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EARTH SCIENCES DIVISION

Preliminary Environmental Investigations at the Lawrence Berkeley Laboratory

I. Javandel

November 1990

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PRELIMINARY
ENVIRONMENTAL INVESTIGATIONS
AT THE LAWRENCE BERKELEY LABORATORY

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Earth Sciences Division

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Berkeley, CA 94720

November 1990

This work was done at the Lawrence Berkeley Laboratory, which is operated by the University of California for the U. S. Department of Energy under contract DE-AC03-76SF00098.

EXECUTIVE SUMMARY

Lawrence Berkeley Laboratory (LBL) is a research facility managed by the University of California for the United States Department of Energy (DOE). It is located in the Berkeley Hills adjacent to the main campus of the University of California at Berkeley. Ernest Lawrence started the Laboratory in 1940 essentially as a center for nuclear physics research. Since then it has grown to 12 major research divisions and supporting organizations housed in more than 100 buildings. Out of necessity, most of these buildings have some shop facilities for manufacturing research instrumentation. Others have different physical, chemical and biological laboratories. Over the years, many types of chemicals, some hazardous, have been used in these shops and laboratories.

In the summer of 1986, as a part of the environmental baseline study for the development of East Canyon area within the site, LBL staff collected several samples of soil, groundwater, surface water, and vegetation from within the property's boundary, as well as from the adjacent areas. Groundwater samples were collected from a few flowing horizontal drains (hydraugers). Chemical analysis of water samples from two adjacent hydraugers east of Building 51 showed low levels of solvents (chlorinated hydrocarbons). Flow rates from these hydraugers are of the order of one or two liters per minute. Because of the persistence of these levels of chemical concentration in the effluent water from these two hydraugers and the observation of some contaminations elsewhere in the Laboratory, in 1989, LBL submitted a proposal to DOE for a site-wide environmental characterization and monitoring program. Meanwhile, during Fiscal Year 1990, using laboratory overhead resources, LBL carried out a preliminary investigation. The results of it are as follows:

1. The source of contamination observed in the hydraugers' effluent east of Building 51 is believed to be leakage from a sanitary sewer coming from Building 71. This sewer line was decommissioned during 1988. A few chlorinated hydrocarbons were detected in a relatively narrow aquifer formed along the bed of the main branch of the original Blackberry Canyon Creek. Observed concentrations of these chemicals in the groundwater never exceeded 0.1 mg/L during the course of this investigation. To investigate the extent of contamination we are currently in the process of installing three new monitoring wells downstream from the observed position of the contaminant plume.

2. Chemical analysis of "grabbed" samples from a few wells and slope indicators in the "old town" (Buildings 7, 52, 53 area) showed chlorinated hydrocarbons ranging up to 2 mg/L. However, study of subsurface geologic information from past and recent drilling as well as a single pumping test indicates that the contaminated water is limited to a very thin saturated seam (about 4 inches thick), having a very low hydraulic transmissivity. Further studies will be carried out to

check the validity of this conclusion.

3. Chemical analysis of water samples collected from three nearby wells in the Corporation Yard (Buildings 69-75 area) showed some low concentrations of chlorinated solvents (less than 0.1 mg/L). Based on present information, the plume of contamination in this area seems to be relatively small. A more detailed study is being carried out to characterize this contamination.

A site-wide program of investigation is being implemented during Fiscal Year 1991 to complete the characterization of the above three problem areas, and to identify other possible environmental contamination at LBL. Specific attention will be paid to monitoring the presence of contamination at the property boundary. Some interim remedial actions may be proposed and if approved, carried out during Fiscal Year 1991.

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1. INTRODUCTION

Objectives

The objectives of this preliminary investigation were to identify the source and the extent of groundwater contamination causing discharge of contaminants from hydraugers east of Building 51, and to look for the presence of other possible soil and groundwater contaminations elsewhere within the LBL property.

Background

In September 1986, chemical analysis of a mixed water sample collected from three horizontal drains (hydraugers) discharging in an area east of Building 51 (see Figure 6) showed 13 ppb of trichloroethylene (TCE) and 94 ppb perchloroethylene (PCE). In addition, groundwater samples were collected from hydraugers discharging in the vicinity of Buildings 54, 71, 75, 77 and offsite areas such as small springs along Claremont Creek and Wildcat Creek. None of these samples showed any of the EPA priority pollutants above the detection limits (Lawrence Berkeley Laboratory, 1986).

A Department of Energy (DOE) Environmental Survey Team visited LBL during February 22-29 1988. In their report (Department of Energy, 1988), they referred to the 1986 findings of solvents in groundwater and indicated that the polluted groundwater discharging through the hydraugers enters the storm water system, which eventually flows into the San Francisco Bay. They also pointed out that "the LBL has not conducted any follow up work since the 1986 study revealed the presence of organic chemical contaminants."

In their conclusions they reported that "The Survey found no environmental problems at the LBL facility that represent an immediate threat to human life." They recognized, however, that full understanding of some of the identified environmental problems are beyond the scope of that Survey.

Following the outcome of the above Survey, in September 1988 LBL hired Harding Lawson associate (HLA) to perform a fast track sampling effort at the LBL site (Harding Lawson, 1988). HLA collected water samples from three slope indicators. One of these, situated on the hill east of Building 46, has no LBL facility upstream from it. Chemical analysis of the sample from this slope indicator did not show any contamination. The other two slope indicators were located north and south of Building 53. The water sample from the slope indicator north of Building 53 showed a very low level of chloroform, TCE and PCE, all of them below their respective Safe Drinking Water Act (SDWA) maximum contaminant level (MCL). The sample collected from the slope indicator south of Building 53, however, showed a relatively high concentration of TCE and PCE, far above the MCL. Figure 1 shows the location of these slope indicators, and the results of chemical analysis are given in Table 1.

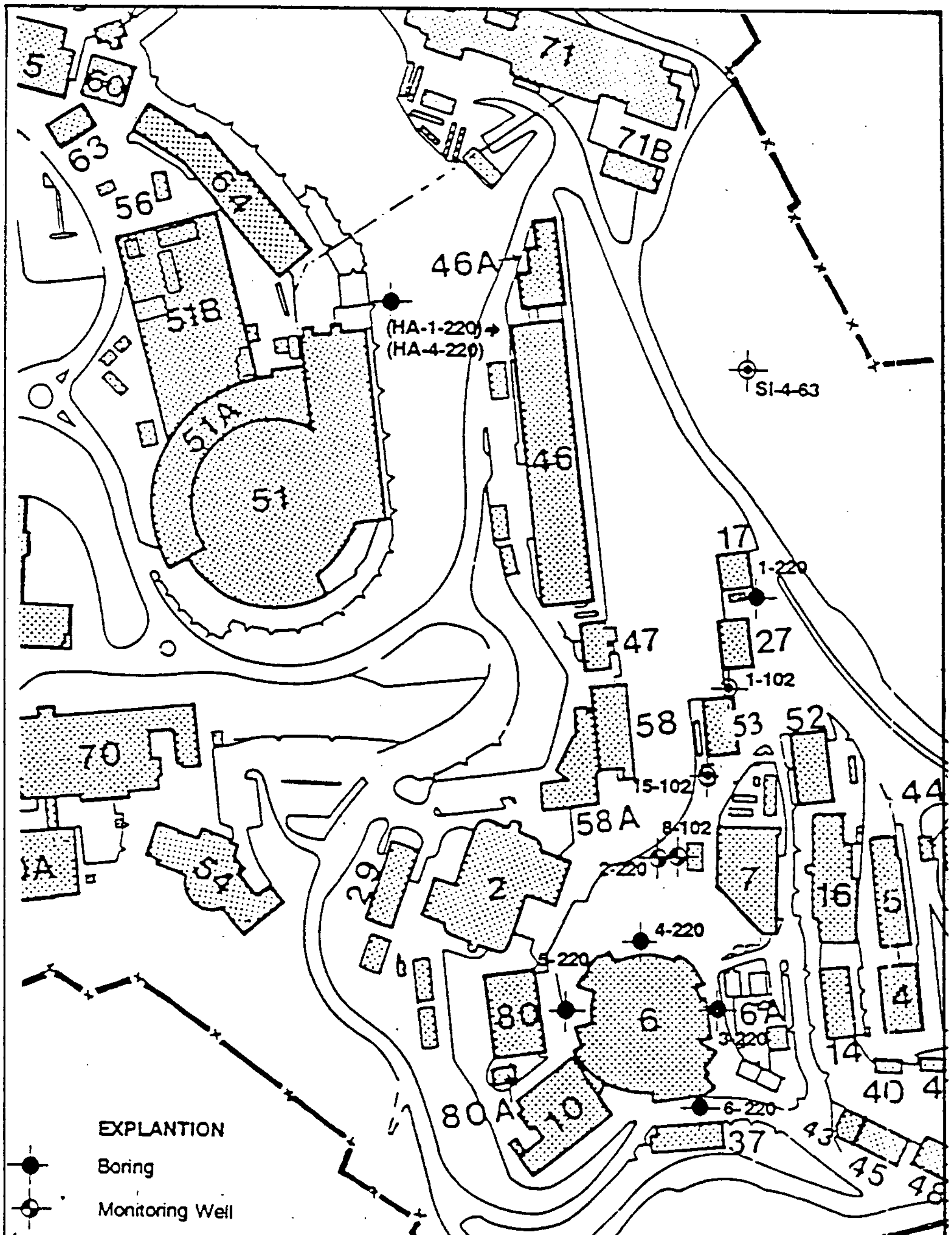

Figure 1. Location of monitoring wells, slope indicators, and soil samples used in 1988 HLA studies.

Table 1
Chemical analysis of water and soil samples, fast track study (from HLA, 1988).

Wells / Slope Indicators	Sampling Depth ft	Compound	Concentration water (ppb),soil(µg/kg)
SI 1-102 (water)	62.0	Chloroform TCE PCE	1.0 2.9 1.1
SI 15-102 (water)	54.0	1,1-DCE 1,1-DCA Chloroform TCE PCE	8.0 6.4 8.3 567. 490.
Boring 1-220(water)	84.5	TCE	0.8
Well 2-220 (water)	26.	Chloroethane 1,1-DCA 1,1-DCE 1,1,1-TCA PCE TCE Vinyl Chloride	3.6 1.0 5.4 0.7 5.3 24. 3.
Well 8-102 (water)	26.	1,1-DCE 1,1-DCA Chloroform 1,1,1-TCA TCE PCE	3.9 0.7 2.2 0.8 49.3 4.9
HA1 (soil)	0.5	Toluene PCE TCE	12. 15. 6.5

Trichloroethane (TCA); Dichloroethane (DCA); Dichloroethylene (DCE).

Assuming that the source of contamination observed in the hydraugers are from the Building 53 area, HLA drilled two boreholes, one at the south east of Building 17 and the other in the area west of Building 7. The location of these borings are also shown in Figure 1. The first one called 1-220 was drilled to the depth of 85 feet. No significant groundwater was encountered during drilling. A grab sample of water collected from the bottom of this borehole several days later, showed less than 1 ppb of TCE. The second one which was completed as a Monitoring Well 2-220 was drilled to the depth of 40 feet. Water sample collected from this well showed 24 ppb of TCE, 5.3 ppb of PCE and small concentrations of some other volatile organic compounds. The result of chemical analysis from this well is also shown in Table 1.

Six soil samples collected to the depth of 3.5 ft near the discharge area of the hydraugers carrying contaminated water, showed maximum of 42 µg/kg of PCE and 13 µg/kg of TCE. Table 2 shows MCLs for some of the above chemicals for the sake of comparison.

Further sampling of hydraugers east of Building 51 by the LBL staff during June and September 1988 and January 1989 showed PCE, TCE and 1,2-Dichloroethylene (1,2-DCE). One of the NW-SE trending hydraugers also showed Freon 113. To stop the discharge of contaminated water, in September 1988, LBL installed granulated carbon treatment systems to remove solvents from the hydrauger discharges before the water is released into the environment.

On January 11, 1989, five water samples were collected from the head of creeks originating from the LBL property and tested for halogenated and aromatic organic compounds. No contaminants were detected in these samples.

In 1988, LBL prepared a site characterization program and requested fundings from DOE for FY 91 through 93. Meanwhile, during FY 90 LBL carried out a preliminary environmental investigation which is being reported here.

Physical Setting

Lawrence Berkeley Laboratory (LBL), covers about 130 acres of hilly terrain on the east side of the University of California at Berkeley. Figure 2 shows the location of LBL in San Francisco Bay Area. Elevation over the site vary from about 500 feet above mean sea level at the western boundary to a maximum of approximately 1,050 feet on the eastern boundary. The laboratory property contains three main canyons. Strawberry Canyon forms the southern portion of the property. A north-south trending canyon along the east part of the property joins the head of Strawberry Canyon. Finally, Blackberry Canyon drains the central portions of the laboratory property. Blackberry Canyon Creek originally had three major tributaries. One of these tributaries was located west of present position of Building 71. The major branch positioned between present locations of Buildings 71 and 46. Finally, the third tributary was passing in the vicinity of Buildings 47 and 58 area. The first tributary joined the

Table 2
Maximum contaminant levels for some chemicals of interest

Compound	MCL, µg/L
Bebzene	5
Carbontetrachloride	5
1,1-Dichloroethylene (1,1-DCE)	7
1,2-Dichloroethane (1,2-DCA)	5
1,1,1 Thrichloroethane (1,1,1-TCA)	200
Trichloroetylene (TCE)	5
Perchloroethylene (PCE)	4
Vinyl chloride	2

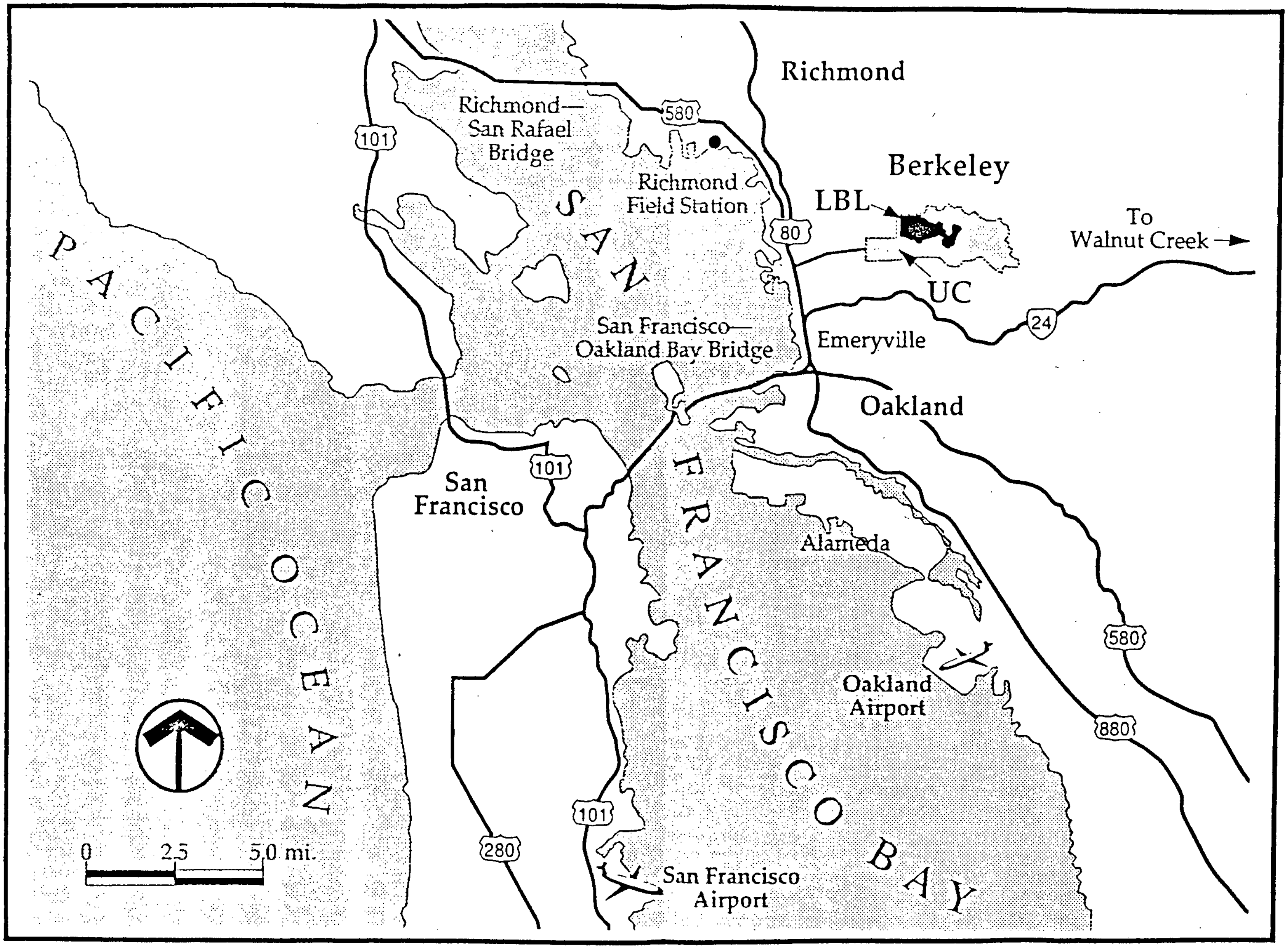

Figure 2. Location of Lawrence Berkeley Laboratory in San Francisco Bay Area.

major one in the present area of Blackberry parking lot and the third tributary joined the major one under present position of Building 51B. Figure 3 shows approximate position of the original Blackberry Canyon Creek with respect to the present set up of LBL buildings.

Extensive cut and fill grading of the natural slopes was necessary for the construction of new buildings in the laboratory. As a result, all three branches of Blackberry Canyon Creek have been disrupted and surface water from these tributaries is collected and conveyed through large diameter concrete pipes. Figure 4 compares two air photos from the site, one taken in 1939, before the establishment of LBL, and the other in 1988.

Geology

Three major formations have been identified at the LBL site. Figure 5 presents a geological map showing the distribution of the formations within the LBL property. The western and southern part of the LBL are underlain by a moderately to well consolidated marine Knoxville Formation. This Cretaceous formation consists of shales, siltstones, sandstones and conglomerates. The upper Miocene or lower Pliocene Orinda Formation occupies most of the laboratory property. It consists of poorly consolidated claystones, siltstones, sandstones and conglomerates. The volcanic Moraga Formation covers most of the higher elevation parts of the laboratory. Although the Moraga Formation overlays the Orinda for most areas in LBL property, in some cases Moraga rocks are interbedded with the upper Orinda rocks. The Moraga Formation consists of basalt and andesite flows and pyroclastic tuffs. Except for some outcrops, these rocks are usually deeply weathered.

The geology of the LBL site is very complex from a structural point of view. Two major faults have been identified in the vicinity of LBL. The seismicly active Hayward fault is located on the western side of the site. The inactive Wildcat Canyon fault is located on the eastern side of LBL. Several other faults, such as Strawberry Canyon Fault, also cut through the property. Figure 6 shows the location of inferred faults at LBL. A number of faults shown on this map could not be confirmed (Converse Inc., 1984). More detailed information about the geology of the site may be obtained from Harding Lawson Associate Report (1982) and Converse Consulting Inc. (1984).

Geologic Hazards

Some of the cut and fill operations at LBL have led to changes in the natural ground slope and the undercutting of some of the hilly areas. Geologic configuration of the site together with these slope modifications have led to several active landslides at various parts of the LBL property. Significant efforts have been devoted to the slope stability of these locations over the last two decades. In addition to unloading

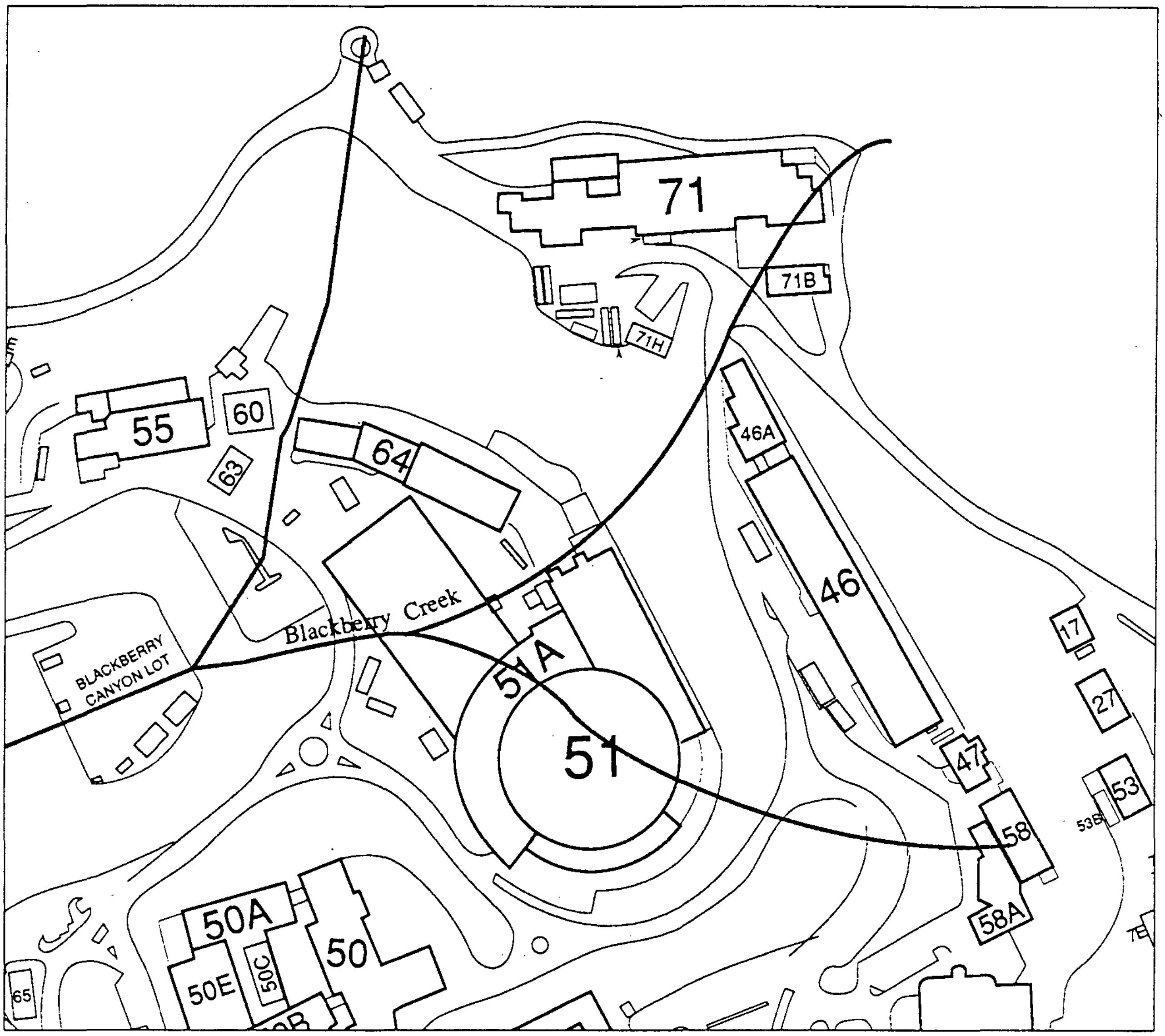

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Figure 3. Approximate position of the original Blackberry Canyon Creek with respect to the present set up of LBL Buildings.

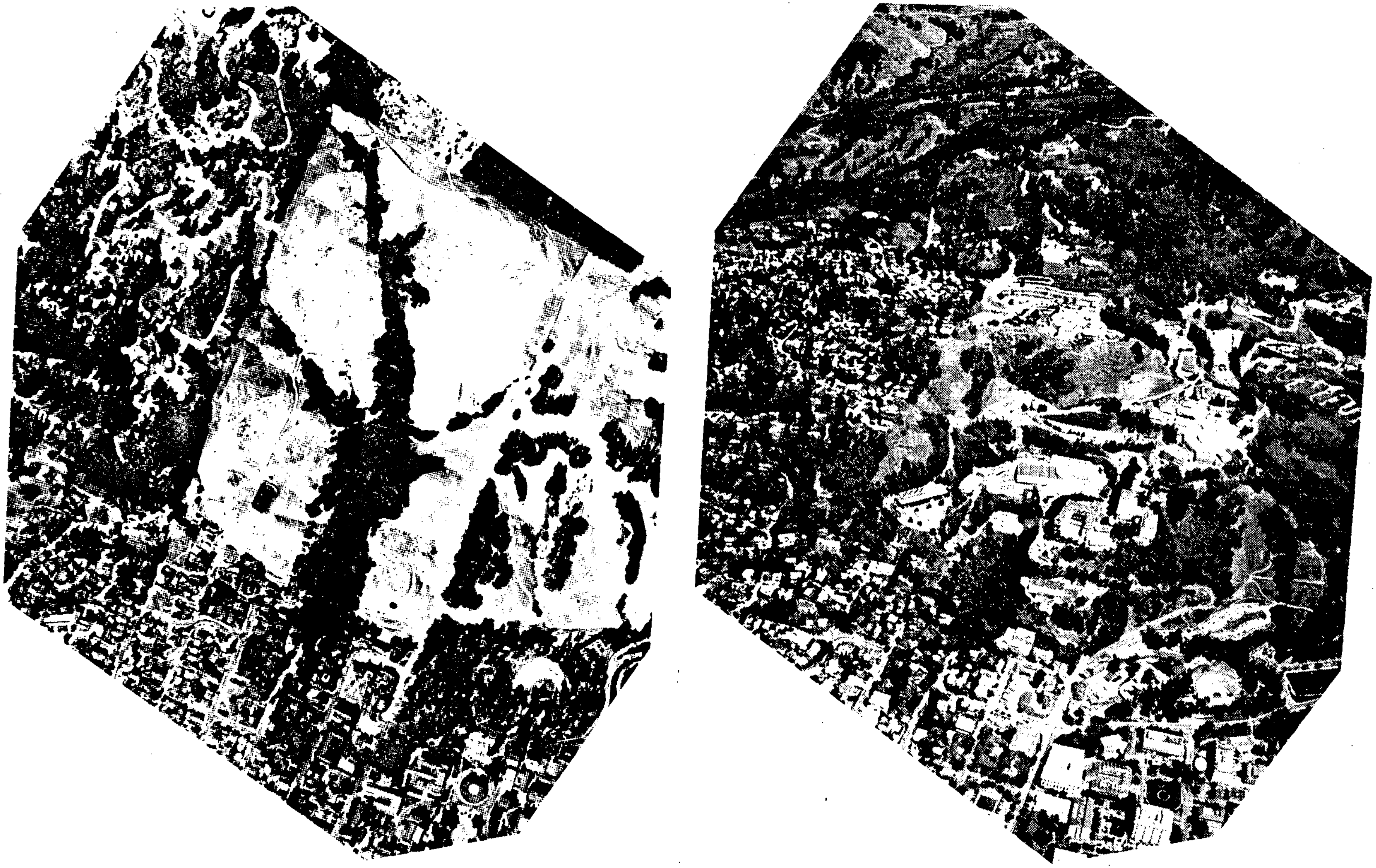

Figure 4. Comparison of two airphotos from the site, one taken in 1939, before the establishment of LBL, and the other in 1988.

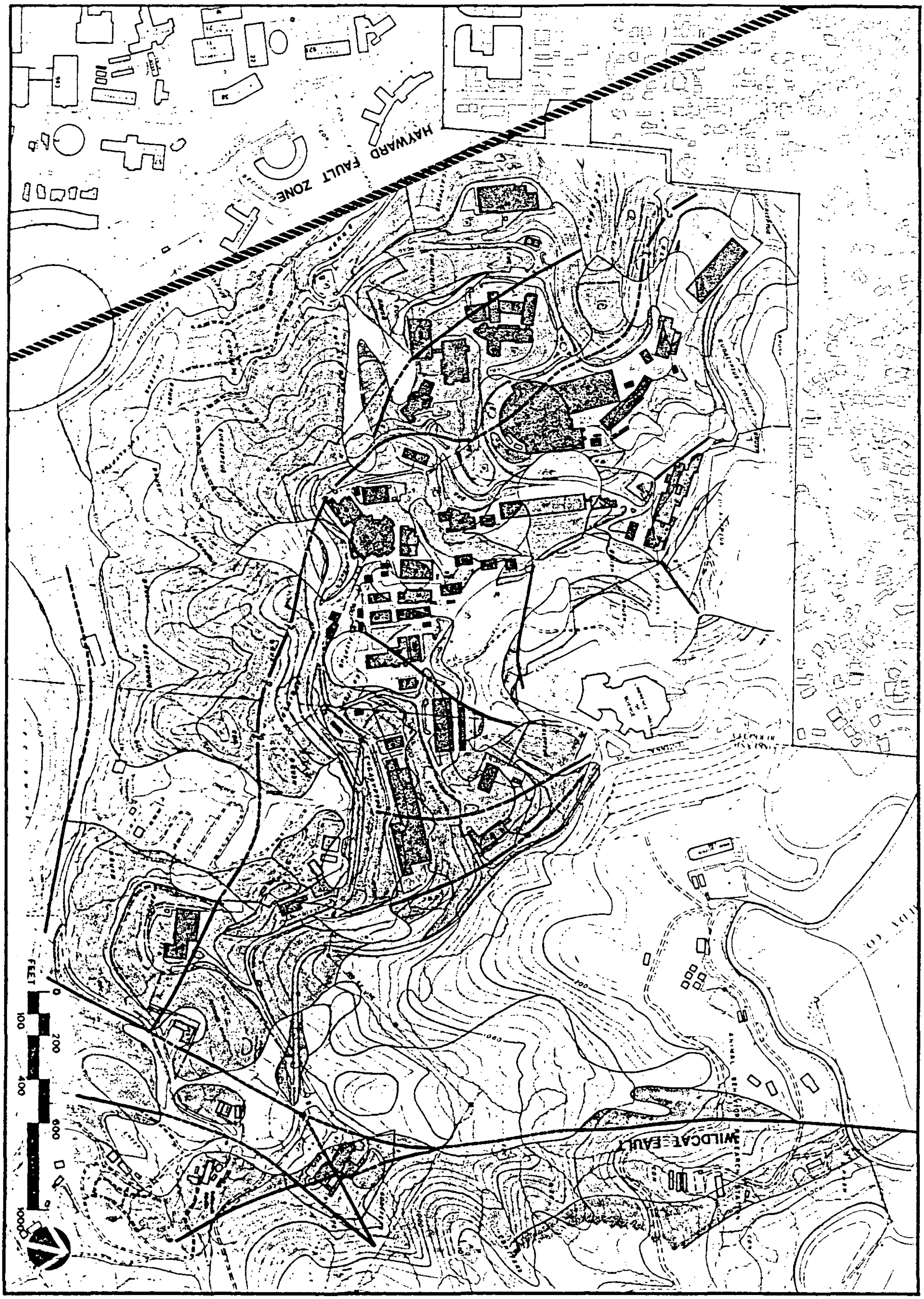

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Figure 5. **GEOLOGY MAP**

LEGEND; ▨ FILL, ☐ COLLUVIUM,
☐ MORAGA VOLCANICS, ▨ ORINDA FORMATION,
☐ CLAREMONT CHERT, ■ UPPER CRETACEOUS ROCK,
—— MINOR INACTIVE FAULTS

REV. APRIL 1980

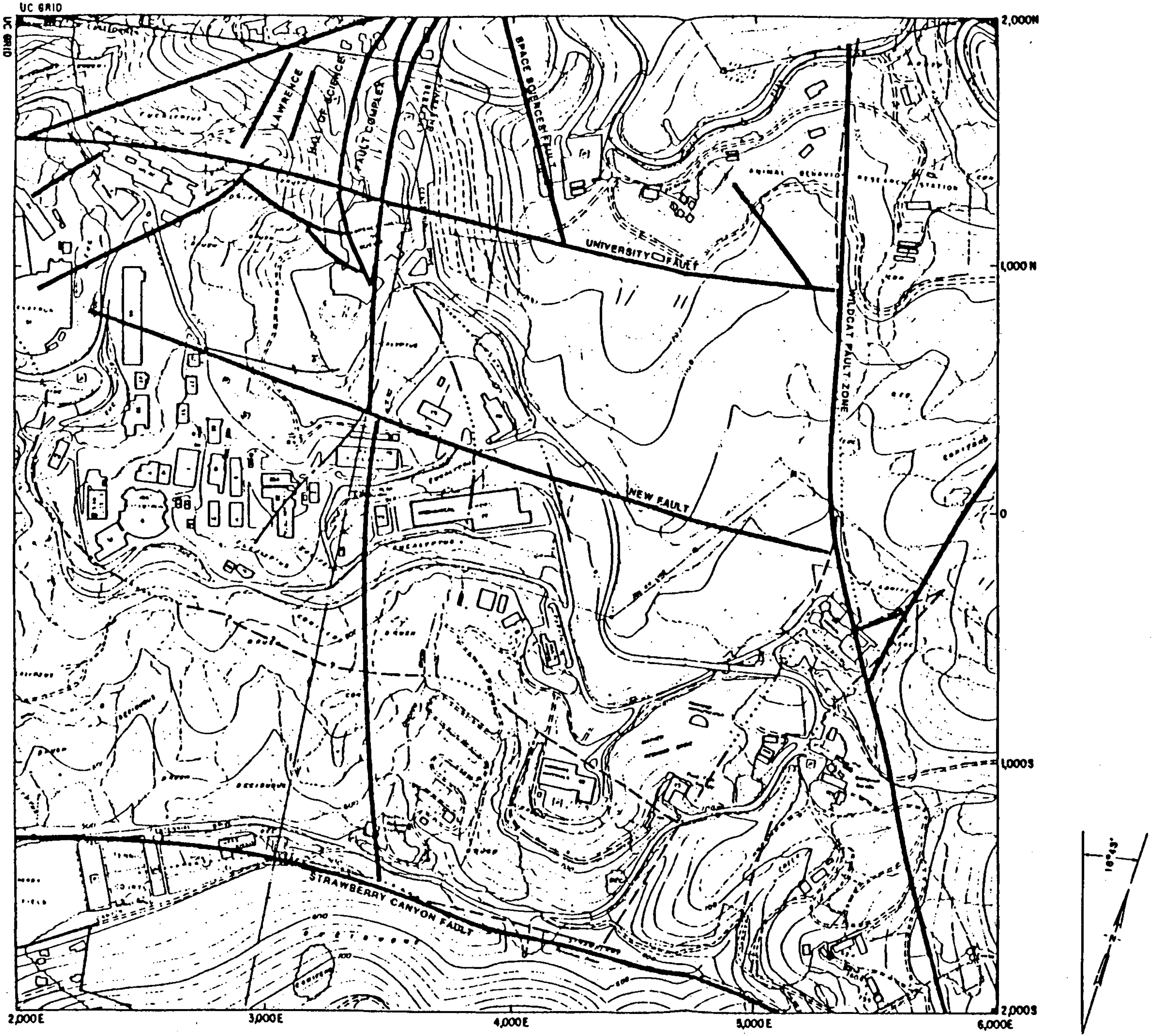

Figure 6. Inferred faults at Lawrence Berkeley Laboratory (Converse Inc., 1984).

the upper parts of some of these slopes and attempting to reduce infiltration, a large number of horizontal drains (hydraugers) have been installed to lower the groudwater levels in these areas. Some wells have also been drilled and automatic pumps have been installed in them to maintain the water levels below certain safe elevations. As a result, hydraugers together with the automatic pumping from wells have artificially modified the natural patterns of groundwater flow.

Organization of This Report

As was pointed out under Objective of this study, the main purpose of this preliminary investigation was to identify source(s) and the extent of groundwater contamination that is manifested by the presence of some solvents in the discharge water of a few hydaurgers in the area east of Building 51. The result of this investigation will be presented in Chapter 2. Chapter 3 will discuss results of our activities in the vicinity of Buildings 6, 7 and 53. Our findings in Corporation Yard area (Buildings 69, 75 and 77) will be presented in Chapter 4. Finally, Chapter 5 will discuss the conclusions of this study and the recommendations for future activities.

2. INVESTIGATION AT BUILDINGS 46-51-71 AREA

For this investigation, in addition to studying the geology of the site, soil gas survey, water sample analysis of available wells, slope indicators and hydraugers, as well as limited number of soil analysis were carried out. A scenario for release of contaminants was then developed. To examine the validity of this scenario, two new wells were constructed. Information obtained from these wells seems to confirm the suggested scenario. The following sections are presented in the sequence that we performed our investigation. This will help the reader to follow the logic used in this study. The chemical analyses of water samples collected from this area are presented in APPENDIX B.

Hydraugers' Monitoring

Figure 7 shows approximate positions of hydraugers in the vicinity of Buildings 46, 51 and 71. Although design information for the hydraugers are available, their exact trend and dip are not known. LBL conducted an inventory of all hydraugers at the site in February 1990. APPENDIX A presents the approximate trend, dip, diameter and length of all the hydraugers at LBL, as well as their present condition.

Most of the hydraugers produced relatively large flow rates after they were installed. However, with time, due to the decline of the water table and plugging, many of them eventually stopped flowing. Only a few, including Hydraugers No. 51.01.01, 51.01.03, and 51.01.04, have continuous discharge all year. Flow rates vary between 0.1 to 2 gal/min. Hydraugers No. 51.01.02 and 51.01.10 flow after major rainfalls. Figure 8 shows the position of these five hydraugers. The first two digits of the hydrauger numbers refer to the building and are not been shown in the figure to avoid crowding (i.e, 51.01.02 is indicated as 1.2).

The most obvious step toward delineation of the contaminated groundwater in this area was to sample all of the flowing hydraugers and analyze the chemical contents of the collected fluid samples. Table 3 presents results of chemical analysis of several samples from these hydraugers over the last four years. Obviously, maximum contamination of PCE, TCE and dichloroethylene (DCE) is consistently observed in samples from the Hydrauger No. 51.01.03 that extends approximately under the northern third section of Building 46A. Hydrauger No. 51.01.04 that also extends under this building, but slightly to the south of 51.01.03, did not show much contaminants in 1986 (6 ppb of PCE). Recent (1989 and 1990) sampling and analysis, however, show all the above three compounds (PCE, TCE, and DCE) in concentrations between 7 to 65 ppb.

Hydrauger No. 51.01.10 trends more to the south than of the above two. This hydrauger flows only after major rainfalls and has not shown any detectable amount of PCE, TCE or DCE.

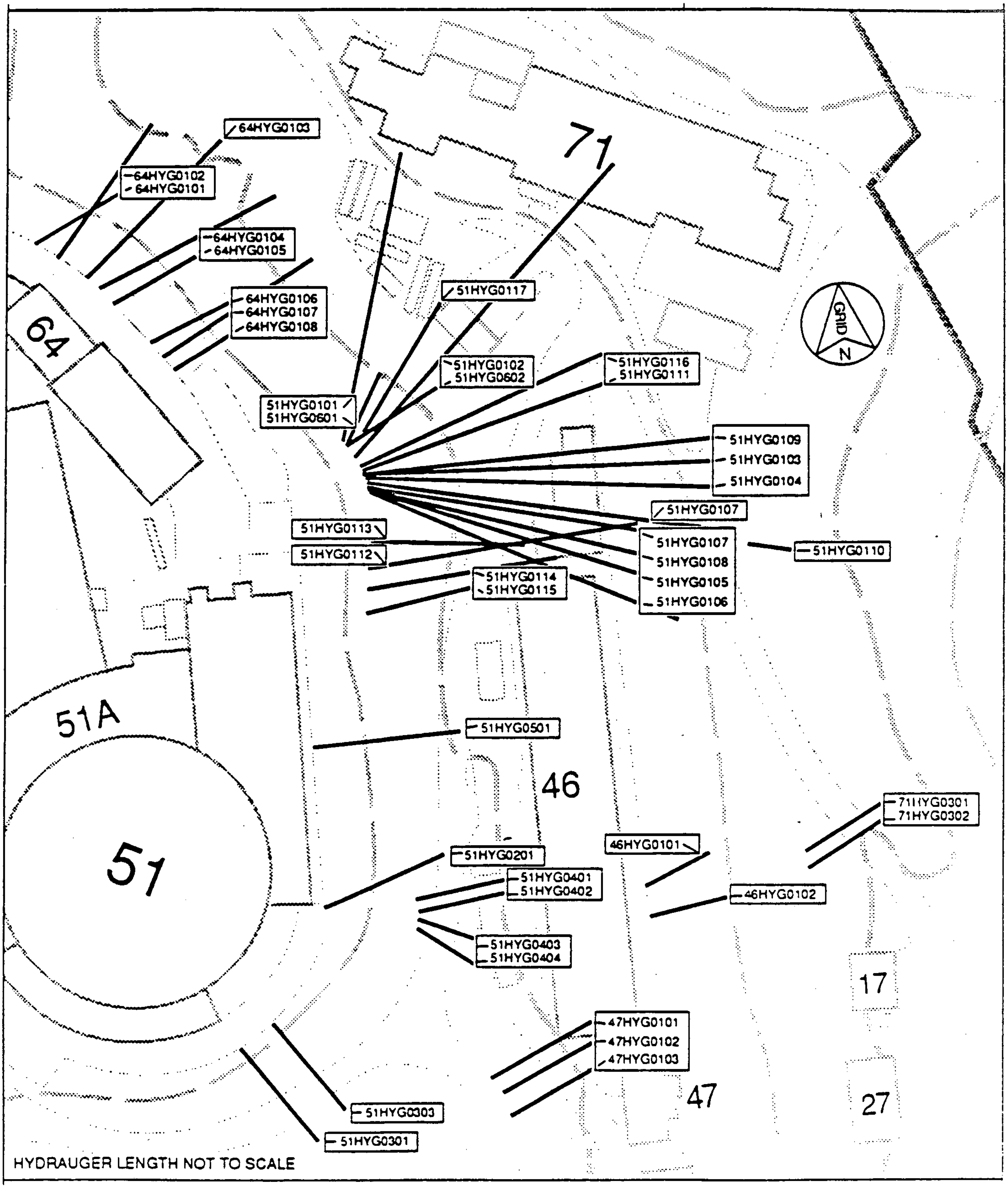

Figure 7. Approximate positions of hydraugers in the vicinity of Buildings 46, 51 and 71.

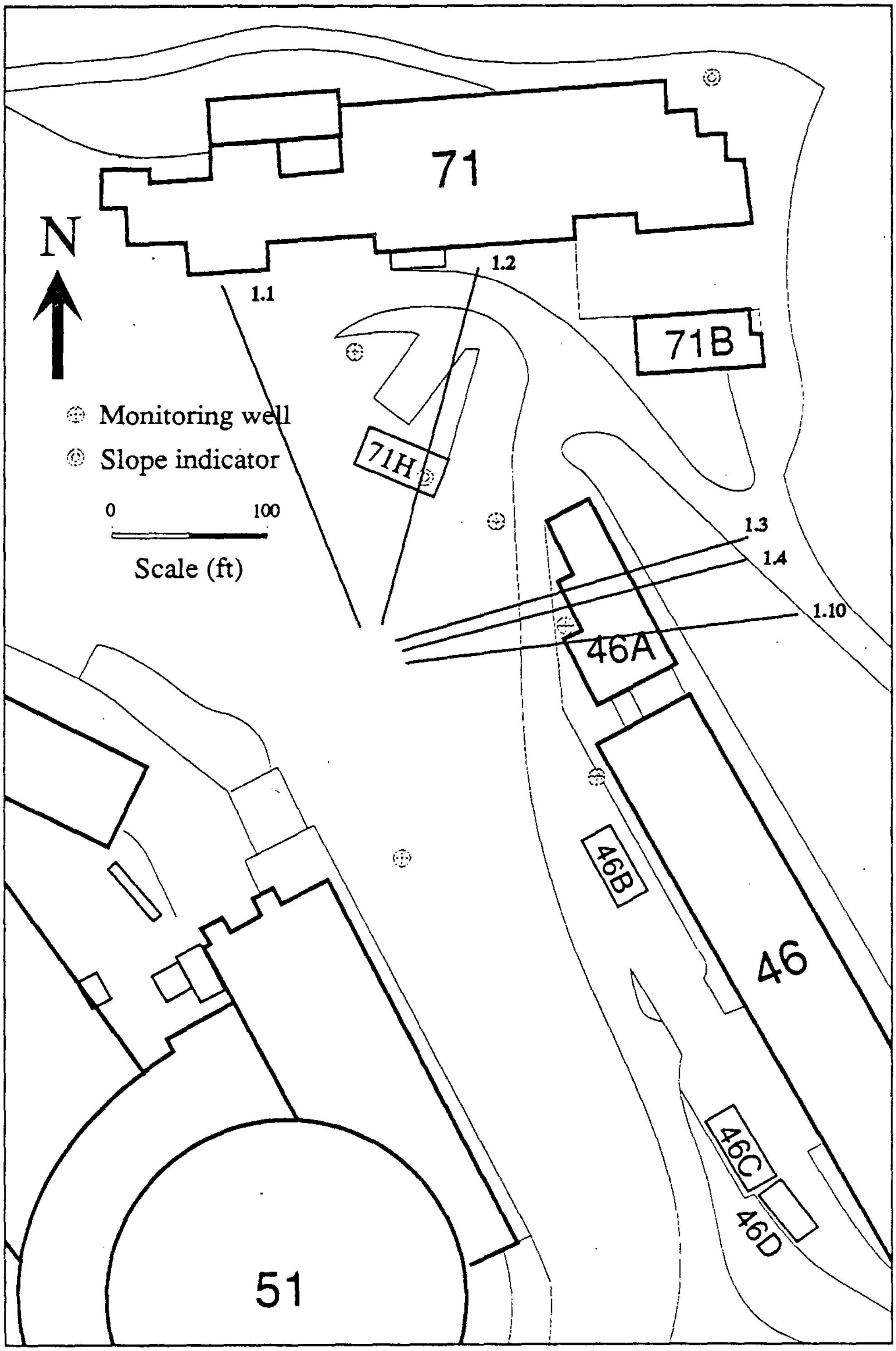

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Figure 8. Approximate position of Hydraugers 1.1, 1.2, 1.3, 1.4 and 1.10 of 51 series.

Table 3
Chemical analysis results of water samples obtained from hydraugers east of Building 51

Hydraugers	Dates sampled							
Compounds	6/17/86	9/13-20/88	1/11/89	1/22/90	2/13/90	3/16/90	7/9/90	9/24/90
51.01.01								
1,1-DCE			2					ND
TCE			5					5
PCE			2					2.2
1,1,1-TCA			10					1.7
Freon 113			120					733
51.01.02								
1,1-DCE						4.9	2.3	
cis-1,2-DCE						0.9	0.3	
TCE						4.1	1.6	
1,1,1-TCA						0.9	0.3	
1,1-DCA						6.8	4.2	
51.01.03								
1,2-DCE		39	35	33				
TCE		52	57	24				
PCE		88	160	45				
1,1-DCA		ND	2	ND				
51.01.04								
cis-1,2-DCE	<5		7					15
TCE	<5		11					20
PCE	6		28					65
1,1-DCA	ND		2					3.4
51.01.10								
1,2-DCE				<0.1	<0.1			
TCE				<0.1	<0.1			
PCE				<0.1	<0.1			

Two other hydraugers, namely 51.01.01 and 51.01.02 have also been sampled. Both extend towards B71. Hydrauger No. 51.01.01 flows most of the time and shows relatively small concentrations of DCE, TCE and PCE (<6 ppb). Furthermore, water from this hydrauger contains some 1,1,1-trichloroethane (1,1,1-TCA) and relatively large concentration of Freon 113 (120 ppb). Hydrauger No. 51.01.02 flows also after major rainfalls and contains relatively low concentrations of both ethylene and ethane compounds.

In summary, this information tends to suggest that groundwater contamination in the 46-51-71 area is limited to a sector between Hydraugers No. 51.01.01 and 51.01.10 with the plume centered under Hydraugers No. 51.01.03 and 51.01.04.

Monitoring of Wells and Slope Indicators

Figure 9 shows the location of existing wells and slope indicators, as well as the two new wells drilled for this study (90-1 and 90-3). To start with, we identified Well No. 27-63 in the fire trail east of Building 51, Well No. 31-63 adjacent to Building 46A and a cluster of two wells and one slope indicator (only C-63 shown here) at the northwest corner of Building 46. These wells were constructed in 1973 for the slope stability studies. A pump has been installed in 31-63 that automatically keeps the water below the depth of 47 ft. In addition two slope indicators were located in the area, one at the northeast corner of Building 71 (1-162) and another beneath the trailer 71H (SI-3). The latter one was not initially accessible. On July 10, 1990, an access was provided from the crawl space of Building 71H that allowed us to collect water samples for analysis.

Chemical analysis of water samples from Slope Indicator No. 1-162, Wells 27-63 and C-63 showed no detectable concentration of halogenated organic compounds tested for. Analysis of a water sample collected from Well No. 31-63 showed very low concentrations of two ethane compounds (1,1-DCA = 2.5 ppb; 1,1,1-TCA = 0.3 ppb). No ethylene compounds have been detected in water samples taken from this well which is located adjacent to Building 46A, where Hydraugers No. 51.01.03 and 51.01.04 are presumed to be extending under. Except for a very low concentration of 1,1-DCA, the major solvents observed in those two hydraugers were DCE, TCE, and PCE which were not found in Well 31-63.

Soil Gas Survey

Sampling soil gases and analyzing for their chemical contents has been recently used for detecting of sources of contamination in the soil, and under favorable conditions for determining the extent of contamination in groundwater aquifers. Therefore, we also considered using this relatively new technique in our investigations.

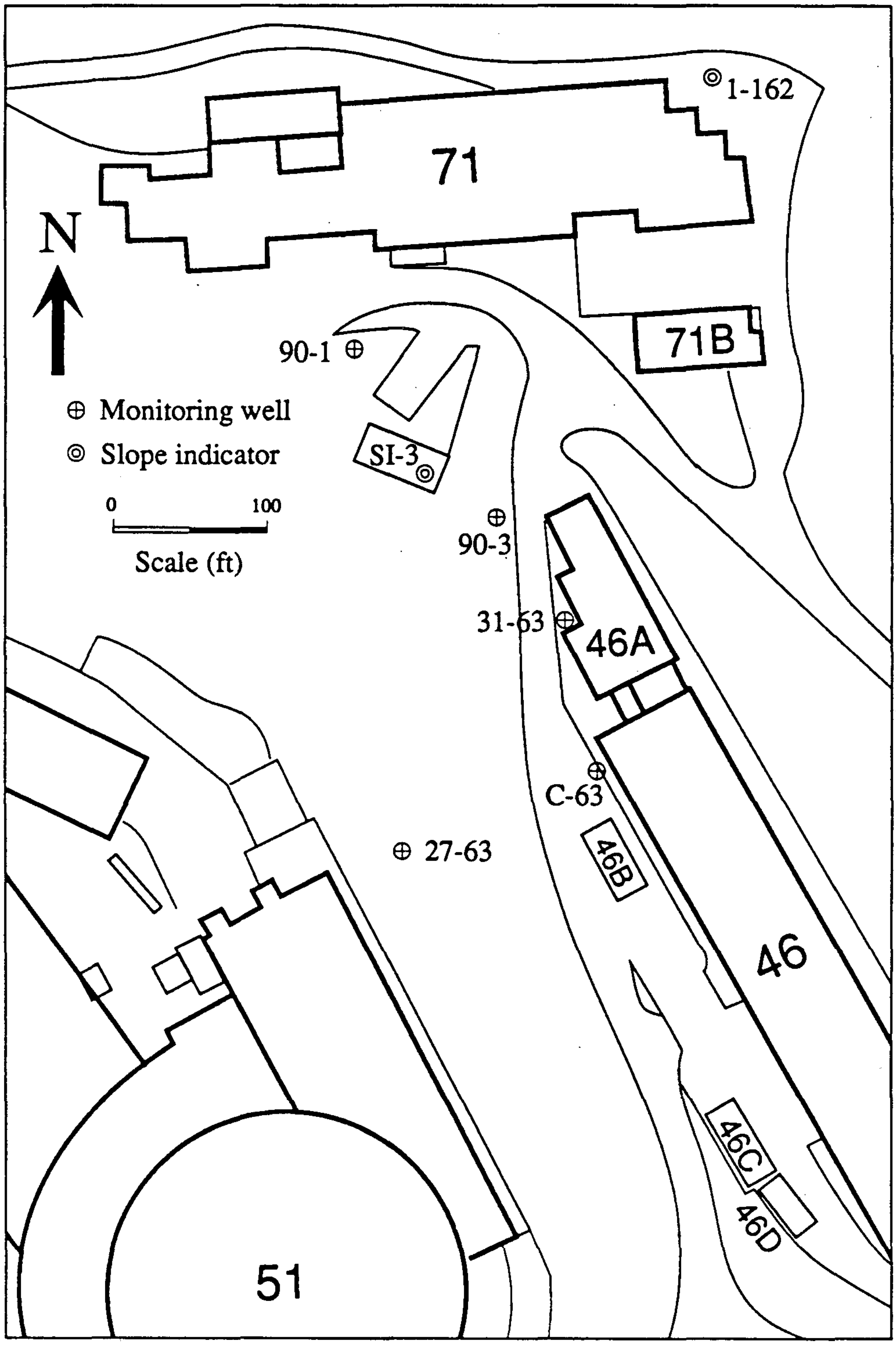

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Figure 9. Location of monitoring wells and slope indicators in the vicinity of Buildings 46–51–71.

Looking for the source of the contamination observed in the groundwater, we were told that some times ago, for a period of ten to 15 years, the parking lot in front of Building 71-H was used for storage of chemical drums, including solvents. Therefore, the most logical place for searching was this parking area.

We first selected a point, called 71.1, on the northeast corner of Building 71H (see Figure 10), and collected soil gas samples at two depths, 5 and 20 ft. Field-laboratory analysis of these two samples showed a very low concentration of gasoline compounds (less than 0.5 µg/L); no ethylene or ethane compounds were detected. Next, we moved to an area at the middle of the lot (71.2) where some decoloration of pavement was apparent. Two gas samples were collected at this point, one at 5 and the other at 10 ft depth. Apart from a very low concentration of gasoline compounds (less than 0.1 µg/L), the shallow sample showed 1.04 µg/L of cis-1,2-DCE and 0.34 µg/L of TCE. No chlorinated hydrocarbons was detected in the deeper sample. Here, a soil sample (71.2s) was collected from 4 ft depth. Analysis of the sample showed very low concentrations (less than 2 µg/kg) of gasoline compounds, such as xylene and ethyl benzene. No chlorinated hydrocarbon tested for were detected.

We later moved to the point 71.3 shown in Figure 10. A soil gas sample was collected from 5 ft depth. Here, again, apart from very low concentration of gasoline compounds, small concentration of 1,1,1-TCA (0.42 µg/L) and TCE (0.28 µg/L) were detected. These results did not confirm any past major spills of solvents in this area the effect of which is still present.

We then moved to the south boundary of Building 71. Extensive distribution of utilities underground limited locations where we could collect soil gas for analysis. Therefore, only two locations were selected. One at the point 71.4 and the other at 71.5 (Figure 10). A soil gas sample collected at 5 ft depth at point 71.4 showed a relatively high concentrations of Freon 113, (887 µg/L) and cis-1,2-DCE (193 µg/L). Some TCE (11.5 µg/L) and PCE (5.57 µg/L) were also detected in this sample. Note that except for Freon 113 which was stored in a large tank located very close to this sampling location, the other three compounds detected here are exactly the same that we have seen in the Hydraugers No. 51.01.03 and 51.01.04, which extend under Building 46A. We then tried to get a sample from 10 ft depth. Hitting hard rock, we had to stop penetration and obtained a sample at 7.5 ft depth instead. This sample also showed some Freon 113 and DCE but in much smaller concentrations, indicating that the source was perhaps very close to the upper sampling point where we obtained the soil gas. Analysis of the soil gas sample from 5 ft depth at the point 71.5 did not show any detectable concentration of compounds tested for.

Another area that was under suspicion was near Building 46A. That is the site of a former motor pool operation which used an underground gasoline storage tank. Therefore, we examined three locations on the north side of B46A as shown in Figure 10. Samples were collected from depths between 5 to 20 ft. The shallow samples did

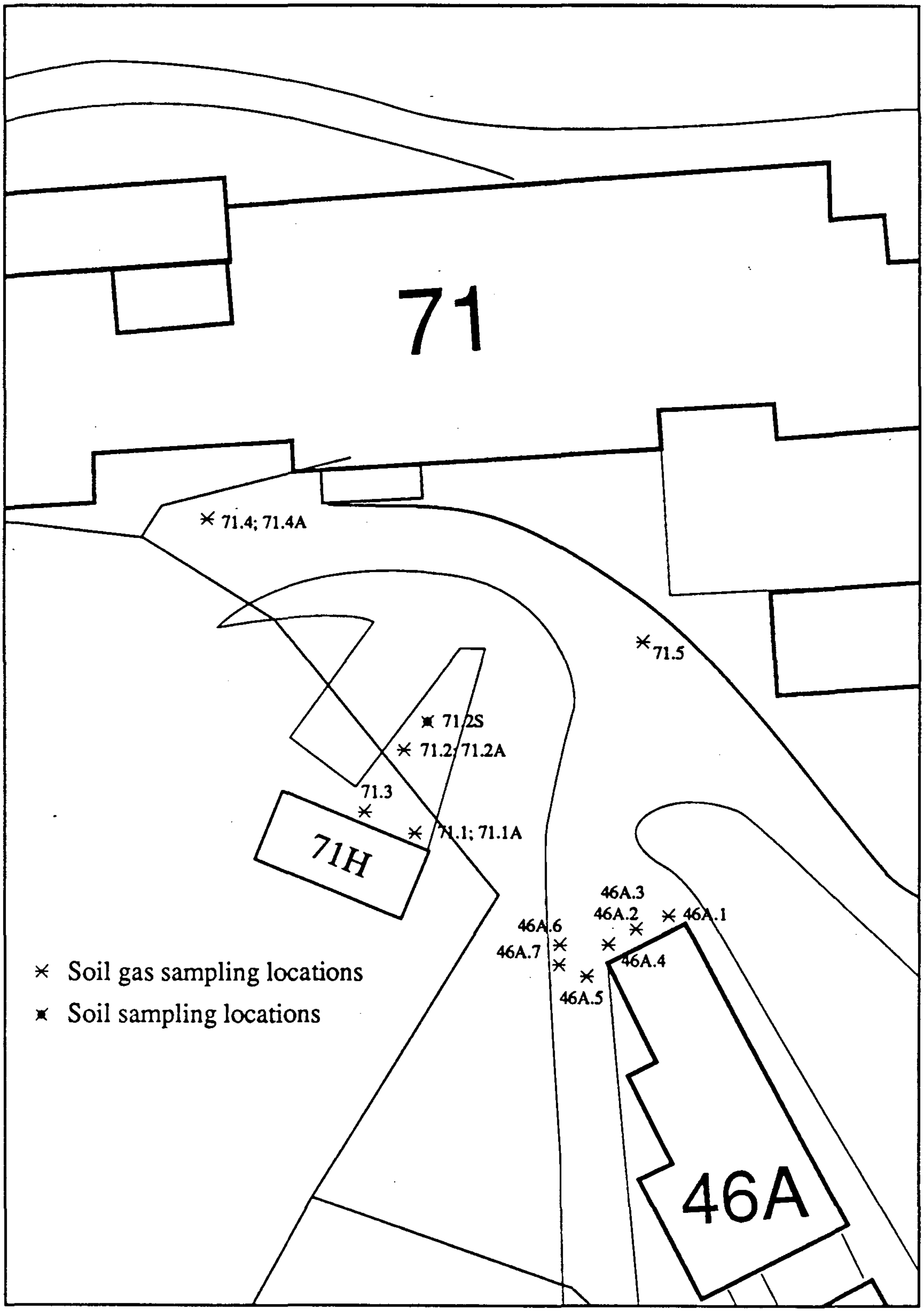

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Figure 10. Soil gas and soil sampling locations in the vicinity of Bldgs. 46A and 71.

not show any detectable gasoline compounds. Samples collected from 10 to 20 ft showed some low level aromatic hydrocarbons (less than 0.5 μg/L). Only one shallow (5 ft) sample (46A-2) showed 0.16 μg/L of PCE. Another soil gas sample (46A-5) collected at 10 ft depth also showed a very low concentration of PCE (0.13 μg/L). We then moved across the street to points 46A-6 and 46A-7. Two soil gas samples collected at the depths of 20 and 30 ft did not show any detectable level of chemicals tested for.

Table 4 shows a summary of analytical results of the soil and soil gas survey discussed above and others in the vicinity of Buildings 7 and 53 that will be described in Chapter 3. The list of chemicals for which soil and soil gas samples were tested are also shown in Table 4. The detection limit for soil analysis was 0.1 μg/kg and for soil gas analysis was 0.01 μg/L. Details of soil gas survey are reported in a separate report (Hydro Geo Chem Inc., 1990). Figure 11 shows concentration of chemicals detected in the soil gas survey in the vicinity of Buildings 46A and 71.

Scenario Development

At this stage of study, before deciding on further drilling, we had to come up with some sort of scenario for contaminant releases. On one hand, we could not confirm any major spills on the Building 71H Parking Lot. On the other hand, we were positive that all of the contaminants detected in groundwater in this area were used in the past in both Buildings 71 and 46. Talking with the staff, nobody remembered any significant spills outside these buildings. In a visit to Building 71 we observed some floor drains in the area where solvents have been used. No underground tanks for either product or waste of chlorinated hydrocarbon were used in this area. Therefore, a possible source for the release of contaminants to the environment was sanitary sewers. Figure 12 shows the sanitary sewer system in between Buildings 46, 51 and 71.

The information we had on the sanitary sewers around Building 77 gave some credibility to the above possibility. In October 1977, Pacific NW Pipeline Survey Co., Inc. conducted a photographic examination of the sanitary sewer systems of LBL; only 6 inchs pipes and larger were examined. A section of sanitary sewers south of Building 77 was found to be chemically corroded. This section was down gradient from the Mechanical Shops building (Building 77), which houses a metal plating shop and other activities using acids and caustic solutions, among others. At other places at LBL, sections of sanitary sewers were found to have problems such as joint offsets and cracks. Details of this investigation can be found in the report prepared by Pacific NW Pipeline Survey Co., Inc., (1977).

Further evidences for this scenario are as follows.

1. A soil gas sample showing relatively high concentrations of DCE, together with TCE and PCE was taken from point 71.4 located almost at the same

Table 4
Summary of Analytical Results

(Units of Concentration: µg/L for Soil Gas, µg/kg for Soil)

SAMPLE	COMMENT	DEPTH (feet)	BENZENE	TOLUENE	ETHYL BENZENE	M,P-XYLENE	O-XYLENE	1,1-DCA	1,1,1-TCA	CIS-1,2-DCE	TRANS-1,2-DCE	DCM	FREON 113	TCE	PCE
FB16JUN			0.02	0.03	0.01	0.03	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
FB17JUN			<0.01	0.01	<0.01	0.03	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
71-1		5	<0.01	0.12	<0.01	0.11	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
71-1A		20	<0.01	0.11	0.23	0.31	0.15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
71-2		5	<0.01	0.04	<0.01	0.05	0.01	<0.01	<0.01	1.04	<0.01	<0.01	<0.01	0.34	<0.01
71-3		5	<0.01	0.07	0.01	0.03	0.01	<0.01	0.42	<0.01	<0.01	<0.01	<0.01	0.28	<0.01
71-2A		10	0.03	0.02	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
71-2S	SOIL	4	<0.10	<0.10	0.31	0.90	0.38	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
71-4-X		5	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	193.00	<0.01	<0.01	887.00	11.50	5.57
71-4-Y		5	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	181.00	<0.01	<0.01	753.00	10.10	5.01
71-4A		7.6	0.01	<0.01	0.05	0.01	0.02	<0.01	<0.01	1.69	<0.01	<0.01	10.00	<0.01	<0.01
71-5		5	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
46-A1		5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
46-A2		5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.16
46-A3		10	<0.01	0.01	0.01	0.02	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
46-A4		20	0.01	0.06	0.07	0.17	0.09	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
46-A5-X		10	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.13
46-A5-Y		10	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.13
46-A6		20	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
46-A7-X		30	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
46-A7-Y		30	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
53-1		5	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.18
53-2		18	<0.01	0.01	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.68
7-1-X		5	0.88	0.26	0.30	0.64	0.50	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
7-1-Y		5	0.61	0.24	0.21	0.32	0.47	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
7-2		17.6	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	1.24	<0.01	<0.01	<0.01	<0.01	1.60	4.86
53-S	SOIL	4	<0.10	0.16	0.15	0.53	0.15	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
53-E	SOIL	4	0.15	0.25	0.10	0.42	0.21	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

X,Y = SERIAL DUPLICATES

FB = FIELD BLANK

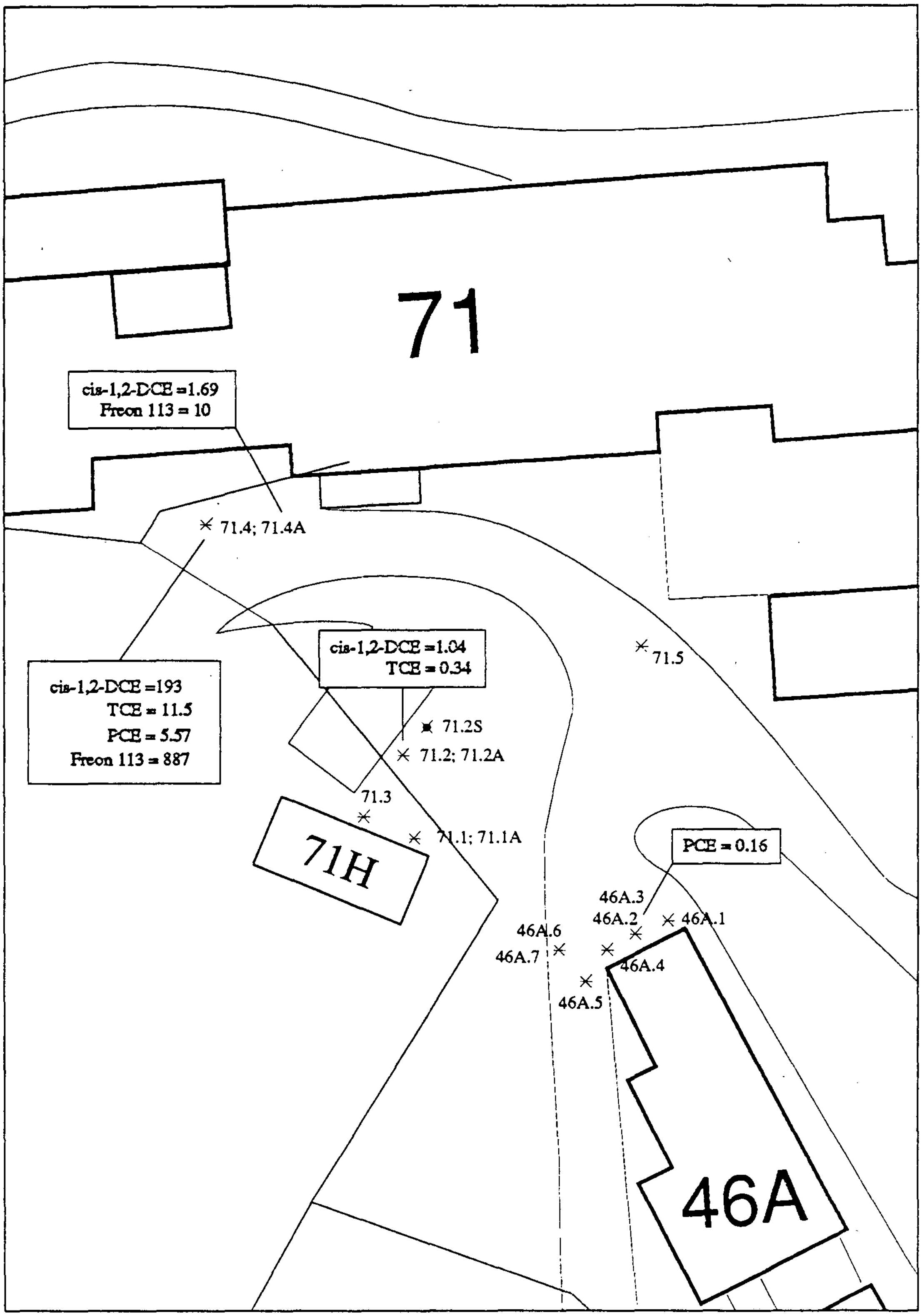

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Figure 11. Soil gas survey results in the area of Bldgs. 46A –71.

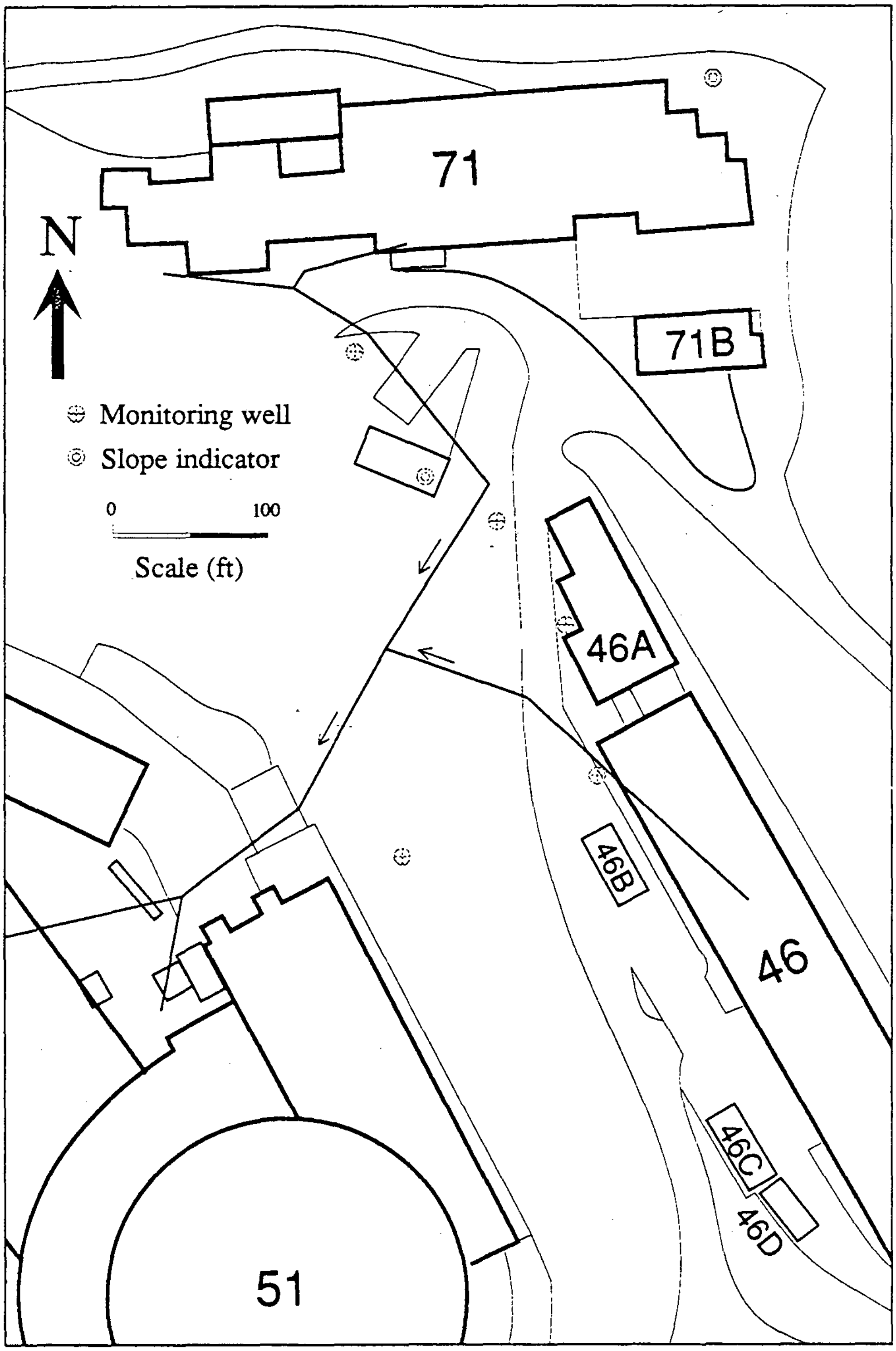

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Figure 12. Sanitary sewer lines in the vicinity of Bldgs. 46, 51 and 71.

elevation as the sanitary sewer line and down gradient from one branch and close to the junction of two sanitary sewer lines coming out of Building 71 (see Figure 11).

2. The same three chemicals that have been consistently observed in water samples taken from Hydrauger No. 51.01.03 were detected in the soil gas collected from point 71.4. Meaning that some sort of pathway should bring these chemicals from that area near point 71.4 to that part of the groundwater that enters the hydrauger.
3. The fact that Well 31-63 adjacent to Building 46A does not show PCE, TCE and DCE suggests that the source of these chemicals could not be from the Building 46A area.
4. The fact that none of the wells and slope indicator located at the northwest corner of Building 46 show any contaminant eliminates the possibility of the northern part of that building to be a source of these three chemicals.

One more issue needs to be resolved. If hydraugers extending below Building 46A carry PCE, TCE, and DCE, what is the reason for not detecting those chemicals in the water samples collected from Well 31.63 that is drawing groundwater close to Building 46A? Figure 13 shows an east-west cross section passing under B46A. Approximate position of water table during summer of 1990 and both Hydrauger No. 51.01.03 and Well 31-63 are shown in this figure. Most of the indicated elevations are approximate. However, they are accurate enough to justify the following argument.

Hydraugers are designed to drain groundwater and lower water table. Therefore, they should be perforated over their entire lengths. The planned value of dip of this hydrauger and its exit point elevation along the fire trail are known. Having the distance between the fire trail and the position of Well 31-63, we have estimated the elevation of the hydrauger in the vicinity of Well 31-63 to be about 805 ft. Having the elevation of top of the well and the depth to the water, we estimated the elevation of water level in the well to be about 767 ft.

It is apparent from this figure that the water entering the hydrauger is coming from a part of the aquifer which is close to the west side of the road. This is approximately the same section of the aquifer which receives contaminants from the sanitary sewer coming from Building 71. The piezometric map of groundwater in this area that is presented in Figure 14 seems to support the above scenario too.

The above explanation is another indication that the sanitary sewer from Building 71 could be a pathway for delivery of PCE, TCE and DCE to the groundwater west of the road passing beside Building 46.

Because of a thick artificial fill in the eastern part of the parking lot, the sanitary sewer from Building 71 is very deep next to Building 71H. This could be the reason that we were not able to detect high levels of solvents in the soil gas samples collected

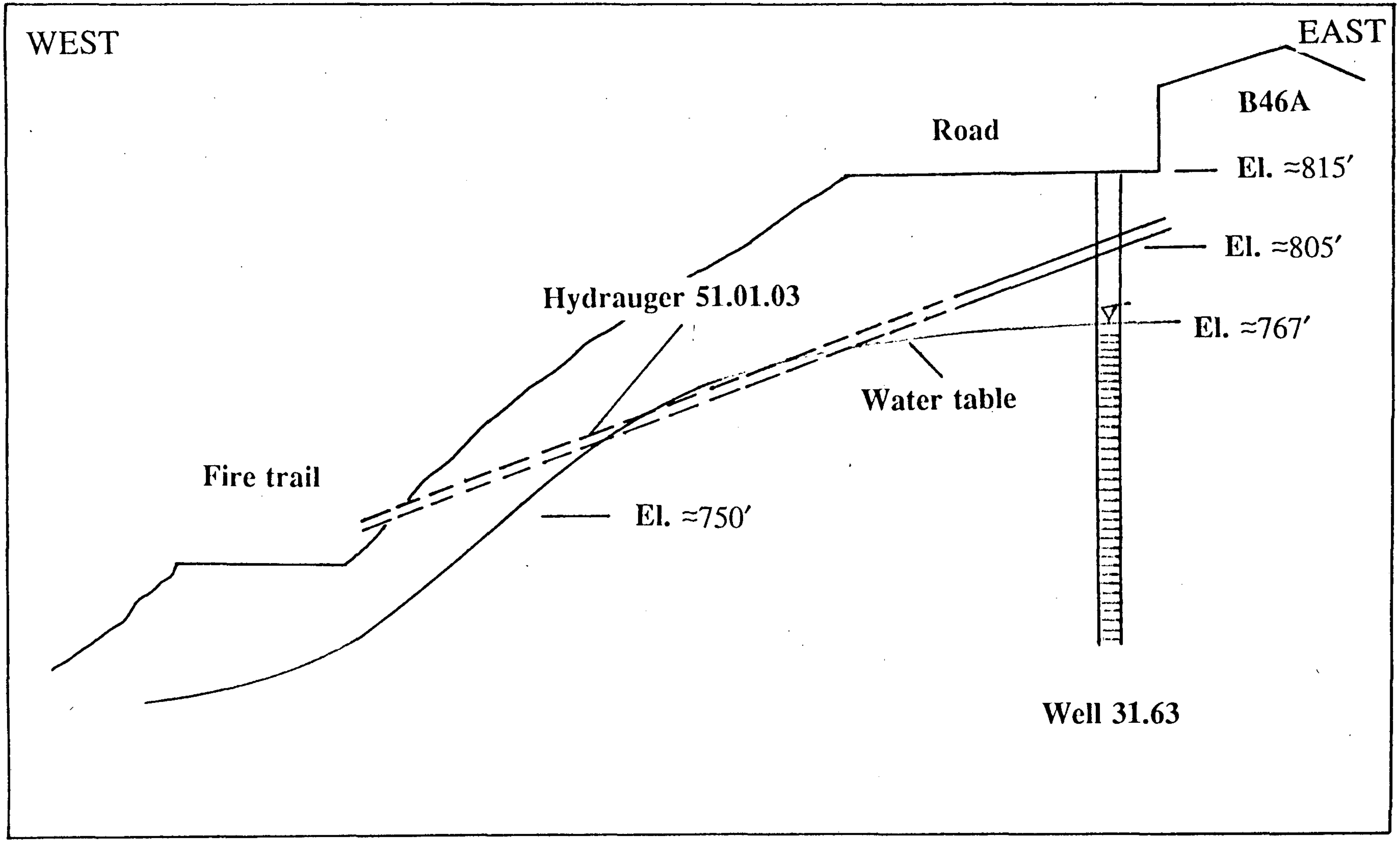

Figure 13. A west-east cross section beneath Building 46A.

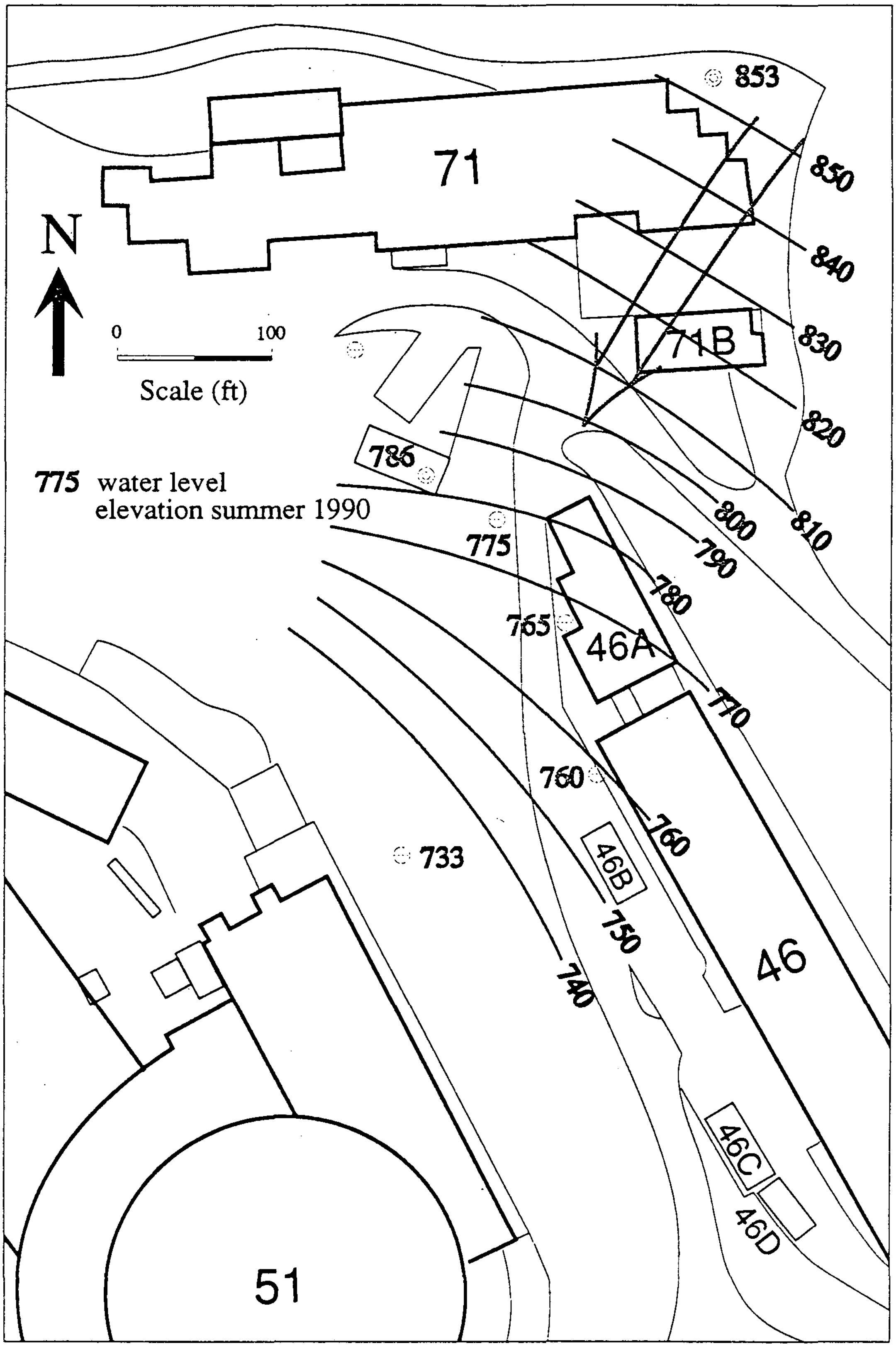

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Figure 14. Piezometric map of groundwater in the vicinity of Bldgs. 46, 51 and 71, during the summer of 1990.

in the area close to Building 71H.

Drilling and Construction of New Wells

Because we have a significant amount of near surface geologic data that has been provided by the past slope stability studies, our strategy was to have the maximum benefit of this data and minimize the expensive cost of drilling.

Following the development of the above scenario, we got very much interested about the quality of water in slope indicator SI-3, which is located beneath Building 71H (see Figure 9). As was noted before, trailer 71H was placed above this slope indicator and therefore we could not access it. Although the clearance beneath this trailer is very small, we asked the Construction and Maintenance Department to cut the lower side of this trailer to provide an access to SI-3. On July 10, 1990 we measured the depth to the water and collected a sample. The chemical analysis of this sample showed both types of solvents - PCE, TCE, and DCE observed previously in the soil gas at point 71.4 and DCA and TCA that were detected in Well 31-63. This also confirmed the above scenario and indicated that this could be a part of the aquifer that receives contaminants from both sides, east and west of Building 71.

The question that we had to answer at this point was: Over what length of sewer line are the contaminants entering the groundwater? To answer this question we decided to construct a monitoring well down gradient from the sanitary sewer, somewhere between SI-3 and the upper junction of the sewer line. The point selected is shown as 90-1 in Figure 9. Since the depth of water in SI-3 was about 58 ft, we decided to go to 60 ft depth. No saturated zone was encountered. Therefore, we continued drilling down to 80 ft. Still no saturated zone was reached. We decided to leave the well temporarily uncased and monitor any water inflow. After a week a few inches of water collected at the bottom of the well allowing us to obtain a sample. The chemical analysis of this sample showed tracers of toluene and carbon disulfide. None of the other solvents under consideration were detected.

The second point selected for drilling was 90-3 shown in Figure 9. The logic for selecting this point was as follows. As was pointed out in the INTRODUCTION, the main branch of Blackberry Creek, before it was blocked, was located between Buildings 71 and 46A (see Figure 3). This creek recharges a relatively narrow saturated zone which seems to exist under the bed of the creek. Information available from past drilling seems to indicate that most of the boreholes drilled close to this creek encountered the water table. Boreholes drilled west of this narrow zone (such as the middle part of B71) did not show a water table during drilling. Looking at the air photos of 1939, before construction of any building at LBL (see Figure 4), distribution of vegetation seems to confirm the limited extent of the shallow saturated zone. The position of 90-3 was selected to hit this narrow saturated zone and be down gradient from the sanitary sewer coming from Building 71. The topography of the area prevented us from drilling further to the west.

Sure enough, chemical analysis of the water sample taken from this well showed a relatively high concentration of PCE, TCE and DCE, close to what we have been observing in Hydrauger No. 51.01.03. In addition we measured 1,1-DCA close to the level detected in SI-3, but higher than what we observed in Well 31-63.

Figures 15 through 19 present the distribution of PCE, TCE, cis-1,2-DCE, 1,1-DCE and 1,1-DCA, respectively, in this area. A careful examination of these figures suggests that the plume of contamination in the groundwater is limited to a narrow area along the old bed of Blackberry Creek.

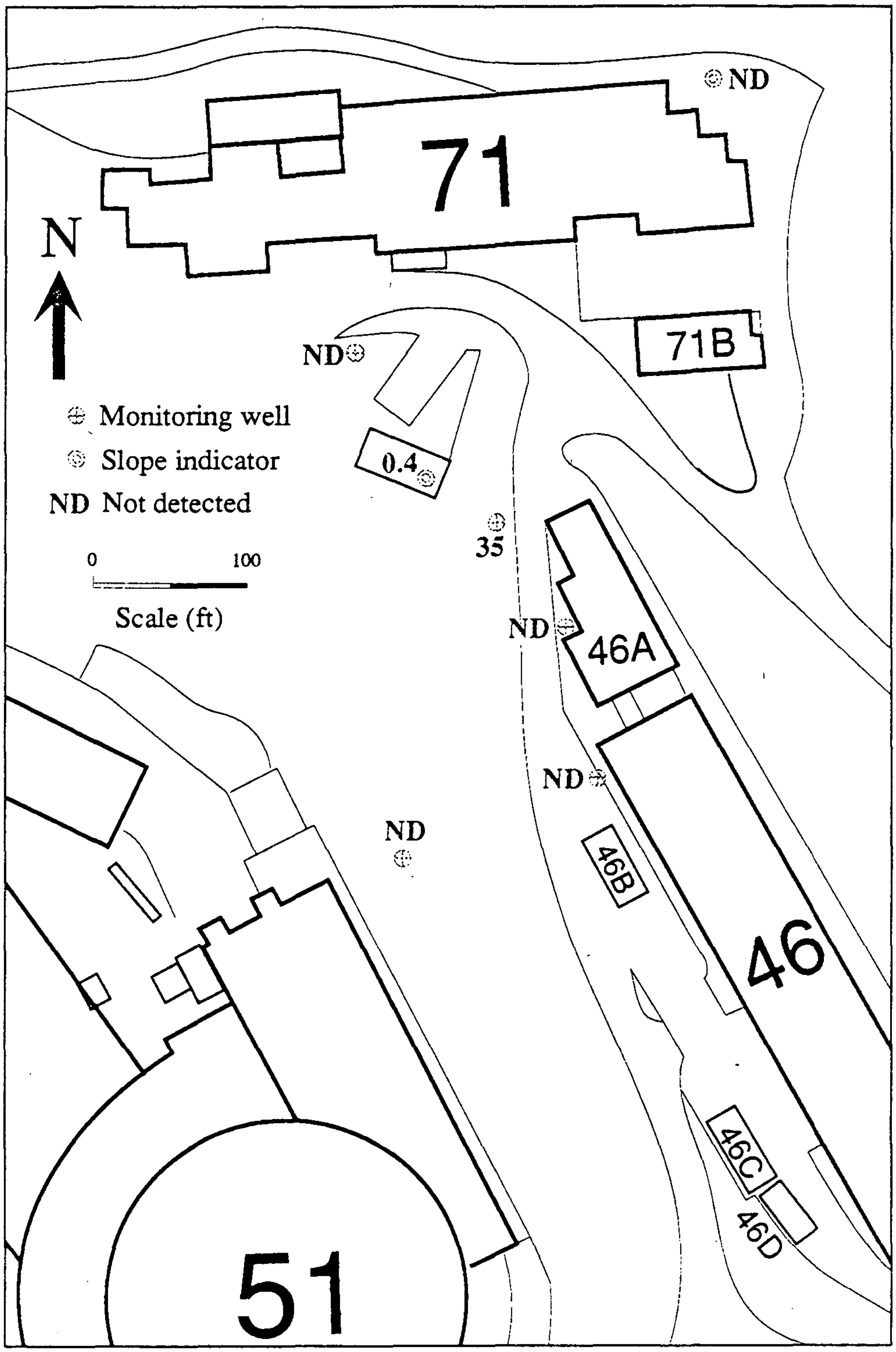

Figure 15. Perchloroethylene (PCE) concentration in ppb, measured in water samples from wells and slope indicators in July 1990.

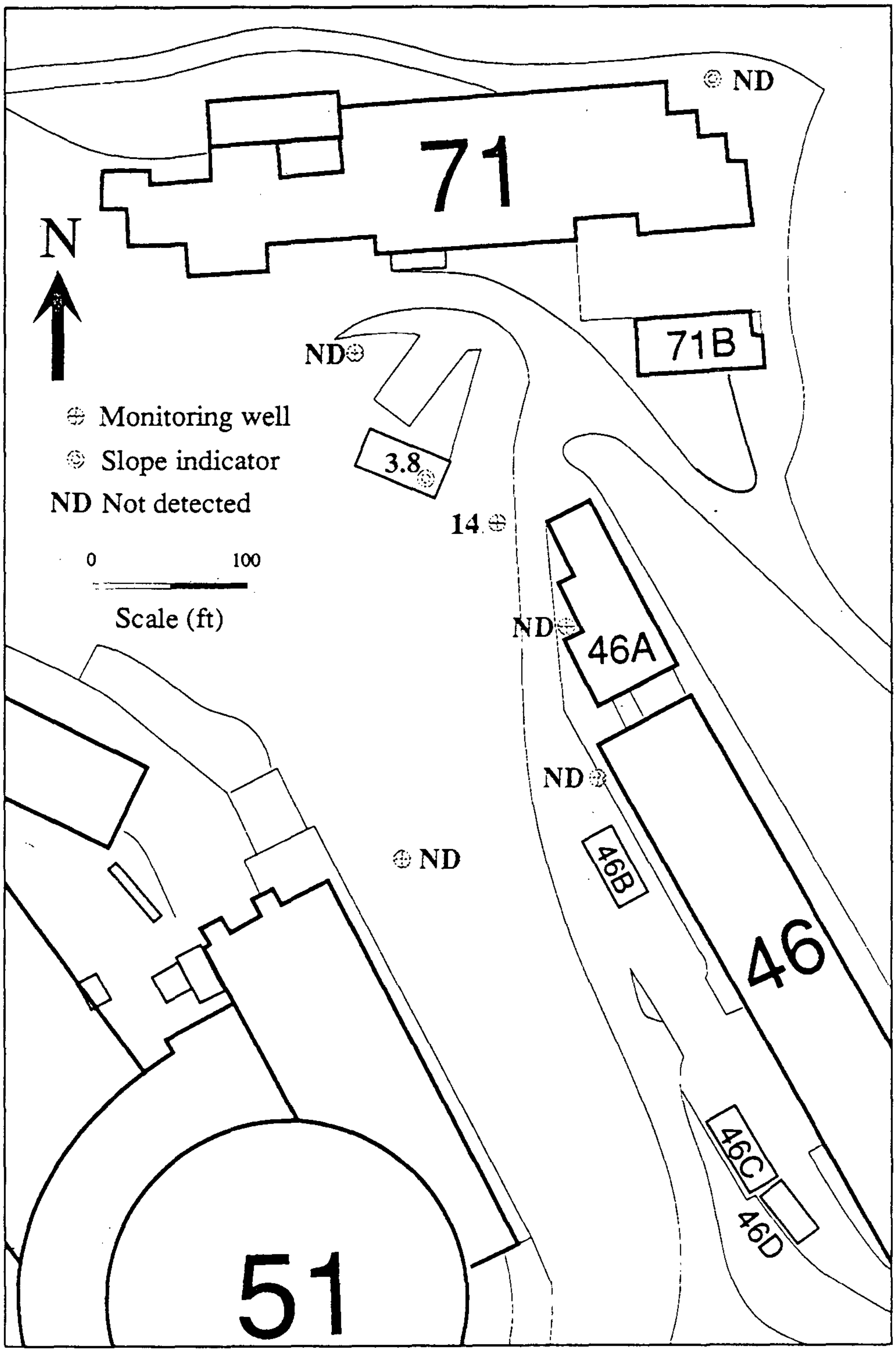

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Figure 16. Trichloroethylene (TCE) concentration in ppb, measured in water samples from wells and slope indicators in July 1990.

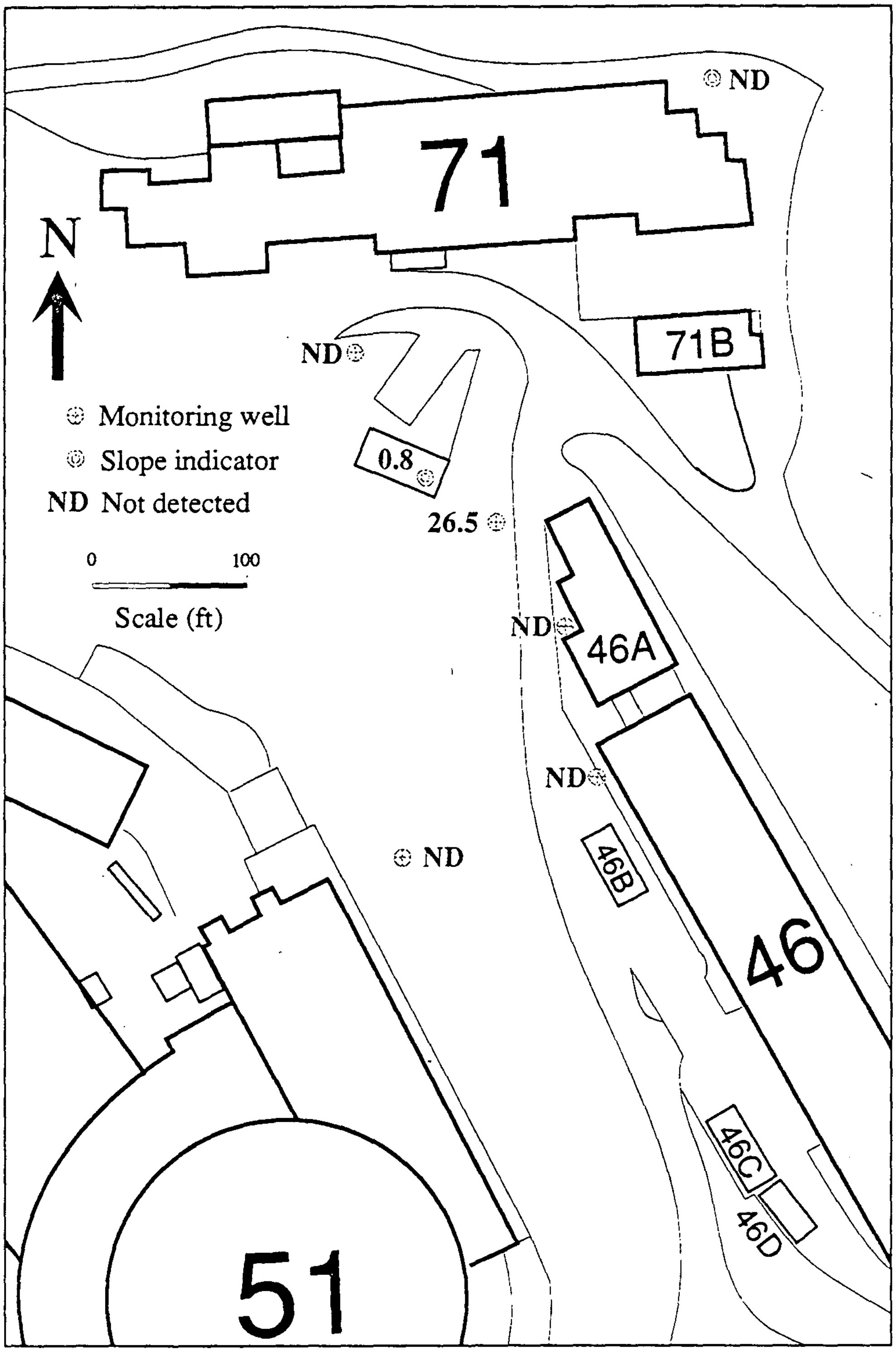

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Figure 17. cis 1,2-Dichloroethylene (cis 1,2-DCE) concentration in ppb, measured in water samples from wells and slope indicators in July 1990.

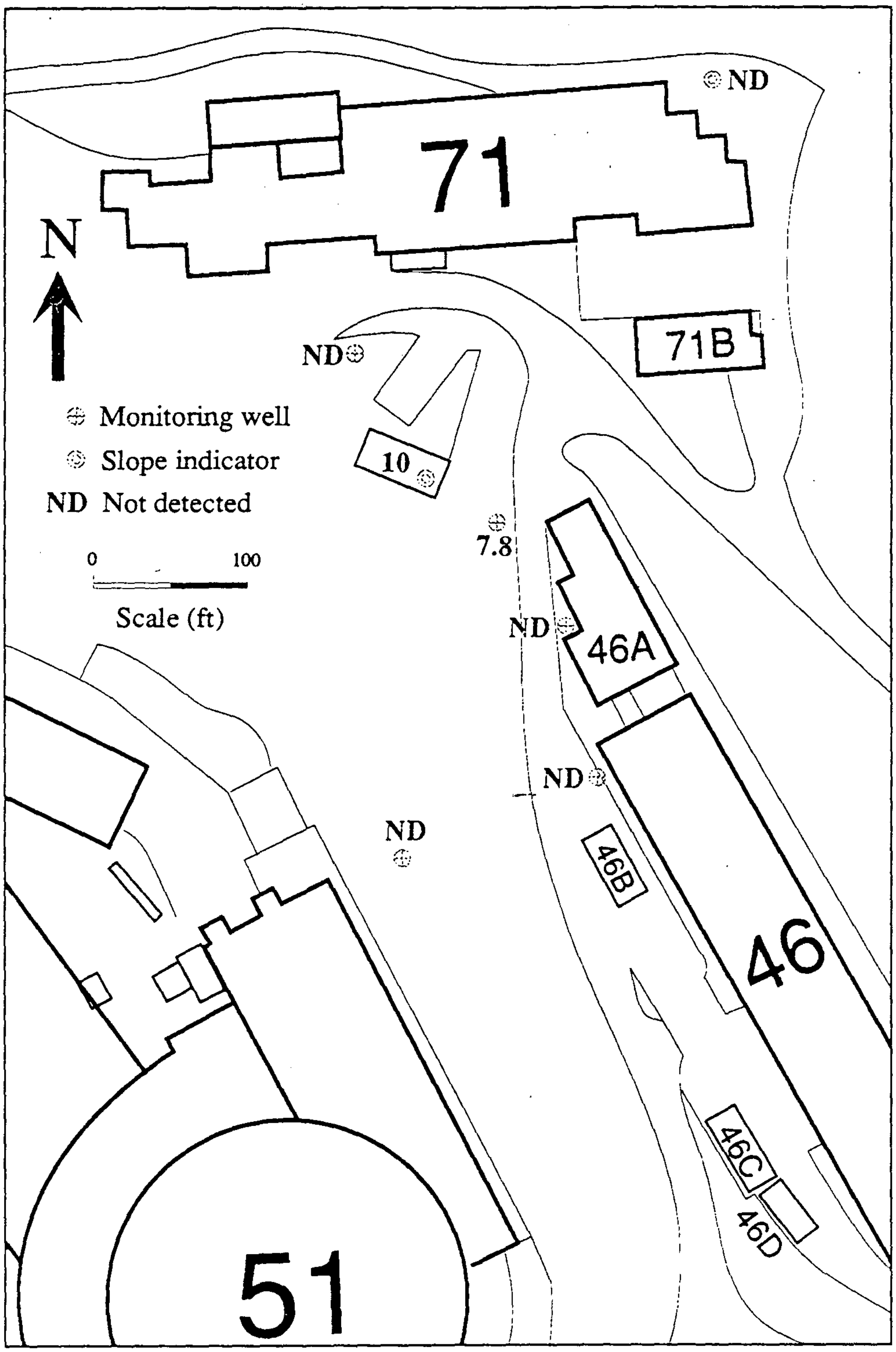

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Figure 18. 1,1-Dichloroethylene (1,1-DCE) concentration in ppb, measured in water samples from wells and slope indicators in July 1990.

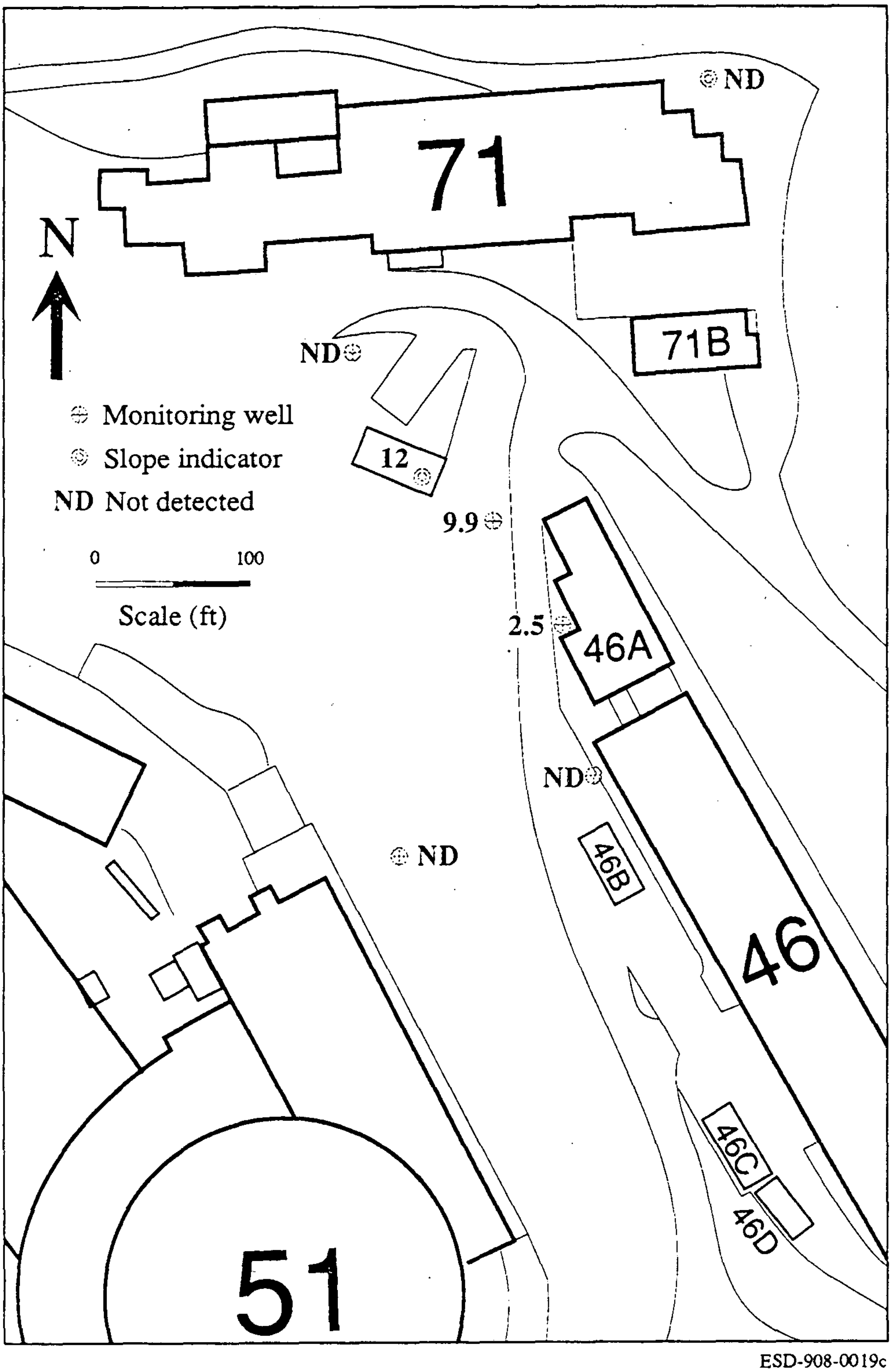

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Figure 19. 1,1 Dichloroethane (1,1-DCA) concentration in ppb, measured in water samples from wells and slope indicators in July 1990.

3. INVESTIGATION AT BUILDINGS 6-7-53 AREA

As was pointed out in the INTRODUCTION, during a fast track sampling, HLA identified some contamination in a slope indicator south of Building 53, and in a monitoring well west of Building 7E. To further characterize the nature and distribution of the contamination in this area, we conducted two rounds of soil and soil gas surveys, measured water levels in the available wells and slope indicators, constructed a new monitoring well and sampled and analyzed the collected water samples for their organic chemical contents. The results of the chemical analysis of water samples collected in this area are also presented in APPENDIX B.

Figure 20 shows the location of monitoring wells and slope indicators in the vicinity of Buildings 6, 7 and 53. During the last year of study (1989-1990), Well 1.220 was dry and slope indicator 1.102 was partially filled with dirt; therefore, neither could be used. Unfortunately, construction activities for the Advanced Light Source Building has damaged the two other monitoring wells 2-220 and 8-102 shown in Figure 1. However, we identified another Well 7.102 south of Building 53. Another monitoring Well 2.102 was also added to this study. The following is a discussion of the activities carried out in this area and the results of study to date.

Soil Gas Survey

Two rounds of soil gas surveys were carried out at this area. Figure 21 shows the location of round one soil and soil gas sampling and Figure 22 presents the results of these activities. At that time we had not yet developed the scenario of the sanitary sewer system as a source of contamination. Therefore, we concentrated close to the area where groundwater contamination had been observed during the 1988 study. Since Building 53 has been a shop in which solvents were used, we started at the front of this building. Two soil gas samples were collected at 5 and 18 ft depths. The shallow sample showed a small concentration of PCE (1.18 μg/L) and the deeper one about half as much. A soil sample (53.S) was then collected from 4 ft depth. It showed very small amounts (less than 1 μg/kg) of gasoline compounds such as toluene, and xylene. But no trace of other organic solvents was detected.

A rack of solvent drums that are currently used in Building 53 is located outside on the northeast corner of the building. Although safety precautions such as drip trays were provided, to examine the effect of past practices a soil sample down gradient from the track was collected (53.ES) from 4 ft depth. This sample also showed some low level of gasoline compounds, but no other solvents were detected. Both south and east parts of Building 53 are currently used for parking. Two other soil gas samples were collected and analyzed. One north of Building 7 at point 7.1 and another at point 7.2 which is located northwest of Building 7. The sample from point 7.1 was collected from 5 ft depth and showed less than 1 μg/L each of benzene, toluene and xylene, but no chlorinated solvents. The sample 7.2 was taken from 17.6 ft depth. It

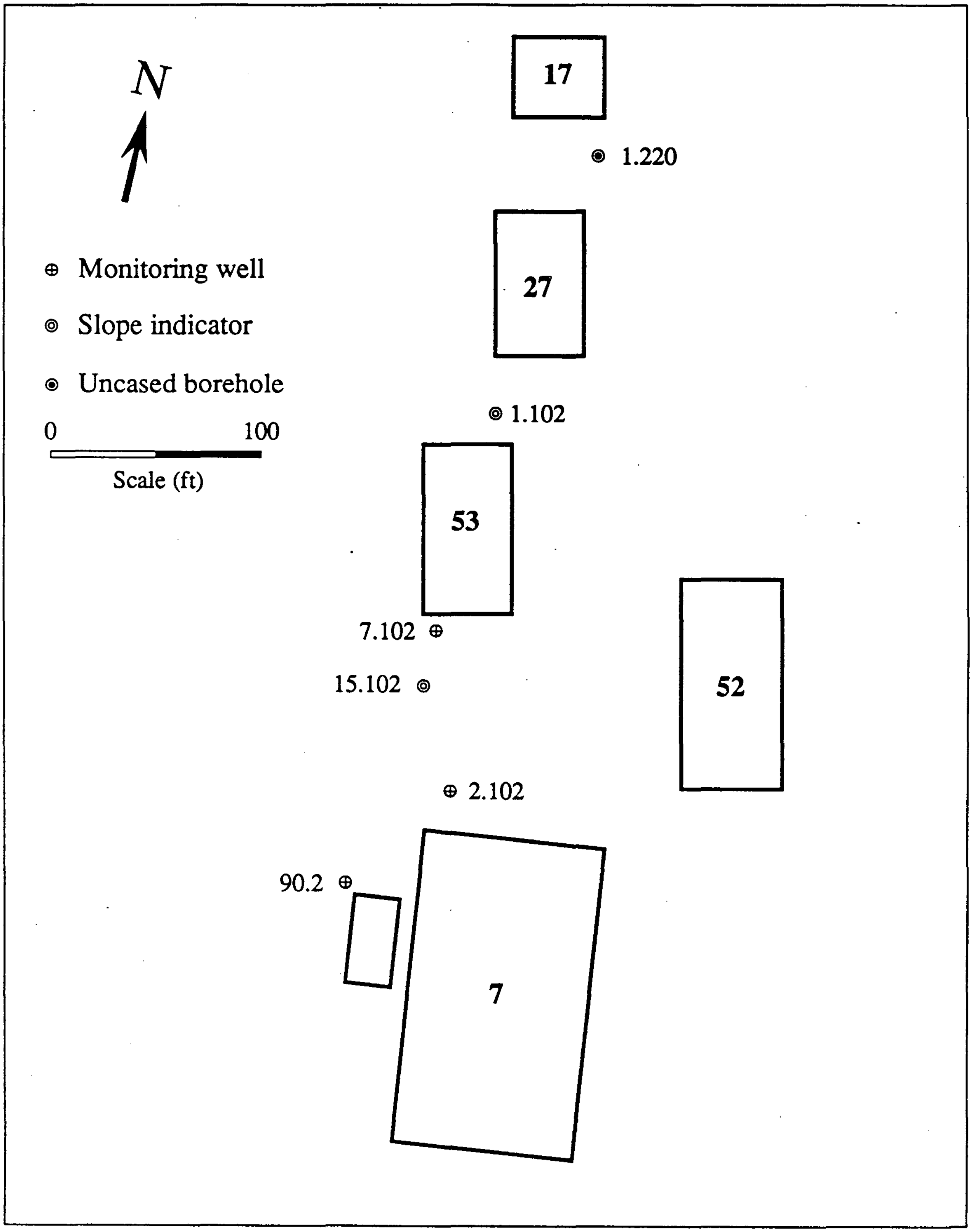

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Figure 20. Locations of monitoring wells and slope indicators in the vicinity of Bldgs. 6, 7 and 53.

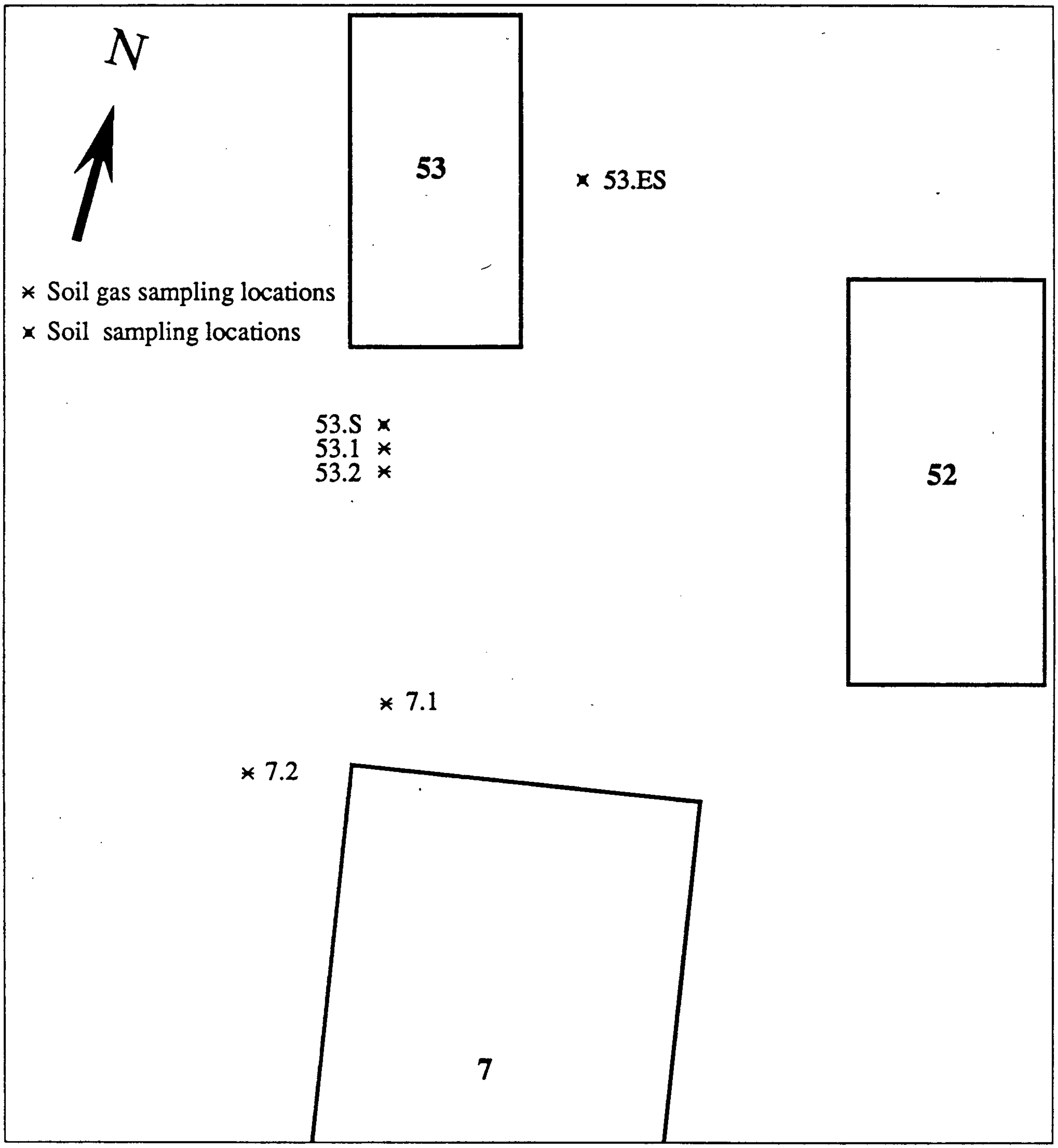

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Figure 21. Locations of round one soil and soil gas survey in the vicinity of Buildings 7, 52 and 53.

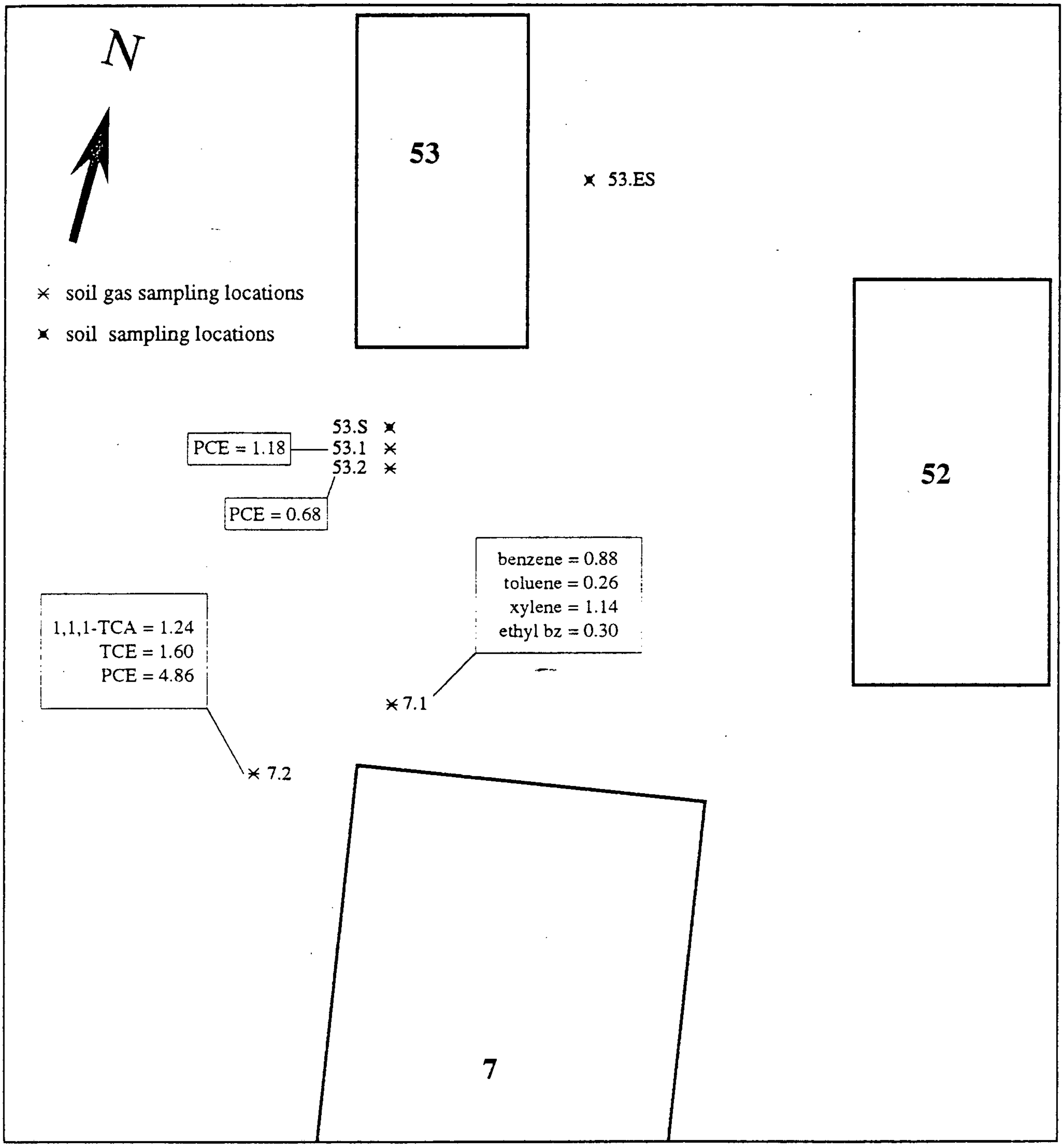

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Figure 22. Results of round one soil and soil gas surveys in the vicinity of Buildings 7, 52 and 53.

showed 1.24 µg/L of 1,1,1-TCA, 1.6 µg/L TCE and 4.86 µg/L of PCE. In Table 4 are listed the chemicals for which these samples were tested for and the results of the analyses.

Subsequent to the development of the scenario that assumed sanitary sewers as a source of contamination in the Building 71 area, we decided to have a closer look at the sanitary sewers in this area too. Thus we conducted a second soil gas survey concentrating on the sewer lines. To be as close as possible to the sewer lines and avoid damaging them, we accurately located the position of sanitary sewer lines in the vicinity of Buildings 7, 52 and 53. We traced the alignments on the ground and measured the depth to the lines at several points

Figure 23 shows the plan of sanitary sewers in this area; Figure 24 the locations from which we collected soil and soil gas samples; and Figure 25 our significant findings. Table 5 shows the results of this survey.

The first series of soil gas sampling points south of Building 53 (points 53.1 to 53.5) were located about 1 foot away from the sanitary sewer line and at depths corresponding approximately to the bottom of the line. All five samples showed a small concentration of PCE (all less than 1 µg/L). Sampling points 53.6, 53.7, and 53.8 were located between the previous points but at 10 ft depth. Only 53.8 showed a relatively high concentration of PCE and some small concentration of TCE and TCA. In addition, two soil samples were collected from 5 and 7 ft depth at points 53.9 and 53.10. Except for 5.5 µg/kg of toluene which was detected in sample 53.10, no other contaminants were reported.

The fact that we measured a relatively high concentration of PCE and some TCE and TCA in one out of ten sampling point along the line suggests that perhaps if there has been a leakage along the sanitary sewers it happened at localized points such as pipe joints.

As shown in Figure 25, some significant concentration of PCE (4.98 µg/L) was measured at a point along the sanitary sewer out of Building 52. The sampling point of 7.3 is located along a section of the line which is downstream from many of the older buildings "old town." The sample shows 1,1,1-TCA (9.1 µg/L) and some TCE and PCE, both less than 1 µg/L.

Monitoring of Wells and Slope Indicators

Water samples collected from monitoring Well 7.102 and slope indicator 15.102 show relatively high concentrations of PCE, in the order of several hundred ppb. Concentration of TCE and DCE are much less, but still significant. In addition, they show relatively high concentration of ethane compounds. Figure 26 through 29 show distribution of PCE, TCE, 1,1-DCE and total ethylene and ethane compounds in the water samples taken during July 1990 from monitoring wells and slope indicators in this area. A new well was drilled at the northwest corner of Building 7, called 90.2. This

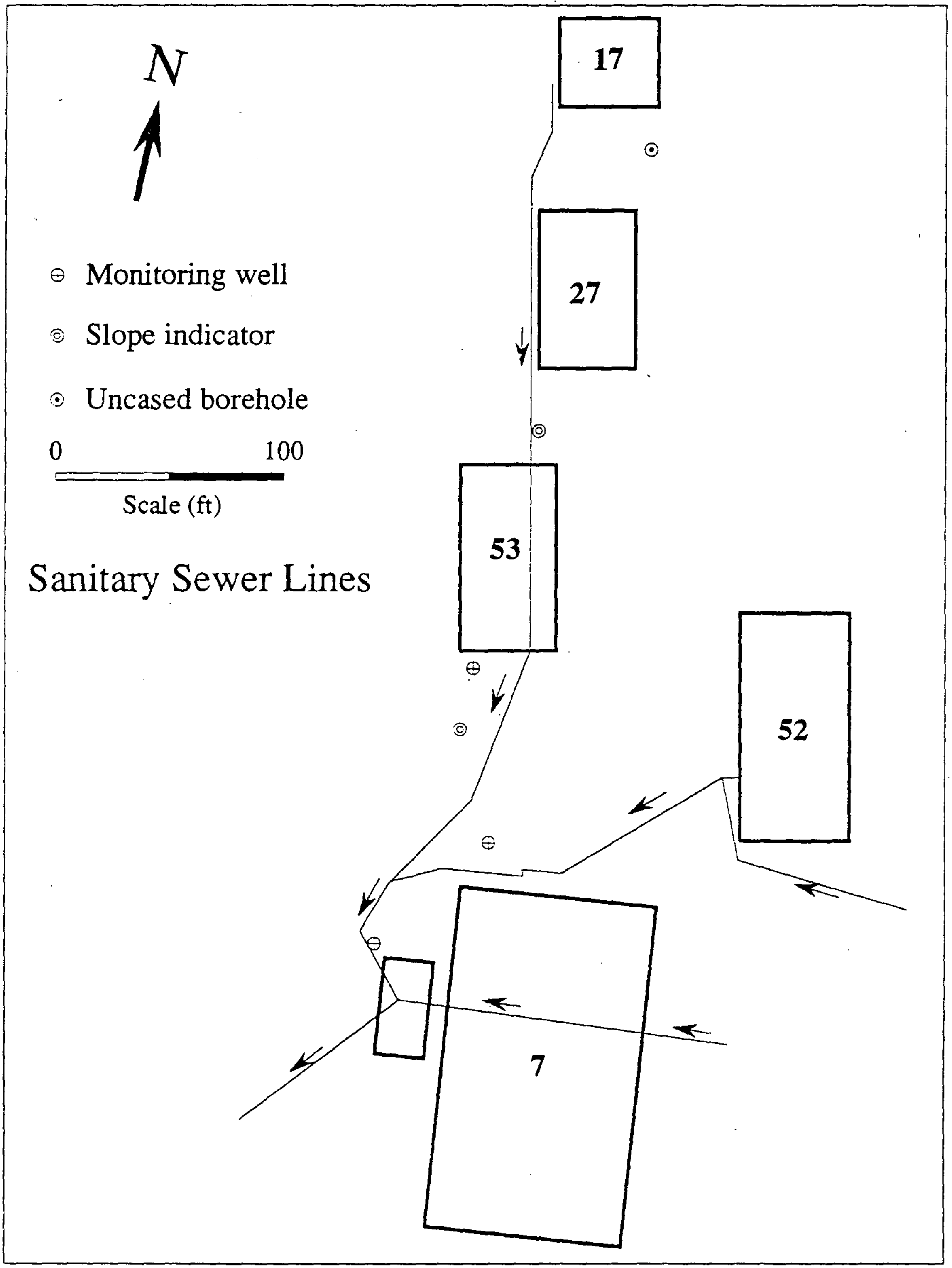

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Figure 23. Sanitary sewer lines in the vicinity of Bldgs. 7, 52 and 53.

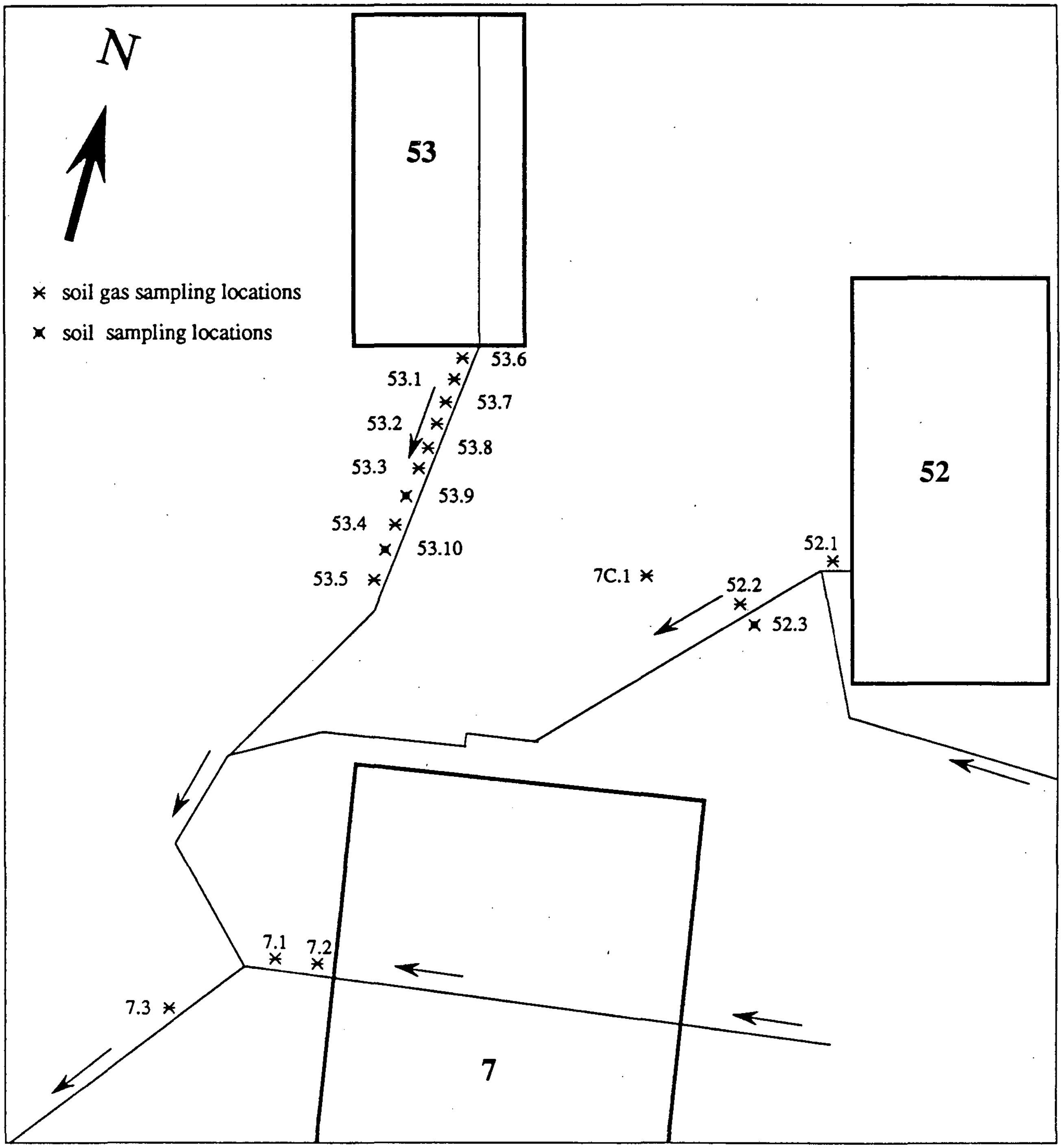

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Figure 24. Locations of round two soil and soil gas survey in the vicinity of Bldgs. 7, 52 and 53.

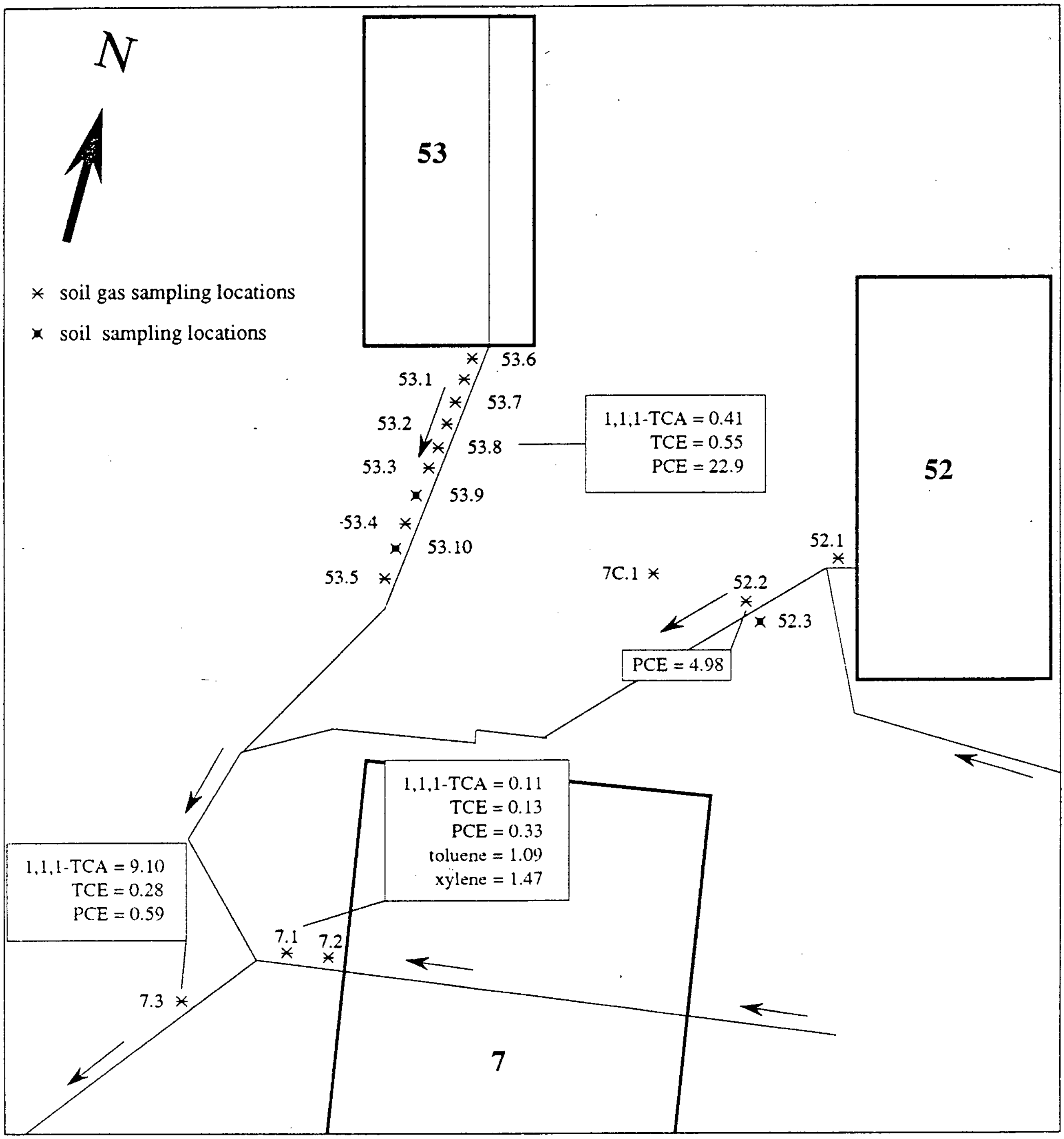

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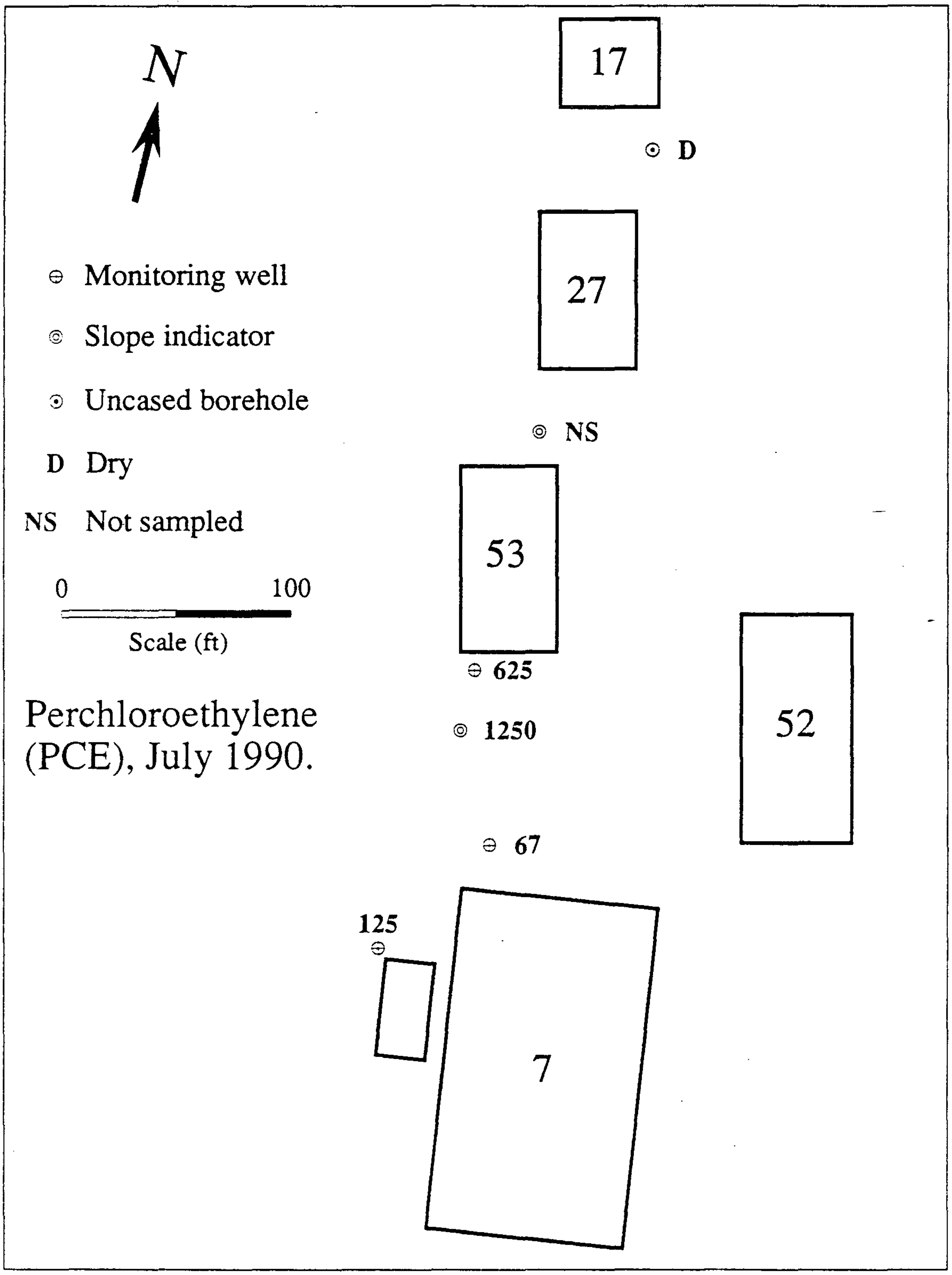
Figure 25. Results of round two soil and soil gas survey in the vicinity of Bldgs. 7, 52 and 53.

Table 5
Summary of Analytical Results

(Units of Concentration: µg/L for Soil Gas, µg/kg for Soil)

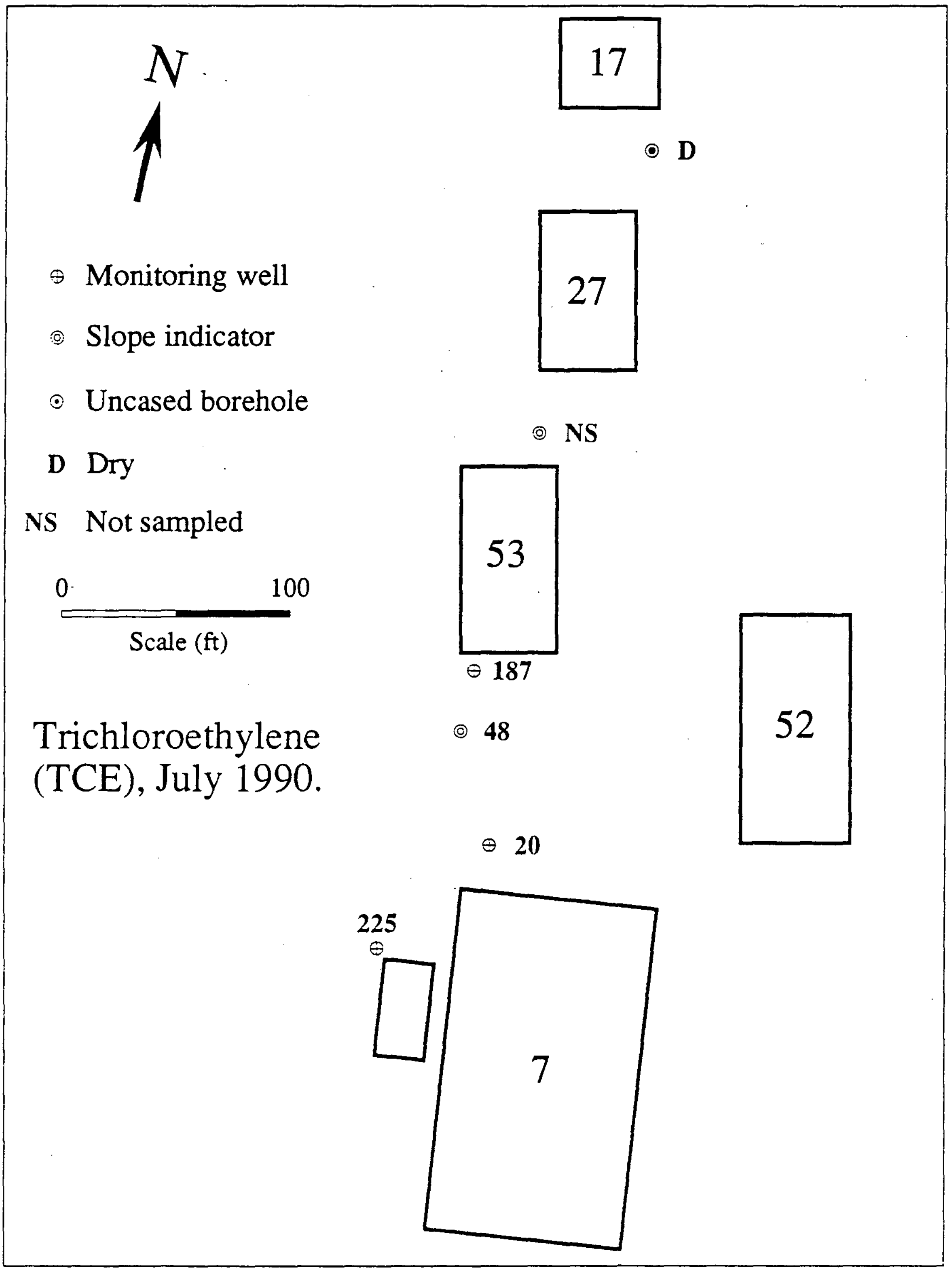
SAMPLE	DEPTH (feet)	MATRIX	FREON-113	METHYLENE CHLORIDE	TRANS-1,2-DCE	1,1-DCA	CIS-1,2-DCE	1,1,1-TCA	TCE	PCE	BENZENE	TOLUENE	ETHYL BENZENE	M,P-XYLENE	O-XYLENE	TOTAL HYDROCARBONS
FB22SEPT#1	0.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
FB23SEPT#1	0.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SG52.1	10.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.68
SG52.2	10.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	4.98	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SG52.3	9.00	MID SOIL	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SG52.3-A	9.00	BOT SOIL	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SG52.3-B	9.00	BOT SOIL	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	12.90
SG53.1	3.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.67	<0.01	0.37	<0.01	0.32	<0.01	2.62
SG53.10-A	5.00	SOIL	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SG53.10-B	5.00	SOIL	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	5.51	<0.10	<0.10	<0.10	<0.10
SG53.2	5.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.15	<0.01	<0.01	<0.01	0.47	<0.01	2.06
SG53.3	4.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.10	<0.01	0.29	<0.01	0.29	<0.01	2.37
SG53.4	5.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.47	<0.01	<0.01	<0.01	0.35	<0.01	1.94
SG53.5	6.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.20	<0.01	0.30	<0.01	0.32	<0.01	2.31
SG53.6	10.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.10	0.30	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SG53.7	10.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.10	1.70	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SG53.8	10.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	0.41	0.55	22.90	<0.01	<0.01	<0.01	<0.01	<0.01	8.94
SG53.9	8.00	SOIL	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
SG69.1	5.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SG69.2	5.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.66
SG69.3	5.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SG69.4	5.00	GAS	<0.01	<0.01	<0.01	<0.01	0.08	<0.01	0.17	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	61.90
SG69.5	5.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	2.71
SG7.1	6.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	0.11	0.13	0.33	<0.01	1.09	0.25	1.15	0.32	9.35
SG7.2-A	6.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.29	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SG7.2-B	6.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.10	<0.01	<0.01	0.34	<0.01	<0.01	2.01
SG7.3	8.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	9.10	0.28	0.59	<0.01	<0.01	<0.01	<0.01	<0.01	6.90
SG75.1	5.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SG75.2	5.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.68
SG7C.1	4.00	GAS	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

FB = FIELD BLANK
A,B = SERIAL DUPLICATES
MID = MIDDLE SOIL TUBE
BOT = BOTTOM SOIL TUBE



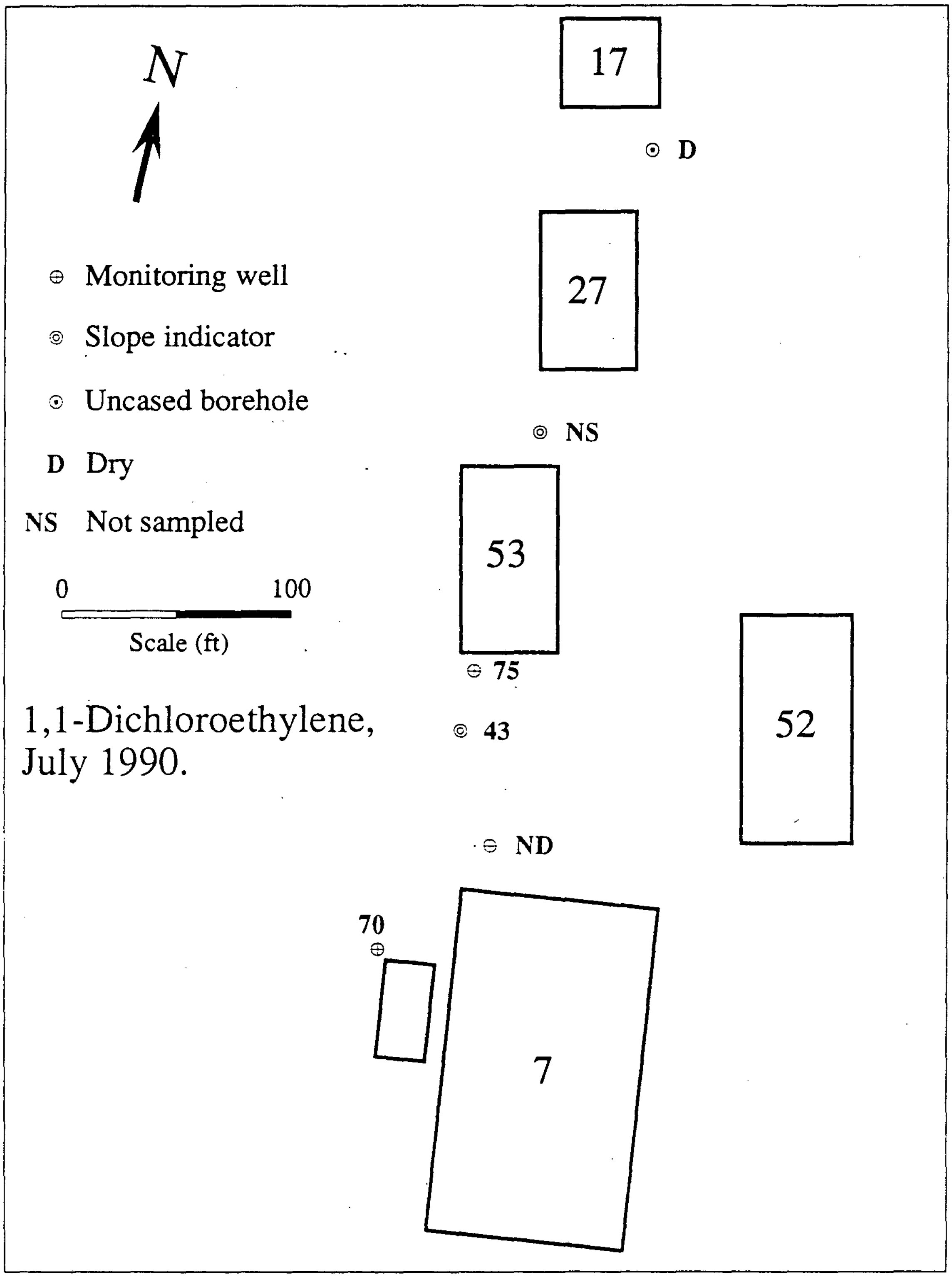
ESD-908-0018d

Figure 26. Perchloroethylene (PCE) concentration in ppb, measured in water samples from wells and slope indicators in July 1990.



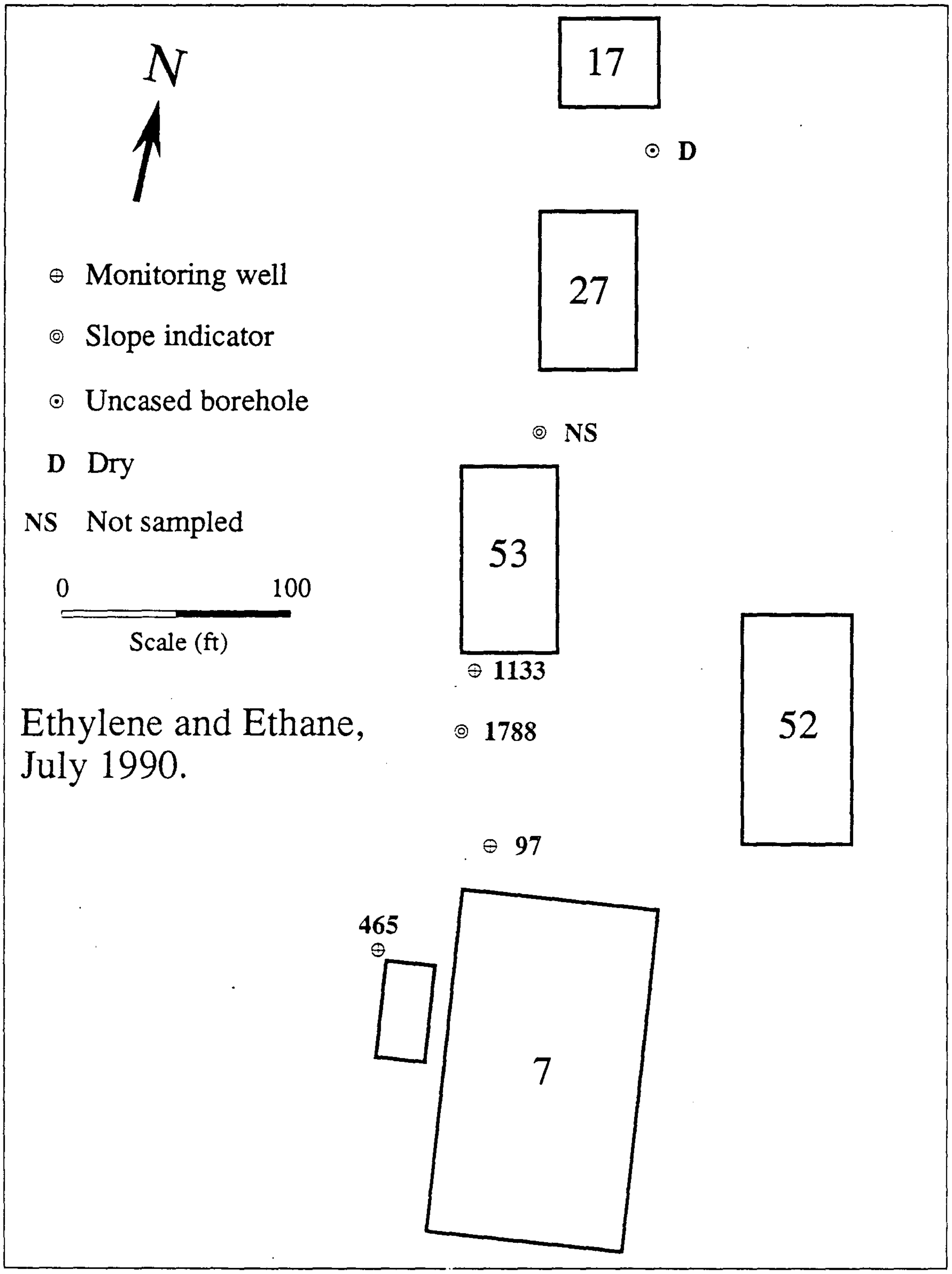
ESD-908-0018a

Figure 27. Trichloroethylene (TCE) concentration in ppb, measured in water samples from wells and slope indicators in July 1990.



ESD-908-0018b

Figure 28. 1,1-Dichloroethylene concentration in ppb, measured in water samples from wells and slope indicators in July 1990.



ESD-908-0018c

Figure 29. Total ethylene and ethanes concentrations in ppb, measured in water samples from wells and slope indicators in July 1990.

well is located very close to a sanitary sewer line coming from Buildings 17, 27, 53, 52, 4 and 5. At about 30 ft depth a saturated interval about 4 inches thick was encountered in this well. The auger was then removed from the well to allow water to enter the well. A sample was then collected by a bailer. Chemical analysis of this sample showed significant concentration of contaminants as presented in Figures 26 through 29. The drilling was then continued to 60 ft depth. No other saturated zone was encountered. The auger was then partially pulled up covering the 4 inch interval. The auger was left in that position over night. The well next morning did not show any water. This proved that the only saturated interval in this well was the one observed at about 30 ft depth. The well was filled with bentonite to the depth of about 35 ft and a 10 ft screen was installed at that depth. Details of the construction of monitoring well 90.2 are reported elsewhere (Kaldveer Associates, 1990).

Following these observations we examined many of the geological logs of the boreholes drilled in this area over the last twenty years. Many logs indicated a thin saturated zone at a depth of about 30 ft.

Well 90.2 was drilled and completed on July 19 and 20th ,1990. On September 19, 1990, we measured the water level in the well at about 20.8 ft below the top of the PVC casing. We then depleted the well, pumping down the water level to 34.5 ft depth and measured the water level buildup. Table 6 shows the variation of depth to the water with time in this well. In a period of about 20 days, the water level raised about 2.8 ft. Recalling that the total drawdown was initially 13.7 ft, we had a recovery of about 20% in 20 days. This test shows that either the overall hydraulic transmissivity of the 4-in saturated interval is very small or the source of water is depleted or both. In the near future we are planning to conduct the same test in the other wells in this area.

In summary, the above observations suggest that although concentration of contaminants in water samples collected in the Building 6, 7, 53 area is relatively high, total volume of water containing these chemicals is rather limited. Further investigations may confirm this preliminary conclusion.

Table 6
Pumping test results of Well 90.2

Date	Time	Depth to Water, ft	Comments
9/5/90	2:05 pm	20.8	Before pumping
9/5/90	2:21	34.5	After depleting
9/5/90	2:32	34.2	
9/5/90	3:05	34.0	
9/20/90	10:19 am	31.7	
9/20/90	1:40 pm	31.6	
9/23/90	10:35 am	31.6	
10/9/90	2:05 pm	31.7	

4. INVESTIGATION AT BUILDINGS 69-75-77 AREA

Our activities in this area consisted of soil gas surveys and groundwater sampling and analysis. Figure 30 shows the location of monitoring wells and slope indicators in the vicinity of Buildings 69, 75 and 77. Groundwater samples were collected and analyzed for the purgeable volatile organics. Figure 31 and 32 show distribution of PCE and TCE in the water samples taken from these wells and slope indicators. Well 15-130 close to B 69 has not shown any contaminants during our sampling period.

Water levels were routinely measured in these wells and slope indicators. Well 15-130 showed a sharp rise and fall of water level, about 15 feet, during the late May 1990 rainfalls (see Figure 33). Other three wells in this area did not show any significant or fast response to that rainfall. This observation may be an indication that Well 15-130 is connected to a major fracture system or other high permeability channel. If this is true, any contaminant that could have entered into this well could be easily washed away in a short period of time.

A large number of hydraugers have been constructed in this area. During our investigation eight of these hydraugers were flowing; Figure 34 shows their approximate location. The flow rates from these hydraugers were measured in May 1990 and varied between 0.002 and 0.65 gpm. Water samples were collected from these hydraugers and analyzed for the purgeable volatile organics. Very low levels (less than 1 ppb) of PCE were detected in some of these hydraugers.

Figure 35 shows the sanitary sewer lines in this area. Since the general direction of groundwater in this area is from north to south (see Figure 36) , contamination observed in Well 9.130 can not be explained by leakage from these lines. During September 1990 we conducted the first round of soil gas surveys in this area. Figure 37 shows the locations where soil gas samples were collected and tested. Points 69.1 and 69.3 were chosen at two sides of the contaminated Well 9.130. Points 69.2, 69.4 and 69.5 were randomly selected because this area was used as a salvage yard in the past and some spills could have occurred. Two other points, namely 75.1 and 75.2 were selected to be very close to the sanitary line out of Building 75. All of the above soil samples were collected from a depth of 5 ft.

Results of this soil gas survey are also shown in Table 5. No significant amount of TCE or PCE were detected in these soil gas samples. Figure 38 shows total hydrocarbons detected in these samples.

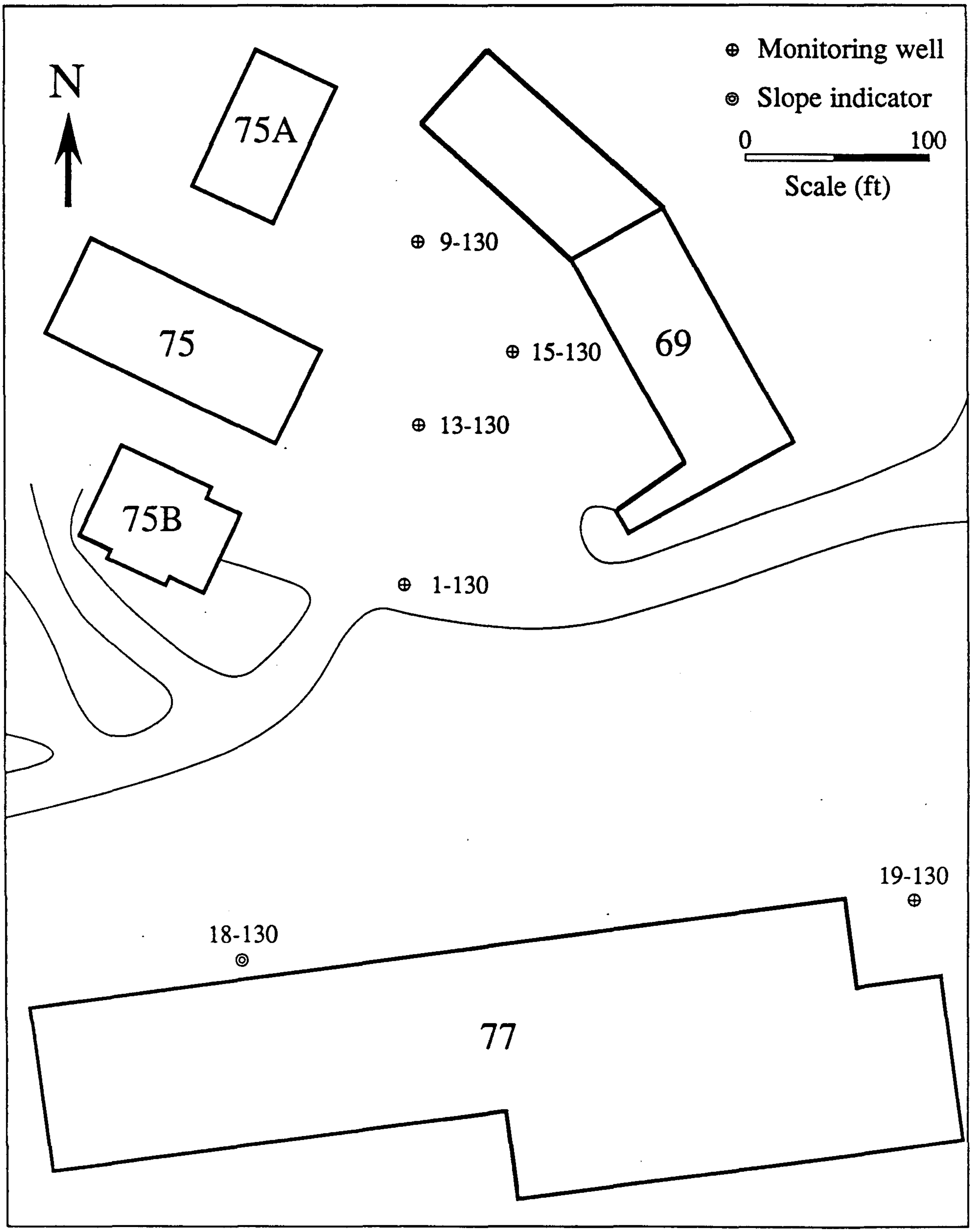


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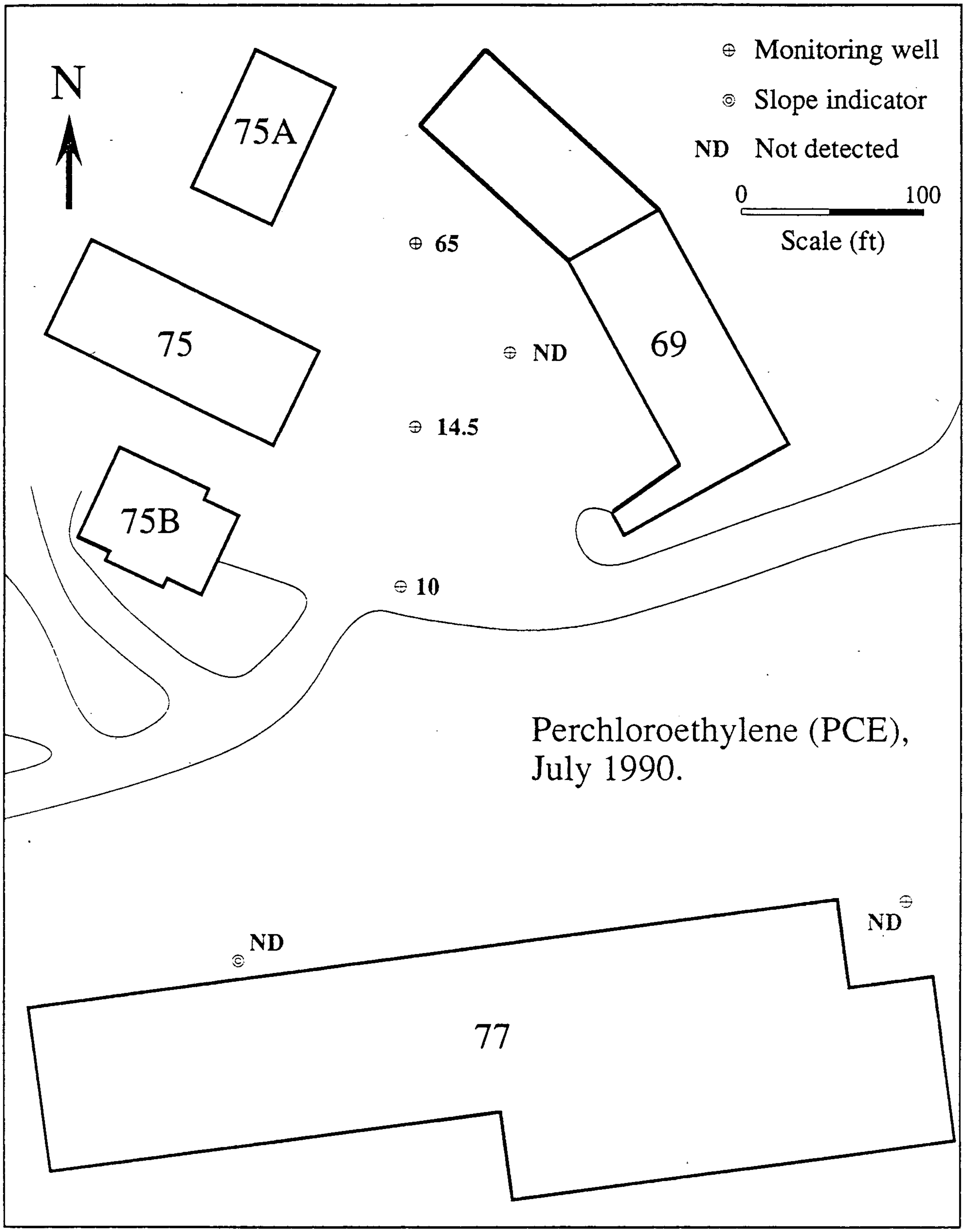
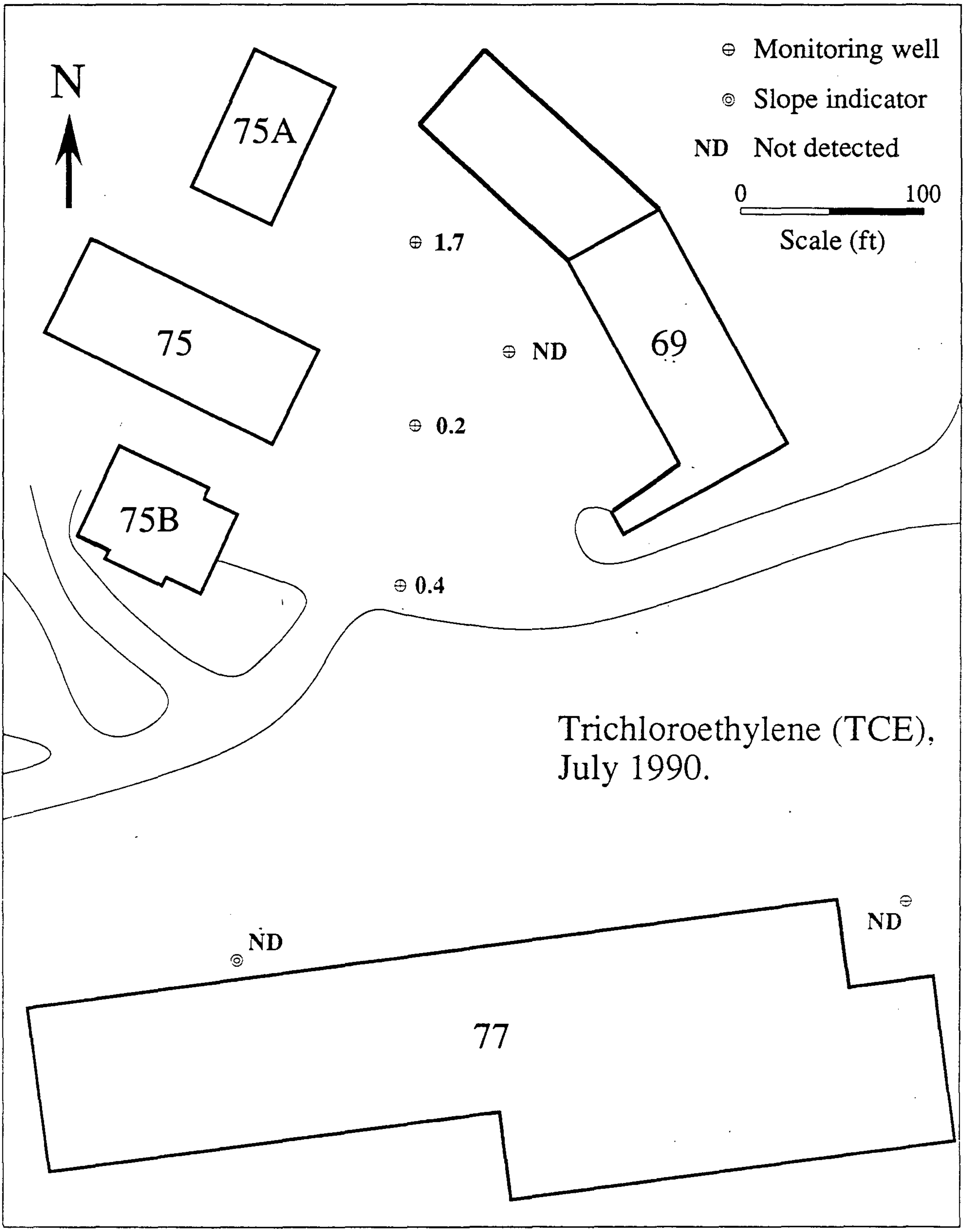
Figure 30. Locations of monitoring wells and slope indicators in the vicinity of Buildings 69, 75 and 77.



ESD-908-0017a

Figure 31. Perchloroethylene (PCE) concentration in ppb, measured in water samples from wells and slope indicators in July 1990.



ESD-908-0017b

Figure 32. Trichloroethylene (TCE) concentration in ppb, measured in water samples from wells and slope indicators in July 1990.

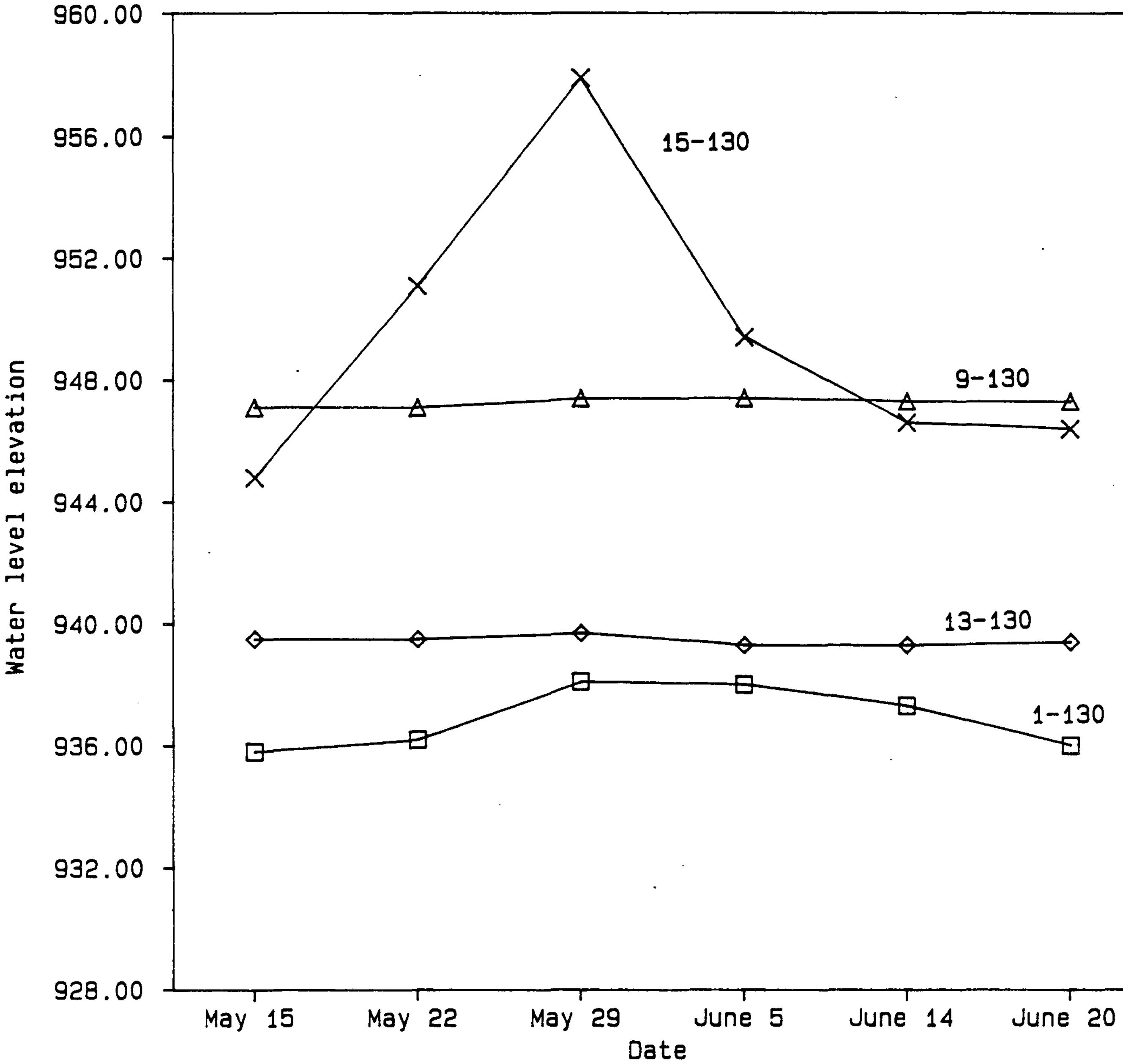
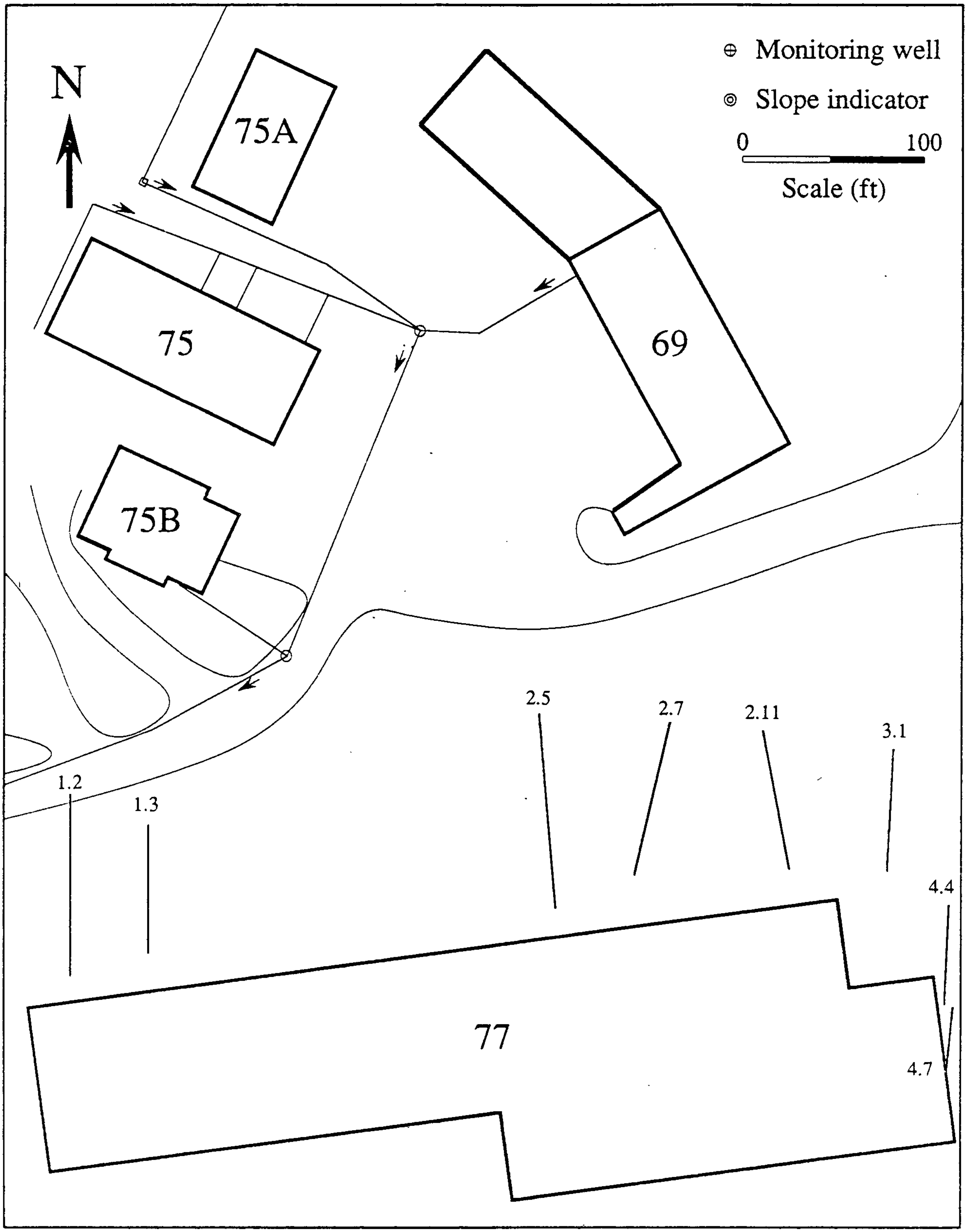
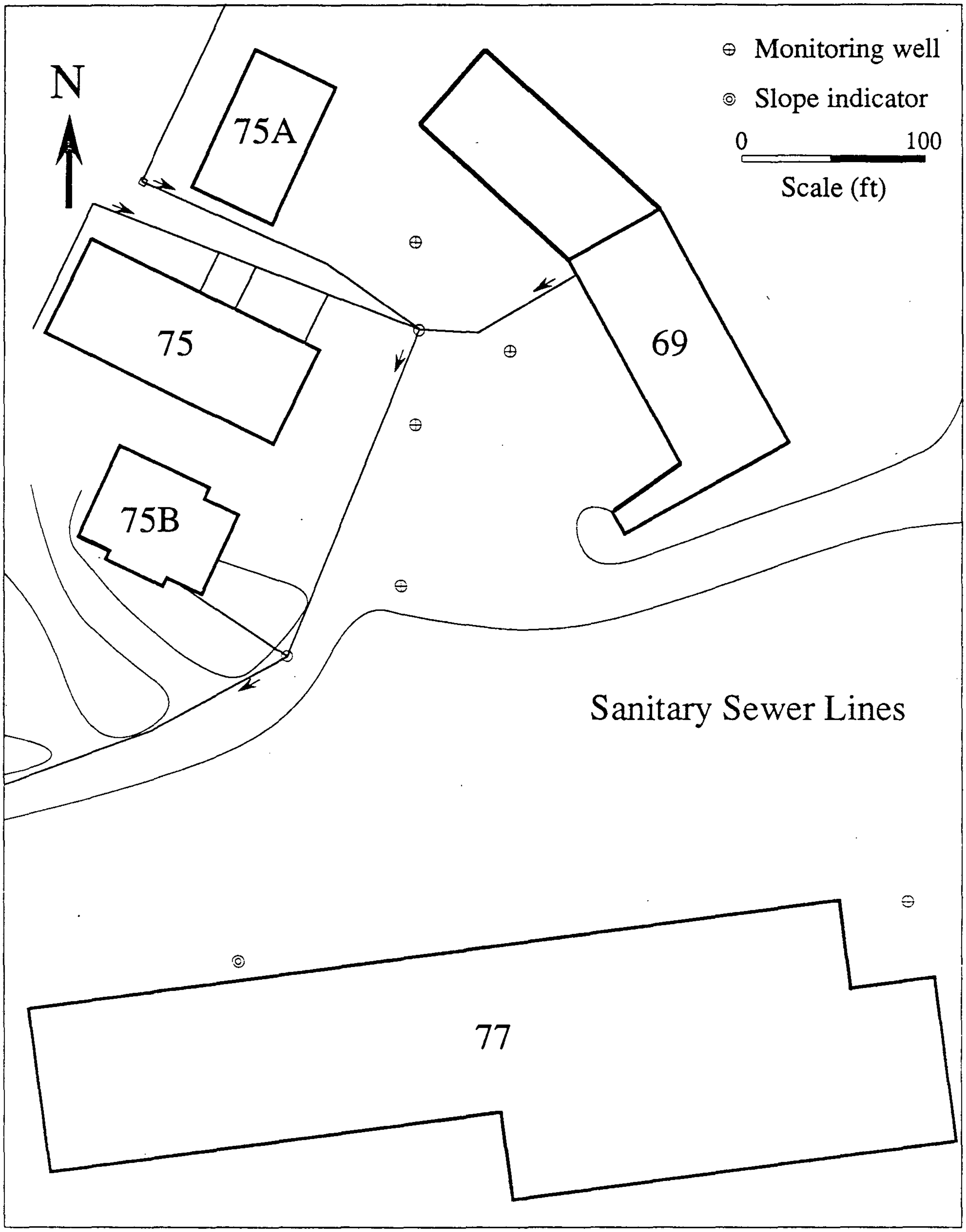


Figure 33. Time variation of water levels in four wells in Buildings 69 and 75 area.



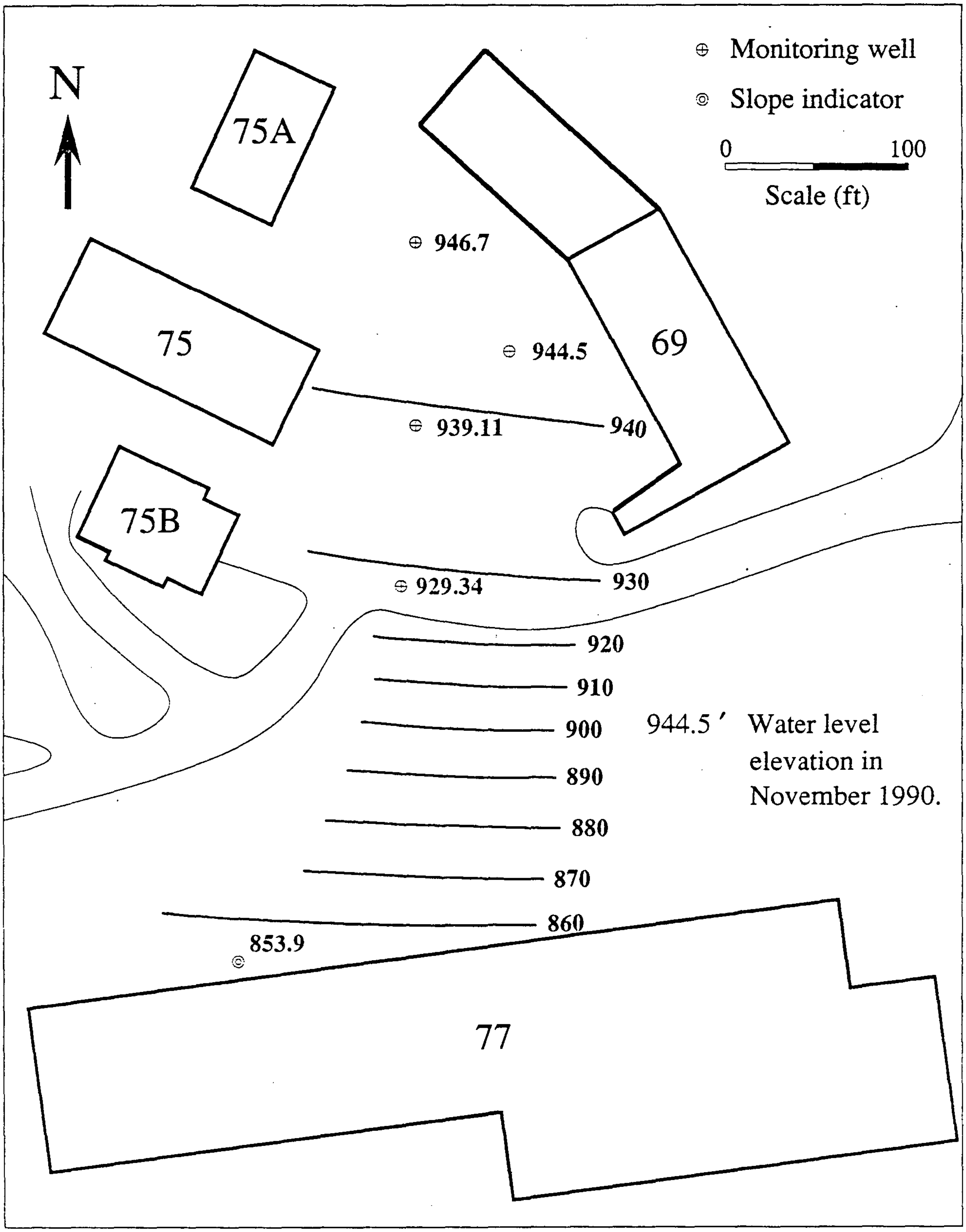
ESD-9010-0038

Figure 34. Approximate position of eight flowing hydraugers north of Building 77.



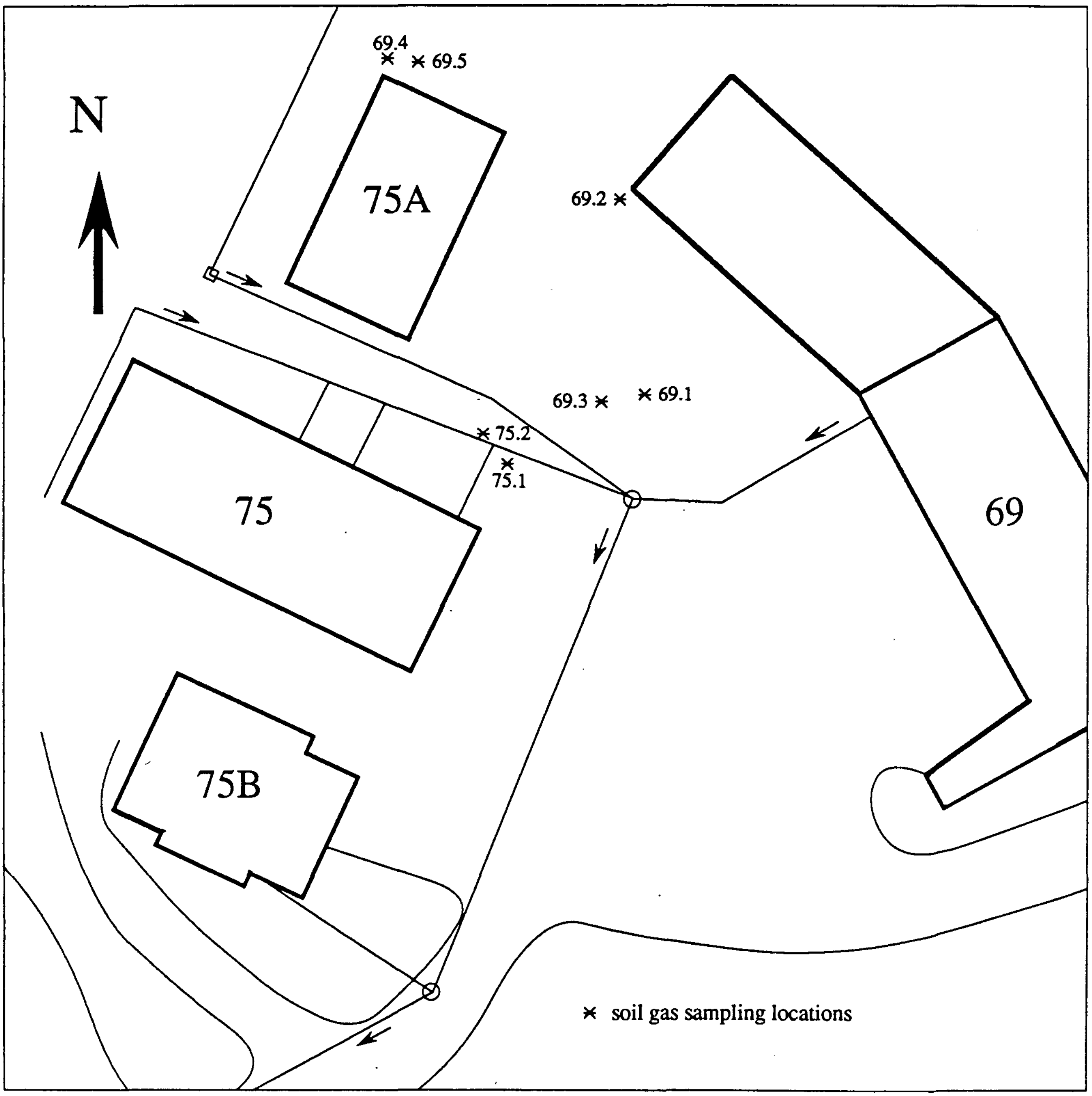
ESD-908-0017c

Figure 35. Sanitary sewer lines in the vicinity of Bldgs. 69 and 75.



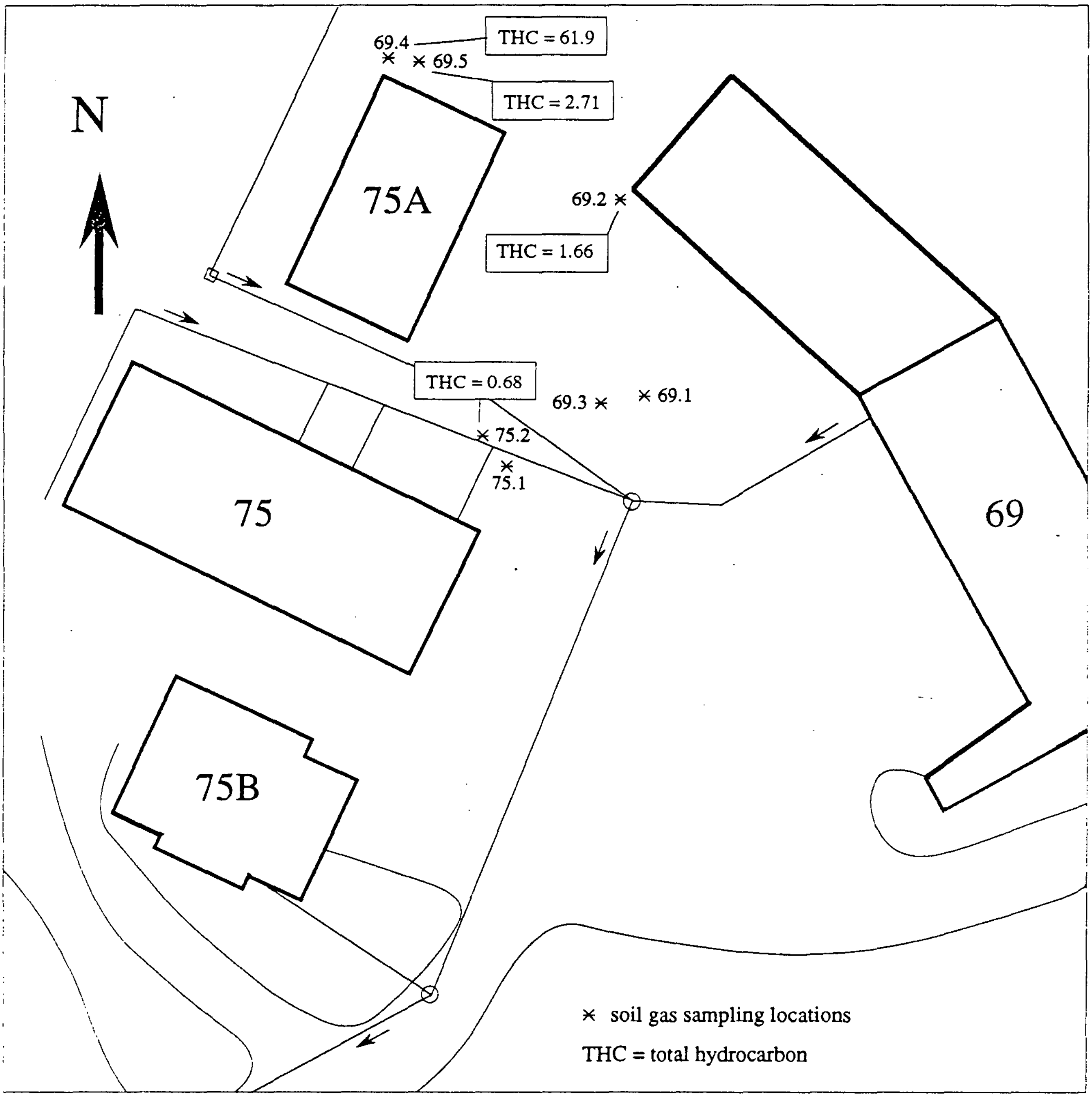
ESD-9011-0043

Figure 36. Piezometric map of groundwater in November 1990.



ESD-9010-0027

Figure 37. Soil gas sampling locations in the vicinity of Bldgs. 69, 75 and 75A.



ESD-9010-0036

Figure 38. Results of soil gas analysis in the vicinity of Bldgs. 69, 75 and 75A.

5. CONCLUSIONS

The results of this preliminary investigation revealed that:

1. A plume of contaminated groundwater is present in the area between LBL Buildings 71 and 46A. The groundwater contaminants identified in this area are PCE, TCE, DCE, DCA and Freon 113. During the course of this investigation, measured concentrations of these chemicals in the groundwater never exceeded 100 ppb.
2. Study of many of the geologic logs available from earlier slope stability investigations, suggests that there is a relatively narrow aquifer along the original channel bed of the main branch of Blackberry Canyon Creek. Except for some isolated pockets of gravel and sands, the aquifer in the Buildings 71-46A area is formed mainly by siltstones showing different degrees of weathering. In this area, water levels have been artificially controlled by hydraugers and automatic pumps installed in some wells. However, the relatively steep topography has resulted in a peizometric surface with a gradient up to about 0.25 to the southwest.
3. Results of soil gas surveys, together with the areal distribution of chemicals and the direction of groundwater flow, supports the scenario that the source of contamination observed in the hydraugers' effluent east of Building 51, is mainly leakage from sanitary sewers coming from Building 71.
4. Chemical analysis of "grabbed" samples from a few wells and slope indicators in the "old town area" (Buildings 7, 52, and 53 area) showed chlorinated hydrocarbons ranging up to 2 mg/L. However, the study of subsurface geologic information from past and recent drilling, as well as a single pumping test, indicate that the contaminated water is limited to a very thin saturated seam (about 4-inch thick), having a very low hydraulic transmissivity.
5. Chemical analysis of water samples collected from three nearby wells in the Corporation Yard (Buildings 69-75 area) showed some low concentrations of PCE and TCE (less than 0.1 mg/L). Water samples taken from eight flowing hydraugers, immediately south of this area, did not show contaminant concentrations in excess of 1 ppb.
6. Groundwater flow in the Buildings 69, 75 and 77 area is essentially toward the south, with gradients ranging from 0.1 in the flat zone, between Buildings 69 and 75, to 0.35 in the steep zone north of Building 77.

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This work was done at the Lawrence Berkeley Laboratory, which is operated by the University of California for the U. S. Department of Energy under contract DE-AC03-76SF00098. Many individuals contributed to carrying out this task. Chao Shan and Hoi-Ying Holman were responsible for water level measurements, sampling and chemical analysis. Richard Johnson arranged for hiring outside contractors and devoted much time to make sure everything run smoothly. Frequent help rendered by Charles Smith in field activities is acknowledged. Richard Shaw and Roberte Baird were instrumental in locating underground utilities, needed for safe operation of soil gas surveys and drilling. The encouragement and guidance of Donald Eagling, Jensen Young, James (Buck) Koonce, Werner Ganz, Richard Scudero and many others made the implementation of this task much easier. I would like to thank Marcelo Lippmann and Ronald Pauer for their careful review of the report. Last but not least, Mark Jasper is responsible for preparing most of the illustrations of this report.

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APPENDIX A

LBL Hydrauger Inventory

An inventory of all LBL hydraugers is presented in Table A1. The inventory was carried out during February 1990. The first column of this table shows the number which has been recently assigned to individual hydraugers. Column two refers to the building next to the exit point of each hydrauger. The third column shows the trend, and columns four and five are planned and recently measured dips of the hydraugers. The measured dip is representative of a small section of the hydraugers close to their exit points. Both trends and dips presented are based on the U. C. Grid System whose north is about 17 degrees off of the true north. Columns six and seven show the diameter and material types of hydraugers. Conditions of hydraugers at the time of inventory are presented in column 8. Column 10 gives the measured flow rate of hydraugers at the time of inventory.

Table A1
LBL hydrauger inventory

LBL #	BLDG NO.	TREND	DIP		DIAM.	MAT'L. TYPE	COND.	COLL. SYSTEM	FLOW RATE	COMMENTS	APPRX. LENGTH
			PLND.	MSRD.							
37.01.01	37	N15E	15	15	2"	PVC	GOOD	EXTN	1GPM	(NEW) CONNECTED TO NEW COOLING TOWER	130'
46.01.01	46	N65E		15	2"	STEEL	FAIR	NONE	DRY	BENT AT END	70'
46.01.02	46	N82E		5	2"	STEEL	FAIR	NONE	DRY	BENT AT END	?
47.01.01	47	N65E		10	2"	STEEL	GOOD	NONE	DRY		90'
47.01.02	47	N65E		15	2"	STEEL	GOOD	NONE	TRKL	RUNNING INTO RDWY. NEEDS EXT. TO DRAIN	120'
47.01.03	47	N65E			2"	STEEL	GOOD	NONE	1GPH	RUNNING INTO RDWY. NEEDS EXT. TO DRAIN	90'
51.01.01	51	N14E	15		1.5"	PVC	GOOD	MFD	3GPM	RUNOFF RECYCLED THRU COOLING TOWER	330'
51.01.02	51	N43E	20		1.5"	PVC	GOOD	C.B.	DRY	4" DIA. FLEXIPIPE EXTENSION TO DRAIN	300'
51.01.03	51	N68E	30		2"	PVC	GOOD	MFD	DRY	ENVIRON. MONTRD., RECYCLED THRU COOLING TOWER	190'
51.01.04	51	S83E	20		2.5"	STEEL	GOOD	MFD	3GPM	ENVIRON. MONTRD., RECYCLED THRU COOLING TOWER	290'
51.01.05	51	S65E		15	2.5"	STEEL	GOOD	C.B.	DRY	RED HOSE EXTENSION TO CATCH BASIN	210'
51.01.06	51	S60E	25		2"	STEEL	GOOD	MFD	DRY	ENVIRON. MONTRD., RECYCLED THRU COOLING TOWER	180'
51.01.07	51	S77E	10		1.5"	PVC	GOOD	C.B.	DRY	OLD NO. 81D	210'
51.01.08	51	S70E	40		2"	STEEL	GOOD	C.B.	DRY	SEVERED 12' FRONT BLDG. 46 @ SHEET PILE WALL, 9/74	150'
51.01.09	51	S89E	20	20	1.5"	PVC	GOOD	MFD	DRIP	OLD NO. 81C	290'
51.01.10	51	S75E	20		1.5"	PVC	GOOD	C.B.	DRIP	EXTENDED TO CATCH BASIN, SEVERED 12' FRONT BLDG. 46	170'
51.01.11	51	N74E	15	15	1.5"	PVC	GOOD	C.B.	DRY	OLD NO. 81A	200'
51.01.12	51	S83E	16	16	1.5"	PVC	GOOD	C.B.	DRY	OLD NO. 81B	180'
51.01.13	51	N83E	5	5	1.5"	PVC	GOOD	NONE	DRY	OLD NO. 8	150'
51.01.14	51	N85E		17	1.5"	PVC	GOOD	NONE	DRY	OLD NO. 9	150'
51.01.15	51	N80E		12	1.5"	PVC	GOOD	NONE	DRY	OLD NO. 10	150'
51.01.16	51	S88E	20	20	4"	CONC.	GOOD	MFD	DRY	ENVIRON. MONTRD., RECYCLED THRU COOLING TOWER	?
51.01.17	51	N60E	20	20					1GPM	PIPE BURIED, NEEDS TO BE EXPOSED AND EXTENDED	?
51.02.01	51	N70E	9		2"	PVC	GOOD	NONE	DRIP	PUSH DOWN ON END WATER FLOWS, DIP NOT READABLE	220'
51.03.01	51	S30E	4		2"	STEEL	POOR	NONE	DRIP	PERFORATED PIPE VERY RUSTY @ END	55'
51.03.02	51									LOST	
51.03.03	51	S32E			2"	STEEL	POOR	NONE	DRY	PERFORATED PIPE VERY RUSTY @ END	55'
51.04.01	51	N82E			2"	STEEL	GOOD	C.B.	DRY	DRAINS UNDER ROAD TO WHITE PVC TO CMP	?
51.04.02	51	S85E			2"	STEEL	GOOD	C.B.	DRY	DRAINS UNDER ROAD TO WHITE PVC TO CMP	?
51.04.03	51	S65E			2"	STEEL	GOOD	C.B.	DRY	DRAINS UNDER ROAD TO WHITE PVC TO CMP	?
51.04.04	51	S50E			2"	STEEL	GOOD	C.B.	DRY	DRAINS UNDER ROAD TO WHITE PVC TO CMP	?
51.05.01	51	N68E		5	2"	STEEL	GOOD	TRGH	TRKL	CONNECTS TO VERT. WELL ON FIRE TRAIL, WELL LOST	50'

51.06.01	51	N30E			2"	STEEL	FAIR	MFD	TRKL	CONNECTS TO 2" STEEL PIPE UNDER RDWY. NEEDS CLEANING?	
51.06.02	51	N60E			2"	STEEL	FAIR	MFD	TRKL	CONNECTS TO 2" STEEL PIPE UNDER RDWY. NEEDS CLEANING?	
54.01.01	54	N35E	23	23	1.5"	PVC	GOOD	MFD	DRY	CLEAN, 1-1/2" GREY PVC EXTENSION @ END	150'
54.01.02	54	N40E	20	20	1.5"	PVC	GOOD	C.B.	DRY	CLEAN, 1-1/2" GREY PVC EXTENSION @ END	140'
54.01.03	54	N60E	16	16	1.5"	PVC	GOOD	C.B.	DRY	CLEAN, 1-1/2" GREY PVC EXTENSION @ END	165'
54.01.04	54	N80E	35		2"	STEEL	FAIR	C.B.	DRIP	RUSTED NEAR OPENING	190'
54.01.05	54	N85E	14		2"	STEEL	FAIR	C.B.	DRIP	RUSTED NEAR OPENING	170'
54.01.06	54	S70E	20		2"	STEEL	FAIR	C.B.	DRY	RUSTED NEAR OPENING	180'
54.01.07	54	S75E	NA		2"	STEEL	FAIR	C.B.	DRY	RUSTING NEAR OPENING, NEWLY DISCOVER 1990 SURVEY	?
54.01.08	54	N60E	NA		2"	STEEL	FAIR	C.B.	TRKL	RUSTING NEAR OPENING, NEWLY DISCOVERED 1990 SURVEY	?
64.01.01	64	N45E	10	10	2"	PVC	GOOD	NONE	DRY	CLEAN	100'
64.01.02	64	N65E	10	20	2"	STEEL	GOOD	NONE	TRKL	EXTENSION TO DRAIN	100'
64.01.03	64	N60E	20	10	2"	STEEL	FAIR	MFD	DRY	RUSTED NEAR END	105'
64.01.04	64	N65E	10	10	2"	STEEL	FAIR	MFD	DRY	RUSTED NEAR END	100'
64.01.05	64	N60E	20	20	2"	STEEL	FAIR	MFD	DRY	RUSTED NEAR END	180'
64.01.06	64	N60E	20	15	2"	STEEL	FAIR	MFD	DRY	RUSTED NEAR END	130'
64.02.02	64	N60E		20	2"	STEEL	GOOD	MFD	DRY	UNHOOKED FROM MANIFOLD	105'
64.02.03	64	N36E		20	2"	STEEL	GOOD	MFD	DRIP	CLEAN	?
71.03.01	46	N63E		5	2"	STEEL	FAIR	NONE	TRKL	RUSTED ON END	45'
71.03.02	46	N60E		5	2"	STEEL	FAIR	NONE	DRY	RUSTED ON END, DIPS INTO HILL	40'
74.02.01	74	N5W		20	2"	STEEL	FAIR	MFD	?	MANIFOLDED TO DRAIN UNREADABLE	140'
77.01.04	77	N12E			2"	STEEL	GOOD	NONE	DRIP	LOCATED BETWEEN 77.01.02 & 77.01.03	230'
77.02.04	77	N10W		10	1.5"	PVC	GOOD	MFD	DRY	MANIFOLDED TO TROUGH, NEEDS TO BE ROUTED TO C.B.	320'
77.02.05	77	N1E		10	1.5"	PVC	GOOD	MFD	TRKL	MANIFOLDED TO TROUGH, NEEDS TO BE ROUTED TO C.B.	310'
77.02.06	77	N12E		10	1.5"	PVC	GOOD	MFD	DRIP	MANIFOLDED TO TROUGH, NEEDS TO BE ROUTED TO C.B.	300'
77.02.07	77	N22E	10	10	1.5"	PVC	GOOD	MFD	TRKL	MANIFOLDED TO TROUGH, NEEDS TO BE ROUTED TO C.B.	290'
77.02.11	77	N5E	5	1	2"	STEEL	GOOD	MFD	DRIP	MANIFOLDED TO RED RUBBER HOSE, RUNS INTO TROUGH	30'
77.02.12	77	N1E	4		2"	STEEL	GOOD	MFD	DRIP	MANIFOLDED TO RED RUBBER HOSE, RUNS INTO TROUGH	35'
77.03.01	77	N5E	12	5	2"	STEEL	GOOD	MFD	TRKL	MANIFOLDED RED RUBBER HOSE; 0.008 GAL/MIN	120'
77.03.02	77	N20W		8	2"	STEEL	GOOD	NONE	DRY		105'
77.03.03	77	N10E	11	25	2"	STEEL	GOOD	NONE	DRY		125'
77.04.02	77	N10E	10	8	2"	STEEL	GOOD	NONE	DRIP	LOCATED ALONG LOWER WALL OF BLDG. 77 EAST HIGH-BAY	330'
77.04.03	77	N30E	15	15	2"	STEEL	GOOD	NONE	DRY		240'
77.04.04	77	N8E	10	5	2"	STEEL	GOOD	NONE	1GPM		210'
77.04.05	77							NL		LOST	
77.04.06	77	N30E	10	5	2"	STEEL	GOOD	NONE	DRIP		165'
77.04.07	77	N35E	12	5	2"	STEEL	GOOD	NONE	TRKL		55'

77.04.08	77	N45E	10	5	2"	STEEL	GOOD	NONE	DRIP		180'
77.04.11	77	N20E	15		2"	STEEL	BAD	NONE	DRY	EXPOSED PIPE BADLY RUSTED	120'
77.04.12	77	N33E	7	20	2"	STEEL	GOOD	MFD	DRY	RUSTED ON END	125'
77.04.13	77	N30E		20	2"	STEEL	GOOD	MFD	DRY		?
77.04.14	77	N45E		15	2"	STEEL	GOOD	MFD	DRY		150'
77.04.15	77	N50E		10	2"	STEEL	FAIR	MFD	DRY	BENT	190'
77.05.01	77	N4E		5	2"	STEEL	FAIR	MFD	DRY	RUSTED ON END	?
77.05.02	77	N15E	15	15	2"	STEEL	FAIR	MFD	DRY	RUSTED ON END, PERFORATED	?
77.05.03	77	N45E	15	25	2"	STEEL	FAIR	MFD	DRY	RUSTED ON END, PERFORATED	?
77.05.04	77	N70E	15	12	2"	STEEL	FAIR	MFD	DRY	RUSTED ON END, PERFORATED	?
77.05.05	77	S87E	5	10	2"	STEEL	FAIR	MFD	DRY	RUSTED ON END, PERFORATED	?
90.01.01	90	N70E		5	2"	STEEL	GOOD	NONE	DRY		
90.01.02	90	N80E		5	2"	STEEL	GOOD	NONE	DRIP		

ABBREVIATIONS

PERF=PERFORATED
GPM=GALLONS PER MINUTE
GPH=GALLONS PER HOUR
C.B.=CATCH BASIN
TRGH=TROUGH
TRKL=TRICKLE
EXTN=EXTENSION

MFD=MANIFOLDED
PLND.=PLANNED
MSRD.=MEASURED
MAT'L=MATERIAL
COND.=CONDITION
COLL.=COLLECTOR
DIAM.=DIAMETER

HYDRAUGER NOTATION: 77.01.05 INDICATES BUILDING 77, NODE 1, HYDRAUGER 5

APPENDIX B

DATA MANAGEMENT

Sampling Procedure

The sampling procedure which was followed during the preliminary investigation is outlined below. Except in a few cases, because of very low yield of wells and slope indicators, some of the recommended steps such as purging the well before sampling were not followed. Since we were looking for the overall picture of contamination at LBL, we believe that a more stringent procedure was not warranted.

1. Decision on time and location of sampling was made by the Technical Supervisor.
2. The individual in charge of sampling prepared a table which included the date and location of sampling, and assigned a serial number to the sample and wrote that number both on the vial containing the sample and in the field book.
3. Using a Teflon bailer, a water sample was collected from a well or slope indicator.
4. A 40 cc vial with Teflon lined cap was completely filled with the bailer water and, after closing the cap, the vial was turned upside down to make sure that there was no air bubble trapped.
5. The sample was taken to the laboratory inside LBL within half an hour.
6. In the laboratory, sample(s) were locked in a special refrigerator provided for this purpose. The individual in charge of sampling and the person in charge of chemical analysis of samples each had a copy of the key to the refrigerator. Samples were kept at 4 degrees C in the refrigerator. The person in charge of sampling then informed the preson in charge of chemical analysis.

7 Each day a copy of the field book showing activities of that day was given to the Technical Supervisor.

8 Following the appropriate EPA methods the samples were usually tested within two days. A copy of the GC/MS results was kept in the laboratory file and a copy was forwarded to the Technical Supervisor.

9. A few times, multiple samples from a given well were collected and delivered to the laboratory and once a tap water sample was included among the samples.

Tables B1 and B2 present the date when each sample was taken, its laboratory identification number and the identification of well, slope indicator or hydrauger from which the sample was collected. Table B3 refers to the EPA method used for analysis of water samples as well as the list of chemicals for which samples were tested. Laboratory reports showing results of chemical analysis of individual samples are also included.

Table B1

Water sample identification for wells and slope indicators.

Date	Lab. Sample No.	Well/SI No.
2/28/90	2.90.01	C.63
2/28/90	2.90.02	SI-8
2/28/90	2.90.03	31.63
2/28/90	2.90.04	27.63
5/01/90	5.90.14	drinking water
5/02/90	5.90.11	C63
5/02/90	5.90.12	2.151
5/02/90	5.90.15	1.130
5/03/90	5.90.22	7.102
5/03/90	5.90.16	15.102
7/03/90	7.90.01	14.102
7/03/90	7.90.03	27.63
7/03/90	7.90.07	2.85
7/03/90	7.90.08	2.151
7/03/90	7.90.09	C.63
7/03/90	7.90.10	31.63
7/03/90	7.90.11	1.162
7/03/90	7.90.12	B75C
7/03/90	7.90.13	13.130
7/03/90	7.90.14	9.130
7/03/90	7.90.15	15.130
7/03/90	7.90.16	1.130
7/03/90	7.90.17	18.130
7/03/90	7.90.18	19.130
7/10/90	7.90.20	2.102
7/10/90	7.90.21	SI-3
7/10/90	7.90.22	SI-3
7/13/90	7.90.23	31.63
7/17/90	7.90.24	31.63
7/24/90	7.90.25	90.2
7/24/90	7.90.26	90.1
7/24/90	7.90.27	90.3
8/30/90	8.90.32	MW1
9/20/90	9.90.33	90.2

Table B2

Water sample identification for hydraugers.

Date	Lab. Sample No.	Hydraugers No.
1/22/90	1.90.01	51.01.10
1/22/90	1.90.02	51.01.03A
1/22/90	1.90.03	51.01.03
3/16/90	3.90.02	51.01.02
5/01/90	5.90.01	77.03.01
5/01/90	5.90.02	77.02.11
5/01/90	5.90.03	77.02.07
5/01/90	5.90.04	77.02.05
5/01/90	5.90.05	64.01.02
5/01/90	5.90.06	47.01.02
5/01/90	5.90.07	47.01.03
5/01/90	5.90.08	54.01.04
5/01/90	5.90.09	54.01.05
5/01/90	5.90.10	54.01.06
5/01/90	5.90.13	54.01.07
5/03/90	5.90.17	77.04.07
5/03/90	5.90.18	77.04.04
5/03/90	5.90.19	77.01.03
5/03/90	5.90.21	37.01.01
7/02/90	7.90.02	51.01.02
7/02/90	7.90.04	51.05.01
7/02/90	7.90.05	51.02.01
7/02/90	7.90.06	37.01.01
7/09/90	7.90.19	51.01.02
9/20/90	9.90.35	51.01.03A
9/24/90	9.90.36	51.01.04
9/24/90	9.90.37	51.01.03A
9/24/90	9.90.38	51.01.01
9/26/90	9.90.39	64.01.02
9/26/90	9.90.40	64.01.07

Table B3

Analytical Method

EPA method 624/1624 was used to determine the concentration of the following volatile organic compounds in water samples obtained from January to September of 1990.

Benzene
Bromobenzene
Bromochloromethane
Bromodichloromethand
Bromoform
Bromomethane
n-Butylbenzene
sec-Butylbenzene
ter-Butylbenzene
Carbon tetrachloride
Chlorobenzene
Chloroethane
2-Chloroethylvinyl ether
Chloroform
Chloromethane
2-Chlorotoluene
4-Chlorotoluene
Dibromochloromethane
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
Dibromomethane
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
cis-1,2-Dichloroethene
trans-1,2-Dichloroethene
1,2-Dichloropropane
1,3-Dichloropropane
2,2-Dichloropropane
1,1-Dichloropropene
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Ethylbenzene
Hexachlorobutadiene
Isopropylbenzene
4-Isopropyltoluene
Methylene chloride
Naphthalene
n-Propylbenzene
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethene
Toluene
1,2,3-Trichlorobenzene
1,2,4-Trichlorobenzene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Trichlorofluoromethane
1,2,3-Trichloropropane
Trichlorotrifluoromethane
1,2,4-Trimethylbenzene
1,3,5-Trimethylbenzene
Vinyl chloride
o-xylene
m-xylene
p-xylene

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 1.90.01

EPA Method: 624/1624

Date of Collection: 01/22/90

Instrument: GC/MS

Date of Analysis: 01/26/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compound	nd	≤0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

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WATER SAMPLE ANALYSIS

Sample No: 1.90.02

EPA Method: 624/1624

Date of Collection: 01/22/90

Instrument: GC/MS

Date of Analysis: 01/26/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
cis 1,2-Dichloroethene	40.0	0.02	-
Trichloroethene	25.0	0.09	-
Tetrachloroethene	36.0	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

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EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 1.90.03

EPA Method: 624/1624

Date of Collection: 01/22/90

Instrument: GC/MS

Date of Analysis: 01/26/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
cis 1,2-Dichloroethene	33.0	0.02	-
Trichloroethene	24.0	0.09	-
Tetrachloroethene	45.0	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

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WATER SAMPLE ANALYSIS

Sample No: 2.90.01
EPA Method: 624/1624
Date of Collection: 02/28/90
Instrument: GC/MS
Date of Analysis: 03/01/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

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WATER SAMPLE ANALYSIS

Sample No: 2.90.02

EPA Method: 624/1624

Date of Collection: 02/28/90

Instrument: GC/MS

Date of Analysis: 03/01/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compound	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 2.90.03

EPA Method: 624/1624

Date of Collection: 02/28/90

Instrument: GC/MS

Date of Analysis: 03/01/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1-dichloroethane	2.5	0.02	-
Chloroform	0.7	0.01	-
1,1,1-Trichloroethane	0.3	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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WATER SAMPLE ANALYSIS

Sample No: 2.90.04

EPA Method: 624/1624

Date of Collection: 02/28/90

Instrument: GC/MS

Date of Analysis: 03/01/90

Compound	Concentration μg/L	Detection limit μg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 3.90.02

EPA Method: 624/1624

Date of Collection: 03/16/90

Instrument: GC/MS

Date of Analysis: 03/19/90

Compound	Concentration µgr/L	Detection limit µgr/L	Comments
Dichlorotrifloroethane	nd	nd	-
1,1-Dichloroethene	4.9	0.05	-
1,1-Dichloroethane	6.8	0.02	-
cis 1,2-Dichloroethene	0.9	0.02	-
1,1,1-Trichloroethane	0.9	0.01	-
Trichloroethene	4.1	0.09	-

nd = not determined

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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WATER SAMPLE ANALYSIS

Sample No: 5.90.01

EPA Method: 624/1624

Date of Collection: 05/01/90

Instrument: GC/MS

Date of Analysis: 05/02/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1,1-Trichloroethane	0.07	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.02

EPA Method: 624/1624

Date of Collection: 05/01/90

Instrument: GC/MS

Date of Analysis: 05/02/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Tetrachloroethene	0.6	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi - Ying Holman

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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.03

EPA Method: 624/1624

Date of Collection: 05/01/90

Instrument: GC/MS

Date of Analysis: 05/02/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.04

EPA Method: 624/1624

Date of Collection: 05/01/90

Instrument: GC/MS

Date of Analysis: 05/02/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
m-xylene	0.25	0.02	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.05

EPA Method: 624/1624

Date of Collection: 05/01/90

Instrument: GC/MS

Date of Analysis: 05/02/90

Compound	Concentration μg/L	Detection limit μg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.06

EPA Method: 624/1624

Date of Collection: 05/01/90

Instrument: GC/MS

Date of Analysis: 05/02/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Chloroform	1.7	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.07

EPA Method: 624/1624

Date of Collection: 05/01/90

Instrument: GC/MS

Date of Analysis: 05/02/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Chloroform	1.3	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.08

EPA Method: 624/1624

Date of Collection: 05/01/90

Instrument: GC/MS

Date of Analysis: 05/02/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Tetrachloroethene	Trace	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.09

EPA Method: 624/1624

Date of Collection: 05/01/90

Instrument: GC/MS

Date of Analysis: 05/02/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.10

EPA Method: 624/1624

Date of Collection: 05/01/90

Instrument: GC/MS

Date of Analysis: 05/02/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.11

EPA Method: 624/1624

Date of Collection: 05/02/90

Instrument: GC/MS

Date of Analysis: 05/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.12

EPA Method: 624/1624

Date of Collection: 05/02/90

Instrument: GC/MS

Date of Analysis: 05/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Chloroform	0.27	0.01	-
Trichloroethene	0.36	0.09	-
Tetrachloroethene	10.05	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.13

EPA Method: 624/1624

Date of Collection: 05/01/90

Instrument: GC/MS

Date of Analysis: 05/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.14 EPA Method: 624/1624

Date of Collection: 05/01/90 Instrument: GC/MS

Date of Analysis: 05/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Chloroform	65.0	0.01	-
Bromodichloromethane	4.5	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.15

EPA Method: 624/1624

Date of Collection: 05/02/90

Instrument: GC/MS

Date of Analysis: 05/04/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Trichloroethene	0.4	0.09	-
Tetrachloroethene	10.0	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.16

EPA Method: 624/1624

Date of Collection: 05/03/90

Instrument: GC/MS

Date of Analysis: 05/04/90

Compound	Concentration µgr/L	Detection limit µgr/L	Comments
1,1-Dichloroethene	43.0	0.05	-
Trans 1,2-Dichloroethene	6.2	0.02	-
1,1-Dichloroethane	19.0	0.02	-
cis 1,2-Dichloroethene	375.0	0.01	-
Chloroform	30.5	0.01	-
1,1,1-Trichloroethane	6.5	0.01	-
Carbon Tetrachloride	0.9	0.02	-
Benzene	7.6	0.01	-
Trichloroethene	48.0	0.09	-
Toluene	0.4	0.02	-
1,1,2-Trichloroethane	0.7	0.01	-
Tetrachloroethene	1250.0	0.01	-
1,1,1,2-Tetrachloroethane	0.6	0.02	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.17 EPA Method: 624/1624

Date of Collection: 05/03/90 Instrument: GC/MS

Date of Analysis: 05/04/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.18

EPA Method: 624/1624

Date of Collection: 05/03/90

Instrument: GC/MS

Date of Analysis: 05/04/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Tetrachloroethene	0.6	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.19
EPA Method: 624/1624

Date of Collection: 05/03/90
Instrument: GC/MS

Date of Analysis: 05/04/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Toluene	Trace	0.02	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.21

EPA Method: 624/1624

Date of Collection: 05/03/90

Instrument: GC/MS

Date of Analysis: 05/04/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Trichlorotrifluoroethane	nd	nd	-
cis 1,2-Dichloroethene	0.1	0.01	-
1,1,1-Trichloroethane	0.1	0.01	-
Trichloroethene	trace	0.09	-
Tetrachloroethene	trace	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 5.90.22	EPA Method: 624/1624
Date of Collection: 05/03/90	Instrument: GC/MS
Date of Analysis: 07/03/90	

Compound	Concentration µg/L	Detection limit µg/L	Comments
Vinyl Chloride	30.7	0.01	-
1,1-Dichloroethene	55.0	0.05	-
Trans 1,2-Dichloroethene	6.0	0.02	-
1,1-Dichloroethane	20.0	0.02	-
cis 1,2-Dichloroethene	55.0	0.01	-
Chloroform	37.5	0.01	-
1,1,1-Trichloroethane	5.2	0.01	-
Carbon Tetrachloride	32.5	0.02	-
1,2-dichloroethane	44.0	0.01	-
Trichloroethene	175.0	0.09	-
Tetrachloroethene	500.0	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-ying Holman

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EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.01

EPA Method: 624/1624

Date of Collection: 07/03/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Vinyl Chloride	48.8	0.01	-
1,1-Dichloroethene	75.0	0.05	-
trans 1,2-Dichloroethene	8.0	0.02	-
1,1-Dichloroethane	20.0	0.02	-
cis 1,2-Dichloroethene	62.5	0.02	-
Chloroform	37.5	0.01	-
1,1,1-Trichloroethane	6.0	0.01	-
Carbon Tetrachloride	37.5	0.02	-
1,2-Dichloroethane	26.0	0.01	-
Trichloroethene	187.5	0.09	-
Tetrachloroethene	625.0	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.02

EPA Method: 624/1624

Date of Collection: 07/02/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1-Dichloroethene	1.6	0.05	-
1,1-Dichloroethane	3.2	0.02	-
cis 1,2-Dichloroethene	0.2	0.02	-
Chloroform	trace	0.01	-
Trichloroethene	0.7	0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.03

EPA Method: 624/1624

Date of Collection: 07/03/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.04

EPA Method: 624/1624

Date of Collection: 07/02/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.05

EPA Method: 624/1624

Date of Collection: 07/02/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1,1-Trichloroethane	0.1	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.06

EPA Method: 624/1624

Date of Collection: 07/02/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1-Dichloroethene	0.3	0.05	-
Chloroform	trace	0.01	-
1,1,1-Trichloroethane	0.3	0.01	-
Trichloroethene	0.1	0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.07 EPA Method: 624/1624

Date of Collection: 07/03/90 Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Chloroform	0.2	0.01	-
Trichloroethene	trace	0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.08

EPA Method: 624/1624

Date of Collection: 07/03/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Chloroform	0.2	0.01	-
Trichloroethene	0.5	0.09	-
Tetrachloroethene	2.5	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.09

EPA Method: 624/1624

Date of Collection: 07/03/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-ying Holman

LAWRENCE BERKELEY LABORATORY
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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.10

EPA Method: 624/1624

Date of Collection: 07/03/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1-Dichloroethane	1.4	0.02	-
Chloroform	0.4	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi - - Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.11

EPA Method: 624/1624

Date of Collection: 07/03/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.12

EPA Method: 624/1624

Date of Collection: 07/03/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration μg/L	Detection limit μg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.13

EPA Method: 624/1624

Date of Collection: 07/03/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Trichloroethene	0.2	0.09	-
Tetrachloroethene	14.5	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
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WATER SAMPLE ANALYSIS

Sample No: 7.90.14

EPA Method: 624/1624

Date of Collection: 07/03/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
cis 1,2-Dichloroethene	7.0	0.02	-
Trichloroethene	1.7	0.09	-
Tetrachloroethene	65.0	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.15

EPA Method: 624/1624

Date of Collection: 07/03/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
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WATER SAMPLE ANALYSIS

Sample No: 7.90.16

EPA Method: 624/1624

Date of Collection: 07/03/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Trichloroethene	0.3	0.09	-
Tetrachloroethene	2.2	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.17

EPA Method: 624/1624

Date of Collection: 07/03/90

Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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WATER SAMPLE ANALYSIS

Sample No: 7.90.18
EPA Method: 624/1624

Date of Collection: 07/03/90
Instrument: GC/MS

Date of Analysis: 07/03/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY

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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.19

EPA Method: 624/1624

Date of Collection: 07/09/90

Instrument: GC/MS

Date of Analysis: 07/10/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1-Dichloroethene	2.3	0.05	-
1,1-Dichloroethane	4.2	0.02	-
cis 1,2-Dichloroethene	0.3	0.02	-
1,1,1-Trichloroethane	0.3	0.01	-
Trichloroethene	1.6	0.09	-
Toluene	trace	0.02	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.20

EPA Method: 624/1624

Date of Collection: 07/10/90

Instrument: GC/MS

Date of Analysis: 07/10/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
trans 1,2-Dichloroethene	0.3	0.02	-
1,1-Dichloroethane	2.1	0.02	-
cis 1,2-Dichloroethene	8.0	0.01	-
Trichloroethene	20.0	0.09	-
Toluene	trace	0.02	-
Tetrachloroethene	67.0	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.21 EPA Method: 624/1624

Date of Collection: 07/10/90 Instrument: GC/MS

Date of Analysis: 07/10/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1-Dichloroethene	10.0	0.05	-
1,1-Dichloroethane	12.0	0.02	-
cis-1,2-Dichloroethene	0.8	0.02	-
1,1,1-Trichloroethane	0.3	0.01	-
Trichloroethene	3.8	0.09	-
Tetrachloroethene	0.4	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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WATER SAMPLE ANALYSIS

Sample No: 7.90.23

EPA Method: 624/1624

Date of Collection: 07/13/90

Instrument: GC/MS

Date of Analysis: 07/13/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1-Dichloroethane	2.2	0.02	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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WATER SAMPLE ANALYSIS

Sample No: 7.90.24

EPA Method: 624/1624

Date of Collection: 07/17/90

Instrument: GC/MS

Date of Analysis: 07/18/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Carbon Disulfide	nd	nd	-
1,1-Dichloroethane	2.0	0.02	-
Chloroform	0.2	0.01	-
1,1,1-Trichloroethane	0.1	0.01	-
Benzene	0.4	0.01	-
Toluene	trace	0.02	-
Napthalene	1.2	0.02	-

nd = not determined

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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WATER SAMPLE ANALYSIS

Sample No: 7.90.25

EPA Method: 624/1624

Date of Collection: 07/20/90

Instrument: GC/MS

Date of Analysis: 07/20/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Dichlorotrifluroethane	nd	nd	-
1,1-Dichloroethene	70.0	0.05	-
trans 1,2-Dichloroethene	0.3	0.02	-
1,1-Dichloroethane	12.0	0.02	-
cis 1,2-Dichloroethene	0.6	0.01	-
Chloroform	22.5	0.01	-
1,1,1-Trichloroethane	4.2	0.01	-
Carbon Tetrachloride	5.6	0.02	-
Benzene	0.06	0.01	-
Trichloroethene	225.0	0.09	-
Toluene	10.5	0.02	-
1,1,2-Trichloroethane	0.7	0.01	-
Tetrachloroethene	125.0	0.01	-

nd = not determined

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-ying Holman

LAWRENCE BERKELEY LABORATORY
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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 7.90.26

EPA Method: 624/1624

Date of Collection: 07/24/90

Instrument: GC/MS

Date of Analysis: 07/25/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Carbon disulfide	nd	nd	-
Toluene	trace	0.02	-

nd = not determined

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY

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WATER SAMPLE ANALYSIS

Sample No: 7.90.27

EPA Method: 624/1624

Date of Collection: 07/24/90

Instrument: GC/MS

Date of Analysis: 07/25/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Vinyl Chloride	10.3	0.01	-
1,1-Dichloroethene	7.8	0.05	-
Trans 1,2-Dichloroethene	2.9	0.02	-
1,1-Dichloroethane	9.9	0.02	-
cis 1,2-Dichloroethene	26.5	0.02	-
Trichloroethene	14.0	0.09	-
Toluene	trace	0.02	-
Tetrachloroethene	35.0	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

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WATER SAMPLE ANALYSIS

Sample No: 9.90.32	EPA Method: 624/1624
Date of Collection: 09/19/90	Instrument: GC/MS
Date of Analysis: 09/27/90	

Compound	Concentration µg/L	Detection limit µg/L	Comments
cis 1,2-Dichloroethene	0.3	0.02	-
Trichloroethene	10.5	0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY

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WATER SAMPLE ANALYSIS

Sample No: 9.90.33

EPA Method: 624/1624

Date of Collection: 09/20/90

Instrument: GC/MS

Date of Analysis: 09/27/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1-Dichloroethene	36.0	0.05	-
1,1-Dichloroethane	9.0	0.02	-
cis 1,2-Dichloroethene	0.5	0.02	-
Chloroform	4.0	0.01	-
1,1,1-Trichloroethane	1.5	0.01	-
Carbon Tetrachloride	1.4	0.02	-
Trichloroethene	80.5	0.09	-
1,1,2-Trichloroethane	3.0	0.01	-
Tetrachloroethene	100.0	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 9.90.35

EPA Method: 624/1624

Date of Collection: 09/20/90

Instrument: GC/MS

Date of Analysis: 09/27/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1-Dichloroethene	1.9	0.05	-
Trans 1,2-Dichloroethene	2.2	0.02	-
1,1-Dichloroethane	1.8	0.02	-
cis 1,2-Dichloroethene	95.0	0.02	-
Trichloroethene	28.5	0.09	-
Tetrachloroethene	15.0	0.01	-
Napthalene	3.5	0.02	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
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LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 9.90.36

EPA Method: 624/1624

Date of Collection: 09/24/90

Instrument: GC/MS

Date of Analysis: 09/27/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1-Dichloroethene	2.4	0.05	-
1,1-Dichloroethane	3.4	0.02	-
cis 1,2-Dichloroethene	15.0	0.02	-
Trichloroethene	20.0	0.09	-
Tetrachloroethene	65.0	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 9.90.37

EPA Method: 624/1624

Date of Collection: 09/24/90

Instrument: GC/MS

Date of Analysis: 09/27/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
1,1-Dichloroethene	1.7	0.05	-
Trans 1,2-Dichloroethene	4.0	0.02	-
1,1-Dichloroethane	1.7	0.02	-
cis 1,2-Dichloroethene	100.0	0.02	-
Trichloroethene	28.0	0.09	-
Tetrachloroethene	20.0	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 9.90.38

EPA Method: 624/1624

Date of Collection: 09/24/90

Instrument: GC/MS

Date of Analysis: 09/27/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
Trichlorotrifluroethane	733.0	nd	-
1,1,1-Trichloroethane	1.7	0.01	-
Trichloroethene	5.0	0.09	-
Tetrachloroethene	2.2	0.01	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 9.90.39

EPA Method: 624/1624

Date of Collection: 09/26/90

Instrument: GC/MS

Date of Analysis: 09/27/90

Compound	Concentration μg/L	Detection limit μg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

LAWRENCE BERKELEY LABORATORY
EARTH SCIENCES DIVISION
LABORATORY REPORT

WATER SAMPLE ANALYSIS

Sample No: 9.90.40

EPA Method: 624/1624

Date of Collection: 09/26/90

Instrument: GC/MS

Date of Analysis: 09/27/90

Compound	Concentration µg/L	Detection limit µg/L	Comments
All Compounds	nd	≤ 0.09	-

Name of person performed the analysis: Dr. Hoi-Ying Holman

Signature: Hoi-Ying Holman

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