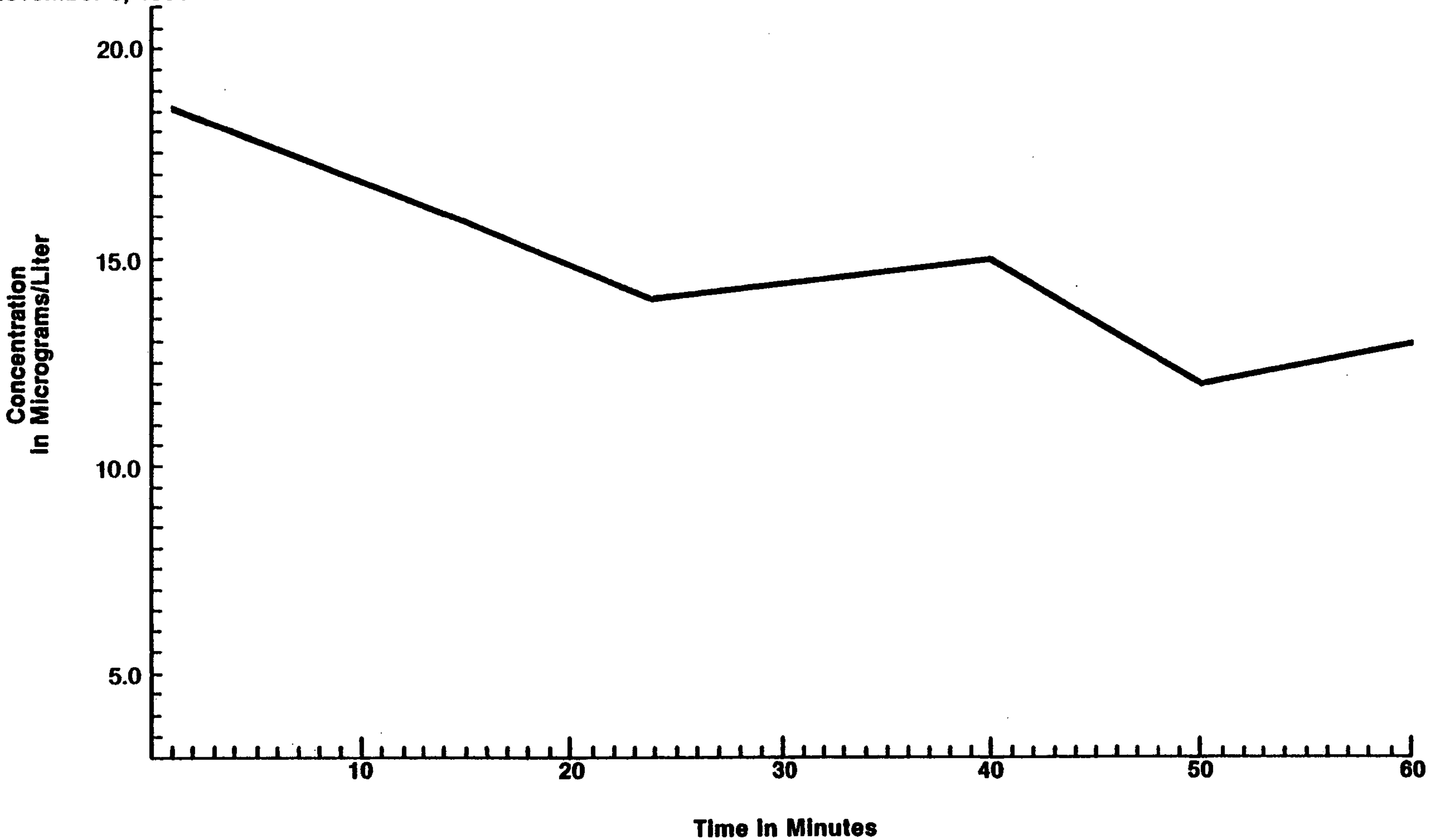


Figure 24

Concentration vs. Time During Well Pumpage
Lakewood Groundwater Study

Concentration of 1,2 (Trans)-Dichloroethylene
Well H-2

November 5, 1981

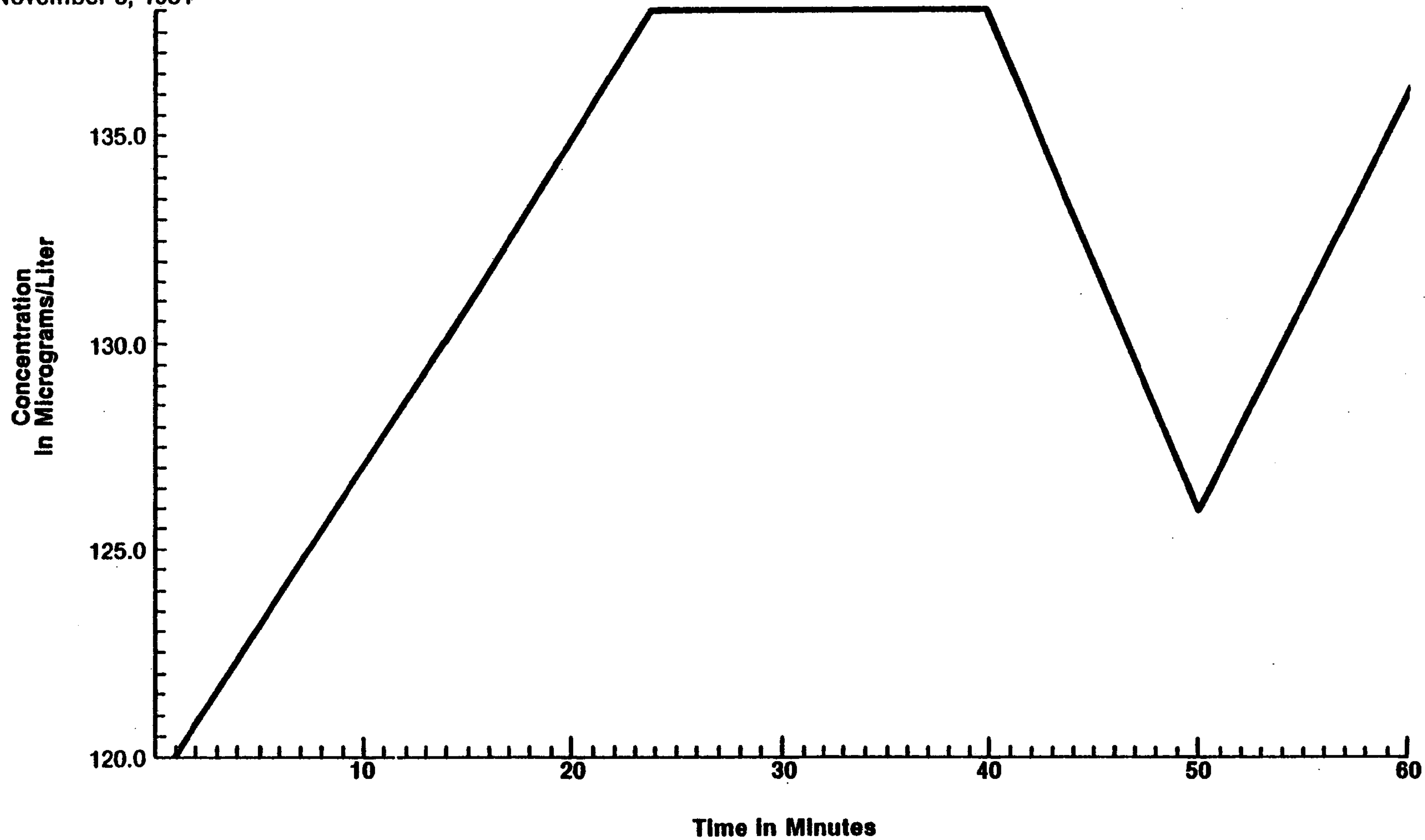


Figure 25

Table 9

General Geochemical Parameters

(mg/l)

WELL	SAMPLE	HARD	COND[1]	ALK	TDS	PH[2]	SO4	CL
OBSERVATION WELL 1	46-075	79	190	42	225	6.2	8.4	6.6
OBSERVATION WELL 2	46-076	69	143	42	320	6.4	4.6	2.9
OBSERVATION WELL 3	46-077	130	203	78	270	6.4	8.6	8.4
OBSERVATION WELL 4	46-078	154	344	40	330	6.2	18.0	31
OBSERVATION WELL 5	46-079	252	449	66	410	6.5	156	3.3
OBSERVATION WELL 6	46-080	96	202	58	350	6.4	8.4	5.4
OBSERVATION WELL 7	48-081	140	160	74	310	6.7	6.4	5.2
OBSERVATION WELL 8	46-082	210	168	78	220	6.5	7.8	4.6
OBSERVATION WELL 9	46-083	99	193	64	300	6.1	8.4	8.6
OBSERVATION WELL 10	46-084	63	162	49	270	6.2	19	3.4
PRODUCTION WELL H-1	N. A.	NA	NA	NA	NA	NA	NA	NA
PRODUCTION WELL H-2	46-086	86	223	77	160	6.1	14	13

1/ Conductivity is expressed as wmohs.

2/ pH is expressed in pH units.

TABLE 10

PRIORITY POLLUTANT ORGANIC COMPOUNDS
DETECTED
(UG/L)

WELL	SAMPLE	DICHLORO	TRI	TETRA	NAPHTHALENE	PCB 1254
OB WELL 1	46-075	8.0	0.5	2.0	ND	ND
OB WELL 2	46-076	0.3	ND	0.2	ND	ND
OB WELL 3	46-077	ND	ND	ND	<4.0	ND
OB WELL 4	46-078	2.5	ND	ND	ND	ND
OB WELL 5	46-079	ND	ND	ND	ND	ND
OB WELL 6	46-080	14.0	1.3	2.6	ND	ND
OB WELL 7	46-081	ND	ND	5.1	<4.0	0.130
OB WELL 8	46-082	ND	ND	ND	ND	ND
OB WELL 9	46-083	ND	ND	ND	ND	ND
OB WELL 10	46-084	ND	ND	ND	ND	ND
PR WELL H-1	46-085	9.0	0.3	5.0	NA	NA
PR WELL H-2	46-086	127.0	19.0	111.0	NA	NA

ND --- NOT DETECTED
NA --- NOT ANALYZED

5.3 Discussion

The observation wells provided data concerning the interconnection between the upper and lower aquifers. Clearly, the two zones are slightly interconnected and it is reasonable to expect that vertical pathway of high permeability is signigicantly lower than horizontal. The hypothesis that the annular gravel around H-2 could provide a vertical pathway for contaminant migration remains viable. Chemical analysis of the ground water from the observation wells indicates that the target contaminants (1, 2
(trans) Dichloroethylene, Trichloroethylene and Tetrachloroethylene) are present in wells immediately adjacent to H-2. The concentrations are significantly lower than are present in H-2 during static or pumped conditions.

It is possible that these materials are present in the aquifer, between 35 and 90 ft. moving with the ground water through zones of higher permeability.

Since a hydraulic interconnection has been demonstrated, the background water chemistry becomes significant. If the waters are similar geochemically, it is likely that they have a similar source and occur as a common ground water regime. The study generated data concerning the general chemical nature of the ground water in observation wells 1-10 and from the deeper water in H-2. Analyses seemed to exhibit significant variation in the parameters analyzed. No clear trend was obvious; hence the data was analyzed statistically. Using the Biomedical Computer Programs, P-series, 1979, a cluster analysis was performed. The program formed clusters of analytical data based on one of four distance measures. These distances are the Euclidean distance (L_2) the square root of the sum of the squares of the difference between the values of the variables for two cases); the Lp distance (the sum of the p^{th} power of the absolute difference); chi-square or phi-square (both measure the difference of frequencies in two cases).

Initially each case was considered a unique cluster. The program, by a series of steps, amalgamates two clusters having the shortest distance between them, forming a new, single cluster. This process of combining clusters continue until all the cases are combined into a single cluster. The data so obtained is presented in Figure 26. This figure shows that the data tends to amalgamate into two unique clusters. One cluster is formed by the data from observation wells 1, 2, 3, 4, 6, 7, 8, 9, 10, and H-2. The other cluster is the data from observation well 5. It would appear that the ground water in observation well 5 has a longer residence, perhaps representing a zone of low velocity or "stagnation" (of flow) in the regional flow network.

Chemical analyses for organic priority pollutants show the presence of Trace Naphtaline in observation wells 3 and 7. Also, in observation well 7, PCB 1254 has been identified. These are likely due to local sources in the immediate vacinity of the wells. The priority metal analyzis (Table 13) indicates that distinctive geochemical differences do exist between the observation wells and the production zone of this aquifer. Based upon this information, and the pump test results, the lower aquifer appears to have a higher transmissivity than the upper zone. It should also be noted, the upper aquifer does not meet drinking water standards based on numerous violations of heavy metal standards.

6.0 Conclusions and Recommendations

It is concluded from this investigation that the shallow zone of the aquifer serving Lakewood H-1 and 2 is not the source of contaminants reaching the lower, production zone. It is reasonable to assume that the principle contaminants, in H-1 and 2, are not the result of disposal or spillage in the recent past at or near the site. The hypothesis that these contaminants are migrating vertically through the gravel around H-2 remains a possibility. It is possible that a deeper zone, between 35 and 90 feet, beneath the surface is significantly contaminated. It is therefore recommended that an additional well be constructed near H-2 to a depth as required in order to establish or rule out this "intermediate zone" of contamination. Depth selection would necessarily be based on field data obtained by careful sampling during drilling. The OVA-128 should be used to analyze bailed water during drilling. Such a well would be constructed by cable tool, installing casing continuously and sampling at a very close interval, perhaps 1 foot. If a "hot" zone of contamination is encountered, the drilling would stop and slot cut at depth using a Mills knife. Extreme care in order not to provide an additional pathway of migration into the production zone would have to be present during this drilling program.

If it is determined that the source of contaminants is desired, additional wells completed deeper in the formation are required. The depth selection would be based on the results of the single additional well. From the information obtained in this study it is reasonable to assume that without removal of the source, the contamination of Lakewood H-1 and H-2 will continue for an unknown period of time. The problem is serious enough to warrant taking the two wells out of service indefinitely or begining treatment by advanced technology for removal of these compounds.

We recommend:

1) A survey should be initiated at Clover Creek for the target compounds.

2) the construction of a deeper well near H-2 to evaluate the presence of these compounds beyween a depth of 35 and 90 feet

3) The construction of 8-10 additional wells, screened in the zone located in 2 above. These wells would be best constructed interactively making use of the OVA and HNU. With these wells, a better data base will be established for tracking this contamination to its source.

TABLE 13

Priority Metals Analysis

(ug/l)

WELL	SB	AS	BE	CD	CR	CU	PB	HG	NI	SE	AG	TL	ZN
OBSERVATION WELL 1	<2	211	3.9	1.2	194	328	72	1.4	510	<2.5	2.1	<1.0	680
OBSERVATION WELL 2	<2	9	<0.1	<0.2	6	14	19	0.15	38	<2.5	<0.3	<1.0	70
OBSERVATION WELL 3	<2	500	6.6	1.8	250	448	338	1.4	900	<2.5	2.3	<1.0	70
OBSERVATION WELL 4	<2	244	4.2	1.0	159	280	154	0.6	535	<2.5	2.3	<1.0	650
OBSERVATION WELL 5	<2	69	2.1	0.4	69	120	132	0.3	165	<2.5	<0.3	<1.0	260
OBSERVATION WELL 6	<2	44	1.7	0.5	19	84	132	0.5	170	<2.5	<0.3	<1.0	210
OBSERVATION WELL 7	<2	111	5.6	4.3	231	456	220	2.7	510	<2.5	1.0	<1.0	1110
OBSERVATION WELL 8	<2	178	7.0	2.0	200	408	176	1.5	730	<2.5	1.0	<1.0	950
OBSERVATION WELL 9	<2	104	2.1	0.6	28	144	47	0.3	413	<2.5	0.3	<1.0	330
OBSERVATION WELL 10	<2	111	1.7	0.6	28	96	56	0.3	375	<2.5	0.3	<1.0	220
PRODUCTION WELL H-1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
PRODUCTION WELL H-2	<2	7	<0.1	<0.2	8	8	62	6.0	60	<2.5	0.3	<1.0	80

```
BMDP2M PAGE    3
LAKEWOOD GROUNDWATER STUDY


     C N
       O                    1 1
     A .    1  4  9  3  6  1  0  7  8  2  5

     S L    0  0  0  0  0  H  0  0  0  0  0
       A    0  0  0  0  0  -  1  0  0  0  0
     E B    1  4  9  3  6  2  0  7  8  2  5
       E
       L

 AMALG.
DISTANCE
            *  *  *  *  *  *  *  *  *  *  *
    1.924   I  I  I  I  I  I  I  -+-  I  I
    1.975   I  I  I  -+-  I  I   I    I  I
    2.222   I  I  I   I   I  I   -+--    I
    2.605   I  I  I   -+--   I    I      I
    2.730   I  I  I    -+---      I      I
    2.708   I  I  I     ---+----         I
    2.966   I  I  -------+-              I
    2.961   I  ---------+-               I
    3.354   ----------+-                 I
    4.009             -+----------
```

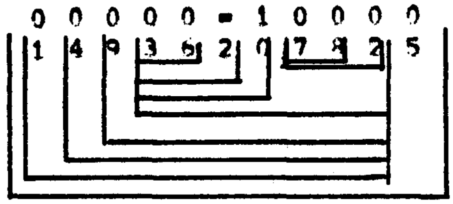


Figure 26

Convergence and Amalgamation Analysis

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APPENDIX

A. PERMISSION FOR DRILLING FORM

B. WELL LOGS

C. OVA DATA

D. WELL LOGS FROM H-1 AND H-2

E. SITE SAFETY PLAN

APPENDIX

Well Logs

Note: All water levels are as of 17 November 1981

Observation well #1 -- Date: 10-9-81

0'-14'	sand and gravels with cobbles, loose. Grain size decrease with depth.
14'-17'	Generally fine to medium gravels with few cobbles. A smell of solvents was detected around 16'.
17'-23'	Same as above. There was a heavy smell of solvents around 22'.
23'-24'	Generally large cobbles, loose.
24'-30'	Small to medium cobbles.

Boring completed at 30'

Water level after drilling 21.11 ft.

Observation Well #2 -- Date 10-12-81

0'-15'	Coarse sand and gravels with few cobbles, loose.
15'-18'	Mainly coarse gravel.
18'-21'	Fine to medium gravels.
21'-26'	Coarse gravels with few large cobbles.
26'-30'	Small to medium gravels, loose.
30'-35'	Same as above with large cobbles.

Boring complete at 35'

Water level after drilling 31.90 feet

Observation Well #3 -- 10-14-81

0'-25' Generally fine to medium sand and gravels, loose.

25'35' Medium to coarse gravels.

Boring completed at 35'

Water level after drilling 29.05 feet

Observation Well #4 - 10-15-81

0'-13' Sand and gravels, loose. Gravel size generally range from fine to medium with few coarse gravels. There appears to be slight increase in grain size from 10'.

13'-18' Medium to coarse gravels with few cobbles, loose.

18'-28' Same as above with occasional large cobbles.

28'-35' Generally coarse gravels with few cobbles. Grain size increase with depth.

Boring completed at 35'

Water level after drilling 26.75 feet.

Observation Well #5 -- 10-20-81

0'-4' Sand and gravels, loose.

4'-8' Generally fine to medium gravels, loose.

8'-17' Fine gravels with occasional zones of cobbles.

17'-28' Medium to coarse gravels with few boulders, loose. Grain size generally increase with depth.

28'-35' Fine sand and gravels with few cobbles.

Boring completed at 35'

Water level after drilling 29.10 feet

Observation Well #6 -- 10-21-81

0'-5' Sandy clay with gravels (fill)

5'-9' Sand and gravels, loose. Gravels are generally fine.

9'-10' Medium to coarse sand and gravels with few cobbles.

10'-35' Coarse gravels and cobbles. Grain size increase with depth.

Boring completed at 35'

Water level after drilling 30.90 feet.

Observation Well #7 -- 10-21-81

0'-3' Sand and gravels (fill).

3'-6' Sand and gravels with few cobbles.

6'-18' Generally fine to coarse gravels.

18'-29' Medium to coarse gravels with occasional cobbles.

29'-35' Sand and gravels with clay lenses.

Boring completed at 35'

Water level after drilling 33.25 feet.

Observation Well #8 -- 10-21-81

0'-2' Top soil - dark brown sandy clay.

2'-7' Medium to coarse sand and gravels with few cobbles.

7'-26' Generally coarse gravels with occasional zones of fine gravels.

26'-28' Sand and gravels with few cobbles.

28'-35' Coarse gravels with cobbles.

Boring completed at 35'

Water level after drilling 30.35 feet.

Observation Well #9 -- 10-22-81

0'-2' Top soil, sandy clay with few gravels.

2'-11' Coarse gravels.

11'-15' Fine to medium gravels with few cobbles.

15'-23' Generally coarse gravels with cobbles, clean and loose.

23'-35' Cobbles, loose

Boring completed at 35'

Water level after drilling 31.65 feet.

Observation Well #10 -- 10-22-81

0'-4' Gravels.

4'-6' Generally medium to coarse sand.

6'-15' Sand and gravel.

15'-27' Medium to coarse gravels with few cobbles, loose.

27'-34' Coarse sand and gravels with cobbles.

34'-35' Medium to coarse gravels.

Boring ~~Boding~~ completed at 35'

Water level after drilling 30.70 feet.

APPENDIX

OVA - Organic Vapor Analyzer Results

Observation Wells 1, 2, 3, and 4. Date: 10-9-81 thru 10-19-81.

Each of the monitoring wells had a varying degree of methane as a contaminant. Only Tetrachloroethylene was positively detected in well number 1.

Observation Wells 3, 4, and 5. Date: 10-20-81.

There was a varying degree of total organics in Well #5, between 15'-30' level. The highest reading was 30 ppm.

- 100 ml. of the 1.1.2 trichloroethylene standard was run with a peak developing at the predicted retention time of 7 minutes.

- 200 ml. of water from well #5 showed no results.

- 200 ml. of water from well #3 showed a peak in the backflush cycle at about 11 minutes. This could indicate the presence of tetrachloroethylene or a substance with a similar molecular weight.

- 200 ml. of water from well #4 showed no results.

Observation wells 6 & 7. Date 10-21-81.

The survey mode was used to "sniff" wells 6 and 7 during well construction. The readings showed very small levels of total organic vapor.

Observation wells 1, 2, 3, 8, and 9. Date 10-22-81.

The survey mode was used to "sniff" #8 and 9 during well construction. The readings indicated less than 5 ppm total organics in the well.

- 200 ml. of water from well #1 showed a small methane peak and a very small peak at 2-3 minutes was noted in the backflush cycle.

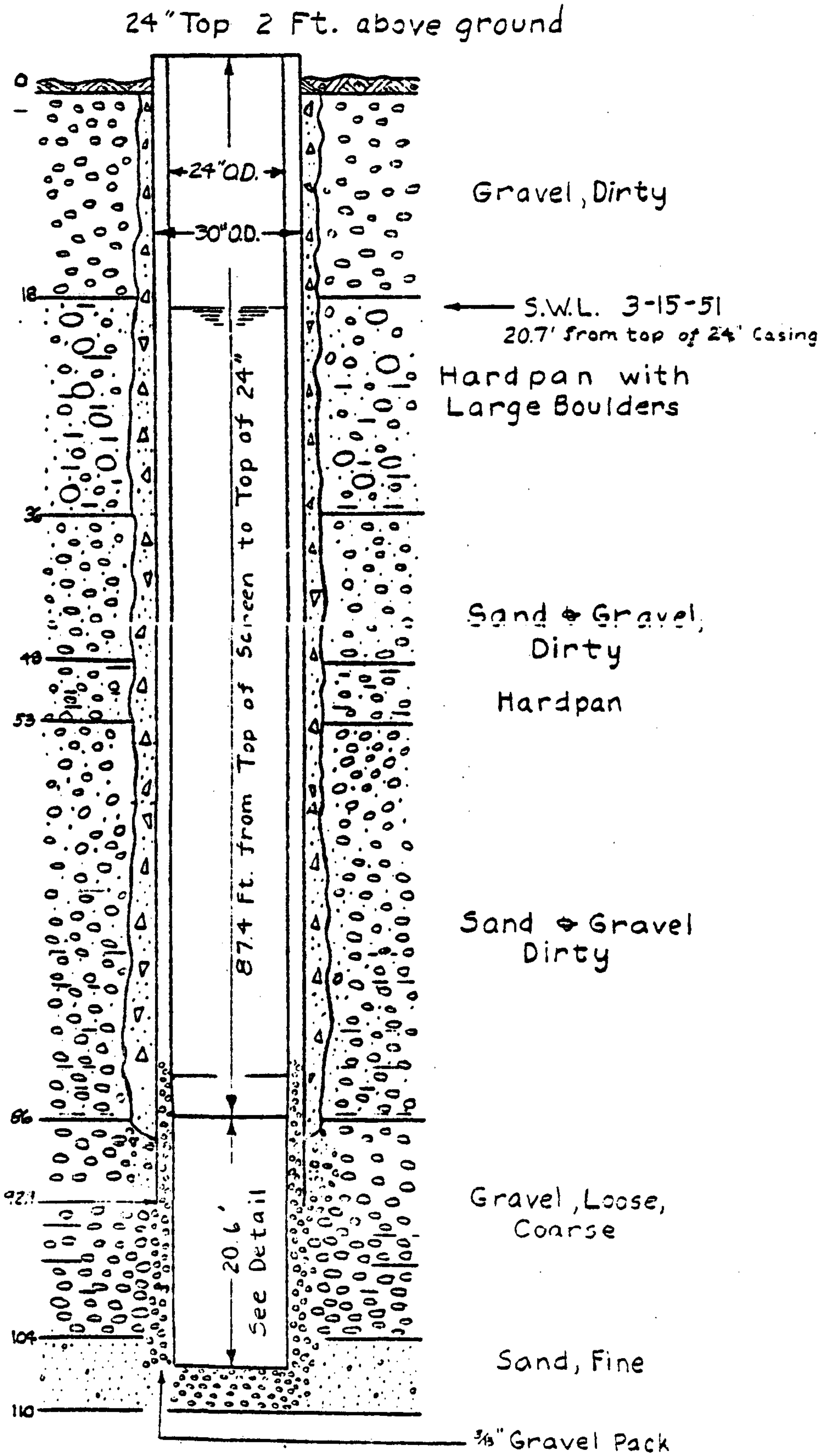
- 200 ml. of water from well #2 showed no results.

- 200 ml. of water from well #3 showed a small peak at 11-12 min. which may indicate a low level of tetrachloroethylene or a substance of like molecular weight. Small peaks also noted at 12-13 min. of backflush cycle. Possibly this may merely be "noise" on the strip chart recorder.

Observation Well #4. Date 10-23-81.

- 50 ml. of the trichloroethylene standard was run with a peak developing at the predicted time of 4.5 min.

- 200 ml. of water from well #4 showed a peak at about 3 min. This may indicate presence of dichloroethylene.



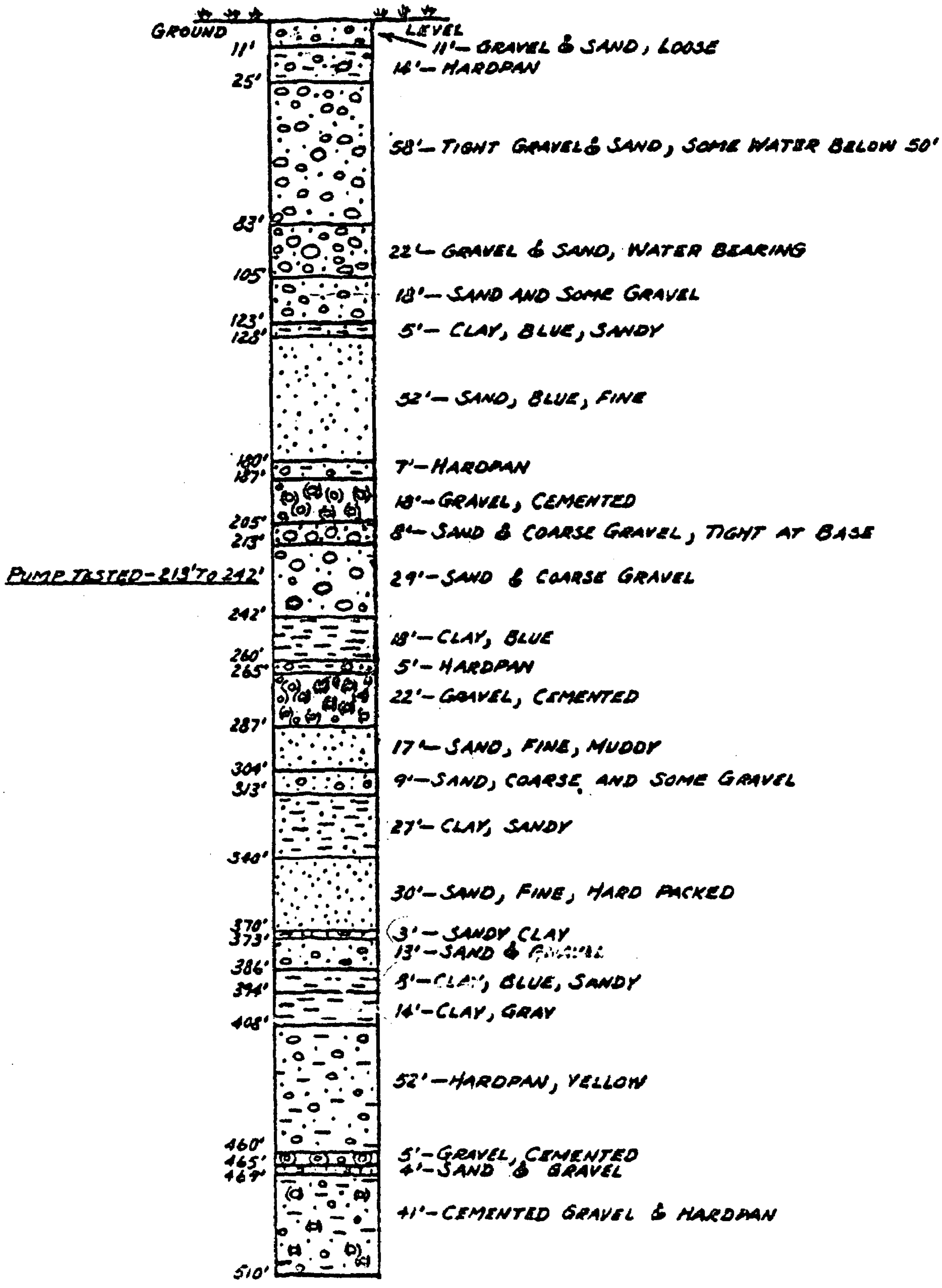
WELL DATA

30" & 24" Casing 3/8" Thick

Δ Cement, Gravel & Sand Grout Backfill

Gravel Backfill from 106' to 110' Below Screen

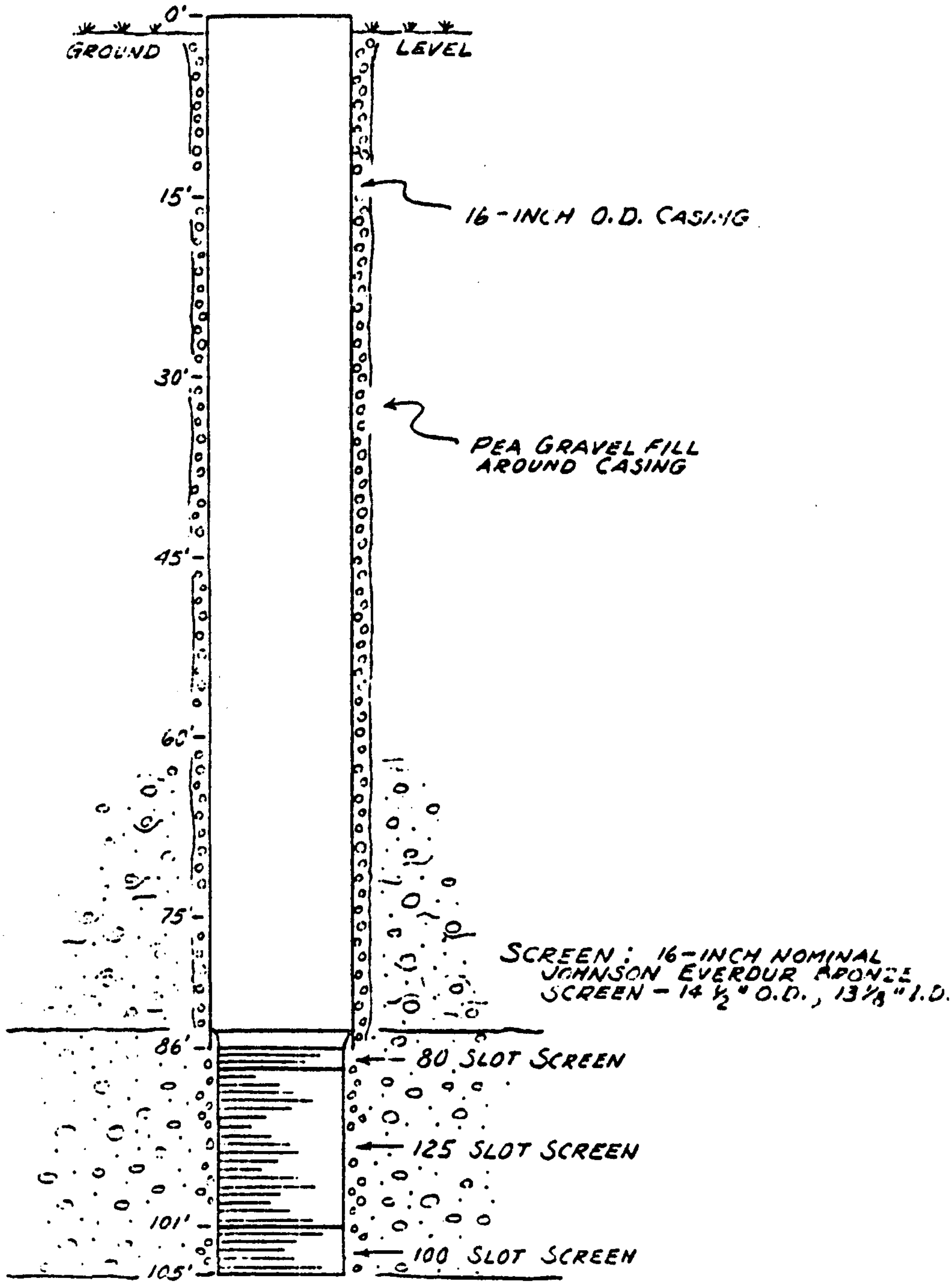
TEST WELL NO. 2 AT PONDERS CORNER



HOLE BOTTOMED AT 510'

LAKEWOOD WATER DISTRICT PIERCE COUNTY, WASHINGTON	ROBINSON AND ROBERTS GROUND WATER GEOLOGISTS TACOMA, WASHINGTON John W. Robinson	SEPT. 24, 1959
DRILLED BY: L.R. GAUDIO DRILLING CO.		A-433, H.M.

CONSTRUCTION DETAILS OF WELL H-2 AT PONDERS CORNER



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DRILLED BY: L.R. GAUDIO DRILLING CO.		A-434, H. N.