ALISTO ENGINEERING GROUP

ENVIRONMENTAL PROTECTION

99 OCT 15 PM 2:11

October 15, 1999

Asked Brady to stop by to review 1725 Remediation System. Left msg w/ S. Meeks (Delta) re Remediation system effectiveness.

10-210-11

Ms. Eva Chu
Alameda County Health Care Services Agency
1131 Harbor Bay Parkway, Room 250
Oakland, California 94502-6577

Subject: Corrective Action Plan
Xtra Oil Company Service Station (dba Shell)
1701 Park Street
Alameda, California

Dear Ms. Chu:

Alisto Engineering is please to submit this Corrective Action Plan for Xtra Oil Company service station (dba Shell), 1701 Park Street, Alameda, California.

Please call if you have questions or comments.

Sincerely,

ALISTO ENGINEERING GROUP

Brady Nagle

Brady Nagle
Project Manager

Enclosure

cc: Mr. Keith Simas, Xtra Oil Company
Ms. Ade Fagorala, California Regional Water Quality Control Board

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CORRECTIVE ACTION PLAN

Xtra Oil Company Service Station
1701 Park Street
Alameda, California

OCT 1999

Project No. 10-210-11

October 1999

CORRECTIVE ACTION PLAN

Xtra Oil Company Service Station
1701 Park Street
Alameda, California

Project No. 10-210-11

Prepared for:

Xtra Oil Company
2307 Pacific Avenue
Alameda, California

Prepared by:

Alisto Engineering Group
1575 Treat Boulevard, Suite 201
Walnut Creek, California

October 14, 1999

Kin Leung
Project Engineer

Al Sevilla, P.E.
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1.0 INTRODUCTION

In July 1999, Xtra Oil Company retained Alisto Engineering Group to prepare a Corrective Action Plan (CAP) to address the residual petroleum hydrocarbon in the soil and groundwater at the Xtra Oil Service Station (doing business as a Shell Station) at 1701 Park Street, Alameda, California, and to comply with the requirements of the Alameda County Health Care Services Agency (ACHCSA), the Zone 7 Alameda County Flood Control and Water Conservation District, and the California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB). This CAP presents a summary of site assessment activities completed to date, objectives of the corrective action, evaluation of remedial alternatives, recommended remedial actions, and a detailed scope of work for implementing the recommended remedial actions.

1.1 Purpose and Scope of Work

This CAP was prepared to: (1) evaluate alternative remedial technologies/measures applicable to the site; (2) develop a course of action to address residual hydrocarbons in the soil and groundwater; and (3) comply with applicable rules and regulations of the governing regulatory agencies. The scope of work included the following:

- Review previous site investigation reports to assess site conditions and evaluate geologic and hydrogeologic characteristics of the subsurface.

- Perform a remedial feasibility study (FS) to evaluate alternative remedial measures applicable to the site, including a detailed cost-effectiveness analysis of the evaluated remedial alternatives.

- Develop a remedial action plan which includes a scope of work for additional site investigation and remedial pilot testing, if warranted, and a description of the proposed remediation system.

1.2 Site Location and Description

The Xtra Oil Service Station is on the north corner Park Street and Buena Vista Avenue, Alameda , California. A site vicinity map is shown in Figure 1. The site is at an elevation of approximately 20 feet above mean sea level and encompasses an area of approximately 0.5 acre. It is presently occupied by a retail fuel station with three (two 10,000-gallon and one 7,000-gallon) underground fuel storage tanks (USTs). The site layout and features, locations of the USTs, and existing groundwater monitoring wells are shown on Figure 2.

The Xtra Oil property is surrounded by residential and commercial properties. Adjacent to and northwest of the site is a residential property, and to the south, north and southeast are commercial properties.

1.3 Project Background

In April 1994, there was major renovation at the Xtra Oil Service Station to expand into the adjoining property northwest of the site. Three underground gasoline storage tanks and an underground diesel storage tank were removed and replaced with three double-walled storage tanks. One underground storage tank, which was used to store home heating oil, was also removed from the adjoining property. Analysis of soil samples collected from the sidewalls of the fuel tank cavity and below the former dispenser islands indicated the presence of petroleum hydrocarbons in the vicinity of the tank area. Analysis of a soil sample collected from beneath the former heating fuel oil tank did not detect petroleum hydrocarbons above the reported detection limits (Alisto 1994). Locations of the former underground storage tanks, dispenser islands, and soil samples are shown on Figure 3. The analytical results and depths at which the samples were collected are presented in Table 1.

To assess the nature and extent of petroleum hydrocarbons in soil and groundwater, a preliminary site assessment was conducted at the site in November 1994. The assessment involved drilling three onsite boreholes, B-1, B-2 and B-3, near the property line to the east, south, and west of the former underground fuel storage tanks and dispenser islands. These borings were later converted into monitoring wells MW-1, MW-2, and MW-3. Results of the investigation revealed the presence of detectable concentrations of petroleum hydrocarbons in the soil samples collected from the borings for wells MW-1 and MW-2 at 7.0 to 8.0 feet below grade, which is within the capillary fringe. Analysis of a soil sample collected from the boring for well MW-3 did not detect petroleum hydrocarbons above the reported detection limits (Alisto 1995a).

At the request of the ACHCSA, an additional site investigation was performed in April 1997. The investigation involved drilling an exploratory soil boring (SB-1) and installing a monitoring well (MW-4) north of the former USTs and dispenser islands. Results of the investigation revealed the presence of petroleum hydrocarbons in the soil in well MW-4, and the presence of total organic carbon (TOC) in soil boring SB-1 (Alisto, 1997c). The results of soil sampling and analysis during well installation are summarized in Table 1.

A quarterly groundwater level measurement and sampling program was initiated at the site in November 1994. The groundwater gradient direction, as interpreted for each sampling event, has ranged from northeasterly to southeasterly. Since the beginning of the monitoring program, liquid-phase petroleum hydrocarbons have been observed in well MW-2 at a thickness of up to 0.21 foot. Weekly product removal has reduced the hydrocarbon thickness to approximately 0.13 foot in March 1999. Dissolved-phase petroleum hydrocarbons have been detected consistently in wells MW-1, MW-2, and MW-4 and periodically in MW-3 (Alisto 1995b, c, d; 1996a, b, c; 1997a,b; 1998a, b, c; and 1999a, b, c). Historic groundwater measurement and analytical results are presented in Table 2.

In February 1995, a review of the files of the ACHCSA was performed to identify offsite properties with confirmed releases of petroleum hydrocarbons to the subsurface. The review revealed seven sites within a ¼-mile radius of the site, with each having on- and off-site groundwater monitoring wells. An Exxon service station is located approximately 100 feet northeast of the site, and has approximately 18 monitoring wells and an operating groundwater and soil vapor extraction system.

In June 1996, review of subsurface utility records at the City of Alameda Public Works Department revealed the presence of a 10-inch-diameter sanitary sewer along the centerline of Park Street at a depth of approximately 11 feet below grade. There is also a 6-inch-diameter sanitary sewer along the centerlines of Buena Vista Avenue and Eagle Avenue (Alisto, 1997c). Since the depth to groundwater at the site varies from 6 to 9 feet below grade, the trench and backfill material for the sanitary sewer pipe in Park Street may be influencing the lateral migration of petroleum hydrocarbons from the site towards Park Street. A copy of the sanitary sewer location map is enclosed as Figure 4.

1.4 Well Construction Summary

The following is a summary of the construction details for the groundwater monitoring wells installed to date.

Well Number	Date Installed	Total Depth (feet)	Well Screen Interval (feet below grade)	Diameter (inches)
MW-1	October 1994	20	5 – 20	2
MW-2	October 1994	20	5 – 20	2
MW-3	October 1994	20	5 – 20	2
MW-4	April 1997	14.5	4.5 – 14.5	2

2.0. SITE GEOLOGY AND HYDROGEOLOGY

2.1 Geology

The site is located east of San Francisco Bay in Alameda, California, and lies in the Coastal Range geomorphic province that is characterized by northwesterly trending mountains and valleys. San Francisco Bay occupies a Pliocene age structural depression and is underlain by Late Pliocene-Early Pleistocene alluvial sediment. The upper 500 feet of this coarse, poorly-sorted sediment is derived mainly from the Sacramento-San Joaquin drainage system. The recent sediment load in this system has been greatly increased by hydraulic mining and farming. Bay mud, the youngest deposit in San Francisco Bay, is a soft, unconsolidated sediment generally consisting of 90 percent clay and silt-size detritus, and is prevalent in the area (Page, 1996).

Soils types encountered while drilling during previous investigations consisted primarily of sand, silt, and clay. Silty to gravelly sands were encountered from surface grade to about 8 feet below grade, which is underlain by sandy silt to sandy clay. Boring logs prepared from the previous site investigations are included as Appendix A.

2.2 Hydrogeology

The shallow groundwater beneath the site, as measured on March 30, 1999, is at approximately 5.4 to 6.5 below ground surfaces (bgs). Since groundwater monitoring began in 1994, groundwater elevation has increased by approximately 3 feet. Groundwater flow during this period has consistently been in a northeasterly to southeasterly direction with a gradient across the site ranging from 0.004 to 0.03 foot per foot. The groundwater flow direction and gradient are generally consistent with regional conditions. Figure 5 shows the potentiometric groundwater elevation contour map as interpreted from the results of the March 1999 monitoring events performed at the site.

3.0 SUMMARY OF FINDINGS:

The results and findings of previous investigation or assessment work performed at the site are summarized below:

- The extent of petroleum hydrocarbons in the subsurface soil has been adequately assessed and is limited to the immediate vicinity of the former USTs and dispenser islands.

- The lateral extent of dissolved-phase hydrocarbons in shallow groundwater has not been fully defined. It appears that the plume might have migrated offsite to the east and southeast into Park Street and Buena Vista Avenue.

- Petroleum hydrocarbons were detected at concentrations of up to 12000 milligrams per kilogram (mg/kg) total petroleum hydrocarbons as gasoline (TPH-G) and 2200 mg/kg benzene in soil samples collected from former fuel-tank cavity and dispenser islands. TPH-G at 12000 mg/kg and benzene at 6700 mg/kg were detected in the soil sample collected from the boring for well MW-2.

- Liquid-phase petroleum hydrocarbons have been observed in well MW-2 since November 1994 with a thickness of up to 0.21 foot. Hydrocarbon thickness in MW-2 has decreased to 0.13 foot in March 1999.

- Dissolved-phase petroleum hydrocarbons have been detected consistently in onsite monitoring wells MW-1, MW-2, and MW-4, and periodically in MW-3 at concentrations of up to 100000 micrograms per liter (ug/L) TPH-G, and 22000 ug/L benzene.

- MTBE has been detected in the groundwater samples from wells MW-1, MW-2, and MW-4 at concentrations up to 21000 ug/L.

4.0 REMEDIAL FEASIBILITY STUDY

Based on the results of previous site investigation and groundwater monitoring events, the ACHCSA requested Xtra Oil to implement a corrective plan for the residual petroleum hydrocarbons in the soil and groundwater at the site to minimize or prevent impact to subsurface environment and public health. A remedial FS was performed to identify and evaluate general response actions, available technologies, and viable remediation alternatives appropriate for the site.

The objective of the FS was to identify and evaluate alternative, viable remedial technologies and cleanup measures before selecting the preferred remediation plan based on technical, economic, environmental, and regulatory factors. To achieve this objective, the FS encompassed the following:

- Review of site conditions and findings of previous studies performed at the site.
- Establishment of remedial objectives or cleanup goals.
- Identification of potentially applicable general response actions and technologies.
- Screening of each response action and technology on the basis of technical effectiveness and implementability.
- Analysis of the most cost-effective, viable remedial alternatives and technologies.

4.1 Pertinent Site Conditions

The site conditions and results of the remedial investigation and problem assessment performed to date are discussed in detail in the preceding sections of this report. Pertinent findings of the site characterization and remedial investigation used as the basis for the FS are summarized in Sections 1.0 through 3.0.

4.2 Remedial Action Objectives

The primary objective of any remedial action is to reduce the toxicity, mobility, and volume of contaminated materials in a manner that will protect both public health and the environment. The following factors were considered in establishing remedial objectives for this site:

- Soils encountered during previous investigations generally consisted of interbedded sands, silts and clays.
- Free product has been observed in monitoring well MW-2 since November 1994.
- TPH-G, benzene, and MTBE have been detected in groundwater at concentrations of up to 100000, 22000, and 21000 ug/l, respectively.
- The extent of residual adsorbed-phase hydrocarbons appears to be limited to the immediate vicinity of the former USTs and dispenser islands.

- Dissolved-phase hydrocarbons appear to have migrated offsite in an east-to-southeast direction. The presence of sanitary sewers along Park Street and Buena Vista Avenue appears to have influenced the lateral movement of the hydrocarbon plume. and northeast

- Based on past experience on sites with similar geological and hydrogeological settings, it appears that the saturated and vadose zones at the site are conducive to groundwater pumping, vapor extraction, and air sparging to remediate hydrocarbons in the soil and groundwater, if warranted.

4.3 General Response Actions

In accordance with the United States Environmental Protection Agency (EPA), Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988), and the California Site Mitigation Decision Tree Manual (DOHS, 1986), general response actions are measures that are implemented to manage and/or control a specific contamination problem to meet remedial-action objectives. General response actions that have been considered for this site include:

Active Remediation

- Containment
- Excavation
- Treatment
- Collection
- Disposal
- Discharge

Passive Remediation

- Natural Processes
- Monitoring and Sampling

The viability of passive or active remedial response actions depends on the nature and extent of hydrocarbons in the soil and groundwater and their potential impact on the environment and public health and safety. Consideration of passive remediation requires assessment and definition of the nature and extent of the hydrocarbon plume, as well as the transport and fate of petroleum hydrocarbons. The assessment must also integrate available information on present and future exposure pathways, sensitive receptors, and impact on site use. The active remedial response actions may be further divided by technology types and subdivided into specific remedial process options such as air stripping and carbon adsorption.

4.4 Screening of Remedial Alternatives

The screening of alternatives presented in this section was based on the criteria from Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (US EPA 1988). The emphasis for preliminary screening of technologies was on technical effectiveness, applicability, implementability, and cost. Public health and environmental considerations are part of the technical effectiveness criteria.

4.4.1 Technical Effectiveness

The specific technology types and process options identified were evaluated based on: (1) potential effectiveness in handling the estimated areas or volumes of affected media and meeting reduction goals for hydrocarbon constituents; (2) effectiveness in protecting human health and the environment during implementation; and (3) proven reliability to remediate the nature and concentrations of hydrocarbons present at the site.

4.4.2 Implementability

Implementability encompasses both the technical and institutional feasibility of implementing a technology type or process option. Technical implementability was used as an initial screening tool to eliminate technology types and process options that are clearly ineffective or inappropriate for site-specific conditions. Subsequent and more detailed evaluation places greater emphasis on the institutional aspects of implementability, such as the ability to obtain the necessary permits; availability of treatment, storage, and disposal facilities; and availability of necessary equipment and skilled workers to implement the technology.

4.4.3 Cost

The relative cost of the various options was also evaluated as part of the initial screening process. Preliminary rather than detailed estimates of capital and operation and maintenance costs are used. At this initial stage of the evaluation process, cost comparison is based on the best available data and engineering judgment.

4.5 Applicability of Intrinsic Bioattenuation/Passive Remediation

Intrinsic bioattenuation or passive remediation may be applicable at sites where potential impact on the environment and public health and safety is limited and residual hydrocarbons in the soil and groundwater pose minimal or no-health risk. Factors to be considered in evaluating the viability of passive remediation include:

- Site-specific geologic and hydrogeologic conditions, including soil characteristics and aquifer parameters.
- Locations of sensitive receptors and exposure pathways relative to the site.
- Beneficial use of the impacted groundwater.
- Present and planned land uses of the site.

- Concentration of regulated chemicals in the soil and groundwater.

- Cost/benefit relative to other active remedial efforts.

Intrinsic bioattenuation relies solely on natural processes to mitigate the impacted soil and groundwater rather than on engineered controls and technologies. The only activity typically required under this response option is ongoing monitoring and sampling to evaluate the effectiveness of passive remediation and for risk management. The natural processes that influence the reductions of hydrocarbon concentration include:

- **Biodegradation:** Microorganisms present in the soil and/or groundwater convert the hydrocarbons into carbon dioxide and water.

- **Volatilization:** Volatile components of petroleum hydrocarbons vaporize and migrate to the vadose zone and eventually to the atmosphere.

- **Adsorption:** Hydrocarbons are adsorbed by the soil particles and become immobile. Only the water-soluble components that come in contact with infiltrating water or rising groundwater will become mobile and dissolve.

- **Dispersion/Dilution:** Dilution and dispersion of constituents in the groundwater may reduce detectable levels at the point of compliance to acceptable standards.

The most common applications for passive remediation are post-assessment and post-active remediation. At sites where the levels of residual hydrocarbons in the soil and groundwater pose minimal or no risk to the environment and public health and safety, passive remediation with ongoing monitoring and sampling may be the most cost-effective remedial response. Where active remediation has been implemented and continued operation is no longer cost effective, passive remediation may be used to verify that remaining constituent will pose no threat.

4.6 Screening of Active Remediation Options for Detailed Analysis

The following are general response actions and corresponding remedial technologies selected based on the initial screening process for a detailed cost-effective evaluation.

General Response Actions	Remedial Technology Types
Soil	
Excavation	Soil Excavation
Treatment	Vapor Extraction/Treatment Bioremediation Microencapsulation Thermal Destruction
Disposal	Land Disposal
Groundwater	
Collection	Recovery Wells Subsurface Drains
Treatment	Physical/Chemical Treatment Physical/Thermal Treatment Biological Treatment
Discharge	Offsite Discharge

The following is a brief description of each of the selected remedial alternatives for the soil and groundwater at the site:

4.6.1 Soil Remediation

Based on the above screening process, the following technology alternatives are determined to be potentially applicable for remediation of soil at this site:

- Vapor extraction/treatment
- Bioremediation
- Microencapsulation
- Soil excavation and offsite thermal disposal, bioremediation, or microencapsulation
- Land disposal

Following is a brief description of each soil remedial alternative:

- Vapor Extraction/Treatment

Vacuum extraction is an effective method for in-situ removal of dissolved-phase, residual, and vapor-phase volatile hydrocarbons from subsurface soils. The process of vacuum extraction involves in-situ volatilization of hydrocarbons and induction of air flow through soils by application of a significant vacuum within the soil matrix. In-situ volatilization is typically accomplished with an extraction system connected to vertical or horizontal extraction wells. As the subsurface vacuum propagates through subsoils, liquid hydrocarbons are volatilized and the hydrocarbon vapors are extracted from the soils through wells. The extraction of the vapor-saturated soil gas from the pores results in fresh air entering the zone of influence, which enhances volatilization and subsequent removal of the volatile hydrocarbon compounds.

The extracted soil gas vapors are typically treated using either a thermal oxidizer in which the gas is oxidized or vapor-phase activated carbon adsorption.

- Ex-Situ Enhanced Bioremediation

This method requires that the soil be excavated and placed on a plastic-lined area of the site. As the soil is placed, perforated pipes are laid horizontally to allow for withdrawal and reinjection of air. Additionally, the soil pile is covered with polyethylene sheeting to preclude the escape of volatile compounds into the atmosphere.

A vacuum pump is used to circulate air through the pile. The recirculated air is passed through activated carbon or a thermal treatment device to remove hydrocarbon vapors extracted from the pile. Air at elevated temperatures exiting the thermal treatment device may be recirculated through the pile to enhance volatilization.

- Microencapsulation

This method requires that the soil be physically mixed with a two-part, non-hazardous chemical solution applied sequentially. The hydrocarbon content of the soil is encapsulated into micron-sized spheres that are covered with an insoluble silica compound. In some situations, the chemical solutions may be injected into the soil for in-situ microencapsulation. The hydrocarbons still remain but are undetectable using standard analytical methods.

- Thermal Destruction

In this method, excavated soil is treated by application of heat for complete combustion or destruction of hydrocarbons, either onsite or offsite at a permitted treatment facility. Through thermal treatment, hydrocarbon contaminants in soil are converted to carbon dioxide and water. Treated soil is then returned to the excavated pit, reused for grading, or disposed of at an approved landfill. Onsite treatment is frequently more economical than offsite treatment due to the cost savings associated with transportation of the soil offsite.

- Land Disposal

  Following excavation, treatment, and chemical profiling, contaminated soil may be disposed of at a landfill, depending on the level of hydrocarbon constituents remaining in the soil. Designated facilities are available for disposal of the contaminated soil.

4.6.2 Groundwater Remediation

The following are options selected to be potentially viable for recovery/treatment of dissolved-phase hydrocarbons in the groundwater at the site:

Collection

- Recovery wells
- Interceptor trenches and drains

Treatment

- Carbon adsorption
- Air stripping/off-gas treatment with carbon adsorption
- Combined vapor extraction, air sparging/off-gas treatment with carbon adsorption
- Ultraviolet light/hydrogen peroxide treatment
- Biological treatment

The following is a brief description of available options under each remedial category.

4.6.2.1 Collection Options

Groundwater may be recovered or extracted by the use of either recovery wells or trenches and drains. Selection of the collection system depends on site-specific conditions and aquifer characteristics.

Recovery Wells

There are three basic types of recovery-well pumping systems: skimming, single-pump, and dual-pump. Skimming-pump systems are designed to remove liquid-phase hydrocarbons from the water surface in a well or sump with little or no water production. Single-pump systems produce both water and liquid-phase hydrocarbons and require aboveground separation of fluids. In a dual-pump system, water is withdrawn at a controlled rate to create a cone of depression while a suspended hydrocarbon pump is placed above the water pump to remove immiscible-phase hydrocarbons. Single/dual-pump systems may be used to collect both free product and dissolved-phase hydrocarbons in the groundwater.

Trenches and Drains

Interceptor trenches and drains are used to recover liquid-phase hydrocarbons that are present above a shallow water table or a perching barrier of low hydraulic conductivity. Trenches or drains are excavated downgradient of the liquid-phase hydrocarbon plume. The trench must extend several feet below the expected lowest seasonal fluctuation of the water table or to a geologic barrier that may be restricting the migration of hydrocarbons. Liquid-phase hydrocarbons will migrate into the trench under the influence of the natural groundwater gradient and may be collected by pumping. Pumping from the trench lowers the water table, thereby inducing free-product flow to the trench. The use of trenches is limited by technical feasibility and construction and soils disposal costs. Trenches and drains are not suitable for use at this site because of the extent of hydrocarbons in the soil and groundwater, surrounding site uses, and cost.

4.6.2.2 Treatment Options

There are several proven technologies available for treatment of petroleum hydrocarbons in groundwater. Following is a brief description of treatment technologies considered for this site:

Activated Carbon Adsorption

Activated carbon adsorption is a proven technology for removal of organic compounds from water. The technology is based on the principle that certain organic constituents preferentially adsorb to organic carbon. Activated carbon absorption is capable of efficiently removing very low concentrations of dissolved organics from groundwater, including BTEX and most other gasoline and diesel constituents.

The most common application of carbon adsorption is passing groundwater under pressure through a product/water separator followed by two or three separate carbon treatment units piped in series. Each unit consists of a canister filled with activated carbon. As the carbon in the first canister is exhausted, it is recharged with fresh carbon, then returned onstream as the downstream unit. This ensures that a second contact stage remains online to protect against discharge of hydrocarbon constituents as the first stage approaches exhaustion or breakthrough. Expended carbon is removed and transported to a suitable recycling facility. The adsorbed-phase hydrocarbons are destroyed during the carbon recycling or regeneration process.

A major cost in the carbon adsorption system is the disposal or recycling of spent carbon. Fresh carbon costs about $1 per pound but with the cost of disposal or recycling, the total carbon cost is about $3 per pound. Due to these costs, this method is more expensive than other methods for treating high concentrations of dissolved-phase hydrocarbons in groundwater.

Air Stripping with Off-Gas Treatment by Activated Carbon

In air stripping, recovered groundwater is pumped into the top of a column and flows downward through a packing material or series of trays. Air is forced upward through the column, providing sufficient air-water contact to typically remove from 90 to over 99 percent of dissolved-phase BTEX constituents. The treated water is collected at the bottom of the column and is discharged or further treated, if required. Air discharged at the top of the tower is treated by activated carbon before discharge to the atmosphere.

Air stripping is typically used when hydrocarbon concentrations are too high for economical use of activated carbon water treatment or when air effluent discharge limits are less stringent.

Vapor Extraction/Air Sparging with Thermal or Vapor Treatment

In air sparging, forced air is introduced through a series of wells below the water table to induce volatilization of both dissolved/adsorbed-phase contaminants from groundwater and soil. The air-sparged volatile hydrocarbons from the soil and groundwater are then extracted by inducing a high air flow through the soils by application of a significant vacuum within the soil matrix. The extraction of the vapor-saturated soil gas from the pores results in fresh air entering the zone of influence. This enhances volatilization and subsequent removal of the volatile hydrocarbon compounds. The extracted vapors are typically fed into a thermal treatment unit or activated carbon system where the hydrocarbon vapors are thermally oxidized or removed to meet air-quality standards.

Ultraviolet Light/Hydrogen Peroxide Treatment

This method destroys organic contaminants dissolved in water by means of chemical oxidation. Ultraviolet (UV) light acts as a catalyst in the chemical oxidation of organic contaminants in water by its combined effect on the organic contaminant and its reaction with hydrogen peroxide. Hydrogen peroxide radicals formed by reaction with UV light are very powerful chemical oxidants that will react with any organic contaminants in the water. Due to high energy and material costs and susceptibility to problems (e.g., burnout of UV lights, changes in influent-contaminant concentrations, and lamp fouling) leading to ineffective treatment and lower effluent quality, this method is not widely used for groundwater treatment.

Biological Treatment

Biological treatment techniques used by municipal wastewater facilities may be scaled down and applied to removal of dissolved-phase hydrocarbons from groundwater. The hydrocarbons serve as a food source for certain aerobic microorganisms that convert the organic compounds into carbon dioxide, water, energy, and biological solids. Disadvantages of biological treatment include high operating and maintenance costs. Also, biological systems are more complex than other treatment systems and are more prone to operational problems. For these reasons, biological treatment of groundwater is not widely practiced or used in small-scale applications.

4.6.3 Selection of Viable Options for Detailed Analysis

The primary goal for soil and groundwater remediation at the site, based on the above considerations, is to reduce dissolved-phase hydrocarbons in the groundwater to meet cleanup goals, and remove residual adsorbed-phase hydrocarbons in the capillary fringe as specified by applicable rules and regulations. Specifically, remedial activities will be designed to reduce the concentrations of BTEX constituents to the maximum extent that is feasible and cost-effective to meet cleanup goals that are protective of public health and the environment.

Based on the screening process, the most viable alternatives selected for detailed analysis are:

1. No action with groundwater monitoring and sampling (intrinsic bioattenuation).

2. Groundwater recovery with treatment by activated carbon.

3. Groundwater recovery with air stripping and vapor extraction with thermal treatment.

4. Air sparging and vapor extraction with thermal treatment.

5. Air sparging and vapor extraction with internal combustion engine.

The only viable option for recovery of groundwater is the use of extraction wells; therefore, detailed analysis of other recovery options was not performed.

With respect to effluent discharge, the most feasible option is to discharge to either the local sanitary sewer or a nearby surface water/storm drain under a National Pollutant Discharge Elimination System (NPDES) permit.

In accordance with the regulations of the Bay Area Air Quality Management District (BAAQMD), vapor discharged from an air stripper or SVE system requires pre-treatment to meet air quality objectives.

Option 1: <u>No-Action/Groundwater Monitoring and Sampling</u>

No remedial action would be involved under this option except for continued groundwater monitoring and sampling. As such, no capital costs would be incurred.

Option 2: <u>Groundwater Recovery with Activated Carbon Treatment</u>

Groundwater remediation using this option involves the use of groundwater extraction wells equipped with submersible pumps to hydraulically contain the hydrocarbon plume and recover dissolved-phase hydrocarbons in the groundwater. Extracted groundwater would be treated using carbon adsorption before discharge either to the local sanitary sewer or to a nearby storm drain.

Option 3: Groundwater Recovery with Air Stripping and Vapor Extraction with Thermal Treatment

Under this option, groundwater extraction wells would be used to hydraulically contain the hydrocarbon plume and recover dissolved-phase hydrocarbons in the groundwater. Extracted groundwater would be treated in an air stripping column to remove the volatile hydrocarbons in the gaseous phase before discharge either to the local sanitary sewer or to a nearby storm drain. The off-gas from the air stripper would pass through a thermal oxidizer before discharge to the atmosphere. To enhance the remediation process, vapor extraction would also be conducted with extracted vapors treated by the same thermal oxidizer.

Option 4: Air Sparging and Vapor Extraction with Thermal Treatment

This option would involve the use of vapor extraction wells and air sparging wells for in-situ treatment of soils and groundwater. The adsorbed-phase hydrocarbons would be extracted from the vapor extraction wells and passed through a thermal oxidizer where the hydrocarbons would be oxidized before discharge to the atmosphere. Additionally, air will be injected into the air sparging wells to below groundwater level to enhance volatilization of hydrocarbons in the groundwater.

Option 5: Air Sparging and Vapor Extraction with Internal Combustion Engine

This option would require the use of vapor extraction wells and air sparging wells for in-situ treatment of soils and groundwater similar to Option 4. The residual hydrocarbons in the soil would be recovered by vapor extraction wells and passed through an internal combustion engine where the hydrocarbons would be oxidized before discharge to the atmosphere.

4.7 Cost Comparison of Selected Remediation Options

To aid in selection of the recommended groundwater remediation alternative, a detailed cost comparison is necessary to determine the overall cost effectiveness of the viable options.

The true economic value of an alternative is best expressed in terms of present worth because of the difference in the duration of each remedial alternative to comply with regulatory requirements. The present worth or life-cycle cost of an alternative represents the financial requirements of time-related projects, and is the sum of the present worth of capital expenditures and the annual operation and maintenance costs for the duration of the remedial plan. The present worth of each alternative was calculated based on the following equation, an annual interest rate of 6 percent, and the estimated duration of each remedial alternative:

$$\text{Present Worth} = \text{Capital Cost} + [\text{Annual O\&M} \times P_F]$$

$$\text{where: } P_F = \frac{(1 + i)^n - 1}{i(1 + i)^n}$$

and

P_F = Present worth factor
i = interest rate per period
n = number of periods (duration)

The capital and annual costs and present worth of each selected remediation option are summarized in Table A below.

The cost estimates are preliminary in nature and are for comparative purposes only. Based on the cost comparison, it is apparent that the present worth or life-cycle cost of Option 4 is the lowest of the remedial-action options, although Option 1 has the lowest present worth of all the five options. Options 3 and 5 have the highest overall cost due to either the high capital and/or higher annual operating costs.

4.8 Detailed Analysis of Selected Remediation Options

In addition to cost comparison, the selected remediation options were evaluated based on the following criteria:

- **Short-Term Effectiveness**

  All the engineered remedial action alternatives may be implemented expeditiously following regulatory approval. Since short-term remedial effectiveness is independent of the treatment method chosen, the alternatives are rated equal in short-term effectiveness. With the presence of liquid-phase hydrocarbons, the intrinsic remediation alternative does not provide equivalent short-term effectiveness to control potential plume migration and an ongoing source of hydrocarbons in the groundwater.

- **Long-Term Effectiveness**

  A difference in long-term effectiveness between the various treatment alternatives is foreseen since the duration of groundwater remediation may be significantly reduced if assisted by air sparging/vapor extraction. Therefore, Option 4 would provide the greatest benefits due to the shorter duration of system operation. Options 2, 3, and 5 would require a longer time, and the no-action option would require the longest time to complete.

TABLE A
COST COMPARISON OF SELECTED REMEDIATION ALTERNATIVES

COST ITEMS	ALTERNATIVES				
	OPTION 1 NO ACTION	OPTION 2 GROUNDWATER RECOVERY/ CARBON TREATMENT	OPTION 3 GROUNDWATER RECOVERY/ AIR STRIPPING WITH VAPOR EXTRACTION – *THERMAL TREATMENT*	OPTION 4 AIR SPARGING/ VAPOR EXTRACTION - THERMAL TREATMENT	OPTION 5 AIR SPARGING/ VAPOR EXTRACTION - TREATMENT BY AN INTERNAL COMBUSTION ENGINE
CAPITAL COST					
Design and Permitting	$ 0	$ 10,000	$ 15,000	$ 10,000	$ 10,000
Installation	0	30,000	35,000	30,000	30,000
Equipment	0	30,000	80,000	50,000	25,000
Vapor Extraction Wells/Air Sparging Points	0	0	20,000	20,000	20,000
Groundwater Recovery Wells	0	15,000	15,000	0	0
Contingencies	0	10,000	10,000	10,000	10,000
TOTAL CAPITAL COST	$ 0	$ 95,000	$ 175,000	$ 120,000	$ 95,000
ANNUAL COST					
Groundwater Monitoring	$ 6,000	$ 6,000	$ 6,000	$ 6,000	$ 6,000
Equipment Maintenance/Carbon Replacement	0	24,000	28,000	20,000	26,000
Water and/or Vapor Influent/Effluent Sampling and Analysis	0	7,000	9,000	2,000	2,000
Discharge Permits, Fees, and Reports	0	10,000	12,000	10,000	10,000
Utilities	0	3,000	15,000	12,000	18,000
TOTAL ANNUAL COST	$ 6,000	$ 50,000	$ 70,000	$ 50,000	$ 62,000
PRESENT WORTH					
Estimated Duration	30 years	5 years	4 years	2 years	4 years
Capital Cost	$ 0	$ 95,000	$ 175,000	$ 120,000	$ 95,000
Annual Costs For Duration	$ 82,600	$ 210,600	$ 242,600	$ 91,700	$ 214,800
TOTAL PRESENT WORTH	$ 82,600	$ 305,600	$ 417,600	$ 211,700	$ 309,800

- **Implementability/Applicability**

There are no differences in implementability for each of the treatment options. Activated carbon units, thermal oxidation systems, air stripping units, internal combustion engines, and air sparging equipment are all proven technologies and are relatively compact and easy to operate. Sufficient space exists on the property for any of the viable remediation systems.

The no-action option, not involving active remediation, would rely on natural biodegradation processes and the attenuation of petroleum hydrocarbons in the groundwater. This option may not be applicable to the site because of regulatory concerns regarding the potential continuous migration of the dissolved-phase hydrocarbon plume offsite.

- **Reduction in Toxicity, Mobility, or Volume**

All remedial options would ultimately result in removal and destruction of hydrocarbons in the soil and groundwater. This is valid for air stripping systems, only if discharged air is treated to remove the stripped contaminants. During biological treatment, the hydrocarbons are oxidized into soluble salts, carbon dioxide, and water. The no-action option would rely on natural biodegradation processes and attenuation of petroleum hydrocarbons in the groundwater. Extraction of groundwater would reverse the groundwater gradient in the capture zone near the extraction well(s) to recover dissolved-phase hydrocarbons.

- **Overall Protection of Human Health and the Environment**

As summarized in Table B, the potential risk of exposure from hydrocarbon-impacted soil and groundwater to local residents and workers through the various exposure routes is minimal based on the current use of the property. However, there is potential risk of exposure to workers and local residents if future use of the property changes, or if dissolved-phase hydrocarbons continue to increase at the site while performing certain remedial or construction activities.

- **Compliance with Applicable Rules and Regulations**

The treatment options have been developed and selected to satisfy applicable regulatory requirements. Factors to be addressed with thermal oxidation and air stripping systems include vapor emissions, noise levels, and visual aspects.

- **Regulatory Agency and Community Acceptance**

The primary concern in obtaining regulatory and community acceptance of the various remediation options is the potential impact on public health, environment, noise, and aesthetics at the site. For this reason, the air stripping system is not usually used in residential areas unless noise abatement measures are provided at an additional cost.

TABLE B
POTENTIAL EXPOSURE PATHWAYS

Potentially Exposed Population	Exposure Route, Medium, and Exposure Point	Pathway Selected for Evaluation	Reason for Selection or Exclusion
CURRENT LAND USE			
Local Residents and Workers	Inhalation of volatiles at the site	No	Impacted soil and groundwater are covered by concrete, pavement, and building foundation.
Local Residents	Ingestion of or dermal contact with impacted groundwater or soil at the site	No	Hydrocarbon-affected soils are covered by concrete, pavement, or building foundation.
FUTURE LAND USE			
Hypothetical Future Residents	Ingestion, dermal contact, or inhalation of volatiles from groundwater	Yes	Since the area is mixed residential and commercial, it is likely that a residential development would be constructed within 1/4-mile of the site. However, it is unlikely that the shallow groundwater from the vicinity of the site would be used as a potential drinking water source.
Hypothetical Future Residents and Construction Workers	Ingestion of or dermal contact with impacted groundwater or soil at the site	Yes	If excavation is undertaken, it is possible that workers would be exposed.

Properly designed air sparging and thermal oxidation systems do not result in significant noise levels and therefore would be more acceptable to the regulatory agencies and the community. The systems will be designed to meet local building and planning requirements and to blend with existing building architecture. From the regulatory agency standpoint, all alternative response actions were developed to comply with the goals and objectives of the regulatory agencies. Without engineered remediation, however, regulatory agencies may not accept intrinsic bioremediation as a remedial option because of the proximity of the sanitary sewer lines downgradient of the site.

4.9 Selection of Preferred Option

Since the options considered for detailed analysis meet the basic evaluation criteria set forth herein, the preferred alternative was therefore selected on the basis of cost, technical feasibility, ease of implementation, overall protection of public health and the environment, and regulatory agency and community acceptance.

Based on the preceding cost comparison, it is apparent that Option 4, Air Sparging and Vapor Extraction with Thermal Treatment, has the lowest present worth or life-cycle cost among the active or engineered remedial plans. Option 1 has the lowest present worth among the remedial options, but was not selected based on consideration of regulatory agency acceptance and other factors. Considering the following technical and non-economic factors, Option 4 was selected as the most cost-effective and preferred remedial plan for this site:

1. Based on current and expected future land use in the area and the proximity of neighboring properties, dissolved-phase hydrocarbons detected in the groundwater are a potential environmental concern.

2. Groundwater extraction is not recommended because of the potential to influence petroleum hydrocarbon plumes at the several nearby properties. this should not be a concern. Radius of influence will be <50'

3. The shallow groundwater at the site is of poor quality and is not used for supply purposes.

4. The characteristics of the sediments encountered in the unsaturated and water-bearing zones are conducive to air sparging and vapor extraction.

Additional concerns that need to be addressed during engineering design and implementation of the selected remedial option are effluent discharge requirements and minimization of the system's visual impact based on current use of the site and adjacent properties.

w/o GWE can there be plume control?

5.0 PROPOSED REMEDIAL ACTION PLAN

Based on results of the previous site investigation, it is apparent that petroleum hydrocarbons have impacted the shallow groundwater beneath the site. From the preceding remedial FS and cost-effectiveness analysis, it is therefore recommended that air sparging and vapor extraction with thermal treatment be implemented at this site. The preliminary layout of the proposed remediation system is shown in Figure 6. A process-flow diagram of the proposed system is shown in Figure 7.

As part of the proposed remedial action plan, the following activities are also recommended to obtain additional site information for the final engineering design of the recommended remediation system:

can look at Exxons vapor extraction data

- Perform vapor extraction pilot testing to confirm the effectiveness and applicability of soil vapor extraction as a remedial alternative at the site. Based on results of the pilot testing, additional vapor extraction wells may be added to the final system design, or the vapor treatment technology may be changed to activated carbon.

- After vapor extraction pilot testing, perform air sparging pilot testing to confirm the effectiveness of this remedial technology at the site. Based on results of the pilot testing, additional air sparging wells may be warranted as part of the final system design.

5.1 Description of Proposed Remediation System

The proposed remediation system will consist of the following components:

1. The horizontal PVC well screen, which was installed during site renovation in 1994, will be used for soil vapor extraction. The layout of the horizontal well screen is shown on Figure 6.

2. A regenerative thermal oxidation unit with an electrically-driven regenerative vacuum blower will be installed for vapor extraction. The oxidation unit would include a knockout drum for moisture removal, an air compressor for a pneumatic valve-control system, and a microprocessor-based, electronic control system for automatic operation.

3. Seven air sparging wells will be installed and connected to an air compressor for air sparging. The locations of the proposed air sparging wells are shown on Figure 6.

4. An equipment enclosure, which includes a reinforced concrete pad with a 6-foot-tall chain-link fence, will be installed for security and visual screening of the aboveground equipment.

Before installation of other system components, approvals and permits for the design and operation of the remediation system will be obtained from the appropriate agencies. At the completion of system installation, the remediation equipment will be operated and tested to ensure compliance with permit conditions. At a minimum, influent and effluent samples will be analyzed and collected in accordance with the discharge permit. An O&M program will be followed to ensure continued safe and reliable system operation.

5.2 Implementation Plan

Implementation of the proposed remedial plan will involve the following tasks:

Task 1: Air Sparging Wells Installation

Seven air sparging wells will be installed at locations as shown on Figure 6. Each soil boring will be drilled to a total depth of 25 feet. The air sparging wells will be constructed using 2-inch-diameter PVC casings with screen between depths of 23 to 25 feet.

Task 2: Vapor Extraction Pilot Testing

Following installation of the air sparging wells, a soil vapor extraction pilot testing will be performed to confirm the effectiveness and applicability of vapor extraction as a remedial alternative at the site.

The vapor extraction pilot testing will be conducted by creating a vacuum to the existing horizontal well screen. An explosion-proof blower will be used to generate the vacuum for vapor extraction, while two 200-pound vapor phase activated carbon canisters will be used to treat the off-gas. The applied vacuum readings, flowrates, influent and effluent hydrocarbon concentrations, and resultant vacuum influence in surrounding monitoring wells will be recorded at appropriate intervals during the test.

Task 3: Air Sparging Pilot Testing

After vapor extraction pilot testing has been completed, air sparging pilot testing will be conducted to confirm the effectiveness and applicability of air sparging to address dissolved-phase petroleum hydrocarbons in groundwater. Selected air sparging wells will be used for air injection.

The air sparging equipment will include an air compressor with air filter, an in-line pressure regulator and air flow meter; a manual shut off valve, and fittings attached to the pipe header leading to the air sparging wells. The air sparge pilot test will be initiated after a leak check of all system components. Test parameters will be monitored at 30-minute intervals at all wells within the monitoring network.

Task 4: Engineering Design and Permitting

Following the completion of the pilot testings, the final engineering design of the proposed remediation system will be prepared. System design will include equipment selection and sizing, and layout of system components. This task will include preparation of plans and specifications for submittal to the appropriate permitting agencies for approval.

An air discharge permit application for the vapor extraction and treatment system will be prepared and submitted to BAAQMD. The building and construction permit applications that are necessary to install the proposed remediation system will also be prepared and submitted to appropriate agencies.

Task 5: Pre-Construction Activities

Pre-construction activities will include development of a site-specific safety plan, liaison with appropriate agencies to review the work plan (if necessary), scheduling of construction and field activities and subcontractors, and location of underground utility lines and piping.

Task 6: Treatment System Installation and Startup

Equipment and hardware for the remediation system will be installed in accordance with the final engineering design. Startup of recovery system equipment includes troubleshooting and adjustment of operating parameters.

Task 7: Startup, Operation, and Maintenance

After startup, operation and maintenance of the system will include weekly (or as required) collection and analysis of influent and effluent samples, preparation of monthly progress reports, and periodic maintenance of the system equipment.

5.3 Implementation Schedule

The site activities proposed herein will be completed within approximately 180 work days after work plan approval and acquisition of the air quality permits. The schedule for completion of the major tasks is as follows:

Activity	Estimated Work Days after Work Plan Approval
Air Sparging Wells Installation	30
Vapor Extraction Pilot Testing	35
Air Sparging Pilot Testing	35
Engineering Design and Permitting	90
Pre-Construction Activities	150
Equipment Installation	170
Startup and Troubleshooting	180

Due to the nature and logistics involved in extraction/treatment system permitting and installation, this schedule may be subject to revision. Any changes to the schedule will be communicated in advance to the appropriate agencies and parties involved.

5.4 Site Safety Plan

All field procedures and activities related to the performance of site work will be in accordance with the site-specific safety plan. The site safety plan will be developed in compliance with applicable requirements of the Federal Occupational Safety and Health Administration (OSHA) and California OSHA.

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TABLE 1 - SUMMARY OF RESULTS OF SOIL SAMPLING
XTRA OIL COMPANY SERVICE STATION
1701 PARK STREET, ALAMEDA, CALIFORNIA

ALISTO PROJECT NO. 10-210

SAMPLE ID	DEPTH (feet)	DATE OF SAMPLING	TPH-G (mg/kg)	TPH-D (mg/kg)	B (mg/kg)	T (mg/kg)	E (mg/kg)	X (mg/kg)	MTBE (mg/kg)	TOTAL LEAD (mg/kg)	PAHs (mg/kg)	TOC (mg/kg)	LAB
SW-N-9	9	04/08/94	5.4	ND<10	0.63	0.045	0.15	0.16	---	ND<4.0	---	---	MCC
SW-E-N-9	9	04/08/94	4,600	540	59	230	79	370	---	ND<4.0	---	---	MCC
SW-E-C-9	9	04/08/94	5,300	1,300	54	220	93	430	---	ND<4.0	---	---	MCC
SW-E-S-9	9	04/08/94	12,000	2,200	130	640	210	940	---	---	---	---	MCC
SW-S-9	9	04/08/94	1,900	730	ND<0.5	1.7	25	41	---	---	---	---	MCC
SW-W-S-9	9	04/08/94	2.5	ND<10	0.030	0.033	0.069	0.23	---	---	---	---	MCC
SW-W-C-9	9	04/08/94	28	22	0.24	0.93	0.53	2.4	---	ND<4.0	---	---	MCC
SW-W-N-9	9	04/08/94	7.1	ND<10	0.63	0.11	0.27	0.64	---	ND<4.0	---	---	MCC
FO-1	6	04/27/94	---	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	---	---	---	---	MCC
SP-1	1	05/06/94	380	210	0.17	1.2	3.1	13	---	6.6	---	---	MCC
SP-2	1	05/06/94	6.5	ND<10	0.082	0.059	0.12	0.50	---	ND<4.0	---	---	MCC
SP-3	1	05/06/94	2.3	ND<10	0.025	0.034	0.018	0.16	---	ND<4.0	---	---	MCC
MW-1	7.5 to 8.0	10/20/94	4,800	2,800	63	330	120	580	---	---	---	---	MCC
MW-2	7.0 to 7.5	10/20/94	12,000	6,700	70	59	220	870	---	---	---	---	MCC
MW-3	8.0 to 8.5	10/20/94	ND<1.0	ND<10	ND<0.005	ND<0.005	ND<0.005	ND<0.005	---	---	---	---	MCC
MW-4	6.0 to 6.5	04/28/97	3.8	2.2	0.018	0.012	0.053	0.12	0.070	---	ND	---	MCC/CHR
MW-4	11.5 to 12.0	04/28/97	5,300	1,100	ND<0.25	23	98	390	15	---	4.1 (a)	---	MCC/CHR
SB-1	6.0 to 6.5	04/28/97	---	---	---	---	---	---	---	---	---	830	SEQ

TABLE 1 - SUMMARY OF RESULTS OF SOIL SAMPLING
XTRA OIL COMPANY SERVICE STATION
1701 PARK STREET, ALAMEDA, CALIFORNIA

ALISTO PROJECT NO. 10-210

SAMPLE ID	DEPTH (feet)	DATE OF SAMPLING	TPH-G (mg/kg)	TPH-D (mg/kg)	B (mg/kg)	T (mg/kg)	E (mg/kg)	X (mg/kg)	MTBE (mg/kg)	TOTAL LEAD (mg/kg)	PAHs (mg/kg)	TOC (mg/kg)	LAB

ABBREVIATIONS:

TPH-G	Total petroleum hydrocarbons as gasoline using EPA Methods 5030/8015
TPH-D	Total petroleum hydrocarbons as diesel using EPA Methods 3510/8015
B	Benzene using EPA Methods 5030/8020
T	Toluene using EPA Methods 5030/8020
E	Ethylbenzene using EPA Methods 5030/8020
X	Total xylenes using EPA Methods 5030/8020
MTBE	Methyl tert butyl ether using EPA Methods 5030/8020
PAHs	Polynuclear aromatic hydrocarbons using EPA Method 8270A
TOC	Total organic carbon
mg/kg	Milligrams per kilogram
ND	Not detected above reported detection limit
---	Not analyzed/applicable/measured
MCC	McCampbell Analytical Inc.
CHR	Chromalab, Inc.
SEQ	Sequoia Analytical

NOTES:

(a) Naphthalene

TABLE 1 - SUMMARY OF GROUNDWATER SAMPLING
XTRA OIL COMPANY SERVICE STATION
1701 PARK STREET, ALAMEDA, CALIFORNIA

ALISTO PROJECT NO. 10-210

WELL ID	DATE OF MONITORING/ SAMPLING	CASING ELEVATION (a) (Feet)	DEPTH TO WATER (Feet)	PRODUCT THICKNESS (Feet)	GROUNDWATER ELEVATION (b) (Feet)	TPH-G (ug/l)	TPH-D (ug/l)	B (ug/l)	T (ug/l)	E (ug/l)	X (ug/l)	MTBE (ug/l)	SVOCs (ug/l)	DO (ppm)	LAB
MW-1	11/04/94	19.60	8.6	---	10.96	60000	6400	13000	4900	1300	5500	---	---	---	MCC
QC-1 (c)	11/04/94	---	---	---	---	54000	---	12000	4500	1200	5200	---	---	---	MCC
MW-1	01/11/95	19.60	6.10	---	13.50	---	---	---	---	---	---	---	---	---	---
MW-1	02/24/95	19.60	6.57	---	13.03	56000	4400	13000	7000	1400	5100	---	---	---	MCC
QC-1 (c)	02/24/95	---	---	---	---	43000	---	8900	4600	970	3300	---	---	---	MCC
MW-1	05/25/95	19.60	6.54	---	13.06	53000	4700	11000	5700	1200	4000	---	---	4.3	MCC
QC-1 (c)	05/25/95	---	---	---	---	48000	---	11000	5300	1200	3800	---	---	---	MCC
MW-1	08/30/95	19.60	8.15	---	11.45	14000	3700	5000	1100	3900	103	---	---	2.8	MCC
QC-1 (c)	08/30/95	---	---	---	---	57000	---	17000	7000	1500	5200	---	---	---	MCC
MW-1	11/16/95	19.60	8.79	---	10.81	100000	5900	22000	17000	2100	8500	---	---	---	MCC
QC-1 (c)	11/16/95	---	---	---	---	95000	---	20000	15000	1800	7800	---	---	---	MCC
MW-1	03/20/96	19.60	6.45	---	13.15	46000	3300	10000	6200	1100	3200	---	---	---	MCC
QC-1 (c)	03/20/96	---	---	---	---	42000	---	9800	5800	970	3000	---	---	---	MCC
MW-1	06/13/96	19.60	7.14	---	12.46	44000	5400	9500	5500	1100	4000	19000	---	---	MCC
QC-1 (c)	06/13/96	---	---	---	---	48000	---	9300	5600	1000	3800	17000	---	---	MCC
MW-1	09/23/96	19.60	7.56	---	12.04	76000	14000	14000	11000	1600	7100	17000	---	6.1	MCC
MW-1	12/19/96	19.60	7.08	---	12.52	46000	---	12000	5500	1200	4100	---	---	---	MCC
MW-1	05/09/97	19.60	7.39	---	12.21	80000	7500	14000	12000	1700	7600	14000	280 (d)	2.7	MCC/CHR
MW-1	09/11/97	19.60	7.50	---	12.10	100000	7700	19000	19000	2400	11000	ND<2100	---	7.2	MCC
MW-1	12/15/97	19.60	7.61	---	11.99	45000	3500	11000	5300	1500	5200	13000	---	6.8	MCC
QC-1 (c)	12/15/97	---	---	---	---	45000	---	11000	5400	1400	5100	14000	---	---	MCC
MW-1	03/11/98	19.60	5.35	---	14.25	40000	3600	5900	3900	1300	4900	8700	---	6	MCC
QC-1 (c)	03/11/98	---	---	---	---	43000	---	7200	5000	1400	5300	14000	---	---	MCC
MW-1	06/23/98	19.60	6.63	---	12.97	44000	3700	5900	6200	1800	6200	870	---	6.2	MCC
QC-1 (c)	06/23/98	---	---	---	---	47000	---	6000	6400	1800	6300	1000	---	---	MCC
MW-1	12/01/98	19.60	6.48	---	13.12	57000	---	7400	12000	2100	8200	7200	---	2.4	MCC
QC-1 (c)	12/01/98	---	---	---	---	57000	---	6800	11000	1900	7500	8300	---	---	MCC
MW-1	03/30/99	19.60	5.74	---	13.86	67000	6500	5700	9400	2500	9400	3200	---	2.1	MCC
QC-1 (c)	03/30/99	---	---	---	---	64000	6400	5500	9000	2400	9100	3100	---	---	MCC
MW-1	08/16/99	19.60	7.02	---	12.58	63000	---	3600	9100	2800	11000	ND<1700	---	1.3	MCC
QC-1 (c)	08/16/99	---	---	---	---	64000	---	3700	8800	2800	11000	ND<1400	---	---	MCC
MW-2	11/04/94	20.31	9.12	0.16	11.31	---	---	---	---	---	---	---	---	---	---
MW-2	01/11/95	20.31	6.75	---	13.56	---	---	---	---	---	---	---	---	---	---
MW-2	02/24/95	20.31	7.11	0.18	13.34	---	---	---	---	---	---	---	---	---	---
MW-2	05/25/95	20.31	7.01	0.01	13.31	---	---	---	---	---	---	---	---	---	---
MW-2	08/30/95	20.31	8.58	0.12	11.82	---	---	---	---	---	---	---	---	---	---
MW-2	11/16/95	20.31	9.07	0.01	11.25	---	---	---	---	---	---	---	---	---	---
MW-2	03/20/96	20.31	6.79	0.01	13.53	---	---	---	---	---	---	---	---	---	---
MW-2	06/13/96	20.31	7.41	0.01	12.91	---	---	---	---	---	---	---	---	---	---
MW-2	09/23/96	20.31	7.83	0.01	12.49	30000	19000	4600	180	1500	4100	2600	---	5.5	MCC
QC-1 (c)	09/23/96	---	---	---	---	33000	---	4700	170	1600	3900	2400	---	---	MCC
MW-2	12/19/96	20.31	7.37	0.01	12.95	29000	---	1600	240	1400	5400	---	(e)	---	MCC
QC-1 (c)	12/19/96	---	---	---	---	29000	---	580	210	1300	5100	---	---	---	MCC
MW-2	05/09/97	20.31	6.11	0.21	14.36	34000	6700000	4600	260	1500	4300	1600	---	3.7	MCC
MW-2	09/11/97	20.31	7.70	0.03	12.63	44000	1200000	3900	250	2400	7400	ND<610	---	6.5	MCC
QC-1 (c)	09/11/97	---	---	---	---	47000	1100000	4000	420	2700	8300	920	---	---	MCC
MW-2	12/15/97	20.31	7.87	0.03	12.46	32000	68000	4600	130	2200	5400	ND<470	---	6	MCC
MW-2	03/11/98	20.31	5.61	0.18	14.84	44000	3800	5200	220	2000	5000	1100	---	6.2	MCC
MW-2	06/23/98	20.31	6.74	0.02	13.59	75000	570000	5900	390	3100	8300	8400	---	6.3	MCC
MW-2	12/01/98	20.31	7.30	---	13.01	36000	---	3800	73	1500	3900	2000	---	1.9	MCC
MW-2	03/30/99	20.31	6.51	0.13	13.90	23000	23000	5000	100	610	870	21000	---	1.7	MCC
MW-2	08/16/99	20.31	8.04	0.21	12.43	30000	---	5200	67	1100	1800	6000	---	2.6	MCC

TABLE 1 - SUMMARY OF GROUNDWATER SAMPLING
XTRA OIL COMPANY SERVICE STATION
1701 PARK STREET, ALAMEDA, CALIFORNIA

ALISTO PROJECT NO. 10-210

WELL ID	DATE OF MONITORING/ SAMPLING	CASING ELEVATION (a) (Feet)	DEPTH TO WATER (Feet)	PRODUCT THICKNESS (Feet)	GROUNDWATER ELEVATION (b) (Feet)	TPH-G (ug/l)	TPH-D (ug/l)	B (ug/l)	T (ug/l)	E (ug/l)	X (ug/l)	MTBE (ug/l)	SVOCs (ug/l)	DO (ppm)	LAB
MW-3	11/04/94	20.57	8.92	---	11.65	ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---	MCC
MW-3	01/11/95	20.57	5.67	---	14.90	---	---	---	---	---	---	---	---	---	---
MW-3	02/24/95	20.57	6.11	---	14.46	ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---	MCC
MW-3	05/25/95	20.57	6.24	---	14.33	91	ND<50	28.0	12.0	2.1	6.5	---	---	---	MCC
MW-3	08/30/95	20.57	8.27	---	12.30	ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	4.6	MCC
MW-3	11/16/95	20.57	8.82	---	11.75	ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---	MCC
MW-3	03/20/96	20.57	5.44	---	15.13	ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---	MCC
MW-3	06/13/96	20.57	6.17	---	14.40	ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	---	---	MCC
MW-3	09/23/96	20.57	6.57	---	14.00	ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	---	4.9	MCC
MW-3	12/19/96	20.57	6.59	---	13.98	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---	MCC
MW-3	05/09/97	20.57	7.00	---	13.57	ND<50	59	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	---	3.3	MCC
MW-3	09/11/97	20.57	6.92	---	13.65	ND<50	82	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	---	7	MCC
MW-3	12/15/97	20.57	7.03	---	13.54	ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	---	6.5	MCC
MW-3	03/11/98	20.57	4.71	---	15.86	ND<50	ND<50	ND<0.5	1.8	0.6	3.1	ND<5.0	---	6.1	MCC
MW-3	06/23/98	20.57	6.33	---	14.24	ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	---	5.7	MCC
MW-3	12/01/98	20.57	6.74	---	13.83	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	---	4	MCC
MW-3	03/30/99	20.57	5.68	---	14.89	ND<50	ND<50	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	---	4.6	MCC
MW-3	08/16/99	20.57	7.67	---	12.90	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	ND<5.0	---	2.7	MCC
MW-4	05/09/97	19.69	7.17	---	12.52	31000	15000	540	1300	1000	4500	1900	2.1 (d)	3.1	MCC/CHR
MW-4	09/11/97	19.69	7.71	---	11.98	40000	6500	2000	3100	1700	7700	3400	---	6.4	MCC
MW-4	12/15/97	19.69	7.87	---	11.82	14000	2100	910	690	390	2700	1700	---	6	MCC
MW-4	03/11/98	19.69	3.51	---	16.18	2800	780	68	94	72	430	140	---	5.5	MCC
MW-4	06/23/98	19.69	5.21	---	14.48	15000	2800	240	630	720	2700	370	---	5.4	MCC
MW-4	12/01/98	19.69	6.45	---	13.24	21000	---	580	1000	530	3600	1700	---	4.4	MCC
MW-4	03/30/99	19.69	5.41	---	14.28	41000	3600	3100	3400	1700	6700	5700	---	4.6	MCC
MW-4	08/16/99	19.69	7.35	---	12.34	24000	---	4600	940	1200	2700	9700	---	3.4	MCC
QC-2 (f)	11/04/94	---	---	---	---	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---	MCC
QC-2 (f)	02/24/95	---	---	---	---	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---	MCC
QC-2 (f)	05/25/95	---	---	---	---	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---	MCC
QC-2 (f)	08/30/95	---	---	---	---	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---	MCC
QC-2 (f)	11/16/95	---	---	---	---	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---	MCC
QC-2 (f)	03/20/96	---	---	---	---	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---	MCC
QC-2 (f)	06/13/96	---	---	---	---	ND<50	---	ND<0.5	ND<0.5	ND<0.5	ND<0.5	---	---	---	MCC

ABBREVIATIONS:

TPH-G	Total petroleum hydrocarbons as gasoline using EPA Methods 5030/8015
TPH-D	Total petroleum hydrocarbons as diesel using EPA Methods 3510/8015
B	Benzene using EPA Methods 5030/8020
T	Toluene using EPA Methods 5030/8020
E	Ethylbenzene using EPA Methods 5030/8020
X	Total xylenes using EPA Methods 5030/8020
MTBE	Methyl tert butyl ether using EPA Methods 5030/8020
SVOCs	Semivolatile organic compounds using EPA Method 8270
DO	Dissolved oxygen
ug/l	Micrograms per liter
ppm	Parts per million
---	Not analyzed/applicable/measurable
ND	Not detected above reported detection limit
MCC	McCampbell Analytical, Inc.
CHR	Chromalab, Inc.

NOTES:

(a) Top of casing surveyed relative to mean sea level.

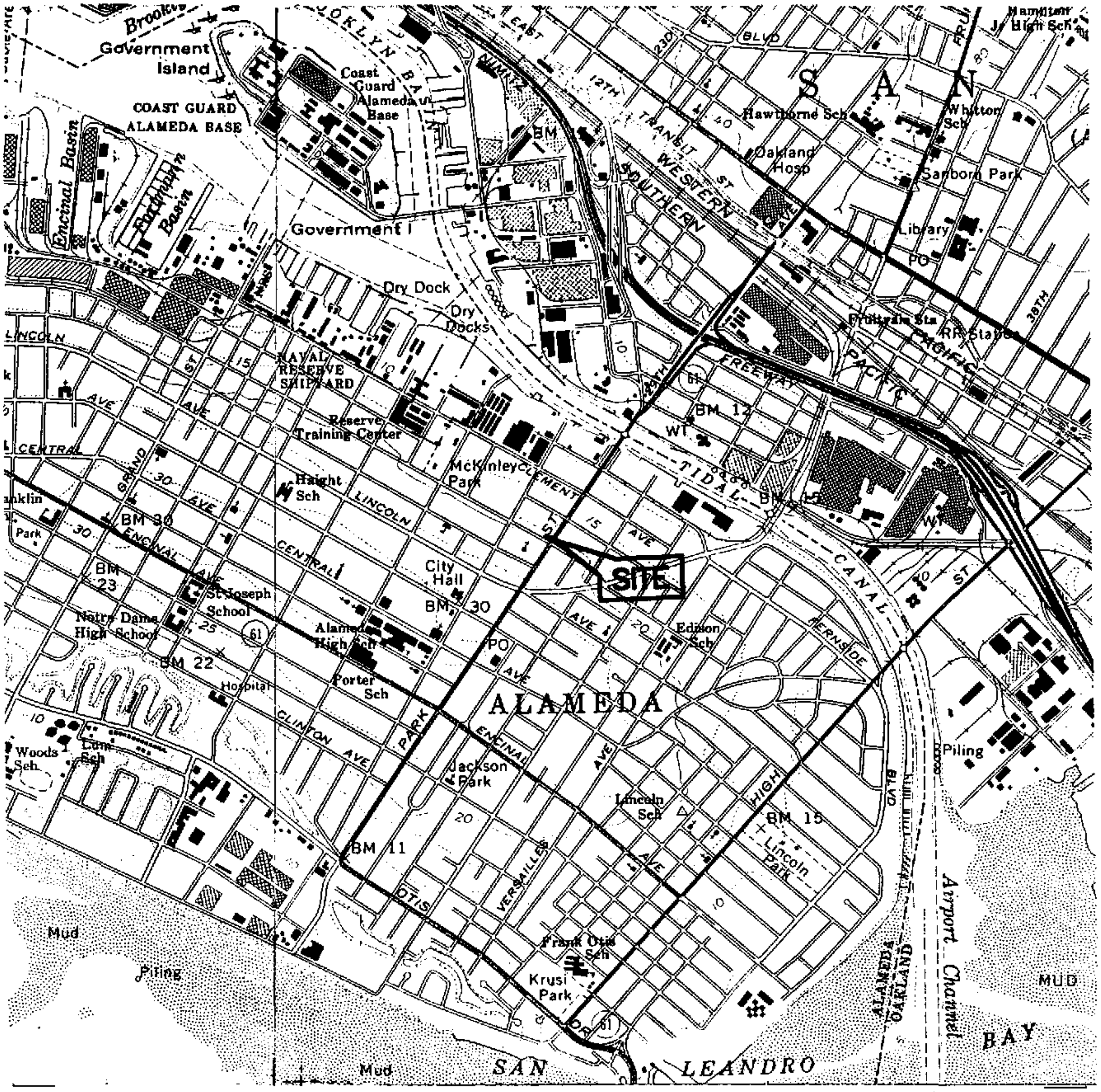
(b) Groundwater elevations expressed in feet above mean sea level, and adjusted assuming a specific gravity of 0.75 for free product.

(c) Blind duplicate.

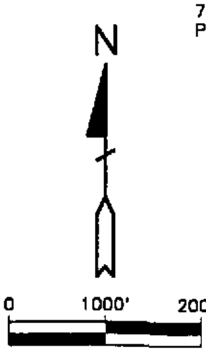
(d) SVOC analysis for polynuclear aromatics detected only naphthalene at the concentration stated.

(e) SVOCs detected at concentrations of 420 ug/l naphthalene, 200 ug/l 2-methylnapthalene, and 14 ug/l phenanthrene.

(f) Travel blank.



SOURCE:
USGS MAP, OAKLAND WEST AND EAST QUADRANGLE, 7.5 MINUTE SERIES. 1959.
PHOTOREVISED 1980.



QUADRANGLE LOCATION

FIGURE 1

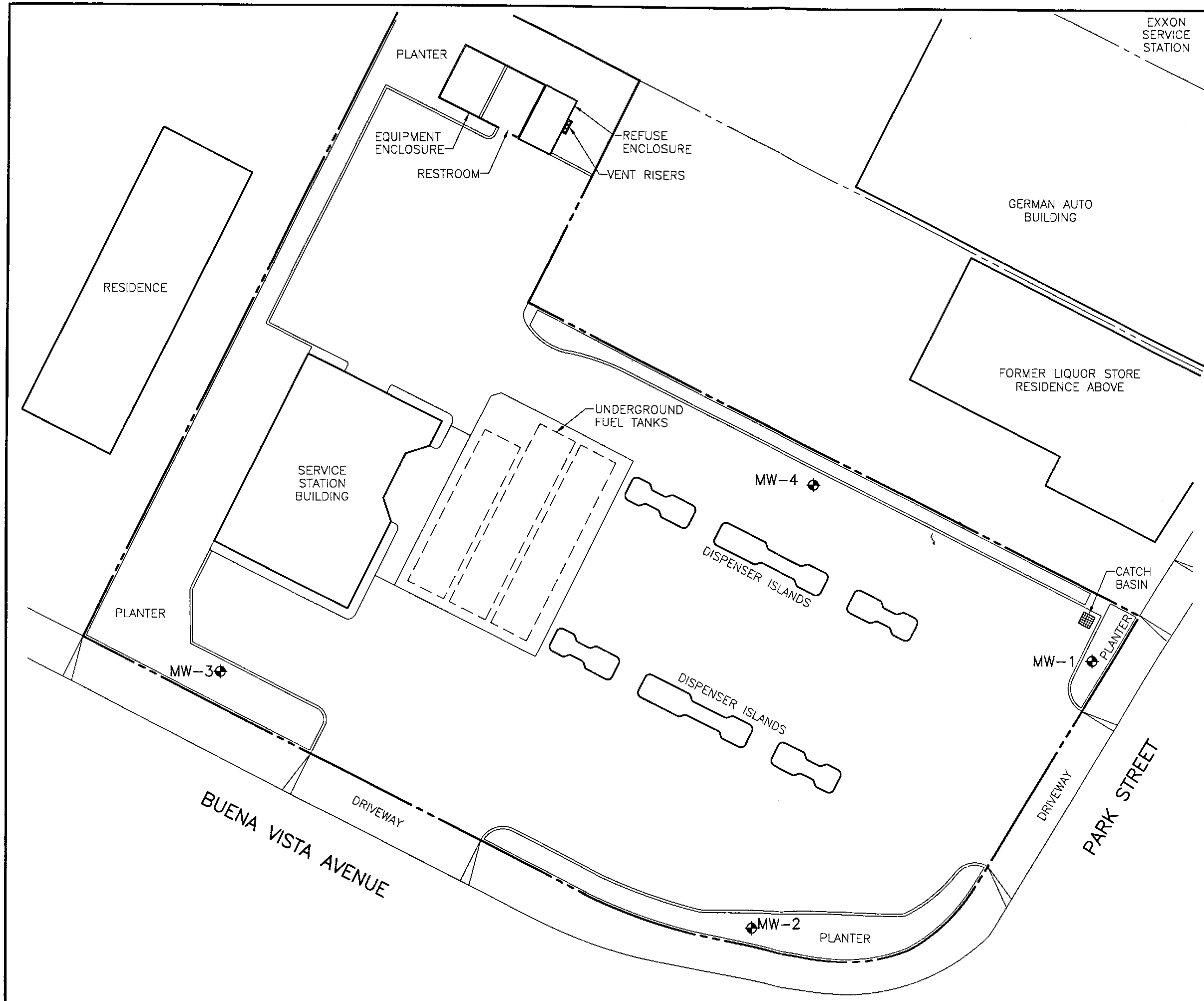
SITE VICINITY MAP

XTRA OIL COMPANY SERVICE STATION
1701 PARK STREET
ALAMEDA, CALIFORNIA

PROJECT NO. 10-210

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

102108--DWC 8-3-94 RKW 1=1



N

0 20 40

SCALE IN FEET

LEGEND

⊕ EXISTING GROUNDWATER MONITORING WELL

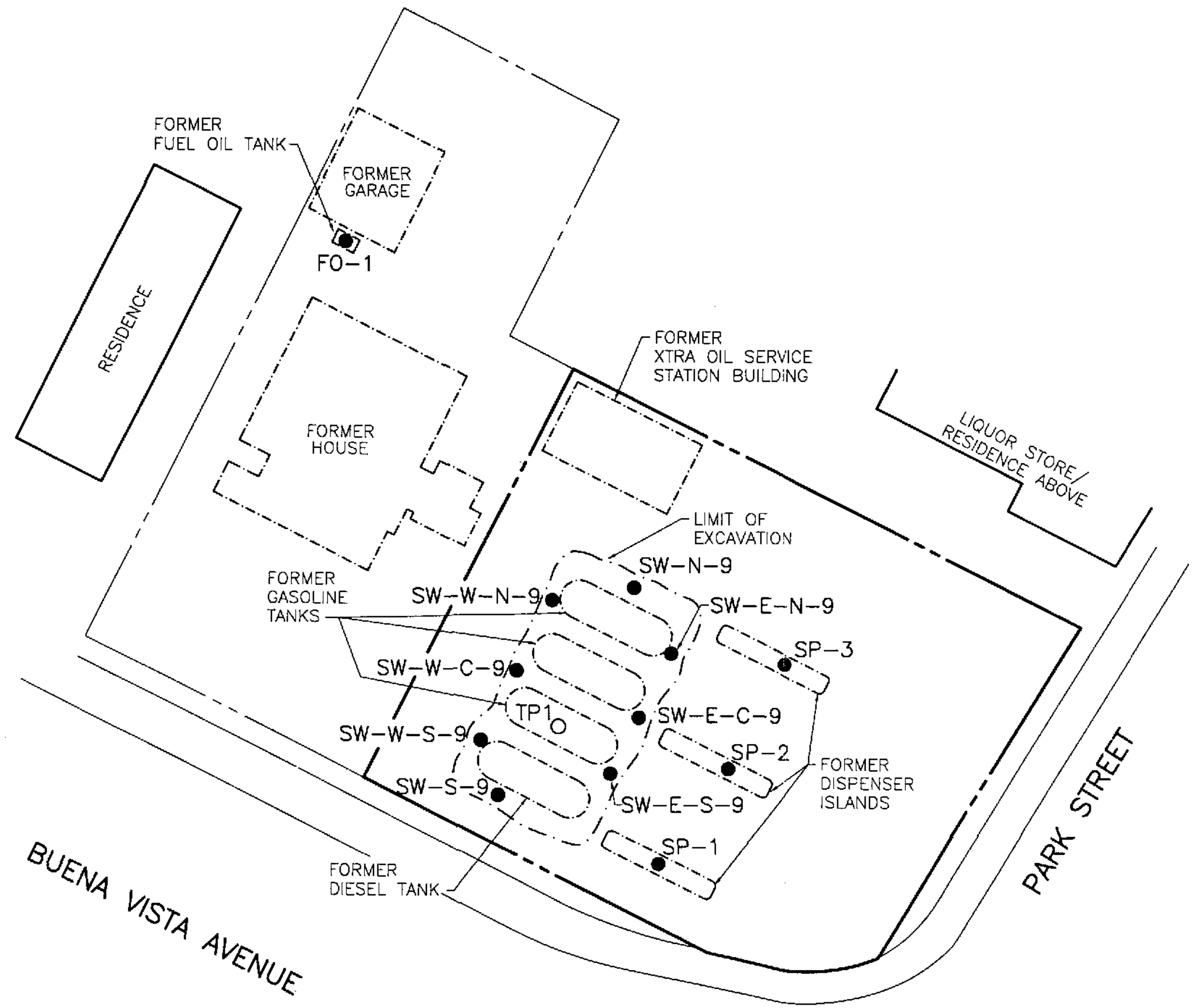
FIGURE 2

SITE PLAN

XTRA OIL COMPANY SERVICE STATION
1701 PARK STREET
ALAMEDA, CALIFORNIA

PROJECT NO. 10-210

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA



N

0 30 60

SCALE IN FEET

LEGEND

● SOIL SAMPLE

○ GROUNDWATER SAMPLE

FIGURE 3

LOCATION OF FORMER UNDERGROUND TANKS AND DISPENSER ISLANDS

XTRA OIL COMPANY SERVICE STATION
1701 PARK STREET
ALAMEDA, CALIFORNIA

PROJECT NO. 10-210

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

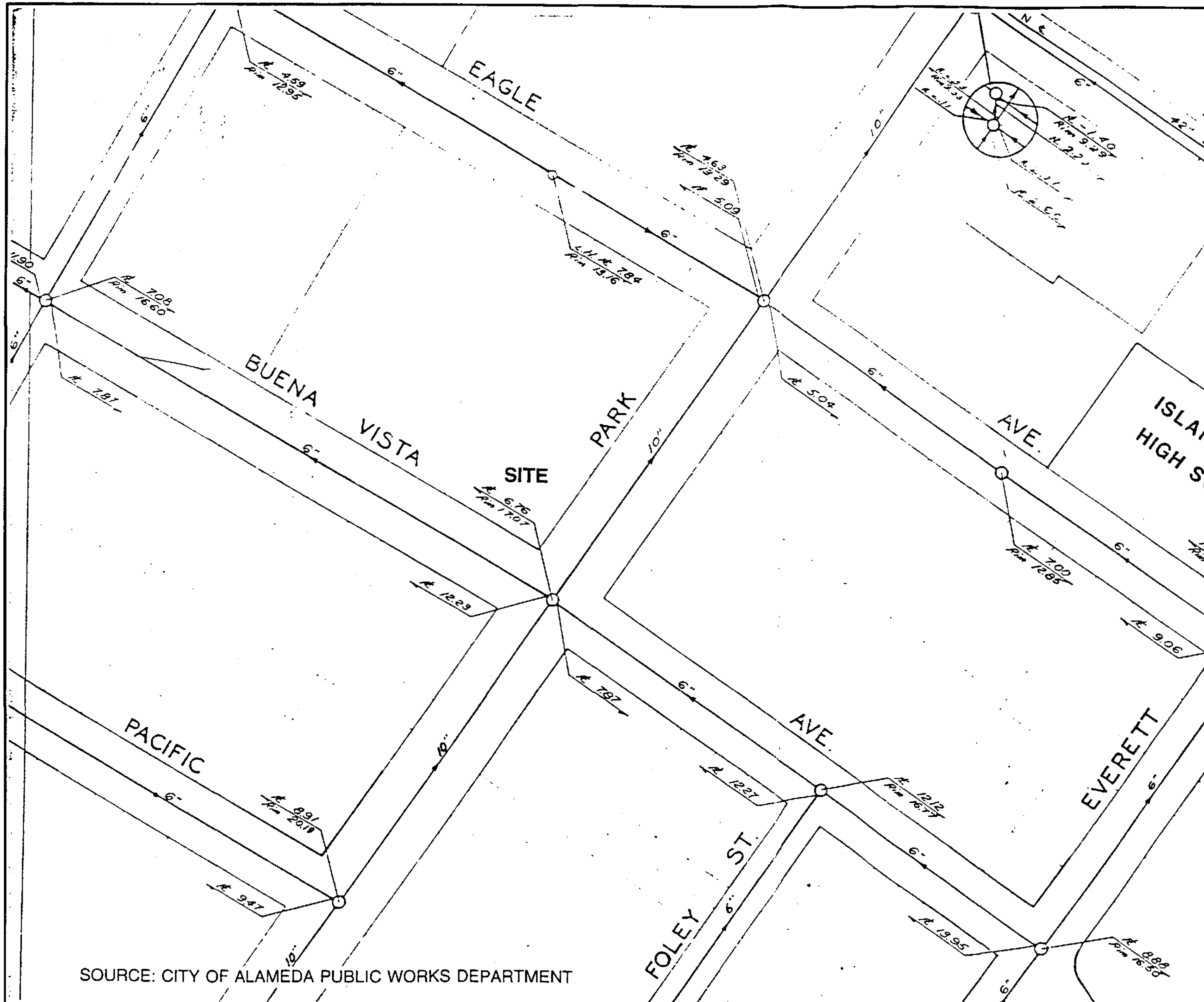


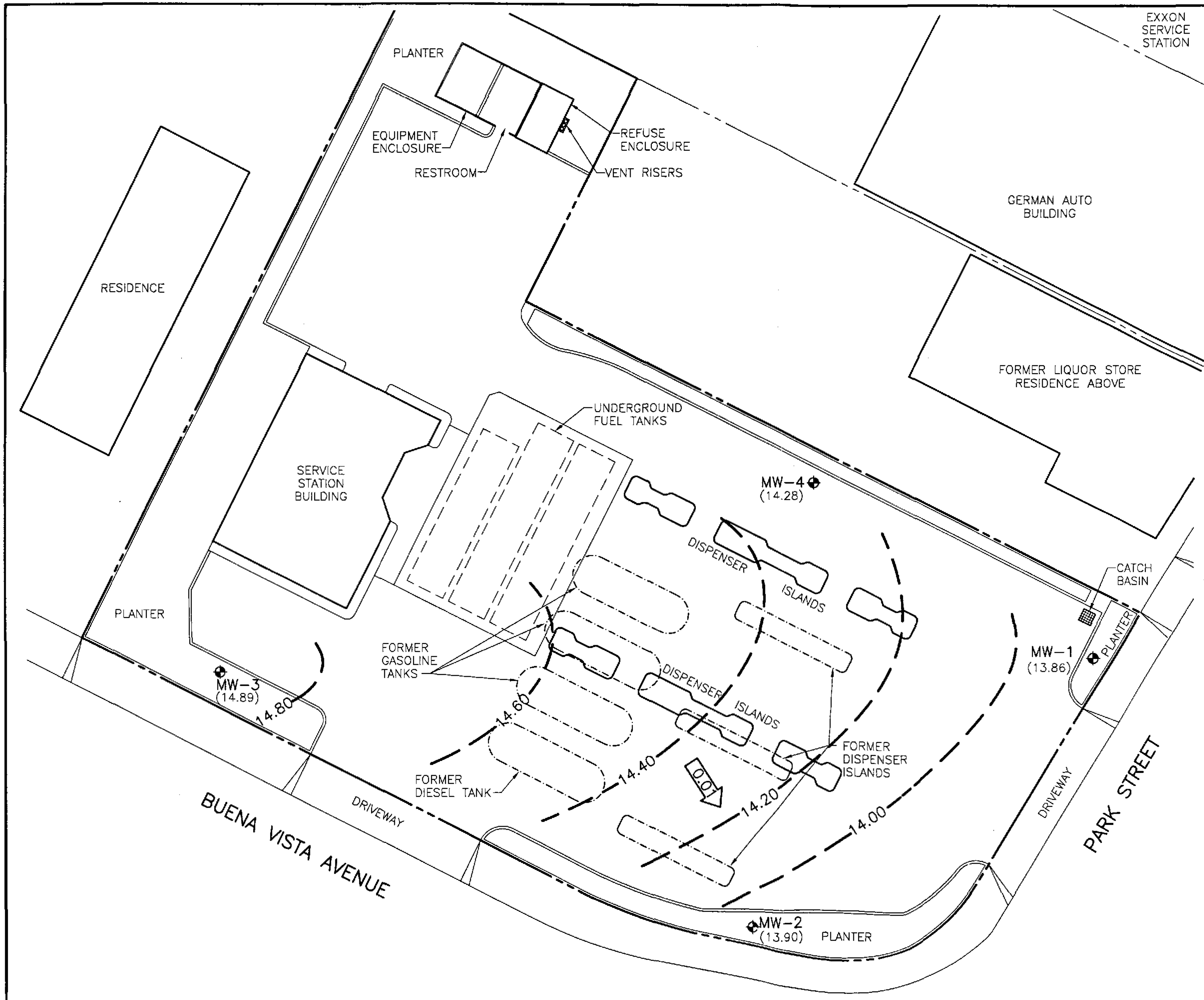
FIGURE 4

SANITARY SEWER LOCATION MAP

XTRA OIL COMPANY SERVICE STATION
1701 PARK STREET
ALAMEDA, CALIFORNIA

PROJECT NO. 10-210

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA



N

0 20 40

SCALE IN FEET

LEGEND

⊕	GROUNDWATER MONITORING WELL
(13.86)	GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
14.00	GROUNDWATER ELEVATION CONTOUR IN FEET ABOVE MEAN SEA LEVEL (CONTOUR INTERVAL—0.20 FOOT)
0.01	CALCULATED GROUNDWATER GRADIENT DIRECTION AND MAGNITUDE IN FOOT PER FOOT

NOTE:
Potentiometric groundwater elevation contours were generated with Quicksurf using the Kriging method with a piece-wise variogram on a triangulated grid surface.

FIGURE 5

POTENTIOMETRIC GROUNDWATER ELEVATION CONTOUR MAP

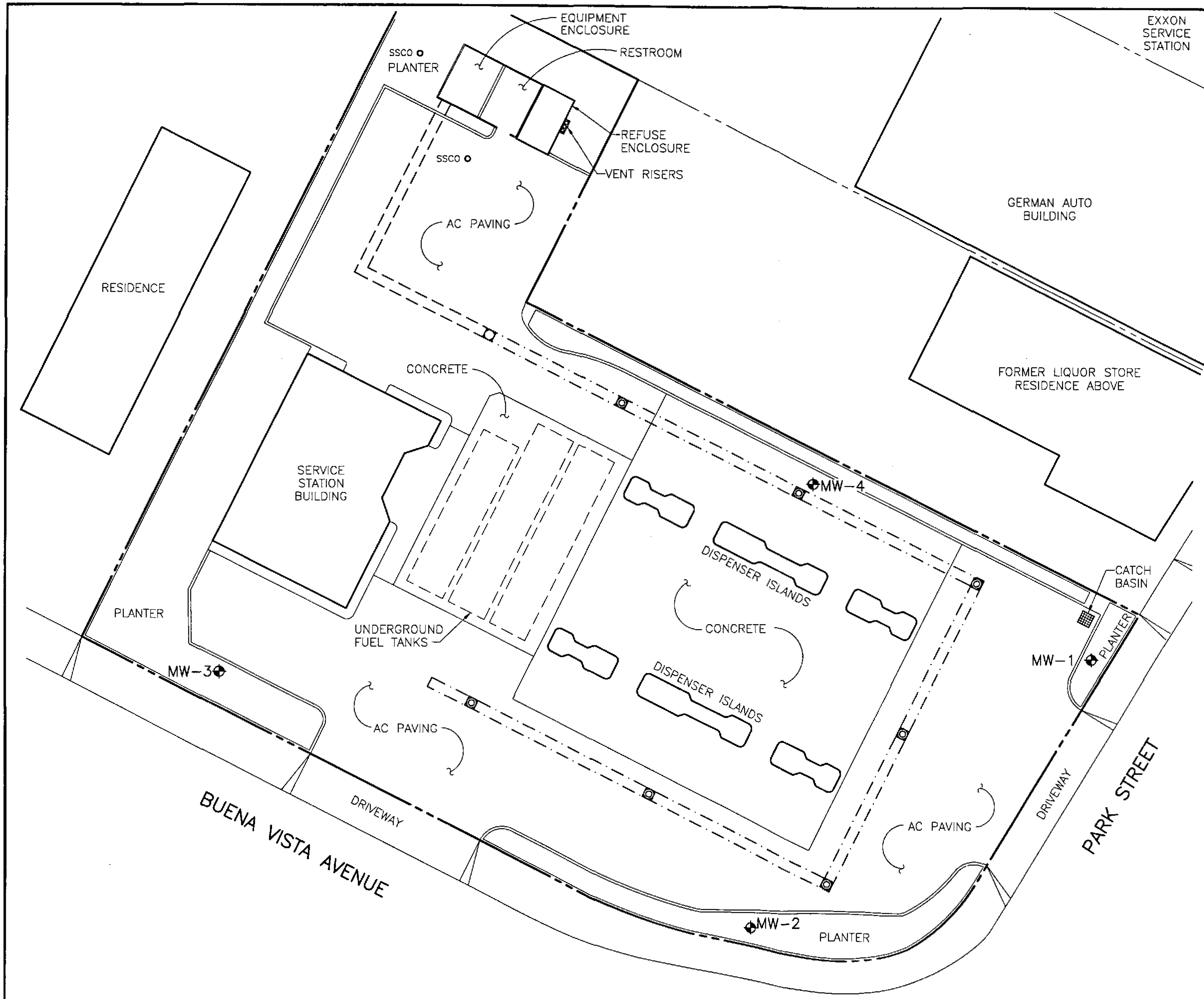
MARCH 30, 1999

XTRA OIL COMPANY SERVICE STATION
1701 PARK STREET
ALAMEDA, CALIFORNIA

PROJECT NO. 10-210

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

10210D-3.DWG 4-12-99 RKW 1=20



N

0 20 40

SCALE IN FEET

LEGEND

EXISTING GROUNDWATER MONITORING WELL

PROPOSED PIPING VAULT

PROPOSED AIR SPARGING POINT WITH WELL VAULT

SSCO SEWER SERVICE CLEANOUT

PROPERTY LINE

EXISTING HORIZONTAL VAPOR EXTRACTION TRENCHING

PROPOSED TRENCHING

ABBREVIATIONS

AC ASPHALT CONCRETE

FIGURE 6

LAYOUT OF PROPOSED REMEDIATION SYSTEM

XTRA OIL COMPANY SERVICE STATION
1701 PARK STREET
ALAMEDA, CALIFORNIA

PROJECT NO. 10-210

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

10210M8-DWG 9-30-99 RKW 1=20

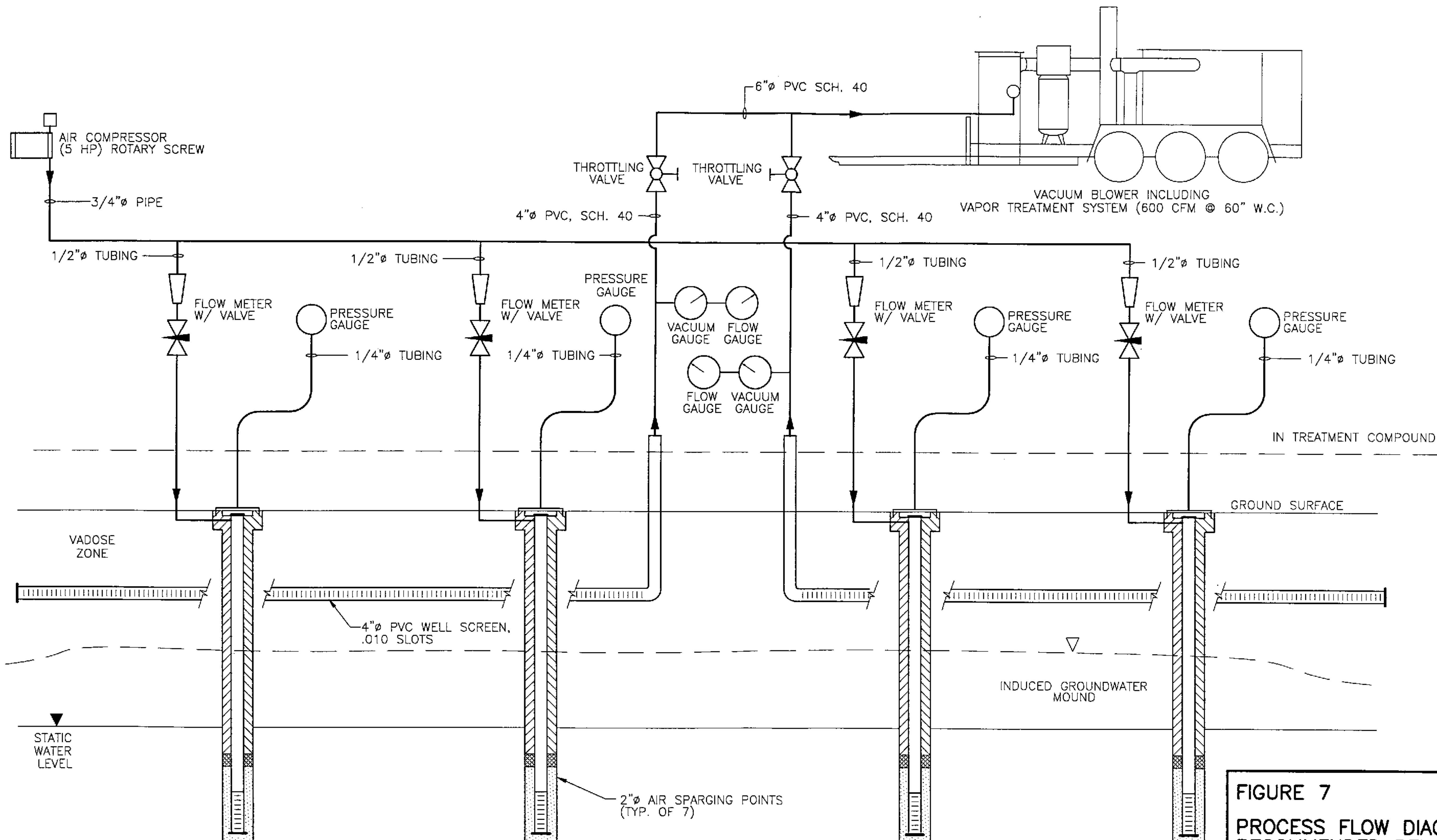


FIGURE 7

PROCESS FLOW DIAGRAM OF RECOMMENDED REMEDIATION SYSTEM

XTRA OIL COMPANY SERVICE STATION
1701 PARK STREET
ALAMEDA, CALIFORNIA

PROJECT NO. 10-210

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

APPENDIX A

BORING LOGS AND WELL CONSTRUCTION DETAILS

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF BORING MW-1

SEE SITE PLAN

ALISTO PROJECT NO: *10-210-03* DATE DRILLED: *10/20/94*

CLIENT: *Xtra Oil Company*

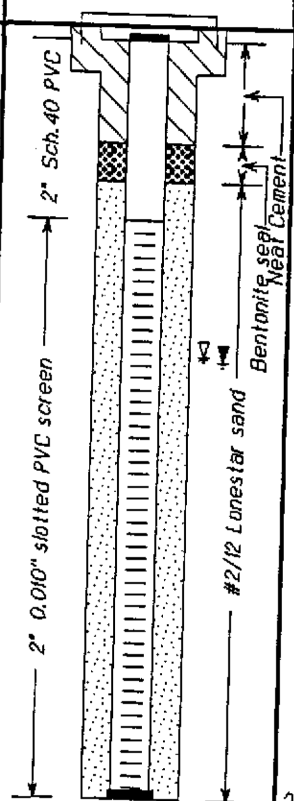
LOCATION: *1701 Park Street, Alameda, California*

DRILLING METHOD: *Hollow Stem Auger (8")*

DRILLING COMPANY: *Soils Exploration Services* CASING ELEVATION: *19.49 'MSL*

LOGGED BY: *John DeGeorge* APPROVED BY: *Al Sevilla*

BLOWS/6 IN.	PID VALUES	WELL DIAGRAM	DEPTH feet	SAMPLES	GRAPHIC LOG	SOIL CLASS	GEOLOGIC DESCRIPTION
			0			SP	Planter-Topsoil
							SAND: brown, moist, medium dense; very fine- to fine-grained sand; trace silt.
9,12,15	18		5				
7,7,9	884						Same: dark green, very moist.
21,27,30	245		10				Same: wet to saturated, very dense.
			15				
			20				
			25				
			30				



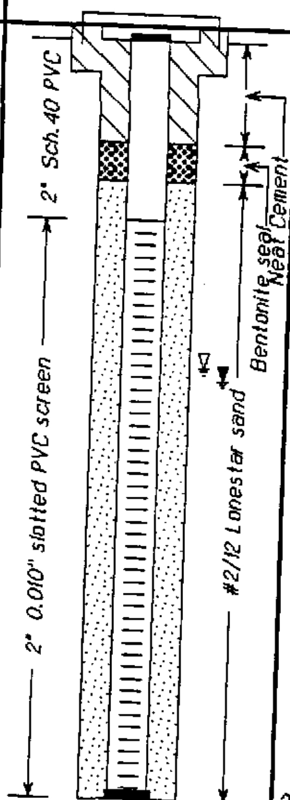
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF BORING MW-2

SEE SITE PLAN

ALISTO PROJECT NO: 10-210-03 DATE DRILLED: 10/20/94
CLIENT: Xtra Oil Company
LOCATION: 1701 Park Street, Alameda, California
DRILLING METHOD: Hollow Stem Auger (8")
DRILLING COMPANY: Soils Exploration Services CASING ELEVATION: 20.29 'MSL
LOGGED BY: John DeGeorge APPROVED BY: Al Sevilla

WELL DIAGRAM



BLOWS/6 IN.	PID VALUES	SOIL CLASS	GEOLOGIC DESCRIPTION
		SP	Planter-Topsoil
			SAND: olive/green, moist, medium dense; very fine- to fine-grained sand; trace silt.
10,14,18	87		
13,20,19	559		Same: dense.
20,24,28	153		Same: light brown, wet to saturated.

DEPTH feet: 5, 10, 15, 20, 25, 30

SAMPLES | GRAPHIC LOG

ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF BORING MW-3

SEE SITE PLAN

ALISTO PROJECT NO: *10-210-03* DATE DRILLED: *10/20/94*

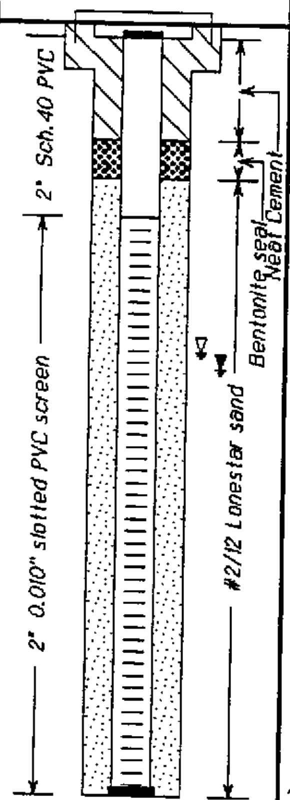
CLIENT: *Xtra Oil Company*

LOCATION: *1701 Park Street, Alameda, California*

DRILLING METHOD: *Hollow Stem Auger (8")*

DRILLING COMPANY: *Soils Exploration Services* CASING ELEVATION: *20.58 'MSL*

LOGGED BY: *John DeGeorge* APPROVED BY: *Al Sevilla*



BLOWS/6 IN.	PID VALUES	DEPTH feet	SOIL CLASS	GEOLOGIC DESCRIPTION
		0	SP	Planter-Topsoil
				SAND: brown, moist, medium dense; very fine- to fine-grained sand; tree roots present.
14,10,9	0	5		
10,15,18	0			Same: moist to wet; silt to 10-15%.
10,14,29	0	10		Same: light brown, wet to saturated, little or no fines.
		15		
		20		
		25		
		30		

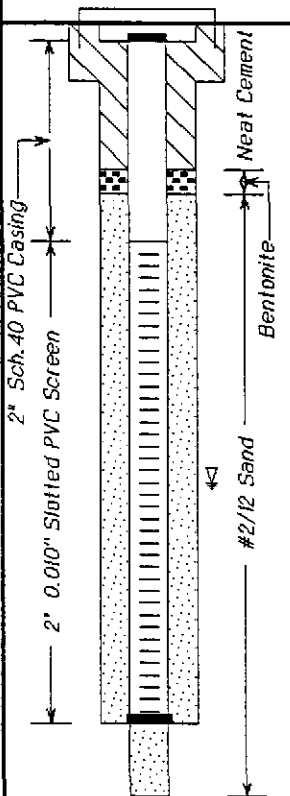
ALISTO ENGINEERING GROUP
WALNUT CREEK, CALIFORNIA

LOG OF WELL MW-4

SEE SITE PLAN

ALISTO PROJECT NO: *10-210-07*	DATE DRILLED: *04/28/97*
CLIENT: *Xtra Oil Company Service Station*	
LOCATION: *1707 Park Street, Alameda, California*	
DRILLING METHOD: *Hand auger/Direct push (6"/3"); 2 split spoon*	
DRILLING COMPANY: *Precision Sampling, Inc.*	CASING ELEVATION:
LOGGED BY: *Brady Nagle*	APPROVED BY: *Al Sevilla*

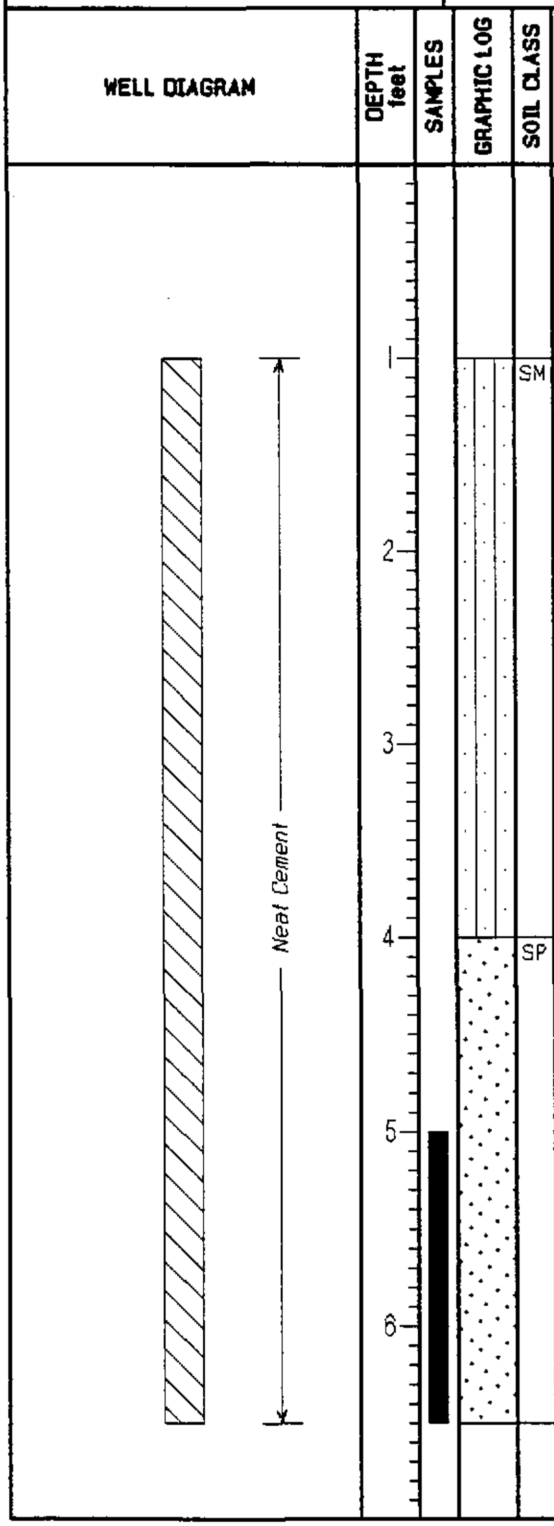
WELL DIAGRAM



PID VALUES	DEPTH feet	SAMPLES	GEOLOGIC DESCRIPTION
			Planted area: import to 1 foot, same gravel at 1/2 foot.
			Sand with Silt: light brown, damp.
	4		
			Color change to olive-gray at 5.5'.
109		■	
	8		Same: increase in clay content.
			Same: moisture change to wet at 9.5'.
803			
	12	■	
			Color change to light brown at 12.5'.
	16		
			Boring terminated at 16 feet.
	20		
	24		

ALISTO ENGINEERING GROUP WALNUT CREEK, CALIFORNIA	LOG OF BORING SB-1	Page 1 of 1

SEE SITE PLAN	
	ALISTO PROJECT NO: *10-210-07* DATE DRILLED: *04/28/97*
	CLIENT: *Xtra Oil Company Service Station*
	LOCATION: *1707 Park Street, Alameda, California*
	DRILLING METHOD: *Hand auger (3"); hand sampler*
	DRILLING COMPANY: *N/A* CASING ELEVATION:
	LOGGED BY: *Brady Nagle* APPROVED BY: *Al Sevilla*



SOIL CLASS	GEOLOGIC DESCRIPTION
	Planted landscape surface: irrigated. Sand with silt: brown, moist. Base rock for about 2" at 1'.
SM	silty SAND: brown, damp to moist; some gravel and brick.
SP	Sand with silt: dark brown, moist; no gravels. Color change to light brown at 5'.
	Boring terminated at 6.5 feet.