PACIFIC
ENVIRONMENTAL
GROUP INC.

'92 T.L.H.

April 1, 1992
Project 320-90.03

Ms. Nancy Vukelich
Chevron USA Products Company
P.O. Box 5004
San Ramon, California 94583-0804

Re: Former Chevron Station 9-0020
1633 Harrison Street
Oakland, California

Dear Ms. Vukelich:

On behalf of Chevron USA Products Company, Pacific Environmental Group, Inc. (PACIFIC) conducted a soil vapor extraction (SVE) feasibility test on December 14, 1991 at the referenced site. Results of the test, including relevant subsurface conditions, testing procedures, and recommendations for possible SVE system design, are included in this letter.

## RELEVANT SUBSURFACE CONDITIONS

The data outlined below was used to design the SVE feasibility test, and confirm design assumptions.

- Soils underlying the site consist primarily of sand, clayey sand, silty sand, sandy silt, and silt. Predicated on site lithology, permeability to air flow was expected to range between 1 and 10 darcys (1 darcy = $9.87 \times 10^{-9}$ cm$^2$). The boring logs of Wells MW-7 and MW-4 are referenced in Western Geologic Resources, Inc. (WGR's) Subsurface Investigation report (June 1989). The geological cross-sections are referenced in WGR's Off-Site Subsurface Investigation report (July 1990).
- Primary petroleum hydrocarbon-impacted areas were identified in the vicinity of Wells MW-7 and MW-4. A site map is included as Figure 1.

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- Immediately before the test was performed, depth to groundwater was measured in all groundwater monitoring wells. Measurements were compared with estimated well screen intervals to determine the feasibility of using groundwater monitoring wells as extraction/monitoring points. Based on the available data, it appeared all wells could serve as monitoring points. After accounting for the upwelling of groundwater during vacuum application, it was determined that Wells MW-7 and MW-4 could serve as extraction points.
- Monitoring and extraction wells were tested for flow restriction by measuring the time response to a pressure perturbation. It appeared flow restriction would not be a factor in limiting the ability to measure subsurface vacuum.

## TEST OBJECTIVES

The primary goal of the test was to supply data necessary to evaluate the use SVE technology at the site, and to provide information for possible SVE system design. Specific test objectives are listed below.

- Measure the induced pressure gradient of a specific strata beneath the subject site at a constant applied pressure.
- Measure the change of subsurface pressure with time at a fixed distance from the pressure application point.
- Collect and analyze samples of extracted soil vapor.
- Measure the change in air flow with changes in applied pressure.

## FIELD PROCEDURES

The SVE test was conducted using a 2.5 horsepower regenerative blower. Soil vapor extracted under vacuum application was treated using vapor-phase activated carbon prior to atmospheric discharge. Pressure gages were placed at the wells surrounding the extraction well to measure subsurface pressure. The applied vacuum (or positive pressure), extracted soil vapor flow rate, and pressure influence on surrounding wells were monitored during the test. A portable flame-ionization detector (FID) was used to analyze extracted soil vapor during the test. Additionally, soil vapor samples were collected from Wells MW-4 and MW-7, and transported to Superior Precision Analytical, Inc. under chain-of-custody protocol. The samples were analyzed by EPA Methods 8015 and 8020 for total petroleum hydrocarbons, calculated as gasoline (TPH-g), and benzene, toluene, ethylbenzene, and total xylenes (BTEX compounds).

Two different test procedures, vacuum application, and positive pressure application, were utilized at the site. The application of positive pressure was required to determine the radius of influence. Under vacuum conditions, radial influence could not be measured; the maximum attainable vacuum was not great enough to create measurable influence, given the location of surrounding monitoring wells. Vacuum application was successful in collecting soil vapor samples.

### Vacuum Application

A pressure gradient was induced by the application of negative pressure (vacuum) on Well MW-7. Pressure gages were positioned on Wells MW-6 and MW-8, located approximately 34 and 41 feet from MW-7, respectively. The applied vacuum, extracted soil vapor flow rate, and vacuum influence on Wells MW-6 and MW-8 were monitored during the test.

### Positive Pressure Application

Positive pressure was applied to Well MW-4. This well was chosen because of its screened interval and location relative to known soil impact (minimizing hydrocarbon transport under positive pressure conditions). Pressure gauges were positioned on Wells MW-2 and MW-5, located approximately 33 and 44 feet from Well MW-4, respectively. The applied pressure, pressure influence, and air flow rate were monitored during the test.

## DATA ANALYSIS

Radial pressure distribution was modelled using field measurements and the steady-state solution to the radial flow equation. Permeability to air flow was calculated using field data and the steady-state solution for the radial volumetric flow rate. Additionally, the radial volumetric flow rate and permeability results were used to generate flow rate versus applied vacuum curves. These curves provided several SVE system design parameters, including effective radius of influence, blower sizing, and maximum design flow rate. Initial petroleum hydrocarbon removal rates were calculated using the soil vapor sample concentration data and maximum design flow rate. Field data sheets are attached. Data analysis calculations and solutions are available upon request.

## FEASIBILITY TEST RESULTS

### Vacuum Application Results

- It appeared flow restriction would not be a factor in limiting the ability to measure subsurface vacuum, however, subsequent to vacuum application at Well MW-7, it was found that subsurface pressure could not be measured. **It was determined that the vacuum application limit restricted the radial flow distribution to a radial boundary** (where the subsurface pressure is equal to atmospheric pressure) which did not encompass the nearest monitoring point. The measured air flow was less than 10 standard cubic feet per minute (scfm). **A similar test using Well MW-4 as an extraction point did not result in a measurable radius of influence.**

is this a problem?

- Two soil vapor samples were collected from Well MW-7. Certified analytical reports (attached) show the TPH-g concentrations ranged from 8,400 to 18,000 parts per million (ppm). Benzene was detected in both air samples, and ranged from 1,000 to 9,300 parts per billion (ppb).

### Positive Pressure Application Results

- By fitting field data to the steady-state radial flow equation, **the radius of influence, $R_I$, was estimated to be 33 feet.** The radius of influence was generated by a pressure differential of 80 inches of water. The air flow rate was approximately 15 scfm.
- The estimated radius of influence is probably conservative because it is not likely that steady-state conditions were obtained.
- The intrinsic permeability to air flow (k) was estimated from boring logs and field data. Boring log data indicated k ranges between 1 and 10 darcys, or an average of 5 darcys. Field data applied to the steady-state flow equations determined k as 3.2 darcys.
- The radial pressure distribution was modelled using the steady state radial flow equation. Based on this analysis and guidelines provided by Chevron Research and Development (1991), **the effective radius of influence was determined to be 18 feet.**

- The effective radius of influence is probably conservative because it is not likely that steady-state conditions were obtained.
- One soil vapor sample was collected from Well MW-4. Certified analytical reports (attached) show the TPH-g concentration was 32 ppm; benzene was not detected.
- Based on an average flow rate of 20 scfm, the soil vapor analytical data suggests the initial removal rate will be approximately 60 pounds TPH-g per day from Well MW-7.

## CONCLUSIONS

The objective of conducting a SVE test was to determine the technological feasibility of using SVE technology at the site, and provide information for possible SVE system design. Analysis of the data collected during the December 14, 1991 SVE test indicates that SVE application is feasible when compared with other soil-based technologies. However, PACIFIC recommends conducting a comparison of applicable remedial technologies prior initiation of remedial system design.

Based on the SVE test results, PACIFIC recommends the following considerations for SVE system design.

- The changes in air flow for changes in applied vacuum, $P_W$, was modelled using the steady-state radial flow equation. Based on this analysis, the maximum flow rate should not exceed 20 scfm (per soil vapor extraction well) with an approximate applied vacuum of 137 inches of water (10 inches of mercury).
- It is not feasible to utilize existing groundwater monitoring wells as soil vapor extraction wells unless there is a significant decrease in groundwater surface elevation.
- Based on the estimated initial removal rate, use of activated carbon adsorption technology is not economically feasible for this site; catalytic oxidation is economically feasible. After soil vapor concentrations decline to approximately 100 ppm, it may be economically feasible to replace catalytic oxidation with vapor-phase activated carbon adsorption.

Please call if you have any questions or comments regarding these results.

Sincerely,

**Pacific Environmental Group, Inc.**

Keith Winemiller
Staff Engineer

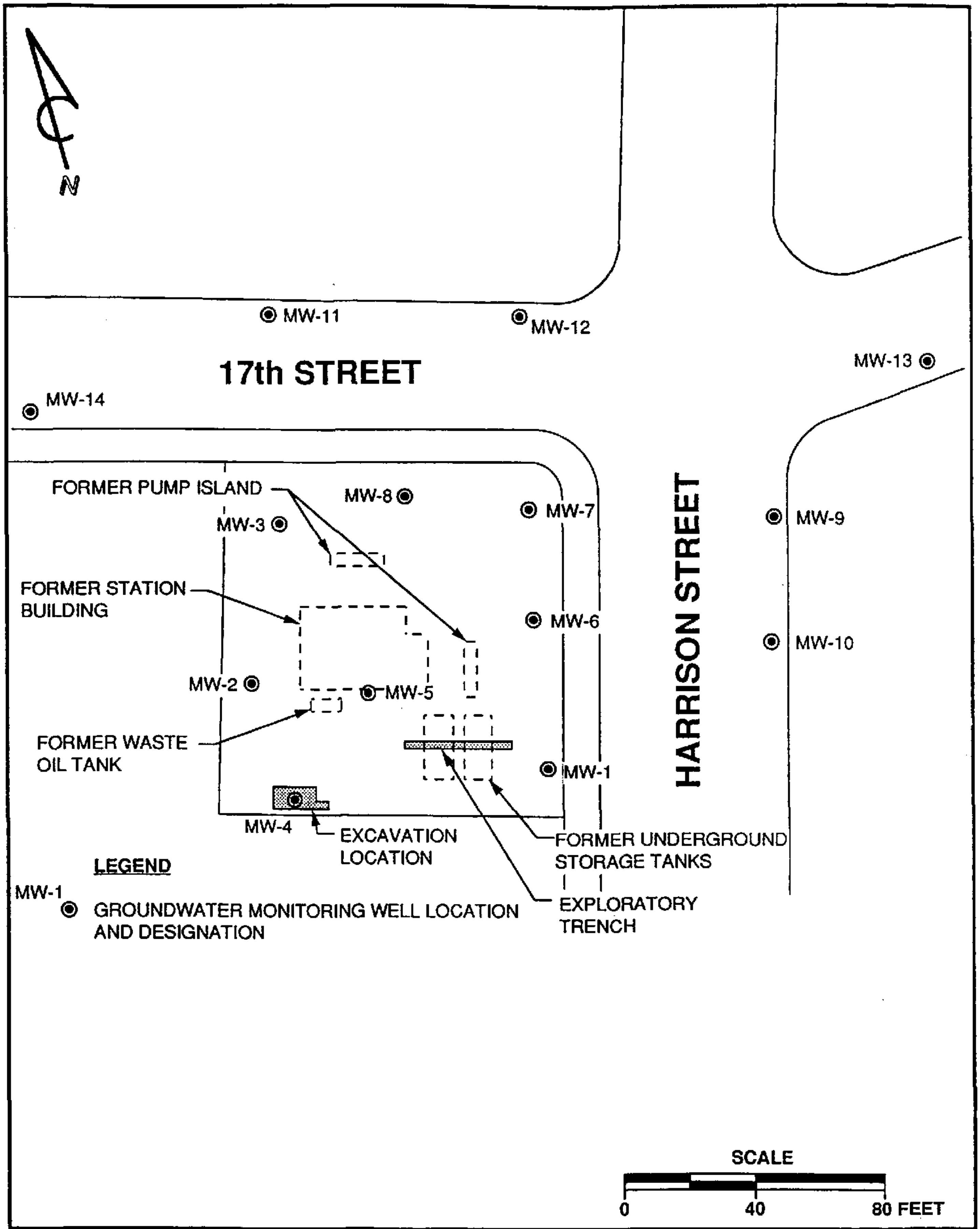
Robert Giattino
Project Engineer

Attachments: Figure 1 - Site Map
Field Sheets
Certified Analytical Reports
Chain-of-Custody Documentation

## REFERENCES:

Johnson, Paul C., Kemblowski, Marian W., and Colthart. James D.: *Quantitative Analysis for the Cleanup of Hydrocarbon-Contaminated Soils by In-Situ Soil Venting*; GROUND WATER, Vol. 28, No. 3, May-June 1990, Pages 413-429.

*Appendix E - General Procedures and Data Interpretation for Vapor Extraction System Pilot Tests*; Chevron Research and Development, 1991.



PACIFIC
ENVIRONMENTAL
GROUP, INC.

**FORMER CHEVRON USA STATION 9-0020**
1633 Harrison Street at 17th Street
Oakland, California

**SITE MAP**

FIGURE:
1
PROJECT:
320-90.03

SVE PILOT TEST 12-14-91

9:00 AM

SITE CONDITIONS: 8 CARS REMAIN IN LOT, BUT IT APPEARS WE WILL HAVE NO TROUBLE. WEATHER IS CLEAR, COLD (~55°F), SEMI-HAZE. BEGINNING EVENT BY COLLECTING DTL.

| WELL | X DTL (ft, in) | SCREEN (BG) | |
|---|---|---|---|
| MW-7 | 22'4" (T.O.C.) | 17'6" | 5' SCREEN |
| MW-6 | 22'9" | 19' | 25A<br>TOC-GRADE |
| MW-1 | 23' | | |
| MW-4 | 24'1" | 19' | |
| MW-5 | 23'4" | 22' | 2"A |
| MW-2 | 23'6" | | |
| MW-3 | 23'1" | | |
| MW-8 | 22'10" | 18'6" | |

NOTE 1: SW PROPERTY LINE BORDERED BY 10 STORY BUILDING WITH A SINGLE LEVEL SUBSURFACE GARAGE. WE WILL OBSERVE FURTHER.

NOTE 2: PREFERENTIAL PATHWAYS: SURFACE OBSERVATION INDICATES TYPICAL SUBSURFACE UTILITIES
○ PHONE ○ WATER ○ ELECTRIC

**PACIFIC ENVIRONMENTAL GROUP, INC.**
1601 Civic Center Drive., Suite 202
Santa Clara, California 95050
(408) 984-6536

PROJECT Oakland JOB NO. 320-90.03
PREPARED BY RG/KW DATE 12-14-91
CHECKED BY ______ DATE ______

TEST 1

START: 12:00, EXTRACTING FROM MW-7.

| WELL | VACUUM (IN $H_2O_g$) | FLOW (SCFM) | TIME | FID (PPM) |
|---|---|---|---|---|
| MW-7 | 40 | <10SCFM | 12:06 | 550 |
| MW-6 | 0 | — | 12:06 | |
| MW-8 | 0 | — | 12:06 | |
| MW-7 | 40 | <10SCFM | 12:19 | 10,000+ TOP SCALE |
| MW-6 | 0 | — | 12:20 | |
| MW-8 | 0 | — | 12:20 | |
| MW-7 | 55 | <10SCFM | 12:50 | 10,000+ |

~ NO APPARENT INFLUENCE ~ CHECKING EXTRACTION PROBE; TIME TO COME TO ATMOSPHERIC EQUILIBRIUM.

EXTRACTION MW-7

AMBIENT PPM = 6.5

| 1 | | 2 | |
|---|---|---|---|
| P(IN $H_2O_g$) | T(S) | P(IN $H_2O$) | T(S) |
| 44 | 0 | 43 | 0 |
| 35 | 3 | 35 | 3 |
| 30 | 6 | 30 | 6 |
| 25 | 9.5 | 25 | 9 |
| 20 | 14 | 20 | 13 |
| 15 | 20 | 15 | 19 |
| 10 | 31 | 10 | 28 |
| 5 | 70 | 5 | 46 |

~ CHECK GROUNDWATER LEVEL IN NEAR AND FAR MONITORING WELLS, RELATIVE MW-7.

| WELL | DTW WITH VACUUM (ft) | DTW WITHOUT VACUUM |
|---|---|---|
| MW-6 | 22' 8" | 22' 8.25" |
| MW-8 | 22' 9.25" | 22' 9.25" |

**PACIFIC ENVIRONMENTAL GROUP, INC.**
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Santa Clara, California 95050
(408) 984-6536

PROJECT Oakland JOB NO. 320-90.03
PREPARED BY RG/KIN DATE 12-14-91
CHECKED BY ______ DATE ______

TEST 2

EXTRACTING FROM MW-4

| WELL | VACUUM (IN $H_2O$ g) | FLOW (SCFM) | TIME | FID (PPM) |
|---|---|---|---|---|
| MW-4 | 40 | <10 | 1:40 | |
| MW-2 | 0 | | 1:40 | |
| MW-5 | 0 | | 1:40 | |
| MW-4 | 40 | <10 | 1:50 | 15 |

~APPLIED POSITIVE PRESSURE TO MW-4

| | | | |
|---|---|---|---|
| MW-4 | ~80 + | 15 | 2:10 |
| MW-2 | 0.02+ | | 2:12 |

PROJECT Oaklnd JOB NO. 380-90.03
PREPARED BY RG/KW DATE 12-14-91
CHECKED BY ______ DATE ______

**Superior Precision Analytical, Inc.**
1555 Burke, Unit I • San Francisco, California 94124 • (415) 647-2081 / fax (415) 821-7123

# CERTIFICATE OF ANALYSIS

LABORATORY NO.: 12629
CLIENT: Pacific Environmental Group
CLIENT JOB NO.: 320-90.03

DATE RECEIVED: 12/17/91
DATE REPORTED: 12/18/91

## ANALYSIS FOR BENZENE, TOLUENE, ETHYL BENZENE & XYLENES
## by EPA SW-846 Methods 5030 and 8020

| | | Concentration(ppb) | | | |
|---|---|---|---|---|---|
| LAB # | Sample Identification | Benzene | Toluene | Ethyl Benzene | Xylenes |
| 1 | MW7-1 | 1000 | 1700 | 1100 | 4100 |
| 2 | MW7-2 | 9300 | 10000 | 5200 | 18000 |
| 3 | MW4-1 | ND<85 | ND<250 | 88 | 400 |

ppb - parts per billion in air

Minimum Detection Limit for Benzene in air = 85 ppb
Minimum Detection Limit for Toluene and Xylenes in air = 250 ppb
Minimum Detection Limit for Ethyl Benzene in air = 65 ppb
Concentration of BTXE in air is calculated based on 20 C and 1 ATM.
Reported as volume to volume.

QAQC Summary:

Daily Standard run at 20ug/L: %DIFF 8020 = <15
MS/MSD Average Recovery = 86% : Duplicate RPD = 1.4%

Richard Srna, Ph.D.

Cecilia G Jorquin (for)
Laboratory Director

**Superior Precision Analytical, Inc.**
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# CERTIFICATE OF ANALYSIS

LABORATORY NO.: 12629
CLIENT: Pacific Environmental Group
CLIENT JOB NO.: 320-90.03

DATE RECEIVED: 12/17/91
DATE REPORTED: 12/18/91

## ANALYSIS FOR TOTAL PETROLEUM HYDROCARBONS
## by Modified EPA SW-846 Method 5030 and 8015

| LAB # | Sample Identification | Concentration (ppm) Gasoline Range |
|---|---|---|
| 1 | MW7-1 | 8400 |
| 2 | MW7-2 | 18000 |
| 3 | MW4-1 | 32 |

ppm - parts per million in air
Minimum Detection Limit for Gasoline in Air: 30 ppm
Concentration of gasoline in air is calculated based on 20 C and 1 ATM and an assumed molecular weight of hexane. Reported as volume to volume.

QAQC Summary:
Daily Standard run at 2mg/L: %DIFF Gasoline = <15
MS/MSD Average Recovery = 91%: Duplicate RPD = 1.1%

Richard Srna, Ph.D.

Cecilia G. Joaquin (for)
Laboratory Director

# Chain of Custody Record

Chevron U.S.A. Inc.
P.O. BOX 5004
San Ramon, CA 94583
FAX (415)842-9591

Chevron Facility Number Former Chevron Station
Facility Address 1633 Harrison St, Oakland
Consultant Project Number 320-90.03
Consultant Name Pacific Environmental Group, Inc.
Address 1601 Civic Center #202, Santa Clara
Project Contact (Name) Lainie Demian
(408) (Phone) 984-6536 (Fax Number) 243-3911

Chevron Contact (Name) Nancy Vukelich
(Phone)
Laboratory Name Superior
Laboratory Release Number <TBD>
Samples Collected by (Name) KEITH WINGMILLER
Collection Date 12 / 16 / 91
Signature

| | | | | | | | Analyses To Be Performed | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample Number | Number of Containers | Matrix S = Soil A = Air W = Water C = Charcoal | Type G = Grab C = Composite D = Discrete | Time | Sample Preservation | Iced (Yes or No) | BTEX + TPH GAS (8020 + 8015) | TPH Diesel (8015) | Oil and Grease (5520) | Chlorinated HC (8010) | Non Chlorinated HC (8020) | Total Lead (AA) | Metals Cd,Cr,Pb,Zn,Ni (ICAP or AA) | | | | | | | Remarks |
| MW7-1 | 1 | A | G | 12:00 | — | N | X | | | | | | | | | | | | | |
| MW7-2 | 1 | " | " | 12:55 | — | N | X | | | | | | | | | | | | | |
| MW4-1 | 1 | " | " | | — | N | X | | | | | | | | | | | | | |

| Relinquished By (Signature) | Organization | Date/Time | Received By (Signature) | Organization | Date/Time |
|---|---|---|---|---|---|
| | PACIFIC | 12-17-91 1035 | X119 KENNEDY | EXPRESS IT | 12-17-91 1035 |
| | | | | Express it | 12-17-1232 |
| | Express it | 1217-1232 | Received For Laboratory By (Signature) SAC | | 12/17/91 |

Turn Around Time (Circle Choice)
24 Hrs.
48 Hrs.
5 Days
10 Days
[✓ As Contracted] NR