Harding Lawson Associates

Transmittal/Memorandum

To: Alameda County Department of Environmental Health
80 Swan Way, Room 200
Oakland, California 94621

Attention: Mr. Lowell Miller

From: David Leland DL
Date: June 1, 1989
Subject: April 1989 PRP Soil Treatment System Monitoring Report
Job No.: 09382,040.02

Remarks: Please find attached a copy of the "*Report of System Monitoring: April 1989, Soil Treatment System, Pacific Renaissance Plaza, Oakland, California*", describing the operations and monitoring of the in situ soil treatment system located at the Pacific Renaissance Plaza site in Oakland.

DL:cb/c9a/043

cc:

A Report Prepared for

California Regional Water Quality Control Board
San Francisco Bay Region
1111 Jackson Street, Room 6000
Oakland, California 94607

REPORT OF SYSTEM MONITORING: APRIL 1989 SOIL TREATMENT SYSTEM PACIFIC RENAISSANCE PLAZA OAKLAND, CALIFORNIA

HLA Job No. 9382,040.02

Submitted on behalf of:

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May 31, 1989

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1.0 INTRODUCTION

This report discusses the installation, operation, and monitoring of the in situ soil treatment system at the Pacific Renaissance Plaza (PRP) site in Oakland, California, from April 6 to May 3, 1989. The PRP site is bounded by 9th, Franklin, and Webster streets and the East Bay Municipal Utilities District (EBMUD) property line approximately 100 feet north of the centerline of 10th Street (Plate 1). The site is part of the Oakland Chinatown Redevelopment Project Area. The soil treatment system is designed to remove petroleum hydrocarbons from soil within site boundaries before it is excavated during construction of the Pacific Renaissance Plaza complex. Construction is scheduled to begin in September 1989.

This report was prepared by Harding Lawson Associates (HLA) on behalf of the City of Oakland Redevelopment Agency (Agency). It is submitted in accordance with monitoring and reporting requirements originally set forth by the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB), in a letter to the City of Oakland dated February 22, 1989, and amended by a letter dated March 17, 1989, from HLA to the RWQCB, that clarified several outstanding items, including reporting periods and submittal report dates.

1.1 Previous Reports

Site history and characterization activities completed by HLA in 1988 are reported in *Site Characterization, Pacific Renaissance Plaza, Chinatown Redevelopment Project Area, Oakland, California (HLA, 1988)*. The site characterization report also presents a preliminary screening of soil treatment alternatives and an evaluation of the potential for biodegradation to effectively remove hydrocarbons from soil at the site.

The *Report of Waste Discharge, Pacific Renaissance Plaza, Chinatown Redevelopment Project Area, Oakland, California (HLA, 1989a)* discusses soil treatment system design and presents the results of the biodegradation treatability study and the proposed operations and monitoring plan for the system. Site background, environmental setting, and previous investigations are also discussed in the report.

Characterization of the extent of soil contamination at the PRP site was updated in the *Report of System Monitoring: March 1989, Soil Treatment System, Pacific Renaissance Plaza, Oakland, California (HLA, 1989b)* using results of system well installation activities.

1.2 Objective of the Treatment System

A portion of the soil at the PRP site contains elevated levels of petroleum hydrocarbons (identified as gasoline) and benzene, toluene, ethylbenzene and xylenes (BTEX). Guidance used by the RWQCB classifies soil with TPH values exceeding 1,000 parts per million (ppm) as hazardous waste *(Leaking Underground Fuel Tank Task Force, 1987)* and soil with TPH values between 100 and 1,000 ppm as designated waste. Soil at this site falls into both categories and would require landfill disposal at Class I (hazardous waste), Class II (designated waste), or Class III facilities.

The Agency wishes to treat soils in place prior to excavation to reduce concentrations to levels acceptable for Class III disposal (i.e., less than 100 ppm TPH). In situ biological treatment using a system of injection and extraction wells was the treatment method selected to accomplish this objective. Ground water produced in conjunction with soil treatment will be treated using the carbon adsorption system that was in place at the site prior to the start of soil treatment.

1.3 Treatment System Description

The treatment process consists of circulating nutrient- and oxygen-enriched water through the contaminated soil to enhance the growth of microorganisms existing in soils at the site. These microorganisms utilize hydrocarbons as an energy source, producing carbon dioxide and water as by-products. This process reduces the concentration of petroleum hydrocarbons in the subsurface.

The treatment system, shown schematically on Plate 2, consists of:

- A 3,000-gallon mixing tank and appurtenances for addition of nutrients and hydrogen peroxide to water to stimulate indigenous microorganisms capable of degrading petroleum hydrocarbons.
- Eleven injection wells, to introduce the nutrient-enriched and oxygenated water to the contaminated zone, and 22 extraction wells, to collect and hydraulically contain ground water after it passes through the contaminated zone.
- Associated piping and controls.
- The existing carbon treatment system, which is used to treat extracted ground water to reduce petroleum hydrocarbons and other organic compounds to discharge limits specified in the Agency's existing NPDES permit.

The nutrients and hydrogen peroxide are stored in separate 300-gallon tanks adjacent to the mixing tank, and are injected into the influent water stream as necessary to achieve target concentrations in injection water.

Water from the mixing tank is pumped to the injection wells for introduction to the subsurface. Injected water travels from the injection wells to the extraction wells through the soil. Extracted water is then pumped to the first of five 21,000-gallon storage tanks in place at the site, filtered to remove fine sediments, and treated by carbon adsorption to reduce hydrocarbon concentrations to NPDES permit limits.

Treated extraction water is either pumped to the nutrient mixing tank to be used for reinjection or discharged to the storm drain.

2.0 TREATMENT SYSTEM OPERATIONS

The bioremediation system at the Pacific Renaissance Plaza (PRP) performs two basic functions: mixing and injection of treatment water, and extraction of ground water.

In the start-up operational mode, the PRP biotreatment system operates in an "open loop". The source of fresh water to the system is an EBMUD fire hydrant located at 10th and Webster streets. The water supply is piped through a backflow preventer and a water meter to the mixing tank. Separate solutions of nutrients (nitrate, ammonia, and phosphates) and hydrogen peroxide are injected in measured quantities into the water as it enters a mixing tank.

A pump delivers the water, nutrients, and hydrogen-peroxide solution from the mixing tank to the injection wells. A solenoid valve at each wellhead is controlled by liquid level probes in the well and regulates the flow of water into the well. The flow within the well itself is by gravity; once water is inside the well casing, it is no longer under pressure from the pump.

Submersible pumps in the extraction wells surrounding the injection wells on the site are also controlled by liquid level probes. All extracted water is collected and delivered to the carbon treatment system. In the "open loop" mode of operation, treated water is discharged to the storm drain.

The long-term mode of system operation is to return water treated by the carbon adsorption system to the mixing/injection system. Recycling ground water in this manner enhances the potential for growth of microbial populations and reduces the quantity of potable water required for operation. This mode, "closed loop" operation, was started up during the latter part of April.

System operational adjustments made in April are summarized below:

- April 3. The hydrogen peroxide concentration was increased to 200 ppm.
- April 10. The hydrogen peroxide concentration was increased to 250 ppm.
- April 12. Extraction well upper liquid-level probe settings were raised one foot to increase water levels in the treatment zone.
- April 12 to 17. Layne Western of Woodland, California, installed "closed loop" system for recirculation to the injection wells of water treated in the carbon system.
- April 18. Extraction well upper liquid-level probe settings were lowered to settings based on 30-day model simulation rates and surveyed well elevations.
- April 21. HLA redeveloped Injection Wells IW-5 and IW-8 to increase injection rates.
- April 21. Operation of the "closed loop" recirculation system began.
- April 28 and May 1. HLA redeveloped Injection Wells IW-1, IW-2, IW-3, IW-4, IW-6, IW-9, IW-10, and IW-11.

Nutrients were injected at an average concentration of 200 ppm in April.

3.0 TREATMENT SYSTEM MONITORING

3.1 Flow and Water-Level Monitoring

Each extraction well (EW series) and injection well (IW series) except EW-22 is equipped with a Neptune totalizing flowmeter to monitor water volume extracted or injected. Meter accuracy is reported by the manufacturer to be within plus/minus 1-1/2 percent down to flows of 1/4 gallon per minute (gpm). Totalizing meter readings in gallons, along with time in minutes, are recorded daily by an HLA engineering technician on a Daily Maintenance Data Sheet (DMDS). The previous totalizer reading, the elapsed time between readings, and the calculated daily average flow rate (gpm) for each well are also recorded on the DMDS.

Depths to water are measured daily at Monitoring Wells MW-15, MW-16, and MW-17 and weekly at the other monitoring wells on site and in the vicinity of the site (Plate 1). Depth to water is measured using a graduated steel tape and repeated until two measurements with a difference of no more than 0.02 feet are obtained. Water elevations are calculated using depth-to-water data and surveyed top-of-casing elevations.

3.2 Sample Collection and Analysis

Water samples are collected from selected extraction wells, injection wells, and monitoring wells and analyzed for inorganic and organic constituents and microbial populations. For each well, the frequency of sampling during the reporting period, analytical parameters, and EPA Test Methods (for organic constituents) are presented in Table 1. Samples are collected from extraction wells using the sampling port at each wellhead. Representative samples of the water distributed to the injection wells are collected from the nutrient and hydrogen peroxide mixing tank on a weekly basis.

For monitoring wells from which a water sample is collected for analysis, the following procedure is used. After water levels are measured, each well is purged using a submersible pump placed near the bottom of the well or by bailing with a stainless steel bailer. During purging, a volume of water equal to at least three times the static-water volume in the casing is removed. Water produced during well purging is collected and stored on site in a Baker tank prior to its treatment by the carbon treatment system. Ground-water samples are collected using a clean stainless steel bailer. Samples for TPH analyses are transferred to clean 1-liter amber glass bottles. Samples for purgeable aromatics and purgeable halocarbons analyses are transferred to 40-milliliter glass volatile organic analysis (VOA) vials. All ground-water samples are stored on blue ice and submitted under chain of custody to Pace Laboratories of Novato, California, for organic analysis, or to HLA's microbiological laboratory for inorganic parameter analyses and microbial evaluations.

The sampling schedule presented in Table 1 differs somewhat from the sampling schedule proposed in Table 1 of the *Report of Waste Discharge* (*HLA, 1989*), as noted below.

- At individual injection and extraction wells, total flow was recorded and flow rates calculated daily throughout the period.
- During this reporting period, a composite sample of injection well water was collected and analyzed for inorganic parameters weekly. Treated water used for reinjection is tested in accordance with NPDES permit requirements for the carbon treatment system.
- Dissolved iron has been added as an analyte.
- For the extraction wells, samples of composite extracted ground water were collected monthly and analyzed for organic constituents by EPA Test Methods 8015 and 8020. Samples for inorganic analysis were collected weekly from selected extraction wells. Specific wells were selected for sampling at locations near monitoring wells and at other locations to provide a representative subset of the extraction wells in the ring. Specifically, extraction Wells EW-1, EW-4, EW-8, EW-12, and

EW-16 are sampled weekly and analyzed for nitrate, ammonia, phosphate, and dissolved iron. Beginning April 18, samples from these wells were also analyzed weekly for dissolved oxygen. Additional extraction wells are sampled on an occasional basis, as listed in Table 1, to check measurements and observations at the regularly sampled extraction wells.

- Water levels are measured daily at the three transect monitoring wells, MW-15, MW-16, and MW-17. Samples are collected and analyzed weekly for nitrate, ammonia, and phosphate, and biweekly for dissolved iron. Dissolved oxygen has been measured weekly starting April 18. Samples were analyzed monthly for EPA Test Method 8015 and 8020.

The sampling schedule may be modified in subsequent months in response to the operation of the system and the need for monitoring data.

3.3 Numerical Modeling of Ground-Water Flow

A numerical model of ground-water flow at the site, developed during the design phase of the project, is described in the *Report of Waste Discharge* (*HLA, 1989*). The version of the model used to develop the results reported in the *Report of Waste Discharge* assumes a single value of -1 foot MSL for the elevation of the bottom of the A-aquifer. Data collected during well installation activities indicates local variations in the elevation of the bottom of the A-aquifer from +2 to -7 feet MSL. To improve the model's representation of the ground-water flow system, and to improve the agreement between observed and simulated ground-water elevation, the bottom elevations input to the model were modified to more closely reflect field observations. The revised model was used to calculate ground-water elevation contours for April 4 and May 2, 31 and 59 days, respectively, after system start-up. Injection and pumping rates used as input to the model were based on totalizer readings from individual injection and extraction wells, averaged over the time periods from March 4 to April 4, and April 4 to May 2.

4.0 RESULTS

4.1 Flow and Ground-Water Elevations

Average injection and extraction rates for the reporting period are presented in Tables 2 and 3. From April 4 to May 2, the average total flow rate for all injection wells was 20.68 gallons per minute (gpm). The flow rate for Wells IW-1 to IW-9 was 19.70 gpm. During the same period, the average total flow rate for Extraction Wells EW-1 to EW-20 was 17.65 gpm. Extraction Well EW-21 did not operate during this period because water levels did not rise high enough to activate the upper liquid-level probe in the well. Extraction Well EW-22 was operational, but is not equipped with a separate totalizing flowmeter. All flow rates were calculated based on readings from the flowmeters on the wellheads. For wells located south of 10th Street, the extraction rate was approximately 90 percent of the injection rate.

Measurements of depth to water and calculated water-level elevations from January 3 to May 2, 1989 are presented in Table 4. Ground-water elevations for April 4 and May 2, 1989 are presented on Plates 3 and 4. April 4 and May 2 elevations describe conditions approximately 31 and 59 days after start-up, respectively.

Contours of ground-water elevations calculated using the numerical model (simulated) are also presented on Plates 3 and 4. In some cases, locations of injection and extraction points used in the model differ slightly from actual well locations because of the nature of discretization of the modeled area. In general, the calculated contours show good agreement with elevations measured at monitoring wells. For May 2, differences between observed and simulated elevations are generally less than one foot for wells located outside of the treatment area with the exception of MW-3 which show a difference of less than two feet. Observed ground-water elevations from the transect wells (MW-15, MW-16, MW-17) within the treatment area were generally one to one

and one half feet higher than simulated ground-water elevations. Modifications of aquifer bottom elevations improved the agreement for observed and simulated ground-water elevations at the transect wells for the April 4 model run. For the other wells within the treatment area, differences are generally less than half a foot. A preliminary assessment of results indicates that hydraulic control was in the process of being established during this period.

4.2 Distribution of Inorganic Constituents and Microbial Populations in Ground Water

Tables 5 and 6 present the inorganic chemical and microbiological results for the bioremediation treatment system from start-up through May 3, 1989. Nitrate and phosphate concentrations in ground water at the site for the May 1-3 sampling rounds are presented on Plates 5 and 6. These preliminary results indicate that the injected nutrients are being disseminated throughout the subsurface within the treatment area. The average nitrate concentration within the treatment zone has ranged from 2.4 to 3.6 times higher than outside the treatment zone. The average phosphate concentration within the treatment zone has ranged from approximately 4 to 13 times higher than outside the treatment zone. Microbial populations within the treatment area have remained stable or increased by up to a factor of 10 during the reporting period.

4.3 Distribution of Petroleum Hydrocarbons in Ground Water

Results of laboratory analysis of ground-water samples for organic parameters are presented in Table 7. Laboratory data sheets are presented in Appendix A. TPH values for the May sampling round are presented on Plate 7.

The reported concentrations of petroleum hydrocarbons in the ground-water samples from the monitoring wells increased from April to May sampling rounds in

three wells, and decreased or remained stable in eight wells. The maximum increase, 3.1 ppm occurred at MW-9. The largest decrease, 8.8 ppm, occurred at MW-11. Petroleum hydrocarbons as TPH were not detected in the sample from Monitoring Well MW-18, located west of the treatment system wells. Reported TPH values from monitoring wells within the treatment area are generally lower for the May round when compared to April results. Reported TPH values for wells outside the treatment area are similar for April and May results with slight decreases at MW-13 and MW-14, slight increases at MW-12 and MW-7, and no change at MW-18. Highest TPH values are within the treatment area. A preliminary assessment of distribution of hydrocarbons indicates good hydraulic control of the injected treatment system water.

Reported TPH values at Extraction Wells EW-1 and EW-16 increased between April and May rounds, while concentrations at EW-4 decreased slightly. During maintenance activities at Well EW-15 on April 18, a separate liquid phase was observed in the well. A sample collected from EW-15 by bailing on April 19 and submitted for laboratory analysis was reported to contain 660,000 ppm of gasoline (Table 7) and appears to confirm field observations. Wells in the vicinity of EW-15 were also checked for the presence of a separate liquid phase. No other occurrences of separate liquid phases were observed. Explanations for the presence of a separate phase include mobilization of residual concentrations of gasoline in soil pores as a result of increased water levels in the treatment area, and changes in surface tension of residual gasoline as a result of microbial activity. Separate phases have not been observed in any monitoring wells.

5.0 ACTIVITIES PLANNED: MAY 1989

Injection wells will be redeveloped to improve the injection rate efficiency. Wells will be swabbed over the entire screen interval to remove silt from the slotted sections. The wells will be bailed to remove the silt and then pumped until the water is clear.

6.0 REFERENCES

Harding Lawson Associates, 1988. *Site Characterization, Pacific Renaissance Plaza, Chinatown Redevelopment Project Area, Oakland, California.* December.

Harding Lawson Associates, 1989a. *Report of Waste Discharge, Pacific Renaissance Plaza, Chinatown Redevelopment Area, Oakland, California.* February.

Harding Lawson Associates, 1989b. *Report of System Monitoring: March 1989, Soil Treatment System, Pacific Renaissance Plaza, Oakland, California.* May 4.

Leaking Underground Fuel Tank Task Force, 1987. *Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure.* December.

Table 1. Schedule for Sampling, Measurement, and Analysis
Soil Treatment System
Pacific Renaissance Plaza

Sampling Station	Flow/Water Levels	Measurement/Analysis: Nitrate	Ammonia	Phosphate	Microbial Enumeration	Dissolved Iron	Dissolved Oxygen	EPA 8015 (TPH)	EPA 8010	EPA 8020 (BTEX)
Injection Wells										
Composite	D	W	W	W	--	--	--	--	--	--
IW-1	D	--	--	--	--	--	--	--	--	--
IW-2	D	--	--	--	--	--	--	--	--	--
IW-3	D	--	--	--	--	--	--	--	--	--
IW-4	D	--	--	--	--	--	--	--	--	--
IW-5	D	--	--	--	--	--	--	--	--	--
IW-6	D	--	--	--	--	--	--	--	--	--
IW-7	D	--	--	--	--	--	--	--	--	--
IW-8	D	--	--	--	--	--	--	--	--	--
IW-9	D	--	--	--	--	--	--	--	--	--
IW-10	D	--	--	--	--	--	--	--	--	--
IW-11	D	--	--	--	--	--	--	--	--	--
Extraction Wells										
Composite	D	W	W	W	--	--	--	M	M	M
EW-1	D	W	W	W	W	B	W	M	--	M
EW-2	D	--	--	--	--	--	--	--	--	--
EW-3	D	--	--	--	--	--	--	--	--	--
EW-4	D	W	W	W	W	B	W	M	--	M
EW-5	D	--	--	--	--	--	W	--	--	--

Table 1. Schedule for Sampling, Measurement, and Analysis
Soil Treatment System
Pacific Renaissance Plaza

Sampling Station	Flow/Water Levels	Measurement/Analysis								
		Nitrate	Ammonia	Phosphate	Microbial Enumeration	Dissolved Iron	Dissolved Oxygen	EPA 8015 (TPH)	EPA 8010	EPA 8020 (BTEX)
EW-6	D	--	--	--	--	--	--	--	--	--
EW-7	D	--	--	--	--	--	--	--	--	--
EW-8	D	W	W	W	W	M	W	--	--	--
EW-9	D	--	--	--	--	--	B	--	--	--
EW-10	D	--	--	--	--	--	--	--	--	--
EW-11	D	--	--	--	--	--	B	--	--	--
EW-12	D	W	W	W	--	M	W	--	--	--
EW-13	D	--	--	--	--	--	--	--	--	--
EW-14	D	--	--	--	M	--	M	--	--	--
EW-15	D	M	M	M	M	M	M	--	--	--
EW-16	D	W	W	W	W	B	B	M	--	M
EW-17	D	M	M	M	--	M	M	--	--	--
EW-18	D	--	--	--	--	--	B	--	--	--
EW-19	D	W	W	W	--	M	W	W	--	--
EW-20	D	--	--	--	--	--	--	--	--	--
EW-21	D	M	M	M	--	M	--	M	--	M
EW-22	D	--	--	--	--	--	--	--	--	--
Monitoring Wells										
MW-2	W	--	--	--	--	--	--	--	--	--
MW-3	W	--	--	--	--	--	--	--	--	--

Table 1. Schedule for Sampling, Measurement, and Analysis
Soil Treatment System
Pacific Renaissance Plaza

Harding Lawson Associates

Sampling Station	Flow/Water Levels	Measurement/Analysis								
		Nitrate	Ammonia	Phosphate	Microbial Enumeration	Dissolved Iron	Dissolved Oxygen	EPA 8015 (TPH)	EPA 8010	EPA 8020 (BTEX)
MW-5	W	--	--	--	--	--	--	M	--	M
MW-6	W	--	--	--	--	--	--	--	--	--
MW-7	W	B	B	B	--	--	--	M	--	M
MW-8	W	--	--	--	--	--	--	--	--	--
MW-9	W	W	W	W	W	B	W	M	--	M
MW-10	W	W	W	W	--	M	W	M	--	M
MW-11	W	W	W	W	M	B	W	M	--	M
MW-12	W	W	W	W	--	B	W	M	--	M
MW-13	W	W	W	W	--	M	B	M	--	M
MW-14	W	W	W	W	--	W	M	M	--	M
MW-15	D	W	W	W	W	W	W	M	--	M
MW-16	D	W	W	W	W	W	W	M	--	M
MW-17	D	W	W	W	W	W	W	M	--	M
MW-18	W	W	W	W	M	M	W	M	--	M

Notes:
- D = daily
- W = weekly
- B = biweekly
- M = monthly
- -- = no analysis or measurement

Table 2. Injection Well Flow Rates: April 1989

Meter No.	02-May-89 Totalizer Reading	04-Apr-89 Totalizer Reading	Elapsed Time (min)	Average Flow Rate (gpm)
IW-1	292280	149809	40610	3.51
IW-2	246385	135156	40610	2.74
IW-3	208550	112611	40610	2.36
IW-4	208866	118017	40610	2.24
IW-5	65484	43268	40610	0.55
IW-6	154781	82650	40610	1.78
IW-7	336571	203639	40610	3.27
IW-8	110940	59773	40610	1.26
IW-9	179982	98729	40610	2.00
IW-10	51826	42237	40610	0.24
IW-11	74539	44523	40610	0.74
Total (1-9)	1803839	1003652	40610	19.70
Total (10,11)	126365	86760	40610	0.98
Total (1-11)	1930204	1090412	40610	20.68

Table 3. Extraction Well Flow Rates: April 1989

Meter No.	02-May-89 Totalizer Reading	04-Apr-89 Totalizer Reading	Elapsed Time (min)	Average Flow Rate (gpm)
EW-1	42766	21538	40605	0.52
EW-2	46357	22947	40605	0.58
EW-3	62163	32993	40605	0.72
EW-4	40643	17386	40605	0.57
EW-5	84915	48529	40605	0.90
EW-6	33083	13236	40605	0.49
EW-7	31126	15623	40605	0.38
EW-8	33639	13012	40605	0.51
EW-9	65133	32634	40605	0.80
EW-10	55698	28287	40605	0.68
EW-11	46118	24207	40605	0.54
EW-12	45159	25533	40605	0.48
EW-13	53029	28393	40605	0.61
EW-14	38649	21611	40605	0.42
EW-15	42162	26021	40605	0.40
EW-16 *	45777	133422	40605	3.15
EW-17	138890	64775	40605	1.83
EW-18	169966	78656	40605	2.25
EW-19	86444	42468	40605	1.08
EW-20	29983	14044	40605	0.39
EW-21			40605	0.00
EW-22			40605	0.00
Total (1-20)	1191700	705315	40605	17.65
Total (21-22)	0	0	40605	0.00
Total (1-22)	1191700	705315	40605	17.65

* Meter was replaced on 4/19/89. Totalizer reading for 5/2/89 reflects starting meter volume at 10 gallons. Actual volume extracted between 4/4/89 and 5/2/89 is 142,533 gallons.

Table 4. Water-Level Elevations

Well No.	MW-2		MW-3		MW-5		MW-6		MW-7		MW-8		MW-9	
	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING
	40.05	39.55	39.02	38.35	38.45	37.86	39.95	39.59	39.35	39.10	40.63	40.47	38.65	38.50
DATE	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation
03-Jan-89	33.10	6.45	32.35	6.00	33.00	4.86	30.22	9.37	31.15	7.95	32.78	7.69	30.58	7.92
05-Jan-89	-	-	32.35	6.00	33.00	4.86	30.22	9.37	31.15	7.95	32.78	7.69	30.58	7.92
02-Feb-89	33.05	6.50	33.01	5.34	31.82	6.04	30.23	9.36	30.51	8.59	32.62	7.85	31.67	6.83
08-Feb-89	33.83	5.72	32.21	6.14	32.02	5.84	31.05	8.54	31.44	7.66	33.03	7.44	30.65	7.85
15-Feb-89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18-Feb-89	30.59	8.96	29.26	9.09	31.90	5.96	30.05	9.54	30.21	8.89	31.96	8.51	30.16	8.34
25-Feb-89	29.85	9.70	28.68	9.67	30.32	7.54	30.57	9.02	31.10	8.00	31.90	8.57	30.80	7.70
02-Mar-89	-	-	-		-	-	-	-	-	-	-	-	30.05	8.45
11-Mar-89	-	-	-		-	-	-	-	-	-	-	-	23.06	15.44
18-Mar-89	-	-	32.20	6.15	32.01	5.85	-	-	31.52	7.58	-	-	22.45	16.05
25-Mar-89	-	-	27.76	10.59	27.53	10.33	-	-	30.08	9.02	-	-	22.62	15.88
30-Mar-89	-	-	-	-	-	-	-	-	-	-	-	-	23.00	15.50
04-Apr-89	28.52	11.03	27.56	10.79	-	-	28.00	11.59	29.00	10.10	30.45	10.02	22.61	15.89
08-Apr-89	-	-	-	-	-	-	-	-	-	-	-	-	23.12	15.38
11-Apr-89	-	-	-	-	-	-	-	-	-	-	-	-	23.37	15.13
12-Apr-89	28.59	10.96	27.63	10.72	-	-	27.17	12.42	28.96	10.14	30.45	10.02	-	-
18-Apr-89	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19-Apr-89	-	-	-	-	-	-	-	-	28.13	10.97	-	-	23.36	15.14
25-Apr-89	-	-	-	-	-	-	-	-	-	-	-	-	22.80	15.70
02-May-89	28.71	10.84	26.84	11.51	-	-	27.49	12.10	28.54	10.56	29.80	10.67	22.73	15.77

Note: Elevations are in feet above Mean Sea Level (MSL)

Table 4. Water-Level Elevations

Well No.	MW-10		MW-11		MW-12		MW-13		MW-14		MW-15		MW-16	
	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING
	36.74	36.35	37.98	37.55	37.70	37.00	39.79	39.77	39.27	40.26	39.69	40.73	39.55	40.53
DATE	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation	Depth to Water	Elevation
03-Jan-89	27.34	9.01	30.30	7.25	-	-	-	-	-	-	-	-	-	-
05-Jan-89	27.34	9.01	30.30	7.25	-	-	-	-	-	-	-	-	-	-
02-Feb-89	28.11	8.24	30.03	7.52	-	-	-	-	-	-	-	-	-	-
08-Feb-89	27.65	8.70	29.52	8.03	-	-	-	-	-	-	-	-	-	-
15-Feb-89	-	-	-	-	28.89	8.11	-	-	-	-	-	-	-	-
18-Feb-89	27.65	8.70	28.02	9.53	-	-	-	-	-	-	-	-	-	-
25-Feb-89	27.12	9.23	29.05	8.50	30.87	6.13	32.63	7.14	31.07	9.19	32.83	7.90	32.43	8.10
02-Mar-89	27.23	9.12	28.98	8.57	28.46	8.54	32.79	6.98	32.28	7.98	32.40	8.33	32.50	8.03
11-Mar-89	23.59	12.76	28.93	8.62	28.22	8.78	30.12	9.65	28.64	11.62	27.10	13.63	25.64	14.89
18-Mar-89	23.17	13.18	27.79	9.76	27.85	9.15	30.29	9.48	28.20	12.06	26.62	14.11	24.74	15.79
25-Mar-89	23.19	13.16	28.10	9.45	27.47	9.53	29.76	10.01	27.79	12.47	26.28	14.45	24.88	15.65
30-Mar-89	23.56	12.79	28.48	9.07	27.43	9.57	30.12	9.65	27.99	12.27	26.50	14.23	25.48	15.05
04-Apr-89	23.34	13.01	28.61	8.94	28.44	8.56	29.60	10.17	27.84	12.42	26.84	13.89	25.53	15.00
08-Apr-89	23.50	12.85	29.31	8.24	-	-	30.49	9.28	27.81	12.45	26.81	13.92	25.74	14.79
11-Apr-89	23.64	12.71	29.45	8.10	-	-	30.62	9.15	28.04	12.22	27.21	13.52	26.24	14.29
12-Apr-89	-	-	-	-	28.64	8.36	-	-	-	-	-	-	-	-
18-Apr-89	-	-	-	-	-	-	-	-	-	-	27.08	13.65	26.02	14.51
19-Apr-89	23.41	12.94	26.77	10.78	26.98	10.02	30.19	9.58	27.13	13.13	-	-	-	-
25-Apr-89	23.39	12.96	29.18	8.37	27.47	9.53	30.40	9.37	27.75	12.51	27.01	13.72	25.97	14.56
02-May-89	23.54	12.81	28.44	9.11	27.36	9.64	29.42	10.35	27.50	12.76	25.91	14.82	24.42	16.11

Note: Elevations are in feet above Mean Sea Level (MSL)

Table 4. Water-Level Elevations

Well No.	MW-17		MW-18	
	GROUND SURFACE	TOP OF CASING	GROUND SURFACE	TOP OF CASING
	39.16	40.16	36.56	35.88
DATE	Depth to Water	Elevation	Depth to Water	Elevation
03-Jan-89	-	-	-	-
05-Jan-89	-	-	-	-
02-Feb-89	-	-	-	-
08-Feb-89	-	-	-	-
15-Feb-89	-	-	26.89	8.99
18-Feb-89	-	-	-	-
25-Feb-89	32.02	8.14	26.90	8.98
02-Mar-89	-	-	26.66	9.22
11-Mar-89	23.45	16.71	26.28	9.60
18-Mar-89	23.35	16.81	26.18	9.70
25-Mar-89	23.35	16.81	25.70	10.18
30-Mar-89	-	-	-	-
04-Apr-89	24.18	15.98	26.10	9.78
08-Apr-89	24.28	15.88	25.82	10.06
11-Apr-89	24.83	15.33	-	-
12-Apr-89	-	-	26.16	9.72
18-Apr-89	24.64	15.52	-	-
19-Apr-89	-	-	25.89	9.99
25-Apr-89	24.57	15.59	27.91	7.97
02-May-89	22.71	17.45	25.76	10.12

Note: Elevations are in feet above Mean Sea Level (MSL)

Table 5. Results of Inorganic Chemical and Microbial Analyses of Ground-Water Samples from System Wells

WELL	DATE	NITRATE	PHOSPHATE	DISSOLVED IRON (Fe)	AMMONIA	MICROBIAL ENUMERATION TC	HCU
LOD		0.5(ppm)	0.5(ppm)	0.1(ppm)	0.5(ppm)	NA	NA
EW-1							
	15-Mar-89	17.6	ND	ND	ND	7.8E+6	1.2E+2
	29-Mar-89	9.7	3.5	NT	ND	1.8E+6	3.8E+2
	04-Apr-89	13.2	3.8	ND	ND	3.3E+5	2.2E+2
	11-Apr-89	24.6	2.8	NT	ND	NT	NT
	18-Apr-89	30.8	1.0	ND	ND	3.3E+5	7.8E+1
	25-Apr-89	33.4	3.0	NT	ND	6.8E+4	--
	02-May-89	37.0	5.0	NT	ND	4.5E+5	--
EW-4							
	15-Mar-89	16.7	0.6	ND	ND	5.1E+6	9.5E+1
	29-Mar-89	25.5	2.8	NT	ND	5.3E+5	1.7E+2
	04-Apr-89	31.7	4	ND	ND	2.5E+5	6.8E+1
	11-Apr-89	34.1	3.3	NT	ND	4.3E+4	4.5E+1
	18-Apr-89	43.6	5.3	ND	ND	4.3E+4	1.1E+2
	25-Apr-89	49.3	5.0	NT	ND	9.0E+4	--
	02-May-89	48.4	9.0	NT	ND	2.5E+5	--
EW-5							
	29-Mar-89	28.0	3.8	NT	ND	NT	NT
EW-8							
	15-Mar-89	11.4	0.5	ND	ND	NT	NT
	29-Mar-89	28.0	3.5	NT	ND	NT	NT
	04-Apr-89	33.0	3.8	ND	ND	3.1E+5	1.4E+2
	11-Apr-89	37.8	2.8	NT	ND	2.0E+4	4.5E+1
	18-Apr-89	33.4	3.8	NT	ND	4.1E+5	1.4E+2
	25-Apr-89	47.5	8.0	NT	ND	3.4E+4	--
	02-May-89	39.6	11.0	NT	ND	6.8E+4	--
EW-12							
	15-Mar-89	13.2	1.0	ND	ND	NT	NT
	29-Mar-89	22.0	3.3	NT	ND	NT	NT
	04-Apr-89	22.9	3.8	ND	ND	NT	NT
	11-Apr-89	20.2	3.8	NT	ND	NT	NT
	18-Apr-89	28.6	1.3	NT	ND	NT	NT
	25-Apr-89	39.2	2.8	NT	ND	NT	NT
	02-May-89	33.4	3.0	NT	NT	1.0E+6	--
EW-14							
	18-Apr-89	NT	NT	NT	NT	1.1E+7	1.4E+3
EW-15							
	18-Apr-89	NT	NT	NT	NT	1.1E+6	1.4E+2
	25-Apr-89	45.8	23.0	ND	NT	1.6E+5	--
	02-May-89	NT	NT	NT	NT	NT	NT

Table 5. Results of Inorganic Chemical and Microbial Analyses of Ground-Water Samples from System Wells

WELL	DATE	NITRATE	PHOSPHATE	DISSOLVED IRON (Fe)	AMMONIA	MICROBIAL ENUMERATION TC	MICROBIAL ENUMERATION HCU
LOD		0.5(ppm)	0.5(ppm)	0.1(ppm)	0.5(ppm)	NA	NA
EW-16							
	15-Mar-89	1.8	0.5	ND	ND	NT	NT
	29-Mar-89	18.4	3.0	NT	ND	NT	NT
	04-Apr-89	31.7	5.0	ND	ND	5.7E+5	3.9E+2
	11-Apr-89	28.6	4.8	NT	ND	1.2E+5	2.2E+2
	18-Apr-89	37.8	14.0	ND	1.2	3.2E+6	1.4E+3
	25-Apr-89	47.5	11.0	NT	ND	8.4E+5	--
	02-May-89	46.2	15.0	NT	ND	3.5E+5	--
EW-17							
	18-Apr-89	NT	NT	NT	NT	NT	NT
	25-Apr-89	6.2	8.3	ND	ND	NT	NT
	02-May-89	NT	NT	NT	NT	NT	NT
EW-19							
	15-Mar-89	NT	NT	NT	NT	NT	NT
	29-Mar-89	NT	NT	NT	NT	NT	NT
	04-Apr-89	18.5	4.0	ND	ND	NT	NT
	11-Apr-89	33.4	4.0	NT	ND	NT	NT
	18-Apr-89	41.8	7.0	NT	ND	NT	NT
	25-Apr-89	NT	NT	NT	NT	NT	NT
	02-May-89	50.6	2.5	NT	ND	NT	NT

NOTES:

HCU: Hydrocarbon Utilizers
TC: Total Count
LOD: Limit of Detection.
NA: Limit of Detection not applicable.
ND: Not detected at or above LOD.
NT: Not tested.
--: Results not available.
Inorganic constituents are reported in parts per million (ppm).
Microbial counts are reported in colony-forming units per milligram of water.

Table 6. Results of Inorganic Chemical and Microbial Analyses of Ground-water Monitoring Well Samples

WELL	DATE	NITRATE	PHOSPHATE	DISSOLVED OXYGEN	DISSOLVED IRON (Fe)	AMMONIA	MICROBIAL ENUMERATION TC	MICROBIAL ENUMERATION HCU
LOD		0.5(ppm)	0.5(ppm)	0.5(mg/l)	0.1(ppm)	0.5(ppm)	NA	NA
MW-9								
	03-Mar-89	37.0/32.0*	1.5	1.0**	ND	ND	5.3E+5	9.5E+2
	10-Mar-89	NT	NT	NT	NT	NT	NT	NT
	15-Mar-89	6.0	6.0	NT	ND	ND	5.9E+6	1.8E+2
	29-Mar-89	37.0	32.0	NT	NT	ND	1.8E+6	2.1E+2
	04-Apr-89	41.8	36.0	NT	ND	ND	3.6E+5	1.1E+2
	11-Apr-89	42.1	60.0	NT	NT	ND	3.6E+5	1.4E+2
	18-Apr-89	56.3	60.0	8.4	ND	0.9	1.2E+6	2.2E+2
	25-Apr-89	88.0	50.0	>20.0	NT	2.9	9.9E+5	--
	02-May-89	74.8	62.5	18.2	NT	4.8	3.5E+6	--
MW-10								
	03-Mar-89	8.4/5.5*	1.0	4.0**	ND	ND	2.3E+5	3.5E+2
	10-Mar-89	NT	NT	NT	NT	NT	NT	NT
	15-Mar-89	5.5	1.2	NT	ND	ND	NT	NT
	29-Mar-89	11.4	4.5	NT	NT	ND	NT	NT
	04-Apr-89	15.0	1.3	NT	ND	ND	NT	NT
	11-Apr-89	16.5	2.3	NT	NT	ND	NT	NT
	18-Apr-89	16.0	5.3	5.0	NT	ND	NT	NT
	25-Apr-89	14.1	2.0	2.2	NT	ND	NT	NT
	02-May-89	NT	6.5	2.6	NT	ND	NT	NT
MW-11								
	03-Mar-89	ND/ND*	0.8	2.0**	ND	ND	1.1E+6	2.8E+3
	10-Mar-89	NT	NT	NT	NT	NT	NT	NT
	15-Mar-89	ND	1.0	NT	ND	ND	NT	NT
	29-Mar-89	31.7	4.3	NT	NT	ND	NT	NT
	04-Apr-89	37.0	5.0	NT	ND	ND	NT	NT
	11-Apr-89	40.7	24.0	NT	NT	ND	3.8E+5	1.1E+2
	18-Apr-89	56.3	26.0	5.7	ND	ND	1.2E+6	1.7E+2
	25-Apr-89	44.0	29.7	11.8	NT	ND	4.7E+5	--
	02-May-89	74.8	41.3	17.1	NT	ND	2.4E+6	--
MW-12								
	03-Mar-89	11.4/6.2*	1.0	5.8**	ND	ND	7.1E+5	1.1E+1
	10-Mar-89	NT	NT	NT	NT	NT	NT	NT
	15-Mar-89	12.3	1.1	NT	ND	ND	NT	NT
	29-Mar-89	13.6	4.8	NT	NT	ND	NT	NT
	04-Apr-89	11.4	1.5	NT	ND	ND	NT	NT
	11-Apr-89	7.5	5.0	NT	NT	ND	NT	NT
	18-Apr-89	9.2	6.8	2.1	ND	ND	NT	NT
	25-Apr-89	3.5	1.8	1.4	NT	ND	NT	NT
	02-May-89	12.3	5.0	2.3	NT	ND	NT	NT

Table 6. Results of Inorganic Chemical and Microbial Analyses of Ground-water Monitoring Well Samples

WELL	DATE	NITRATE	PHOSPHATE	DISSOLVED OXYGEN	DISSOLVED IRON (Fe)	AMMONIA	MICROBIAL ENUMERATION TC	HCU
LOD		0.5(ppm)	0.5(ppm)	0.5(mg/l)	0.1(ppm)	0.5(ppm)	NA	NA
MW-13								
	03-Mar-89	11.4/8.6*	1.0	2.0**	0.25	ND	4.1E+6	1.7E+2
	10-Mar-89	NT	NT	NT	NT	NT	NT	NT
	15-Mar-89	9.2	1.1	NT	ND	ND	NT	NT
	29-Mar-89	8.8	6.3	NT	NT	ND	NT	NT
	04-Apr-89	9.7	3.5	NT	ND	ND	NT	NT
	11-Apr-89	13.2	2.8	NT	NT	ND	NT	NT
	18-Apr-89	15.0	8.5	6.0	NT	ND	NT	NT
	25-Apr-89	20.2	2.5	NT	NT	ND	NT	NT
	02-May-89	37.8	2.3	6.8	NT	ND	NT	NT
MW-14								
	03-Mar-89	37.0/22.0*	0.8	3.0**	ND	ND	3.6E+5	2.2E+2
	10-Mar-89	NT	NT	NT	NT	NT	NT	NT
	15-Mar-89	37.0	1.0	NT	ND	ND	NT	NT
	29-Mar-89	22.8	3.8	NT	NT	ND	NT	NT
	04-Apr-89	29.9	3.8	NT	ND	ND	NT	NT
	11-Apr-89	37.4	2.8	NT	NT	ND	NT	NT
	18-Apr-89	43.6	5.8	NT	NT	ND	NT	NT
	25-Apr-89	35.2	1.3	NT	NT	ND	NT	NT
	02-May-89	40.5	5.3	6.7	NT	ND	NT	NT
MW-15								
	03-Mar-89	42.2/19.0*	0.9	4.0**	ND	ND	4.5E+5	2.8E+2
	10-Mar-89	40.5	2.2	NT	NT	NT	1.0E+6	2.8E+2
	15-Mar-89	35.2	1.2	NT	ND	ND	6.9E+6	2.8E+2
	29-Mar-89	20.2	4.2	NT	NT	ND	9.1E+5	2.1E+2
	04-Apr-89	24.6	5.3	NT	ND	ND	4.4E+5	1.4E+2
	11-Apr-89	23.1	4.0	NT	NT	ND	2.7E+6	1.7E+2
	18-Apr-89	31.9	1.3	6.3	ND	ND	3.1E+6	2.9E+1
	25-Apr-89	42.2	1.8	9.6	ND	ND	2.2E+5	--
	02-May-89	50.6	3.5	11.4	NT	ND	8.5E+5	--
MW-16								
	03-Mar-89	49.3/17.0*	1.2	2.0**	ND	ND	8.4E+5	1.4E+2
	10-Mar-89	14.5	2.2	NT	ND	ND	1.4E+5	1.2E+3
	15-Mar-89	11.4	3.0	NT	ND	ND	6.0E+6	1.1E+3
	29-Mar-89	33.4	7.2	NT	NT	ND	1.6E+6	3.5E+3
	04-Apr-89	39.6	11.5	NT	0.2	NT	2.2E+6	1.2E+3
	11-Apr-89	37.8	16.0	NT	NT	ND	6.7E+5	1.4E+3
	18-Apr-89	52.8	20.0	14.0	ND	ND	1.3E+6	2.3E+2
	25-Apr-89	49.3	22.0	>20.0	ND	ND	5.1E+5	--
	02-May-89	57.2	31.3	14.6	NT	ND	2.2E+6	--

Table 6. Results of Inorganic Chemical and Microbial Analyses of Ground-water Monitoring Well Samples

WELL	DATE	NITRATE	PHOSPHATE	DISSOLVED OXYGEN	DISSOLVED IRON (Fe)	AMMONIA	MICROBIAL ENUMERATION TC	HCU
LOD		0.5(ppm)	0.5(ppm)	0.5(mg/l)	0.1(ppm)	0.5(ppm)	NA	NA
MW-17								
	03-Mar-89	NT	NT	NT	NT	NT	NT	NT
	10-Mar-89	12.3	0.8	NT	ND	ND	1.6E+5	1.1E+3
	15-Mar-89	7.5	3.1	NT	ND	ND	1.1E+7	3.5E+3
	29-Mar-89	25.5	3.8	NT	NT	ND	2.6E+6	1.1E+3
	04-Apr-89	35.2	3.5	NT	ND	ND	3.3E+6	6.8E+2
	11-Apr-89	49.4	8.0	NT	NT	ND	1.5E+6	3.9E+2
	18-Apr-89	52.8	16.0	11.8	ND	ND	1.2E+6	1.4E+2
	25-Apr-89	51.0	11.6	13.5	ND	ND	6.0E+5	--
	02-May-89	52.8	17.0	13.3	NT	ND	5.1E+6	--
MW-18								
	03-Mar-89	15.4/9.3*	0.5	2.9**	ND	ND	1.3E+6	7.9E+1
	10-Mar-89	NT	NT	NT	NT	NT	NT	NT
	15-Mar-89	4.0	1.1	NT	ND	ND	NT	NT
	29-Mar-89	8.8	3.0	NT	NT	ND	NT	NT
	04-Apr-89	6.6	2.8	NT	ND	ND	NT	NT
	11-Apr-89	6.6	3.8	NT	NT	ND	NT	NT
	18-Apr-89	6.6	5.8	5.0	NT	ND	NT	NT
	25-Apr-89	2.2	1.3	3.0	NT	ND	NT	NT
	02-May-89	8.8	4.5	3.4	NT	ND	NT	NT

NOTES:

HCU: Hydrocarbon Utilizers
TC: Total Count
LOD: Limit of Detection.
NA: Limit of Detection not applicable.
ND: Not detected at or above LOD.
NT: Not tested.
* : First value from HLA laboratory
Second value from Pace Laboratories, Inc.
**: Results from Pace Laboratories, Inc.
--: Results not available.
Inorganic constituents reported in parts per million (ppm).
Microbial counts reported in colony-forming units per milligram of water.

Table 7. Results of Organic Chemical Analyses of Ground-Water Monitoring Well Samples

Purgeable Aromatics (EPA Method 8020)
Petroleum Hydrocarbons (EPA Method 8015)

WELL	DATE		BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES, TOTAL	TPH AS GASOLINE
LOD		(mg/l)	0.0005	0.0005	0.0005	0.0005	0.25
MW-5							
	03-May-89		ND	ND	ND	0.029	ND
MW-7							
	04-Apr-89		ND	0.0007	0.0010	0.0012	ND
	03-May-89		ND	0.0012	0.0018	0.0048	0.27
MW-9							
	02-Mar-89		NT	NT	NT	NT	1.2
	04-Apr-89		0.19	0.35	0.041	0.36	1.5
	01-May-89		0.43	0.60	0.033	0.64	4.6
MW-10							
	02-Mar-89		NT	NT	NT	NT	2.8
	04-Apr-89		1.6	0.76	0.13	0.68	4.2
	01-May-89		1.2	0.67	0.16	0.67	3.4
MW-11							
	02-Mar-89		NT	NT	NT	NT	15
	04-Apr-89		2.5	3.8	0.17	2.4	10
	19-Apr-89		3.8	2.8	ND	5.7	14
	01-May-89		1.3	1.7	0.069	1.7	5.2
MW-12							
	15-Feb-89		ND	ND	ND	ND	ND
	03-Mar-89		NT	NT	NT	NT	ND
	05-Apr-89		0.0014	0.0023	ND	0.0054	ND
	02-May-89		0.026	0.0033	ND	0.0063	0.10
MW-13							
	02-Mar-89		NT	NT	NT	NT	1.4
	04-Apr-89		0.041	0.039	0.0038	0.28	0.71
	01-May-89		0.048	0.049	0.013	0.13	0.34
MW-14							
	02-Mar-89		NT	NT	NT	NT	ND
	04-Apr-89		0.44	0.063	ND	0.27	1.4
	01-May-89		0.35	0.011	<0.0013	0.094	0.94
MW-15							
	03-Mar-89		NT	NT	NT	NT	3.9
	04-Apr-89		0.88	0.97	0.11	0.93	3.7
	02-May-89		1.5	1.1	0.086	0.74	2.7
MW-16							
	02-Mar-89		NT	NT	NT	NT	2.1
	04-Apr-89		2.1	2.2	0.18	1.4	6.7
	02-May-89		0.74	0.94	0.11	0.95	2.7
MW-17							
	04-Apr-89		3.1	2.9	0.27	3.9	12
	02-May-89		1.2	1.0	0.11	1.4	3.9

Table 7. Results of Organic Chemical Analyses of Ground-Water Monitoring Well Samples

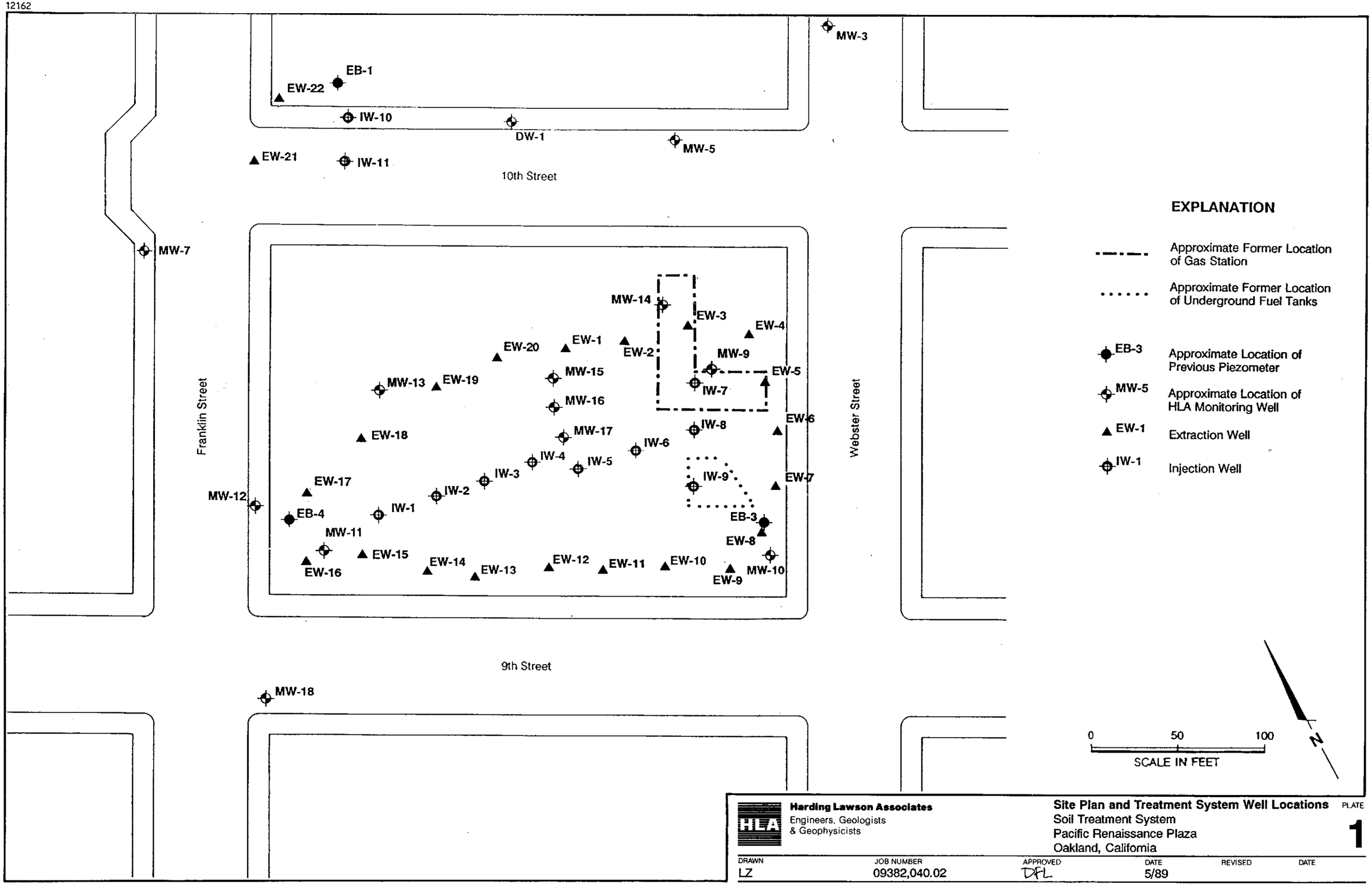
Purgeable Aromatics (EPA Method 8020)
Petroleum Hydrocarbons (EPA Method 8015)

WELL	DATE		BENZENE	TOLUENE	ETHYL-BENZENE	XYLENES, TOTAL	TPH AS GASOLINE
LOD		(mg/l)	0.0005	0.0005	0.0005	0.0005	0.25
MW-18							
	15-Feb-89		ND	ND	ND	ND	ND
	03-Mar-89		NT	NT	NT	NT	ND
	05-Apr-89		ND	ND	ND	ND	ND
	02-May-89		ND	ND	ND	ND	ND
EW-1							
	04-Apr-89		1.6	1.0	0.087	1.8	5.9
	01-May-89		3.2	1.2	0.15	1.4	6.3
EW-4							
	04-Apr-89		NT	NT	NT	NT	2.5
	01-May-89		0.56	0.28	0.034	0.72	2.0
EW-8							
	01-May-89		1.1	0.49	0.021	0.30	2.3
EW-12							
	01-May-89		1.8	0.66	0.048	0.62	3.6
EW-13							
	19-Apr-89		0.068	0.0064	ND	0.20	0.79
EW-15							
	19-Apr-89		13080	61000	16000	140000	660000
EW-16							
	04-Apr-89*		2.8/3.3	2.0/2.6	0.10/0.14	0.99/1.2	8.9/8.8
	19-Apr-89		0.002	0.0027	ND	0.0021	0.57
	01-May-89		5.0	4.6	0.34	2.5	12.0
EW-19							
	01-May-89		1.4	1.2	0.068	0.77	3.4
BLANK							
	05-Apr-89		0.5	ND	ND	ND	ND

NOTES:

LOD: Limit of Detection.
ND: Not detected at or above LOD.
NT: Not tested.
*: Two values indicate results of duplicate samples
Organic constituents reported in milligrams per liter.

12162



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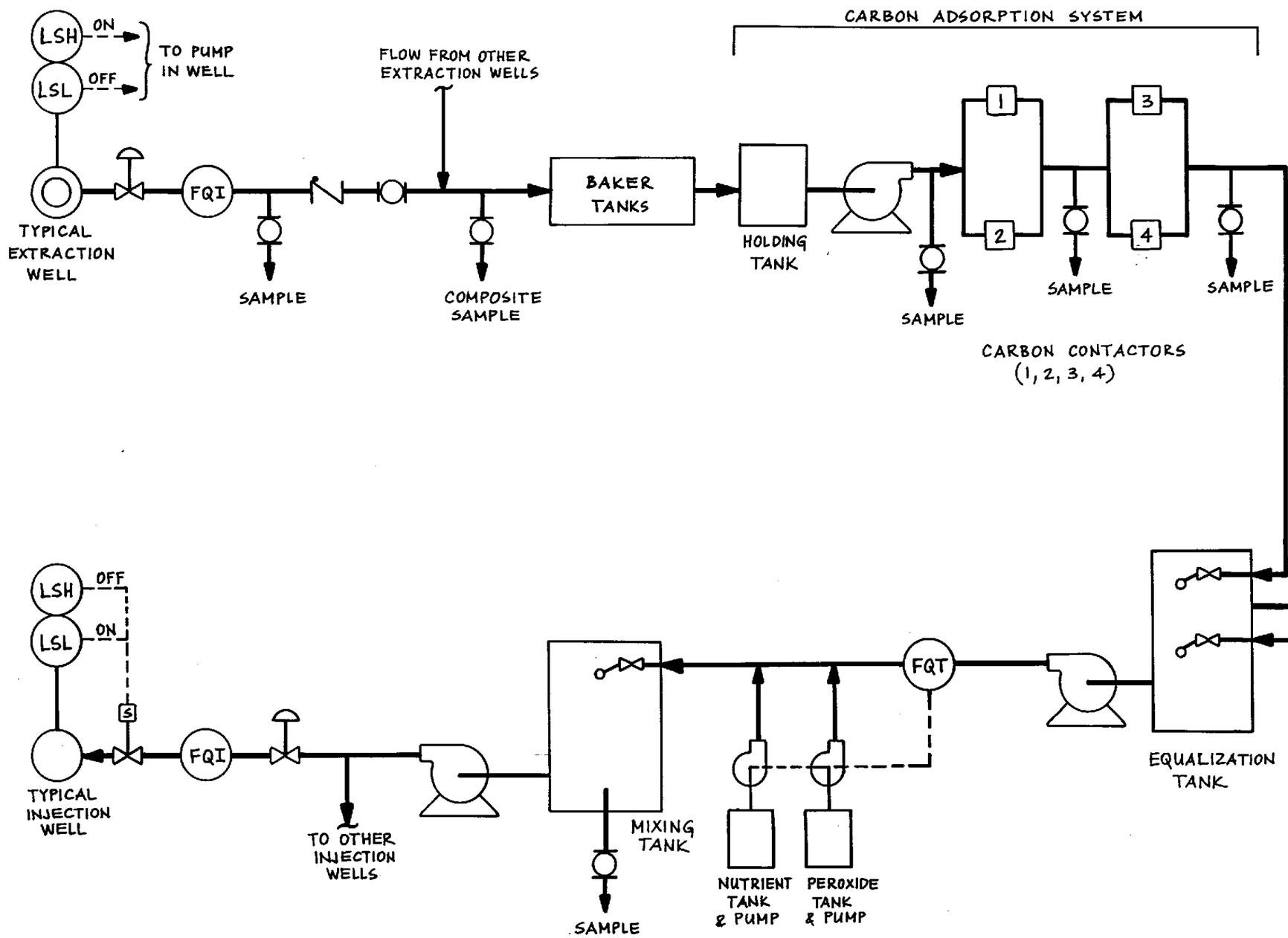
Site Plan and Treatment System Well Locations PLATE **1**
Soil Treatment System
Pacific Renaissance Plaza
Oakland, California

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
LZ	09382,040.02	DFL	5/89		



LEGEND

- BALL VALVE
- GATE VALVE
- SOLENOID VALVE
- CHECK VALVE
- FLOAT VALVE
- PUMP

ABBREVIATIONS

LSH	HIGH LEVEL SWITCH
LSL	LOW LEVEL SWITCH
FQI	FLOW INDICATOR
FQT	FLOW TRANSMITTER

109463

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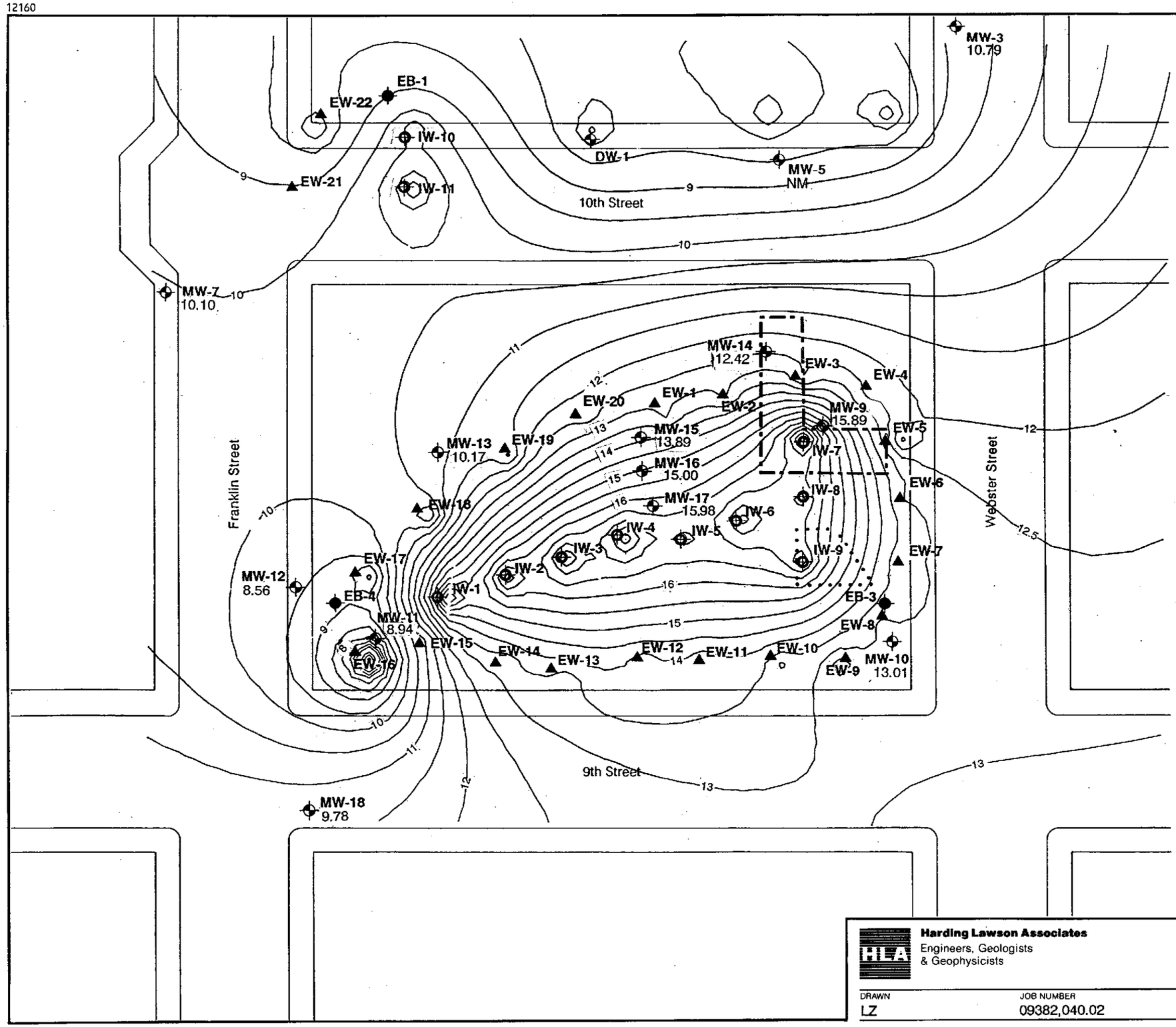
Schematic Diagram
Soil Treatment System
Pacific Renaissance Plaza
Oakland, California

PLATE **2**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
AK	09382,040.02		5/89		

12160



EXPLANATION

- Approximate Former Location of Gas Station
- Approximate Former Location of Underground Fuel Tanks
- EB-3 — Approximate Location of Previous Piezometer
- MW-5 — Approximate Location of HLA Monitoring Well
- EW-1 — Extraction Well
- IW-1 — Injection Well
- 13.01 — Observed Ground-Water Elevation
- 16 — Simulated Ground-Water Elevation

0 50 100
SCALE IN FEET

N

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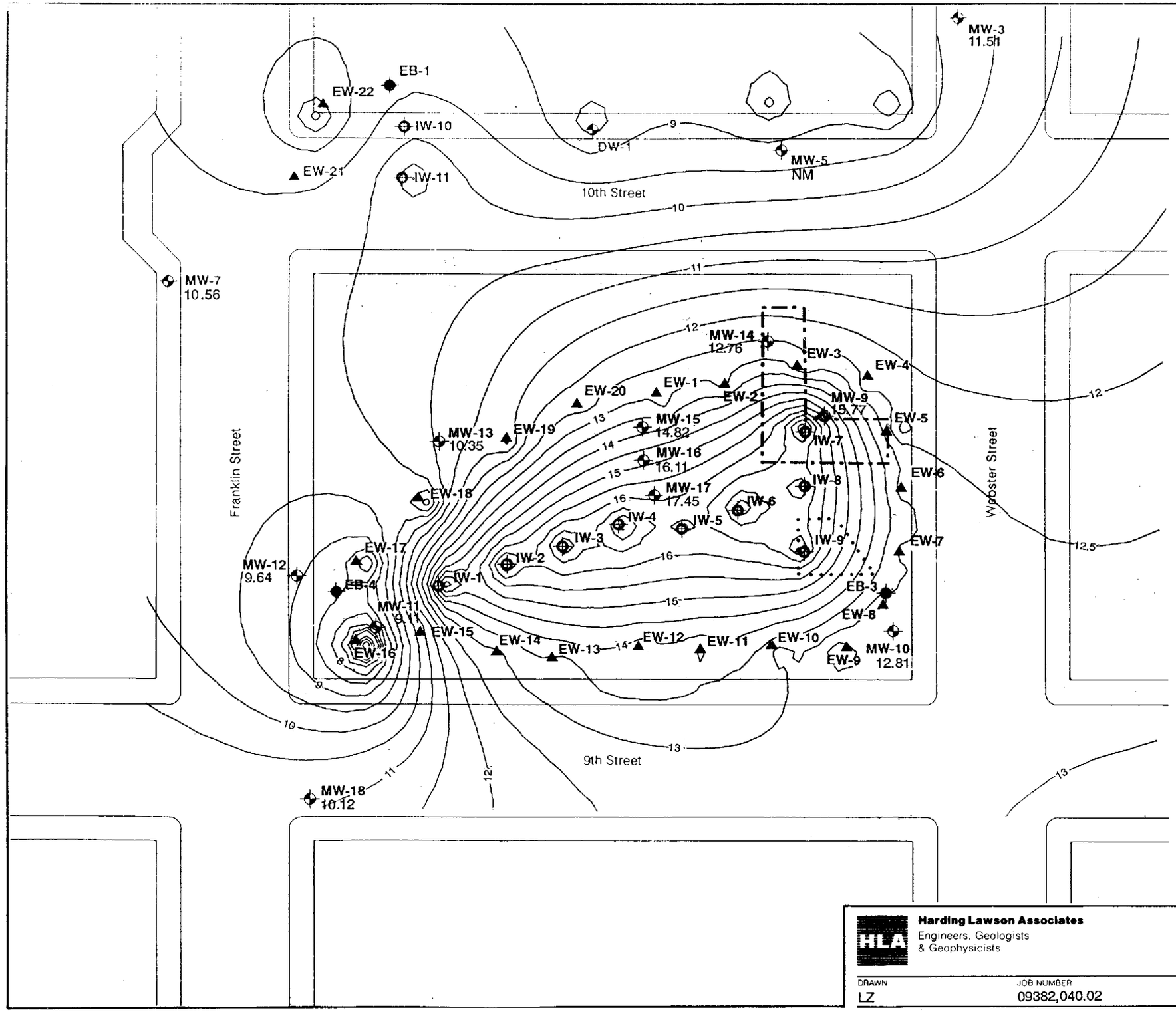
Observed and Simulated Ground-Water Elevations: April 4, 1989
Soil Treatment System
Pacific Renaissance Plaza
Oakland, California

PLATE **3**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
LZ	09382,040.02	DFL	5/89		

12161



EXPLANATION

- Approximate Former Location of Gas Station
- Approximate Former Location of Underground Fuel Tanks
- EB-3 — Approximate Location of Previous Piezometer
- MW-5 — Approximate Location of HLA Monitoring Well
- EW-1 — Extraction Well
- IW-1 — Injection Well
- 12.81 — Observed Ground-Water Elevation
- 16 — Simulated Ground-Water Elevation

0 50 100
SCALE IN FEET

N

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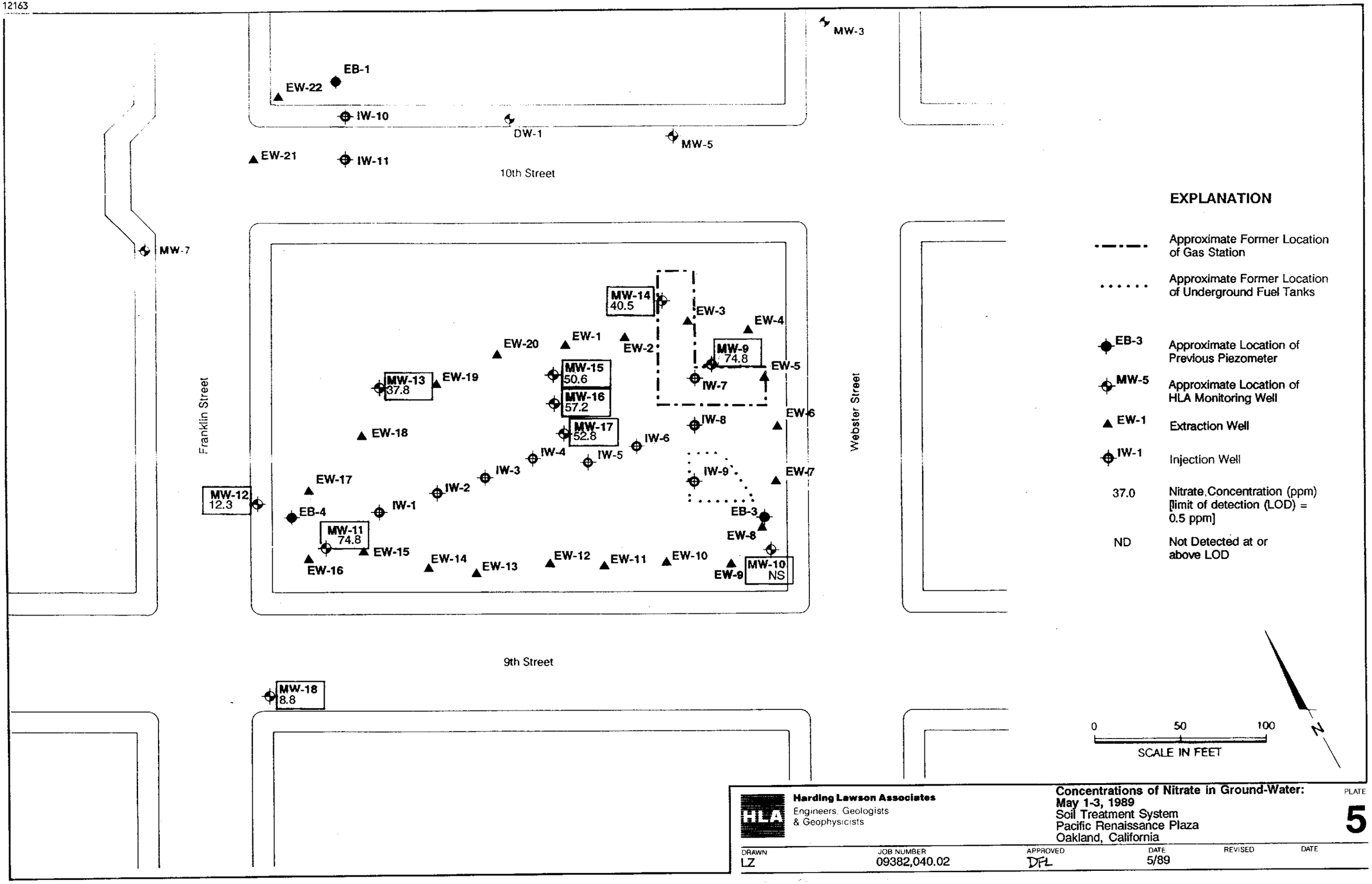
Engineers, Geologists & Geophysicists

Observed and Simulated Ground-Water Elevations: May 1-2, 1989
Soil Treatment System
Pacific Renaissance Plaza
Oakland, California

PLATE **4**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
LZ	09382,040.02	DFL	5/89		

12163



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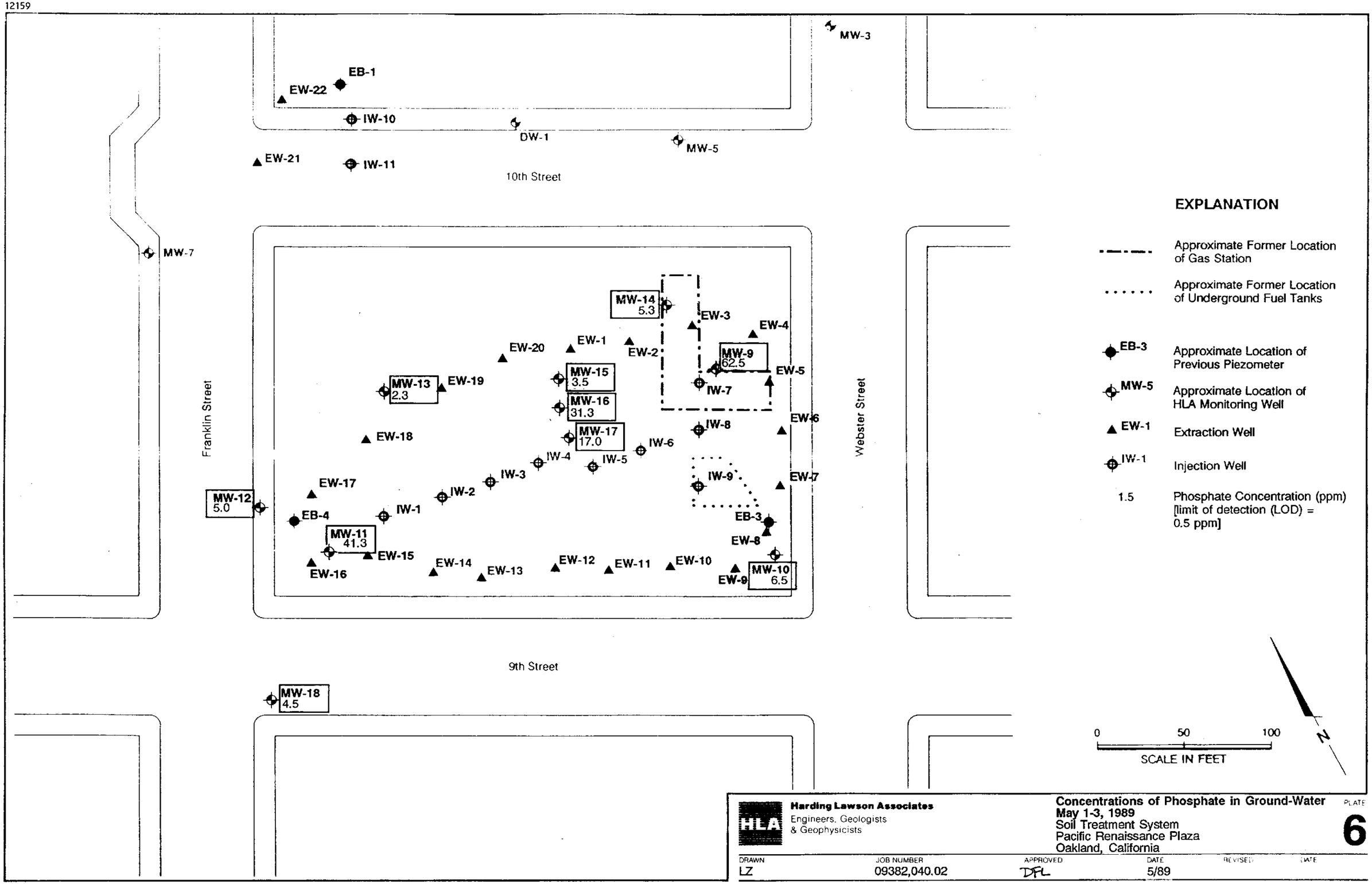
Concentrations of Nitrate in Ground-Water: May 1-3, 1989
Soil Treatment System
Pacific Renaissance Plaza
Oakland, California

PLATE **5**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
LZ	09382,040.02	DFL	5/89		

12159



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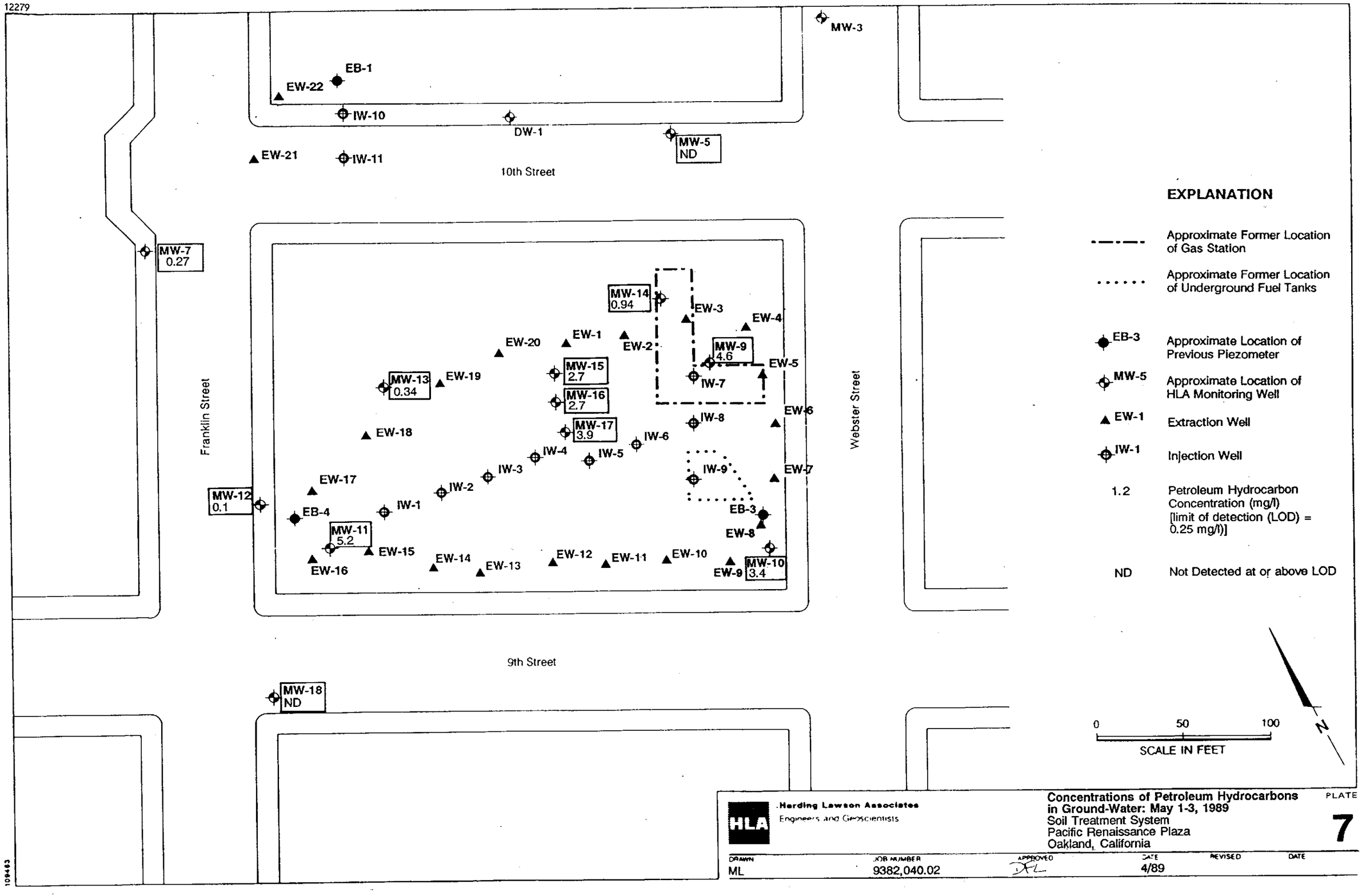
Concentrations of Phosphate in Ground-Water
May 1-3, 1989
Soil Treatment System
Pacific Renaissance Plaza
Oakland, California

PLATE **6**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
LZ	09382,040.02	DFL	5/89		

12279



EXPLANATION

- Approximate Former Location of Gas Station
- Approximate Former Location of Underground Fuel Tanks
- EB-3 — Approximate Location of Previous Piezometer
- MW-5 — Approximate Location of HLA Monitoring Well
- EW-1 — Extraction Well
- IW-1 — Injection Well
- 1.2 — Petroleum Hydrocarbon Concentration (mg/l) [limit of detection (LOD) = 0.25 mg/l)]
- ND — Not Detected at or above LOD

0 50 100

SCALE IN FEET

N

109483

HLA Harding Lawson Associates
Engineers and Geoscientists

Concentrations of Petroleum Hydrocarbons in Ground-Water: May 1-3, 1989
Soil Treatment System
Pacific Renaissance Plaza
Oakland, California

PLATE **7**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
ML	9382,040.02	DFL	4/89		

Appendix A

LABORATORY ANALYTICAL RESULTS FOR WATER SAMPLES

pace laboratories, inc.

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa
Novato, California

REPORT OF LABORATORY ANALYSIS

Harding Lawson Associates
200 Rush Landing Road
Novato, CA 94947
Y 89 9:
Attn: Mr. David Leland

May 02, 1989
PACE Project Number: 490419503

Pacific Ren. Plaza

Date Sample(s) Collected: 04/19/89
Date Sample(s) Received: 04/19/89

PACE Sample Number:			724950	724960	724970
			89161920	89161921	89161922
Parameter	Units	MDL	EW-13	EW-16	MW-11
ORGANIC ANALYSIS					
PURGEABLE FUELS AND AROMATICS					
TOAL PETROLEUM HYDROCARBONS, LIGHT FRAC.					
Purgeable Fuels, as Gasoline (EPA 8015)	mg/L	0.25	0.79	0.57	14
PURGEABLE AROMATICS (BTXE BY EPA 8020)					
Benzene	mg/L	0.0005	0.068	0.0020	3.8
Ethylbenzene	mg/L	0.0005	ND	ND	ND
Toluene	mg/L	0.0005	0.0064	0.0027	2.8
Xylenes, total	mg/L	0.0005	0.20	0.012	5.7

MDL Method Detection Limit
ND Not detected at or above the MDL.

pace laboratories, inc.

REPORT OF LABORATORY ANALYSIS

Offices:
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Tampa, Florida
Coralville, Iowa
Novato, California

May 02, 1989
PACE Project Number: 490419503

PACE Sample Number:			724980
			89161918
Parameter	Units	MDL	EW-15
ORGANIC ANALYSIS			
PURGEABLE FUELS AND AROMATICS			
TOAL PETROLEUM HYDROCARBONS, LIGHT FRAC.			
Purgeable Fuels, as Gasoline (EPA 8015)	mg/L	0.25	660,000
PURGEABLE AROMATICS (BTXE BY EPA 8020)			
Benzene	mg/L	0.0005	13,000
Ethylbenzene	mg/L	0.0005	16,000
Toluene	mg/L	0.0005	61,000
Xylenes, total	mg/L	0.0005	140,000

MDL Method Detection Limit
ND Not detected at or above the MDL.

Approval:

Stephen F. Nackord
Project Manager for
PACE Laboratories

Douglas E. Oram, Ph.D
Technical Reviewer for
PACE Laboratories

pace laboratories, inc.

REPORT OF LABORATORY ANALYSIS

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa
Novato, California

Harding Lawson Associates
200 Rush Landing Road
Novato, CA 94947

May 16, 1989
PACE Project Number: 490501501

Attn: Mr. David Leland

Pacific Ren. Plaza

Date Sample(s) Collected: 05/01/89
Date Sample(s) Received: 05/01/89

			EW-1	EW-4	EW-8
PACE Sample Number:			727330	727340	727350
Parameter	Units	MDL	89180101	89180102	89180103
ORGANIC ANALYSIS					
PURGEABLE FUELS AND AROMATICS					
TOAL PETROLEUM HYDROCARBONS, LIGHT FRAC.			-	-	-
Purgeable Fuels, as Gasoline (EPA 8015)	mg/L	0.05	6.3	2.0	2.3
PURGEABLE AROMATICS (BTXE BY EPA 8020)			-	-	-
Benzene	mg/L	0.0002	3.2	0.56	1.1
Ethylbenzene	mg/L	0.0002	0.15	0.034	0.021
Toluene	mg/L	0.0002	1.2	0.28	0.49
Xylenes, total	mg/L	0.0002	1.4	0.72	0.30

MDL Method Detection Limit

pace laboratories, inc.

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Coralville, Iowa
Novato, California

May 16, 1989
PACE Project Number: 490501501

PACE Sample Number:			EW-12 727360	EW-16 727370	EW-19 727380
Parameter	Units	MDL	89180104	89180105	89180106
ORGANIC ANALYSIS					
PURGEABLE FUELS AND AROMATICS					
TOAL PETROLEUM HYDROCARBONS, LIGHT FRAC.			-	-	-
Purgeable Fuels, as Gasoline (EPA 8015)	mg/L	0.05	3.6	12	3.4
PURGEABLE AROMATICS (BTXE BY EPA 8020)			-	-	-
Benzene	mg/L	0.0002	1.8	5	1.4
Ethylbenzene	mg/L	0.0002	0.048	0.34	0.068
Toluene	mg/L	0.0002	0.66	4.6	1.2
Xylenes, total	mg/L	0.0002	0.62	2.5	0.77

MDL Method Detection Limit

pace laboratories, inc.

REPORT OF LABORATORY ANALYSIS

Offices:
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa
Novato, California

May 16, 1989
PACE Project Number: 490501501

PACE Sample Number:			MW-13 727390	MW-11 727400	MW-10 727410
Parameter	Units	MDL	89180107	89180108	89180109
ORGANIC ANALYSIS					
PURGEABLE FUELS AND AROMATICS					
TOAL PETROLEUM HYDROCARBONS, LIGHT FRAC.			-	-	-
Purgeable Fuels, as Gasoline (EPA 8015)	mg/L	0.05	0.34	5.2	3.4
PURGEABLE AROMATICS (BTXE BY EPA 8020)			-	-	-
Benzene	mg/L	0.0002	0.048	1.3	1.2
Ethylbenzene	mg/L	0.0002	0.013	0.069	0.16
Toluene	mg/L	0.0002	0.049	1.7	0.67
Xylenes, total	mg/L	0.0002	0.13	1.7	0.67

MDL Method Detection Limit

pace laboratories, inc.

REPORT OF LABORATORY ANALYSIS

Offices:
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Tampa, Florida
Coralville, Iowa
Novato, California

May 16, 1989
PACE Project Number: 490501501

PACE Sample Number:			MW-9 727420	MW-14 727430
Parameter	Units	MDL	89180110	89180111
ORGANIC ANALYSIS				
PURGEABLE FUELS AND AROMATICS				
TOAL PETROLEUM HYDROCARBONS, LIGHT FRAC.			-	-
Purgeable Fuels, as Gasoline (EPA 8015)	mg/L	0.05	4.6	0.94
PURGEABLE AROMATICS (BTXE BY EPA 8020)			-	-
Benzene	mg/L	0.0002	0.43	0.35
Ethylbenzene	mg/L	0.0002	0.033	LT 0.0013
Toluene	mg/L	0.0002	0.60	0.011
Xylenes, total	mg/L	0.0002	0.64	0.094

MDL Method Detection Limit
LT Less than.

The data contained in this report were obtained using EPA or other approved methodologies. All analyses were performed by me or under my direct supervision.

Douglas E. Oram

Douglas E. Oram, Ph.D.
Organic Chemistry Manager

pace laboratories, inc.

Offices:
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Tampa, Florida
Coralville, Iowa
Novato, California

REPORT OF LABORATORY ANALYSIS

Harding Lawson Associates
200 Rush Landing Road
Novato, CA 94947

May 16, 1989
PACE Project Number: 490502503

Attn: Mr. David Leland

Pacific Ren. Plaza

Date Sample(s) Collected: 05/02/89
Date Sample(s) Received: 05/02/89

			MW-15	MW-16	MW-17
PACE Sample Number:			727680	727690	727700
Parameter	Units	MDL	89182012	89182013	89182014
ORGANIC ANALYSIS					
PURGEABLE FUELS AND AROMATICS					
TOAL PETROLEUM HYDROCARBONS, LIGHT FRAC.			-	-	-
Purgeable Fuels, as Gasoline (EPA 8015)	mg/L	0.05	2.7	2.7	3.9
PURGEABLE AROMATICS (BTXE BY EPA 8020)			-	-	-
Benzene	mg/L	0.0002	1.5	0.74	1.2
Ethylbenzene	mg/L	0.0002	0.086	0.11	0.11
Toluene	mg/L	0.0002	1.1	0.94	1.0
Xylenes, total	mg/L	0.0002	0.74	0.95	1.4

MDL Method Detection Limit

pace laboratories, inc.
Minneapolis, Minnesota
Tampa, Florida
Coralville, Iowa
Novato, California

REPORT OF LABORATORY ANALYSIS

May 16, 1989
PACE Project Number: 490502503

PACE Sample Number:			MW-18 727710	MW-12 727720
Parameter	Units	MDL	89182015	89182016
ORGANIC ANALYSIS				
PURGEABLE FUELS AND AROMATICS				
TOAL PETROLEUM HYDROCARBONS, LIGHT FRAC.			-	-
Purgeable Fuels, as Gasoline (EPA 8015)	mg/L	0.05	ND	0.10
PURGEABLE AROMATICS (BTXE BY EPA 8020)			-	-
Benzene	mg/L	0.0002	ND	0.026
Ethylbenzene	mg/L	0.0002	ND	ND
Toluene	mg/L	0.0002	ND	0.0033
Xylenes, total	mg/L	0.0002	ND	0.0063

MDL Method Detection Limit
ND Not detected at or above the MDL.

The data contained in this report were obtained using EPA or other approved methodologies. All analyses were performed by me or under my direct supervision.

Douglas E. Oram, Ph.D.
Organic Chemistry Manager

DISTRIBUTION

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SOIL TREATMENT SYSTEM
PACIFIC RENAISSANCE PLAZA
OAKLAND, CALIFORNIA
May 31, 1989

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