GeoStrategies Inc.

JE

January 28, 1993

94610

Alameda County
Department of Environmental Health
80 Swan Way, Room 200
Oakland, California 94621

Attention: Mr. Barney Chan

Reference: UNOCAL Service Station No. 1871
96 MacArthur Boulevard
Oakland, California

Mr. Chan:

As requested by Mr. Robert A. Boust of UNOCAL Corporation, we are forwarding a copy of the Quarterly Monitoring Report dated January 28, 1993 prepared for the above referenced location. This report presents the fourth quarterly groundwater sampling performed at the above mentioned site.

If you have any questions or comments, please call.

Sincerely,

David J. Vossler
Senior Geologist

DJV/rmt

Enclosure

cc: Mr. Robert A. Boust, UNOCAL Corporation
Mr. Paul Supple, ROUX Associates
Mr. Lester Feldman, Regional Water Quality Control Board

:ellenu\868final.wp

GeoStrategies Inc.

QUARTERLY MONITORING REPORT

UNOCAL Service Station No. 1871
96 MacArthur Boulevard
Oakland, California

786801-1

January 28, 1993

GeoStrategies Inc.

January 28, 1993

UNOCAL Corporation
P.O. Box 5155
San Ramon, California 94583

Attn: Mr. Robert A. Boust

Re: QUARTERLY MONITORING REPORT
UNOCAL Service Station No. 1871
96 MacArthur Boulevard
Oakland, California

Mr. Boust:

This Quarterly Monitoring Report has been prepared by GeoStrategies Inc. (GSI) and presents the results of the 1992 fourth quarter sampling for the above referenced site (Plate 1).

There are currently three monitoring wells at the site; Wells MW-1 MW-2 and MW-3 (Plate 2). These wells were installed in 1992 by ROUX Associates.

CURRENT QUARTER SAMPLING RESULTS

Depth to water measurements were obtained in each monitoring well on November 3, 1992. Static ground-water levels were measured from the surveyed top of the well casing and recorded to the nearest $\pm$0.01 foot. Water-level elevations were referenced to Mean Sea Level (MSL) datum and are presented in Table 1. Water-level data were used to construct a quarterly potentiometric map (Plate 3). Shallow ground-water flow direction was to the southwest with a calculated hydraulic gradient of 0.01.

Each well was checked for the presence of floating product. Floating product was not observed in the wells this quarter. The field data sheets are included in Appendix A.

2140 WEST WINTON AVENUE • HAYWARD, CALIFORNIA 94545 • (510) 352-4800
601 UNIVERSITY AVENUE • SUITE 150 • SACRAMENTO, CALIFORNIA 95825 • (916) 568-7500

Ground-water samples were collected on November 3, 1992. Samples were analyzed for Total Petroleum Hydrocarbons calculated as Gasoline (TPH-Gasoline), according to EPA Method 8015 and for Benzene, Toluene, Ethylbenzene, Xylenes (BTEX) according to EPA Method 8020. The ground-water samples were analyzed by National Environmental Testing (NET) Pacific, Inc., a California State-certified laboratory located in Santa Rosa, California. The laboratory analytical report and Chain-of-Custody form are included in Appendix B. These data are summarized and presented in Table 2. A chemical isoconcentration map for benzene is presented on Plate 4. Groundwater sampling field methods and procedures are included in a Appendix C.

If you have any questions, please call.

GeoStrategies Inc. by,

Ellen C. Fostersmith
Geologist

Diane M. Lundquist, P.E.
Senior Engineer
C 46725

REGISTERED PROFESSIONAL ENGINEER
DIANE M. LUNDQUIST
NO. C46725
CIVIL
STATE OF CALIFORNIA

Plate 1. Vicinity Map
Plate 2. Site Plan
Plate 3. Potentiometric Map
Plate 4. Benzene Isoconcentration Map

Appendix A: Field Data Sheets
Appendix B: Laboratory Analytical Report and Chain-of-Custody Form
Appendix C: Field Methods and Procedures

QC Review: _____

TABLE 1

FIELD MONITORING DATA

WELL NO.	MONITORING DATE	CASING DIA. (IN)	TOTAL WELL DEPTH (FT)	WELL ELEV. (FT)	DEPTH TO WATER (FT)	PRODUCT THICKNESS (FT)	STATIC WATER ELEV. (FT)	PURGED WELL VOLUMES	pH	TEMPERATURE (F)	CONDUCTIVITY (u MHOS/CM)
MW-1	03-Nov-92	4	25.0	81.18	16.18	----	65.00	3	6.98	71.1	978
MW-2	03-Nov-92	4	25.0	76.61	12.05	----	64.56	2	7.17	73.0	784
MW-3	03-Nov-92	4	25.0	77.48	13.24	----	64.24	2	7.01	72.8	850

Notes: 1. Static water elevations referenced to Mean Sea Level (MSL).
2. Physical parameter measurements represent stabilized values.
3. pH values reported in pH units.

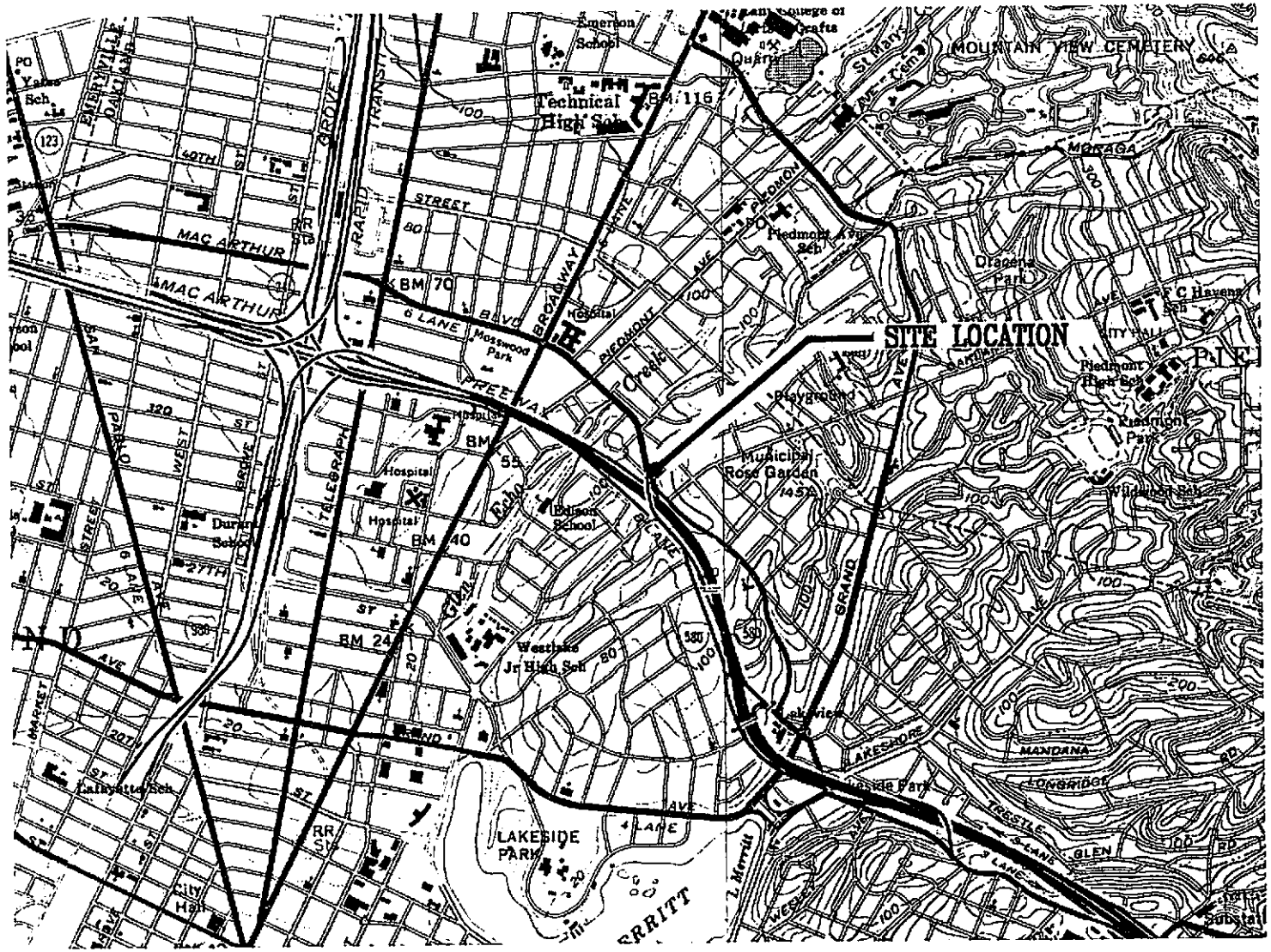
TABLE 2

HISTORICAL GROUND-WATER QUALITY DATABASE

SAMPLE DATE	SAMPLE POINT	TPH-G (PPB)	BENZENE (PPB)	TOLUENE (PPB)	ETHYLBENZENE (PPB)	XYLENES (PPB)
03-Nov-92	MW-1	260000	2300	4600	3700	17000
03-Nov-92	MW-2	140	2.2	<0.5	<0.5	2
03-Nov-92	MW-3	2100	120	15	38	200

TPH-G = Total Petroleum Hydrocarbons calculated as Gasoline
PPB = Parts per Billion

NOTE: 1. All data shown as <X are reported as ND (none detected).



Base Map: USGS Topographic Map

GeoStrategies Inc.

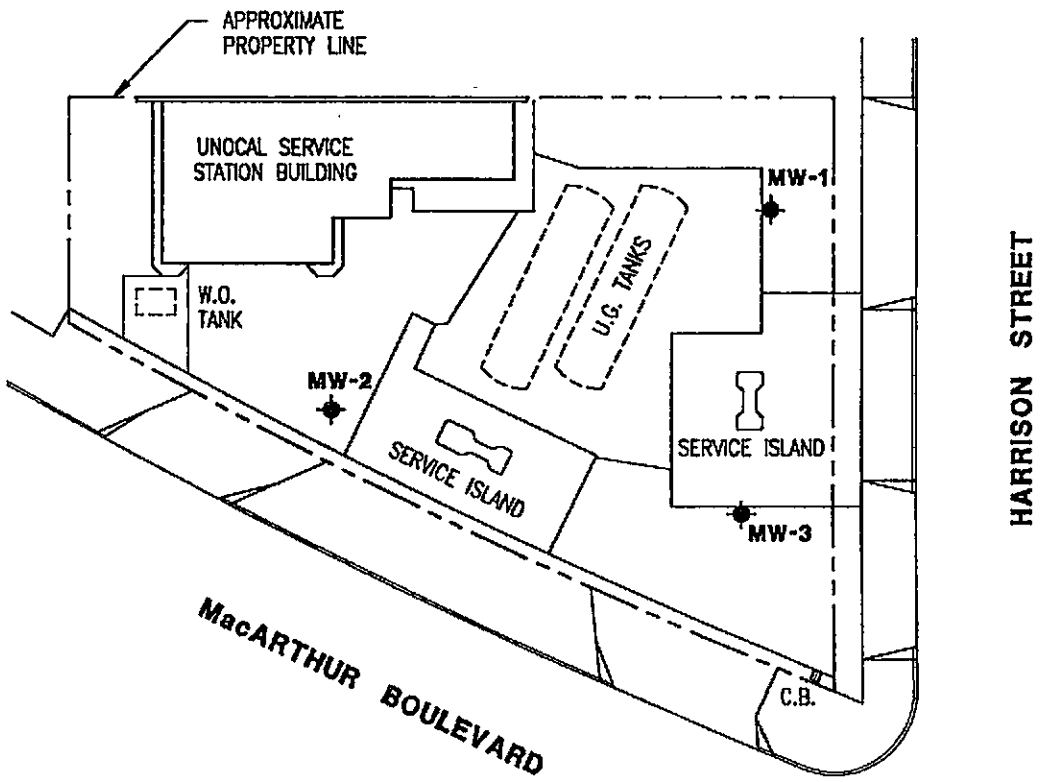
VICINITY MAP
UNOCAL Service Station #1871
96 MacArthur Boulevard
Oakland, California

PLATE 1

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
7868		12/92	

EXPLANATION

Ground-water monitoring well



Base Map: UNOCAL Waste Oil Tank Replacement plan dated 04-14-92 and ROUX Assoc Well Location Fig. 4 dated 05/92

N

0 30

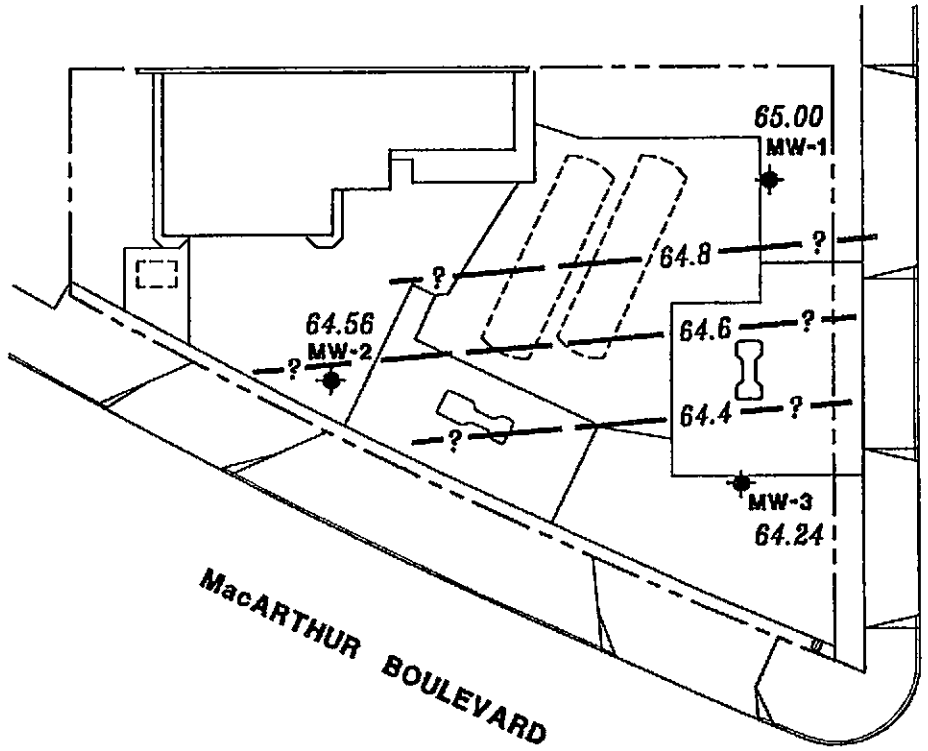
Scale in Feet

GeoStrategies Inc.

SITE PLAN
UNOCAL Service Station #1871
96 MacArthur Boulevard
Oakland, California

PLATE
2

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
7868		12/92	



HARRISON STREET

EXPLANATION

- Ground–water monitoring well
- 99.99 — Ground–water elevation contour. Approximate Gradient = 0.01
- 99.99 — Ground–water elevation in feet referenced to Mean Sea Level (MSL) measured on November 3, 1992

NOTES: 1. Contours may be influenced by irrigation practices and/or site construction activities.

Approximate Ground–water Flow Direction

N

0 30

Scale in Feet

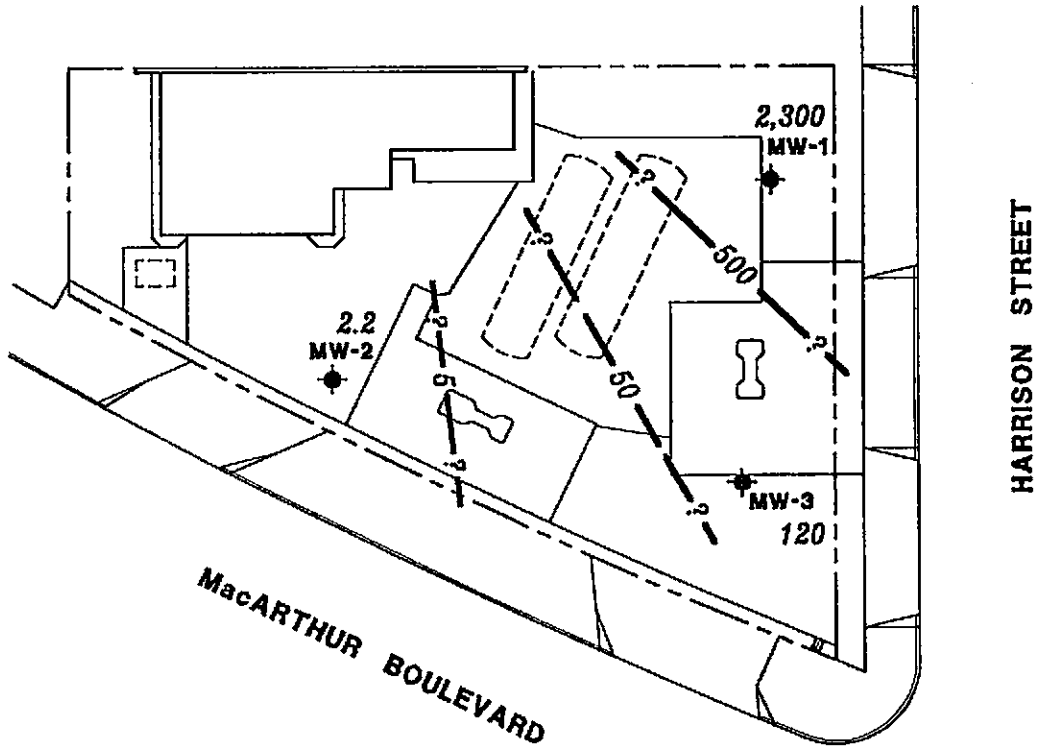
Base Map: UNOCAL Waste Oil Tank Replacement plan dated 04–14–92 and ROUX Assoc Well Location Fig. 4 dated 05/92

GeoStrategies Inc.

POTENTIOMETRIC MAP
UNOCAL Service Station #1871
96 MacArthur Boulevard
Oakland, California

PLATE 3

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
786801–1		1/93	



EXPLANATION

- Ground-water monitoring well
- 0.05 — Benzene isoconcentration contour
- *0.05* — Benzene concentration in ppb sampled on November 3, 1992
- *ND* — Not Detected (See laboratory reports for detection limits)

N

0 30

Scale in Feet

Base Map: UNOCAL Waste Oil Tank Replacement plan dated 04-14-92 and ROUX Assoc Well Location Fig. 4 dated 05/92

GeoStrategies Inc.

BENZENE ISOCONCENTRATION MAP
UNOCAL Service Station #1871
96 MacArthur Boulevard
Oakland, California

PLATE **4**

JOB NUMBER	REVIEWED BY	DATE	REVISED DATE
786801-1		1/93	

APPENDIX A
FIELD DATA SHEETS

GETTLER–RYAN INC.

General and Environmental Contractors

WELL SAMPLING FIELD DATA SHEET

COMPANY Unocal JOB # 3868-01

LOCATION 96 MacArthur Blvd / Harrison DATE 11-3-92

CITY Oakland TIME

Well ID. MW-1 Well Condition OK

Well Diameter 4 in. Hydrocarbon Thickness Sheen ft.

Total Depth 25.0 ft.

Depth to Liquid- 16.18 ft.

Volume Factor (VF)			
	2" = 0.17	6" = 1.50	12" = 5.80
	3" = 0.38	8" = 2.60	
	4" = 0.66	10" = 4.10	

(# of casing volumes) 5 x 8.82 x(VF) .66 = (Estimated Purge Volume) 29.1 gal. (5.8)

Purging Equipment DI

Sampling Equipment Bailer

Starting Time 1453 Purging Flow Rate 4 gpm.

(Estimated Purge Volume) 29.1 gal. / (Purging Flow Rate) 4 gpm. = (Anticipated Purging Time) 7.3 min.

Time	pH	Conductivity	Temperature	Volume
1454	7.35	953	72.6	4 gal
1457	7.21	1166	73.9	12 ↓
15.48	6.98	978	71.1	13 ↓

Did well dewater? Yes If yes, time 1457 Volume 12 gal

Sampling Time 1548 Weather Conditions ~~Sun~~ Sun

Analysis for BTXE, Bio Assay Bottles Used 3x40 ml & 1x1L

Chain of Custody Number

COMMENTS Well recovers very slow

FOREMAN G. Sanchez ASSISTANT

GETTLER–RYAN INC.

General and Environmental Contractors

WELL SAMPLING FIELD DATA SHEET

COMPANY Unocal JOB # 3868.01

LOCATION 96 MacArthur Blvd / Harrison DATE 11-3-92

CITY Oakland TIME

Well ID. MW-2 Well Condition OK

Well Diameter 4 in. Hydrocarbon Thickness — ft.

Total Depth 25.0 ft.

Depth to Liquid- 12.05 ft.

Volume Factor (VF)			
	2" = 0.17	6" = 1.50	12" = 5.80
	3" = 0.38	8" = 2.60	
	4" = 0.66	10" = 4.10	

(# of casing volumes) 5 x 12.95 x(VF) .66 = (Estimated Purge Volume) 42.7 gal. (8.5)

Purging Equipment DI

Sampling Equipment Bailer

Starting Time 1519 Purging Flow Rate 4 gpm.

(Estimated Purge Volume) 42.7 gal. / (Purging Flow Rate) 4 gpm. = (Anticipated Purging Time) 10.7 min.

Time	pH	Conductivity	Temperature	Volume
1520	7.23	769	72.8	4 gal
1523	7.19	748	73.4	16 ↓
1559	7.17	784	73.0	17 ↓

Did well dewater? Ya If yes, time 1523 Volume 16 gal

Sampling Time 1559 Weather Conditions Sun

Analysis gas BTXE Bottles Used 3X40 ml

Chain of Custody Number

COMMENTS

FOREMAN G. Sanf ASSISTANT

GETTLER–RYAN INC.

General and Environmental Contractors

WELL SAMPLING FIELD DATA SHEET

COMPANY Unocal JOB # 3868.01

LOCATION 96 MacArthur Blvd / Harrison DATE 11-3-92

CITY Oakland TIME

Well ID. MW-3 Well Condition ok

Well Diameter 4 in. Hydrocarbon Thickness — ft.

Total Depth 25.0 ft.

Depth to Liquid- 13.24 ft.

Volume Factor (VF)			
	2" = 0.17	6" = 1.50	12" = 5.80
	3" = 0.38	8" = 2.60	
	4" = 0.66	10" = 4.10	

(# of casing volumes) 5 x 11.76 x(VF) .66 = (Estimated Purge Volume) 38.8 (7.8) gal.

Purging Equipment DD

Sampling Equipment Bailer

Starting Time 1507 Purging Flow Rate 4 gpm.

(Estimated Purge Volume) 38.8 gal. / (Purging Flow Rate) ~4 gpm. = (Anticipated Purging Time) 9.7 min.

Time	pH	Conductivity	Temperature	Volume
1508	7.00	922	74.8	4 gal
1511	6.89	923	75.0	76 gal
1542	7.01	850	72.8	17 gal

Did well dewater? If yes, time Volume

Sampling Time 1542 Weather Conditions Sun

Analysis gas BTXE Bottles Used 3x40 ml

Chain of Custody Number

COMMENTS Well recovers very slow

FOREMAN G. Sam ASSISTANT

APPENDIX B
LABORATORY ANALYTICAL REPORT
AND
CHAIN-OF-CUSTODY FORM

NET NATIONAL ENVIRONMENTAL TESTING, INC.

NET Pacific, Inc.
435 Tesconi Circle
Santa Rosa, CA 95401
Tel: (707) 526-7200
Fax: (707) 526-9623

Frank Cline
Gettler-Ryan Inc.
2150 W. Winton Avenue
Hayward, CA 94545

Date: 11/22/1992
NET Client Acct No: 67900
NET Pacific Job No: 92.49182
Received: 11/05/1992

Client Reference Information

Unocal, 96 MacArthur Blvd./Harrison, Oakland, Job 3868.01

Sample analysis in support of the project referenced above has been completed and results are presented on following pages. Please refer to the enclosed "Key to Abbreviations" for definition of terms. Should you have questions regarding procedures or results, please feel welcome to contact Client Services.

Approved by:

Jules Skamarack
Laboratory Manager

JS:rct
Enclosure(s)

Ref: Unocal, 96 MacArthur Blvd./Harrison, Oakland, Job 3868.01

			Descriptor, Lab No. and Results		
			MW-1	MW-2	
Parameter	Method	Reporting Limit	11/03/1992 15:48 142975	11/03/1992 15:59 142976	Units
TPH (Gas/BTXE,Liquid)					
METHOD 5030 (GC,FID)			--	--	
DATE ANALYZED			11-09-92	11-09-92	
DILUTION FACTOR*			1,000	1	
as Gasoline	5030	50	260,000	140	ug/L
METHOD 8020 (GC,Liquid)			--	--	
DATE ANALYZED			11-09-92	11-09-92	
DILUTION FACTOR*			1,000	1	
Benzene	8020	0.5	2,300	2.2	ug/L
Ethylbenzene	8020	0.5	3,700	ND	ug/L
Toluene	8020	0.5	4,600	ND	ug/L
Xylenes (Total)	8020	0.5	17,000	2.0	ug/L
SURROGATE RESULTS			--	--	
Bromofluorobenzene	5030		89	89	% Rec.

Ref: Unocal, 96 MacArthur Blvd./Harrison, Oakland, Job 3868.01

			Descriptor, Lab No. and Results		
			MW-3	Trip	
Parameter	Method	Reporting Limit	11/03/1992 15:42 142977	142978	Units
TPH (Gas/BTXE,Liquid)					
METHOD 5030 (GC,FID)			--	--	
DATE ANALYZED			11-11-92	11-09-92	
DILUTION FACTOR*			1	1	
as Gasoline	5030	50	2,100	ND	ug/L
METHOD 8020 (GC,Liquid)			--	--	
DATE ANALYZED			11-11-92	11-09-92	
DILUTION FACTOR*			1	1	
Benzene	8020	0.5	120	ND	ug/L
Ethylbenzene	8020	0.5	38	ND	ug/L
Toluene	8020	0.5	15	ND	ug/L
Xylenes (Total)	8020	0.5	200	0.7	ug/L
SURROGATE RESULTS			--	--	
Bromofluorobenzene	5030		93	86	% Rec.

Ref: Unocal, 96 MacArthur Blvd./Harrison, Oakland, Job 3868.01

QUALITY CONTROL DATA

Parameter	Reporting Limits	Units	Cal Verf Stand % Recovery	Blank Data	Spike % Recovery	Duplicate Spike % Recovery	RPD
Gasoline	50	ug/L	115	ND	102	101	1.0
Benzene	0.5	ug/L	101	ND	98	80	20
Toluene	0.5	ug/L	96	ND	97	99	1.0
Gasoline	50	ug/L	109	ND	104	80	9.0
Benzene	0.5	ug/L	108	ND	N/A	N/A	N/A
Toluene	0.5	ug/L	125	ND	101	92	8.0

COMMENT: Blank Results were ND on other analytes tested.

NET®

KEY TO ABBREVIATIONS and METHOD REFERENCES

<	:	Less than; When appearing in results column indicates analyte not detected at the value following. This datum supercedes the listed Reporting Limit.
*	:	Reporting Limits are a function of the dilution factor for any given sample. To obtain the actual reporting limits for this sample, multiply the stated Reporting Limits by the dilution factor (but do not multiply reported values).
ICVS	:	Initial Calibration Verification Standard (External Standard).
mean	:	Average; sum of measurements divided by number of measurements.
mg/Kg (ppm)	:	Concentration in units of milligrams of analyte per kilogram of sample, wet-weight basis (parts per million).
mg/L	:	Concentration in units of milligrams of analyte per liter of sample.
mL/L/hr	:	Milliliters per liter per hour.
MPN/100 mL	:	Most probable number of bacteria per one hundred milliliters of sample.
N/A	:	Not applicable.
NA	:	Not analyzed.
ND	:	Not detected; the analyte concentration is less than applicable listed reporting limit.
NTU	:	Nephelometric turbidity units.
RPD	:	Relative percent difference, 100 [Value 1 - Value 2]/mean value.
SNA	:	Standard not available.
ug/Kg (ppb)	:	Concentration in units of micrograms of analyte per kilogram of sample, wet-weight basis (parts per billion).
ug/L	:	Concentration in units of micrograms of analyte per liter of sample.
umhos/cm	:	Micromhos per centimeter.

Method References

Methods 100 through 493: see "Methods for Chemical Analysis of Water & Wastes", U.S. EPA, 600/4-79-020, rev. 1983.

Methods 601 through 625: see "Guidelines Establishing Test Procedures for the Analysis of Pollutants" U.S. EPA, 40 CFR, Part 136, rev. 1988.

Methods 1000 through 9999: see "Test Methods for Evaluating Solid Waste", U.S. EPA SW-846, 3rd edition, 1986.

SM: see "Standard Methods for the Examination of Water & Wastewater, 17th Edition, APHA, 1989.

Gettler - Ryan Inc. ENVIRONMENTAL DIVISION — 1945 Chain of Custody

COMPANY Unocal — JOB NO. 96047

JOB LOCATION 96 MacArthur Blvd / Harrison

CITY Oakland — PHONE NO. 782-7500

AUTHORIZED Frank Cline — DATE 11-3-92 — P.O. NO. 3868.01

SAMPLE ID	NO. OF CONTAINERS	SAMPLE MATRIX	DATE/TIME SAMPLED	ANALYSIS REQUIRED	SAMPLE CONDITION LAB ID
MW-1	3	H_2O	11-3-92 / 1548	THC(gas) BTXE	
MW-2	↓	↓	↓ / 1559	↓	
MW-3	↓	↓	↓ / 1542	↓	
trip	1	↓	— / —		

CUSTODY SEALED 11/4/92 @ 1900 MWT Sealed

RELINQUISHED BY: S. Sanchez 11-3-92 1710 — RECEIVED BY: Refrig #1 11-3-92 1710

RELINQUISHED BY: 11-4-92 14:00 — RECEIVED BY: Mike Tanner 11/4/92

RELINQUISHED BY: Mike Tanner 11/4/92 1900 — RECEIVED BY LAB: 11/5/92 0800

DESIGNATED LABORATORY: NET — DHS #:

REMARKS: Normal TAT

DATE COMPLETED 11-3-92 — FOREMAN G. Sanchez

APPENDIX C

FIELD METHODS AND PROCEDURES

GROUND-WATER SAMPLING AND ANALYSIS

Quality Assurance/Quality Control Objectives

The sampling and analysis procedures employed by Gettler-Ryan Inc. (G-R) for ground-water sampling and monitoring follow specific Quality Assurance/Quality Control (QA/QC) guidelines. Quality Assurance objectives have been established by G-R to develop and implement procedures for obtaining and evaluating water quality and field data in an accurate, precise, and complete manner so that sampling procedures and field measurements provide information that is comparable and representative of actual field conditions. Quality Control (QC) is maintained by G-R by using specific field protocols and requiring the analytical laboratory to perform internal and external QC checks. It is the goal of G-R to provide data that are accurate, precise, complete, comparable, and representative. The definitions for accuracy, precision, completeness, comparability, and representativeness are as follows:

- Accuracy - the degree of agreement of a measurement with an accepted referenced or true value.

- Precision - a measure of agreement among individual measurements under similar conditions. Usually expressed in terms of the standard deviation.

- Completeness - the amount of valid data obtained from a measurement system compared to the amount that was expected to meet the project data goals.

- Comparability - expresses the confidence with which one data set can be compared to another.

- Representativeness - a sample or group of samples that reflects the characteristics of the media at the sampling point. It also includes how well the sampling point represents the actual parameter variations which are under study.

As part of the G-R QA/QC program, applicable federal, state, and local reference guidance documents are followed. The procedures outlined in these regulations, manuals, handbooks, guidance documents, and journals are incorporated into the G-R sampling procedures to assure that; (1) ground-water samples are properly collected, (2) ground-water samples are identified, preserved, and transported in a manner such that they are representative of field conditions, and (3) chemical analysis of samples are accurate and reproducible.

Guidance and Reference Documents Used to Collect Groundwater Samples

These documents are used to verify G-R sampling procedures and are consistent with current regulatory guidance. If site specific work and sampling plans are required, those plans will be developed from these documents, and newly received applicable documents.

U.S.E.P.A. - 330/9-51-002	NEIC Manual for Groundwater/Subsurface Investigation at Hazardous Waste Sites
U.S.E.P.A. - 530/SW611	Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities (August, 1977)
U.S.E.P.A. - 600/4-79-020	Methods for Chemical Analysis of Water and Wastes (1983)
U.S.E.P.A. - 600/4-82-029	Handbook for Sampling and Sample Preservation of Water and Wastewater (1982)
U.S.E.P.A. - 600/4-82-057	Test Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (July, 1982)
U.S.E.P.A. - SW-846#, 3rd Edition	Test Methods for Evaluating Solid Waste - Physical/Chemical Methods (November, 1986)
40 CFR 136.3e,Table II (Code of Federal Regulations)	Required Containers, Preservation Techniques, and Holding Times
Resources Conservation and Recover Act (OSWER 9950.1)	Groundwater Monitoring Technical Enforcement Guidance Document (September, 1986)
California Regional Water Quality Control Board (Central Valley Region)	A Compilation of Water Quality Goals (September, 1988); Updates (October, 1988)
California Regional Water Quality Control Board (North Coast, San Francisco Bay, and Central Valley)	Regional Board Staff Recommendations for Initial Evaluations and Investigation of Underground Tanks: Tri-Regional Recommendations (June, 1988)

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general and environmental contractors

Guidance and Reference Documents Used to Collect Groundwater Samples (cont.)

Regional Water Quality Control Board (Central Valley Region)	Memorandum: Disposal, Treatment, and Refuse of Soils Contaminated with Petroleum Fractions (August, 1986)
State of California Department of Health Services	Hazardous Waste Testing Laboratory Certification List (March, 1987)
State of California Water Resources Control Board	Leaking Underground Fuel Tank (LUFT) Field Manual (May, 1988), and LUFT Field Manual Revision (April, 1989)
State of California Water Resources Control Board	Title 23, (Register #85.#33-8-17-85), Subchapter 16: Underground Tank Regulations; Article 3, Sections 2632 and 2634; Article 4, Sections 2645, 2646, 2647, and 2648; Article 7, Sections 2670, 2671, and 2672 (October, 1986: including 1988 Amendments)
Alameda County Water District	Groundwater Protection Program: Guidelines for Groundwater and Soil Investigations at Leaking Underground Fuel Tank Sites (November, 1988)
American Public Health Association	Standard Methods for the Examination of Water and Wastewaters, 16th Edition
Analytical Chemistry (journal)	Principles of Environmental Analysis, Volume 55, Pages 2212-2218 (December, 1983)
Napa County	Napa County Underground Storage Tank Program: Guidelines for Site Investigations; February 1989.
Santa Clara Valley Water District	Guidelines for Preparing or Reviewing Sampling Plans for Soil and Groundwater Investigation of Fuel Contamination Sites (January, 1989)

Guidance and Reference Documents Used to Collect Groundwater Samples (cont.)

Santa Clara Valley Water District	Investigation and Remediation at Fuel Leak sites: Guidelines for Investigation and Technical Report Preparation (March 1989)
Santa Clara Valley Water District	Revised Well Standards for Santa Clara County (July 18, 1989)
American Petroleum Institute	Groundwater Monitoring & Sample Bias; API Publication 4367, Environmental Affairs Department, June 1983
American Petroleum Institute	A Guide to the Assessment and Remediation of Underground Petroleum Releases; API Publication 1628, February 1989
American Petroleum Institute	Literature Summary: Hydrocarbon Solubilities and Attenuations Mechanisms, API Publication 4414, August 1985
Site Specific (as needed)	General and specific regulatory documents as required.

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Because ground-water samples collected by G-R are analyzed to the parts per billion (ppb) range for many compounds, extreme care is exercised to prevent contamination of samples. When volatile or semi-volatile organic compounds are included for analysis, G-R sampling crew members will adhere to the following precautions in the field:

1. A clean pair of new, disposable gloves are worn for each well being sampled.

2. When possible, samples are collected from known or suspected wells that are least contaminated (i.e. background) followed by wells in increasing order of contamination.

3. Ambient conditions are continually monitored to maintain sample integrity.

When known or potential organic compounds are being sampled for, the following additional precautions are taken:

1. All sample bottles and equipment are kept away from fuels and solvents. When possible, gasoline (used in generators) is stored away from bailers, sample bottles, purging pumps, etc.

2. Bailers are made of Teflon or Stainless Steel. Other materials such as plastic may contaminate samples with phthalate esters which interfere with many Gas Chromatography (GC) analyses.

3. Volatile organic ground-water samples are collected so that air passage through the sample does not occur or is minimal (to prevent volatiles from being stripped from the samples): sample bottles are filled by slowly running the sample down the side of the bottle until there is a positive convex meniscus over the neck of the bottle; the Teflon side of the septum (in cap) is positioned against the meniscus, and the cap screwed on tightly; the sample is inverted and the bottle lightly tapped. The absence of an air bubble indicates a successful seal; if a bubble is evident, the cap is removed, more sample is added, and the bottle is resealed.

4. Extra Teflon seals are brought into the field in case seals are difficult to handle and/or are dropped. Dropped seals are considered contaminated and are not used. When replacing seals or if seals become flipped, care is taken to assure that the Teflon seal faces down.

Sample analysis methods, containers, preservatives and holding times are shown on Table 1.

Laboratory and field handling procedures of samples are monitored by including QC samples for analysis with every submitted sample lot from a project site. QC samples may include any combination of the following:

A. Trip Blank: Used for purgeable organic compounds only; QC samples are collected in 40 milliliter (ml) sample vials filled in the analytical laboratory with organic-free water. Trip blanks are sent to the project site, and travel with project site samples. Trip blanks are not opened, and are returned from a project site with the project site samples for analysis.

B. Field Blank: Prepared in the field using organic-free water. These QC samples accompany project site samples to the laboratory and are analyzed for specific chemical parameters unique to the project site where they were prepared.

C. Duplicates: Duplicated samples are collected "second samples" from a selected well and project site. They are collected as either split samples or second-run samples collected from the same well.

D. Equipment Blank: Periodic QC sample collected from field equipment rinsate to verify decontamination procedures.

The number and types of QC samples are determined as follows:

A. Up to 2 wells - Trip Blank Only

B. 2 to 5 Wells - 1 Field Blank and 1 Trip Blank

C. 5 to 10 Wells - 1 Field blank, 1 Trip Blank, and 1 Duplicate

D. More than 10 Wells - 1 Field Blank, 1 Trip Blank, and 1 Duplicate per each 12 wells

E. If sampling extends beyond one day, quality control samples will be collected for each day.

Additional QC is performed through ongoing and random reviews of duplicate samples to evaluate the precision of the field sampling procedures and analytical laboratory. Precision of QC data is accomplished by calculating the Relative Percent Difference (RPD). The RPD is evaluated to assess whether values are within an acceptable range (typically ± 20% of duplicate sample).

SAMPLE COLLECTION

This section describes the routine procedures followed by G-R while collecting ground-water samples for chemical analysis. These procedures include decontamination, water-level measurements, well purging, physical parameter measurements, sample collection, sample preservation, sample handling, and sample documentation. Critical sampling objectives for G-R are to:

1. Collect ground-water samples that are representative of the sampled matrix and,

2. Maintain sample integrity from the time of sample collection to receipt by the analytical laboratory.

Sample analyses methods, containers, preservation, and holding times are presented in Table 1.

Decontamination Procedures

All physical parameter measuring and sampling equipment are decontaminated prior to sample collection using Alconox or equivalent detergent followed by steam cleaning with deionized water. Any sampling equipment surfaces or parts that might absorb specific contaminants, such as plastic pump valves, impellers, etc., are cleaned in the same manner.

Sample bottles, bottle caps, and septa used for sampling volatile organics are thoroughly cleaned and prepared in the laboratory. Sample bottles, bottle caps, and septa are protected from all potential chemical contact before actual usage at a sample location.

During field sampling, equipment placed in a well are decontaminated before purging or sampling the next well. The equipment are decontaminated by cleaning with Alconox or equivalent detergent followed by steam cleaning with deionized water.

Water-Level Measurements

Prior to purging and sampling a well, the static-water levels are measured in all wells at a project site using an electric sounder and/or calibrated portable oil-water interface probe (Figure 4). Both static water-level and separate-phase product thickness are measured to the nearest ±0.01 foot. The presence of separate-phase product is confirmed using a clean, acrylic or polyvinylchloride (PVC) bailer, measured to the nearest ±0.01 foot with a decimal scale tape.

Water-Level Measurements (continued)

The monofilament line used to lower the bailer is replaced between wells with new line to preclude the possibility of cross-contamination. Field observations (e.g. well integrity, product color, turbidity, water color, odors, etc.) are noted on the G-R Well Sampling Field Data Sheet shown in Figure 4. Before and after each use, the electric sounder, interface probe and bailer are decontaminated by washing with Alconox or equivalent detergent followed by rinsing with deionized water to prevent cross-contamination.

As mentioned previously, water-levels are measured in wells with known or suspected lowest dissolved chemical concentrations to the highest dissolved concentrations.

Well Purging

Before sampling occurs, well casing storage water and interstitial water in the artificial sand pack will be purged using (1) a positive displacement bladder pump constructed of inert, non-wetting, Teflon and stainless steel, (2) a pneumatic-airlift pumping system, (3) a centrifigal pumping system, or (4) a Teflon or Stainless steel bailer (Figure 5). Methods of purging will be assessed based on well size, location, accessibility, and known chemical conditions. Individual well purge volumes are calculated from borehole volumes which take into account the sand packed interval in the well annular space. As a general rule, a minimum of 3 and a maximum of 10 borehole volumes will be purged. Wells which dewater or demonstrate slow recharge periods (i.e. low-yield wells) during purging activities may be sampled after fewer purging cycles. If a low-yield (low recovery) well is to be sampled, sampling will not take place until at least 80 percent of the previously measured water column has been replaced by recharge, or as per local requirements. Physical parameter measurements (temperature, pH, and specific conductance) are closely monitored throughout the well purging process and are used by the G-R sampling crew as indicators for assessing sufficient purging. Purging is continued until all three physical parameters have stabilized. Specific conductance (conductivity) meters are read to the nearest ± 10 umhos/cm, and are calibrated daily. pH meters are read to the nearest ± 0.1 pH units and are calibrated daily. Temperature is read to the nearest 0.1 degree F. Calibration of physical parameter meters will follow manufacturers specifications. Monitoring wells will be purged according to the protocol presented in Figure 5. Collected field data during purging activities will be entered on the G-R Well Sampling Field Data Sheet shown in Figure 4. Copies of the G-R Field Data Sheets will be reviewed by the G-R Sampling Manager for accuracy and completeness.

DOCUMENTATION

Sample Container Labels

Each sample container will be labeled by an adhesive label, noted in permanent ink immediately after the sample is collected. Label information will include:

Sample point designation (i.e. well number or code)

Sampler's identification

Project number

Date and time of collection

Type of preservation used

Well Sampling Data Forms

In the field, the G-R sampling crew will record the following information on the Well Sampling Data Sheet for each sample collected:

Project number

Client

Location

Source (i.e. well number)

Time and date

Well accessibility and integrity

Pertinent well data (e.g. depth, product thickness, static water-level, pH, specific conductance, temperature)

Calculated and actual purge volumes

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Chain-of-Custody

A Chain-of-Custody record (Figure 6) shall be completed and accompany every sample and every shipment of samples to the analytical laboratory in order to establish the documentation necessary to trace sample possession from time of collections. The record will contain the following information:

- Sample or station number or sample identification (ID)
- Signature of collector, sampler, or recorder
- Date and time of collection
- Place of collection
- Sample type
- Signatures of persons involved in chain of possession
- Inclusive dates of possession

Samples shall always be accompanied by a Chain-of-Custody record. When transferring the samples, the individual relinquishing and receiving the samples will sign, date, and note the time on the Chain-of-Custody record. G-R will be responsible for notifying the laboratory coordinator when and how many samples will be sent to the laboratory for analysis, and what types of analyses shall be performed.

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TABLE 1

SAMPLE ANALYSIS METHODS, CONTAINERS, PRESERVATIONS, AND HOLDING TIMES

Parameter	Analytical Method	Reporting Units	Container	Preservation	Maximum Holding Time
Total Petroleum Hydrocarbons (Gasoline)	EPA 8015 (modified)	mg/l ug/l	40 ml. vial glass, Teflon	cool, 4 C HCl to pH<2	14 days (maximum)
Benzene Toluene Ethylbenzene Xylenes (BTEX	EPA 8020	mg/l ug/l	50 ml. vial glass, Teflon lined septum	cool, 4 C HCl to pH<2	7 days (w/o preservative) 14 days (w preservative)
Oil & Grease	SM 503E	mg/l ug/l	1 l glass, Teflon lined septum	H2SO4 or HCl to pH<2	28 days (maximum)
Total Petroleum Hydrocarbons (Diesel)	EPA 8015 (modified)	mg/l ug/l	40 ml. vial glass, Teflon lined septum	cool, 4 C	14 days (maximum)
Halogented Volatile Organics (chlorinated solvents)	8010	mg/l ug/l	40 ml. vial glass, Teflon lined septum	cool, 4 C	14 days (maximum)
Non chlorinated solvents	8020	mg/l ug/l	40 ml. vial glass, Teflon lined septum	cool, 4 C HCl to pH<2	14 days (maximum)
Volatile Organics	8240	mg/l ug/l	40 ml. vial glass, Teflon lined septum	cool, 4 C HCl to pH<2	14 days (maximum)
Semi-Volatile Organics	8270	mg/l ug/l	1 l amber glass, Teflon lined septum	cool, 4 C	7 days extract 40 days (maximum to analyze)
Specific Conductance (Field test)		umhos/cm			
pH (Field test)		pH units			
Temperature (Field test)		Deg F			

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WELL SAMPLING FIELD DATA SHEET

FIGURE 4

COMPANY _____ JOB # _____

LOCATION _____ DATE _____

CITY _____ TIME _____

Well ID. _____ Well Condition _____

Well Diameter _____ in. Hydrocarbon Thickness _____ ft.

Total Depth _____ ft.

Depth to Liquid- _____ ft.

Volume Factor (VF)			
	2" = 0.17	6" = 1.50	12" = 5.80
	3" = 0.38	8" = 2.60	
	4" = 0.66	10" = 4.10	

(# of casing volumes) _____ x _____ x(VF) _____ = (Estimated Purge Volume) _____ gal.

Purging Equipment _____

Sampling Equipment _____

Starting Time _____ Purging Flow Rate _____ gpm.

(Estimated Purge Volume) _____ gal. / (Purging Flow Rate) _____ gpm. = (Anticipated Purging Time) _____ min.

Time	pH	Conductivity	Temperature	Volume

Did well dewater? _____ If yes, time _____ Volume _____

Sampling Time _____ Weather Conditions _____

Analysis _____ Bottles Used _____

Chain of Custody Number _____

COMMENTS _____

FIGURE 5

Monitoring Well Sampling Protocol Schematic

Sampling Crew Reviews Project Sampling Requirements/Schedule

↓

Field Decontamination and Instrumentation Calibration

↓

Check Integrity of Well (Inspect for Well Damage)

↓

Measure and Record Depth to Water and Total Well Depth (Electric Well Sounder)

↓

Check for Floating Product (Oil/Water Interface Probe)

Floating Product Present

↓

Confirm Product Thickness (Acrylic or PVC Bailer)

↓

Collect Free-Product Sample

↓

Dissolved Product Sample Not Required

↓

Record Data on Field Data Form

Floating Product Not Present

↓

Purge Volume Calculation

$V = \pi (r/12)^2 h(\_\%\ vol)(7.48) = \_\_\_$ /gallons

V = Purge volume (gallons)

π = 3.14159

h = Height of Water Column (feet)

r = Borehole radius (inches)

↓

Evacuate water from well equal to the calculated purge volume while monitoring groundwater stabilization indicator parameters (pH, conductivity, temperature) at intervals of one casing volume.

Well Dewaters after One Purge Volume (Low yield well)

↓

Well Recharges to 80% of Initial Measured Water Column Height in Feet within 24 hrs. of Evacuation.

↓

Measure Groundwater Stability Indicator Parameters (pH, Temperature, Conductivity)

↓

Collect Sample and Complete Chain-of-Custody

↓

Preserve Sample According to Required Chemical Analysis

↓

Transport to Analytical Laboratory

Well Readily Recovers

↓

Record Groundwater Stability Indicator Parameters from each Additional Purge Volume

Stability indicated when the following Criteria are met:

pH :	± 0.1 pH units
Conductivity:	± 10%
Temperature:	1.0 degrees F

Groundwater Stability Achieved

↓

Collect Sample and Complete Chain-of-Custody

↓

Preserve Sample According to Required Chemical Analysis

↓

Transport to Analytical Laboratory

Groundwater Stability Not Achieved

↓

Continue Purging Until Stability is Achieved

↓

Collect Sample and complete Chain-of-Custody

↓

Preserve Sample According to Required Chemical Analysis

↓

Transport to Analytical Laboratory

Chain of Custody
FIGURE 6

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COMPANY _____ JOB NO. _____

JOB LOCATION _____

ITY _____ PHONE NO. _____

UTHORIZED _____ DATE _____ P.O. NO. _____

SAMPLE ID	NO. OF CONTAINERS	SAMPLE MATRIX	DATE/TIME SAMPLED	ANALYSIS REQUIRED	SAMPLE CONDITION LAB ID

ELINQUISHED BY: RECEIVED BY:

ELINQUISHED BY: RECEIVED BY:

ELINQUISHED BY: RECEIVED BY LAB:

ESIGNATED LABORATORY: _____ DHS #: _____

EMARKS: _____

ATE COMPLETED _____ FOREMAN _____