Tetra Tech EM Inc.

135 Main Street, Suite 1800 ◆ San Francisco, CA 94105 ◆ (415) 543-4880 ◆ FAX (415) 543-5480

February 15, 2001

R0387

#71

Barney Chan
Hazardous Materials Specialist
Alameda County Health Care Services Agency
Environmental Health Services
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577

Subject: **Submittal of Draft Evaluation of Remedial Alternatives for the J.W. Silveira Company Underground Storage Tank Site at 2301 East 12th Street in Oakland, California**

Dear Mr.Chan:

Enclosed is one copy of the draft Evaluation of Remedial Alternatives for the J. W. Silveira Company underground storage tank site located at 2301 East 12th Street in Oakland, California. I believe that we have developed a feasible remediation plan for the site using a combination of soil excavation and air sparging. As we only arrived at the idea for this plan within the past few days, we have not yet had the opportunity to discuss it with you. Thus, your comments on this document, and on the proposed remedial alternatives would be appreciated.

The sections of this report in which cleanup goals and general response actions are presented (Sections 3.0 and 4.0) are not as all-encompassing as a true feasibility study would present them. This is because we have not conducted a risk assessment or a groundwater beneficial use assessment for the site to date. Any comments you may have on these two sections in particular would be very helpful.

After receipt of comments from you, TtEMI will address them and submit a hard copy of the final report to you within 5 working days. The final copy of the report will include a registered geologist's stamp and signature.

Thank you for your assistance. Please call me at (415) 222-8316 with any questions.

Sincerely,

for Hal Dawson
Project Manager/Geologist

cc: J.W. Silveira Company
Shapiro Buchman Provine & Patton LLP
File

DRAFT
EVALUATION OF REMEDIAL ALTERNATIVES

UNDERGROUND STORAGE TANK SITE
2301 EAST 12TH STREET
OAKLAND, CALIFORNIA

FEBRUARY 15, 2001

Prepared For

J.W. SILVEIRA COMPANY
499 Embarcadero Street
Oakland, California 94606

Prepared By

TETRA TECH EM Inc.
135 Main Street, Suite 1800
San Francisco, California 94105

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Hal Dawson, TtEMI Project Manager

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1.0 INTRODUCTION

This report for J.W. Silveira Company was prepared to identify and evaluate alternatives to remediate environmental contamination at the underground storage tank (UST) site located at 2301 East 12th Street, in Oakland, California. The report was prepared by Tetra Tech EM Inc. (TtEMI) in response to the Alameda County Environmental Health Services request for a discussion of remedial alternatives to reduce the level of contamination at the site. This report contains seven sections. Section 1.0 describes the purpose and scope of this report. Section 2.0 provides background information of the site. Section 3.0 discusses the cleanup goals for the site. Section 4.0 discusses the screening of remedial technologies. Section 5.0 presents an evaluation of potential remedial alternatives. Section 6.0 discusses the comparative analysis of remedial alternatives. Section 7.0 provides a summary of this report. Figures and tables follow the text of the report.

PURPOSE AND SCOPE

The purpose of this report is to evaluate feasible remedial alternatives for the site that (1) will minimize the potential for human and ecological exposure to petroleum hydrocarbon contamination in groundwater, (2) are feasible and able to be implemented, and (3) are cost effective.

The long-term goal for the site is to obtain closure by meeting the regulatory agency requirements for no further action and site closure. The short-term goal is to decrease the contaminant concentrations in soil and groundwater at the site by targeting the areas with the highest concentrations for remediation.

Regulatory guidelines will be used to help determine the cleanup levels for the site. The regulatory guidelines used for comparison of risk-based screening levels (RBSLs) are presented in a California Regional Water Quality Control Board (RWQCB) report titled *Application of Risk-Based Screening Levels and Decision Making to Sites With Impacted Soil and Groundwater*, Volumes 1 and 2, dated August 2000. Currently no risk assessment has been conducted for the site and RBSLs for cleanup goals have not been established for the site. In general, the RBSLs from the RWQCB document will be used to estimate the area of the site that is the focus for cleanup based upon site assumptions. It is noted that these guidelines are not regulations or established policies for determining when a site requires no further action or when site closure requirements have been attained.

2.0 BACKGROUND

The site is located at the south corner of the intersection of East 12th Street and 23rd Avenue in Oakland, California (Figure 1).

2.1 SITE HISTORY

Four USTs were previously located at the site. Two of the USTs were 1,000-gallon tanks and were used for waste oil storage; one of the USTs was a 6,000-gallon tank that contained gasoline; and one of the USTs was a 1,000-gallon tank that contained diesel fuel. Figure 2 shows the previous locations of the USTs at the site. The gasoline and diesel tanks were removed on December 21, 1990, and the 2 waste oil tanks were removed on February 11, 1991. It was reported that contamination was discovered at both ends of the 1,000-gallon waste oil tanks and at the northern end of the 6,000-gallon gasoline tank. As part of the UST removal action activities, six groundwater monitoring wells and one extraction well were installed at the site. The monitoring wells have been sampled from 1992 through 2000.

2.2 GEOLOGY

Boring logs for the previous site investigations show that the soil underlying the site consists primarily of silts and low plasticity clays. Figure 3 shows a cross section and the upper lithology of the site.

2.3 GROUNDWATER

Groundwater elevations are measured in the monitoring wells during all groundwater sampling activities. The groundwater flow direction for the site ranges from approximately north 35 degrees west (N35W) to N70W. This flow direction is relatively consistent with the direction of the slope of the ground surface at the site. The groundwater gradient is approximately 0.03 to 0.04 feet/foot (ft/ft).

2.2 NATURE AND EXTENT OF CONTAMINATION

Soil analytical results from the site have detected volatilize volatile organic carbons (VOCs), total petroleum hydrocarbons as gasoline (TPH-g), and TPH as diesel (TPH-d) chemical compounds. Figure 4 shows the combined detected concentrations of gasoline in soil at the site from all past investigations.

Groundwater Analytical Results from the site have detected VOCs, TPH-g, and TPH-d in the majority of the groundwater samples collected from the six monitoring wells. The TPH-g concentrations in groundwater at the site are graphically represented on Figures 5. MTBE was not detected in any of the groundwater samples during all of the sampling events.

3.0 CLEANUP GOALS

The cleanup goals for the site are estimated based on the RBSLs presented in the RWQCBs report. To accurately determine the RBSLs for a site, a risk assessment and an assessment of groundwater beneficial use must be performed. At the time of the submittal of this report, neither a risk assessment nor a groundwater beneficial use assessment has been completed. For the purpose of estimating cleanup values from the RWCQBs RBSLs, some assumptions were made. These assumptions are (1) that groundwater at the site is not a current or potential source of drinking water, (2) that the locations of soil impacted with contamination are less than 10 feet (or 3 meters) below the ground surface (bgs), and (3) that surface water receptors will not be affected by the contaminant plume. Considering these assumptions, Table B of the RWCQB report was used as a guideline to determine the level of site cleanup that should be attained.

3.1 CHEMICALS OF CONCERN

The following is a list of the chemicals of concern in groundwater at the site and the corresponding estimated RBSLs. These chemical compounds are petroleum hydrocarbons and associated compounds that can potentially pose a risk to human health or the environment. These chemicals and their respective estimated RBSLs are:

- TPH-gasoline: 500 milligrams per liter (μg/L)
- Benzene: 46 μg/L

3.2 AREAS OF CONCERN

The areas of concern for this site are the locations where contamination is present in soil and groundwater at concentrations that exceed the RBSLs. Figures 5 shows the area where TPH as gasoline exceed the RBSLs.

4.0 GENERAL RESPONSE ACTIONS

The first phase of the feasibility study (FS) process is to develop general response actions to be considered for potential remedial alternatives that will address the remedial action objectives. Remedial technologies and process options are then identified for each general response action. Process options are specific processes within a type of remedial technology; each technology may have one or more associated process options. General response actions for groundwater at the site must reduce the level of contamination of petroleum hydrocarbon constituents.

For the screening of remedial technologies, general response actions such as containment, removal, treatment, and disposal are responses or remedies intended to meet the remedial action objectives. The general response actions focus on the most applicable actions for remediating chemicals of concern at the site. The physical characteristics of the site, particularly the clayey and heterogeneous soil, may negatively influence the possible effectiveness and the ability to implement many of the potential response actions and remedial technologies. General response actions considered for evaluation include no action, source excavation, and in situ and ex situ treatment. Each of these general response actions are discussed in detail in the subsections below

4.1 NO ACTION

Under the no action alternative, no action would be taken to remediate the area of contamination, and existing contaminants would degrade and attenuate naturally over time. In this case, the no action alternative is not acceptable to the regulatory agencies. No action will only be used as a baseline for comparison of the active remedial alternatives since contaminants from the site may pose a potential threat to human health and the environment. For this site, no action would only include monitoring of the groundwater; active remediation would not be conducted. Active remediation refers to actions employing physical, biological, and/or chemical technologies that would reduce contaminant levels more rapidly than degradation and natural attenuation.

4.2 SOURCE EXCAVATION

Source excavation would involve removing the saturated soil within the delineated groundwater hot spot. This general response action would significantly reduce the volume of chemicals of concern. Excavated saturated soil would be disposed of in an approved off-site landfill.

4.3 IN SITU TREATMENT

In situ treatment uses chemical, physical, and/or biological processes to reduce the volume or mobility of the chemicals of concern in soil and/or groundwater. In situ treatment generally requires that an area of the site be dedicated to housing an aboveground portion of the treatment system. In situ treatments are:

<u>Biological Treatment</u>

- Co-Metabolic Treatment
- Enhanced Bioremediation

Physical/Chemical Treatment

- Air Sparging
- Bioslurping
- Steam Flushing
- In-Well Air Stripping
- Reactive Treatment Walls
- Chemical Oxidation

4.4 EX SITU TREATMENT

Ex situ treatment consists of extracting groundwater and providing aboveground treatment. Treated effluent is then used for on-site irrigation or discharged to an appropriate municipal wastewater treatment plant. Ex situ treatment technologies for groundwater are:

- Biological Reactors
- Air Stripping
- Granular Activated Carbon
- Separation
- Sprinkler Irrigation
- Ultraviolet Oxidation

5.0 EVALUATION OF POTENTIAL REMEDIAL ALTERNATIVES

The following four remedial alternatives were retained for further consideration to address groundwater remedial action objectives at the site.

- Remedial Alternative 1: No Action
- Remedial Alternative 2: Excavation and Disposal Off-Site
- Remedial Alternative 3: In Situ Chemical Oxidation
- Remedial Alternative 4: In Situ Air Sparging

The other remedial alternatives described above in Section 4 were deemed cost inhibitive due to the amount of funding that would be required to complete them, or infeasible due to the geology of the site. The four remedial alternatives that were retained for further consideration are discussed below.

5.1 REMEDIAL ALTERNATIVE 1: NO ACTION

Under this alternative, no action would be undertaken at the site. Groundwater monitoring would be required to be conducted quarterly. The following subsections present an evaluation of the no action alternative.

5.1.1 Overall Protection of Human Health and the Environment

Remedial action objectives would not be met under the no-action alternative. Any risk posed to human health or the environment at the site would remain for a long period of time. Therefore, this alternative would not be protective of human health or the environment.

5.1.2 Long-term Effectiveness and Permanence

Remedial action objectives would eventually be met under the no-action alternative through natural degradation processes. High levels of the chemicals of concern are present in groundwater at the hot spots, and the UST has been closed for over 10 years; therefore, one can assume that degradation is proceeding slowly. Monitoring of the groundwater wells at the site from 1992 to present indicates that concentrations have decreased slightly over time. Assuming a performance period of 50 years, the goal of long-term effectiveness and permanence could potentially be met under the no action alternative.

5.1.3 Short-term Effectiveness

The no-action alternative would have little short-term effectiveness for the site because the chemicals of concern would continue to migrate down gradient from the site.

5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Chemical of concerns would not be treated under the no-action alternative. Therefore, a reduction of toxicity, mobility, or volume through treatment would not be achieved.

5.1.5 Implementability

This alternative is readily implementable from a technical and administrative standpoint because construction activities would not be conducted.

5.1.6 Cost

Costs for no action would include quarterly groundwater monitoring of the site for 50 years. There would be no capital cost, and O&M costs would be about $650,000, for a total estimated cost of $650,000.

5.2 REMEDIAL ALTERNATIVE 2: EXCAVATION AND DISPOSAL

This treatment alternative would consist of mechanically excavating the soil in the groundwater hot-spot areas near wells MW-1, MW-2, and MW-3. Based on the plume delineation, an area of about 22 by 37 feet and an area of 8 by 20 feet, both to a depth of about 13 feet bgs, would need to be excavated for an anticipated volume of approximately 470 cubic yards (cy). Figure 6 shows this proposed area for excavation. Trench stabilization and dewatering would be required during excavation because the proposed excavation depth (13 feet bgs) extends below the static groundwater level. Soil disposal would be required at an approved off-site landfill. Following excavation, clean engineered fill would be used as backfill. Post-excavation groundwater monitoring would then be conducted to obtain site closure requirements. The following subsections present an evaluation of the mechanical excavation and disposal alternative.

5.2.1 Overall Protection of Human Health and the Environment

Mechanical excavation would provide overall protection of human health and the environment by removing the hot-spot areas, assuming that most of the source of contamination is removed. Excavating the source area would potentially remove chemicals of concern at concentrations greater than the remedial action objectives, thereby eliminating any the risk to human or ecological receptors.

5.2.2 Long-term Effectiveness and Permanence

Long-term effectiveness and permanence would potentially be met under mechanical excavation and disposal, if most of the source area were removed during excavation. Residual contaminants would degrade within the site area, and groundwater would be monitored to ensure that remedial action objectives were met.

5.2.3 Short-term Effectiveness

Mechanical excavation would result in potential exposure of workers to contaminated soil and groundwater. Potential short-term impacts would be minimized by securing the treatment area and restricting access to authorized personnel only. Risk to site workers would be minimized by establishing appropriate health and safety procedures to prevent direct contact with, ingestion, or inhalation of contaminated soil and groundwater. Trench stabilization would be required to ensure worker safety during excavation to depths of about 13 feet bgs. Excavated soil would be dewatered, as required, and transported to and disposed of in an approved off-site landfill.

5.2.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction in toxicity, mobility, and volume would not necessarily be met through excavation and disposal. Saturated soil would be treated, as required by land disposal requirements. Mobility of chemicals of concern would be reduced by placement in an approved landfill. Reduction of volume and toxicity would only be achieved if pretreatment were performed prior to disposal.

5.2.5 Implementability

This alternative is readily implementable. Excavated soil would most likely be disposed of in an approved California Class I or II landfill (or in another state's landfill, potentially accessible by rail). Contractors are readily available and trained to perform these types of excavation activities. Permits from the city and county would have to be obtained before the process could be implemented.

5.2.6 Cost

Capital costs for mechanical excavation and disposal would be about $162,000, with O&M costs of about $91,000, for a total estimated cost of $253,000. Costs associated with the mechanical excavation alternative include source excavation, disposal at an approved off-site landfill, and site restoration. Groundwater monitoring would most likely be performed annually for approximately 15 years. : seems excessive

5.3 REMEDIAL ALTERNATIVE 3: IN SITU CHEMICAL OXIDATION

This remedial alternative involves in situ chemical oxidation of organic compounds using an oxidizing agent. The most common field application to date is the injection of hydrogen peroxide into subsurface groundwater, which creates a hydroxyl free radical. The hydroxyl free radical is capable of oxidizing complex organic compounds. Oxidized organic compounds are converted into harmless end products.

Hydrogen peroxide is a powerful oxidizing agent whose composition products (water and oxygen) are nontoxic. Under this treatment alternative, fuel constituents and chlorinated solvents in groundwater would be treated in situ to meet remedial action objectives.

The heterogeneous nature of the site could make it difficult to adequately distribute the oxidizer. Several applications of hydrogen peroxide may be necessary to reduce the concentrations of the chemicals of concern at the site. Also, the area that is treated with hydrogen peroxide would eliminate any naturally occurring biodegradable enzymes in the soil. This would essentially eliminate future natural degradation of groundwater contamination within the treated area after the injection of hydrogen peroxide. To treat these areas of concern, two treatment areas of 12 by 20 feet and 8 by 20 feet would be laid out. Inside this treatment areas approximately 285 injection points, would be installed. Figure 7 shows the proposed treatment area and the grid injection points. The injection points would be screened from 5 to 15 feet bgs. An injection apparatus would be used to control the flow of hydrogen peroxide and into the soil and groundwater. The following subsections present an evaluation of the in situ chemical oxidation alternative.

5.3.1 Overall Protection of Human Health and the Environment

The in situ chemical oxidation system would be capable of providing overall protection of human health and the environment by reducing risks posed by chemicals of concern in groundwater through in situ chemical oxidation treatment. Intermittent (likely 2 to 4 times over the course of one year) injection of hydrogen peroxide would continue until groundwater remedial action objectives are achieved. This technology has been shown to decrease concentrations of petroleum hydrocarbons and associated chemical compounds similar to the chemicals of concern at this site. The in situ nature of the technology produces no residual waste streams, minimizing short-term risks. Residual hydrogen peroxide decomposes into water and oxygen in the subsurface. The heterogeneous subsurface conditions and clayey soils at the site could cause incomplete treatment, thereby reducing the effectiveness of the remedial alternative.

5.3.2 Long-term Effectiveness and Permanence

In situ chemical oxidation treatments would be continued intermittently until groundwater remedial action objectives are achieved. It is estimated that it would take approximately 1 year, assuming uniform hydrogen peroxide distribution, before this process would have a measurable effect on the contamination at the site. Residual by-products generated during the remediation of the groundwater would be minimal. The process produces no by-product waste streams and injection amounts can be controlled based on the degree of contaminant removal that is desired.

5.3.3 Short-term Effectiveness

Following implementation of in situ chemical oxidation, assuming complete treatment, the treated groundwater would meet remedial action objectives, thereby reducing risk to human and ecological receptors.

Securing the treatment area and restricting access only to authorized personnel would minimize potential short-term impacts. Establishing appropriate health and safety procedures would minimize the risk to site workers. Hydrogen peroxide would require special handling. This risk would be mitigated by the use of appropriate personal protective equipment (PPE) and contingency measures, such as eye-wash stations.

5.3.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Toxicity, mobility, and volume of chemicals of concern would be reduced through in situ treatment by this remedial alternative. Petroleum hydrocarbons and associated chemical compounds would be converted into nontoxic compounds.

5.3.5 Implementability

The in situ chemical oxidation process could be easily implemented, and the process is technically capable of treating the chemicals of concern in groundwater to meet remedial action objectives. Aside from using a contractor experienced in hydrogen peroxide injection, no special equipment, materials, or technical specialists would be required for the implementation of this remedial alternative. Several vendors are readily available to conduct the work and supply the required chemicals. Permits from the city and county would have to be obtained before the process could be implemented.

5.3.6 Cost

Capital costs for in situ chemical oxidation would be about $91,000, and O&M costs would be about $49,900, for a total estimated cost of $140,900. Costs associated with the in situ chemical oxidation alternative include the hydrogen peroxide injection and site restoration. Groundwater monitoring would most likely be performed annually for approximately 15 years.

5.4 REMEDIAL ALTERNATIVE 4: IN SITU AIR SPARGING

This remedial alternative involves air sparging, which uses air to sparge VOC (such as TPH as gasoline and benzene) in groundwater. Additionally, enhanced biodegradation of contaminants susceptible to aerobic microbial degradation occurs using this alternative. The air sparging system consists of an aboveground blower (or air compressor) and subsurface air ejection points that are connected to the blower with subsurface piping. Air bubbles traverse through the engineered soil column, creating an underground bubbler. Air sparging helps to strip VOCs from the groundwater, and to stimulate biodegradation of TPH as diesel and oil, both of which are less volatile than VOCs. The in situ air sparging system would consist of horizontal air ejection ports and a horizontal well vent. The area in which the in situ air sparging system would be installed would be excavated into the saturated zone. Essentially, a trench approximately 2 to 3 feet wide would be excavated laterally across the plume. Figure 8 shows the proposed area for the in situ air sparging system. The subsurface piping would be installed below the seasonal low groundwater level, and the trench would be backfilled with clean porous engineered fill material. Air from the blower would constantly flow from the underground piping and percolate up (toward the ground surface) through the groundwater and backfill material in the trench. The following subsections present an evaluation of the in situ chemical oxidation alternative.

how about adding extraction wells w/i trench?

5.4.1 Overall Protection of Human Health and the Environment

The in situ air sparging system would be capable of providing overall protection of human health and the environment by reducing the risk posed by the chemicals of concern in groundwater through removal of VOCs and enhanced biodegradation of SVOCs. The system would be operated until groundwater remedial action objectives are achieved. The estimated length of time the system will need to be in operation is 15 years.

5.4.2 Long-term Effectiveness and Permanence

The in situ air sparging system would be operated until groundwater remedial action objectives were achieved. The time required to reduce the concentrations of the chemicals of concern in groundwater to levels protective of human and ecological receptors is estimated to be approximately 15 years. However, this timeline is dependant on the rate at which the chemicals of concern leach into groundwater.

5.4.3 Short-term Effectiveness

During implementation of this remedial alternative, in situ groundwater treated by air sparging would meet remedial action objectives.

Construction of the air injection system and soil removal would result in potential exposure of workers to contaminated groundwater and soil. Securing the treatment area and restricting access to only authorized personnel would minimize potential short-term impacts. Establishing appropriate health and safety procedures, and taking measures to prevent direct contact with contaminated media would minimize risk to site workers.

5.4.4 Reduction of Toxicity, Mobility, or Vclume through Treatment

Toxicity, mobility, and volume of chemicals of concern would be reduced through in situ treatment by this remedial alternative. Petroleum hydrocarbons would be converted into nontoxic compounds.

5.4.5 Implementability

Construction and operation of the in situ air sparging system would be easily implemented and the system is technically capable of treating the chemicals of concern in groundwater to remedial action objectives. No special equipment, materials, or technical specialists would be required for the implementation of this remedial alternative. Permits from the city and county would have to be obtained before the process could be implemented.

5.4.6 Cost

Capital costs for in situ air sparging would be about $47,000, and O&M costs would be about $112,000, for a total estimated cost of about $159,000.

6.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVES

A comparative analysis of the four remedial alternatives considered for the site is discussed below.

6.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The no action alternative would provide the lowest overall protection to human health and the environment. In situ air sparging would provide the highest protection to human health and the environment. Both excavation with disposal and in situ chemical oxidation would provide a lower overall protection of human health and the environment. In situ air sparging would remove in situ contamination from the hot spots at the site and could possibly reduce contaminant concentrations up gradient from the system. Additionally, some of the contaminated soil would be removed during installation of system. Excavation and disposal would remove any in situ contamination in the area of the excavation and some of the groundwater outside of the removal area would also be removed during dewatering. In situ chemical oxidation would only affect the area that is treated. Groundwater contamination outside the treatment area would most likely not be reduced.

6.2 LONG-TERM EFFECTIVENESS AND PERMANENCE

With respect to long-term effectiveness, none of the remedial alternatives will effectively clean up all of the affected groundwater at the site. Of the three active remedial alternatives, in situ air sparging would positively affect (clean up) the largest volume of groundwater. The estimated amount of time it would take to clean up groundwater upgradient of the system is 20 years. Both excavation with disposal and in situ chemical oxidation would treat the hot spots at the site. Residual contamination would remain until natural degradation processes reduced chemicals of concern concentrations below cleanup levels, in approximately 40 years. Excavation and disposal would be the most effective method for treating the hot spots.

6.3 SHORT-TERM EFFECTIVENESS

For in situ chemical oxidation a single treatment of hydrogen peroxide would require the least amount of time to construct and implement, estimated at about 2 weeks. Mechanical excavation and disposal would require approximately 3 weeks to construct and implement. Construction for in situ air sparging is expected to be completed within 5 weeks.

Adverse short-term risks from construction would not occur under the no action alternative. Both excavation with disposal and in situ air sparging would have the greatest risks during construction, due to the volume of soil that would be excavated and transported off site for disposal. Shoring, dewatering, and site controls for the excavations would be required. The in situ chemical oxidation alternative would pose a slightly higher risk to site workers than the other remedial alternatives, caused by worker exposure to hydrogen peroxide during the treatment.

6.4 REDUCTION IN TOXICITY, MOBILITY, AND VOLUME THROUGH TREATMENT

Excavation and disposal is the best remedial alternative for reduction of the mobility, toxicity, and volume of the chemicals of concern. In descending order of effectiveness, in situ air sparging and in situ chemical oxidation would reduce the mobility, toxicity, and volume of the chemicals of concern. The no action remedial alternative would not achieve any reduction in toxicity, mobility, and volume of the contaminants of concern.

6.5 IMPLEMENTABILITY

The no-action remedial alternative would be the most easily implementable alternative. In situ chemical oxidation would be the next most easily implementable remedial alternative. Excavation and disposal would be moderately hard to implement because the excavation would extend across the public sidewalk and into the street. In situ air sparging would be the hardest to implement due to installation of the treatment system. Contractors and vendors experienced in environmental cleanup work using each of the selected remedial alternatives are readily available to conduct the work.

6.6 COST

Excavation and disposal is the most expensive alternative, at approximately $253,000. Remedial alternative, in situ air sparging, is the next expensive alternative at approximately $159,000. In situ chemical oxidation is the least expensive alternative at approximately $140,900.

7.0 SUMMARY

In summary, no action is not a viable remedial alternative for the site because the regulatory agencies do not find it to be an acceptable method to attain site closure. Excavation and disposal can easily be implemented and can be an effective remedial alternative, but it is also the most expensive of the selected remedial alternatives. In situ chemical oxidation can easily be implemented, but the site geology would likely demand several treatments. In situ air sparging is likely the hardest remedial alternative to implement, but this process will also likely be the most effective for site cleanup.

Based on the fact that in situ air sparging would most likely prove to be the most cost effective and best cleanup method for the site, TtEMI recommends this remedial alternative. Application of this remedial alternative will provide overall protection of human health and the environment; will be permanent and effective in the long-term; will be effective in the short term; will reduce the toxicity, mobility, and volume of the contaminants of concern; and the costs associated with in situ air sparging are reasonable. Although implementation of this process may be the most difficult of the selected remedial alternatives, the end result should be that site closure could be attainable.

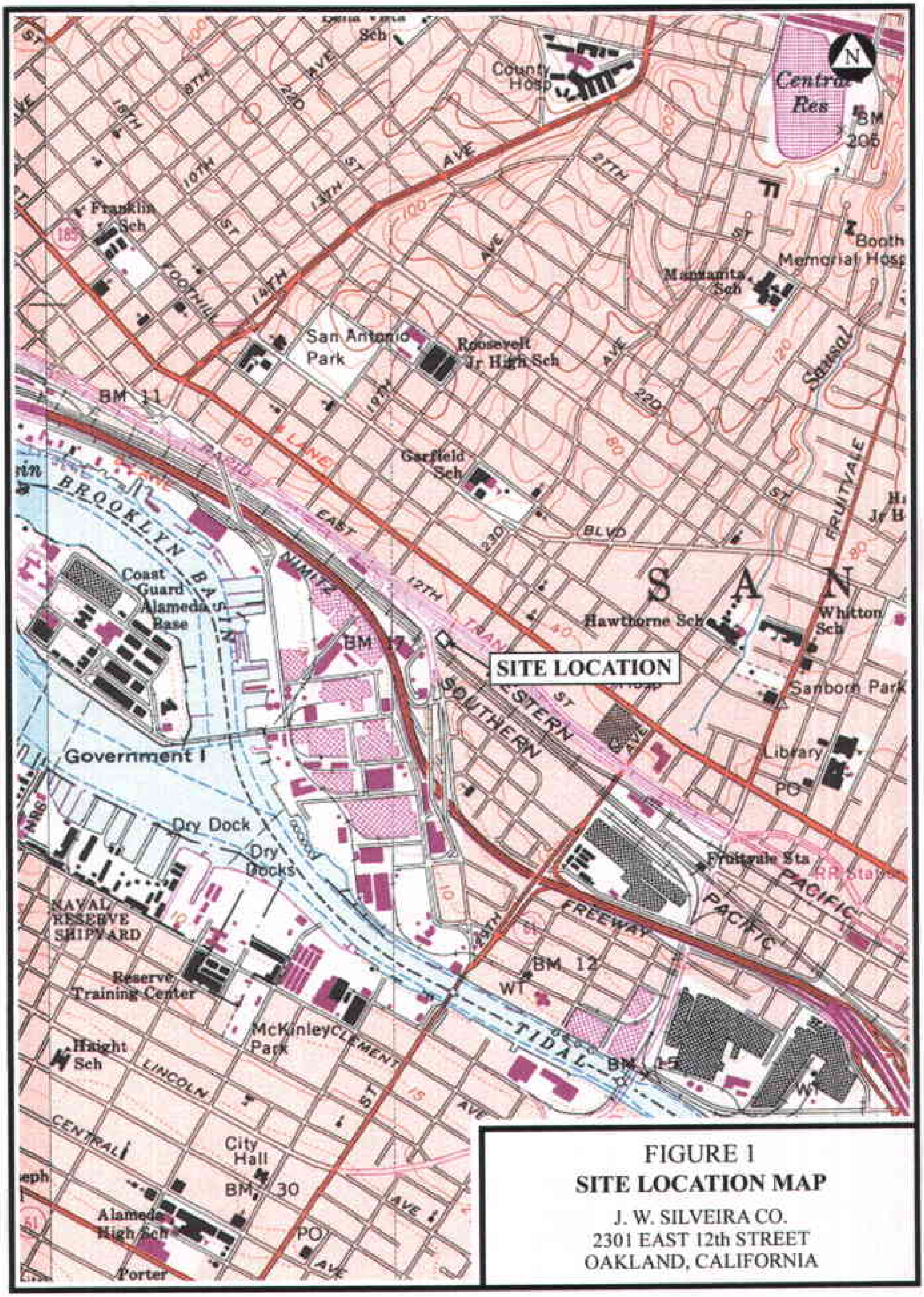


FIGURE 1
SITE LOCATION MAP

J. W. SILVEIRA CO.
2301 EAST 12th STREET
OAKLAND, CALIFORNIA

Tetra Tech EM Inc.

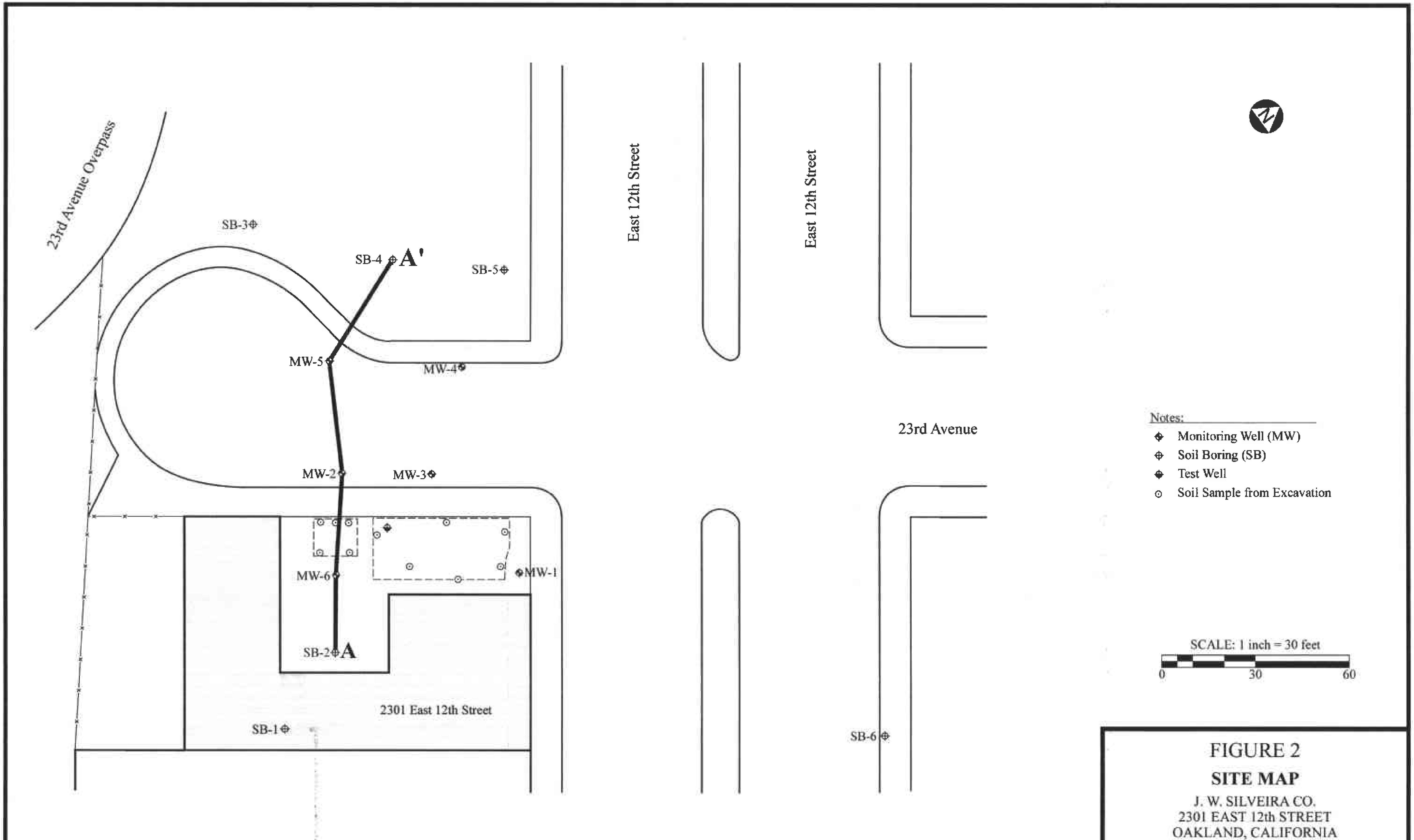


FIGURE 2
SITE MAP
J. W. SILVEIRA CO.
2301 EAST 12th STREET
OAKLAND, CALIFORNIA

Tetra Tech EM Inc.

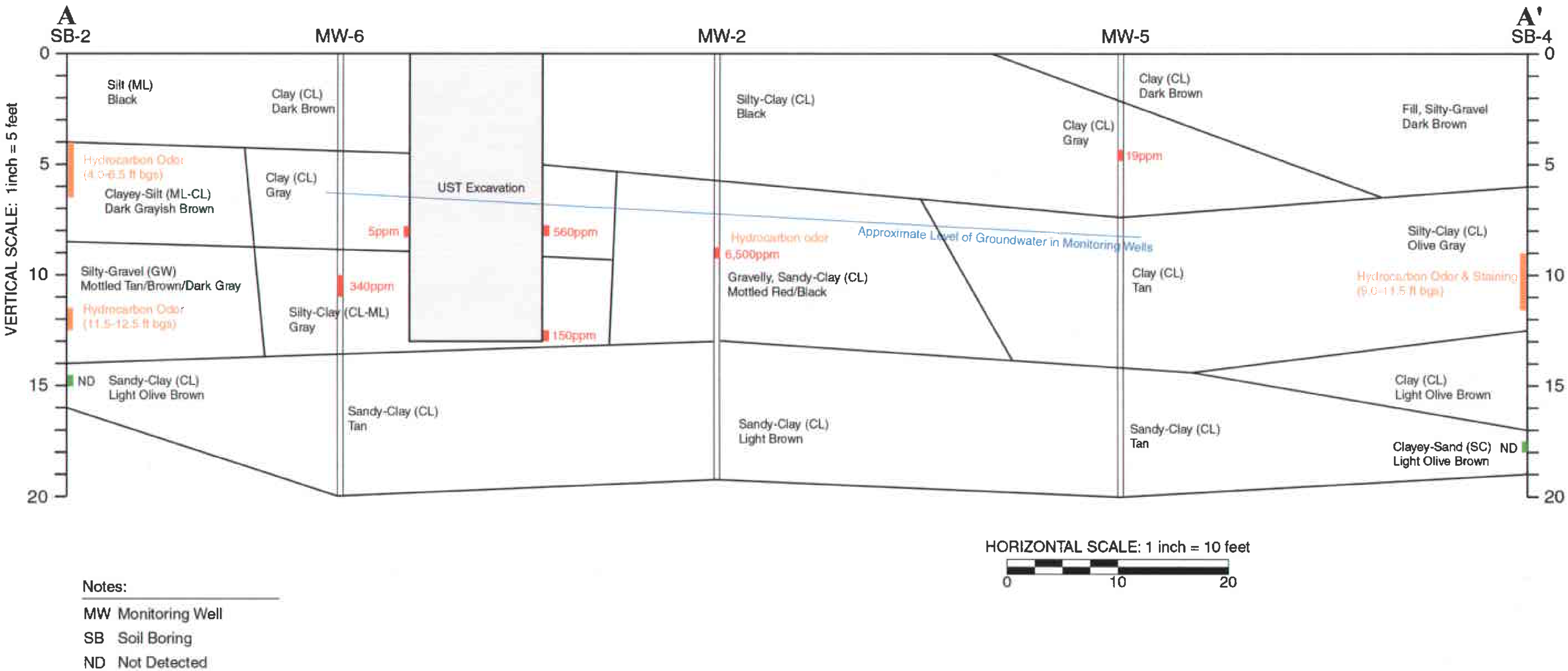


FIGURE 2
CROSS SECTION A-A'
GASOLINE IN SOIL
J. W. SILVEIRA CO.
2301 EAST 12th STREET
OAKLAND, CALIFORNIA

Tetra Tech EM Inc.

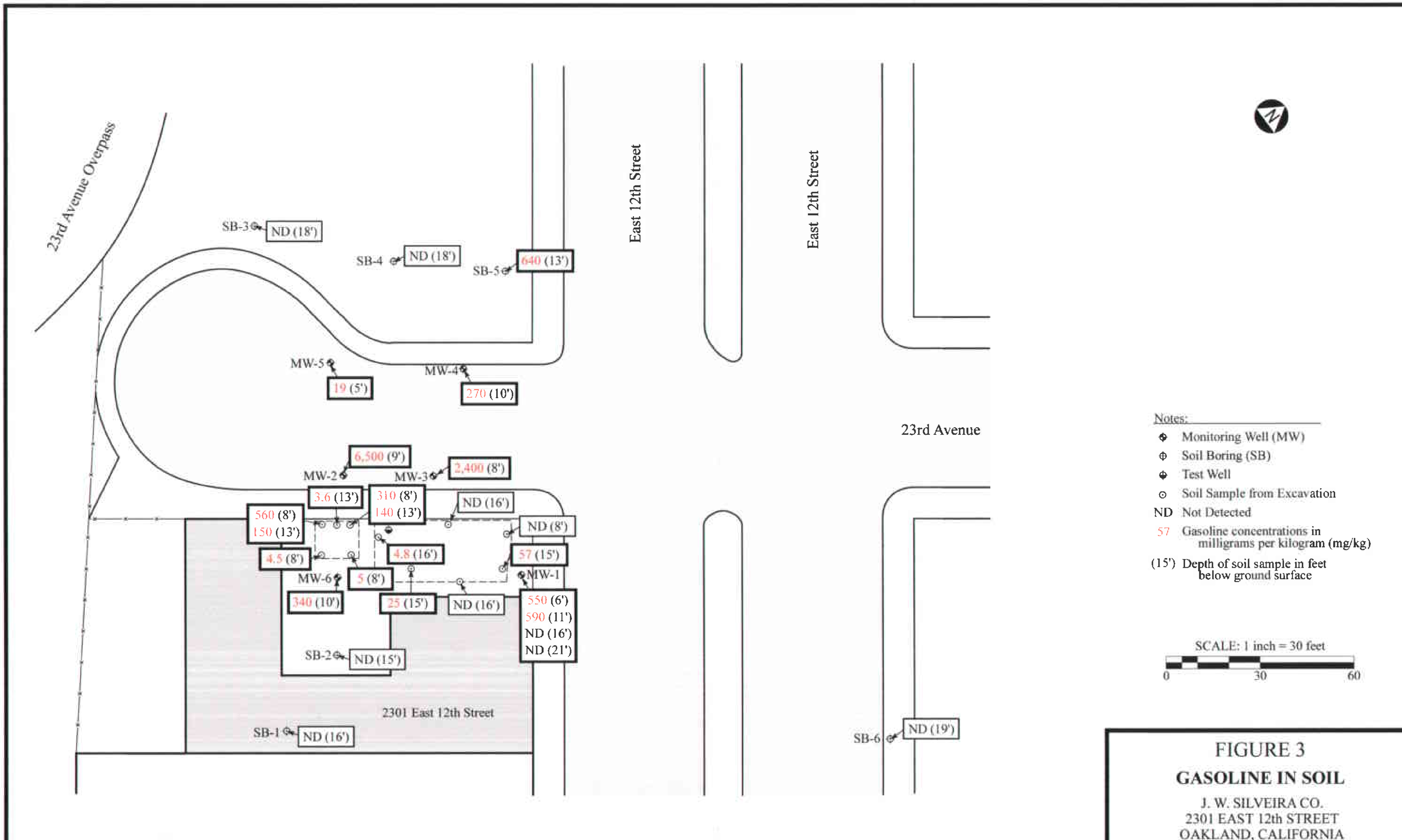
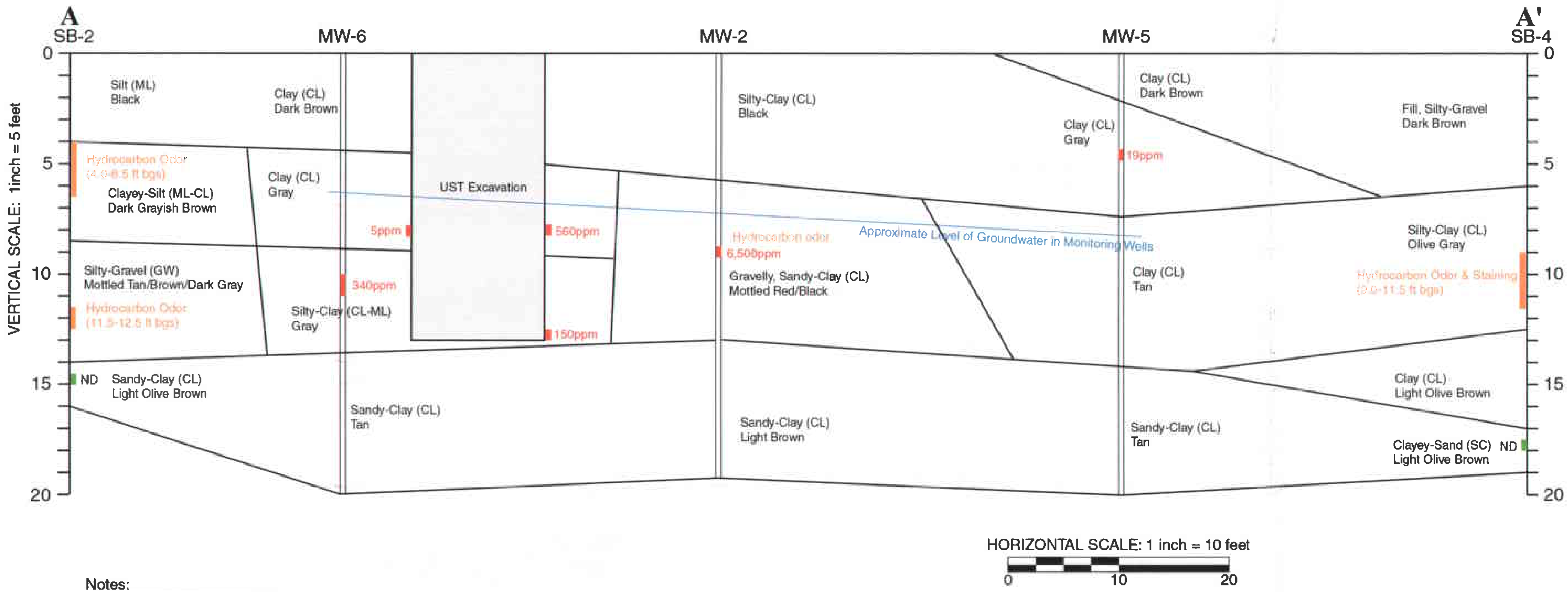


FIGURE 3

GASOLINE IN SOIL

J. W. SILVEIRA CO.
2301 EAST 12th STREET
OAKLAND, CALIFORNIA

Tetra Tech EM Inc.



Notes:

MW Monitoring Well
SB Soil Boring
ND Not Detected

FIGURE 3
CROSS SECTION A-A'
GASOLINE IN SOIL

J. W. SILVEIRA CO.
2301 EAST 12th STREET
OAKLAND, CALIFORNIA

Tetra Tech EM Inc.

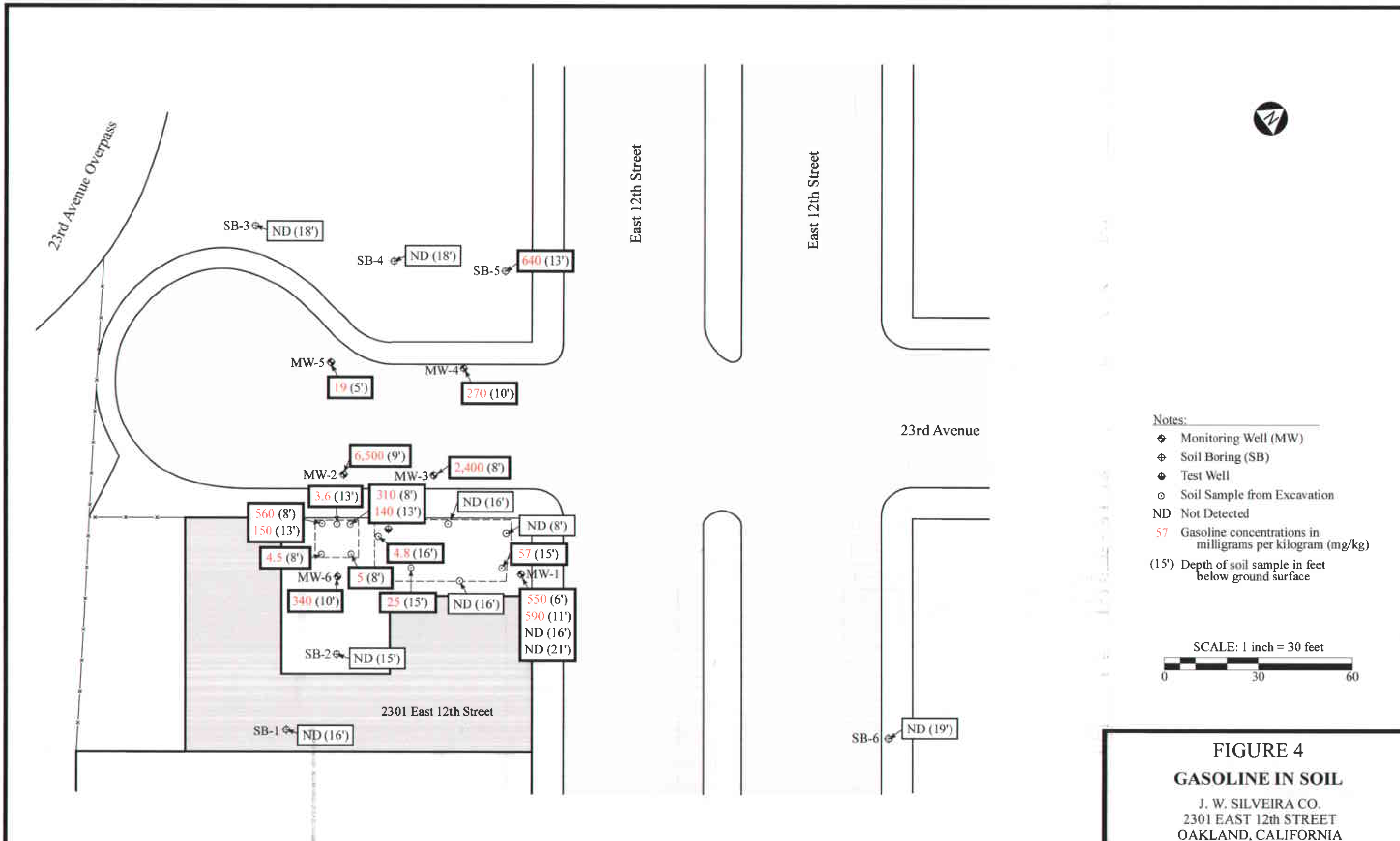


FIGURE 4

GASOLINE IN SOIL

J. W. SILVEIRA CO.
2301 EAST 12th STREET
OAKLAND, CALIFORNIA

Tetra Tech EM Inc.

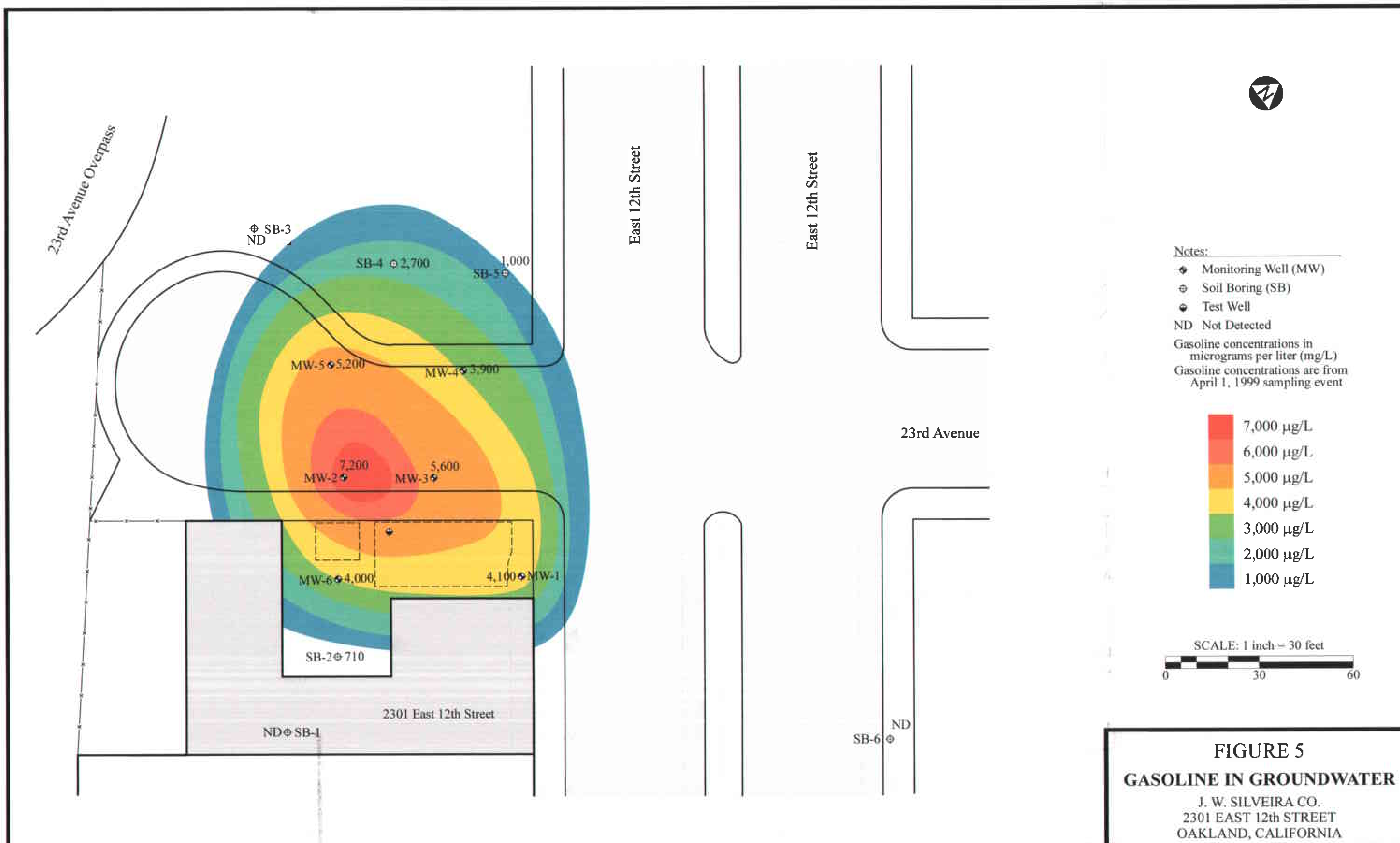


FIGURE 5
GASOLINE IN GROUNDWATER
J. W. SILVEIRA CO.
2301 EAST 12th STREET
OAKLAND, CALIFORNIA

Tetra Tech EM Inc.

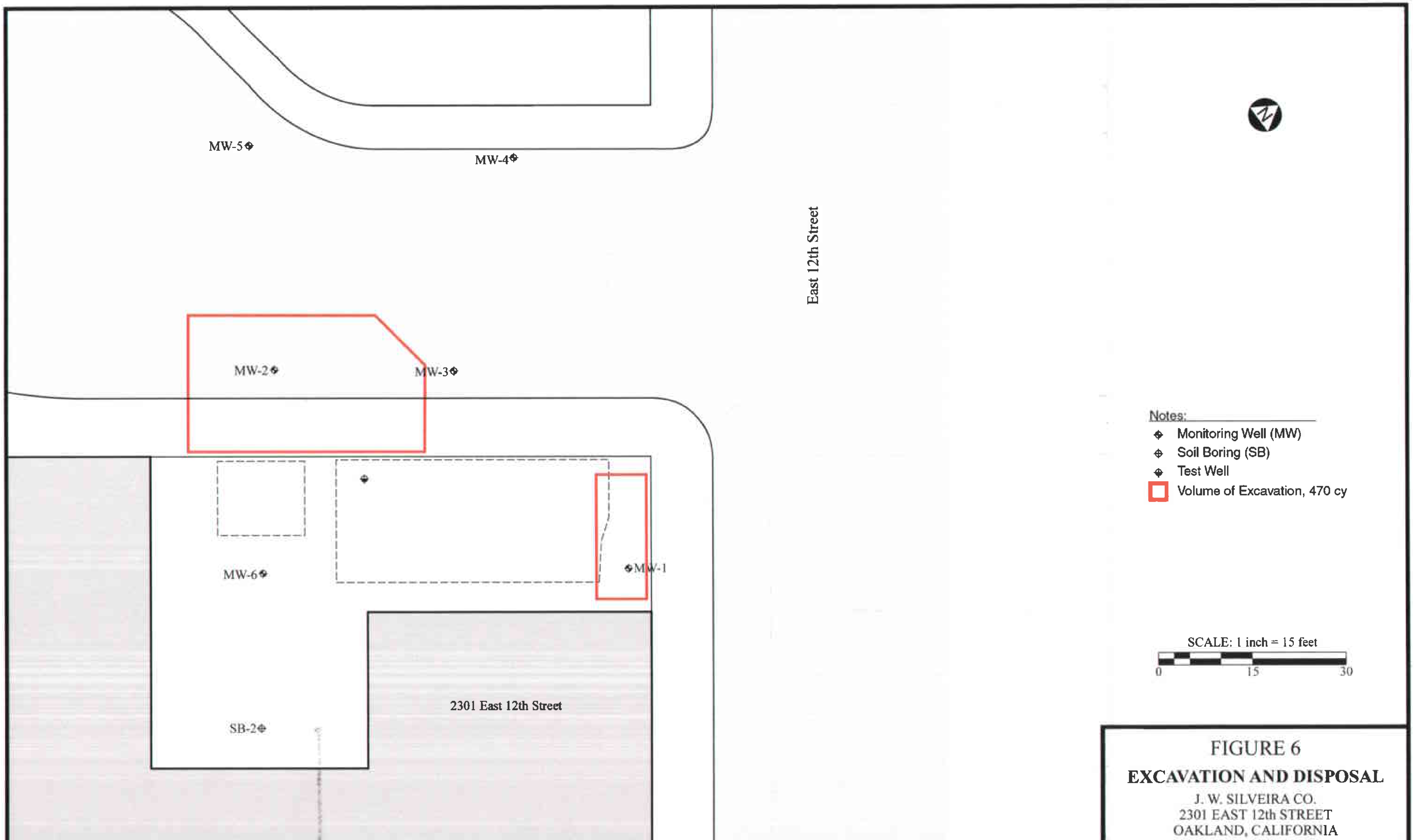


FIGURE 6
EXCAVATION AND DISPOSAL
J. W. SILVEIRA CO.
2301 EAST 12th STREET
OAKLAND, CALIFORNIA

Tetra Tech EM Inc.

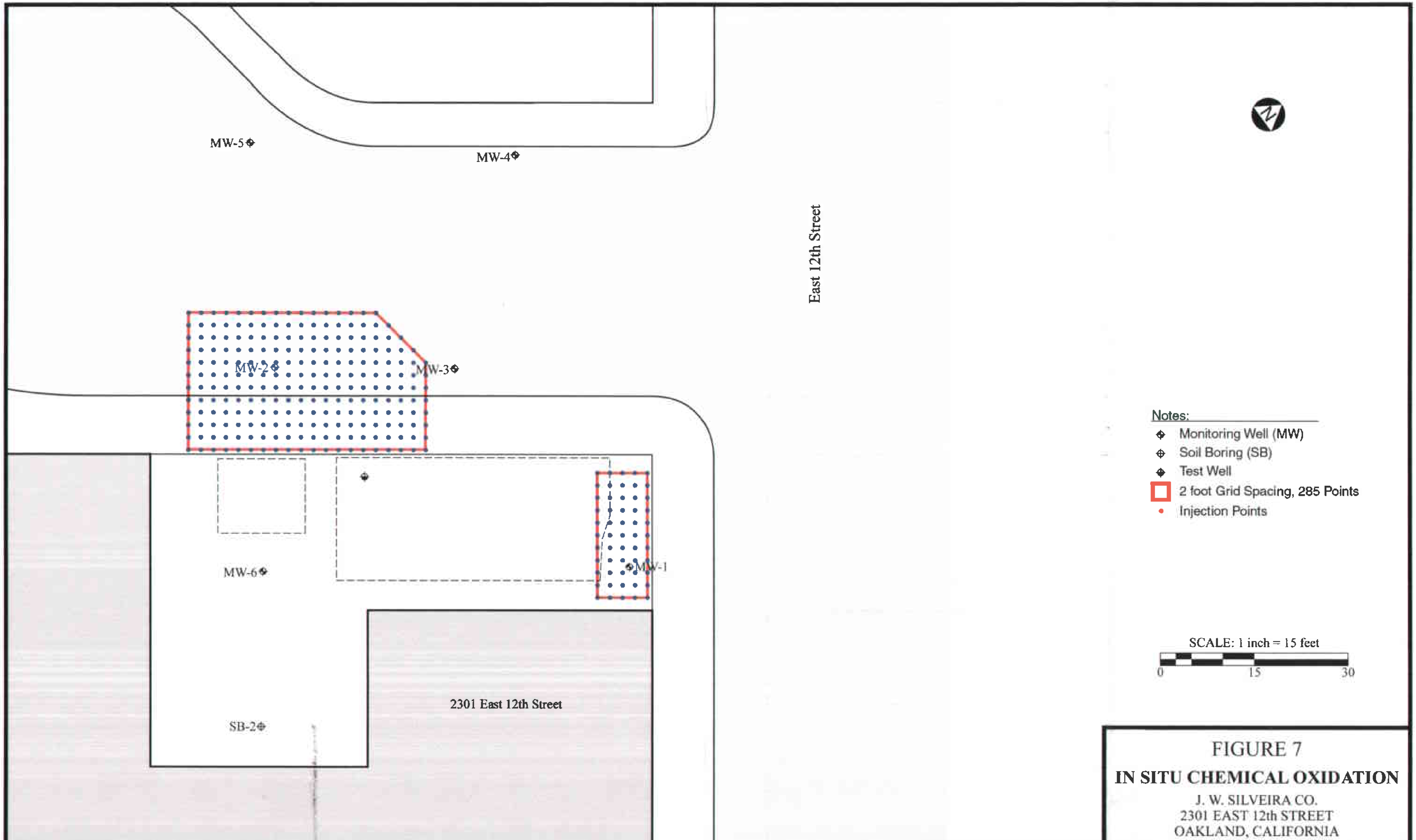


FIGURE 7

IN SITU CHEMICAL OXIDATION

J. W. SILVEIRA CO.
2301 EAST 12th STREET
OAKLAND, CALIFORNIA

Tetra Tech EM Inc.

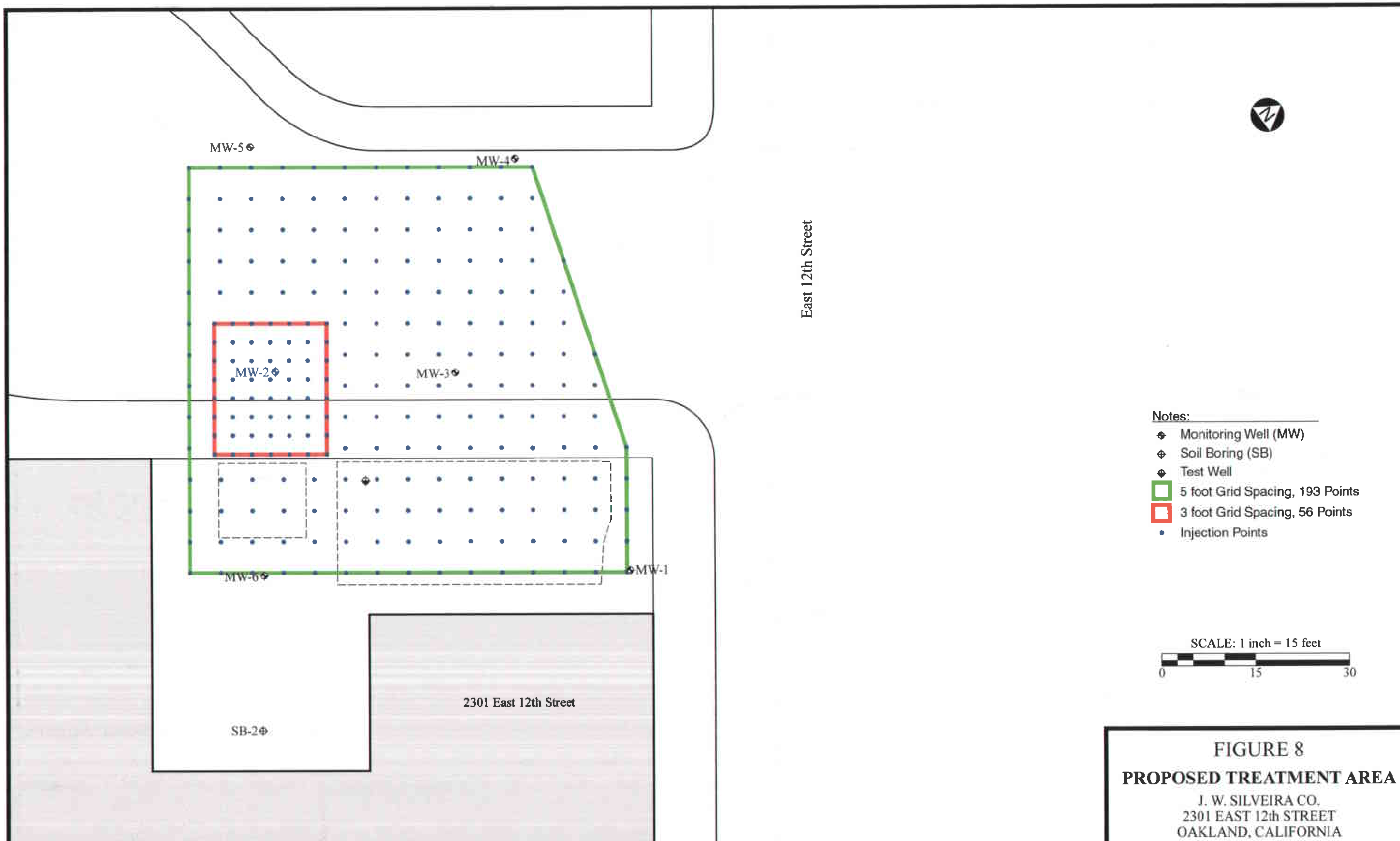


FIGURE 8

PROPOSED TREATMENT AREA

J. W. SILVEIRA CO.
2301 EAST 12th STREET
OAKLAND, CALIFORNIA

Tetra Tech EM Inc.

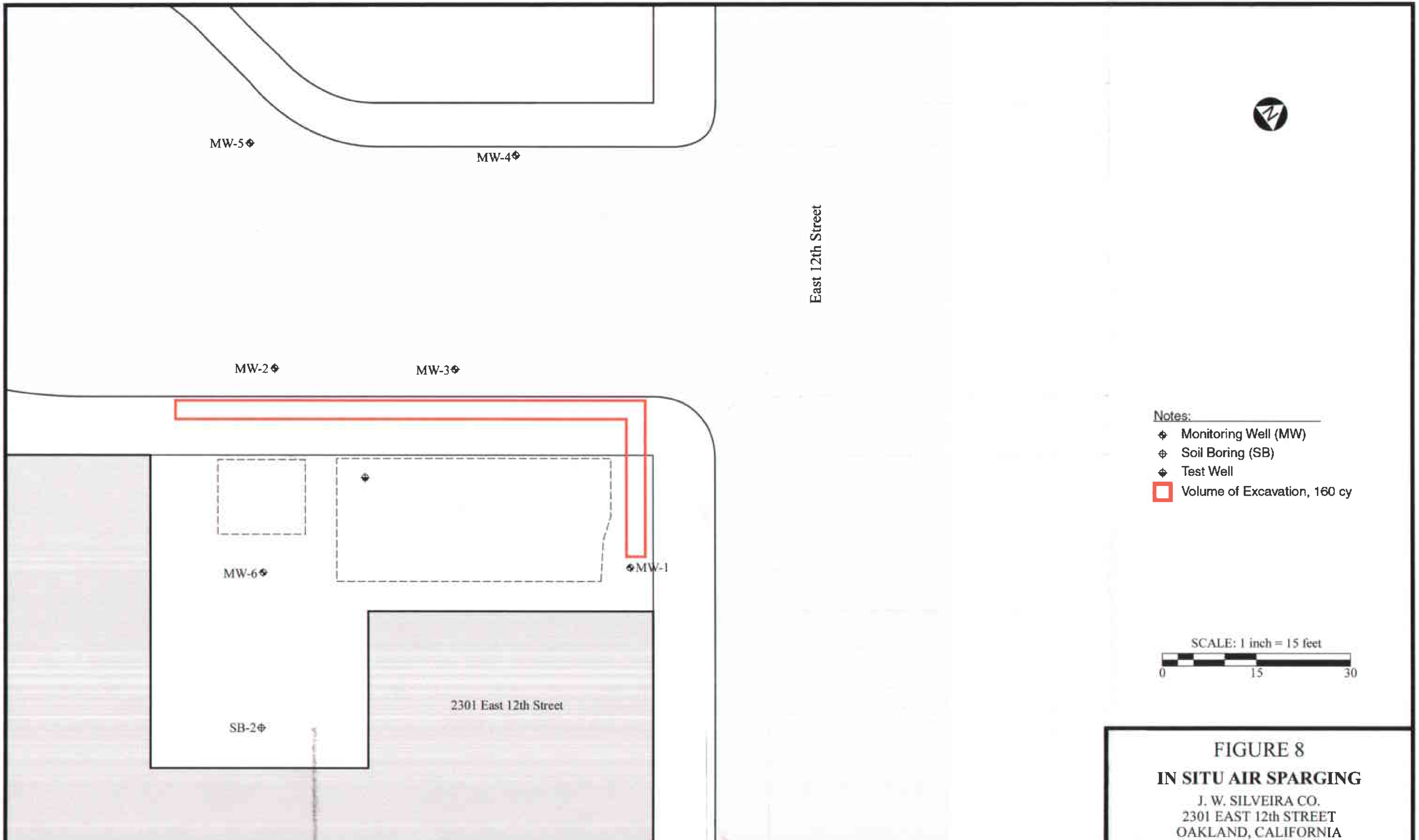


FIGURE 8

IN SITU AIR SPARGING

J. W. SILVEIRA CO.
2301 EAST 12th STREET
OAKLAND, CALIFORNIA

Tetra Tech EM Inc.