A Report Prepared for

City of Oakland
Redevelopment Agency
One City Hall Plaza
Oakland, California 94612

DRAFT

GROUND-WATER INVESTIGATION
CHINATOWN REDEVELOPMENT PROJECT AREA
OAKLAND, CALIFORNIA

HLA Job No. 9382,013.02

by

Janet Peters
Project Geologist

Grant L. Ohland
Project Hydrogeologist

Harding Lawson Associates
7655 Redwood Boulevard
P.O. Box 578
Novato, California 94948
415/892-0821

January 8, 1988

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

I INTRODUCTION

This report presents the results of Harding Lawson Associates' (HLA) investigation of soils and ground water in the vicinity of 11th and Webster streets in the Chinatown Redevelopment Project Area of Oakland, California (Plate 1). The purpose of the investigation was to evaluate ground-water contamination from underground fuel storage tanks as outlined in HLA's Work Plan dated November 13, 1987 (HLA, 1987c). The Work Plan recommended that additional ground-water monitoring wells be installed to assess ground-water conditions at the site and that these wells be monitored and sampled to evaluate on-site ground-water contamination.

II SITE INVESTIGATION HISTORY

Four underground storage tanks were located under the sidewalk along the northeastern edge of a now-vacant lot bounded by 11th, 10th, Webster and Franklin Streets (Plate 2). The lot is part of the Chinatown Redevelopment Project Area; an underground parking facility and high-rise office complex will be constructed on a portion of the lot. Construction is scheduled to begin in early 1988.

The four underground storage tanks were removed in April 1987. During tank removal, HLA collected soil samples and observed the excavation activities. Concentrations of total petroleum hydrocarbons (TPH) (as gasoline) measured in soil samples collected below the tanks ranged from 3,200 to 11,000 parts per million (ppm). On the basis of these observations and test results, HLA concluded that hydrocarbons had migrated into the surrounding soils (HLA, 1987a). It was recommended that a ground-water monitoring well be installed to evaluate the impact of the release on water quality and that a test boring be drilled in the tank excavation to evaluate the vertical distribution of hydrocarbons.

The second phase of the site investigation was conducted in late May 1987 when two test borings were drilled and sampled. Boring 1, located south of the former tank location, was completed as a ground-water monitoring well (MW-1). Boring 2 (B2), drilled to ground water, was located within the tank excavation. The locations of Boring B2 and Monitoring Well MW-1 are shown on Plate 2. Soil samples were collected from both borings and analyzed for TPH, and for benzene, toluene, and xylenes (BTX) to evaluate the vertical extent of soil contamination. One ground-water sample was collected from MW-1 and analyzed for TPH, BTX, and ethylbenzene, and for purgeable organohalides using U.S. Environmental

Protection Agency (EPA) Test Method 601. High concentrations of TPH and BTX were detected in the ground-water sample and in the soil samples from Boring B2. The results of chemical analyses from this and subsequent investigations are shown on Table 1. From these results, HLA again concluded that leakage had occurred from one or more of the former tanks at this site (HLA, 1987b). It was recommended that a Leak Report be filed with the Regional Water Quality Control Board, San Francisco Bay Region (RWQCB, 1985), and that further ground-water investigations be conducted.

The third phase of the site investigation began in August 1987. The goal of this phase was to: 1) confirm the ground-water data collected previously; 2) prepare a preliminary assessment of the lateral extent of hydrocarbon migration; and 3) begin evaluating of technologies suitable for source control. During this phase, HLA resampled MW-1, conducted soil gas mapping as a reconnaissance tool for ground-water plume identification, and drilled and sampled six additional soil borings near the former tank site.

Analytical data from the resampling of MW-1 confirmed the high BTX and TPH concentrations, but GC/MS analysis did not detect any other volatile organic compounds. Benzene concentrations ranged from 4,900 parts per billion (ppb) in the ground-water sample collected in May 1987 to 11,000 ppb found in the August 1987 sample.

Soil gas mapping for plume identification was inconclusive. Therefore, Borings B3 through B8 were drilled near the former tank location to evaluate soil and ground-water contamination. The locations of these borings and the soil gas probes are shown on Plate 2. Soil samples from near the water table and a ground-water sample were collected from each soil boring and analyzed for BTX,

ethylbenzene, and TPH. The highest concentrations in the ground-water were found near the former tank location and in the assumed downgradient direction near Boring B6 (HLA, 1987d).

As a result of the data evaluation in the third phase of the investigation, HLA recommended that an interim soil remediation program be initiated as a source control measure. This program is currently underway. HLA also recommended that additional ground-water monitoring wells be installed to assess hydrogeologic conditions at the site, and that monitoring and sampling be conducted to further evaluate the vertical and horizontal extent of subsurface contamination (HLA, 1987c). The procedures and results of the ground-water investigation are discussed in the following sections.

III FIELD INVESTIGATION

Four borings were drilled and sampled in the investigation area between December 8 and December 12, 1987 (Plate 3). The borings were drilled to depths ranging from 40 to 46 feet and completed as Monitoring Wells MW-2 through MW-5. Drilling was performed by Bay Area Exploration, Inc., of Suisun, California, using a CME 55 hollow-stem auger rig. An HLA geologist supervised the drilling and well installation and collected soil samples for lithologic characterization and chemical analyses. The wells were constructed of 4-inch-diameter PVC casing with sufficient well screen to allow monitoring above the water table. Logs of the borings and well completion details are shown in Appendix A.

Soil samples were collected at 5-foot intervals from ground surface to the total depth of the boring. Samples were collected with a Modified California split-barrel sampler lined with 2.5 inch-diameter stainless steel tubes. Soil samples were screened in the field for volatile organic compounds using a portable organic vapor analyzer (OVA) and checked for the presence of hydrocarbon odors. A soil sample at or slightly above the water table was collected in each boring for chemical analyses. The ends of these sample tubes were sealed with foil-lined plastic caps taped to the tubes.

All soil samples were stored on ice until they were delivered with completed chain of custody forms to Curtis & Tompkins, Ltd., Analytical Laboratories, of San Francisco, California, for analyses. Chemical analytes requested were TPH (as gasoline), and BTX and ethylbenzene (BTXE).

Equipment used for drilling and soil sampling was decontaminated prior to and after use as outlined in Appendix B. HLA employees performing field work were safety trained and used Level D protective equipment.

After the surface seal of each well had set for at least 12 hours, the well was developed by a combination of swabbing and pumping. Swabbing was performed in 5-foot intervals over the entire screened section of each well. A pump was then placed near the bottom of each well and pumped until the water was relatively free of turbidity. Water discharged during well development was collected and stored onsite in a 21,000 gallon Baker tank.

After installation and development, each of the five wells (MW-1 through MW-5) was sampled and its water level elevation measured. Samples and measurements were obtained on December 14 and 21, 1987, except for MW-5, which was sampled on December 15, 1987. Sampling followed standard HLA protocol. Quality control duplicate samples were collected from Well MW-4 and trip blanks were included with each sampling event. Because of soil excavation activities, a sample from Well MW-1 could not be obtained during the December 21, 1987, sampling round.

Prior to collecting ground-water samples, each well was purged using a submersible pump placed near the bottom of the well. During purging, a volume of water equal to a least three times the static-water volume in the casing was removed. Indicator parameters (pH, conductivity and temperature) were monitored during purging. The stability of these readings following the removal of three casing volumes provides additional evidence that the static water had been removed. Discharge water produced during well purging was collected and stored on site in the Baker tank.

Ground-water samples were collected using a clean stainless steel bailer. The samples were then transferred to clean 1-liter amber glass bottles for TPH analyses, 40 milliliter (ml) glass volatile organic analysis (VOA) vials for BTXE analyses, and 250-ml plastic containers for lead analyses. All ground-water samples were stored on ice until delivered with completed chain of custody forms to Curtis & Tompkins, Inc., Analytical Laboratories, of San Francisco, California. All soil and ground-water samples were analyzed using U.S. EPA Test Methods 3550/ 8015, 602, 7420, and/or 5030.

Depth to water prior to the purging of each well was measured using a graduated steel tape and chalk until two measurements with a difference of less than or equal to 0.02 feet were obtained. Water-level elevations were calculated using the depth to water data and well measuring point elevations surveyed by KCA Engineers, Inc., of San Francisco, California. Equipment used in development and sampling was decontaminated following procedures outlined in Appendix B.

IV AQUIFER TESTING

Aquifer testing was conducted to quantify the hydraulic properties of the uppermost aquifer in the study area. Estimates of aquifer transmissivity and hydraulic conductivity were obtained to allow subsequent estimation of groundwater flow velocities and the influence of pumping on water levels in the aquifer.

Aquifer testing typically involves monitoring water-level changes that occur in response to a stress applied to the aquifer system. Stresses are usually applied to the aquifer by pumping or by adding and/or removing a mass (slug) to or from a well.

Aquifer testing was conducted December 15 through 18, 1987, in three phases: 1) slug testing of Wells MW-3 and MW-4; 2) aquifer testing by pumping Well MW-3; and 3) recovery testing after pumping Well MW-3. The methods used to collect and analyze hydraulic data for the aquifer testing are described below.

A. Field Methods

Water-level responses during aquifer testing procedures were monitored with 10 psi pressure transducers connected to computerized dataloggers that recorded water-level changes at specified intervals. Recorded data were subsequently processed for analysis. The following protocol was used when installing transducers in wells monitored for water-level response.

1) The depth to water in the well prior to transducer placement was measured with a steel tape until two measurements with a difference of less than or equal to 0.02 feet were obtained.

2) The bottom of the transducer body was submerged in the well to a depth such that the transducer ports would not be plugged by silt and clay in the bottom of the well and operational interferences caused by pump or slug placement would be avoided.

3) Calibration of the data logger and transducer was checked by raising the transducer body exactly 1 foot and noting the change in measured submergence in the water column. Calibration was considered adequate if the measured change in submergence was within .02 feet of the 1 foot change in submergence.

4) Equipment placed in the wells to conduct aquifer testing was cleaned prior to use. Equipment cleansing was conducted according to the decontamination procedures outlined in Appendix B. Equipment was also decontaminated after use in each well to prevent cross contamination between wells on site.

1. Slug Testing

Slug testing provides estimates of aquifer hydraulic conductivity (permeability) and is generally conducted by adding or removing a mass of constant volume to or from a well. Water-level changes in response to slug placement or removal are recorded and analyzed according to established methods.

Slug testing was conducted on Wells MW-3 and MW-4 using a closed volume steel slug. The slug was placed into and then removed from the well. Water-level changes resulting from the instantaneous placement or removal of the slug were recorded using a pressure transducer and datalogger. Resulting changes in water levels were monitored until the water level in the well returned to a static condition.

The placement of the slug in the well caused an initial rise in the water level, followed by a water-level decline. Hence, this type of test is called a falling head slug test. Conversely, the removal of the slug from the well causes an initial water-level decline followed by rising water levels. This type of test is termed a rising head slug test.

The rising and falling head tests were repeated for each well to provide confirmation of the data collected during the first test.

2. Aquifer Testing by Pumping Well MW-3

After completion of the slug testing, a second aquifer test was conducted by pumping Well MW-3. This test was performed to verify estimates of aquifer hydraulic conductivity obtained from slug testing.

Well MW-3 was pumped at an average rate of 5.7 gpm for approximately 190 minutes using a 1 hp submersible pump powered by a portable generator. The intake of the pump was set to a depth of 36 feet below the top of the casing. Water pumped from the well during the test was collected and stored in the on-site Baker tank. Water-level responses or drawdowns were monitored in both the pumping well (MW-3) and Wells MW-4 and MW-5 throughout the test using pressure transducers and dataloggers.

3. Recovery Testing

A recovery test followed the pumping test of Well MW-3. Because of the effects of well loss on measured water levels, drawdown data collected in the pumping well do not adequately represent aquifer response to pumping. Well loss results in a difference between the water level in a pumping well and the water level in the aquifer surrounding the well. Therefore, a recovery test was conducted to estimate aquifer transmissivity and hydraulic conductivity in the vicinity of the pumping well (MW-3).

Recovery testing was conducted by measuring water-level recovery in Wells MW-3, MW-4, and MW-5 for approximately 150 minutes after pumping was stopped. The use of a check (foot) valve at the top of the pump housing prevented water from flowing back down the discharge line into the well, thus ensuring that measured water-level recovery was the result of water recharging the well from aquifer materials.

B. Analytical Methods

1. Slug Testing

Water-level responses collected during the slug testing of Wells MW-3 and MW-4 were analyzed using a technique described by Bouwer and Rice (1976). This technique was designed to analyze slug tests conducted in unconfined aquifers and requires the graphical representation of the logarithm of water-level changes versus time. The resulting graphs of the data from Wells MW-3 and MW-4 are shown in Appendix C (Plates C1 through C4). The linear portion of the data is subsequently used in calculating aquifer hydraulic conductivity. Calculation sheets for the slug test analyses are also included in Appendix C (Sheets C-1 through C-4). Only rising head slug tests were used to estimate aquifer hydraulic conductivity. Water-level responses measured during the falling head slug tests were not analyzed because early time data were affected by the inertial effects of the slug entering the well.

2. Aquifer Testing by Pumping Well MW-3

As previously stated, an aquifer test was conducted by pumping Well MW-3 at an average rate of 5.7 gpm for approximately 190 minutes. The test was stopped because of insufficient water-level drawdown in Wells MW-4 and MW-5. Drawdown data from the pumping well (MW-3) were not analyzed because of the effect of well loss on drawdown. Water-level data collected in Wells MW-3, MW-4, and MW-5 for the pumping period and the subsequent recovery period are shown on Plates 4 through 6. Water levels in Well MW-5 were also monitored for approximately 28 hours prior to testing to evaluate pre-test trends and diurnal water-level fluctuations (Plate 6).

3. Recovery Testing

Water-level recovery data from Well MW-3 were analyzed to estimate aquifer transmissivity and hydraulic conductivity using a method described by Theis (1935). As specified by the Theis recovery method, residual drawdown data were plotted versus the logarithm of dimensionless time (time since pumping stopped divided by the time since pumping started) for Well MW-3 (Plate C5). The linear portion of these data was used in calculating aquifer transmissivity and hydraulic conductivity. The calculation sheet used for determining aquifer parameters is presented in Appendix C (Sheet C-5). Aquifer storativity can not be determined using this method.

V RESULTS

The borings drilled by HLA during this and previous investigations indicate that the uppermost unconfined aquifer at this site consists of approximately 40 feet of medium- to poorly-sorted sand with a small percentage of fines. A locally continuous clay unit was found approximately 40 feet below ground surface (Plate 7). Ground water is generally 22 to 26 feet below ground surface with a hydraulic gradient of approximately 3.1×10^{-3} towards the southwest (Plate 8). Water-level elevations are presented in Table 2.

The results of the slug test data analysis are summarized in Table 3. Estimates of hydraulic conductivity range from 4.5 to 6.3 ft/day. The maximum drawdowns observed during the pumping of Well MW-3 are presented in Table 4. However, these data were not analyzed for reasons previously discussed.

Maximum water-level recovery (after 150 minutes) in Wells MW-3 and MW-5 was 11.24 and 0.05 feet, respectively. Recovery data from Well MW-3 were used to calculate an aquifer hydraulic conductivity of 2.2 ft/day and a transmissivity of 35 ft^2/day.

Ground-water flow velocities were calculated using the estimated range of aquifer hydraulic conductivity (2.2 to 6.3 ft/day), the above hydraulic gradient (3.1×10^{-3}), and an assumed effective porosity of 25 percent. Resulting velocities ranged from 0.03 to 0.08 ft/day.

The results of soil and ground-water sample analyses are presented in Table 5 and copies of the laboratory reports are included in Appendix D. Plate 9 shows the distribution of TPH and BTXE in samples collected from the ground water at the site. The highest concentrations of TPH and BTXE were found in

samples from Well MW-1, located adjacent to and downgradient of the former tanks. Concentrations of TPH, benzene, ethylbenzene, and xylenes were also found in Well MW-4, downgradient of Well MW-1, and at Well MW-2 upgradient of Well MW-1. Analytical results for samples collected from Well MW-5 on December 15, 1987, showed elevated concentrations of benzene. No detectable concentrations of chemicals analyzed for were found in samples from MW-3. Dissolved lead was not detected in any samples.

Concentrations of TPH and benzene in ground-water samples collected from wells MW-1, MW-2, and MW-4 exceed ground-water action levels. Toluene and xylenes concentrations measured in ground-water samples from MW-1, and benzene concentrations from MW-5 also exceed their respective action levels. The California Department of Health Services (DOHS) action levels (U.S. EPA, 1987) for ground water are as follows:

Chemical	DOHS Drinking Water Action Level (ppb)
TPH	2000
Benzene	0.7
Toluene	100
Xylenes	620
Ethylbenzene	Not available

The soil sample collected near the water table from Boring MW-2 contained 510,000 ppb TPH. Although a slight response was noted on the OVA for samples collected at the water table at Wells MW-4 and MW-5, soil samples from Borings MW-3 through MW-5 did not contain detectable levels of the chemicals analyzed for.

VI DISCUSSION AND CONCLUSIONS

The conclusions of the ground-water investigation HLA conducted at the Chinatown Redevelopment Area, Oakland, California, between December 7 and December 21, 1987, are as follows:

- The uppermost aquifer in the study area is composed of approximately 40 feet of medium- to poorly-sorted sand with a small percentage of silt and clay. The aquifer is underlain by a locally continuous clay zone approximately 40 feet below ground surface.

- Water levels in the uppermost aquifer range from 22 to 26 feet below ground surface and saturated thicknesses range from 12 to 16 feet.

- The hydraulic gradient in the unconfined uppermost aquifer in the study area is to the southwest at a magnitude of approximately 3.1×10^{-3}.

- Estimates of aquifer hydraulic conductivity determined from the slug testing of Wells MW-3 and MW-4 and the recovery testing of Well MW-3 were in general agreement. Aquifer hydraulic conductivity ranged from 2.2 to 6.3 ft/day and calculated ground-water flow velocities range from 0.03 to 0.08 ft/day.

- Concentrations of Total Petroleum Hydrocarbons (TPH) and benzene in ground-water samples collected from Wells MW-1, MW-2, and MW-4 exceed DOHS Drinking Water Action Levels. Toluene and xylene concentrations measured in ground-water samples from MW-1, and the benzene concentration measured in MW-5 were also above their respective action levels.

- The concentrations of chemicals in the ground water are highest near the former tank location and decrease downgradient. The lateral extent of contamination has not been defined by this phase of investigation.

- TPH and BTXE were detected in upgradient Well MW-2. The presence of these chemicals in this well could be attributed to: 1) migration of fuel from the leaking tank through the backfill of the tank and/or the engineered fill of Eleventh Street, or 2) migration of petroleum hydrocarbons from an unknown upgradient source.

VII RECOMMENDATIONS

On the basis of these conclusions, HLA recommends developing an interim ground-water remediation program in conjunction with proposed construction dewatering during site development. Ground-water treatment system should reduce concentrations of petroleum hydrocarbons and BTXE in the dewatering effluent to levels acceptable for surface discharge. Acceptable treatment levels will depend upon the final disposition of ground water removed from this site.

Additionally, a final remediation plan should be developed. This plan will require characterization of the horizontal and vertical extent of ground-water contamination. This characterization should be coordinated with the installation of the dewatering system scheduled for early 1988. Dewatering wells have been proposed by the site developer at 50- to 70-foot spacing along the perimeter of the site. The ground water from selected wells should be sampled upon well installation. If detectable concentrations of TPH and BTXE are found in the sampled wells, additional off-site investigation may be necessary. The underlying aquifer system should also be included in this characterization.

VIII REFERENCES

Bouwer H. and Rice R.C., 1976. A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, Water Resources Research, vol. 12, No. 3, pp. 423-428.

California Regional Water Quality Control Board, San Francisco Bay Region (RWQCb), 1985. Guidelines for Addressing Fuel Leaks. September.

Harding Lawson Associates, 1987a. Report, Services Following Tank Removal, Chinatown Redevelopment Project No. 97110, Oakland, California. May 8.

Harding Lawson Associates, 1987b. Initial Gasoline Leak Investigation, Chinatown Redevelopment Project Area, Oakland, California. June 19.

Harding Lawson Associates, 1987c. Work Plan, Gasoline Leak Investigation, Chinatown Redevelopment Project Area, Oakland, California. November 13.

Harding Lawson Associates, 1987d. Report, Chinatown Contamination Investigation, Chinatown Redevelopment Project Area, Oakland, California. December 28.

Theis, C.V. 1935. The Relation between the Lowering of the Piezometric Surface and the Rate and Duration of Discharge of a Well Using Ground-Water Storage, Transactions, American Geophysical Union, vol. 16, part 2, pp. 519-524.

U.S. Environmental Protection Agency (EPA), 1987, Drinking Water Standards and Health Advisory Table, Drinking Water Branch, Region IX, San Francisco, California.

TABLES

Table 1. Previous Investigations, Laboratory Results of Chemical Analyses of Soil and Ground-Water Samples

Boring No.	Sample Depth (feet)	Date Sampled	Total Petroleum Hydrocarbons (as gasoline) (ppb)[1]	Benzene (ppb)	Ethyl-Benzene (ppb)	Toluene (ppb)	Xylenes (ppb)
B1	20.0 - 20.5	5/26/87	430	12	NA[2]	ND (0.2)[3]	ND (0.2)
B2	15.0 - 15.5	5/26/87	3,700,000	9,800	NA	22,000	74,000
B2	20.0 - 20.5	5/26/87	2,400,000	1,600	NA	5,500	42,000
B2	25.0 - 25.5	5/26/87	16,000,000	48,000	NA	110,000	190,000
B3	15.5 - 16.0	10/9/87	ND(50)	0.5	ND(0.2)	0.6	ND(0.2)
B3	20.5 - 21.0	10/9/87	ND(50)	0.5	ND(0.2)	ND(0.2)	ND(0.2)
B3	25.5 - 26.0	10/9/87	2,000,000	5,800	14,600	13,400	50,000
B3	30.0 - 30.5	10/9/87	2,500,000	14,000	21,000	10,000	47,100
B3	35.5 - 36.0	10/9/87	31,000	350	350	450	850
B4	15.5 - 16.0	10/9/87	ND(50)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
B4	20.5 - 21.0	10/9/87	ND(50)	ND(0.2)	ND(0.2)	3.0	ND(0.2)
B4	25.5 - 26.0	10/9/87	120.0	11.7	1.0	ND(0.2)	24.3
B4	30.0 - 30.5	10/9/87	1,400.0	740.0	556.0	61.8	606.0
B4	35.5 - 36.0	10/9/87	860.0	525.0	29.5	14.0	198.0
B5	20.5 - 21.0	10/9/87	ND(50)	ND(0.2)	ND(0.2)	0.5	ND(0.2)
B5	25.5 - 26.0	10/9/87	2,800,000	8,300	28,000	10,000	197,000
B5	30.0 - 30.5	10/9/87	29,000	21	270	100	880
B5	35.5 - 36.0	10/9/87	470,000	13,047	1,232	492	6,594
B6	21.0 - 21.5	10/8/87	ND(50)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
B6	30.0 - 30.5	10/8/87	870,000	4,800	5,800	6,000	24,900
B7	25.5 - 26.0	10/8/87	1,100	4.9	1.9	0.7	3.4
B8	20.5 - 21.0	10/8/87	ND(50)	ND(0.2)	ND(0.2)	ND(0.2)	ND(0.2)
B8	35.5 - 36.0	10/8/87	330.0	1.4	1.0	18.7	4.5

1 Concentrations in parts per billion
2 Not analyzed
3 Not detected (detection limit)
4 Ground-water sample
5 Detectable concentrations were found for chlorobenzene, 1,2-dichloroethane, 1,2-dichloropropane, ethylene dibromide, trichloroethene, and 1,1,2-trichloroethane.

Note: Soil sample unless otherwise indicated.

Table 1. Previous Investigations, Laboratory Results of Chemical Analyses of Soil and Ground-Water Samples (continued)

Boring No.	Sample Depth	Date Sampled	Total Petroleum Hydrocarbons (as gasoline)	Benzene (ppb)[1]	Ethyl-Benzene (ppb)	Toluene (ppb)	Xylenes (ppb)	Other Purgeable Priority Pollutants (ppb)
MW-1	GW[4]	5/28/87	66,000	4,900	ND(50)	6,800	6,100	..[5]
MW-1	GW	8/28/87	72,000	11,000	ND(50)	6,100	6,000	ND
B3	GW	10/9/87	77,100	9,725	1,350	5,375	6,050	NA
B4	GW	10/9/87	28,500	6,935	580	188	663	NA
B5	GW	10/9/87	57,800	3,465	1,315	2,655	4,480	NA
B6	GW	10/8/87	138,040	11,025	1,675	6,275	12,150	NA
B7	GW	10/8/87	29,440	3,365	418	108	623	NA
B8	GW	10/8/87	3,900	34.5	35.0	41.5	219	NA

1 Concentrations in parts per billion
2 Not analyzed
3 Not detected (detection limit)
4 Ground-water sample
5 Detectable concentrations were found for chlorobenzene, 1,2-dichloroethane, 1,2-dichloropropane, ethylene dibromide, trichloroethene, and 1,1,2-trichloroethane.

Note: Soil sample unless otherwise indicated.

Table 2. Water-Level Elevations, December 1987*

Well	12/14/87	12/21/87
MW-1	15.39	**
MW-2	15.52	15.30
MW-3	15.48	15.46
MW-4	15.23	15.02
MW-5	15.13	15.09

*Feet above Mean Sea Level

**Well inaccessible due to construction.

Table 3. Aquifer Testing Results

Tested Well	Test Number	Saturated Thickness (feet)	Hydraulic Conductivity (feet/day)
Rising Head Slug Test			
MW-3	1	16.0	6.3
MW-3	2	16.0	5.8
MW-4	1	15.0	4.5
MW-4	2	15.0	4.6
Recovery Test			
M-3	-	16.0	2.2

Table 4. Maximum Observed Drawdowns During Pumping of Well MW-3

Well	Maximum Drawdown (feet)	Approximate Distance from Pumping Well (feet)
MW-3	12.57	Pumping Well
MW-4	*	160
MW-5	0.17	110

* = None observed

Table 5. Results of Chemical Analyses of Soil and Ground-Water Samples, Ground-Water Investigation, City of Oakland

Well Name	Date Sampled	Depth (feet)	Total Petroleum Hydrocarbons (as gasoline) (ppb)	Benzene (ppb)	Ethylbenzene (ppb)	Toluene (ppb)	Xylene(s) (ppb)	Dissolved Lead (ppb)
MW-1	12-14-87	GW[a]	16,000	7,300	1,400	4,700	6,800	ND(100)
	12-21-87[d]							
MW-2	12-08-87	26.0-26.5	510,000	ND(1000)[b]	ND (1000)	ND (5000)	ND (1000)	—[e]
	12-14-87	GW	1,600	200	56	ND (50)	ND (10)	ND(100)
	12-21-87	GW	2,110	76	55	10	64	ND(50)
MW-3	12-10-87	27.5-28.0	ND (10,000)	ND (1)	ND (1)	ND (5)	ND (1)	—
	12-14-87	GW	ND (50)	ND (1)	ND (1)	ND (5)	ND (1)	—
	12-21-87	GW	ND (50)	ND (1)	ND (1)	ND (1)	ND (1)	—
MW-4	12-09-87	26.0-26.5	ND (10,000)	ND (1)	ND (1)	ND (5)	ND (1)	—
	12-14-87	GW	770	ND (10)	ND (10)	ND (50)	ND (10)	ND (100)
	12-14-87[c]	GW	710	ND (10)	ND (10)	ND (50)	ND (10)	ND (100)
	12-21-87	GW	2,410	88	38	ND (10)	88	ND (50)
	12-21-87[c]	GW	2,090	81	30	ND (10)	77	ND (50)
MW-5	12-12-87	25.5-26.0	ND (10,000)	ND (5)	ND (5)	ND (5)	ND (5)	—
	12-15-87[f]	GW	4,200	ND (5)	5	ND (5)	45	—
	12-21-87	GW	ND (50)	8	ND (1)	3	3	—

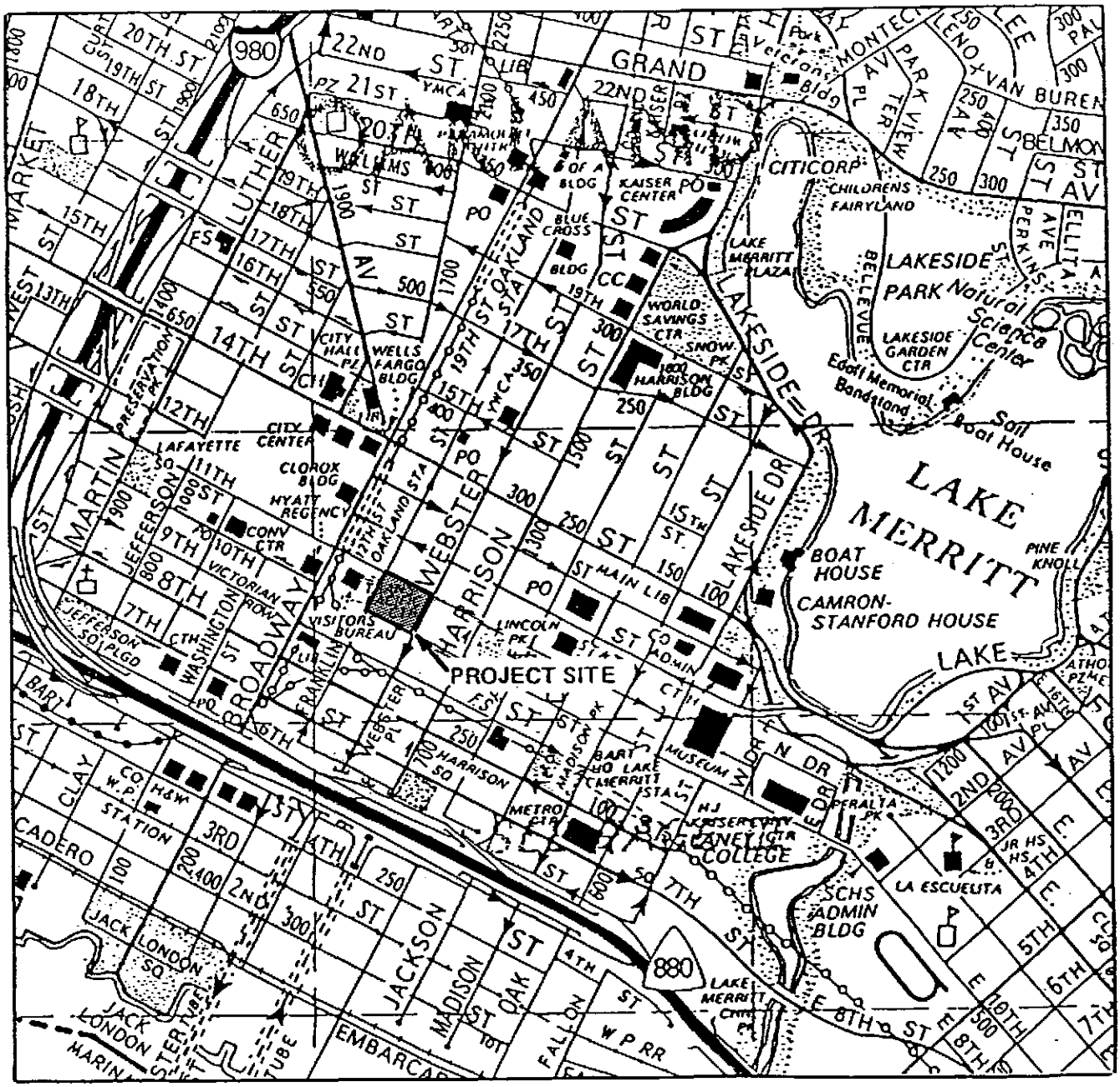
(a) Ground-water sample.
(b) Not detected (detection limits).
(c) Duplicate sample.
(d) Sample not collected because of soil excavation activities.
(e) Not analyzed.
(f) Development sample -- may not be representative of concentrations in the ground water at this well.

Note: Soil sample unless otherwise indicated.

C2796-7

ILLUSTRATIONS

1976



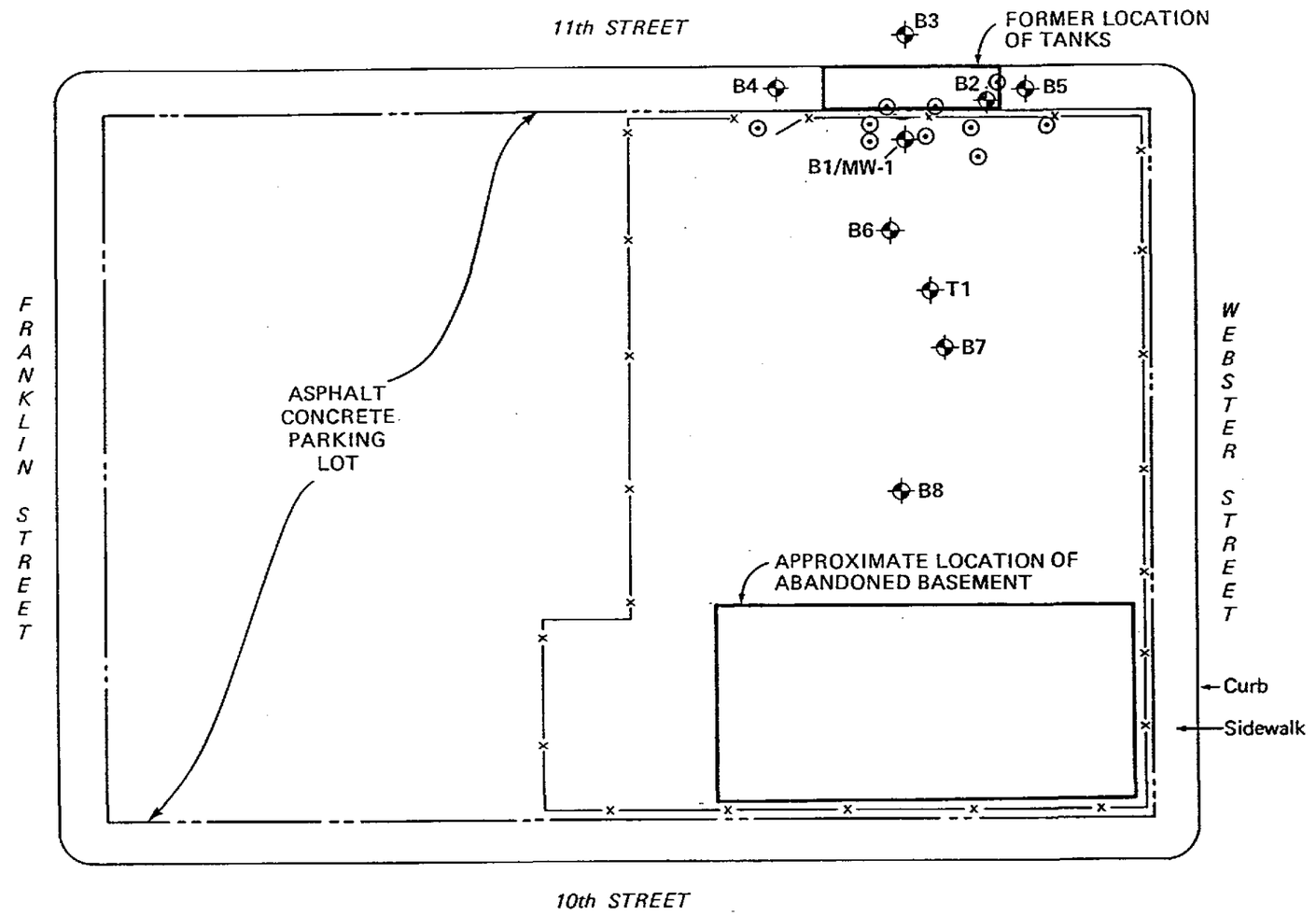
Harding Lawson Associates
Engineers and Geoscientists

Site Location Map
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE **1**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
CSN	9382,013.02		1/88		

1977



EXPLANATION

- Boring or Monitoring Well Location
- Soil Gas Probe Location
- Fence
- Property Line

N

0 40 80

SCALE IN FEET

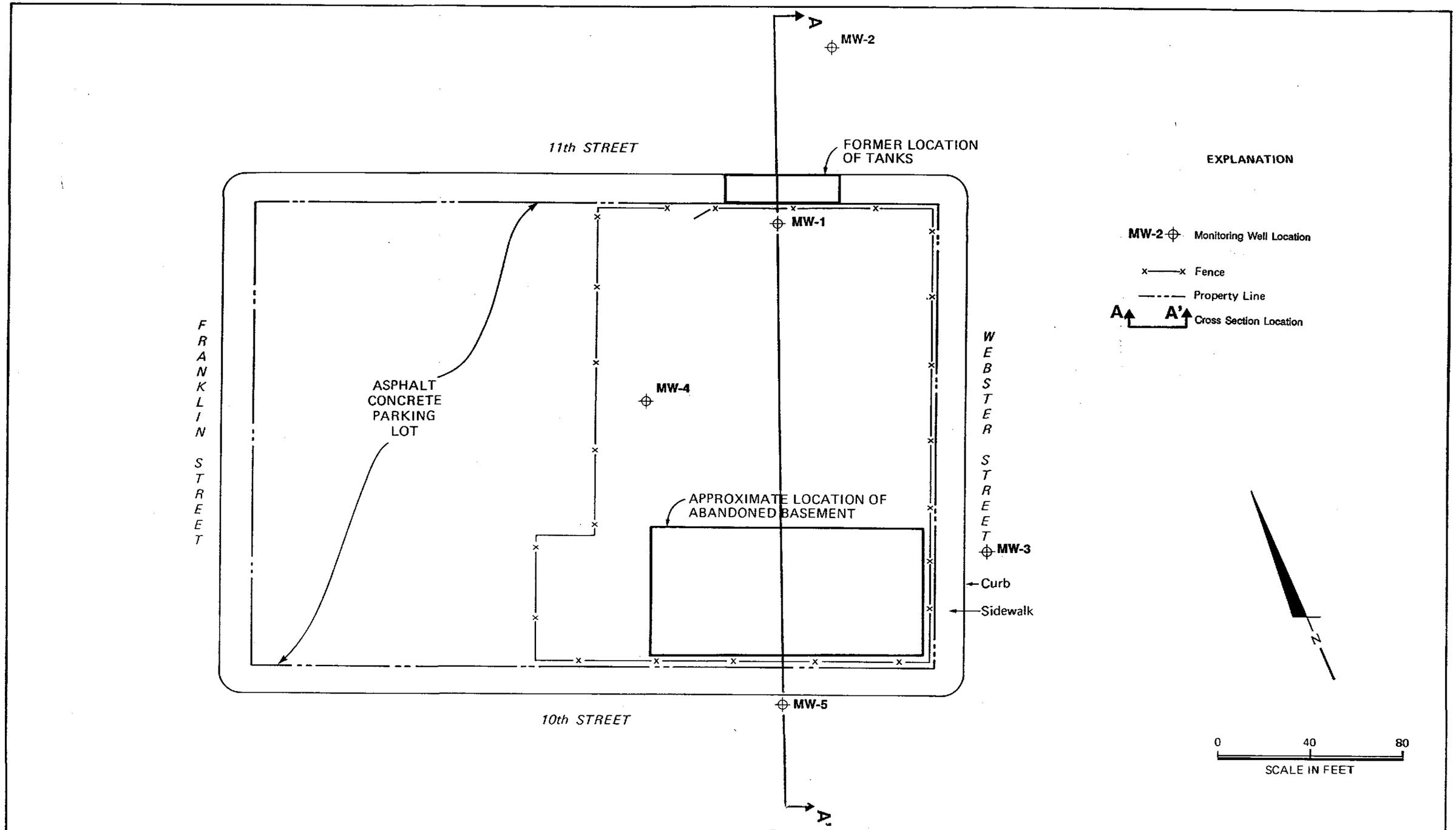
Harding Lawson Associates
Engineers, Geologists & Geophysicists

Site Plan, Previous Investigations
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE **2**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
CSN	9382,013.02		1/88		

1978

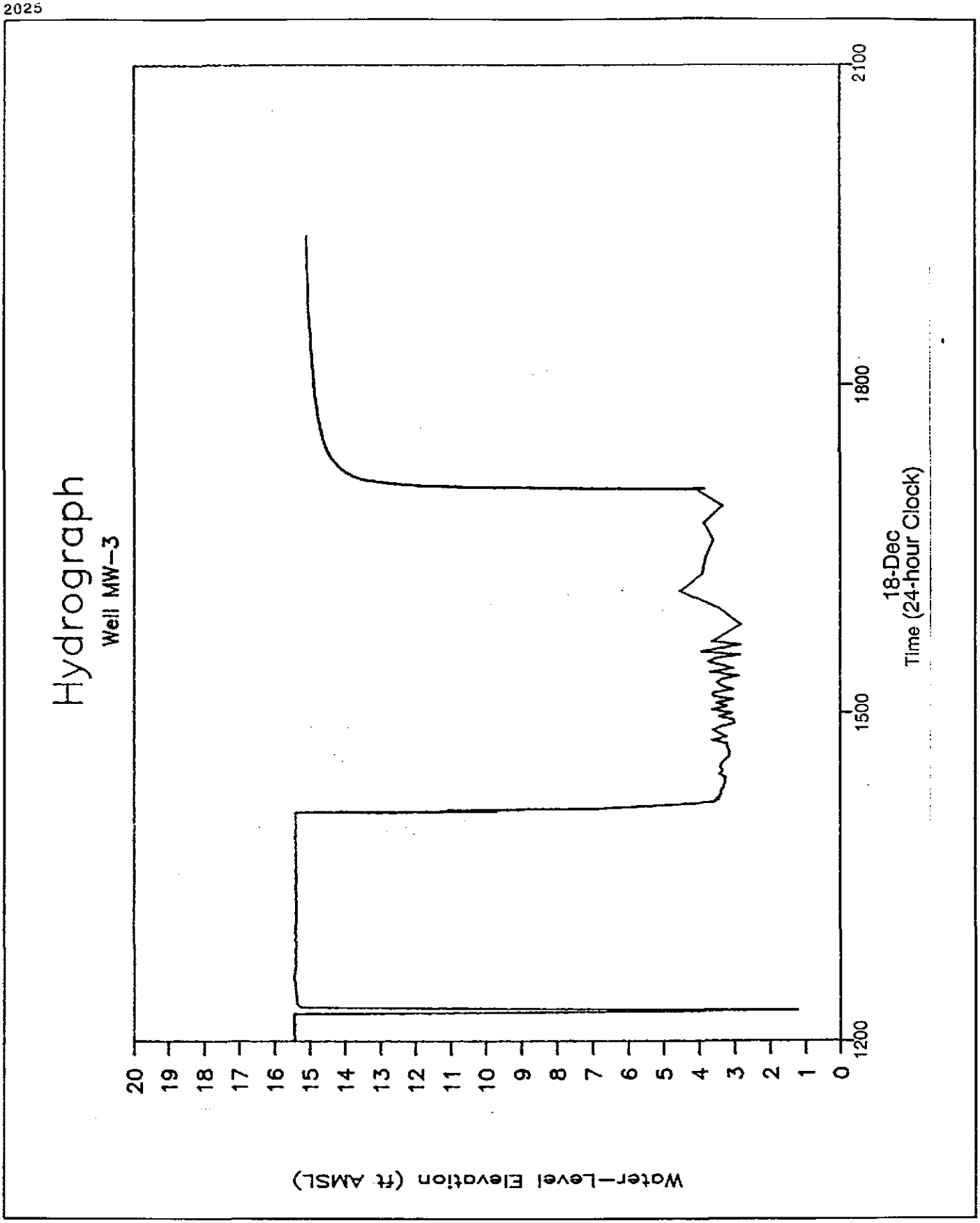


Harding Lawson Associates
Engineers, Geologists & Geophysicists

Monitoring Well Location Map
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE **3**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382,013.02		12/87		

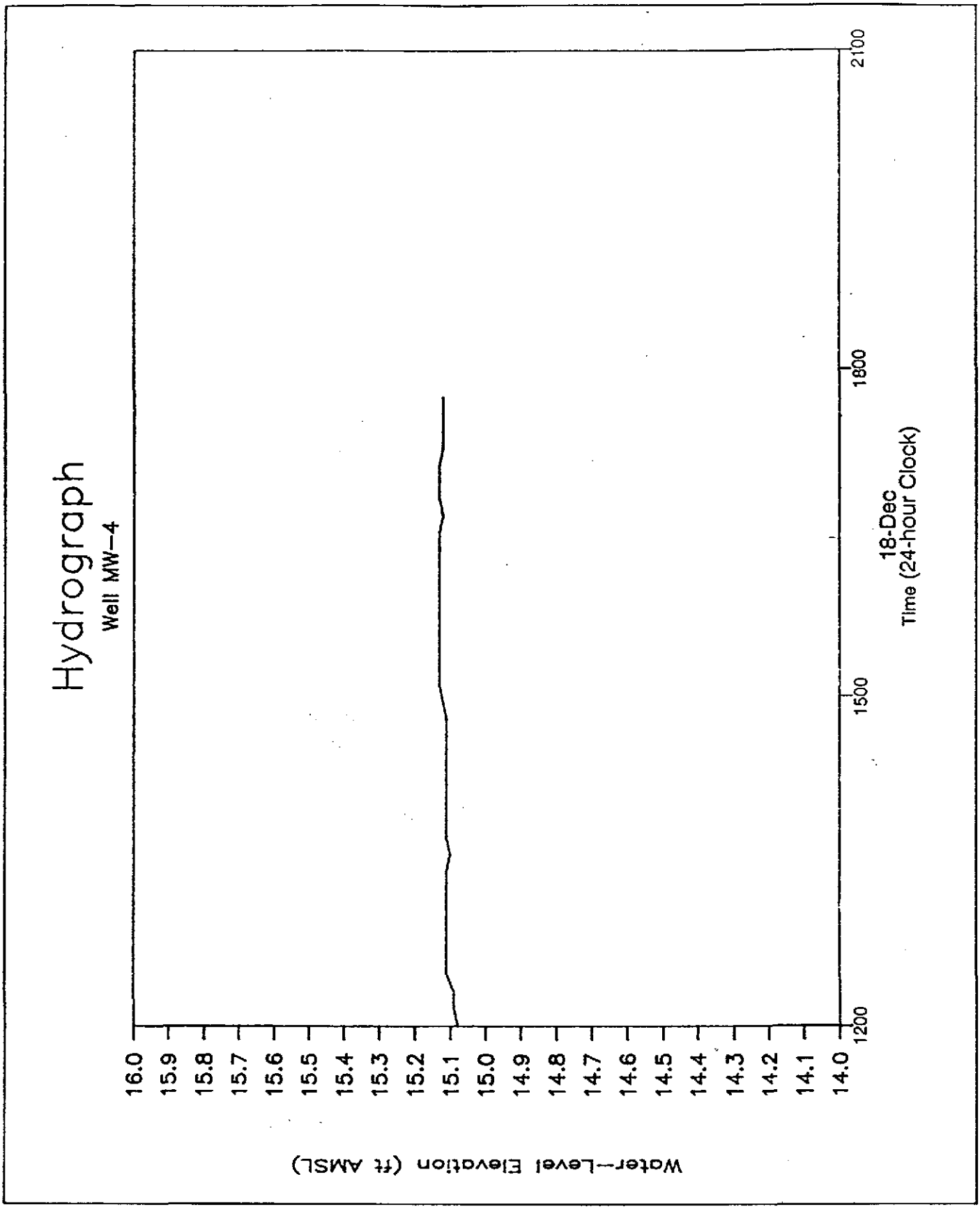


Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Hydrograph, Well MW-3
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE
4

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382,013.02		1/88		

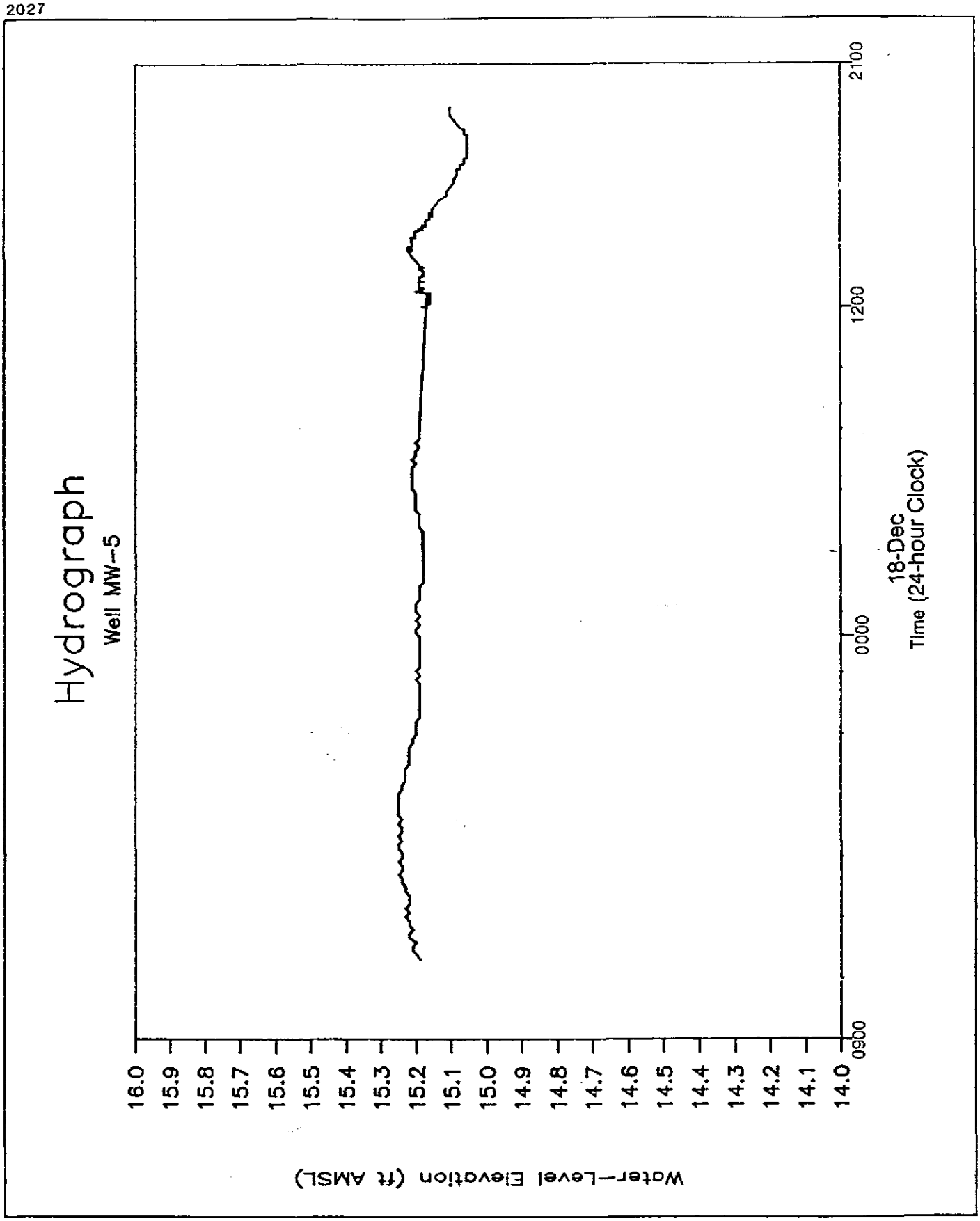


Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Hydrograph, Well MW-4
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE
5

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382,013.02		1/88		



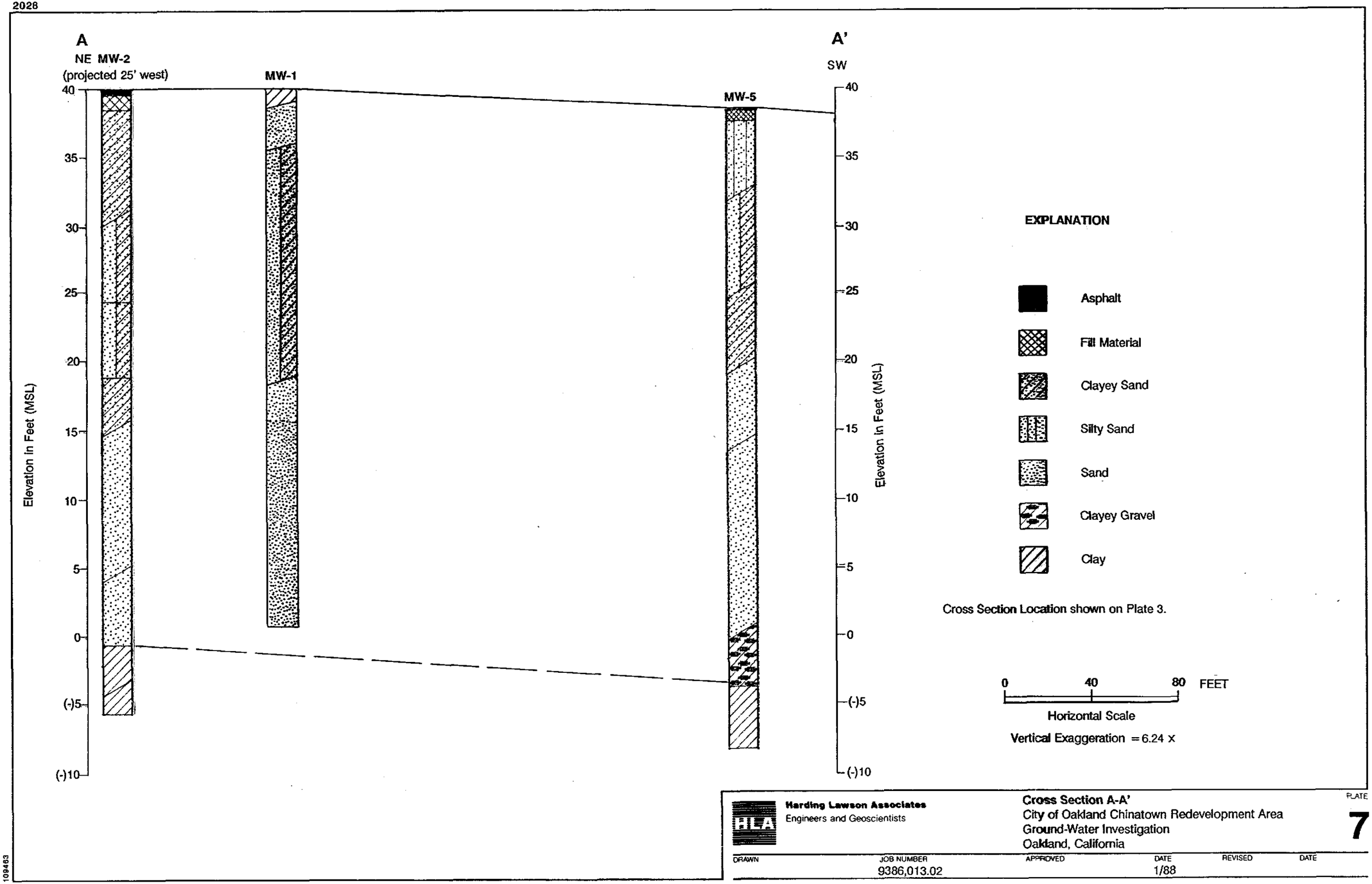
Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Hydrograph, Well MW-5
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE
6

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382,013.02		1/88		

2028



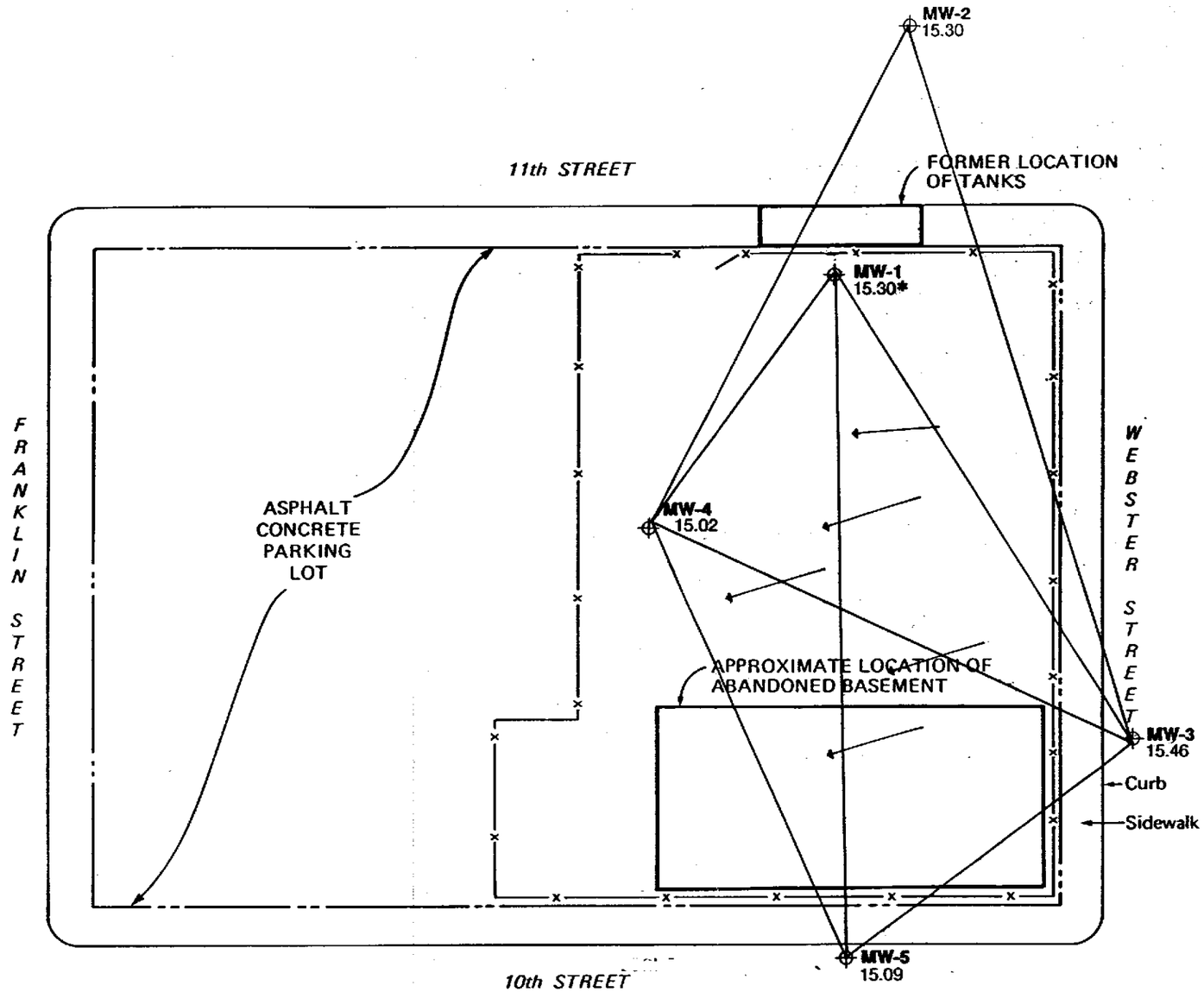
109463

Harding Lawson Associates
Engineers and Geoscientists

Cross Section A-A'
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE **7**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9386,013.02		1/88		



EXPLANATION

- MW-2 ⊕ Monitoring Well Location and Water-Level Elevation
- Fence
- Property Line
- Gradient triangle showing direction of ground-water flow
- Gradient Scale = 0.0037

N

0 40 80

SCALE IN FEET

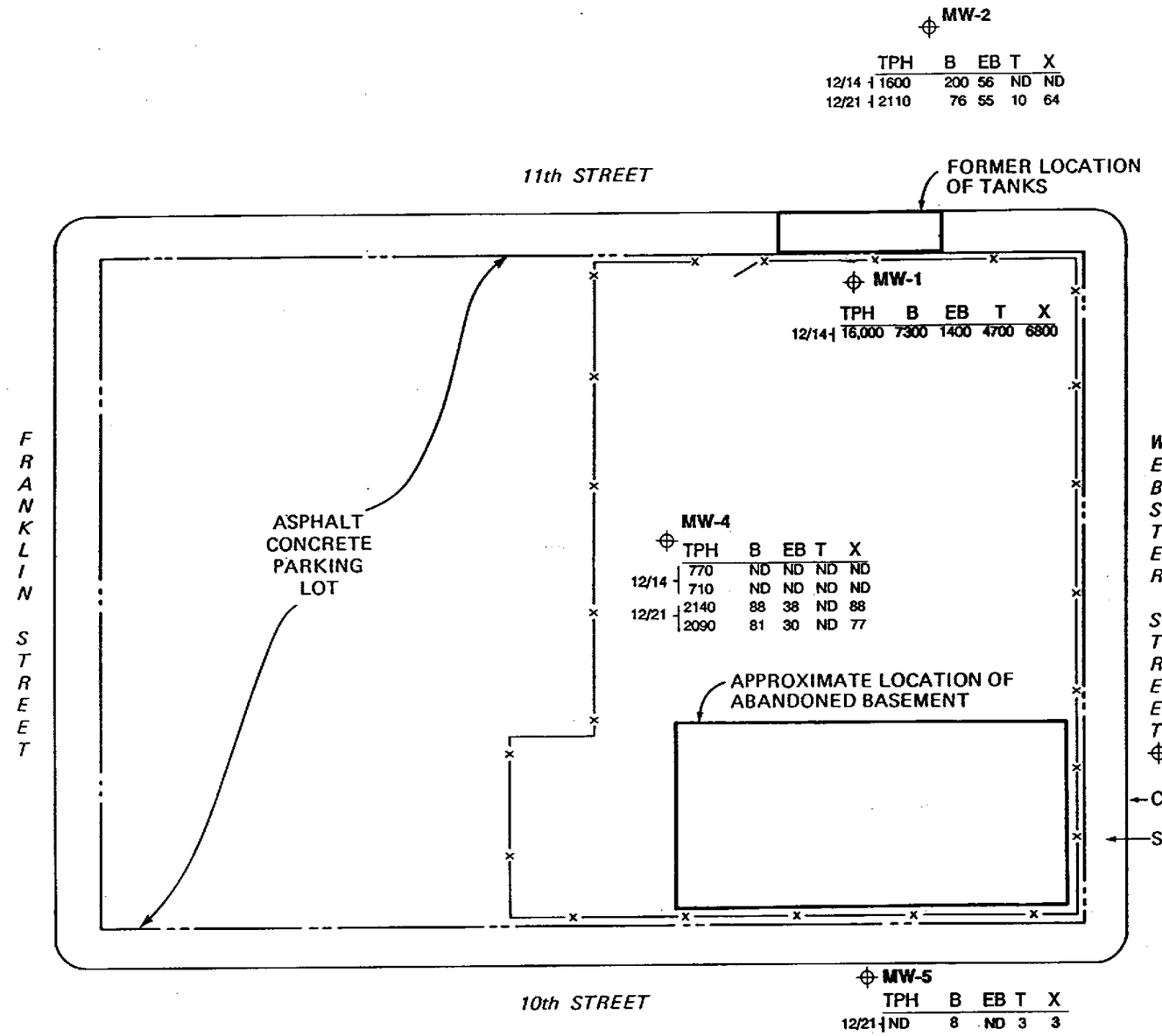
* Well inaccessible due to construction. Gradient calculated using an average of previous measurements.

Harding Lawson Associates
Engineers, Geologists & Geophysicists

Localized Hydraulic Gradient on 12/21/87
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

8

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382,013.02		12/87		



EXPLANATION

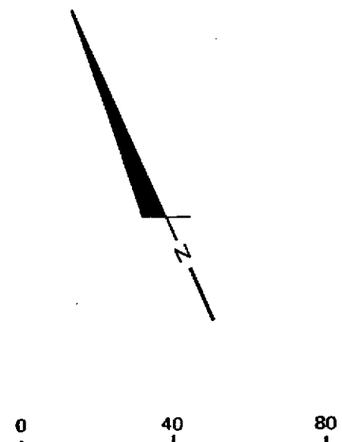
MW-2 ⊕ Monitoring Well Location

x——x Fence

—— - —— Property Line

TPH = Total Petroleum Hydrocarbons (as gasoline)
B = Benzene
EB = Ethylbenzene
T = Toluene
X = Xylenes
ND = Not Detected

Note: Concentrations given in parts per billion (ppb)



Harding Lawson Associates
Engineers, Geologists & Geophysicists

Ground-Water Chemistry Distribution
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE **9**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382,013.02		12/87		

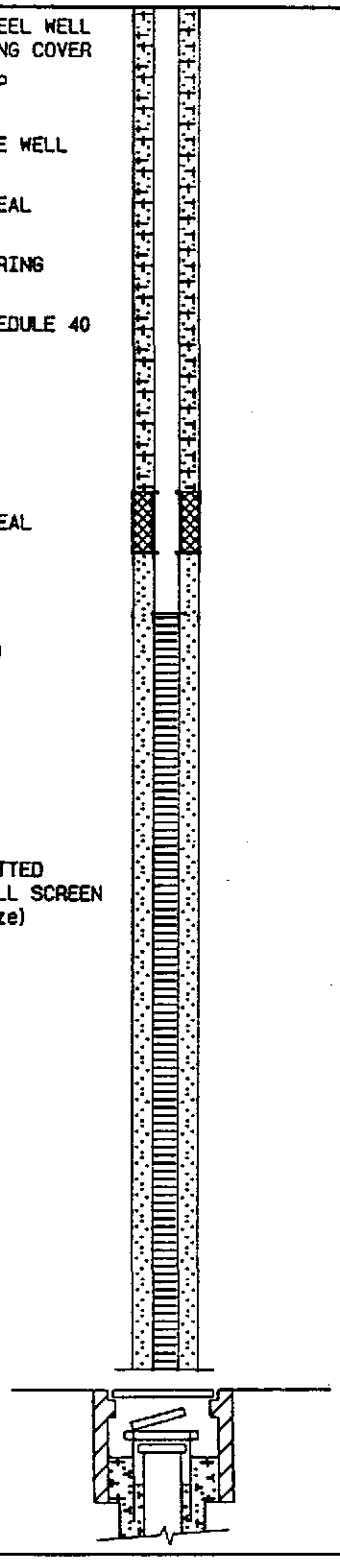
Appendix A

BORING LOGS AND WELL COMPLETION DIAGRAMS

Top of PVC Casing
Elevation 39.55 ft

GROUND SURFACE

See below for Well Top Detail



12 IN. DIAMETER STEEL WELL HOUSING WITH LOCKING COVER

WATERPROOF WELL CAP

REINFORCED CONCRETE WELL HOUSING ENCLOSURE

BENTONITE-CEMENT SEAL

12 IN. DIAMETER BORING

4 IN. DIAMETER SCHEDULE 40 PVC WELL CASING

BENTONITE PELLET SEAL

SAND FILTER PACK
(size: Monterey #3)

4 IN. DIAMETER SLOTTED SCHEDULE 40 PVC WELL SCREEN
(0.020 in. slot size)

BOTTOM CAP

Depth (ft) | Sample

Equipment CME 55 Hollow Stem Auger

Elevation 40.1 ft Date 12/8/87

0 — ASPHALT
ENGINEERED FILL
DARK YELLOWISH BROWN (10YR 4/4-6/5) CLAYEY SAND (SC) medium dense, moist, very fine grained

5

10 — DARK YELLOWISH BROWN (10YR 5/6) SAND WITH CLAY (SP-SC) dense, moist, very fine to fine grained

15 — OLIVE (5Y 4/2) SAND WITH CLAY (SP-SC) medium dense, moist, very fine to fine grained

20 — DARK YELLOWISH BROWN (10YR 5/6) CLAYEY SAND (SC) very dense, moist, very fine grained

25 — OLIVE (5Y 5/2-4/2) SAND (SP) dense, wet, fine grained ▽

30

35 — BROWN (10YR 4/3) SAND (SP) hard, poorly sorted, fine grained

40 — BROWN (10YR 5/3) SANDY CLAY (CL) with gravel, medium stiff, wet, fine sand and gravel

45 — OLIVE (5Y 4/3) CLAY WITH SILT (CL) moist

bottom of boring at 45.5 ft

50

Harding Lawson Associates
Engineers and Geoscientists

Log of Boring and Well Completion Detail MW-2
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE **A1**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382, 012.02		1/88		

Top of PVC Casing
Elevation 38.35 ft

GROUND SURFACE

See below for Well Top Detail

12 IN. DIAMETER STEEL WELL HOUSING WITH LOCKING COVER

WATERPROOF WELL CAP

REINFORCED CONCRETE WELL HOUSING ENCLOSURE

BENTONITE-CEMENT SEAL

11 IN. DIAMETER BORING

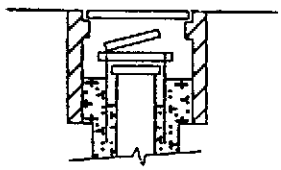
4 IN. DIAMETER SCHEDULE 40 PVC WELL CASING

BENTONITE PELLET SEAL

SAND FILTER PACK (size: Monterey #3)

4 IN. DIAMETER SLOTTED SCHEDULE 40 PVC WELL SCREEN (0.020 in. slot size)

BOTTOM CAP



Depth (ft) | Sample

Equipment CME 55 Hollow Stem Auger

Elevation 39.0 ft Date 12/10/87

0 — ASPHALT
ENGINEERED FILL
DARK YELLOWISH BROWN (10YR 4/4-5/6) SAND (SP) medium dense, poorly sorted, fine to very fine grained

5

DARK YELLOWISH BROWN (10YR 4/4) SAND WITH CLAY (SP-SC)

10

15 — DARK YELLOWISH BROWN (10YR 4/4) CLAYEY SAND (SC) medium dense, moist, very fine to fine grained

20 — BROWN (7.5Y 4/4) SILTY SAND (SM) hard, moist, very fine to fine grained

25 — OLIVE-GRAY (5Y 5/2) SAND (SP) hard, poorly sorted, wet, fine to very fine grained

30 — BROWN (7.5Y 4/4) SAND (SP) dense, poorly sorted, fine grained

35

40 — OLIVE (5Y 4/3) CLAY (CL) stiff

bottom of boring at 41.5 ft

45

50

Harding Lawson Associates
Engineers and Geoscientists

Log of Boring and Well Completion Detail MW-3
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

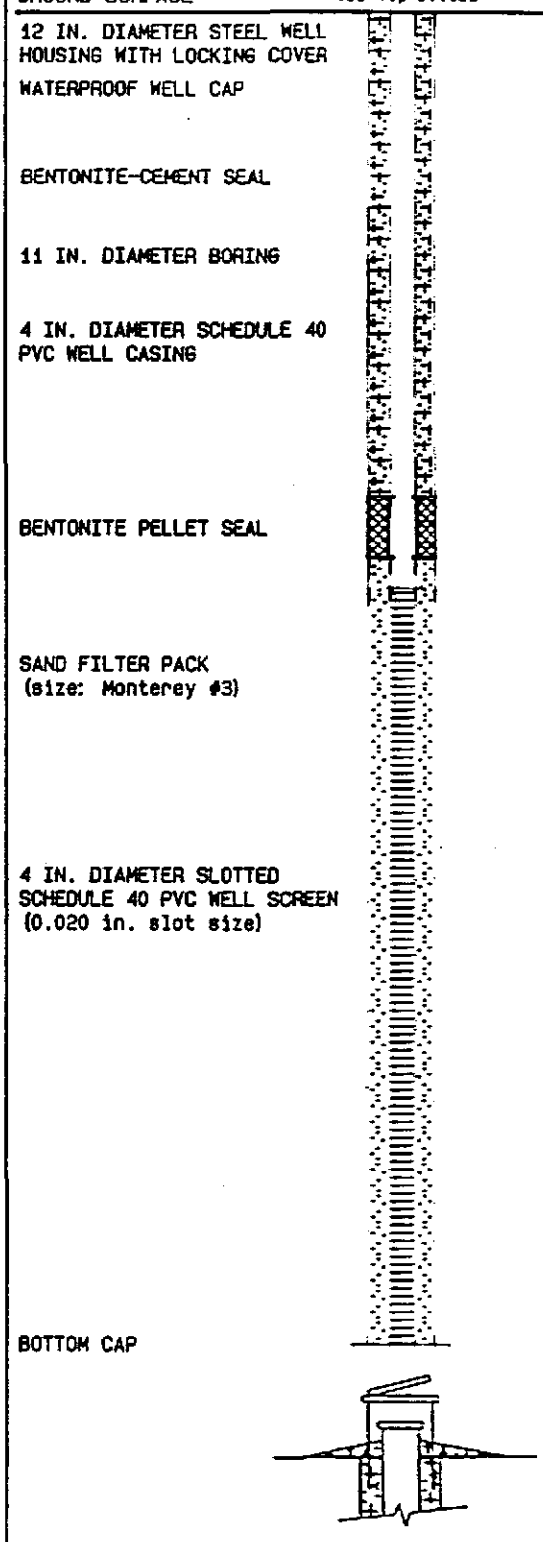
PLATE **A2**

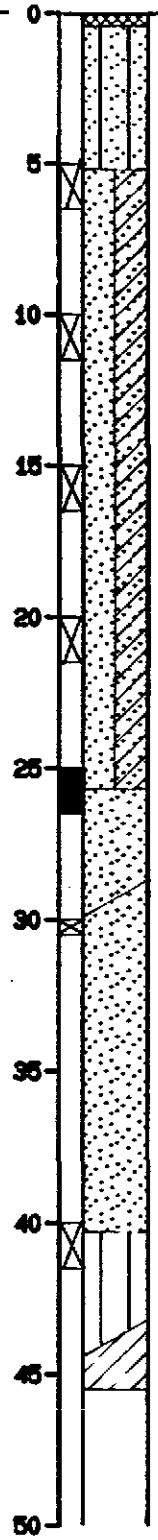
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382.012.02		1/88		

Top of PVC Casing
Elevation 41.71 ft

Equipment CME 55 Hollow Stem Auger

Elevation 40.4 ft Date 12/9/87





CONCRETE
DARK BROWN (10YR 3/3) SILTY SAND (SM) medium dense, very fine to fine grained

YELLOWISH BROWN (10YR 5/6) SAND WITH CLAY (SC-SP) medium dense, poorly sorted, very fine to fine grained

color change to BROWNISH YELLOW (10YR 6/6) medium dense, moist, very fine to fine grained

color change to YELLOWISH BROWN (10YR 5/4)

OLIVE-GRAY (5YR 5/2-4/2) SAND (SP) dense, poorly sorted fine grained
BROWN (10YR 5/3) SAND (SP) dense, poorly sorted

PALE OLIVE (5Y 6/3) SANDY SILT (ML) medium stiff, very fine grained

PALE OLIVE (5Y 6/3) CLAY WITH SILT (CL) stiff,
bottom of boring at 45.5 ft

Harding Lawson Associates
Engineers and Geoscientists

Log of Boring and Well Completion Detail MW-4
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE **A3**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382, 012.02		1/88		

Top of PVC Casing Elevation 37.86 ft

GROUND SURFACE

See below for Well Top Detail

12 IN. DIAMETER STEEL WELL HOUSING WITH LOCKING COVER

WATERPROOF WELL CAP

REINFORCED CONCRETE WELL HOUSING ENCLOSURE
BENTONITE-CEMENT SEAL

12 IN. DIAMETER BORING

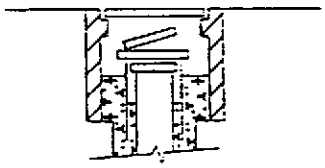
4 IN. DIAMETER SCHEDULE 40 PVC WELL CASING

BENTONITE PELLET SEAL

SAND FILTER PACK (size: Monterey #3)

4 IN. DIAMETER SLOTTED SCHEDULE 40 PVC WELL SCREEN (0.020 in. slot size)

BOTTOM CAP



Depth (ft) | Sample

Equipment CME 55 Hollow Stem Auger

Elevation 38.5 ft Date 12/12/87

0 — CONCRETE
DARK BROWN (10YR 3/3) SILTY SAND (SM) medium dense, moist

5 — YELLOWISH BROWN (10YR 5/6) SAND WITH CLAY (SP-SC) medium dense, poorly sorted

10

15 — DARK YELLOWISH BROWN (10YR 4/4) CLAYEY SAND (SC) medium dense

20 — BROWN (7.5YR 4/4) SAND (SP) poorly sorted, very fine to fine grained

25 — OLIVE-GRAY (5YR 5/2) SAND (SP) dense, poorly sorted

30 — color change to BROWN (2.5Y 4/4)

35

40 — BROWN (10YR 5/3) SANDY GRAVEL WITH CLAY (GC) hard

OLIVE (5Y 4/3) CLAY WITH SILT (CL) stiff

45 — bottom of boring at 46.5 ft

Boring extended from 42.0 to 46.5 ft using 7" diameter auger

50

Harding Lawson Associates
Engineers and Geoscientists

Log of Boring and Well Completion Detail MW-5
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE **A4**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382, 012.02		1/88		

MAJOR DIVISIONS					TYPICAL NAMES
COARSE-GRAINED SOILS MORE THAN HALF IS COARSER THAN NO. 200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN No. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW		WELL GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
			GP		POORLY GRADED GRAVELS WITH OR WITHOUT SAND, LITTLE OR NO FINES
		GRAVELS WITH OVER 12% FINES	GM		SILTY GRAVELS, SILTY GRAVELS WITH SAND
			GC		CLAYEY GRAVELS, CLAYEY GRAVELS WITH SAND
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW		WELL GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
			SP		POORLY GRADED SANDS WITH OR WITHOUT GRAVEL, LITTLE OR NO FINES
		SANDS WITH OVER 12% FINES	SM		SILTY SANDS WITH OR WITHOUT GRAVEL
			SC		CLAYEY SANDS WITH OR WITHOUT GRAVEL
FINE-GRAINED SOILS MORE THAN HALF IS FINER THAN NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50% OR LESS		ML		INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTS WITH SANDS AND GRAVELS
			CL		INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, CLAYS WITH SANDS AND GRAVELS, LEAN CLAYS
			OL		ORGANIC SILTS OR CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		MH		INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS, FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH		ORGANIC SILTS OR CLAYS OF MEDIUM TO HIGH PLASTICITY
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS

UNIFIED SOIL CLASSIFICATION - ASTM D2487-85

■ Undisturbed Sample

⊠ Bulk Sample

(10YR 3/3) Munsell Color Index

Harding Lawson Associates
Engineers and Geoscientists

Unified Soil Classification Chart
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE **A5**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9386,013.02		1/88		

Appendix B

DECONTAMINATION PROCEDURES

DECONTAMINATION PROCEDURES

Equipment Decontamination

All equipment that may come in contact with potentially contaminated soil, drilling fluid, or water is decontaminated prior to and after use. Decontamination consists of steam cleaning (high pressure, hot water rinse) or phosphate-free detergent wash, and deionized (DI) or clean water rinse as appropriate.

Drilling, sampling, aquifer testing and monitoring well installation equipment is decontaminated as follows:

1. Drill rigs, augers, drill rods, drill bits, mud tanks, and sand separators are steam-cleaned, prior to use at the site. Visible soil and grease are removed at this time.

2. Soil sampling equipment (e.g., split-barrel or standard penetration samplers, sampling tubes) is cleaned prior to use in each boring and between sampling. The sampler may be steam cleaned or washed in a phosphate-free detergent solution and rinsed in clean water. Visible soil is removed at this time. Wash solutions and rinse water are replaced prior to each boring.

3. Casing, screen, couplings, and caps used in monitoring well installation are steam-cleaned prior to installation. Visible foreign matter is removed at this time.

4. The exterior surfaces and accessible interior portions of submersible, centrifugal, and positive-displacement pumps are steamed-cleaned prior to each use or prior to each sampling round.

5. Bailers are steam-cleaned or washed in phosphate-free detergent solution and rinsed twice in clean water prior to each use. Rope or string (used with bailers or disposable sampling bottles) that has been in contact with the water in the well or boring is replaced after each sample collection.

6. Steel tapes, well sounders, transducers, and water quality probes are rinsed in distilled-deionized water or wiped clean after each use. Generally, only the wetted end of these devices requires cleaning.

DRAFT

Appendix C

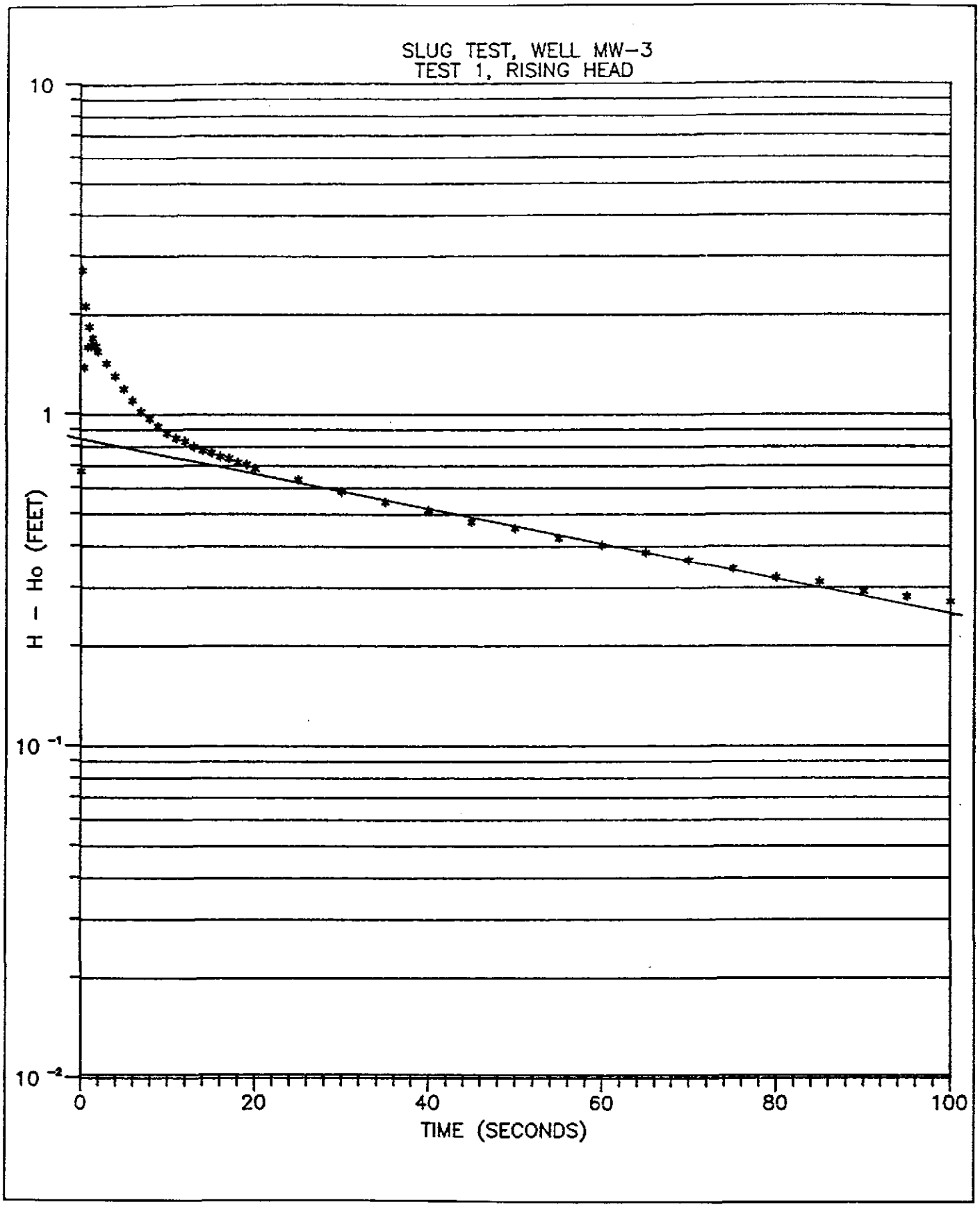
AQUIFER TEST DATA AND CALCULATION SHEETS

F2648-R
January 8, 1988

Appendix C

LIST OF ILLUSTRATIONS

LIST OF CALCULATION SHEETS

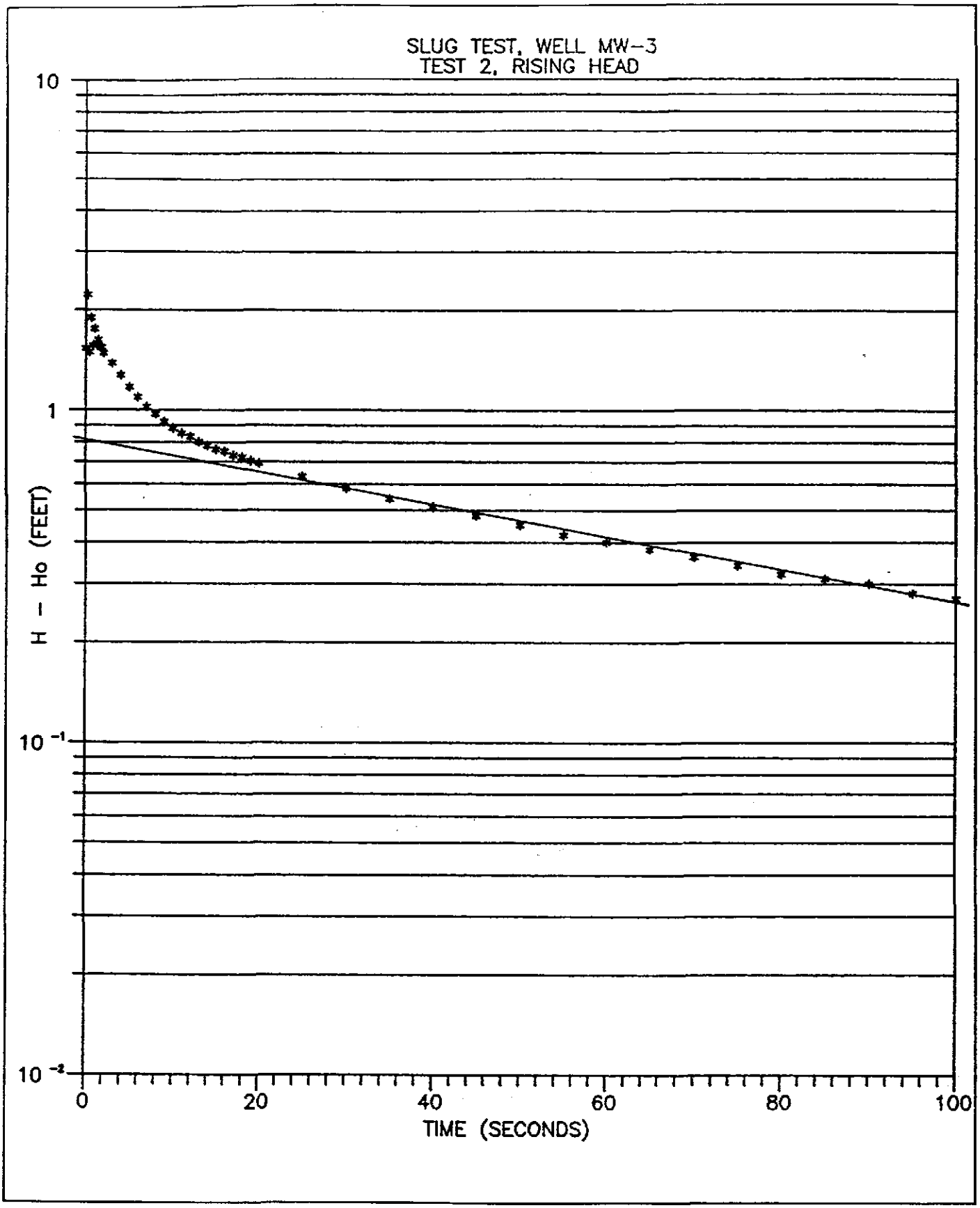


Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Rising Head Slug Test, Test 1, Well MW-3
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE
C1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382,013.02		1/88		

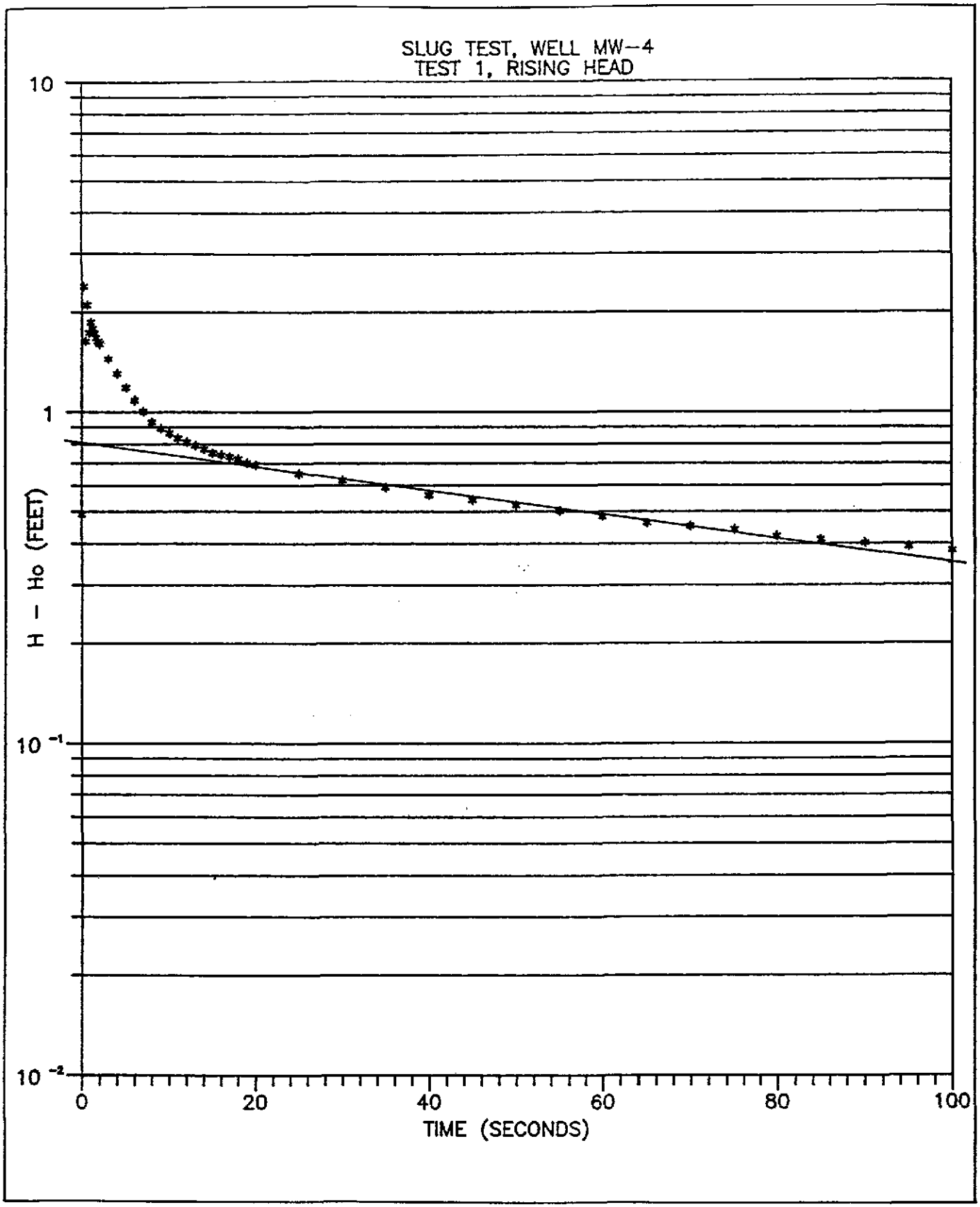


Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Rising Head Slug Test, Test 2, Well MW-3
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE
C2

DRAWN	JOB NUMBER	APPROVED	DATE	RELEASED	DATE
	9382,013.02		1/88		

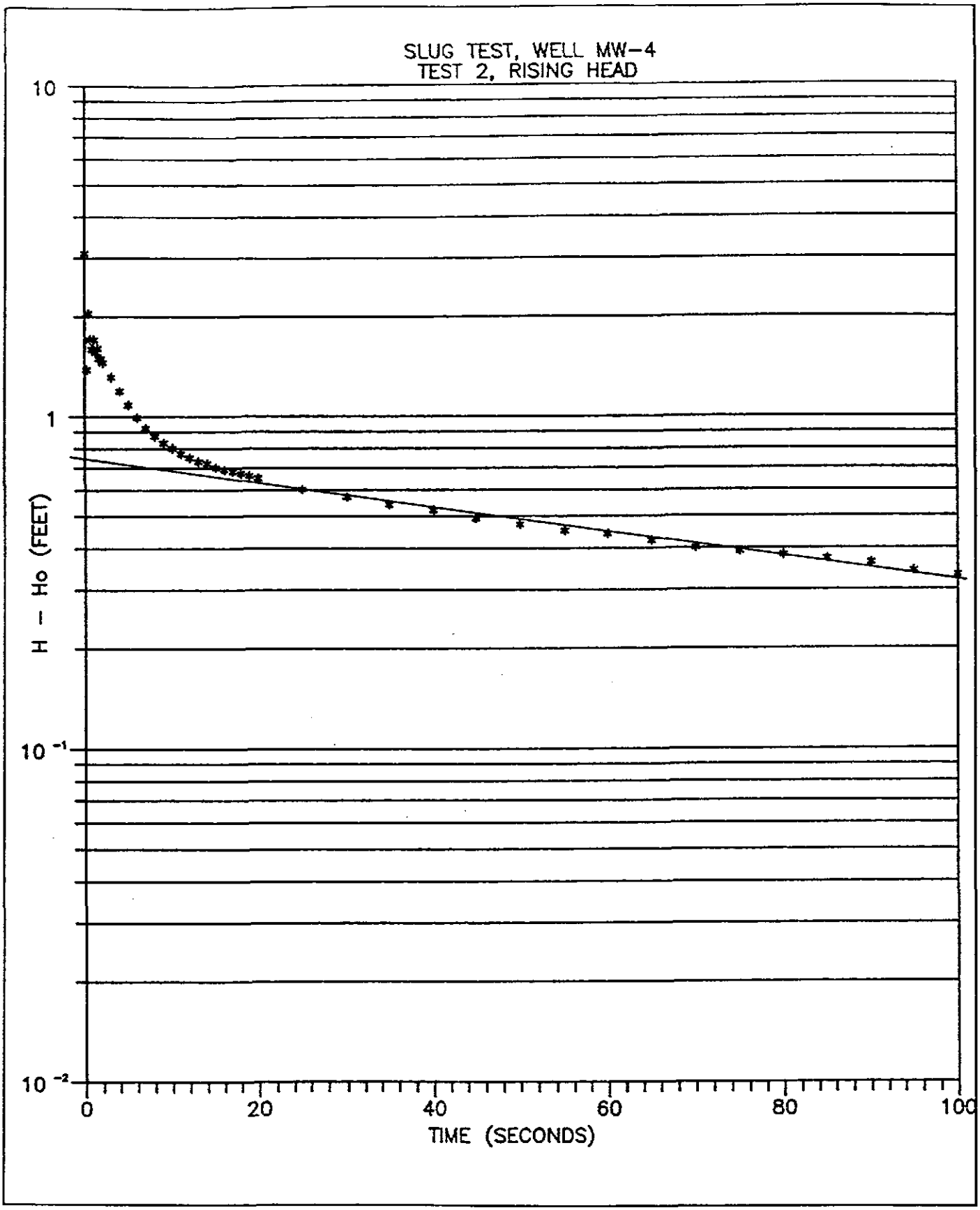


Harding Lawson Associates
Engineers Geologists
& Geophysicists

Rising Head Slug Test, Test 1, Well MW-4
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE
C3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382,013.02		1/88		



Harding Lawson Associates
Engineers, Geologists
& Geophysicists

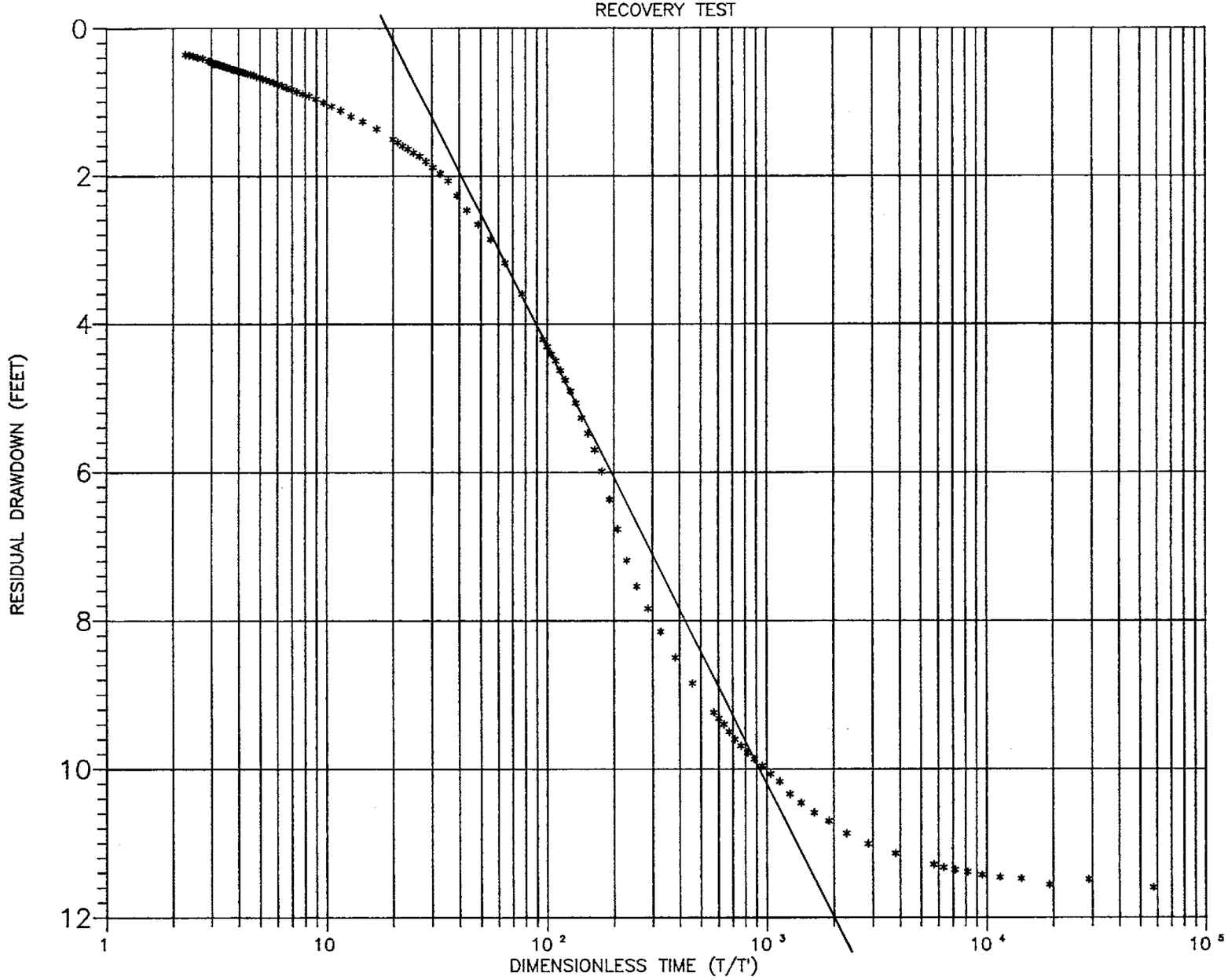
Rising Head Slug Test, Test 2, Well MW-4
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE
C4

DRAWN	JOB NUMBER	APPROVED	DATE	PE. SEO	DATE
	9382,013.02		1/88		

2040

MONITORING WELL MW-3
RECOVERY TEST



Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Residual Drawdown Versus Dimensionless Time
Well MW-3, Recovery Test
City of Oakland Chinatown Redevelopment Area
Ground-Water Investigation
Oakland, California

PLATE **C5**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9382,013.02		1/88		

Sheet C-1. Unconfined Aquifer Slug Test Method for Well MW-3, Test 1

Rising Head Test (Slug removed from well)

Method of Analysis: Bouwer and Rice (1976)

H	Hydraulic head above bottom of well screen	16.0 feet
L	Length of well screen through which water enters/exits well	16.0 feet
D	Saturated thickness of aquifer	16.0 feet
r	Radius of well casing	0.17 feet
r_w	Radius of wellbore	0.46 feet
ϕ	Porosity of gravel pack (assumed)	0.25 unitless
r_c	Effective radius of well casing (including porosity of gravel pack)	0.27 feet

$$r_c = [r^2 + \phi(r_w^2 - r^2)]^{1/2}$$

Calculation of $\ln R_e/r_w$:

$$\ln R_e/r_w = \frac{1}{\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}}$$

where: R_e = Effective radial distance in which the head change is dissipated

C = dimensionless parameter which is a function of L/r_w, determined from analog model studies conducted by Bouwer and Rice (1976)

C = 2.25 (unitless)

$$\ln R_e/r_w = \frac{1}{\frac{1.1}{\ln(16.0/0.46)} + \frac{2.25}{16.0/0.46}}$$

$$\ln R_e/r_w = 2.7$$

Sheet C-1. Unconfined Aquifer Slug Test Method for Well MW-3, Test 1
(Continued)

Rising Head Test (Slug removed from well)

HYDRAULIC CONDUCTIVITY (K)

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \quad \frac{1}{t} \quad \ln \frac{y_o}{y_t}$$

where: y_o = zero time y-axis intercept of linear portion of recovery data

y_o = 0.82 feet

y_t = y-axis intercept at time (t) of linear portion of recovery data

y_t = 0.25 feet

t = 100 seconds

$$K = \frac{(0.27)^2 (2.7)}{2(16.0)} \quad \frac{1}{100} \quad \ln \frac{0.82}{0.25}$$

$K = 7.3 \times 10^{-5}$ ft/second

$K = 4.4 \times 10^{-3}$ ft/minute

K = 6.3 ft/day

Sheet C-2. Unconfined Aquifer Slug Test Method for Well MW-3, Test 2

Rising Head Test (Slug removed from well)

Method of Analysis: Bouwer and Rice (1976)

H	Hydraulic head above bottom of well screen	16.0 feet
L	Length of well screen through which water enters/exits well	16.0 feet
D	Saturated thickness of aquifer	16.0 feet
r	Radius of well casing	0.17 feet
r_w	Radius of wellbore	0.46 feet
ϕ	Porosity of gravel pack (assumed)	0.25 unitless
r_c	Effective radius of well casing (including porosity of gravel pack)	0.27 feet

$$r_c = [r^2 + \phi(r_w^2 - r^2)]^{1/2}$$

Calculation of $\ln R_e/r_w$:

$$\ln R_e/r_w = \frac{1}{\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}}$$

where: R_e = Effective radial distance in which the head change is dissipated

C = dimensionless parameter which is a function of L/r_w, determined from analog model studies conducted by Bouwer and Rice (1976)

C = 2.25 (unitless)

$$\ln R_e/r_w = \frac{1}{\frac{1.1}{\ln(16.0/0.46)} + \frac{2.25}{16.0/0.46}}$$

$$\ln R_e/r_w = 2.7$$

Sheet C-2. Unconfined Aquifer Slug Test Method for Well MW-3, Test 2
(Continued)

Rising Head Test (Slug removed from well)

HYDRAULIC CONDUCTIVITY (K)

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \quad \frac{1}{t} \quad \ln \quad \frac{y_o}{y_t}$$

where: y_o = zero time y-axis intercept of linear portion of recovery data

y_o = 0.81 feet

y_t = y-axis intercept at time (t) of linear portion of recovery data

y_t = 0.27 feet

t = 100 seconds

$$K = \frac{(0.27)^2 (2.7)}{2(16.0)} \quad \frac{1}{100} \quad \ln \quad \frac{0.81}{0.27}$$

$K = 6.8 \times 10^{-5}$ ft/second

$K = 4.1 \times 10^{-3}$ ft/minute

K = 5.8 ft/day

Sheet C-3. Unconfined Aquifer Slug Test Method for Well MW-4, Test 1

Rising Head Test (Slug removed from well)

Method of Analysis: Bouwer and Rice (1976)

H	Hydraulic head above bottom of well screen	15.0 feet
L	Length of well screen through which water enters/exits well	15.0 feet
D	Saturated thickness of aquifer	15.0 feet
r	Radius of well casing	0.17 feet
r_w	Radius of wellbore	0.46 feet
ϕ	Porosity of gravel pack (assumed)	0.25 unitless
r_c	Effective radius of well casing (including porosity of gravel pack)	0.27 feet

$$r_c = [r^2 + \phi(r_w^2 - r^2)]^{1/2}$$

Calculation of $\ln R_e/r_w$:

$$\ln R_e/r_w = \frac{1}{\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}}$$

where: R_e = Effective radial distance in which the head change is dissipated

C = dimensionless parameter which is a function of L/r_w, determined from analog model studies conducted by Bouwer and Rice (1976)

C = 2.20 (unitless)

$$\ln R_e/r_w = \frac{1}{\frac{1.1}{\ln(15.0/0.46)} + \frac{2.20}{15.0/0.46}}$$

$\ln R_e/r_w$ = 2.6

Sheet C-3. Unconfined Aquifer Slug Test Method for Well MW-4, Test 1
(Continued)

Rising Head Test (Slug removed from well)

HYDRAULIC CONDUCTIVITY (K)

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \quad \frac{1}{t} \quad \ln \quad \frac{y_o}{y_t}$$

where: y_o = zero time y-axis intercept of linear portion of recovery data

y_o = 0.80 feet

y_t = y-axis intercept at time (t) of linear portion of recovery data

y_t = 0.35 feet

t = 100 seconds

$$K = \frac{(0.27)^2 (2.6)}{2(15.0)} \quad \frac{1}{100} \quad \ln \quad \frac{0.80}{0.35}$$

$K = 5.2 \times 10^{-5}$ ft/second

$K = 3.1 \times 10^{-3}$ ft/minute

K = 4.5 ft/day

Sheet C-4. Unconfined Aquifer Slug Test Method for Well MW-4, Test 2

Rising Head Test (Slug removed from well)

Method of Analysis: Bouwer and Rice (1976)

H	Hydraulic head above bottom of well screen	15.0 feet
L	Length of well screen through which water enters/exits well	15.0 feet
D	Saturated thickness of aquifer	15.0 feet
r	Radius of well casing	0.17 feet
r_w	Radius of wellbore	0.46 feet
ϕ	Porosity of gravel pack (assumed)	0.25 unitless
r_c	Effective radius of well casing (including porosity of gravel pack)	0.27 feet

$$r_c = [r^2 + \phi(r_w^2 - r^2)]^{1/2}$$

Calculation of $\ln R_e/r_w$:

$$\ln R_e/r_w = \frac{1}{\frac{1.1}{\ln(H/r_w)} + \frac{C}{L/r_w}}$$

where: R_e = Effective radial distance in which the head change is dissipated

C = dimensionless parameter which is a function of L/r_w, determined from analog model studies conducted by Bouwer and Rice (1976)

C = 2.20 (unitless)

$$\ln R_e/r_w = \frac{1}{\frac{1.1}{\ln(15.0/0.46)} + \frac{2.20}{15.0/0.46}}$$

$$\ln R_e/r_w = 2.6$$

Sheet C-4. Unconfined Aquifer Slug Test Method for Well MW-4, Test 2
(Continued)

Rising Head Test (Slug removed from well)

HYDRAULIC CONDUCTIVITY (K)

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \quad \frac{1}{t} \quad \ln \frac{y_o}{y_t}$$

where: y_o = zero time y-axis intercept of linear portion of recovery data

y_o = 0.74 feet

y_t = y-axis intercept at time (t) of linear portion of recovery data

y_t = 0.32 feet

t = 100 seconds

$$K = \frac{(0.27)^2 (2.6)}{2(15.0)} \quad \frac{1}{100} \quad \ln \frac{0.74}{0.32}$$

$K = 5.3 \times 10^{-5}$ ft/second

$K = 3.2 \times 10^{-3}$ ft/minute

K = 4.6 ft/day

Sheet C-5. Residual Drawdown Method for Well MW-3

PUMPED WELL MW-3

OBSERVATION WELL MW-3 RECOVERY

Method of Analysis: Residual Drawdown (Theis, 1935)

Q	Average discharge rate	5.7	gpm = 0.76 ft^3/min
Δs	Change in recovery per one log cycle	5.85	feet
b	Aquifer thickness	16.0	feet

TRANSMISSIVITY (T)

$T = (2.303\ Q)/\ 4\pi\ \Delta s$

$T = 2.303\ (0.76)\ /\ 4\pi\ (5.85)$

$T = 2.4 \times 10^{-2}\ ft^2/min = 35\ ft^2/day$

HYDRAULIC CONDUCTIVITY (K)

$K = T/b$

$K = 2.4 \times 10^{-2}/16.0 = 1.5 \times 10^{-3}\ ft/min$

$= 2.2\ ft/day$

LABORATORY CERTIFICATE

Curtis & Tompkins, Ltd., Analytical Laboratories Since 1878
290 Division Street, San Francisco, CA 94103, Phone (415) 861-1863

Laboratory No. 13923
Preliminary No.

Reported > 12/21/87
Sampled
Received > 12/11/87

For > HARDING LAWSON ASSOCIATES

Report on > 3 Soil Samples

Mark > Job Location: City of Oakland
HLA Job Number: 9382,012.02

See Attached Results

Laboratory Director

Curtis & Tompkins, Ltd.

LABORATORY NUMBER: 13923-2
CLIENT: Harding Lawson Associates
SAMPLE ID: MW-2 26'0"-26'5"
HLA Job #: 9382,012.02 City of Oakland

DATE RECEIVED: 12/11/87
DATE ANALYZED: 12/17/87
DATE REPORTED: 12/21/87

EPA 8020: Volatile Aromatic Hydrocarbons in Soils & Wastes
Extraction Method: EPA 5030 - Purge & Trap

COMPOUND	Result ug/Kg	LOD ug/Kg
Benzene	ND	1000
Toluene	ND	5000
Ethyl Benzene	ND	1000
Total Xylenes	ND	1000
Chlorobenzene	ND	1000
1,4-Dichlorobenzene	ND	1000
1,3-Dichlorobenzene	ND	1000
1,2-Dichlorobenzene	ND	1000

ND = None Detected. Limit of detection (LOD) in last column.

QA/QC:

Duplicate: Relative % Difference	6
Average Spike Recovery %	99

Curtis & Tompkins, Ltd.

LABORATORY NUMBER: 13923-4
CLIENT: Harding Lawson Associates
SAMPLE ID: MW-4 26'0"-26'5"
HLA Job #: 9382,012.02 City of Oakland

DATE RECEIVED: 12/11/87
DATE ANALYZED: 12/17/87
DATE REPORTED: 12/21/87

EPA 8020: Volatile Aromatic Hydrocarbons in Soils & Wastes
Extraction Method: EPA 5030 - Purge & Trap

COMPOUND	Result ug/Kg	LOD ug/Kg
Benzene	ND	1
Toluene	ND	5
Ethyl Benzene	ND	1
Total Xylenes	ND	1
Chlorobenzene	ND	1
1,4-Dichlorobenzene	ND	1
1,3-Dichlorobenzene	ND	1
1,2-Dichlorobenzene	ND	1

ND = None Detected. Limit of detection (LOD) in last column.

QA/QC:

Duplicate: Relative % Difference	7
Average Spike Recovery %	102

Curtis & Tompkins, Ltd.

LABORATORY NUMBER: 13923-5
CLIENT: Harding Lawson Associates
SAMPLE ID: MW-3 27'5"-28'0"
HLA Job #: 9382,012.02 City of Oakland

DATE RECEIVED: 12/11/87
DATE ANALYZED: 12/17/87
DATE REPORTED: 12/21/87

EPA 8020: Volatile Aromatic Hydrocarbons in Soils & Wastes
Extraction Method: EPA 5030 - Purge & Trap

COMPOUND	Result ug/Kg	LOD ug/Kg
Benzene	ND	1
Toluene	ND	5
Ethyl Benzene	ND	1
Total Xylenes	ND	1
Chlorobenzene	ND	1
1,4-Dichlorobenzene	ND	1
1,3-Dichlorobenzene	ND	1
1,2-Dichlorobenzene	ND	1

ND = None Detected. Limit of detection (LOD) in last column.

QA/QC:

Duplicate: Relative % Difference	7
Average Spike Recovery %	102

LABORATORY CERTIFICATE

Curtis & Tompkins, Ltd., Analytical Laboratories, Since 1878
290 Division Street, San Francisco, CA 94103, Phone (415) 861-1863

Laboratory No. > 13945
Preliminary No.

Reported > 12/21/87
Sampled
Received > 12/16/87

For > HARDING LAWSON ASSOCIATES

Report on > 1 Soil Sample

Mark > Job Location: City of Oakland
HLA Job Number: 9382,012.02

See Attached Results

Laboratory Director

Curtis & Tompkins, Ltd.

LAB NUMBER: 13945
CLIENT: Harding Lawson Associates
HLA Job #: 9382,012.02 City of Oakland

DATE RECEIVED: 12/16/87
DATE ANALYZED: 12/17/87
DATE REPORTED: 12/21/87

Results of Analysis for Petroleum Hydrocarbons in Soils & Wastes

Method References: TPH: Total Petroleum Hydrocarbons, EPA 3550/8015

LAB ID	HLA ID	GASOLINE (mg/kg)	KEROSINE (mg/kg)	DIESEL (mg/kg)	OTHER (mg/kg)
13945-1	MW-5 25'5"-26'0"	ND(10)	ND(10)	ND(10)	ND(10)

ND = Not Detected; Limit of detection in parentheses.

QA/QC SUMMARY

Duplicate: Relative % Difference	<1
Spike: % Recovery	109

Curtis & Tompkins, Ltd.

LABORATORY NUMBER: 13945-1
CLIENT: Harding Lawson Associates
SAMPLE ID: MW-5 25'5"-26'0"
HLA Job #: 9382,012.02 City of Oakland

DATE RECEIVED: 12/16/87
DATE ANALYZED: 12/17/87
DATE REPORTED: 12/21/87

EPA 8020: Volatile Aromatic Hydrocarbons in Soils & Wastes
Extraction Method: EPA 5030 - Purge & Trap

COMPOUND	Result ug/Kg	LOD ug/Kg
Benzene	ND	5
Toluene	ND	5
Ethyl Benzene	ND	5
Total Xylenes	ND	5
Chlorobenzene	ND	5
1,4-Dichlorobenzene	ND	5
1,3-Dichlorobenzene	ND	5
1,2-Dichlorobenzene	ND	5

ND = None Detected. Limit of detection (LOD) in last column.

QA/QC:

Duplicate: Relative % Difference	7
Average Spike Recovery %	102

Harding Lawson Associates
7655 Redwood Blvd.
P.O. Box 578
Novato, CA 94948
(415) 892-0821

CHAIN OF CUSTODY FORM

Samplers: Peggy Llewellyn
Job Number: 9382,012.02
Name/Location: City of Oakland
Project Manager: Janet Peters
Recorder: Peggy Llewellyn (Signature Required)

SOURCE CODE	MATRIX: Water	Sediment	Soil	Oil	#CONTAINERS & PRESERV.: Unpres.	H_2SO_4	HNO_3	SAMPLE NUMBER OR LAB NUMBER: Yr	Wk	Seq	DATE: Yr	Mo	Dy	Time	STATION DESCRIPTION/ NOTES	ANALYSIS REQUESTED: EPA 601/8010	EPA 602/8020	EPA 624/8240	EPA 625/8270	Priority Pllntnt. Metals	Benzene/Toluene/Xylene	Total Petrol. Hydrocarb.	Hold
2				X	1			8	1	12	87	12	08		MW-2 25^{S} -26^{D}							X	
					1			8	1	12	87	12	08		MW-2 26^{D} -26^{S}					X	X		
					1			8	1	12	87	12	08		MW-4 25^{S} -26^{D}							X	
					1			8	1	12	87	12	09		MW-1 26^{D}- 26^{S}					X	X		
					1						87	12	10		MW-3 27^{S} -28^{D}					X	X		
					1						87	12	10		MW-3 28^{D} -28^{S}							X	

LAB NUMBER: Yr	Wk	Seq	DEPTH IN FEET	COL MTD CD	QA CODE	MISCELLANEOUS

Curtis & Thompkins
CHAIN OF CUSTODY RECORD

RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
Peggy Llewellyn		
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
DISPATCHED BY: (Signature) DATE/TIME	RECEIVED FOR LAB BY: (Signature)	DATE/TIME 12/10/87
METHOD OF SHIPMENT		

Laboratory Copy White Project Office Copy Yellow Field or Office Copy Pink

6533

P.O. Box 578
Novato, CA 94948
(415) 892-0821

Job Number: 4382.012.02
Name/Location: City of Oakland
Project Manager: Janet Tatum

Samplers: Peggy Hewellyn
Recorder: Peggy Hewellyn (Signature Required)

SOURCE CODE	MATRIX: Water	Sediment	Soil	Oil	#CONTAINERS & PRESERV.: Unpres.	H_2SO_4	HNO_3	SAMPLE NUMBER OR LAB NUMBER: Yr	Wk	Seq	DATE: Yr	Mo	Dy	Time	STATION DESCRIPTION/ NOTES	ANALYSIS REQUESTED: EPA 601/8010	EPA 602/8020	EPA 624/8240	EPA 625/8270	Priority Pllnt. Metals	Benzene/Toluene/Xylene	Total Petrol. Hydrocarb.	TPH-D
00			X		1			86	12	12	87	12	12	0900	MW-5 25'-26'						X	X	
			X		1						87	12	12	0910	MW-5 26'-26.5'								X

LAB NUMBER: Yr	Wk	Seq	DEPTH IN FEET	COL MTD CD	QA CODE	MISCELLANEOUS

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
Peggy Hewellyn		12-15-87 1530
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
DISPATCHED BY: (Signature) DATE/TIME	RECEIVED FOR LAB BY: (Signature)	DATE/TIME 12/16/87 849
METHOD OF SHIPMENT		

Laboratory Copy White | Project Office Copy Yellow | Field or Office Copy Pink

653

Curtis & Tompkins, Ltd.

LAB NUMBER: 13940
CLIENT: Harding Lawson Associates
HLA Job #: 9382,012.02 City of Oakland

DATE RECEIVED: 12/15/87
DATE ANALYZED: 12/15/87
DATE REPORTED: 12/21/87

Dissolved Lead in Water by EPA Method 7420

LAB ID	HLA ID	RESULT (mg/L)	DETECTION LIMIT (mg/L)
13940-1	87121401 Well MW-2	ND	0.10
13940-3	87121404 Well MW-4	ND	0.10
13940-4	87121405 Well MW-4 (Duplicate)	ND	0.10
13940-5	87121406 Well MW-1	ND	0.10
13940-6	87121407 Trip Blank	ND	0.10

QA/QC SUMMARY:

Relative % Difference	<1
Average Spike Recovery %	101

Curtis & Tompkins, Ltd.

LAB NUMBER: 13940
CLIENT: Harding Lawson Associates
HLA Job #: 9382,012.02 City of Oakland

DATE RECEIVED: 12/15/87
DATE ANALYZED: 12/16/87
DATE REPORTED: 12/21/87

Results of Analysis for Petroleum Hydrocarbons in Water

Method References: TPH: Total Petroleum Hydrocarbons, EPA 3550/8015

LAB ID	HLA ID	GASOLINE (mg/L)	KEROSINE (mg/L)	DIESEL (mg/L)	OTHER * (mg/L)	
13940-1	87121401	ND(0.05)	ND(0.05)	ND(0.05)	1.6	MW-2
13940-2	87121403	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	MW-3
13940-3	87121404	ND(0.05)	ND(0.05)	ND(0.05)	0.77	MW-4
13940-4	87121405	ND(0.05)	ND(0.05)	ND(0.05)	0.71	MW-4(Dup)
13940-5	87121406	ND(0.05)	ND(0.05)	ND(0.05)	16	MW-1
13940-6	87121407	ND(0.05)	ND(0.05)	ND(0.05)	ND(0.05)	Trip Blank

* Fingerprint pattern does not match hydrocarbon standard; Quantitation based on largest peaks within boiling range of paint thinner.

ND = Not Detected; Limit of detection in parentheses.

QA/QC SUMMARY

Average spike recovery %	106

Curtis & Tompkins, Ltd.

LAB NUMBER: 13923
CLIENT: Harding Lawson Associates
HLA Job #: 9382,012.02 City of Oakland

DATE RECEIVED: 12/11/87
DATE ANALYZED: 12/17/87
DATE REPORTED: 12/21/87

Results of Analysis for Petroleum Hydrocarbons in Soils & Wastes

Method References: TPH: Total Petroleum Hydrocarbons, EPA 3550/8015

LAB ID	HLA ID	GASOLINE (mg/kg)	KEROSINE (mg/kg)	DIESEL (mg/kg)	OTHER * (mg/kg)
13923-2	MW-2 26'0"-26'5"	ND(10)	ND(10)	ND(10)	510
13923-4	MW-4 26'0"-26'5"	ND(10)	ND(10)	ND(10)	ND(10)
13923-5	MW-3 27'5"-28'0"	ND(10)	ND(10)	ND(10)	ND(10)

* Fingerprint pattern does not match hydrocarbon standard; Quantitation based on largest peaks within boiling range of paint thinner.

ND = Not Detected; Limit of detection in parentheses.

QA/QC SUMMARY

Duplicate: Relative % Difference	<1
Spike: % Recovery	109

Curtis & Tompkins, Ltd.

Well MW-2

LABORATORY NUMBER: 13940-1
CLIENT: Harding Lawson Associates
SAMPLE ID: 87121401
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/15/87
DATE ANALYZED: 12/17/87
DATE REPORTED: 12/21/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	200	10
Toluene	ND	50
Ethyl Benzene	56	10
Total Xylenes	ND	10
Chlorobenzene	ND	10
1,4-Dichlorobenzene	ND	10
1,3-Dichlorobenzene	ND	10
1,2-Dichlorobenzene	ND	10

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	6
Spike Recovery %	99

Curtis & Tompkins, Ltd.

Well MW-3

LABORATORY NUMBER: 13940-2
CLIENT: Harding Lawson Associates
SAMPLE ID: 87121403
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/15/87
DATE ANALYZED: 12/17/87
DATE REPORTED: 12/21/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	ND	1
Toluene	ND	5
Ethyl Benzene	ND	1
Total Xylenes	ND	1
Chlorobenzene	ND	1
1,4-Dichlorobenzene	ND	1
1,3-Dichlorobenzene	ND	1
1,2-Dichlorobenzene	ND	1

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	6
Spike Recovery %	99

Curtis & Tompkins, Ltd.

Well MW-4

LABORATORY NUMBER: 13940-3
CLIENT: Harding Lawson Associates
SAMPLE ID: 87121404
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/15/87
DATE ANALYZED: 12/17/87
DATE REPORTED: 12/21/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	ND	10
Toluene	ND	50
Ethyl Benzene	ND	10
Total Xylenes	ND	10
Chlorobenzene	ND	10
1,4-Dichlorobenzene	ND	10
1,3-Dichlorobenzene	ND	10
1,2-Dichlorobenzene	ND	10

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	6
Spike Recovery %	99

Curtis & Tompkins, Ltd.

Well Mw-4 (Duplicate)

LABORATORY NUMBER: 13940-4
CLIENT: Harding Lawson Associates
SAMPLE ID: 87121405
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/15/87
DATE ANALYZED: 12/17/87
DATE REPORTED: 12/21/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	ND	10
Toluene	ND	50
Ethyl Benzene	ND	10
Total Xylenes	ND	10
Chlorobenzene	ND	10
1,4-Dichlorobenzene	ND	10
1,3-Dichlorobenzene	ND	10
1,2-Dichlorobenzene	ND	10

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	6
Spike Recovery %	99

Curtis & Tompkins, Ltd.

Well MW-1

LABORATORY NUMBER: 13940-5
CLIENT: Harding Lawson Associates
SAMPLE ID: 87121406
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/15/87
DATE ANALYZED: 12/17/87
DATE REPORTED: 12/21/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	7,300	100
Toluene	4,700	500
Ethyl Benzene	1,400	100
Total Xylenes	6,800	100
Chlorobenzene	ND	100
1,4-Dichlorobenzene	ND	100
1,3-Dichlorobenzene	ND	100
1,2-Dichlorobenzene	ND	100

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	6
Spike Recovery %	99

Curtis & Tompkins, Ltd.

Trip Blank

LABORATORY NUMBER: 13940-6
CLIENT: Harding Lawson Associates
SAMPLE ID: 87121407
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/15/87
DATE ANALYZED: 12/17/87
DATE REPORTED: 12/21/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	ND	1
Toluene	ND	5
Ethyl Benzene	ND	1
Total Xylenes	ND	1
Chlorobenzene	ND	1
1,4-Dichlorobenzene	ND	1
1,3-Dichlorobenzene	ND	1
1,2-Dichlorobenzene	ND	1

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	7
Spike Recovery %	102

Harding Lawson Associates
Environmental Services Division
200 Rush Landing Road
Novato, California 94947
(415) 892-0821

CHAIN OF CUSTODY FORM

Samplers: BRENT DOSTERT, DAVE EVANS

ob Number: 9382,012.02

lame/Location: CITY OF OAKLAND - OAKLAND

roject Manager: JANET PETERS

Recorder: Brent Dostert (Signature Required)

SOURCE CODE	MATRIX: Water	Sediment	Soil	Oil	#CONTAINERS & PRESERV.: Unpres.	H_2SO_4	HNO_3	SAMPLE NUMBER OR LAB NUMBER: Yr	Wk	Seq	DATE: Yr	Mo	Dy	Time	STATION DESCRIPTION/ NOTES	ANALYSIS REQUESTED: EPA 601/8010	EPA 602/8020	EPA 624/8240	EPA 625/8270	Priority Pllnt. Metals	Benzene/Toluene/Xylene	Total Petrol. Hydrocarb.	BTXE	DISSOLVED LEAD
(3)	X				X			87	12	1401	87	12	14	1312	well #2							X	X	X
3	X				X			2	"	1403	"	"	"	1500	5 DAY well #3							X	X	
3	X				X			"	"	1404	"	"	"	1600	TURNAROUND well #4							X	X	X
3	X				X			"	"	1405	"	"	"	1610	TIME well 4-DUP							X	X	X
3	X				X			"	"	1406	"	"	"	1640	well #1							X	X	X
3	X				X			"	"	1407	"	"	"	1310	Trip blanks							X	X	X

LAB NUMBER: Yr	Wk	Seq	DEPTH IN FEET	COL MTD CD	QA CODE	MISCELLANEOUS

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: (Signature) Brent Dostert	RECEIVED BY: (Signature)	DATE/TIME 12/14/87 5:4
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
DISPATCHED BY: (Signature) DATE/TIME	RECEIVED FOR LAB BY: (Signature)	DATE/TIME 12/14/87
METHOD OF SHIPMENT		

Laboratory Copy White — Project Office Copy Yellow — Field or Office Copy Pink

6533

LABORATORY CERTIFICATE

Curtis & Tompkins, Ltd., Analytical Laboratories. Since 1878
290 Division Street, San Francisco, CA 94103, Phone (415) 861-1863

Laboratory No. 13947
Preliminary No.

Reported > 12/21/87
Sampled
Received > 12/16/87

For > HARDING LAWSON ASSOCIATES

Report on > 1 Water Sample

Mark > Job Location: City of Oakland
HLA Job Number: 9382,012.02

See Attached Results

Laboratory Director

Curtis & Tompkins, Ltd.

Well MW-5

LAB NUMBER: 13947
CLIENT: Harding Lawson Associates
HLA Job #: 9382,012.02 City of Oakland

DATE RECEIVED: 12/16/87
DATE ANALYZED: 12/16/87
DATE REPORTED: 12/21/87

Results of Analysis for Petroleum Hydrocarbons in Water

Method References: TPH: Total Petroleum Hydrocarbons, EPA 3550/8015

LAB ID	HLA ID	GASOLINE (mg/L)	KEROSINE (mg/L)	DIESEL (mg/L)	OTHER * (mg/L)
13947-1	87121502	ND(0.05)	ND(0.05)	ND(0.05)	4.2

* Fingerprint pattern does not match hydrocarbon standard; Quantitation based on largest peaks within boiling range of paint thinner.

ND = Not Detected; Limit of detection in parentheses.

QA/QC SUMMARY

Relative % Difference	4
Average spike recovery %	116

Curtis & Tompkins, Ltd.

Well MW-5

LABORATORY NUMBER: 13947-1
CLIENT: Harding Lawson Associates
SAMPLE ID: 87121502
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/16/87
DATE ANALYZED: 12/16/87
DATE REPORTED: 12/21/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	ND	5
Toluene	ND	5
Ethyl Benzene	5	5
Total Xylenes	45	5
Chlorobenzene	ND	5
1,4-Dichlorobenzene	ND	5
1,3-Dichlorobenzene	ND	5
1,2-Dichlorobenzene	ND	5

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	1
Spike Recovery %	95

Harding Lawson Associates
Environmental Services Division
200 Rush Landing Road
Novato, California 94949
(415) 892-0821

CHAIN OF CUSTODY FORM

Samplers: BRENT DOSTERT

Job Number: ~~8397~~ 7382, 012.02

Name/Location: CITY OF OAKLAND-OAKLAND

Project Manager: JANET PETERS

Recorder: Brent Dostert (Signature Required)

CODE	MATRIX: Water	Sediment	Soil	Oil	#CONTAINERS & PRESERV.: Unpres.	H_2SO_4	HNO_3	SAMPLE NUMBER OR LAB NUMBER: Yr	Wk	Seq	DATE: Yr	Mo	Dy	Time	STATION DESCRIPTION/ NOTES	ANALYSIS REQUESTED: EPA 601/8010	EPA 602/8020	EPA 624/8240	EPA 625/8270	Priority Pllnt. Metals	Benzene/Toluene/Xylene	Total Petrol. Hydrocarb.
SJ	X				X			87	12	1502	87	12	15	1840	mm 5 ~~4 DAY~~ TURNAROUND Verbal Results to J. Peters by Fax.						X	X

LAB NUMBER: Yr	Wk	Seq	DEPTH IN FEET	COL MTD CD	QA CODE	MISCELLANEOUS

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: (Signature) Brent Dostert	RECEIVED BY: (Signature)	DATE/TIME 12/16/87 0830
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME 12/16/87 1515
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
DISPATCHED BY: (Signature) DATE/TIME	RECEIVED FOR LAB BY: (Signature)	DATE/TIME 12/16/87 1819
METHOD OF SHIPMENT		

Laboratory Copy White — Project Office Copy Yellow — Field or Office Copy Pink

6533

LABORATORY CERTIFICATE

Curtis & Tompkins, Ltd., Analytical Laboratories. Since 1878
290 Division Street, San Francisco, CA 94103, Phone (415) 86[illegible]

Laboratory No. 13940
Preliminary No.

Reported > 12/21/87
Sampled
Received > 12/15/87

For > HARDING LAWSON ASSOCIATES

Report on > 6 Water Samples

Mark > Job Location: City of Oakland
HLA Job Number: 9382,012.02

See Attached Results

Laboratory Director

Curtis & Tompkins, Ltd., Analytical Laboratories, Since 1878
290 Division Street, San Francisco, CA 94103, Phone (415) 861-1863

LAB NUMBER: 13962
CLIENT: Harding Lawson Associates
HLA Job #: 9382,012.02 City of Oakland

DATE RECEIVED: 12/22/87
DATE ANALYZED: 12/22/87
DATE REPORTED: 12/30/87

Dissolved Lead in Water by EPA Method 7420

LAB ID	HLA ID		RESULT (mg/L)	DETECTION LIMIT (mg/L)
13962-1	87122107	Travel Blank	ND	0.05
13962-2	87122101	Well MW-2	ND	0.05
13962-5	87122104	Well MW-4	ND	0.05
13962-6	87122105	Well Mw-4 (Duplicate)	ND	0.05

QA/QC SUMMARY:

Relative % Difference	<1
Average Spike Recovery %	97

Laboratory Director

Curtis & Tompkins, Ltd.

LAB NUMBER: 13962
CLIENT: Harding Lawson Associates
HLA Job #: 9382,012.02 City of Oakland

DATE RECEIVED: 12/22/87
DATE ANALYZED: 12/22/87
DATE REPORTED: 12/30/87

Results of Analysis for Petroleum Hydrocarbons in Water

Method References: TPH: Total Petroleum Hydrocarbons, EPA 3550/8015

LAB ID	HLA ID	GASOLINE (mg/L)	KEROSINE (mg/L)	DIESEL (mg/L)	OTHER (mg/L)	
13962-1	87122107	ND(0.05)	ND(0.05)	ND(0.05)	--	Travel Blank
13962-2	87122101	2.11 *	ND(0.05)	ND(0.05)	--	MW-2
13962-3	87122102	ND(0.05)	1.18 **	ND(0.05)	--	MW-5
13962-4	87122103	ND(0.05)	ND(0.05)	ND(0.05)	--	MW-3
13962-5	87122104	2.41 *	ND(0.05)	ND(0.05)	--	MW-4
13962-6	87122105	2.09 *	ND(0.05)	ND(0.05)	--	MW-4(Dup)

* Fingerprint pattern does not match hydrocarbon standards; Quantitation based on largest peaks within boiling range of aged gasoline.

** Fingerprint pattern does not match hydrocarbon standards; Quantitation based on largest peaks within C8-C13 boiling range.

ND = Not Detected; Limit of detection in parentheses.

QA/QC SUMMARY

Average spike recovery %	103

Curtis & Tompkins, Ltd.

Travel Blank

LABORATORY NUMBER: 13962-1
CLIENT: Harding Lawson Associates
SAMPLE ID: 87122107
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/22/87
DATE ANALYZED: 12/23/87
DATE REPORTED: 12/30/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	ND	1
Toluene	ND	5
Ethyl Benzene	ND	1
Total Xylenes	ND	1
Chlorobenzene	ND	1
1,4-Dichlorobenzene	ND	1
1,3-Dichlorobenzene	ND	1
1,2-Dichlorobenzene	ND	1

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	8
Spike Recovery %	110

Curtis & Tompkins, Ltd.

Well MW-2

LABORATORY NUMBER: 13962-2
CLIENT: Harding Lawson Associates
SAMPLE ID: 87122101
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/22/87
DATE ANALYZED: 12/23/87
DATE REPORTED: 12/30/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	76	10
Toluene	10	10
Ethyl Benzene	55	10
Total Xylenes	64	10
Chlorobenzene	ND	10
1,4-Dichlorobenzene	ND	10
1,3-Dichlorobenzene	ND	10
1,2-Dichlorobenzene	ND	10

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	8
Spike Recovery %	110

Curtis & Tompkins, Ltd.

Well MW-5

LABORATORY NUMBER: 13962-3
CLIENT: Harding Lawson Associates
SAMPLE ID: 87122102
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/22/87
DATE ANALYZED: 12/23/87
DATE REPORTED: 12/30/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	8	1
Toluene	3	1
Ethyl Benzene	ND	1
Total Xylenes	3	1
Chlorobenzene	ND	1
1,4-Dichlorobenzene	ND	1
1,3-Dichlorobenzene	ND	1
1,2-Dichlorobenzene	ND	1

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	8
Spike Recovery %	110

Curtis & Tompkins, Ltd.

Well MW-3

LABORATORY NUMBER: 13962-4
CLIENT: Harding Lawson Associates
SAMPLE ID: 87122103
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/22/87
DATE ANALYZED: 12/23/87
DATE REPORTED: 12/30/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	ND	1
Toluene	ND	1
Ethyl Benzene	ND	1
Total Xylenes	ND	1
Chlorobenzene	ND	1
1,4-Dichlorobenzene	ND	1
1,3-Dichlorobenzene	ND	1
1,2-Dichlorobenzene	ND	1

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	8
Spike Recovery %	110

Curtis & Tompkins, Ltd.

Well MW-4

LABORATORY NUMBER: 13962-5
CLIENT: Harding Lawson Associates
SAMPLE ID: 87122104
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/22/87
DATE ANALYZED: 12/23/87
DATE REPORTED: 12/30/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	88	10
Toluene	ND	10
Ethyl Benzene	38	10
Total Xylenes	88	10
Chlorobenzene	ND	10
1,4-Dichlorobenzene	ND	10
1,3-Dichlorobenzene	ND	10
1,2-Dichlorobenzene	ND	10

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	8
Spike Recovery %	110

Curtis & Tompkins, Ltd.

Well MW-4 (Duplicate)

LABORATORY NUMBER: 13962-6
CLIENT: Harding Lawson Associates
SAMPLE ID: 87122105
HLA JOB NUMBER: 9382,012.02 City of Oakland

DATE RECIEVED: 12/22/87
DATE ANALYZED: 12/23/87
DATE REPORTED: 12/30/87

EPA 602: Volatile Aromatic Hydrocarbons in Water

COMPOUND	CONC ug/L	DETECTION LIMIT ug/L
Benzene	81	10
Toluene	ND	10
Ethyl Benzene	30	10
Total Xylenes	77	10
Chlorobenzene	ND	10
1,4-Dichlorobenzene	ND	10
1,3-Dichlorobenzene	ND	10
1,2-Dichlorobenzene	ND	10

ND = None Detected

QA/QC:

Duplicate, Relative % Difference	8
Spike Recovery %	110

Harding Lawson Associates
7655 Redwood Blvd.
P.O. Box 578
Novato, CA 94948
(415) 892-0821

CHAIN OF CUSTODY FORM

Samplers: JMK JPME

Job Number: 7382 012 02

Name/Location: City of Oakland

Project Manager: JLP

Recorder: _____ (Signature Required)

SOURCE CODE	MATRIX: Water	Sediment	Soil	Oil	#CONTAINERS & PRESERV.: Unpres.	H_2SO_4	HNO_3	SAMPLE NUMBER OR LAB NUMBER: Yr Wk Seq	DATE: Yr Mo Dy Time	STATION DESCRIPTION/ NOTES	ANALYSIS REQUESTED: EPA 601/8010	EPA 602/8020	EPA 624/8240	EPA 625/8270	Priority Pltnt. Metals	Benzene/Toluene/Xylene / EPA 8020	Total Petrol. Hydrocarb. - GAS / EPA 8015 mod.	Pb (Dissolved)
23	X				4			871207	871210 1105	Travel blank BOA ONLY						X	X	X
23	X				4			871201	871211 1220	MW-2						X	X	X
23	X				3			871202	871211 1335	MW-5						X	X	
23	X				3			871203	871211 1415	MW-3						X	X	
23	X				4			871204	871211 1510	MW-4						X	X	X
23	X				4			871205	871211 1515	MW-4 DUP						X	X	X
										24 HR TURNAROUND								

LAB NUMBER: Yr Wk Seq	DEPTH IN FEET	COL MTD CD	QA CODE	MISCELLANEOUS

CT

CHAIN OF CUSTODY RECORD

RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
RELINQUISHED BY: (Signature)	RECEIVED BY: (Signature)	DATE/TIME
DISPATCHED BY: (Signature) DATE/TIME	RECEIVED FOR LAB BY: (Signature)	DATE/TIME 12/31/97
METHOD OF SHIPMENT		

Laboratory Copy White — Project Office Copy Yellow — Field or Office Copy Pink

6533

DISTRIBUTION

GROUND-WATER INVESTIGATION
CHINATOWN REDEVELOPMENT PROJECT AREA
OAKLAND, CALIFORNIA

January 8, 1988

DRAFT

COPY NO ___

		Copy No.
10 copies	City of Oakland Redevelopment Agency One City Hall Plaza Oakland, California Attention: Mr. Peter Chin	1-10
1 copy	Job file	11
1 copy	QC/Bound Report File	12

JLP/GLO/CRS/rmc/F2648-R

QUALITY CONTROL REVIEWER

Tamara L. Williams
Geologist - 3954