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94 MAY -4 PM 2:49

May 2, 1994

Mr. Scott Seery
Department of Environmental Health
Alameda County Health Care Agency
80 Swan Way, Room 200
Oakland, CA 94621

SUBJECT: BEACON STATION NO. 720, 1088 MARINA BLVD., SAN LEANDRO, CALIFORNIA

Dear Mr. Seery:

Enclosed is a copy of the Problem Assessment Report for the above-referenced Ultramar facility.

Please call if you have any questions.

Sincerely,

ULTRAMAR INC.

Terrence A. Fox

Terrence A. Fox
Senior Project Manager
Marketing Environmental Department

Enclosure: Problem Assessment Report

cc: Local Program Coordinator, San Francisco Bay Region, RWQCB

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ALCO HAZMAT

**PROBLEM ASSESSMENT REPORT/
REMEDIAL ACTION PLAN
BEACON STATION #720**

**1088 MARINA BOULEVARD
SAN LEANDRO, CALIFORNIA
AMV PROJECT NO. 19030.01**

April 18, 1994

Prepared By

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TABLE OF CONTENTS

Page

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

PROBLEM ASSESSMENT REPORT/
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SAN LEANDRO, CALIFORNIA
AMV PROJECT NO. 19030.01

1.0 INTRODUCTION

Acton • Mickelson • van Dam, Inc. (AMV), has been authorized by Ultramar Inc. (Ultramar), to continue an ongoing hydrogeologic investigation at Beacon Station #720 located at 1088 Marina Boulevard, San Leandro, County of Alameda, California (Figures 1 and 2). This report summarizes the results of hydrogeologic investigations conducted by AMV and other environmental consulting firms.

1.1 SITE BACKGROUND

The site is located approximately 2 miles east of San Francisco Bay. San Leandro Creek is approximately 1 mile north of the site and flows west toward San Francisco Bay. The surface of the site slopes gently toward the southwest. The surrounding area is predominantly commercial properties. According to information on the U.S. Geological Survey (USGS) San Leandro 7 1/2-minute quadrangle, the site is approximately 35 feet above sea level.

Eight ground water monitoring wells have been installed at the site. Three underground storage tanks (USTs) are known to presently exist at the site. The three USTs have been used for motor vehicle fuel storage and currently contain various grades of unleaded gasoline. It is AMV's understanding that there are no reported incidents in which gasoline has leaked from or was spilled during filling of any of these USTs. The site was previously owned by Kayo Oil of Lodi, California, and was operated as a Fast Gas Station. The site is currently an operating Beacon retail service station.

1.2 REGIONAL GEOLOGIC AND HYDROGEOLOGIC SETTING

The site lies within the San Leandro Alluvial Cone which emanates from the Diablo Mountains and terminates at the eastern shore of San Francisco Bay. The San Leandro Cone is composed of unconsolidated sediments of Quaternary age deposited by nearby San Leandro Creek. Sediments making up the San Leandro Cone consist of interbedded deposits of clay and more permeable sand and gravel. The strata form a series of small confined aquifers with limited lateral extent. Published reports indicate that soil types beneath the site range from sands and gravels deposited in a braided stream environment to fine-grained sediments characteristic of flood stage, overbank deposits. Higher areas in the site vicinity consist of Cretaceous-age marine sediments. The northwest-trending Hayward fault is located at the base of the Diablo Mountains east of the site.

Groundwater Technology, Inc. (GTI), first noted saturated conditions during drilling of ground water monitoring wells at a depth of approximately 20 feet below grade. GTI interpreted the shallow ground water to be present under unconfined conditions. Ground water was reported by GTI to be approximately 14 feet below grade during April 1987.

2.0 RESULTS OF PREVIOUS PHASES OF HYDROGEOLOGIC INVESTIGATION

2.1 REMOVAL OF UNDERGROUND STORAGE TANKS

USTs were removed and soil sampling was performed by CHIPS Environmental Consultants of Morgan Hill, California, during January 1987. A total of three USTs, two 10,000-gallon and one 7,500-gallon-capacity) containing various grades of gasoline were removed. Soil samples were collected from beneath the former UST locations and submitted for analysis of total petroleum hydrocarbons as gasoline (TPHg), and the gasoline constituents benzene, toluene, ethylbenzene, and xylenes (BTEX). Based on the analytical results obtained from these samples, overexcavation of the tank basin was conducted. One soil sample was then collected at each corner of the former tank basin at depths ranging from 19.5 to 20 feet below grade. Concentrations of TPHg in these samples ranged from 26 to 120 parts per million (ppm), with benzene concentrations ranging from 1 to 15 ppm.

A waste oil tank was also removed from the site. Two soil samples were collected from beneath the waste oil tank and submitted for analysis. Waste oil concentrations in these two samples were reported to be 195 and 210 ppm (as waste oil), respectively. Apparently, no overexcavation of the waste oil tank basin took place when the tank was removed.

HVOCs? PNAs? metals? TPH??

2.2 MONITORING WELL INSTALLATION AND SOIL SAMPLE ANALYSIS

GTI submitted a report titled "Subsurface Hydrocarbon Investigation," dated May 15, 1987. The report contained the results of GTI's preliminary hydrogeologic investigation at the site, conducted in April 1987, at which time the site was an Econo Gas station operated by Kayo Oil. Five soil borings were advanced by GTI to a depth of 30 feet below grade and converted to ground water monitoring wells MW-1 through MW-5 (Figure 2). Soil samples were collected from each boring at 5-foot intervals and submitted for analysis of TPHg, total lead, benzene, toluene, and xylenes. Field readings using a photoionization detector (PID) indicated that the soils encountered during drilling from 9 to 17 feet below grade contained detectable concentrations of organic vapors. Soil samples collected at 14 feet below grade (the approximate depth of the soil/ground water interface) were submitted for chemical analysis. A soil sample collected from the boring for monitoring well MW-4 contained the highest total hydrocarbon content (THC) at 2,108 ppm. Concentrations of THC in soil samples obtained from the borings for monitoring wells MW-1, MW-2, and MW-5 were reported at 327, 83, and 983 ppm, respectively. The soil sample collected from the boring for monitoring well MW-3 at 14 feet below grade did not contain detectable levels of petroleum hydrocarbons. Soil sample analytical results are compiled in Table 1. The locations of geologic cross-sections are illustrated on Figure 3.

Soils encountered beneath the site during drilling consisted predominantly of greenish-brown silty clay with occasional, local sand and clayey sand lenses at approximately 14 feet below grade. A geologic cross-section (Figure 4) was constructed based on information obtained from GTI's boring logs for monitoring wells MW-1, MW-4, and MW-5.

Monitoring wells MW-1 through MW-5 were screened from 10 to 30 feet below grade. Depth to water measurements and ground water samples were collected from each new monitoring well and submitted for analysis on April 16, 1987. A sheen was observed in monitoring wells MW-2 and MW-3. Ground water was present between 13.40 and 14.05 feet below respective casing risers on this date. The ground water gradient was reported to be toward the southwest. Ground water sample analysis indicated that ground water beneath the site contained petroleum hydrocarbon constituents. TPHg concentrations in ground water samples ranged from 10 ppm in a sample collected from monitoring well MW-3 to 19.3 ppm in a ground water sample collected from monitoring well MW-4. Quarterly ground water monitoring was subsequently performed by GTI until February 1989.

In July 1987, GTI advanced four soil borings on the site property located west of the UST basin (borings 1 through 4 on Figure 2). Data from these borings are sparse, but it is believed that the borings extended to a depth of 14.5 feet below grade (the approximate depth to ground water). Soil samples were collected from each boring at 9.5 and 14.5 feet below grade. Only one of the soil samples collected above the water table (3B) contained detectable concentrations of petroleum constituents. Sample 3B reportedly contained 10 ppm THC and 0.69 ppm benzene. Each of the samples collected at a depth of 14.5 feet below grade contained detectable concentrations of THC and benzene ranging from 45 to 170 ppm (THC) and 9.8 to 32 ppm (benzene). Analytical results of soil samples collected in July 1987 by GTI are compiled in Table 1.

In February 1989, Du Pont Biosystems (Du Pont) was contracted to perform quarterly ground water monitoring of the existing monitoring wells at the site. Depth to ground water measurements at this time indicated an inferred ground water gradient of 0.0025 foot per foot (ft/ft) towards the southwest. Quarterly monitoring was subsequently performed at this site by Environmental Geotechnical Consultants, Inc. (EGC), and Aegis Environmental, Inc. (Aegis). Historical depth to ground water data (since 1992) are compiled in Table 2; ground water quality data (since 1992) are compiled in Table 3. Ground water levels have fluctuated approximately 2.5 feet since March 1992.

An additional site investigation was conducted by EGC at the site beginning in August 1991. A total of ten soil borings were drilled between August 15 and October 10, 1991. The final three borings were converted to ground water monitoring wells MW-6, MW-7, and MW-8 (Figure 2). Soil samples were collected from each boring at 5-foot intervals. Selected soil samples were submitted to California-certified laboratories for analysis of TPHg and BTEX. Soil sample analytical results are compiled in Table 1. A second geologic cross-section using data from the boring logs for monitoring wells MW-8, MW-4, and MW-3 is illustrated on Figure 5. Ground water samples were collected by EGC through uncased boreholes in borings B-1, B-5, B-6, and borings for monitoring wells MW-7, M-8, and MW-9. Benzene was not detected in the ground water samples collected from B-5, MW-7, or MW-6 (Table 4). Benzene was detected in ground water samples from borings B-1, B-6, and MW-8.

All eight existing wells (MW-1 through MW-8) were resurveyed by EGC in December 1991 at which time quarterly ground water monitoring was also performed. The ground water gradient at this time was reported by EGC at 0.002 ft/ft toward the northwest.

The most recent quarterly monitoring event at the site was performed by Aegis in December 1993. Ground water gradient was reported by Aegis to be less than 0.01 ft/ft toward the southwest at this time.

3.0 ADDITIONAL TESTING

3.1 AQUIFER PUMPING TEST

On October 4 and 5, 1993, AMV conducted an aquifer pumping test at the site to evaluate aquifer characteristics of the shallow water-bearing strata beneath the site. The test was performed by pumping monitoring well MW-4 continuously for approximately 22 hours. A constant pumping rate of approximately 1.9 gallons per minute (gpm) was maintained for the duration of the test. Ground water monitoring well MW-5 was used as the observation well during the test. Monitoring well MW-5 is located approximately 40 feet from monitoring well

MW-4. An automated data logger was used to continuously record water level data in the pumping and observation wells. At the end of the test, a drawdown of approximately 10.6 feet was measured in monitoring well MW-4, and approximately 0.50 foot of drawdown was measured in monitoring well MW-5. Raw data collected during the pumping test and analytical calculations are contained in Appendix A.

Approximately 2,500 gallons of ground water was produced during the 22-hour pumping test. The ground water was routed from the pumping well through a flowmeter to a temporary aboveground tank as approved by the City of San Leandro. The stored ground water was removed from the tank by Kern Vacuum Service of Coalinga, California, and transported to Ultramar's Hanford facility for recycling. Ground water samples were collected during the last hour of the test and submitted to a California-certified laboratory for analysis of BTEX, TPHg, and general metals. The ground water sample collected from monitoring well MW-4 at the end of the test contained a TPHg concentration of 26,000 micrograms per liter (μg/l) and a benzene concentration of 5,100 μg/l. Analytical results are compiled in Tables 5 and 6. Copies of certified analytical reports are presented in Appendix B.

Analysis of aquifer characteristics was facilitated by use of the software program AQTESOLV®, written by Geraghty & Miller, Inc. (1991). Curve matching using AQTESOLV® (Appendix A) indicates an estimated average value of hydraulic conductivity (K) of approximately 0.007 foot/minute (ft/min). This value is within the anticipated range of K values expected for the types of sediment encountered in soil borings in the shallow subsurface beneath the site. The capture zones of monitoring well MW-4 pumping at rates of 1 and 0.5 gpm were simulated using the value for K of 0.007 ft/min, a ground water gradient of 0.002 ft/ft, an assumed aquifer porosity of 25 percent, and an aquifer thickness of 22 feet (Appendix A). At a pumping rate of 1 gpm, which is a feasible long-term pumping rate for monitoring well MW-4, the simulated capture zone extended approximately 45 feet downgradient of the pumping well and reached a maximum upgradient width of approximately 350 feet. Reducing the pumping rate to 0.5 gpm decreased the downgradient capture zone extent to approximately 25 feet from the pumping well. The maximum upgradient width of the capture zone decreased to approximately 205 feet at a pumping rate of 0.5 gpm.

3.2 Soil Vapor Extraction Test

AMV conducted a 4-hour soil vapor extraction pilot test at the site on October 5, 1993. Using monitoring well MW-4 as the test well (Figure 2), a 2-horsepower vacuum blower (Gast Model R512SQ-50) powered by a portable 6.5-kilowatt generator applied a continuous vacuum of about 50 inches of water column at the well head. Also, a 2-inch submersible pump was used to simultaneously extract ground water from monitoring well MW-4 and to maintain drawdown of the water table during the vapor extraction pilot test. Vapor flow rate, measured by a rotameter placed in the exhaust line of the blower and corrected for temperature, was observed to be approximately 9.7 standard cubic feet per minute (scfm). Per requirements of the Bay Area Air Quality Management District (BAAQMD), the emissions from the pilot test were routed through vapor-phase activated carbon prior to discharge to the atmosphere.

Throughout the vapor extraction test, vacuum influence was monitored at a vapor monitoring point installed for testing purposes about 7 feet from monitoring well MW-4. **Vacuum influence was not observed at the vapor monitoring point.**

To determine concentrations of total volatile hydrocarbons (TVH) in the extracted vapors during the pilot test, AMV used Draeger tubes and a flame ionization detector (FID). The FID indicated TVH concentrations were greater than 10,000 ppm as methane throughout the test. Draeger tube readings indicated a concentration greater than 2,500 ppm as octane at the beginning of the test, and a concentration of 1,800 ppm as octane at the end of the 4-hour test. Field readings compiled in table form are contained in Appendix C.

To confirm field readings and to help estimate mass extraction rates of TPHg, two bag samples of extracted vapor were collected; one sample at the beginning and one sample at the end of the test. The samples were submitted for laboratory analysis of TPHg and BTEX. The analytical results (Appendix D) for these samples were 6,200 parts per million-volume (ppmv) TPHg, 260 ppmv benzene at the start, and 3,800 ppmv TPHg and 120 ppmv benzene at the end of the test.

From the analytical results, the estimated extraction rate for TPHg at the end of the 4-hour test was 12.7 pounds per day (lbs/day). The estimated extraction rate for benzene at the end of the test was 0.37 lbs/day. Appendix E contains flow and extraction rate calculations.

Using the pilot test data, an empirical formula for calculating a theoretical zone of vacuum influence predicts a vacuum influence area with a radius of approximately 10 feet extending outward from monitoring well MW-4 (Appendix E). During the test, vacuum influence was not observed at the vapor point located approximately 7 feet from monitoring well MW-4. **A vapor extraction blower of greater capacity than the one used in the pilot test should provide a larger zone of vacuum influence.**

To estimate the possible vacuum influence achieved by a blower of greater capacity, AMV extrapolated the pilot test data resulting from an applied vacuum of 50 inches of water to an applied vacuum of 189 inches of water (14 inches Hg, the maximum practical vacuum achieved by vapor extraction equipment). A linear extrapolation from pilot test data predicts monitoring well MW-4 would produce an extraction flow rate of 36 scfm at the higher vacuum. At 36 scfm extraction flow, the empirical formula for calculating the theoretical zone of vacuum influence predicts a vacuum influence area with a radius of 38 feet. Appendix E includes a graph of the extrapolation, and the calculation predicting the theoretical zone of vacuum influence.

3.3 Air Sparging Test

An 8-hour air sparging pilot test was conducted at the site on October 6, 1993 by AMV. Using a temporary hand-driven sparging point (SP on Figure 2) for introducing air into the saturated zone, a 2-horsepower compressor (Speedaire Model 5Z599) powered by a 6.5-kilowatt generator provided a continuous flow of air for 8 hours. Flow was measured by the use of an in-line rotameter placed at the outlet of the compressor. Flow, corrected for temperature and pressure, ranged from 5.7 to 6.6 scfm. Appendix F contains a summary table of air sparging test data.

During the test, dissolved oxygen was monitored in monitoring wells MW-4 and MW-5. Also, the vapor space in the MW-4 casing was monitored for TVH using the FID and for carbon dioxide (CO_2) using Draeger tubes.

Dissolved oxygen values for water samples collected from monitoring well MW-4 ranged from 13 percent saturation before beginning the sparging to 19 percent saturation at the conclusion of the test, as determined by field readings using a dissolved oxygen meter. FID readings of the monitoring well MW-4 vapor space ranged from 1,200 ppm as methane to greater than 10,000 ppm. CO_2 concentrations measured in the monitoring well MW-4 vapor space ranged from nondetectable at the beginning to 0.3 percent at the conclusion.

AMV collected water samples from monitoring well MW-4 at the beginning, the midpoint, and at the conclusion of sparging for laboratory analysis (Appendix G) of TPHg and BTEX. TPHg concentrations ranged from 21,000 to 31,000 parts per billion (ppb) and benzene concentrations ranged from 1,300 to 2,500 ppb.

Based on the dissolved oxygen and CO_2 measurements taken at the conclusion of the sparging, AMV believes the approximate 6 scfm sparge rate into the sparging point resulted in sparge influence at monitoring well MW-4, which is about 15 feet from the location of the sparging point.

4.0 DISTRIBUTION OF PETROLEUM CONSTITUENTS IN SOIL AND GROUND WATER

4.1 Distribution of Petroleum Constituents in Soil

Most of the soil samples submitted by previous consultants for laboratory analysis have been collected from the zone of water table fluctuation (14 or more feet below grade). Only two soil samples (3B and B-2-2) collected at less than 14 feet below grade have contained detectable concentrations of petroleum constituents. The highest TPHg concentration detected in samples collected above the water table was 10 ppm (sample 3B). Based on the distribution of petroleum constituents in ground water (Section 4.2) and the known direction of ground water flow, AMV has inferred that soil in the vicinity of the underground storage tanks contains petroleum constituents (Figures 4 and 5). The relative concentration of TPHg (or THC) in soil samples collected from the water table interface in borings near the underground storage tank basin seems to support this interpretation, as do the results of the soil vapor extraction test using monitoring well MW-4.

4.2 Distribution of Petroleum Constituents in Ground Water

Depth to ground water beneath the site has ranged from approximately 12 to 17 feet. In December 1993, depth to ground water ranged from 13.06 (MW-6) to 16.05 (MW-8) feet below grade. The direction of ground water flow has varied from northwest to southwest. Depth to ground water measurements made in December 1993 indicate a ground water flow direction toward the west-southwest.

Separate-phase petroleum product has never been detected in monitoring wells at this site. The benzene isoconcentration map illustrated on Figure 7 (from September 22, 1993) is representative of the historic distribution of dissolved benzene in ground water at the site. Ground water samples collected from monitoring wells MW-4, MW-5, MW-1, and MW-2 have historically contained the highest benzene concentrations. Benzene concentrations in monitoring wells MW-6 and MW-7 have generally been trace amounts or have been nondetectable.

Although quarterly sampling of monitoring wells MW-6 and MW-7 appears to indicate delineation of the dissolved hydrocarbon plume in ground water, spot sampling of ground water through uncased borings B-1 through B-7 indicated the presence of petroleum constituents in ground water encountered in borings B-1 and B-6. To determine the presence or absence of petroleum constituents in this area, to allow monitoring of remedial progress, and to serve as another possible extraction point, AMV recommends installation of an additional monitoring well at the southwest corner of the station property (MW-9 on Figure 8). yes.

5.0 DISCUSSION OF REMEDIATION ALTERNATIVES

This section describes methods for the remediation of soil and ground water underlying the site which contain petroleum hydrocarbon constituents. Taking into account both feasibility and cost-effectiveness, the comparison and evaluation of remedial methods addresses two goals:

1. Removal of petroleum hydrocarbons from soil underlying the site to eliminate future impact on ground water.

2. Reduce or inhibit the migration of ground water underlying the site that contains dissolved petroleum hydrocarbons.

5.1 Removal of Petroleum Hydrocarbons from Soils

Strategies considered for removing petroleum hydrocarbons from soils underlying the site include:

- Passive Remediation
- In Situ Soil Vapor Extraction
- Bioventing

Because of the extent of impacted soils with respect to occupied and operating structures, excavation is not a reasonable alternative for this site.

5.1.1 Passive Remediation

This alternative involves leaving the petroleum constituents in the soil and leaving the soil unaltered. Continuing natural volatilization and natural biodegradation of petroleum constituents in the soil would be expected to reduce concentrations of petroleum constituents with time.

Depth to ground water measurements and previous soil sample analytical results indicate ground water is in contact with soil containing petroleum constituents. However, passive remediation could be acceptable in conjunction with ground water remedial action that controls migration of affected ground water. The ground water remedial action would presumably dewater impacted soils, and thus accelerate the natural volatilization and biodegradation processes. However, passive remediation of soils is not typically an expedient process.

5.1.2 In Situ Soil Vapor Extraction

In situ soil vapor extraction, also known as soil venting, utilizes vapor extraction wells to remove volatile hydrocarbons from the soil matrix. Creation of a vacuum on the extraction well(s) results in the removal (extraction) of soil vapors from the subsurface, accompanied by volatilization of petroleum constituents out of the soil matrix. Extraction rates vary with the consistency, moisture content, and grain size of the soil horizon. In addition to the extraction benefit, soil venting can also be effective at promoting biologic breakdown of petroleum hydrocarbon compounds contained in the soil by the introduction of additional oxygen into the subsurface. The extracted soil vapors would require treatment to destroy the entrained hydrocarbons in accordance with local regulatory agency air discharge requirements.

The soil vapor extraction test performed at the site (Section 3.3) indicated the feasibility of inducing adequate airflow in the subsurface for removal of petroleum hydrocarbon constituents via soil venting. Under test conditions, results indicate a relatively small horizontal zone of vacuum influence which would require installing a substantial number of extraction wells to address all soil areas inferred to contain petroleum hydrocarbons. Although costly compared to passive remediation, soil venting is advantageous with respect to timeliness of remediation.

5.1.3 Bioventing

Utilizing indigenous microorganisms to degrade petroleum constituents in soil, bioventing involves the forcing of oxygen into the vadose zone to stimulate and sustain the naturally occurring microorganisms that consume petroleum compounds. In the simplest form, bioventing is accomplished by delivering air to the subsurface, without regard to the venting of excess gasses. The excess gasses would include nitrogen and unconsumed oxygen from the air, carbon dioxide from the metabolic activity of the microorganisms, and possibly volatile hydrocarbons (from the impacted soil) entrained in the flow of excess gasses. However, the soil and microorganisms act as a biofilter for volatile hydrocarbons that might migrate with the excess gasses, thus attenuating the possible spread of hydrocarbons in the subsurface and/or the release of hydrocarbons to atmosphere.

In cases where bioventing without control of excess gasses is unacceptable from a regulatory standpoint, a vent control system can be installed. Such a system might include recovery wells as well as air injection points, through which excess gasses could vent. If necessary, recovery wells could be piped for treatment of venting excess gasses before discharge to atmosphere.

Compared to vapor extraction, bioventing usually involves moving less air in the subsurface, so bioventing equipment can be less costly. However, as a remedial method, bioventing is not as expedient as vapor extraction.

5.2 Removal of Dissolved Petroleum Hydrocarbons from Ground Water

Strategies considered for interim remediation of ground water containing dissolved petroleum hydrocarbons include:

- Ground Water Pumping and Aboveground Treatment
- In Situ Bioremediation
- Vapor Extraction
- Vapor Extraction With Air Sparging

Because ground water containing dissolved benzene has migrated beyond site boundaries, this analysis assumes passive remediation is not an unacceptable alternative.

5.2.1 GROUND WATER PUMPING AND ABOVEGROUND TREATMENT

This remediation alternative involves recovery of ground water by pumping from one or more extraction wells, and discharging the recovered ground water to the sanitary sewer, storm sewer, or an infiltration trench after treatment. Because of the cone of depression created in the potentiometric surface of the water table, implementation of ground water pumping constitutes a method for both controlling the migration of and removing petroleum hydrocarbons from ground water beneath the site.

Tests conducted using monitoring well MW-4 (Section 3.2) indicate that this well will yield approximately 1.0 gpm on a long-term, continuous basis. The short-term theoretical extent of the capture zone resulting from this pumping test was about 45 feet in the downgradient direction. Assuming this data applies to monitoring well MW-5, pumping this well could effectively recover ground water containing TPHg concentrations of 100 μg/l and higher. Sustained, continuous pumping could result in a larger capture zone. Figure 6 illustrates the theoretical capture zone expected due to pumping MW-5 at 1.0 gpm. If this alternative is implemented, evaluation of pumping data may indicate that utilization of an additional existing well or wells (or installation of an additional well or wells) is necessary to achieve a ground water capture zone encompassing the area of ground water known to contain dissolved petroleum constituents.

Although it is often the most effective method for controlling migration of impacted ground water, ground water pumping is typically less time- and cost-effective than other remediation methods at recovering hydrocarbons from ground water. For cost reasons especially, the combination of treatment costs, disposal costs (sewer charges), and analytical costs (discharge compliance) usually make the option of ground water pumping unfavorable compared to other remediation methods. By itself, ground water pumping is a time-inefficient recovery method because the technique has minimal effect on soil which may continue to act as a source of petroleum hydrocarbons to ground water. **For this site, however, the pumping test indicates that ground water pumping would be advantageous over other methods for controlling migration of impacted ground water beyond site boundaries**, by using only on-site well(s) as extraction points.

Another potential drawback of ground water pumping is the possibility for migration of ground water impacted by off-site sources onto the Ultramar site. Operation of a pumping system would require a ground water monitoring program that would detect migration of an off-site plume beneath the Ultramar property.

5.2.2 In Situ Bioremediation

In situ bioremediation involves stimulating the indigenous microorganisms to enhance the degradation of petroleum hydrocarbons present in ground water. Introduction of oxygen and nutrients into the water table through infiltration trenches or wells provides the stimulus. Recirculation of the ground water by pumping, along with reinjection, is necessary to control the migration of the dissolved petroleum hydrocarbon plume and to distribute the nutrients and oxygen.

In conjunction with ground water pumping, the incremental cost for bioremediation can be favorable because of the prospect for expediting the remediation. However, keeping a bioremediation system operational can be difficult because of fouling in the infiltration trenches or wells. Furthermore, to address all impacted ground water, the utilization of bioremediation for this project would involve the undesirable concept of injecting foreign substances into the subsurface beyond site boundaries. Utilization of bioremediation beyond site boundaries is especially undesirable given the current uncertainty with regard to direction of the ground water gradient.

5.2.3 Vapor Extraction

Though typically considered a soil remediation technology, utilization of vapor extraction for removing dissolved hydrocarbons from ground water can be viable under certain conditions. A vapor extraction system operates on the concepts of vapor-liquid equilibrium and vapor flow through soil. Upon applying vacuum to the soil overlying the water table, the reduced pressure in the overlying soil vapor causes the volatile hydrocarbons dissolved in ground water to move from the liquid to the vapor phase. The induced vacuum extraction flow above the water table surface removes the hydrocarbon-enriched vapors. Because the vapor extraction flow continually removes the hydrocarbons that migrate from the ground water into the soil vapor, a state of disequilibrium exists. The volatilization of dissolved hydrocarbons from the ground water into the overlying soil vapor will continue as the system tries to reach equilibrium.

In addition, vapor extraction can promote natural biodegradation of dissolved hydrocarbons by providing a continual source of fresh oxygen to stimulate indigenous microorganisms, which convert the hydrocarbons to carbon dioxide and water. At the same time, vapor extraction would be removing the hydrocarbons in the soil above the water table that presumably impacted ground water in the past, and could potentially impact ground water again. A possible limitation of vapor extraction is inability to control migration of dissolved hydrocarbons in ground water.

By removing the source of contamination, and by removing dissolved hydrocarbons without having to recover and dispose of produced ground water, vapor extraction can economically remediate ground water. In the case of widespread ground water impact, vapor extraction by itself may not be the most time-effective remedial technique. However, use of vapor extraction in combination with other ground water remediation strategies (i.e., ground water pumping or air sparging) can produce a synergistic effect that results in both time- and cost-effective remediation.

5.2.4 Vapor Extraction With Air Sparging

The use of air sparging can enhance the effectiveness of vapor extraction for removing dissolved hydrocarbons from ground water. Sparging air into the water table within the zone of influence of the vapor extraction well(s) can speed remediation by means of air stripping dissolved hydrocarbons from the ground water as the air passes through the ground water enroute to the vapor extraction well(s). Furthermore, introduction of the air via sparging would provide additional oxygen for enhancing the biologic breakdown of hydrocarbon compounds in the subsurface. With strategically located sparge points, air sparging has the additional possible benefit of controlling the migration of dissolved hydrocarbons in ground water.

Subsurface conditions (such as low permeability) which may limit the potential effectiveness of vapor extraction do not necessarily limit the effectiveness of air sparging. Air can possibly be delivered into the subsurface at sufficient pressure to force flow through the low permeability soil units.

Sparging can be particularly favorable from an economic standpoint if used with vapor extraction to control migration and eliminate the need for ground water pumping. Combined with both vapor extraction and ground water pumping, sparging could contribute to the most-expedient remediation possible at this site.

6.0 RECOMMENDATIONS FOR INTERIM REMEDIATION AND ADDITIONAL ASSESSMENT

Based on data compiled for this site and the analysis of remedial alternatives discussed in Section 5.0, AMV proposes the use of vapor extraction to accomplish remediation of soil at the site. For interim remediation of ground water, AMV proposes pumping of monitoring wells MW-4 and MW-5, and proposed monitoring well MW-9, with evaluation of the extent of the resultant capture zone after the system has operated for 4 to 6 months. Proposed monitoring well MW-9 would be located near the southwestern corner of the site, as discussed in Section 4.2 and shown on Figure 8. To achieve the most time-expedient remediation of ground water, AMV also proposes to install an air sparging system.

6.1 VAPOR EXTRACTION SYSTEM

The proposed vapor extraction system will consist of a vacuum blower connected to the existing monitoring wells and the proposed vapor extraction and monitoring well shown on Figure 8. The radii of vacuum influence depicted on Figure 8 around VW-1, the proposed vapor extraction well, should encompass most of the soil in the vadose zone believed to contain petroleum hydrocarbons. This zone of vacuum influence will be accomplished using a blower of sufficient capacity to induce a vacuum of approximately 14 inches of mercury. Inclusion of monitoring wells MW-1, MW-2, MW-3, MW-4, MW-5, MW-8, and proposed monitoring well MW-9 in the vapor extraction system will insure vacuum influence at the periphery of the vacuum zone surrounding VW-1. Extraction from monitoring well MW-8 should additionally address any hydrocarbons remaining in the vicinity of the former waste oil tank excavation.

As shown on Figure 9, a valved manifold will allow the control of flow from each extraction point. This arrangement allows the system to simultaneously pull soil vapors from virtually all vadose impacted areas, or alternatively, from specific extraction points in the vicinity of soil containing the highest TPHg concentrations. Figure 9 also illustrates that carbon adsorption vessels will remove entrained hydrocarbons before discharge to atmosphere.

6.2 GROUND WATER PUMPING

As an interim ground water remediation measure, AMV proposes the pumping of existing monitoring wells MW-4 and MW-5, and proposed monitoring well MW-9, to recover and inhibit the migration of ground water containing petroleum constituents. Although pumping of monitoring wells MW-4, MW-5 and MW-9 should recover ground water containing the highest concentrations of dissolved petroleum constituents underlying the site, evaluation of the long-term extent of the ground water capture zone is necessary to determine if pumping these wells will adequately address the entire inferred plume of dissolved petroleum constituents.

Figure 10 is a process flow diagram for the proposed ground water pumping system. The figure illustrates that carbon adsorption vessels will remove dissolved hydrocarbons from ground water before discharge to the sanitary sewer.

6.3 AIR SPARGING SYSTEM

To expedite ground water remediation, AMV proposes the installation of six sparging wells as indicated on Figure 8. Sparging wells SP-1 through SP-3 are located to assist in removal of dissolved hydrocarbons from ground water in the vicinity of the underground storage tanks, while SP-4 and SP-6 should assist in the removal and/or migration control of dissolved hydrocarbons in the vicinity of the downgradient property boundary. The piping of the sparging system will be similar to the vapor extraction system in that the supply line to each sparging well will have a valve to control the flow of air to each sparging point. This will allow simultaneous sparging of all wells, sparging only the wells of highest hydrocarbon concentrations, or alternating (pulsing) the flow to different wells.

6.4 Remediation System Permit Requirements and Project Schedule

After approval of this plan by Alameda County, completing final design of the remediation system will take about 3 weeks. After completion of final design, AMV expects that applying for and obtaining permits from the Alameda County Building Department, the Bay Area Air Quality Management District, and the San Leandro Water Pollution Control Division (sanitary sewer) will take about 2 months. Once permitted, installation of the remediation system should take about 1 month. A tentative project schedule is illustrated on Figure 11.

7.0 REMARKS

The opinions and conclusions contained in this report represent our professional opinions. These opinions are based, in part, on information provided by the client and were developed in accordance with currently accepted hydrogeologic and engineering practices at this time and location. Other than this, no warranty is implied nor intended.

It is recommended that copies of this report be submitted to:

Mr. Scott Seery
Department of Environmental Health
Alameda County Health Care Agency
80 Swan Way, Room 200
Oakland, CA 94621

Local Program Coordinator for Alameda County
California Regional Water Quality Control Board,
San Francisco Bay Region
2101 Webster Street, Suite 500
Oakland, California 94612

TABLE 1

SOIL SAMPLE ANALYTICAL RESULTS
Concentrations in parts per million (ppm)
Beacon Station #720
1088 Marina Boulevard, San Leandro, CA

Boring No.	Sample No.	Date Sampled	Depth (feet below grade)	Benzene	Toluene	Ethylbenzene	Total Xylenes	TPHg[a]	THC[b]
MW-1	C3	03-30-87	14	2.7	28.0	NA	74.2	NA	327
MW-2	C3	03-30-87	14	1.3	10.4	NA	18.8	NA	83
MW-3	C3	03-30-87	14	ND	ND	NA	ND	NA	ND
MW-4	C3	03-30-87	14	16.8	129.1	NA	427.3	NA	2,108
MW-5	C3	03-30-87	14	7.9	91.6	NA	228.2	NA	983
1	1B	07-07-87	9.5	<0.1	<0.1	NA	<0.1	NA	<1.0
1	1C	07-07-87	14.5	32	110	NA	170	NA	1,000
2	2B	07-07-87	9.5	<0.1	<0.1	NA	<0.1	NA	<1.0
2	2C	07-07-87	14.5	5.8	26	NA	45	NA	220
3	3B	07-07-87	9.5	0.69	0.19	NA	<0.1	NA	10
3	3C	07-07-87	14.5	23	100	NA	150	NA	910
4	4B	07-07-87	9.5	<0.1	<0.1	NA	<0.1	NA	<1.0
4	4C	07-07-87	14.5	18	75	NA	110	NA	560
B-2	2-2	08-15-91	10	0.22	0.088	0.071	0.270	2.1	NA
B-3	3-2	08-15-91	14	3.6	19	9.1	48	560	NA
B-4	4-3	09-19-91	13.5	ND	ND	ND	ND	ND	NA
B-5	5-3	09-19-91	13.0	ND	ND	ND	ND	ND	NA
B-6	6-3	09-19-91	10.0	ND	ND	ND	ND	ND	NA
B-7	7-3	09-20-91	13.5	ND	ND	ND	ND	ND	NA
MW-6	#1	10-10-91	5.0	ND	ND	ND	ND	ND	NA

TABLE 1 (continued)

SOIL SAMPLE ANALYTICAL RESULTS
Concentrations in parts per million (ppm)
Beacon Station #720
1088 Marina Boulevard, San Leandro, CA

Boring No.	Sample No.	Date Sampled	Depth (feet below grade)	Benzene	Toluene	Ethylbenzene	Total Xylenes	TPHg[a]	THC[b]
MW-6	#2	10-10-91	10.0	ND	ND	ND	ND	ND	NA
MW-6	#3	10-10-91	15.0	ND	0.035	0.011	0.047	11	NA
MW-6	#4	10-10-91	20.0	ND	ND	ND	ND	ND	NA
MW-6	#5	10-10-91	25.0	ND	ND	ND	ND	ND	NA
MW-7	#1	10-10-91	7.0	ND	ND	ND	ND	ND	NA
MW-7	#2	10-10-91	10.0	ND	ND	ND	ND	ND	NA
MW-7	#3	10-10-91	13.5	ND	ND	ND	ND	ND	NA
MW-7	#4	10-10-91	15.0	ND	ND	ND	ND	ND	NA
MW-7	#5	10-10-91	20.0	ND	ND	ND	ND	ND	NA
MW-7	#6	10-10-91	25.0	ND	ND	ND	ND	ND	NA
MW-8	#1	10-11-91	5.0	ND	0.010	ND	0.011	ND	NA
MW-8	#2	10-11-91	10.0	ND	ND	ND	0.008	ND	NA
MW-8	#3	10-11-91	13.5	0.012	ND	ND	0.027	ND	NA
MW-8	#4	10-11-91	18.0	0.670	4.800	3.300	20.000	290	NA
MW-8	#5	10-11-91	25.0	0.014	0.056	0.020	0.150	2.6	NA
MW-8	#6	10-11-91	30.0	ND	ND	ND	0.010	ND	NA

[a]TPHg = total petroleum hydrocarbons as gasoline.
[b]THC = total hydrocarbon content.

NA = not applicable.
ND = not detected.

TABLE 2

GROUND WATER MEASUREMENTS
Beacon Station #720
1088 Marina Boulevard, San Leandro, CA

Monitoring Well	Date	Well Head Elevation (feet)	Depth to Ground Water (feet)	Ground Water Elevation (feet)
MW-1	03-30-92	33.10	13.58	19.52
	07-01-92		14.80	18.30
	09-30-92		16.12	16.98
	11-19-92		16.34	16.76
	02-03-93		12.61	20.49
	05-25-93		13.12	19.98
	09-22-93		14.18	18.92
	12-21-93		14.36	18.74
MW-2	03-30-92	32.80	13.32	19.48
	07-01-92		14.42	18.38
	09-30-92		15.78	17.02
	11-19-92		15.99	16.81
	02-03-93		12.31	20.49
	05-25-93		12.97	19.83
	09-22-93		14.32	18.48
	12-21-93		14.52	18.28
MW-3	03-30-92	32.30	12.96	19.34
	07-01-92		14.00	18.30
	09-30-92		15.36	16.94
	11-19-92		15.57	16.73
	02-03-93		11.96	20.34
	05-25-93		14.12	18.18
	09-22-93		13.88	18.42
	12-21-93		14.12	18.18
MW-4	03-30-92	32.90	13.60	19.30
	07-01-92		15.72	17.18
	09-30-92		16.04	16.86
	11-19-92		16.21	16.69
	02-03-93		12.70	20.20
	05-25-93		12.97	19.93
	09-22-93		14.51	18.39
	12-21-93		14.75	18.15

TABLE 2 (continued)

GROUND WATER MEASUREMENTS
Beacon Station #720
1088 Marina Boulevard, San Leandro, CA

Monitoring Well	Date	Well Head Elevation (feet)	Depth to Ground Water (feet)	Ground Water Elevation (feet)
MW-5	03-30-92	32.70	13.48	19.22
	07-01-92		14.58	18.12
	09-30-92		15.82	16.88
	11-19-92		16.00	16.70
	02-03-93		12.40	20.30
	05-25-93		13.01	19.69
	09-22-93		14.37	18.33
	12-21-93		14.58	18.12
MW-6	03-30-92	30.40	12.62	17.78
	07-01-92		12.70	17.70
	09-30-92		13.40	17.00
	11-19-92		13.59	16.81
	02-03-93		12.43	17.97
	05-25-93		--	--
	10-11-93		12.82	17.58
	12-21-93		13.06	17.34
MW-7	03-30-92	31.20	12.34	18.86
	07-01-92		15.54	15.66
	09-30-92		14.64	16.56
	11-19-92		14.80	16.40
	02-03-93		11.36	19.84
	05-25-93		--	--
	09-22-93		13.18	18.02
	12-21-93		13.42	17.78
MW-8	03-30-92	33.80	14.66	19.14
	07-01-92		15.74	18.06
	09-30-92		17.00	16.80
	11-19-92		17.01	16.79
	02-03-93		13.83	19.97
	05-25-93		13.01	20.79
	09-22-93		15.81	17.99
	12-21-93		16.05	17.75

TABLE 3

GROUND WATER ANALYTICAL REPORTS
Beacon Station #720
1088 Marina Boulevard, San Leandro, CA
Concentrations in parts per billion (ppb)

Monitoring Well	Date Collected	Benzene	Toluene	Ethylbenzene	Total Xylenes	TPHg[a]
MW-1	03-30-92	630	550	540	1,900	27,000
	07-01-92	840	1,000	830	3,600	55,000
	09-30-92	150	95	120	470	6,400
	11-19-92	90	11	50	87	1,300
	02-03-93	750	560	950	5,700	53,000
	05-25-93	200	86	470	1,500	9,400
	09-22-93	1,000	510	850	1,100	41,000
	12-21-93	1,000	490	2,700	13,000	41,600
MW-2	03-30-92	2,300	1,700	940	3,300	52,000
	07-01-92	3,500	2,900	1,900	7,900	130,000
	09-30-92	890	350	500	1,700	24,000
	11-19-92	1,900	1,700	870	3,400	32,000
	02-03-93	1,900	2,200	860	4,100	64,000
	05-25-93	3,300	1,500	1,300	5,900	34,000
	09-22-93	640	150	270	2,000	8,000
	12-21-93	1,500	410	1,300	5,000	18,000
MW-3	03-30-92	560	50	630	980	21,000
	07-01-92	150	20	22	300	13,000
	09-30-92	53	2.6	84	96	4,500
	11-19-92	73	6.2	140	120	4,700
	02-03-93	220	40	430	740	23,000
	05-25-93	120	26	370	520	9,900
	09-22-93	370	71	320	640	10,000
	12-21-93	130	8.5	430	380	7,800
MW-4	03-30-92	8,000	4,400	730	2,500	76,000
	07-01-92	6,900	2,200	70	880	95,000
	09-30-92	7,100	1,500	650	2,700	58,000
	11-19-92	5,500	840	400	1,400	33,000
	02-03-93	8,200	6,700	940	4,400	130,000
	05-25-93	16,000	6,600	1,700	8,100	63,000
	09-22-93	6,900	940	150	3,000	23,000
	12-21-93	8,900	1,900	1,100	5,500	28,000

TABLE 3 (continued)

GROUND WATER ANALYTICAL REPORTS
Beacon Station #720
1088 Marina Boulevard, San Leandro, CA
Concentrations in parts per billion (ppb)

Monitoring Well	Date Collected	Benzene	Toluene	Ethylbenzene	Total Xylenes	TPHg[a]
MW-5	03-30-92	2,600	980	390	1,100	29,000
	07-01-92	2,400	1,000	5,200	2,000	52,000
	09-30-92	1,800	780	370	1,700	32,000
	11-19-92	1,000	280	120	370	7,800
	02-03-93	3,500	3,000	780	3,200	74,000
	05-25-93	7,900	4,700	1,900	7,800	57,000
	09-22-93	7,600	2,400	1,200	8,800	52,000
	12.21-93	3,600	1,200	970	3,600	23,000
MW-6	03-30-92	2.1	1.1	ND[b]	0.6	73
	07-01-92	ND	ND	ND	ND	ND
	09-30-92	0.73	ND	ND	0.58	ND
	11-19-92	1.5	<0.5	<0.5	0.9	96
	02-03-93	0.6	<0.5	<0.5	<0.5	73
	05-25-93	NS	NS	NS	NS	NS
	10-11-93	<0.5	<0.5	<0.5	<0.5	<50
	12-21-93	<0.5	<0.5	<0.5	<0.5	<50
MW-7	03-30-92	ND	ND	ND	ND	ND
	07-01-92	ND	ND	ND	ND	ND
	09-30-92	ND	ND	ND	ND	ND
	11-19-92	<0.5	<0.5	<0.5	<0.5	<50
	02-03-93	<0.5	<0.5	<0.5	<0.5	<50
	05-25-93	NS[c]	NS	NS	NS	NS
	09-22-93	0.51	0.82	<0.5	0.81	<50
	12-21-93	<0.5	<0.5	<0.5	<0.5	<50
MW-8	03-30-92	1,700	880	970	1,900	3,000
	07-01-92	1,800	550	520	2,200	72,000
	09-30-92	680	140	140	560	12,000
	11-19-92	530	310	130	560	9,600
	02-03-93	1,500	1,300	490	2,300	44,000
	05-25-93	580	160	170	480	7,400
	09-22-93	490	45	37	140	2,400
	12-21-93	240	7.5	<2.5	82	1,400

[a]TPHg = total petroleum hydrocarbons as gasoline.
[b]ND = not detected.
[c]NS = not sampled.

TABLE 4

SUMMARY OF MOBILE LABORATORY ANALYTICAL RESULTS
FOR GROUND WATER SAMPLES COLLECTED BY EGC, INC.
AUGUST 15 - NOVEMBER 5, 1991
(concentrations in parts per billion)

Sample Location	Date	Benzene	Toluene	Ethylbenzene	Xylenes	TPHg[a]	Laboratory
B-1	08-15-91	14,000	5,700	2,400	9,600	72,000	Sequoia Mobile
B-5	09-20-91	ND[b]	8.8	ND	ND	ND	Applied Analytical Mobile
B-6	09-20-91	490	37	130	360	3,100	Applied Analytical Mobile
MW-7	10-17-91	ND	ND	ND	ND	ND	Applied Analytical Mobile
MW-8	10-24-91	2,400	4,700	1,500	9,000	130,000	Applied Analytical Mobile
MW-6	11-05-91	ND	ND	ND	ND	120	Applied Analytical Mobile

[a]TPHg = Total petroleum hydrocarbons as gasoline.
[b]ND = Nondetectable.

TABLE 5

AQUIFER TEST
GROUND WATER SAMPLE ANALYTICAL RESULTS
MW-4, OCTOBER 5, 1993
Beacon Station #720
1088 Marina Boulevard, San Leandro, CA
Concentrations in milligrams per liter (mg/l)

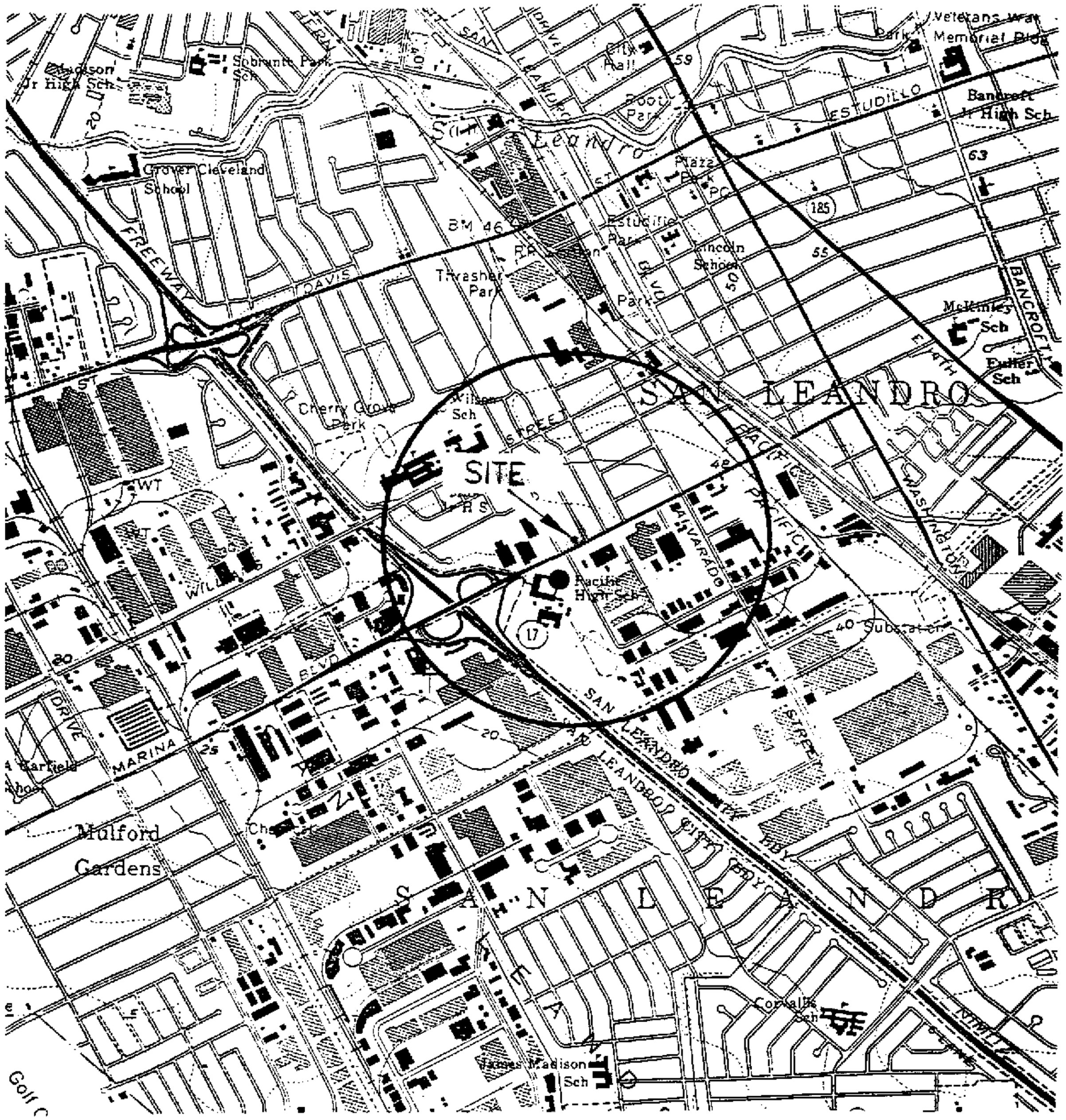
Test Parameter		Units	Test Result	Detection Limit
Hardness as $CaCO_3$ by EPA 130.2		mg/l	550	1
Sulfate by EPA 300.0		mg/l	9.9	0.5
Chloride by EPA 300.0		mg/l	23	0.5
pH by EPA 150.1 (Electrometric)		pH units	6.6	--
Alkalinity, Total ($CaCO_3$) EPA 310.1		mg/l	550	2.0
Hydroxide Alkalinity (OH)		mg/l	ND	0.2
Carbonate Alkalinity (CO_3)		mg/l	ND	1.2
Bicarb Alkalinity (HCO_3)		mg/l	670	2.4
EC by EPA 120.1		µmhos/cm	1,130	1
Total Dissolved Solids, EPA 160.1		mg/l	620	15
MBAS as LAS (MW 340), EPA 425.1		mg/l	0.7	0.01
Calcium	EPA 200.7	mg/l	99	0.050
Copper	EPA 200.7	mg/l	ND	0.020
Iron	EPA 200.7	mg/l	ND	0.030
Magnesium	EPA 200.7	mg/l	58	0.050
Manganese	EPA 200.7	mg/l	3.8	0.0050
Potassium	EPA 200.7	mg/l	0.33	0.20
Sodium	EPA 200.7	mg/l	72	0.20
Zinc	EPA 200.7	mg/l	ND	0.0050

TABLE 6

AQUIFER TEST
GROUND WATER SAMPLE ANALYTICAL RESULTS
Beacon Station #720
1088 Marina Boulevard, San Leandro, CA
Concentrations in micrograms per liter (μg/l)

Date Sampled	Sample No.	Benzene	Toluene	Ethylbenzene	Total Xylenes	TPHg[a]	Total Lead
10-05-93	MW-4	5,100	4,900	770	3,600	26,000	

[a]TPHg = total petroleum hydrocarbons as gasoline.



General Notes

Base Map from U.S.G.S.
San Leandro, California
7.5 Minute Topographic
Photorevised 1980

NORTH

QUADRANGLE LOCATION

0 2,000

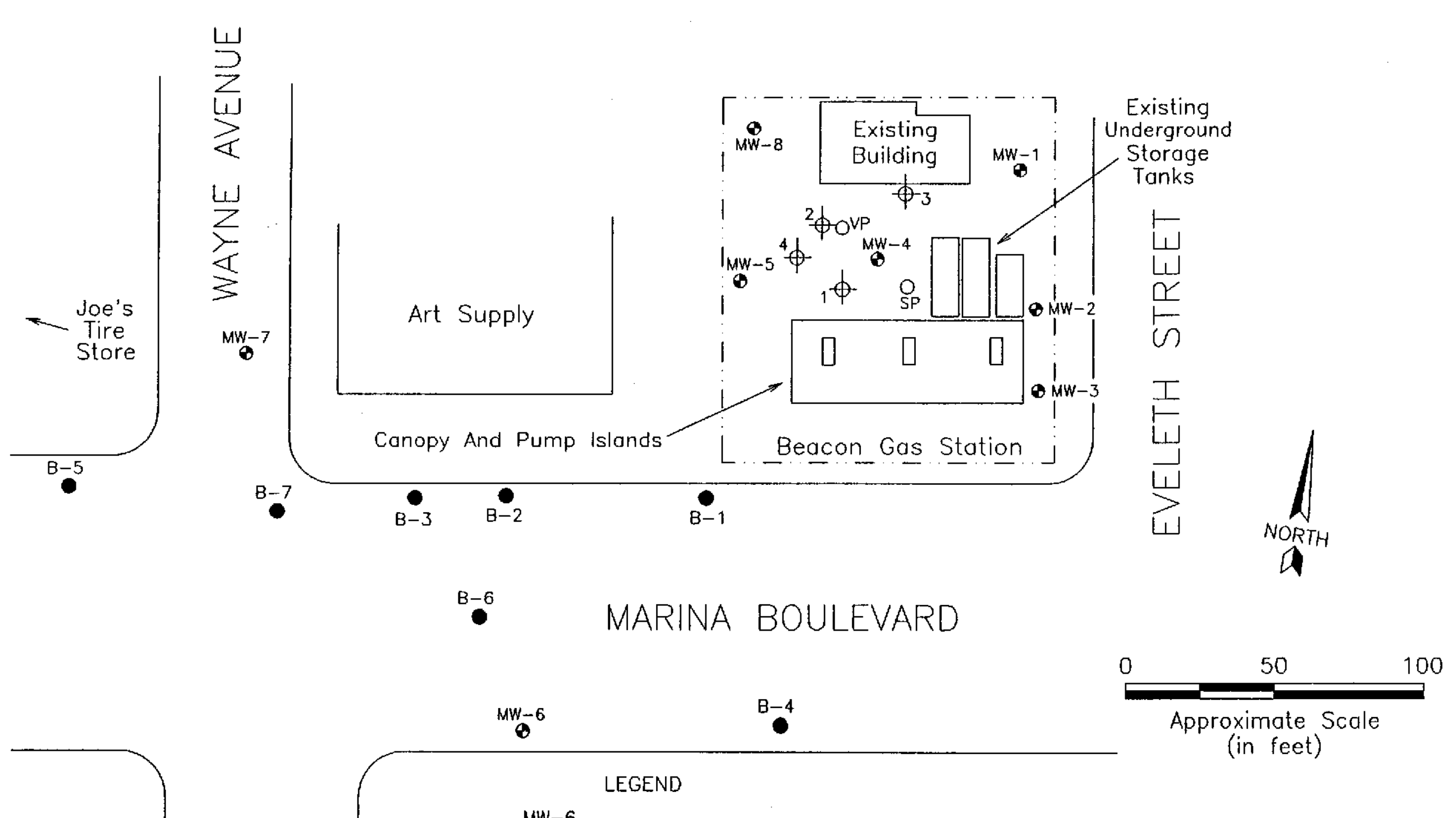
Approximate Scale
(in feet)

FIGURE 1

SITE LOCATION MAP
BEACON STATION #720
1088 MARINA BOULEVARD
SAN LEANDRO, CALIFORNIA

Project No.	Drawn
19030	DA
File No.	Prepared
FIG1	SAL
Revision	Reviewed

Acton • Mickelson • van Dam, Inc.
Consulting Scientists, Engineers, and Geologists
4511 Golden Foothill Parkway, Suite 1
El Dorado Hills, California 95762
(916) 939-7550



LEGEND

- MW-6 — Monitoring Well Location And Number
- 1 — Soil Boring Location And Number (GT1,1987)
- B-2 — Soil Boring Location And Number (EGC,1991)
- VP — Vapor Monitoring Point
- SP — Sparge Point

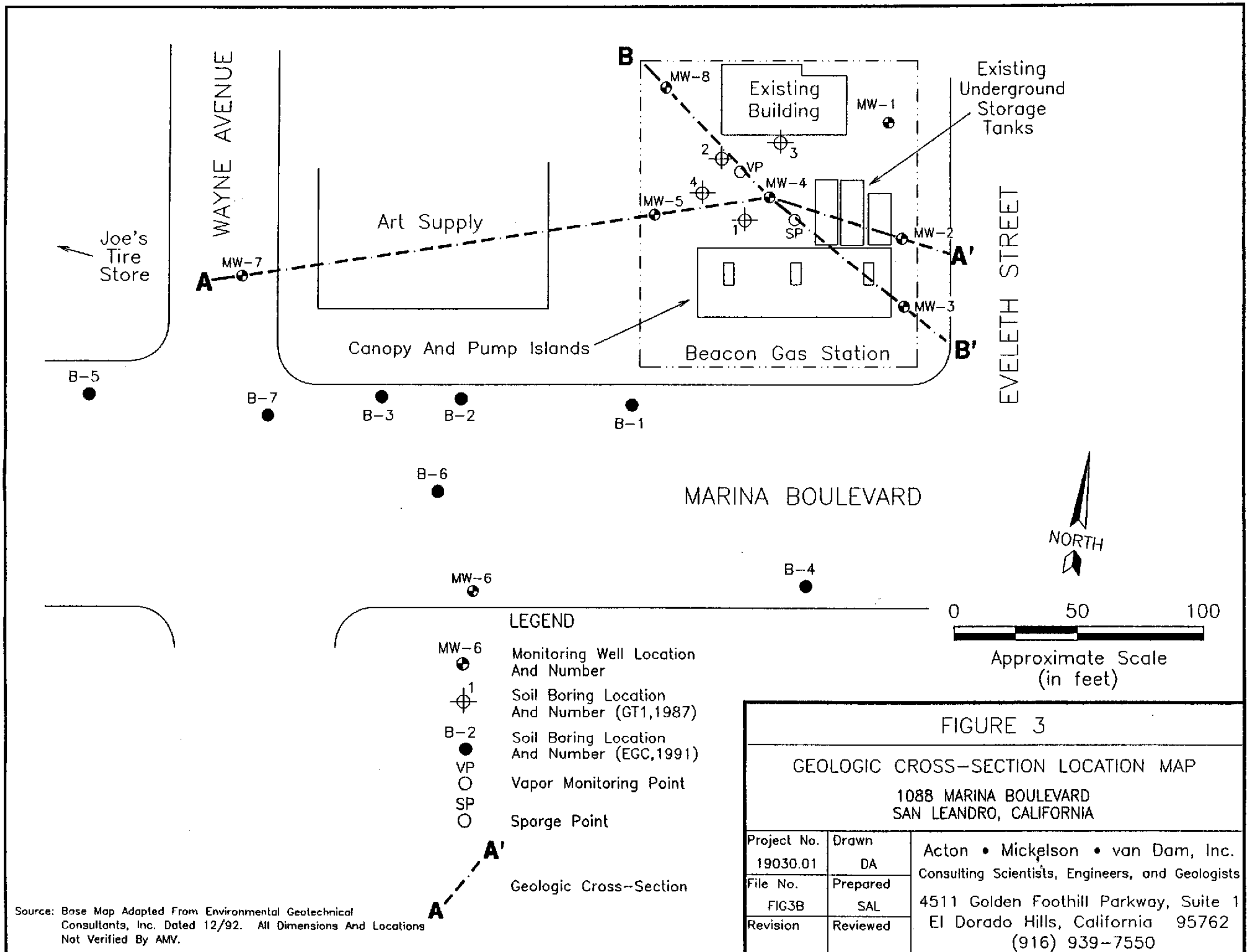
Note: Base Map Adapted From Environmental Geotechnical Consultants, Inc. Dated 12/92. All Dimensions And Locations Not Verified By AMV.

FIGURE 2

SITE MAP
1088 MARINA BOULEVARD
SAN LEANDRO, CALIFORNIA

Project No.	Drawn
19030	LMC
File No.	Prepared
FIG2	SAL 3/11/94
Revision	Reviewed

Acton • Mickelson • van Dam, Inc.
Consulting Scientists, Engineers, and Geologists
4511Golden Foothill Parkway, Suite 1
El Dorado Hills, California 95762
(916) 939-7550



Source: Base Map Adapted From Environmental Geotechnical Consultants, Inc. Dated 12/92. All Dimensions And Locations Not Verified By AMV.

FIGURE 3

GEOLOGIC CROSS-SECTION LOCATION MAP

1088 MARINA BOULEVARD
SAN LEANDRO, CALIFORNIA

Project No.	Drawn	
19030.01	DA	Acton • Mickelson • van Dam, Inc. Consulting Scientists, Engineers, and Geologists
File No.	Prepared	
FIG3B	SAL	4511 Golden Foothill Parkway, Suite 1 El Dorado Hills, California 95762 (916) 939-7550
Revision	Reviewed	

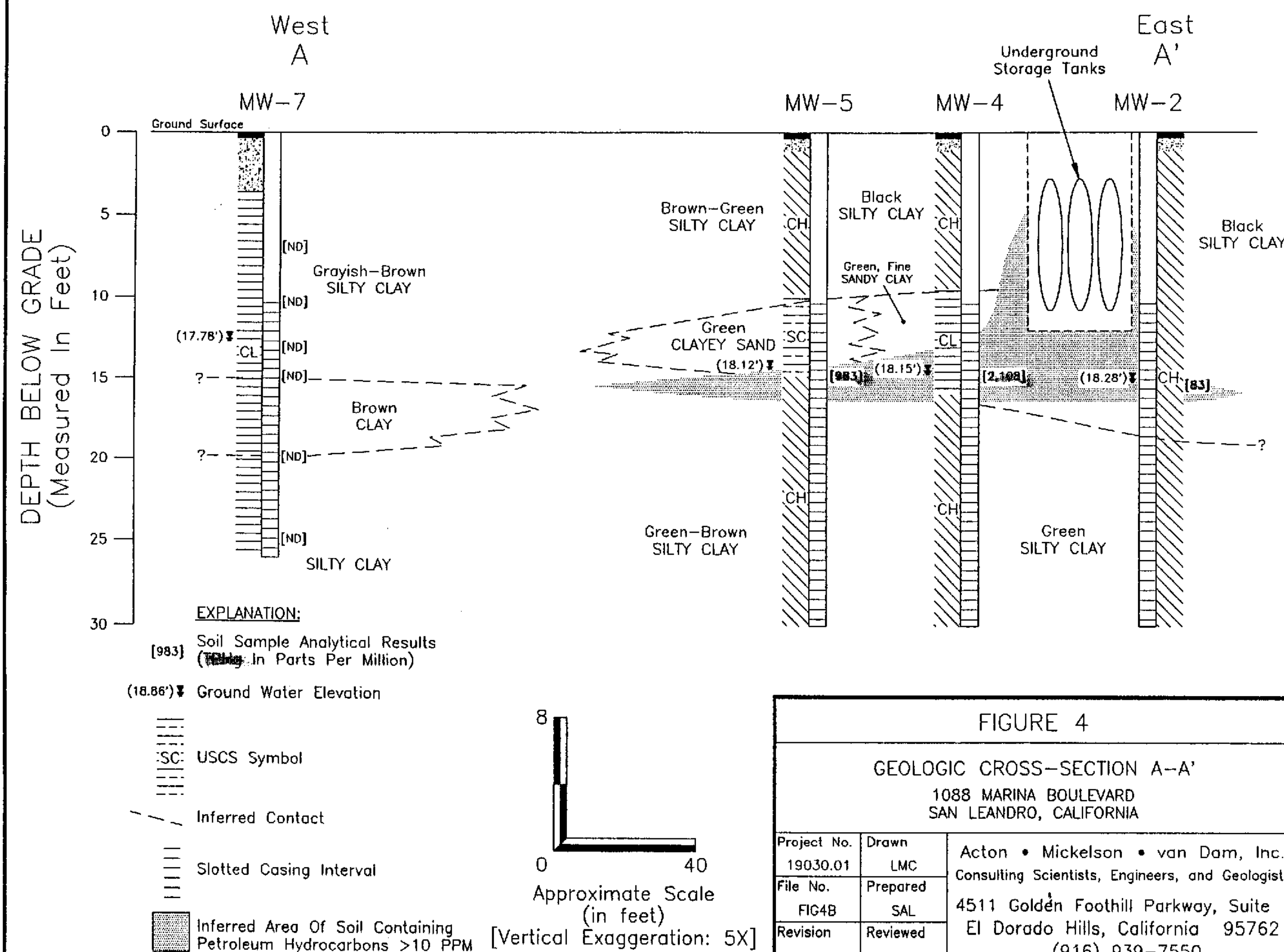


FIGURE 4

GEOLOGIC CROSS-SECTION A-A'
1088 MARINA BOULEVARD
SAN LEANDRO, CALIFORNIA

Project No.	Drawn
19030.01	LMC
File No.	Prepared
FIG4B	SAL
Revision	Reviewed

Acton • Mickelson • van Dam, Inc.
Consulting Scientists, Engineers, and Geologists
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El Dorado Hills, California 95762
(916) 939-7550

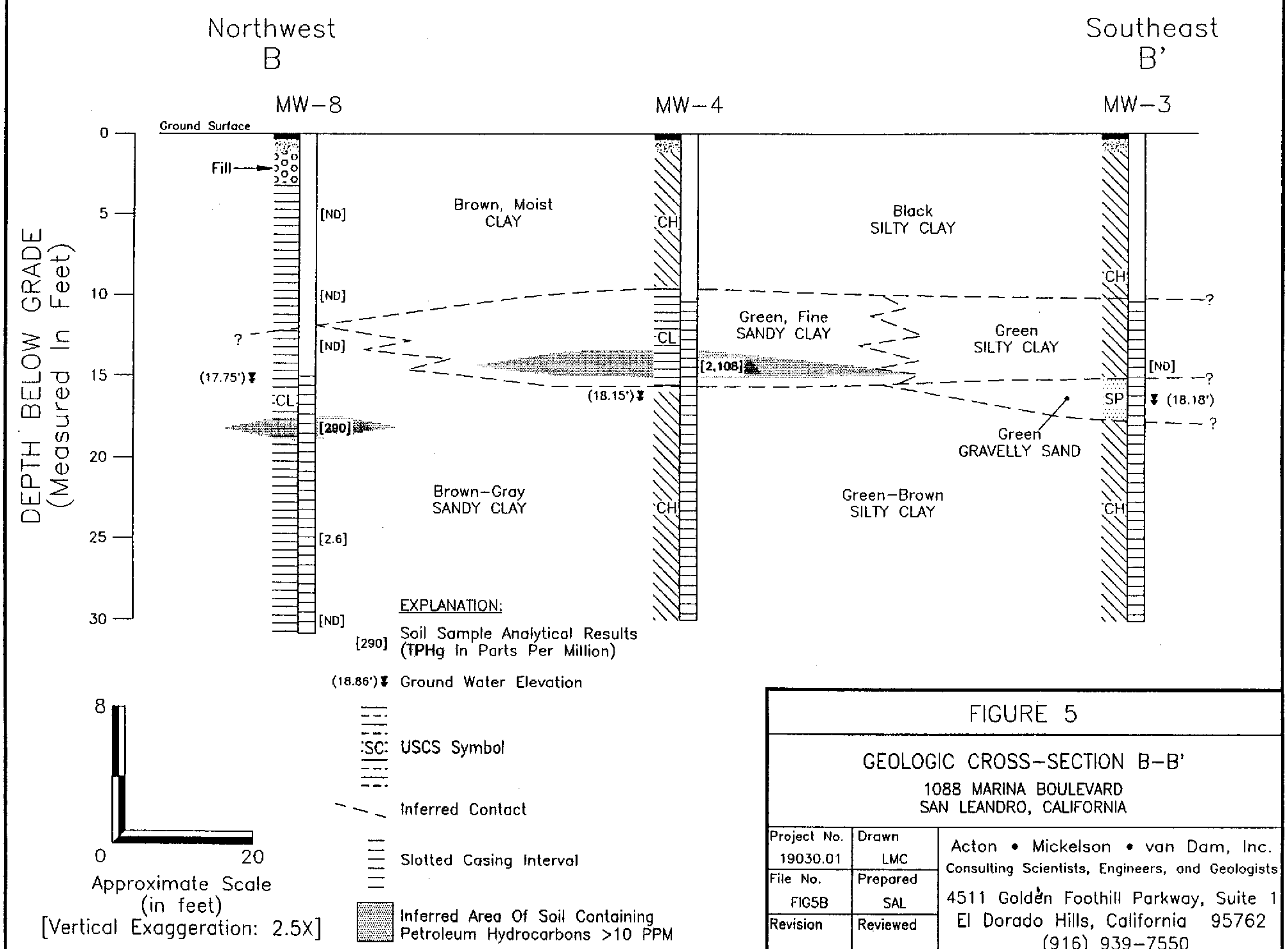


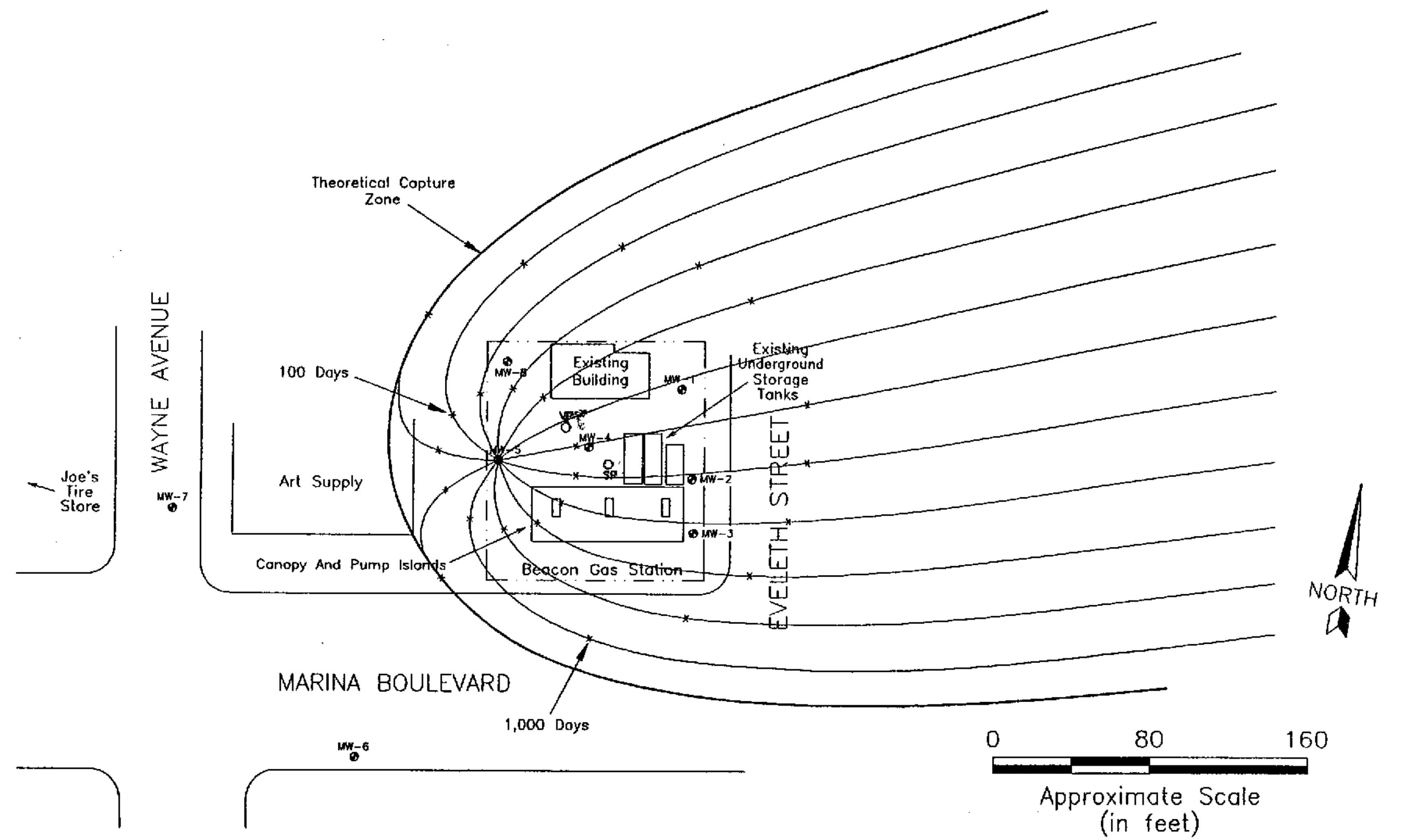
FIGURE 5

GEOLOGIC CROSS-SECTION B-B'

1088 MARINA BOULEVARD
SAN LEANDRO, CALIFORNIA

Project No.	Drawn
19030.01	LMC
File No.	Prepared
FIG5B	SAL
Revision	Reviewed

Acton • Mickelson • van Dam, Inc.
Consulting Scientists, Engineers, and Geologists
4511 Golden Foothill Parkway, Suite 1
El Dorado Hills, California 95762
(916) 939-7550



LEGEND

MW-6 Monitoring Well Location And Number

VP Vapor Monitoring Point

SP Sparge Point

Note: Depicted Capture Zone Is Based On Aquifer Test Data Aquired From Test Performed On MW-4 On 10/4/93-10/5/93 At A Rate Of 1.0 GPM.

Source: Base Map Adapted From Environmental Geotechnical Consultants, Inc. Dated 12/92. All Dimensions And Locations Not Verified By AMV.

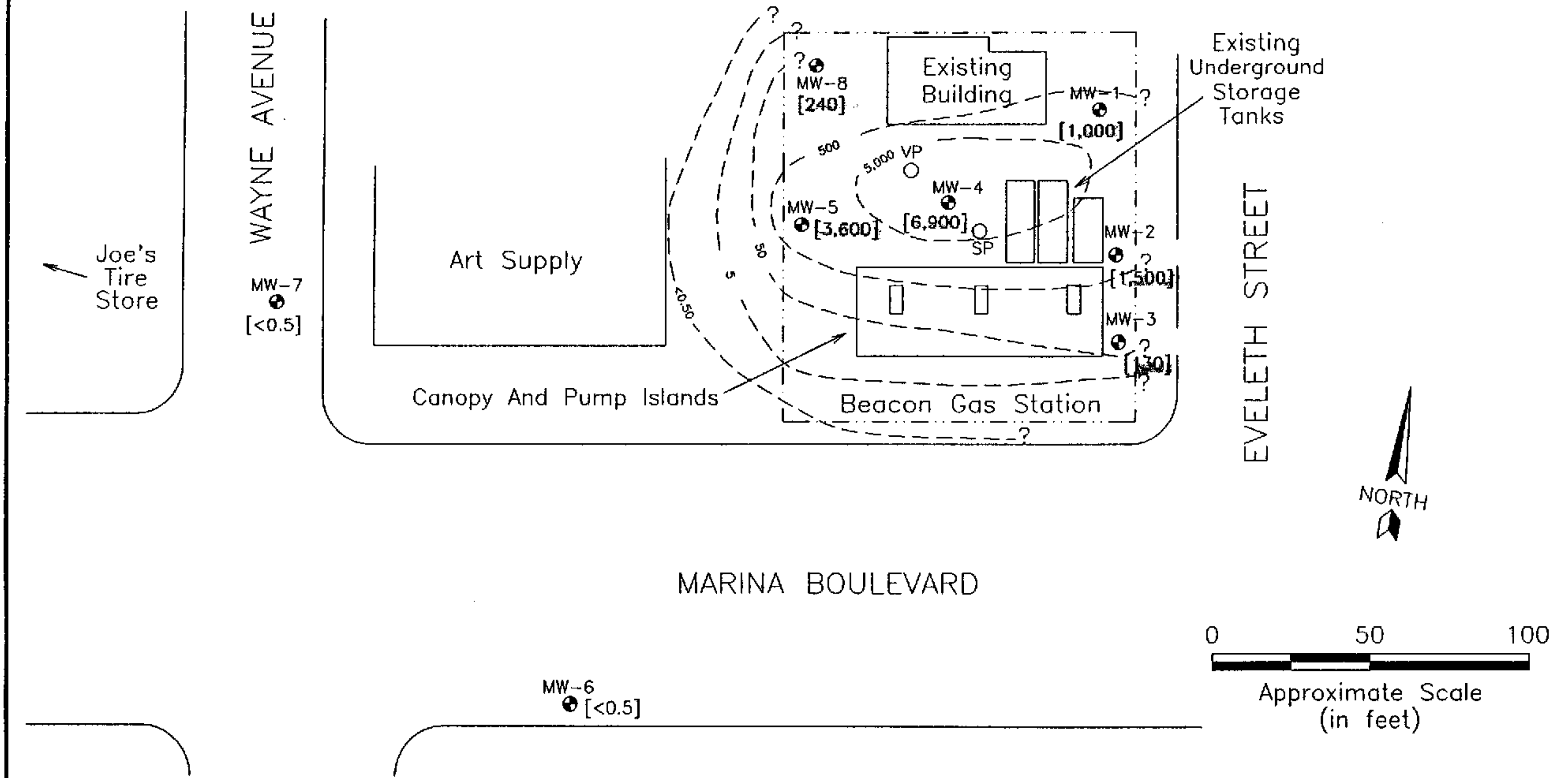
FIGURE 6

THEORETICAL CAPTURE ZONE

1088 MARINA BOULEVARD
SAN LEANDRO, CALIFORNIA

Project No.	Drawn
19030.01	DA
File No.	Prepared
FIG6B	SAL
Revision	Reviewed

Acton • Mickelson • van Dam, Inc.
Consulting Scientists, Engineers, and Geologists
4511 Golden Foothill Parkway, Suite 1
El Dorado Hills, California 95762
(916) 939-7550



LEGEND

MW-6	Monitoring Well Location And Number	[7,600]	Benzene Concentration Measured In Parts Per Billion
VP	Vapor Monitoring Point	1,000	Inferred Benzene Isoconcentration Limits
SP	Sparge Point	[<0.5]	Detection Limit

Note: Base Map Adapted From Aegis Environmental, Inc. Dated 12/93. All Dimensions And Locations Not Verified By AMV.

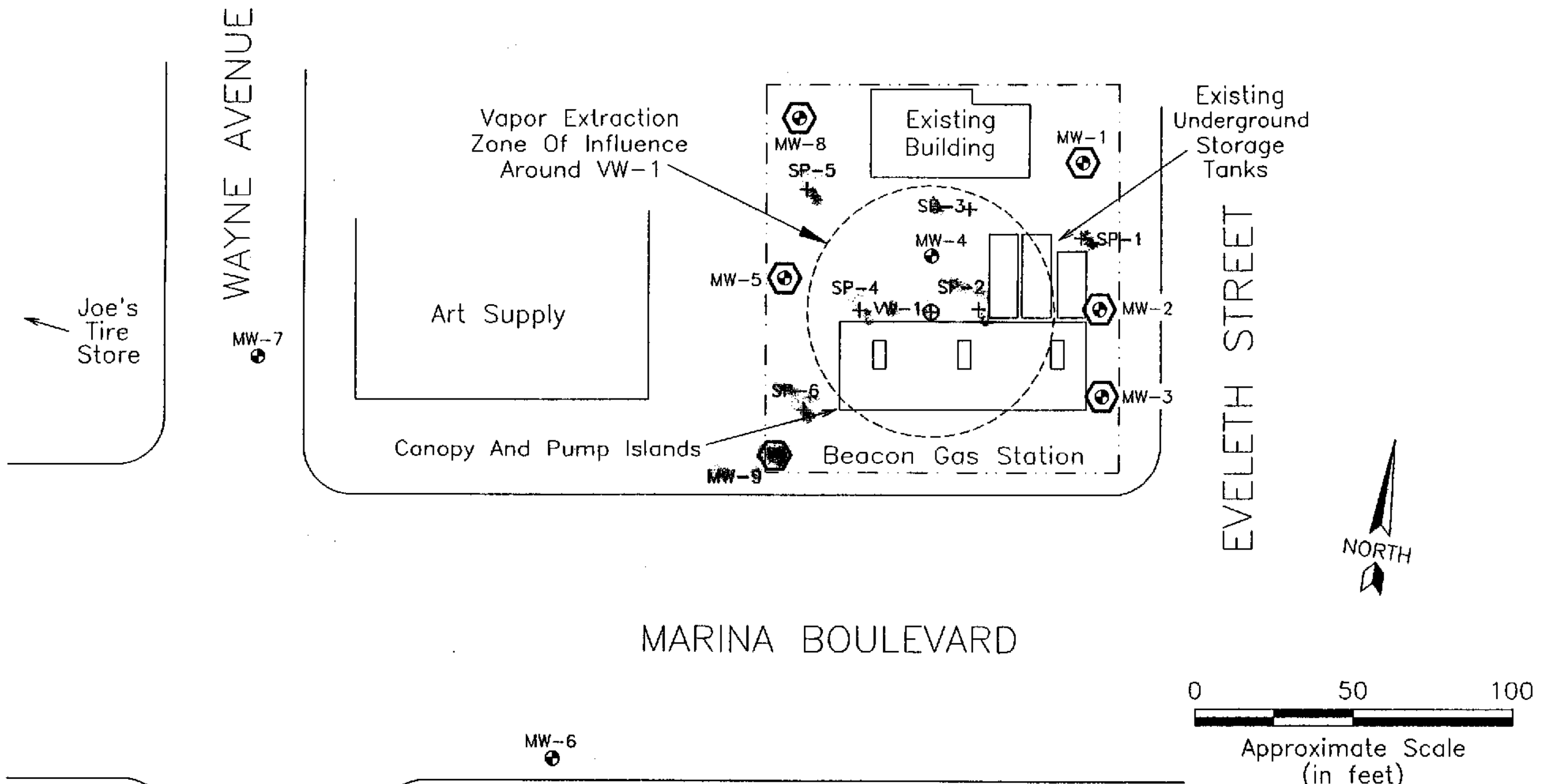
FIGURE 7

BENZENE ISOCONCENTRATION MAP (09/22/93)

1088 MARINA BOULEVARD
SAN LEANDRO, CALIFORNIA

Project No.	Drawn	
19030.01	LMC	
File No.	Prepared	
FIG7	SAL	
Revision	Reviewed	

Acton • Mickelson • van Dam, Inc.
Consulting Scientists, Engineers, and Geologists
4511 Golden Foothill Parkway, Suite 1
El Dorado Hills, California 95762
(916) 939-7550



LEGEND

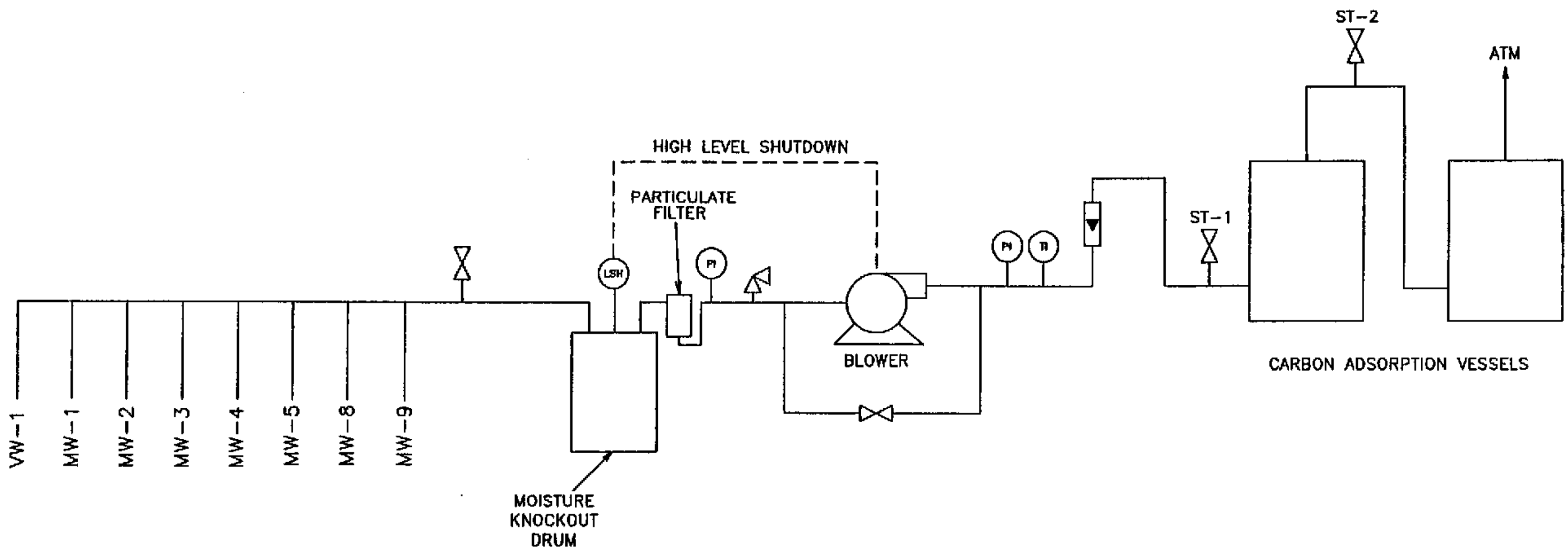
MW-6	Monitoring Well Location And Number
MW-9	Proposed Monitoring Well Location And Number
VW-1	Proposed Vapor Extraction Well Location And Number
MW-8	Monitoring Well/Vapor Extraction Well
SP-5	Proposed Sparge Well Location And Number

Note: Base Map Adapted From Environmental Geotechnical Consultants, Inc. Dated 12/92. All Dimensions And Locations Not Verified By AMV.

FIGURE 8

SITE MAP WITH ZONE OF INFLUENCE
BEACON STATION #720
1088 MARINA BOULEVARD
SAN LEANDRO, CALIFORNIA

Project No.	Drawn	Acton • Mickelson • van Dam, Inc.
19030.01	DA	Consulting Scientists, Engineers, and Geologists
File No.	Prepared	4511 Golden Foothill Parkway, #1
FIG8	SAL	El Dorado Hills, California 95762
Revision	Reviewed	(916) 939-7550



LEGEND:

VALVES

- GATE VALVE
- VACUUM RELIEF VALVE

INSTRUMENTATION

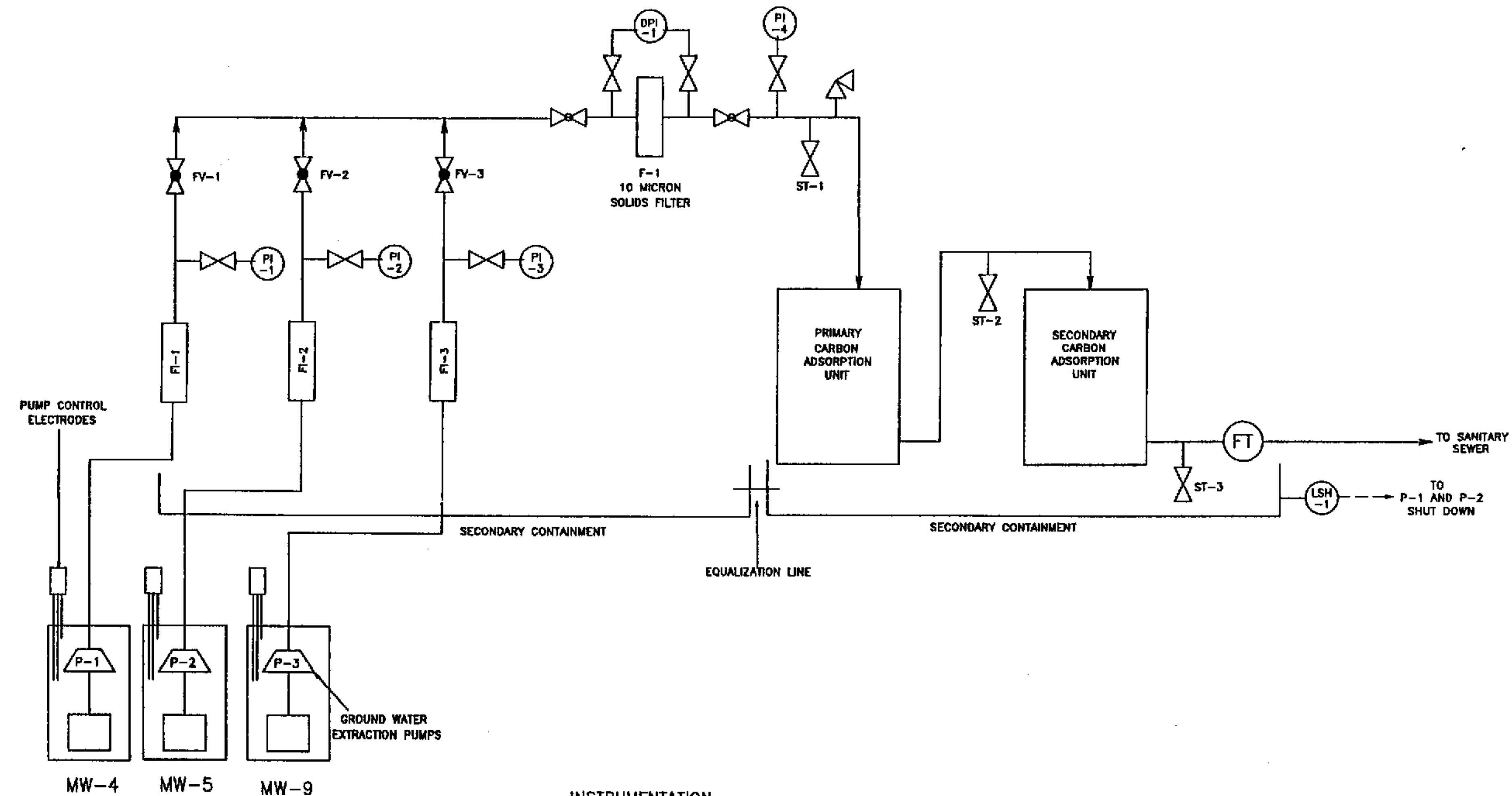
- (PI) PRESSURE INDICATOR
- FLOW METER
- (TI) TEMPERATURE INDICATOR
- (LSH) HIGH LEVEL SWITCH

FIGURE 9

PROCESS FLOW DIAGRAM FOR VAPOR EXTRACTION AND TREATMENT SYSTEM

BEACON STATION #720
1088 MARINA BOULEVARD
SAN LEANDRO, CALIFORNIA

Project No. 19030.01	Drawn DA	Acton • Mickelson • van Dam, Inc. Consulting Scientists, Engineers, and Geologists
File No. 19030F9	Prepared JT	4511 Golden Foothill Parkway, Suite 1
Revision	Reviewed	El Dorado Hills, California 95762 (916) 939-7550



LEGEND:

VALVES

- GATE VALVE
- BALL VALVE
- GLOBE VALVE
- PRESSURE RELIEF VALVE

INSTRUMENTATION

- (PI) PRESSURE INDICATOR
- (DPI) DIFFERENTIAL PRESSURE INDICATOR
- FLOW INDICATOR
- (LSH) HIGH LEVEL SWITCH
- (FT) FLOW TOTALIZER

FIGURE 10
PROCESS FLOW DIAGRAM FOR
GROUND WATER EXTRACTION AND TREATMENT SYSTEM
BEACON STATION #720
1088 MARINA BOULEVARD, SAN LEANDRO, CALIFORNIA

Project No.	Drawn	
19030.01	DA	Acton • Mickelson • van Dam, Inc. Consulting Scientists, Engineers, and Geologists
File No.	Prepared	4511 Golden Foothill Parkway, Suite 1
19030F10	JT	El Dorado Hills, California 95762
Revision	Reviewed	(916) 939-7550

PROJECT SCHEDULE

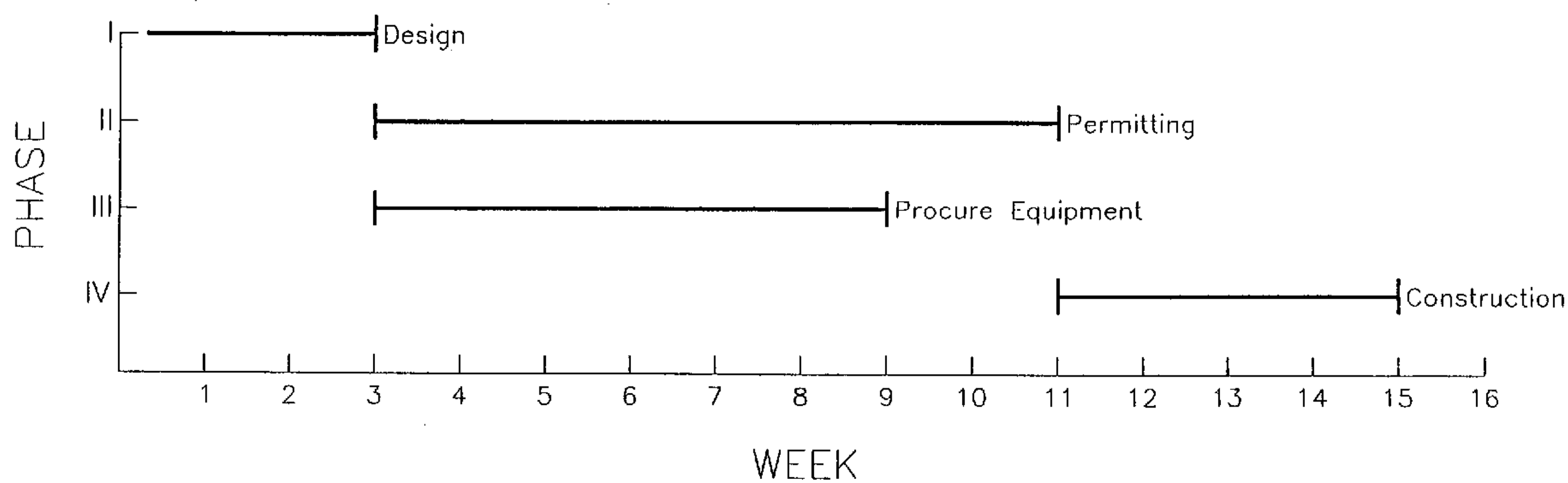


FIGURE 11

PROJECT SCHEDULE
BEACON STATION #720
1088 MARINA BOULEVARD
SAN LEANDRO, CALIFORNIA

Project No.	Drawn	
19030.01	DA	Acton • Mickelson • van Dam, Inc. Consulting Scientists, Engineers, and Geologists
File No.	Prepared	
FIG11	JT	4511 Golden Foothill Parkway, #1 El Dorado Hills, California 95762 (916) 939-7550
Revision	Reviewed	

APPENDIX A

AQUIFER TEST (RAW DATA) AND CALCULATIONS

SE1000C
Environmental Logger
10/07 12:12

Unit# 01919 Test 2

Setups:	INPUT 1	INPUT 2
Type	Level (F)	Level (F)
Mode	TOC	TOC
I.D.	00000	00000
Reference	0.000	0.000
Linearity	0.120	0.040
Scale factor	19.950	10.040
Offset	0.030	0.050
Delay mSEC	50.000	50.000

Step 0 10/04 19:36:32

Elapsed Time	INPUT 1	INPUT 2
0.0000	2.333	0.000
0.0033	2.364	0.000
0.0066	2.402	0.003
0.0100	2.440	0.000
0.0133	2.465	0.000
0.0166	2.496	0.000
0.0200	2.534	0.000
0.0233	2.566	0.003
0.0266	2.597	0.000
0.0300	2.629	0.000
0.0333	2.667	0.000
0.0366	2.692	0.000
0.0400	2.723	0.000
0.0433	2.749	0.000
0.0466	2.780	0.000
0.0500	2.812	0.000
0.0533	2.837	0.000
0.0566	2.862	0.000
0.0600	2.894	0.000
0.0633	2.919	0.000
0.0666	2.950	0.000
0.0700	2.976	0.000
0.0733	2.994	0.000
0.0766	3.020	0.000
0.0800	3.045	0.000
0.0833	3.076	0.000
0.0866	3.095	0.000
0.0900	3.108	0.000
0.0933	3.139	0.000
0.0966	3.171	0.003
0.1000	3.196	0.000
0.1033	3.215	0.000
0.1066	3.240	0.000
0.1100	3.265	0.000
0.1133	3.291	0.000
0.1166	3.316	0.000
0.1200	3.341	0.000
0.1233	3.366	0.003
0.1266	3.385	0.000
0.1300	3.417	0.003
0.1333	3.442	0.003

0.1400	3.486	0.000
0.1433	3.511	0.000
0.1466	3.536	0.003
0.1500	3.555	0.003
0.1533	3.581	0.000
0.1566	3.606	0.000
0.1600	3.625	0.000
0.1633	3.650	0.000
0.1666	3.669	0.003
0.1700	3.694	0.000
0.1733	3.713	0.003
0.1766	3.738	0.003
0.1800	3.757	0.003
0.1833	3.782	0.003
0.1866	3.801	0.003
0.1900	3.820	0.003
0.1933	3.845	0.003
0.1966	3.864	0.003
0.2000	3.877	0.003
0.2033	3.902	0.003
0.2066	3.927	0.003
0.2100	3.946	0.003
0.2133	3.965	0.003
0.2166	3.984	0.003
0.2200	4.009	0.003
0.2233	4.022	0.003
0.2266	4.041	0.003
0.2300	4.066	0.003
0.2333	4.078	0.003
0.2366	4.097	0.003
0.2400	4.122	0.003
0.2433	4.141	0.006
0.2466	4.154	0.003
0.2500	4.179	0.003
0.2533	4.198	0.003
0.2566	4.211	0.003
0.2600	4.230	0.003
0.2633	4.255	0.003
0.2666	4.274	0.003
0.2700	4.286	0.003
0.2733	4.299	0.003
0.2766	4.318	0.006
0.2800	4.343	0.003
0.2833	4.349	0.003
0.2866	4.368	0.003
0.2900	4.387	0.003
0.2933	4.406	0.006
0.2966	4.412	0.006
0.3000	4.431	0.006
0.3033	4.450	0.006
0.3066	4.463	0.003
0.3100	4.482	0.006
0.3133	4.494	0.006
0.3166	4.507	0.003
0.3200	4.519	0.006
0.3233	4.532	0.006
0.3266	4.545	0.006
0.3300	4.557	0.006
0.3333	4.570	0.006
0.3500	4.626	0.006
0.3666	4.677	0.006
0.3833	4.715	0.006
0.4000	4.759	0.009
0.4166	4.809	0.009
0.4333	4.853	0.009

0.4666	4.948	0.009
0.4833	4.992	0.012
0.5000	5.036	0.012
0.5166	5.074	0.012
0.5333	5.124	0.012
0.5500	5.168	0.012
0.5666	5.206	0.015
0.5833	5.250	0.015
0.6000	5.288	0.019
0.6166	5.326	0.015
0.6333	5.370	0.019
0.6500	5.401	0.019
0.6666	5.439	0.019
0.6833	5.477	0.022
0.7000	5.508	0.022
0.7166	5.546	0.022
0.7333	5.578	0.022
0.7500	5.615	0.025
0.7666	5.653	0.025
0.7833	5.685	0.025
0.8000	5.716	0.025
0.8166	5.748	0.025
0.8333	5.779	0.025
0.8500	5.817	0.028
0.8666	5.855	0.028
0.8833	5.886	0.028
0.9000	5.924	0.031
0.9166	5.955	0.031
0.9333	5.981	0.031
0.9500	6.012	0.031
0.9666	6.044	0.034
0.9833	6.075	0.034
1.0000	6.107	0.038
1.2000	6.497	0.044
1.4000	6.850	0.050
1.6000	7.234	0.057
1.8000	7.618	0.063
2.0000	7.977	0.069
2.2000	8.304	0.073
2.4000	8.675	0.076
2.6000	9.059	0.082
2.8000	9.437	0.085
3.0000	9.833	0.089
3.2000	10.393	0.095
3.4000	10.600	0.098
3.6000	10.600	0.101
3.8000	10.607	0.104
4.0000	10.613	0.111
4.2000	10.600	0.111
4.4000	10.613	0.114
4.6000	10.613	0.117
4.8000	10.613	0.120
5.0000	10.613	0.124
5.2000	10.613	0.124
5.4000	10.613	0.127
5.6000	9.588	0.127
5.8000	8.556	0.127
6.0000	7.763	0.127
6.2000	7.271	0.127
6.4000	6.994	0.124
6.6000	6.749	0.124
6.8000	6.547	0.120
7.0000	6.390	0.117
7.2000	6.258	0.117
7.4000	6.144	0.114
[illegible]	[illegible]	[illegible]

7.8000	5.930	0.111
8.0000	5.848	0.108
8.2000	5.785	0.104
8.4000	5.748	0.104
8.6000	5.716	0.104
8.8000	5.685	0.101
9.0000	5.666	0.101
9.2000	5.647	0.101
9.4000	5.628	0.101
9.6000	5.615	0.101
9.8000	5.603	0.098
10.0000	5.590	0.098
12.0000	5.552	0.095
14.0000	5.559	0.098
16.0000	5.552	0.098
18.0000	5.559	0.104
20.0000	5.571	0.104
22.0000	5.609	0.104
24.0000	5.798	0.111
26.0000	6.314	0.111
28.0000	6.447	0.120
30.0000	6.510	0.120
32.0000	6.585	0.127
34.0000	6.604	0.130
36.0000	6.654	0.133
38.0000	6.390	0.136
40.0000	6.636	0.130
42.0000	6.736	0.136
44.0000	6.799	0.143
46.0000	6.824	0.146
48.0000	6.837	0.149
50.0000	6.862	0.149
52.0000	6.856	0.155
54.0000	6.869	0.155
56.0000	6.875	0.158
58.0000	6.913	0.158
60.0000	6.950	0.162
62.0000	6.957	0.165
64.0000	6.969	0.168
66.0000	6.988	0.168
68.0000	6.988	0.168
70.0000	6.982	0.171
72.0000	7.020	0.178
74.0000	7.026	0.178
76.0000	6.818	0.178
78.0000	7.026	0.178
80.0000	7.120	0.181
82.0000	7.164	0.184
84.0000	7.196	0.187
86.0000	7.221	0.184
88.0000	7.227	0.190
90.0000	7.240	0.190
92.0000	7.246	0.193
94.0000	7.265	0.197
96.0000	7.297	0.197
98.0000	7.328	0.197
100.000	7.328	0.200
115.000	7.378	0.216
130.000	7.385	0.232
145.000	7.353	0.238
160.000	7.347	0.251
175.000	7.372	0.257
190.000	7.448	0.267
205.000	7.366	0.270
220.000	7.441	0.279
[illegible]	[illegible]	[illegible]

250.000	7.486	0.292
265.000	7.511	0.298
280.000	7.542	0.302
295.000	7.605	0.305
310.000	7.530	0.311
325.000	7.567	0.317
340.000	7.618	0.321
355.000	7.618	0.324
370.000	7.593	0.324
385.000	7.555	0.330
400.000	7.523	0.333
415.000	7.561	0.337
430.000	7.555	0.337
445.000	7.530	0.343
460.000	7.517	0.346
475.000	7.523	0.349
490.000	7.517	0.349
505.000	7.561	0.352
520.000	7.586	0.356
535.000	7.624	0.356
550.000	7.548	0.359
565.000	7.567	0.365
580.000	7.624	0.365
595.000	7.668	0.368
610.000	7.712	0.371
625.000	7.674	0.375
640.000	7.725	0.378
655.000	7.700	0.381
670.000	7.668	0.384
685.000	7.580	0.387
700.000	7.674	0.391
715.000	7.656	0.391
730.000	7.649	0.397
745.000	7.599	0.397
760.000	7.555	0.400
775.000	7.580	0.400
790.000	10.085	0.426
805.000	10.349	0.432
820.000	8.858	0.422
835.000	9.009	0.429
850.000	9.040	0.429
865.000	8.984	0.432
880.000	8.921	0.432
895.000	8.870	0.438
910.000	8.977	0.441
925.000	9.323	0.438
940.000	9.348	0.448
955.000	9.405	0.448
970.000	9.405	0.454
985.000	9.443	0.448
1000.00	9.386	0.451
1015.00	10.135	0.464
1030.00	10.047	0.460
1045.00	10.192	0.467
1060.00	10.299	0.473
1075.00	10.210	0.467
1090.00	10.437	0.467
1105.00	10.368	0.476
1120.00	10.412	0.476
1135.00	10.343	0.476
1150.00	10.399	0.483
1165.00	10.600	0.480
1180.00	10.607	0.480
1195.00	10.607	0.483
1210.00	10.607	0.486
[illegible]	[illegible]	[illegible]

San Leandro Pumping Test

19030.01

Aquifer test performed: 10/4-5/?

Analysis by: Steven A. Leaty

Aquifer Test Parameters : MW-4

- Pumping rate = 1.90 gpm or 0.254 ft^3/min
- Distance to observation well = 0.01 ft
- Saturated thickness = 30.00-14.58 = 15.42 (1.5) = 22 ft
  - ~ water level on 10/4 ≈ 14.58' below top of casing
  - ~ depth to bottom of screen = 30'
- Depth to top of pumping well screen = Ø
- Depth to bottom of pumping well screen = 15.42 ft
- Hydraulic conductivity ratio (K_z/K_r) = 0.1

: MW-5 (observation well)

- Distance from Pumping Well = 40 ft
- Pumping rate = 0.254 ft^3/min
- Saturated thickness = 22 ft
  - ~ water level on 10/4 ≈ 14.48' below top of casing
  - ~ depth to bottom of well = 30'
- Depth to top of pumping well screen = Ø
- Depth to bottom of pumping well screen = 15.42
- Depth to top of observation well screen = Ø
- Depth to bottom of observation well screen = 15.52

Casing storage affect calculation:

$$t_c = \frac{0.6\,(d_c^2 - d_p^2)}{Q/s}$$

t_c = time of test affected by casing storage (minutes)
d_c = inside diameter of casing
d_p = outside diameter of column pipe (discharge)
Q/s = specific capacity or flowrate divided by drawdown (gpm/ft)

For MW-4:

d_c = 2.0"
d_p = 0.75"
Q = 1.90 gpm
s = drawdown at t_c (guessed and iterated)

① $t_c = \frac{0.6\,[(2.0)^2 - (0.75)^2]}{1.90/1} = \frac{2.06}{1.90} = \underline{\underline{0.16}}$ min

* drawdown at 0.16 minutes into test was 2.3 ft

② $t_c = 2.06/1.90/2.30 = 2.06/0.83 = \underline{\underline{2.48}}$ minutes

- comparison with graphs of drawdown indicates only that portion of the curve well after 3 minutes into the test will be used for analysis.

Estimated Transmissivity Values

Theis:

MW-4, pumping well

$T = 0.081$ ft²/min
$S = 0.0001$

MW-5 @ 40' from pumping well

$T = 0.197$ ft²/min
$S = 0.004$

Cooper-Jacob:

MW-4: $T = 0.069$ ft²/min
$S = 0.0002$

MW-5: $T = 0.230$ ft²/min
$S = 0.0029$

Useful data appears to have been collected throughout the test from both the pumping well (MW-4) and the observation well (MW-5). Average value of all T's using both Theis and Cooper-Jacob analyses is ≃ 0.145 ft^2/min

	Theis	Cooper-Jacob
MW-4	0.081 ft^2/min	0.069 ft^2/min
MW-5	0.197	0.230 ft^2/min
	0.139 ft^2/min	0.150 ft^2/min ≃ 0.145 ft^2/min ← T_{ave}

$T = Kb$ or $K = T/b$

where b = aquifer thickness in feet (sat. thickness)

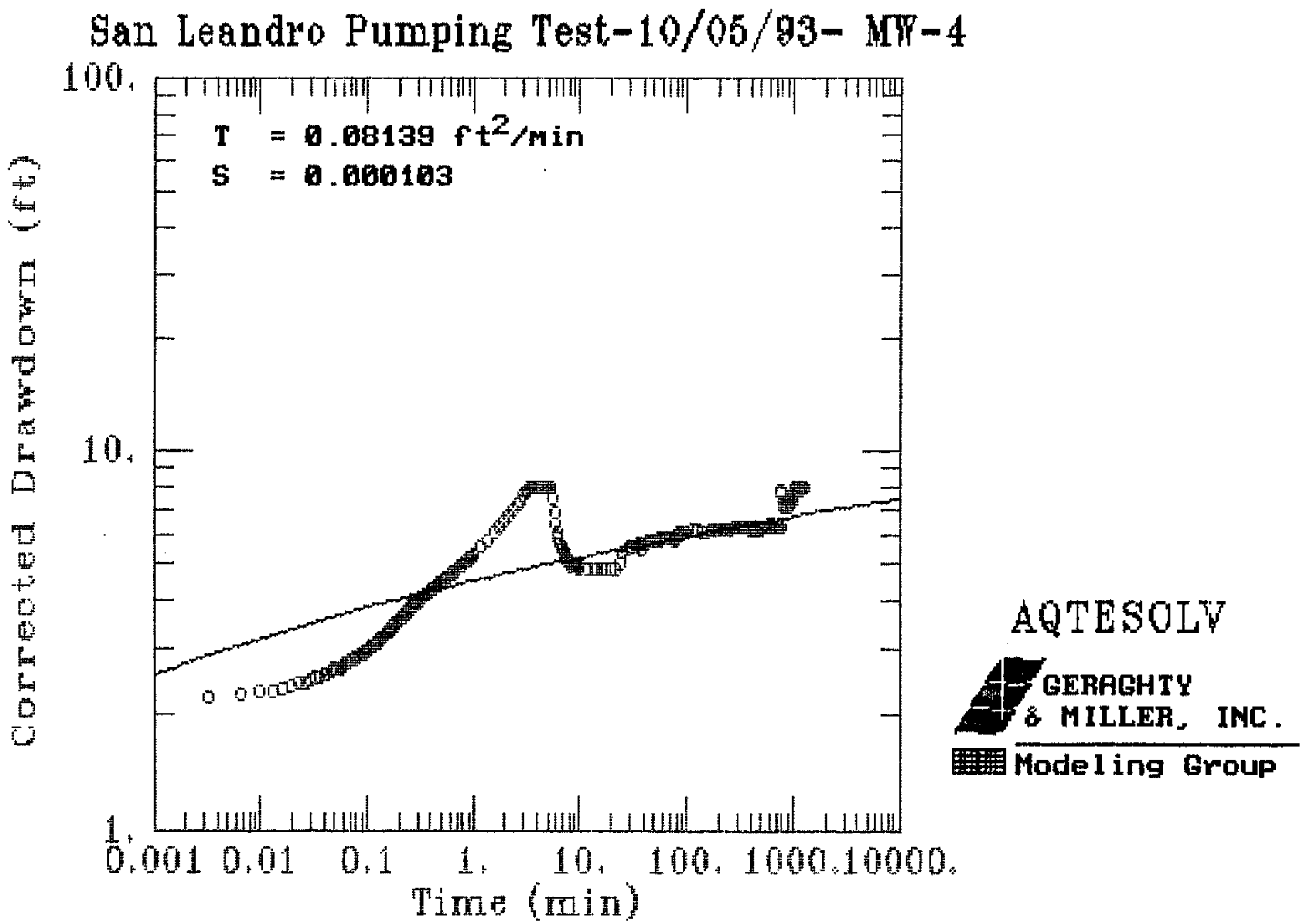
K = Hydraulic conductivity in ft/min

$K = T/b$ b = 22 ft

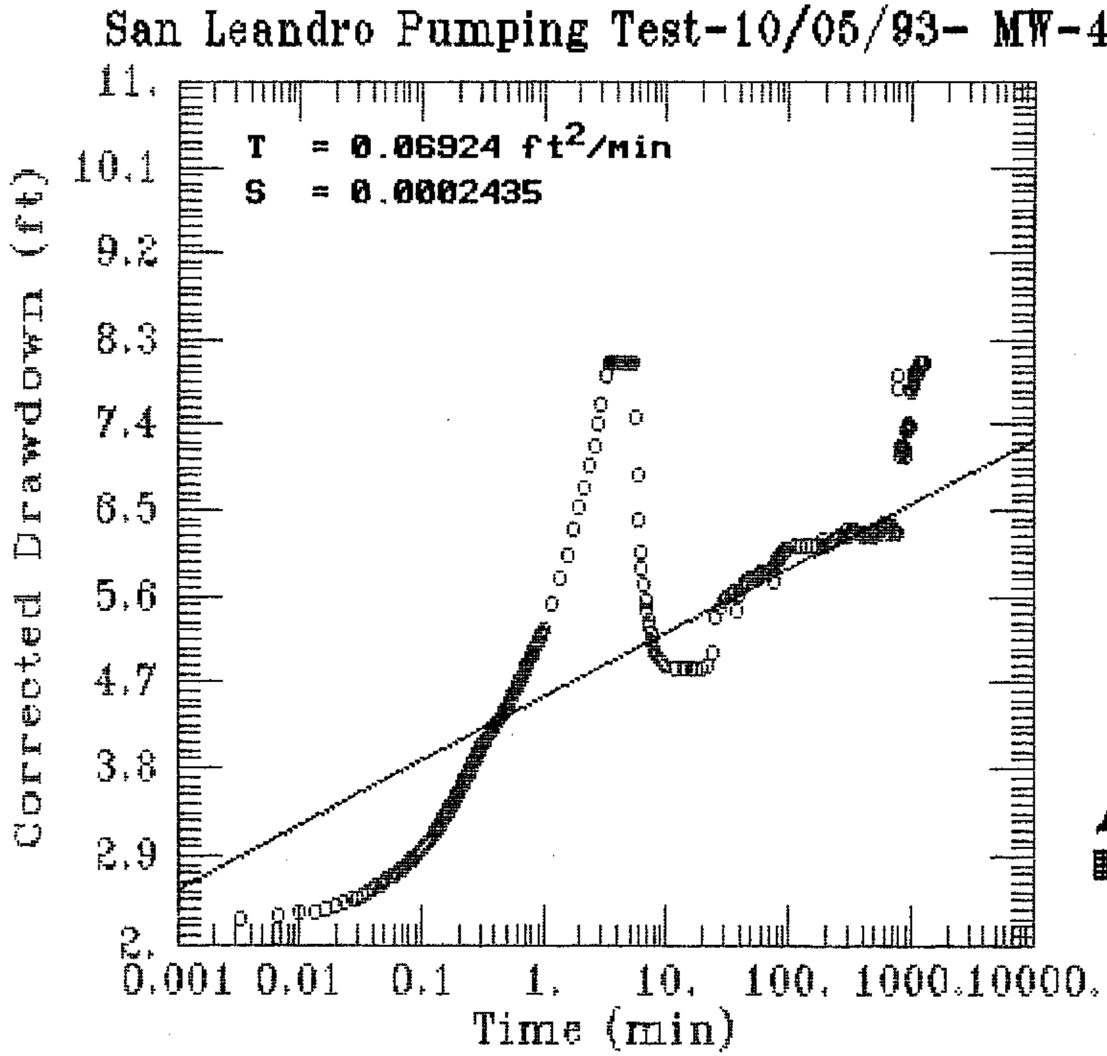
T = 0.145 ft^2/min

$$K = 0.145/22 = \underline{0.0066} \text{ ft/min}$$

Ground Water Gradient at the site has been reported to be approximately 0.002 ft/ft toward the west (Aegis, 4th Quarter '92)



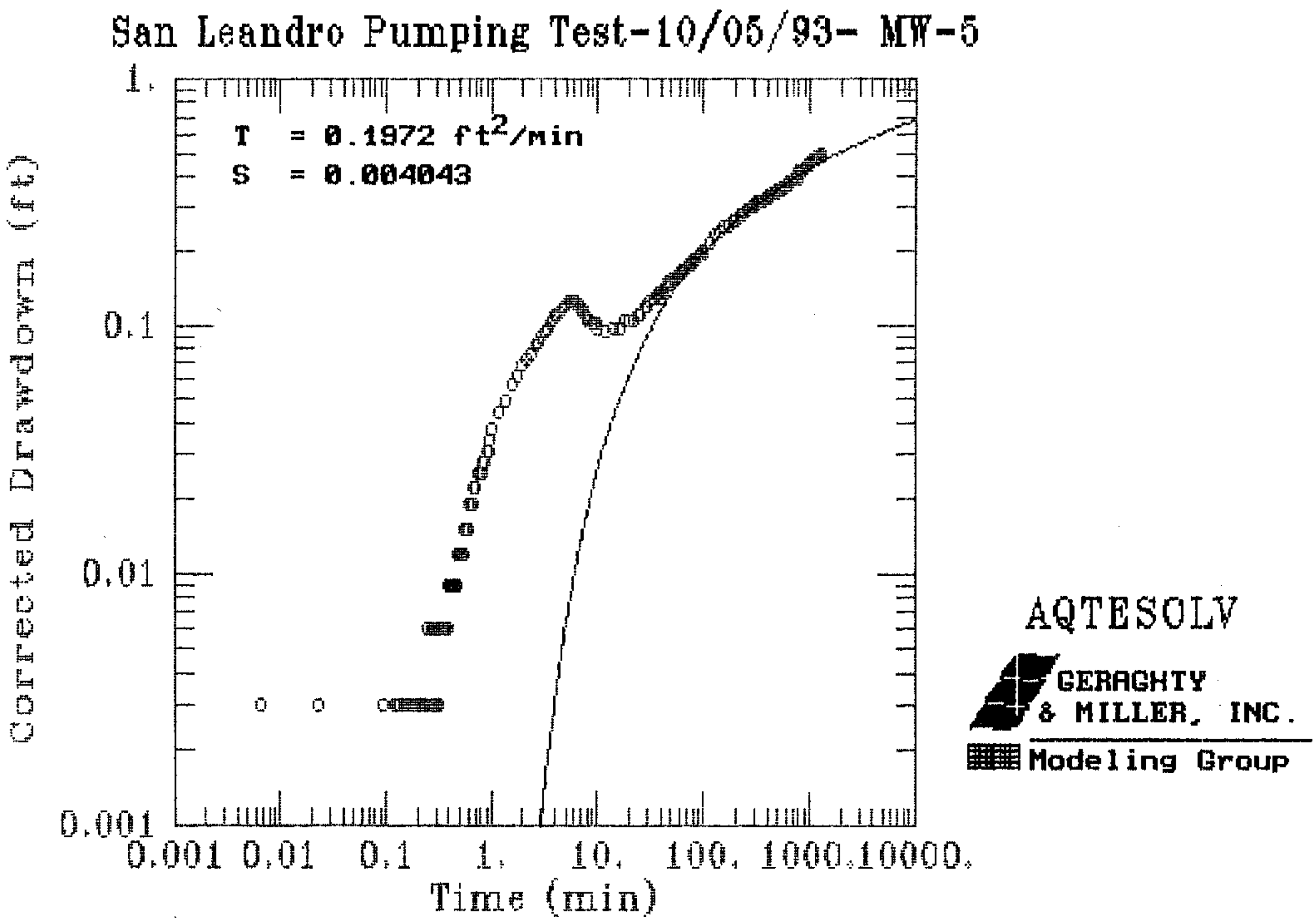
San Leandro Pumping Test-10/05/93- MW-4
T = 0.08139 ft2/min
S = 0.000103
Corrected Drawdown (ft)
Time (min)
100.
10.
1.
0.001 0.01 0.1 1. 10. 100. 1000. 10000.
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group



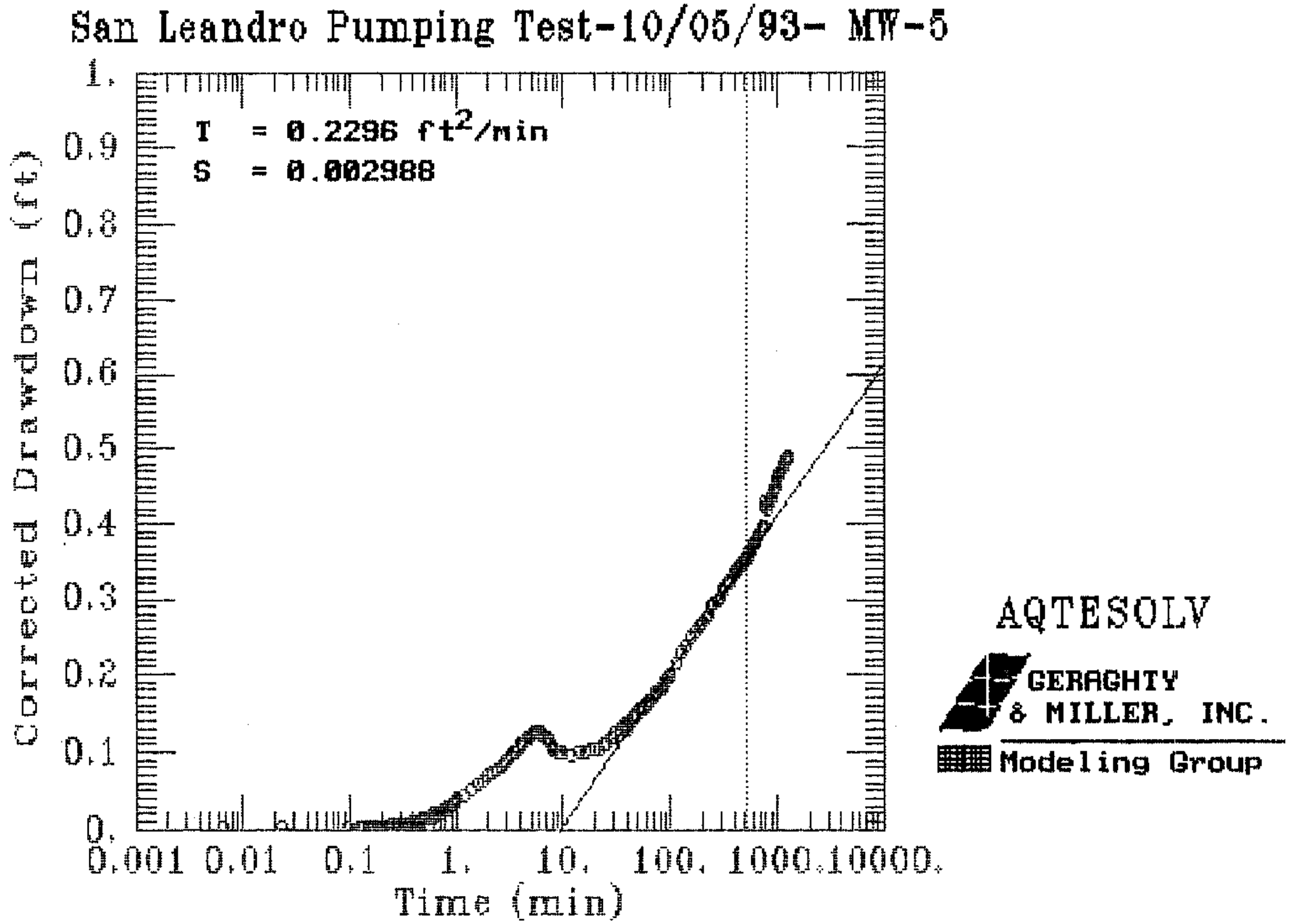
AQTESOLV

GERAGHTY & MILLER, INC.

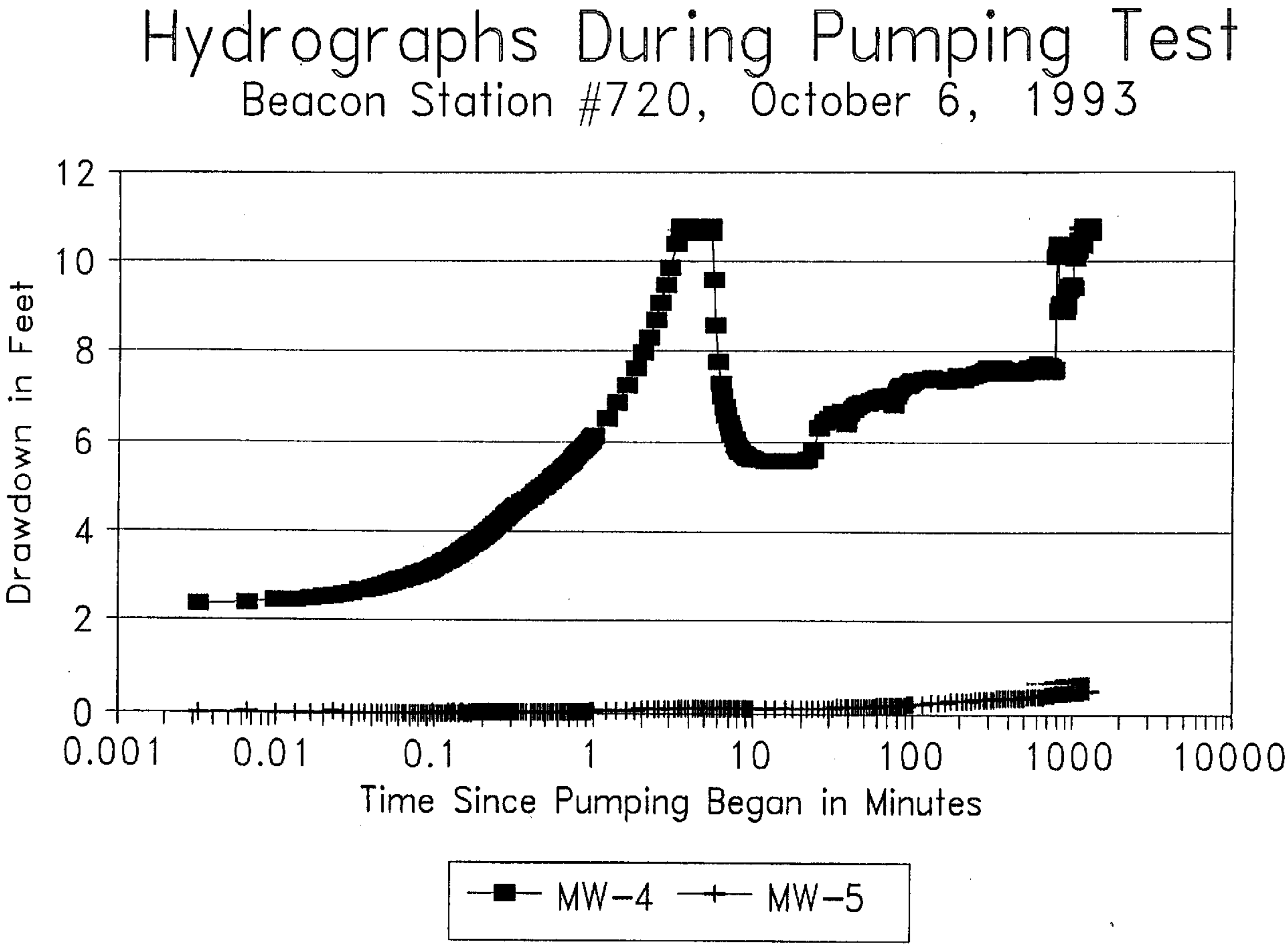
Modeling Group

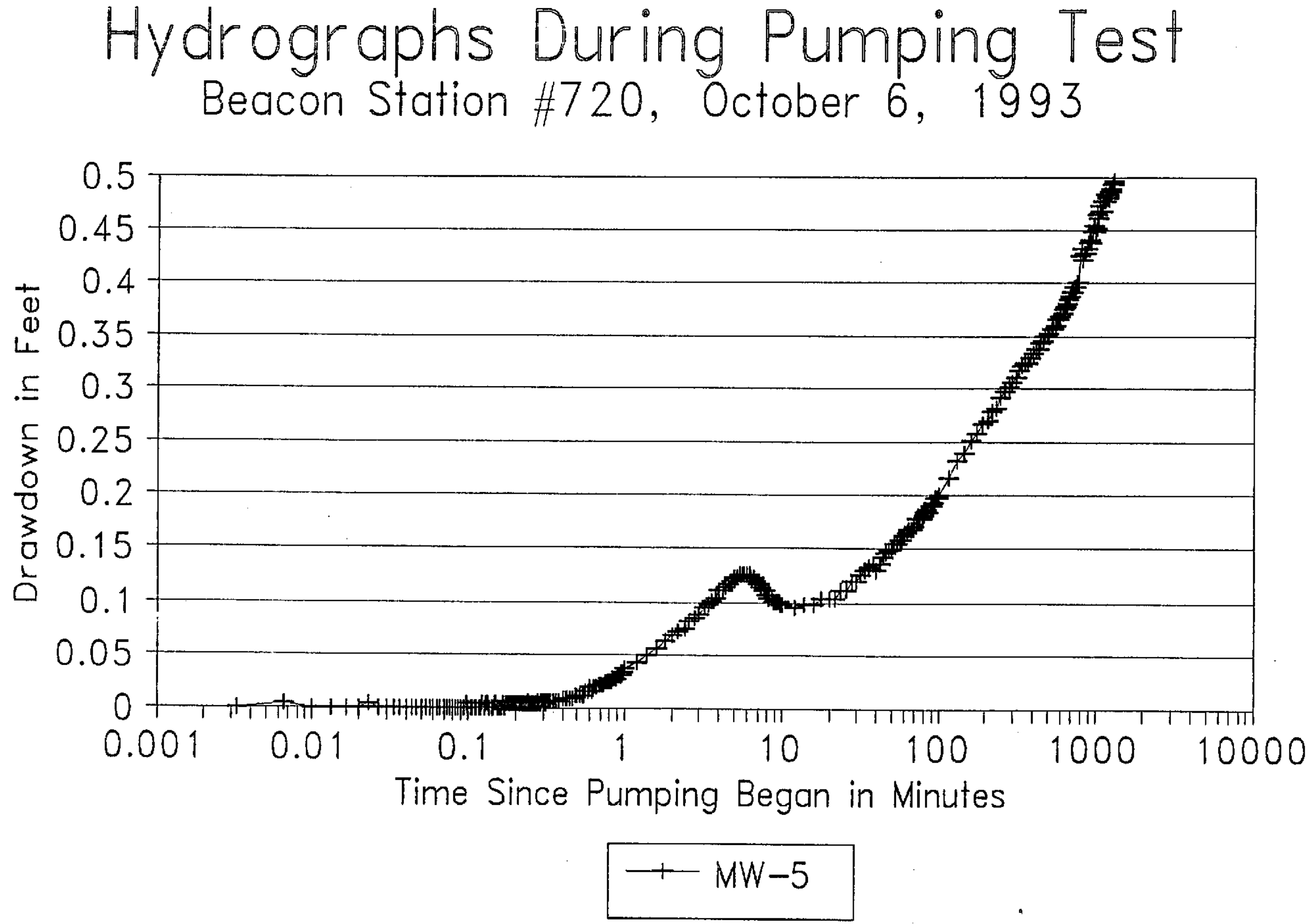


San Leandro Pumping Test-10/05/93- MW-5
T = 0.1972 ft²/min
S = 0.004043
Corrected Drawdown (ft)
Time (min)
1.
0.1
0.01
0.001
0.001 0.01 0.1 1. 10. 100. 1000. 10000.
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group



San Leandro Pumping Test-10/05/93- MW-5
T = 0.2296 ft²/min
S = 0.002988
Corrected Drawdown (ft)
1.
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.
0.001 0.01 0.1 1. 10. 100. 1000. 10000.
Time (min)
AQTESOLV
GERAGHTY & MILLER, INC.
Modeling Group


Hydrographs During Pumping Test
Beacon Station #720, October 6, 1993
Drawdown in Feet
12
10
8
6
4
2
0
0.001
0.01
0.1
1
10
100
1000
10000
Time Since Pumping Began in Minutes
MW-4
MW-5



Hydrographs During Pumping Test
Beacon Station #720, October 6, 1993
Drawdown in Feet
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.001
0.01
0.1
1
10
100
1000
10000
Time Since Pumping Began in Minutes
MW-5

120094720 bytes free

C:\CAPTURE>type 19030b.1

MW-4 Pumping at 1 gpm K is .007 ft/min

50 scale	0	0	.002 gradient	190 grad. dir.	
.007 K	22 b	.25 ø			
10	500				
13	0	100	1000	100	
1 Q	50	150	Y		
999	0	0	N		
999	0	0	0		
999	0	0	0	0	N

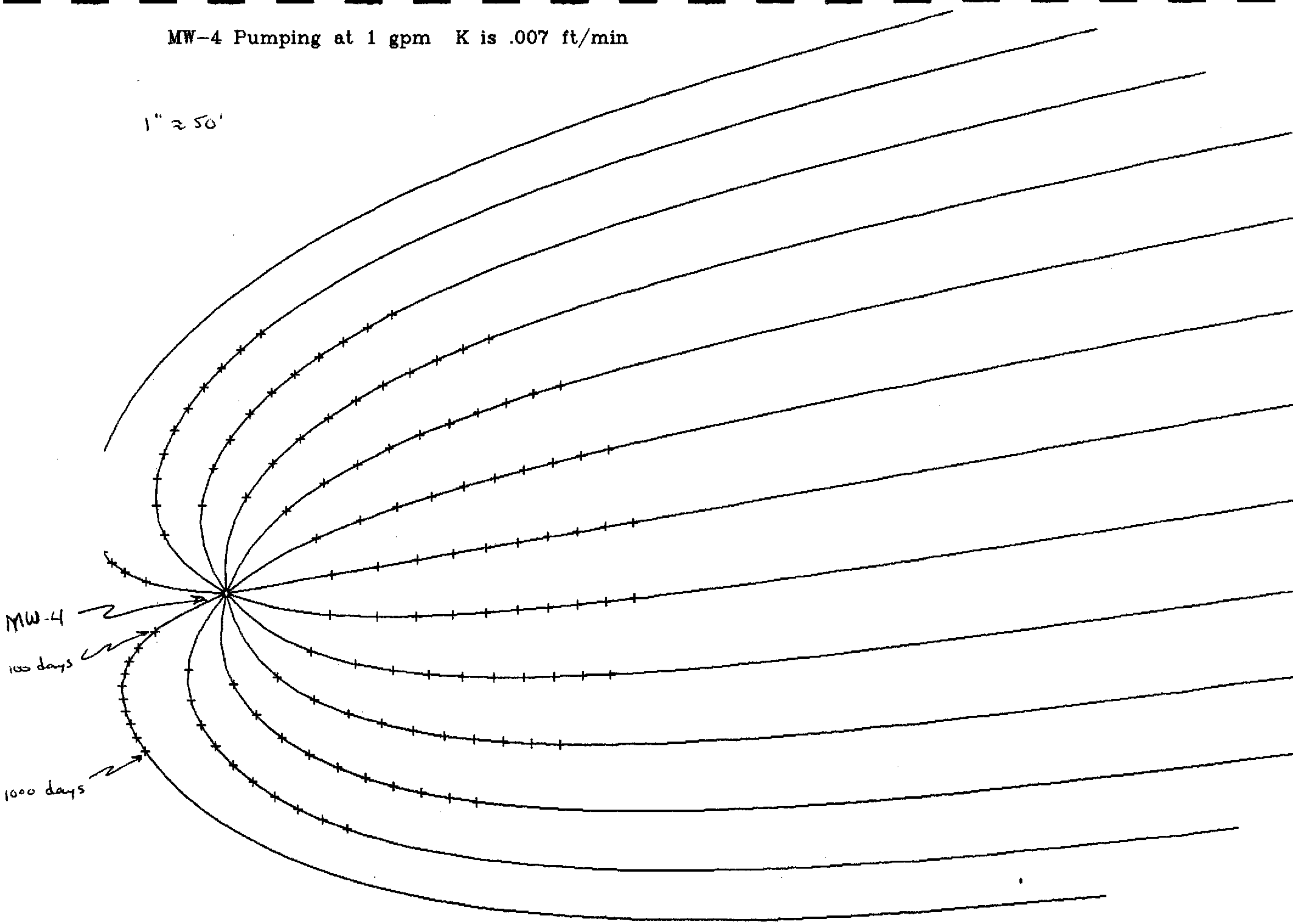
C:\CAPTURE>type 19030c.inp

MW-4 Pumping at 0.5 gpm K is .007 ft/min

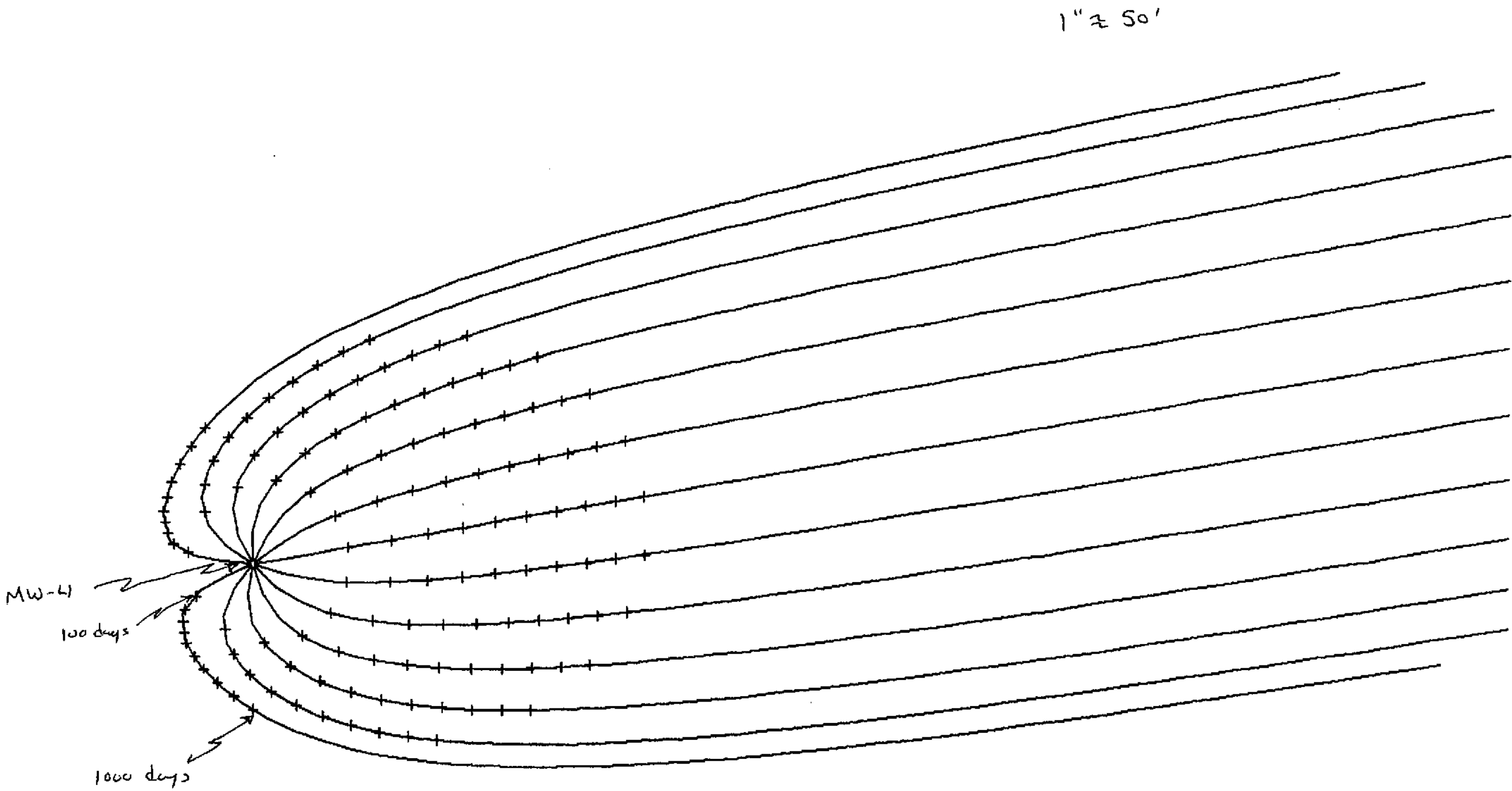
50 scale	0	0	.002 gradient	190 grad. dir	
.007 K	22 b	.25 ø			
10	500				
13	0	100	1000	100	
.5 Q	50	150	Y		
999	0	0	N		
999	0	0	0		
999	0	0	0	0	N

C:\CAPTURE>

MW-4 Pumping at 1 gpm K is .007 ft/min



MW–4 Pumping at 0.5 gpm K is .007 ft/min



APPENDIX B

GROUND WATER SAMPLE ANALYTICAL RESULTS

WEST

October 12, 1993
Sample Log 7603

RECEIVED
NOV 22 1993

William Rocha
Acton, Mickelson & van Dam
5090 Robert J. Matthews Pkwy
El Dorado Hills, CA 95762

Subject: Analytical Results for 1 Water Sample
Identified as: Project # 19030.01 (Beacon 720)
Received: 10/06/93

Dear Mr. Rocha:

Analysis of the sample(s) referenced above has been completed. This report is written to confirm results communicated on October 12, 1993 and describes procedures used to analyze the samples.

Sample(s) were received in 40-milliliter glass vials sealed with TFE lined septae and plastic screw-caps. Each sample was transported and received under documented chain of custody and stored at 4 degrees C until analysis was performed.

Sample(s) were analyzed using the following method(s):

"BTEX" (EPA Method 602/Purge-and-Trap)
"TPH as Gasoline" (Modified EPA Method 8015/Purge-and-Trap)

Please refer to the following table(s) for summarized analytical results and contact us at 916-757-4650 if you have questions regarding procedures or results. The chain-of-custody document is enclosed.

Approved by:

Stewart Podolsky
Senior Chemist

WEST

October 12, 1993
Sample Log 7582

The following abbreviations and qualifiers may be present in the analytical reports to follow:

ug/L	:	Micrograms of target analyte in 1 Liter of sample.
mg/kg	:	Milligrams of target analyte in 1 kg of sample.
B	:	This data qualifier indicates that a method blank from the analytical batch contained this compound and the level found in the sample is within 5 times that level. Use data with caution.
J	:	This data qualifier indicates that the compound was detected at a level below the required reporting limit.
E	:	This data qualifier indicates that the compound was detected at a level above that defined by the highest level calibration standard.
C	:	This data qualifier indicates that the presence of the compound has been confirmed by GC/MS.
TCLP	:	Toxicity Characteristic Leaching Procedure
MS	:	Matrix Spike
MSD	:	Matrix Spike Duplicate
RPD	:	Relative Percent Difference (the difference between two values divided by the mean, expressed as a percentage.
% REC	:	Percent Recovery (the ratio between the measured value and the expected value for a spiked sample, expressed as a percentage.
<	:	Less than
>	:	Greater than

WEST

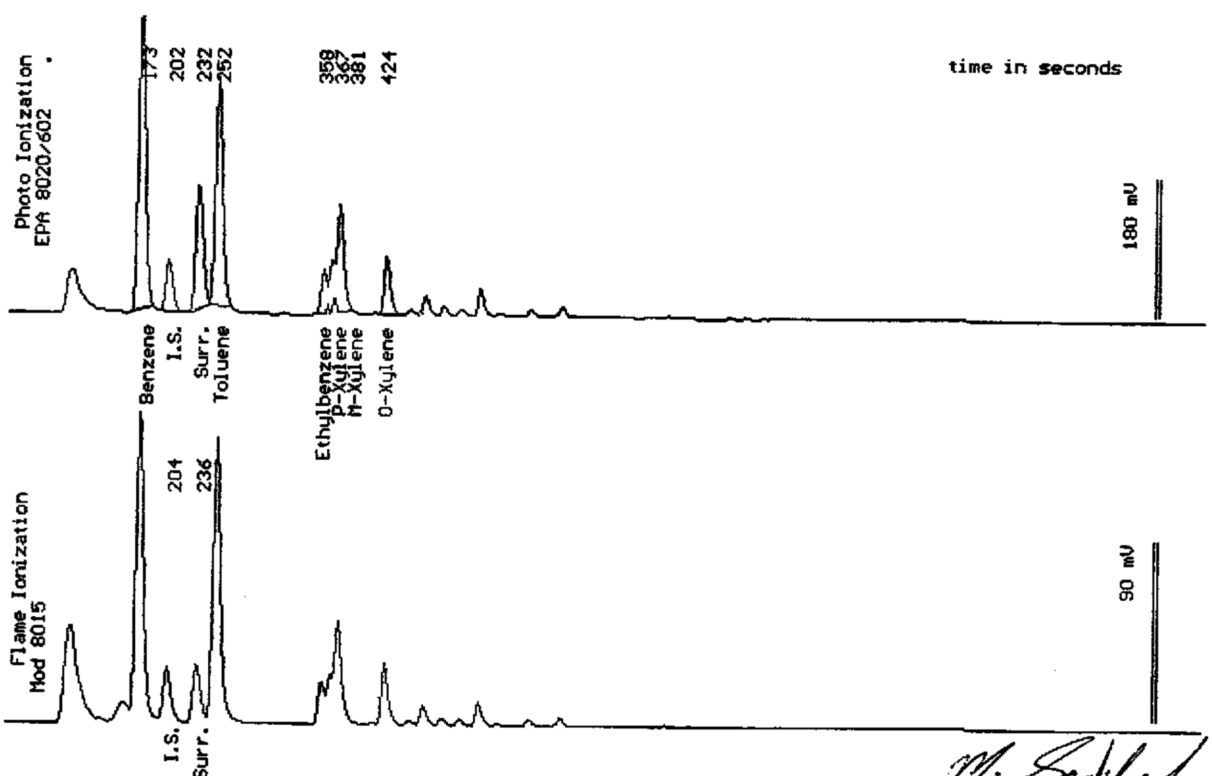
Sample Log 7603

7603-1

Sample: **MW-4**

From : Project # 19030.01 (Beacon 720)
Sampled : 10/05/93
Dilution : 1:50
QC Batch : 2025A
Matrix : Water

Parameter	(MRL) ug/L	Measured Value ug/L
Benzene	(25)	5100
Toluene	(25)	4900
Ethylbenzene	(25)	770
Total Xylenes	(25)	3600
TPH as Gasoline	(2500)	26000
Surrogate Recovery		97 %



Date Analyzed: 10-12-93
Column : 0.53mm ID X 30m DB5 (J&W Scientific)

Mitra Sarkhosh
Senior Chemist

Western Environmental Science & Technology • 45133 County Road 32B • Davis, CA 95616 • 916 753-9500 • FAX: 916 757-4652

Anlab
ANALYTICAL LABORATORY
1910 S STREET, SACRAMENTO, CALIFORNIA 95814 • 916-447-2946 • FAX 916-447-8321

October 22, 1993

Western Environmental Science
& Technology
1046 Olive Drive, Suite 3
Davis, CA 95616
Attn: Les Biddle

Project #: 19030.01
P.O. #: 7603-1
Project Name: Beacon 720

Anlab I.D. AC24612
SAMPLE DESCRIPTION: MW-4
Sample collection date: 10/05/93
Lab submittal date: 10/06/93
Turn-Around-Time: TYPE 10

Client Code: 315
Matrix: W
Time: 20:45
Time: 17:08
Sample Disposal: LAB

TEST PARAMETER		UNITS	TEST RESULT	DETECTION LIMIT
Hardness as CaCO3 by EPA 130.2		mg/l	550	1
Sulfate by EPA 300.0		mg/l	9.9	0.5
Chloride by EPA 300.0		mg/l	23	0.5
pH by EPA 150.1 (Electrometric)		pH.units	6.6	--
Alkalinity, Tot(CaCO3) EPA 310.1		mg/l	550	2.0
Hydroxide Alkalinity (OH)		mg/l	ND	0.2
Carbonate Alkalinity (CO3)		mg/l	ND	1.2
Bicarb Alkalinity (HCO3)		mg/l	670	2.4
EC by EPA 120.1		umhos/cm	1130	1
Tot. Dissolved Solids, EPA 160.1		mg/l	620	15
MBAS as LAS (MW 340),EPA 425.1		mg/l	0.7	0.01
Calcium	EPA 200.7	mg/l	99	0.050
Copper	EPA 200.7	mg/l	ND	0.020
Iron	EPA 200.7	mg/l	ND	0.030
Magnesium	EPA 200.7	mg/l	58	0.050
Manganese	EPA 200.7	mg/l	3.8	0.0050
Potassium	EPA 200.7	mg/l	0.33	0.20
Sodium	EPA 200.7	mg/l	72	0.20
Zinc	EPA 200.7	mg/l	ND	0.0050
Total Anions		meq/l	12	
Total Cations		meq/l	13	

ND = Not Detected

Report Approved By: Wenmlyn Fua
ELAP ID #: 1468

:lmr

Ultramar Inc.

BEACON

CHAIN OF CUSTODY REPORT

Beacon Station No.	Sampler (Print Name)	Date	Form No.
720	William Rocha Jr	10-5-93	1 of 1

Project No.: 19030.01	Sampler (Signature): William Rocha Jr.
Project Location: Marina Blvd. San Leandro, CA	Affiliation: AMV, Inc.

Sample No./Identification	Date	Time	Lab No.	BTEX	TPH (gasoline)	TPH (diesel)	General Mineral Analysis					No. of Containers	REMARKS (Standard TAT)
MW-4	10-5-93			X	X							3	40 ml VOAS, Presv. HCL
"	"						X					1	1L poly, Presv. HNO3
"	"						X					3	1-L poly
"	"						X					1	1-L amber

Relinquished by: (Signature/Affiliation)	Date	Time	Received by: (Signature/Affiliation)	Date	Time
Steve [signature]	10-6-93	1634			
			[signature] WEST	10/6/93	1650

Report To: Bill Rocha, AMV, Inc

Bill to: ULTRAMAR INC.
525 West Third Street
Hanford, CA 93230
Attention: T. Fox

WHITE: Return to Client with Report YELLOW: Laboratory Copy PINK: Originator Copy

32-8003 1/90

APPENDIX C

VAPOR EXTRACTION PILOT TEST DATA

Site: Beacon Station #720
Date: 10-5-93
Test Well: MW-4
Observation Point: VP
Field Conditions: Cloudy, cool, 60° to 65° F.

VAPOR EXTRACTION PILOT TEST DATA

Hour	Flow (cfm)	Vacuum (inches of H_2O)	Pressure (inches of H_2O)	Temperature (degrees F.)	Corrected Airflow for Temperature (scfm)	Vacuum Observation Point (inches of H_2O)	Influent TPHg Air Concentrations (ppm)			Extraction Rates (lbs/day)	
							FID	Draeger	Analytical	TPH	Benzene
0	10	52.0	0.25	90	9.8	0	>10,000	>2,500	6,200	21.0	0.80
1	10	47.0	0.25	99	9.7	0	>10,000	NM	NM	NM	NM
2	10	47.0	0.25	99	9.7	0	>10,000	NM	NM	NM	NM
3	10	48.0	0.20	102	9.7	0	>10,000	NM	NM	NM	NM
4	10	48.0	0.20	100	9.7	0	>10,000	800	3,800	12.7	0.37

[a]Extraction rates were calculated using analytical data (see Enclosure C).
[b]FID reading not adjusted.
[c]NM = not measured.

APPENDIX D

AIR SAMPLE LABORATORY ANALYTICAL REPORTS

WEST

October 7, 1993
Sample Log 7604

RECEIVED OCT 28 1993

William Rocha
Acton, Mickelson & van Dam
5090 Robert J. Matthews Pkwy
El Dorado Hills, CA 95762

Subject: Analytical Results for 2 Air Samples
Identified as: Project # 19030.01 (Beacon 720)
Received: 10/06/93

Dear Mr. Rocha:

Analysis of the sample(s) referenced above has been completed. This report is written to confirm results communicated on October 7, 1993 and describes procedures used to analyze the samples.

The sample(s) were received in:

Tedlar air sampling bags

Each sample was transported and received under documented chain of custody, assigned a consecutive log number and stored at 4 degrees Celsius until analysis commenced.

Sample(s) were analyzed using the following method(s):

"BTEX" (EPA Method 8020/Purge-and-Trap)
"TPH as Gasoline" (Modified EPA Method 8015/Purge-and-Trap)

Please refer to the following table(s) for summarized analytical results and contact us at 916-757-4650 if you have questions regarding procedures or results. The chain-of-custody document is enclosed.

Approved by:

Stewart Podolsky
Senior Chemist

WEST

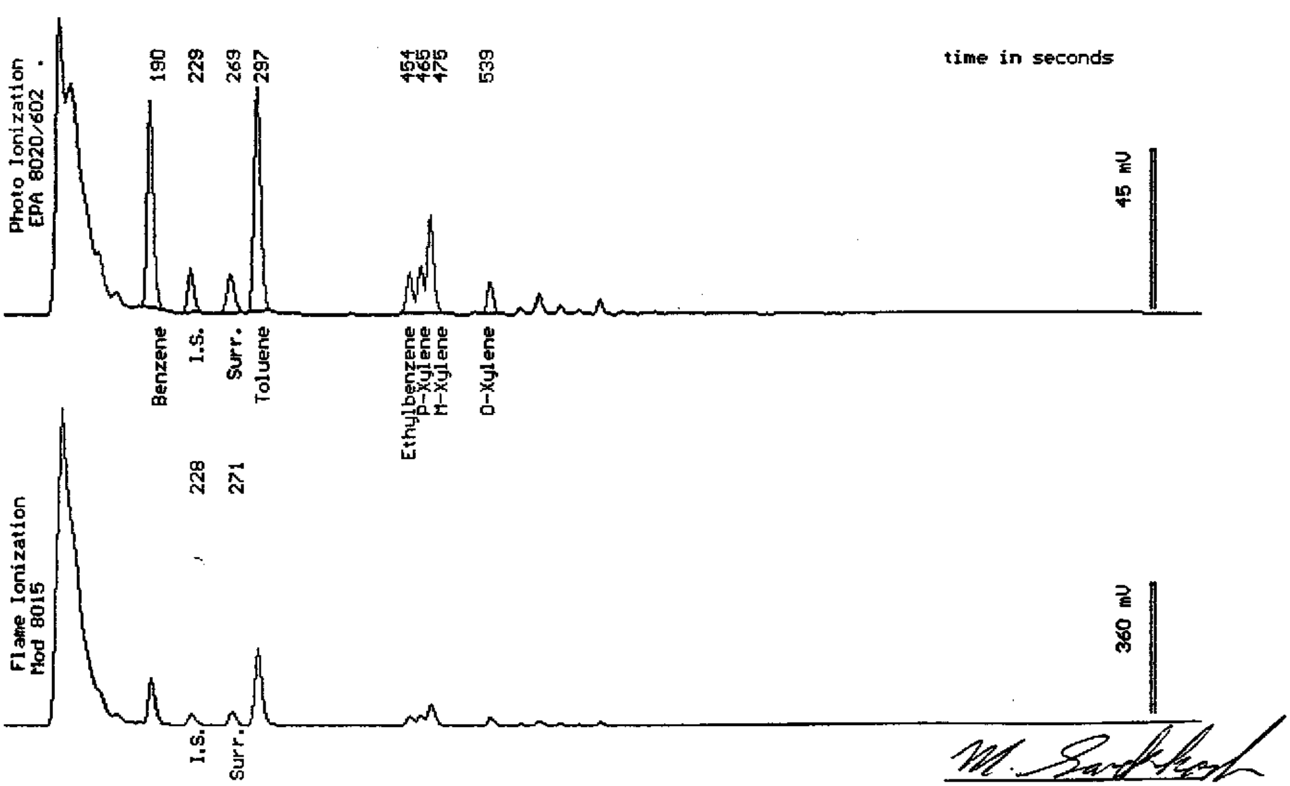
Sample Log 7604

7604-1

Sample: **MW-4-1720**

From : Project # 19030.01 (Beacon 720)
Sampled : 10/05/93
Dilution : 1:50 QC Batch : 4040e
Matrix : Air

Parameter	(MRL) Molar ppm	Measured Value Molar ppm
Benzene	(2.5)	260
Toluene	(2.5)	370
Ethylbenzene	(2.5)	51
Total Xylenes	(2.5)	190
TPH as Gasoline	(250)	6200
Surrogate Recovery		93 %



Date Analyzed: 10-06-93
Column : 0.53mm ID X 30m DBWAX (J&W Scientific)

Mitra Sarkhosh
Senior Chemist

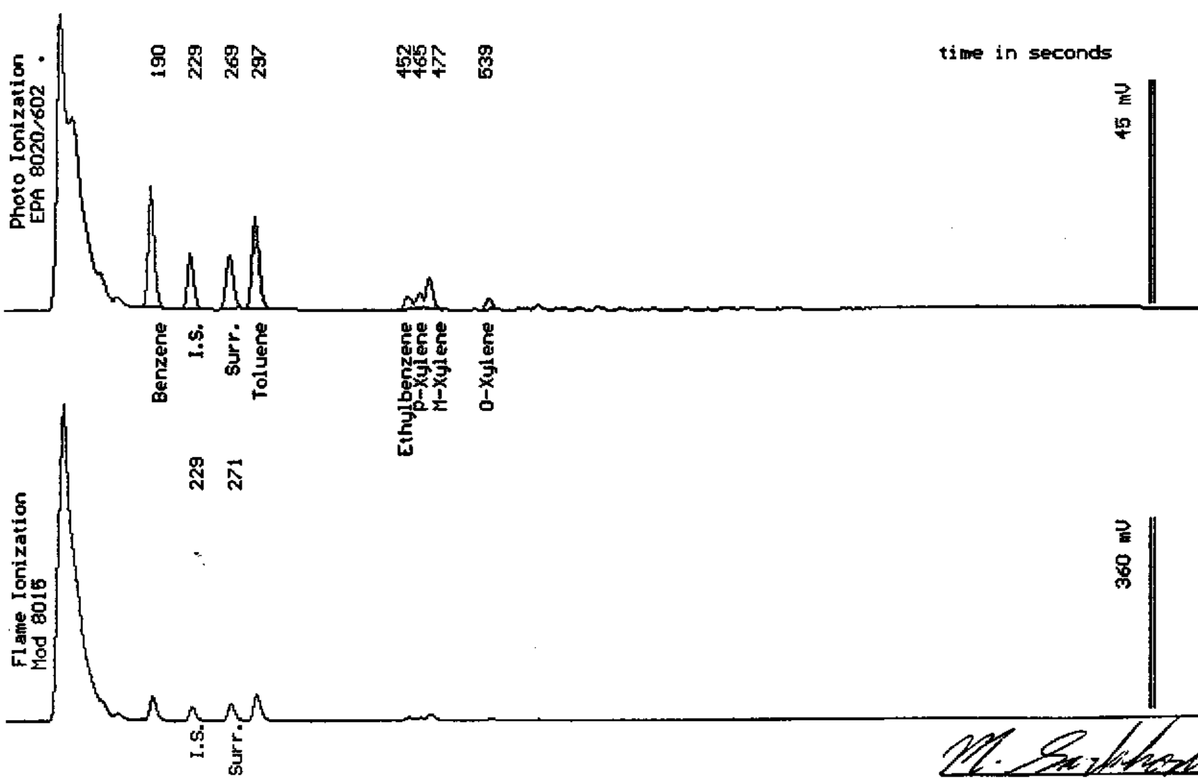
Sample Log 7604

7604-2

Sample: **MW-4-2125**

From : Project # 19030.01 (Beacon 720)
Sampled : 10/05/93
Dilution : 1:50 QC Batch : 4040e
Matrix : Air

Parameter	(MRL) Molar ppm	Measured Value Molar ppm
Benzene	(2.5)	120
Toluene	(2.5)	120
Ethylbenzene	(2.5)	13
Total Xylenes	(2.5)	46
TPH as Gasoline	(250)	3800
Surrogate Recovery		98 %



Date Analyzed: 10-07-93
Column : 0.53mm ID X 30m DBWAX (J&W Scientific)

Mitra Sarkhosh
Senior Chemist

Ultramar Inc.

BEACON

CHAIN OF CUSTODY REPORT

Beacon Station No. 720	Sampler (Print Name) William Rocha	Date 10-5-93	Form No. 1 of 1
Project No. 19030.01	Sampler (Signature) William Rocha Jr.		
Project Location Marina Blvd San Leandro, CA	Affiliation AMV, Inc.		

Sample No./Identification	Date	Time	Lab No.	BTEX	TPH (gasoline)	TPH (diesel)						No. of Containers	REMARKS Standard TAT
MW-4-1720	10-5-93	1720		X	X							1	Tedlar Bag
MW-4-2125	10-5-93	2125		X	X							1	Tedlar Bag

Relinquished by: (Signature/Affiliation)	Date	Time	Received by: (Signature/Affiliation)	Date	Time
Steve [signature]	10-6-93	1632			
Relinquished by: (Signature/Affiliation)	Date	Time	Received by: (Signature/Affiliation)	Date	Time
Relinquished by: (Signature/Affiliation)	Date	Time	Received by: (Signature/Affiliation)	Date	Time
			[signature] WEST	10/6/93	1632

Report To: Bill Rocha AMV, Inc.	Bill to: ULTRAMAR INC. 525 West Third Street Hanford, CA 93230 Attention: T. FOX

WHITE: Return to Client with Report YELLOW: Laboratory Copy PINK: Originator Copy

32-8003 1/90

APPENDIX E

VAPOR EXTRACTION PILOT TEST CALCULATIONS

VAPOR EXTRACTION PILOT TEST CALCULATIONS
AMV PROJECT NO. 19030.01

Extraction Rate

The pilot test flow rate from monitoring well MW-4 at 1720 hours was determined to be approximately 9.8 standard cubic feet per minute (scfm) or 14,112 standard cubic feet per day (scfd). Laboratory analysis of an air sample collected at this time during the pilot test (laboratory report(s) enclosed) indicates the total concentration of gasoline petroleum hydrocarbons (TPHg) in the vapor stream to be 6200 parts per million by volume (ppmv), with a benzene fraction 4.2 percent. These values represent the maximum expected concentration at start-up. Continued system operation should result in decreased concentration.

The maximum volumetric rate of TPHg extraction is calculated as follows:

$$10\sqrt{\frac{530R}{1.0bar} \times \frac{1.0bar}{550R}} = 9.8\,scfm;\quad \frac{9.8\,ft^3}{min} \times \frac{1440\,min}{day} \times \frac{6200}{1E6}\quad TPHg = 87.5\,\frac{ft^3}{day}\,TPHg$$

Using the ideal gas law to determine the equivalent pound-moles (lb-moles) for 14,112 scfd gives:

$$87.5\,\frac{ft^3}{day}\,TPHg \times \frac{lb \cdot mol}{359\,ft^3}\,TPHg = 0.244\,\frac{lb \cdot mol}{day}\,TPHg$$

Using the molecular weight of hexane, the rate of TPHg extracted on a pounds basis is calculated as:

$$0.244\,\frac{lb \cdot mol}{day}\,TPHg \times \frac{86\,lb}{lb \cdot mol} = 21.0\,\frac{lb}{day}\,TPHg$$

With a benzene fraction of 4.2 percent, the lb-moles rate of benzene extraction is calculated as:

$$0.244\,\frac{lb \cdot mol}{day}\,TPHg \times (0.042) = 0.0102\,\frac{lb \cdot mol}{day}\,Benzene$$

On a pounds basis, the extraction rate for benzene is calculated as:

$$0.012\,\frac{lb \cdot mol}{day}\,Bz \times \frac{78\,lb}{lb \cdot mol} = 0.80\,\frac{lb}{day}\,Benzene$$

Vapor Extraction Zone of Influence

Approximation of the vapor extraction zone of influence is calculated using the empirical equation:

$$r = Q/2\pi hv$$

where r = distance from extraction of minimum effective air velocity, ft
Q = extracted air flow rate, scfm
h = thickness of the unsaturated zone of the screened interval
v = assumed minimum effective air velocity, 0.01 feet/minute

The calulated zone of influence is:

$$r = \frac{9.8\,scfm}{2\pi\,(15\,ft.)\,(0.01\,ft/min)} = 10.4\,ft.$$

VAPOR EXTRACTION PILOT TEST CALCULATIONS
AMV PROJECT NO. 19030.01

Extraction Rate

The pilot test flow rate from monitoring well MW-4 at 2125 hours was determined to be approximately 9.7 standard cubic feet per minute (scfm) or 13,968 standard cubic feet per day (scfd). Laboratory analysis of an air sample collected at this time during the pilot test (laboratory report(s) enclosed) indicates the total concentration of gasoline petroleum hydrocarbons (TPHg) in the vapor stream to be 3800 parts per million by volume (ppmv), with a benzene fraction 3.2 percent. These values represent the maximum expected concentration at start-up. Continued system operation should result in decreased concentration.

The maximum volumetric rate of TPHg extraction is calculated as follows:

$$10\sqrt{\frac{530R}{1.0bar} \times \frac{1.0bar}{560R}} = 9.7scfm \; ; \; 9.7\frac{ft^3}{min} \times 1440\frac{min}{day} \times \frac{3800}{1E6}\; TPHg = 53.1\frac{ft^3}{day}\; TPHg$$

Using the ideal gas law to determine the equivalent pound-moles (lb-moles) for 13,968 scfd gives:

$$53.1\frac{ft^3}{day}\; TPHg \times \frac{lb \cdot mol}{359\; ft^3}\; TPHg = 0.148\; \frac{lb \cdot mol}{day}\; TPHg$$

Using the molecular weight of hexane, the rate of TPHg extracted on a pounds basis is calculated as:

$$0.148\; \frac{lb \cdot mol}{day}\; TPHg \times \frac{86\, lb}{lb \cdot mol}\; TPHg = 12.7\frac{lb}{day}\; TPHg$$

With a benzene fraction of 3.2 percent, the lb-moles rate of benzene extraction is calculated as:

$$0.148\; \frac{lb \cdot mol}{day}\; TPHg \times (0.032) = 0.0047\; \frac{lb \cdot mol}{day}\; Benzene$$

On a pounds basis, the extraction rate for benzene is calculated as:

$$0.0047\; \frac{lb \cdot mol}{day}\; Bz \times \frac{78\, lb}{lb \cdot mol}\; Bz = 0.37\frac{lb}{day}\; Benzene$$

Vapor Extraction Zone of Influence

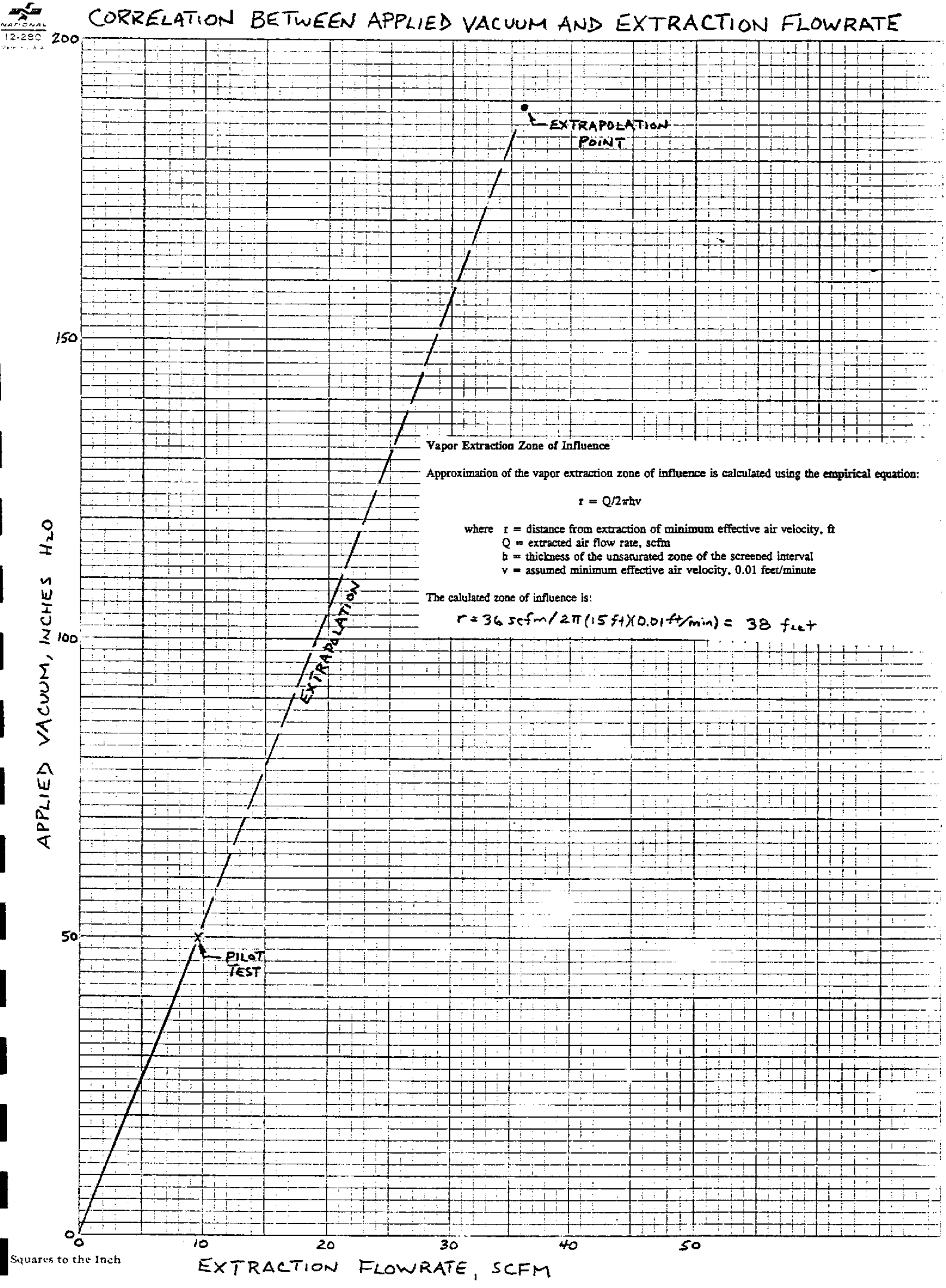
Approximation of the vapor extraction zone of influence is calculated using the empirical equation:

$$r = Q/2\pi hv$$

where r = distance from extraction of minimum effective air velocity, ft
Q = extracted air flow rate, scfm
h = thickness of the unsaturated zone of the screened interval
v = assumed minimum effective air velocity, 0.01 feet/minute

The calulated zone of influence is:

$$r = \frac{9.7\; scfm}{2\pi\,(15\,ft.)\,(0.01\,ft/min)} = 10.3\; ft.$$



Vapor Extraction Zone of Influence

Approximation of the vapor extraction zone of influence is calculated using the empirical equation:

$$r = Q/2\pi hv$$

where r = distance from extraction of minimum effective air velocity, ft
Q = extracted air flow rate, scfm
h = thickness of the unsaturated zone of the screened interval
v = assumed minimum effective air velocity, 0.01 feet/minute

The calulated zone of influence is:

$r = 36\ scfm / 2\pi (15\ ft)(0.01\ ft/min) = 38\ feet$

APPENDIX F

SPARGING TEST DATA

AIR SPARGING PILOT TEST DATA

Site: Beacon Station #720
Date: 10-6-93
Test Wells: MW-4 and MW-5
Observation Point: SP
Field Conditions: Cloudy, partly sunny, 60° to 65° F.

Hour	Flow (cfm)	Temperature (degrees F)	Pressure (psi)	Corrected Flow Pressure and Temperature (scfm)	Observation Well MW-4				Observation Well MW-5	
					Vapor Space Pressure (inches of H_2O)	Vapor Space FID[b] (ppm)	Vapor Space CO_2 (percent)	Water Dissolved Oxygen (percent of saturation)	Vapor Space Pressure (inches of H_2O)	Water Dissolved Oxygen (percent of saturation)
0	4.0	60	20	6.2	0	>10,000	0	NM	0.0	
1	4.0	80	16	5.7	0.0-0.01	>10,000	NM	NM	0.0	13
2	4.0	84	16	5.7	0.0-0.01	>10,000	0	13	0.0	13
3	4.2	80	16	6.0	0.0-0.01	>10,000	NM	13	0.0	15
4	4.2	80	16	6.0	0.0-0.01	>10,000	0	13	0.0	14
5	4.3	84	16	6.1	0.0-0.01	2,000	NM	14	0.0	14
6	4.5	84	14	6.2	0.0-0.01	1,200	0	14	0.0	16
7	5.0	85	12	6.6	0.0-0.01	2,200	NM	15	0.0	15
8	5.0	79	10	6.4	0.0-0.01	6,000	0.3	19	0.0	17

Note: Extraction rates were calculated using analytical data (see Enclosure C).

[a]Pressure reading at monitoring well MW-4 minimal but recorded as 0.0 to 0.01 inches of H_2O.
[b]FID reading not adjusted.
[c]NM = not measured.

APPENDIX G

LABORATORY ANALYTICAL REPORTS, SPARGING TEST

WEST

October 14, 1993
Sample Log 7619

RECEIVED OCT 28 1993

William Rocha
Acton, Mickelson & van Dam
5090 Robert J. Matthews Pkwy
El Dorado Hills, CA 95762

Subject: Analytical Results for 3 Water Samples
Identified as: Project # 19030.01 (Beacon 720)
Received: 10/07/93

Dear Mr. Rocha:

Analysis of the sample(s) referenced above has been completed. This report is written to confirm results communicated on October 14, 1993 and describes procedures used to analyze the samples.

Sample(s) were analyzed using the following method(s):

"BTEX" (EPA Method 602/Purge-and-Trap)
"TPH as Gasoline" (Modified EPA Method 8015/Purge-and-Trap)

Please refer to the following table(s) for summarized analytical results and contact us at 916-757-4650 if you have questions regarding procedures or results. The chain-of-custody document is enclosed.

Approved by:

Stewart Podolsky
Stewart Podolsky
Senior Chemist

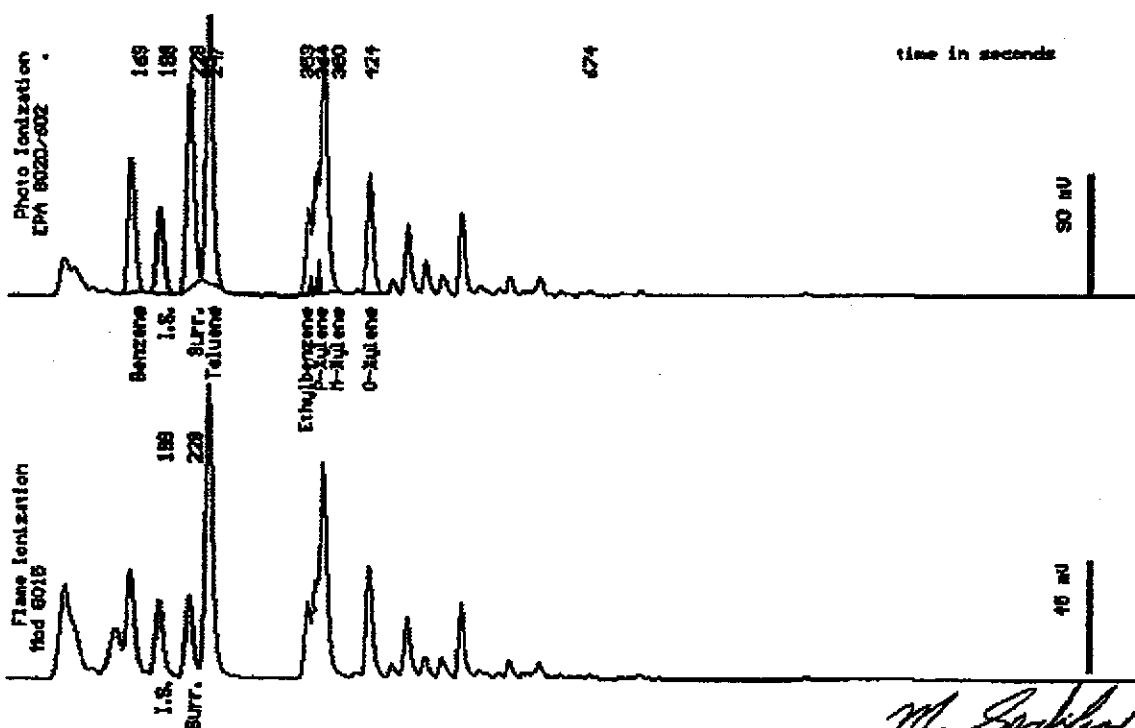
Sample Log 7619

7619-1

Sample: MW-4 0945

From : Project # 19030.01 (Beacon 720)
Sampled : 10/06/93
Dilution : 1:50 QC Batch : 2025c
Matrix : Water

Parameter	(MRL) ug/L	Measured Value ug/L
Benzene	(25)	1300
Toluene	(25)	3400
Ethylbenzene	(25)	880
Total Xylenes	(25)	4900
TPH as Gasoline	(2500)	22000
Surrogate Recovery		94 %



Date Analyzed: 10-13-93
Column : 0.53mm ID X 30m DB5 (J&W Scientific)

Mitra Sarkhosh
Senior Chemist

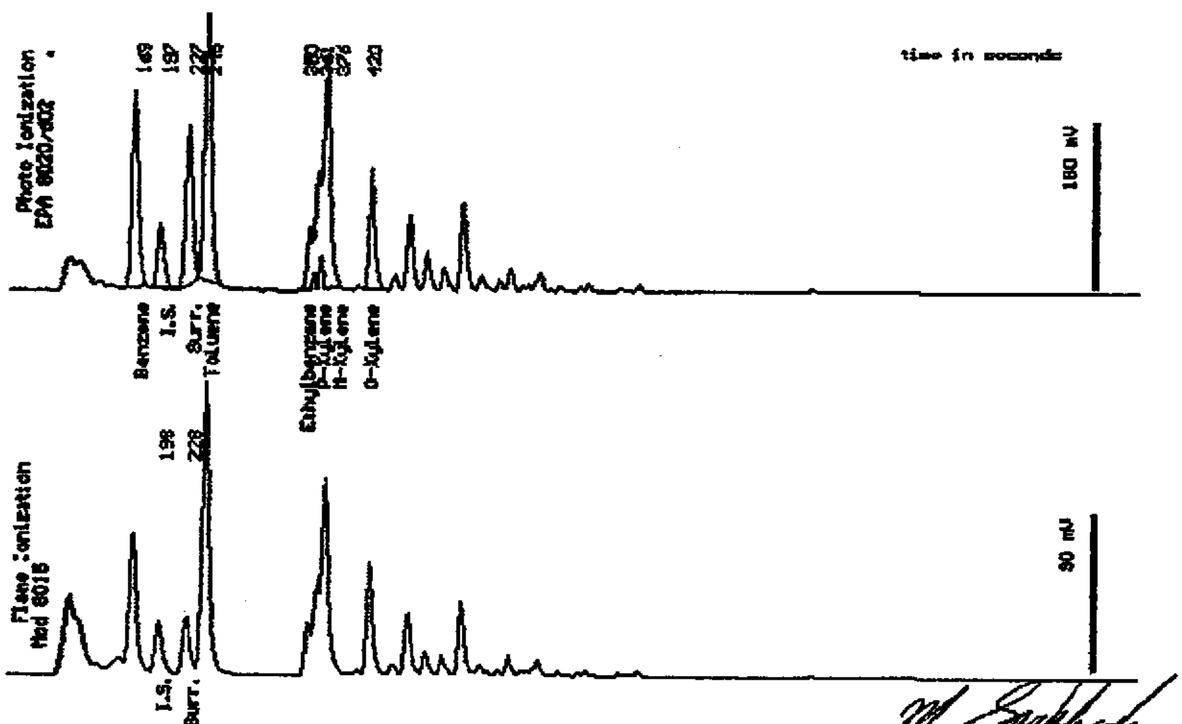
Western Environmental Science & Technology • 45133 County Road 32B • Davis, CA 95616 • 916 753-9500 • FAX: 916 757-4652

Sample Log 7619
7619-2

Sample: MW-4 1515

From : Project # 19030.01 (Beacon 720)
Sampled : 10/06/93
Dilution : 1:50 QC Batch : 2025c
Matrix : Water

Parameter	(MRL) ug/L	Measured Value ug/L
Benzene	(25)	2500
Toluene	(25)	4800
Ethylbenzene	(25)	920
Total Xylenes	(25)	6300
TPH as Gasoline	(2500)	31000
Surrogate Recovery		94 %



Date Analyzed: 10-13-93
Column : 0.53mm ID X 30m DB5 (J&W Scientific)

Mitra Sarkhosh
Senior Chemist

Western Environmental Science & Technology • 45133 County Road 32B • Davis, CA 95616 • 916 753-9500 • FAX: 916 757-4652

WEST

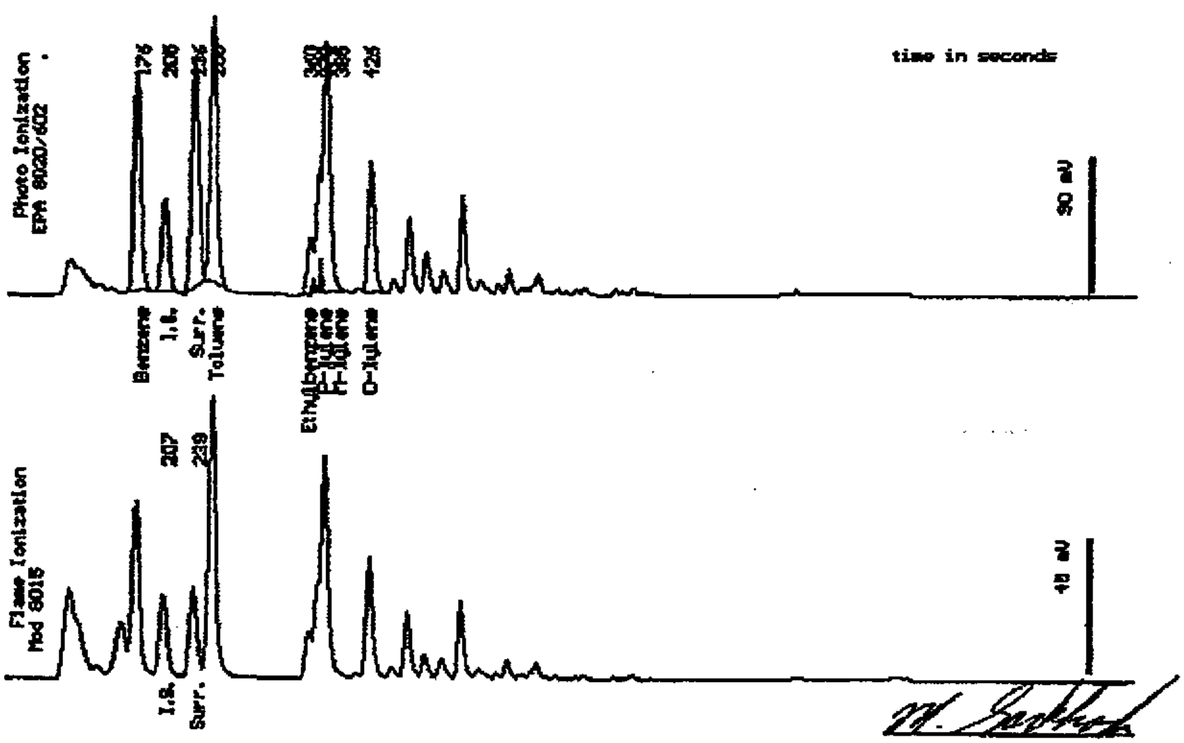
Sample Log 7619

7619-3

Sample: MW-4 1905

From : Project # 19030.01 (Beacon 720)
Sampled : 10/06/93
Dilution : 1:50 QC Batch : 2025c
Matrix : Water

Parameter	(MRL) ug/L	Measured Value ug/L
Benzene	(25)	1900
Toluene	(25)	3400
Ethylbenzene	(25)	540
Total Xylenes	(25)	4700
TPH as Gasoline	(2500)	22000
Surrogate Recovery		98 %



Date Analyzed: 10-13-93
Column : 0.53mm ID X 30m DB5 (J&W Scientific)

Mitra Sarkhosh
Senior Chemist

Ultramar Inc.
CHAIN OF CUSTODY REPORT

BEACON

Beacon Station No.	Sampler (Print Name)	Date	Form No.
720	William Rocha Jr	10-7-93	1 of 1

Project No.: 19030.01

Sampler (Signature): William Rocha Jr.

Project Location: 1088 Marina Blvd San Leandro, CA

Affiliation:

Sample No./Identification	Date	Time	Lab No.	BTEX	TPH (gasoline)	TPH (diesel)						No. of Containers	REMARKS: Standard TAT
MW-4 0945	10-6-93	0945		X	X							3	40ml VOAS, Presv. HCL
1515	10-6-93	1515		X	X							3	40ml VOAS, Presv. HCL
1905	10-6-93	1905		X	X							3	40ml VOAS, Presv. HCL

Relinquished by: (Signature/Affiliation)	Date	Time	Received by: (Signature/Affiliation)	Date	Time
William Rocha Jr., AMV, Inc.	10-7-93	10:51	Troy S. [illegible] (WEST)	10-7-93	10:51
Troy S. [illegible] (WEST)	10-7-93	12:40			
			[illegible] WEST	10/7/93	1240

Report To: Bill Rocha AMV, Inc.

Bill to: ULTRAMAR INC.
525 West Third Street
Hanford, CA 93230
Attention: T. Fox

RECEIVED by W.E.S.T. date 10/7/93

WHITE: Return to Client with Report YELLOW: Laboratory Copy PINK: Originator Copy

32-6003 1/90

APPENDIX H

SAMPLE FLOW RATE CALCULATIONS FOR AIR SPARGING PILOT TEST

AIR SPARGING PILOT TEST CALCULATIONS
AMV PROJECT NO. 19030.01

Corrected Flow Rate

The meter reading for air sparging flow rate into the sparging point (SP) was corrected for temperature and pressure. The flow rate ranged from 5.7 to 6.6 standard cubic feet per minute (scfm).

Sample Calculation:

Formula ⇒

$$\text{Flow Meter Reading} \sqrt{\frac{530\,R}{14.7\,psi} \times \frac{\text{TEST PRESSURE (psi)} + 14.7\,psi}{460\,R + \text{TEMPERATURE (°F)}}} = \text{SCFM}$$

where,

Flow = unadjusted flow into SP in cfm
Pressure = compressor outlet gauge pressure in psi
Temperature = compressor air temperature in Fahrenheit

For the data taken at Hour 0:

$$\text{Corrected flow rate} = 4.0\,cfm \sqrt{\frac{530\,R}{14.7\,psi} \times \frac{(20 + 14.7)\,psi}{460\,R + 60°F}} = 6.2\,scfm$$