August 26, 1997

QUARTERLY GROUNDWATER MONITORING REPORT
625 HEGENBERGER BLVD
OAKLAND, CALIFORNIA
AEI PROJECT NO. 2169

#360

8/26/97

Prepared For:

DIVERSIFIED INVESTMENT MANAGEMENT GROUP
400 OYSTERPOINT BLVD
SUITE 415
SOUTH SAN FRANCISCO, CALIFORNIA

Prepared By:

All Environmental, Inc.
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ALL ENVIRONMENTAL, INC.
Environmental Engineering & Construction

August 25, 1997

Mr. Barney Chan, Hazardous Materials Specialist
Alameda County Health Care Services Agency
Department of Environmental Health
1131 Harbor Bay Parkway, Rm 250
Alameda, CA 94502-6577

RE: Quarterly Groundwater Monitoring Report
Second Quarter of 1997
625 Hegenberger Road
Oakland, California
Project No. 2169

Dear Mr. Chan:

This Quarterly Groundwater Monitoring Report is submitted by All Environmental, Inc. (AEI) on the behalf of Diversified Investment and Management Corp., for the former fuel service station location at 625 Hegenberger Road, Oakland, California. AEI measured the depth to groundwater and collected water samples from five groundwater monitoring wells on July 3, 1997. This groundwater monitoring episode is being conducted to monitor groundwater contamination caused by the release of hydrocarbon fuels at the site and to measure various chemical parameters to judge the suitability of the site for groundwater bioremediation.

Background

In October, 1993, three underground storage tanks and related structures were removed from the site under the observation of Levine Fricke. Approximately 300 cubic yards (cy) of soil was excavated during the tank removal. Levine Fricke and Subsurface Consultants performed several shallow soil borings and installed six groundwater monitoring wells at the site. Results of the comprehensive soil investigation indicated that hydrocarbon contamination was present in elevated levels at the site.

The quarterly monitoring of the six monitoring wells was performed by Levine Fricke through January, 1995. AEI began monitoring the wells in October, 1995. In March 1996, AEI destroyed one of the wells (designated MW-24) in anticipation of excavation activities.

AEI excavated and aerated 1,600 cubic yards of contaminated soil in the spring and summer of 1996 as detailed in AEI's report, "Phase II Environmental Site Assessment" dated March 3, 1997. The excavation extended to the vadose zone, approximately 5 to 7 feet below ground surface (bgs). Figure 1 shows the areas excavated. AEI believes that

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contaminant concentrations remain within the soil at the site. The groundwater contamination should eventually attenuate to low levels. The site is currently being evaluated as a candidate for groundwater bioremediation to expedite the reduction of contamination. For this reason, measurements of dissolved oxygen and oxidation-reduction (redox) potential were collected during the current monitoring episode.

Summary of Activities

Well locations are also shown in Figure 1. The sampling procedure for each monitoring well involved measuring water levels, purging the wells, and collecting a water sample. The depth from the top of the well casing and the total well depth were measured prior to sampling with an electric water level indicator. The wells were purged and a groundwater sample was collected from each well using a battery powered submersible pump. Temperature, pH, dissolved oxygen, conductivity, oxidation-reduction (redox) potential, and turbidity were measured during the purging of the wells. AEI removed approximately 8 to 10 well volumes per well and, provided that the water quality parameters stabilized, a water sample was collected.

Water samples were poured slowly into laboratory-provided glass sampling containers, capped, and shipped on ice under proper chain of custody to McCampbell Analytical Inc. The samples were analyzed for Total Petroleum Hydrocarbons (TPH) as gasoline by EPA Method 5030/8015, benzene, toluene, ethylbenzene, and total xylenes (BTEX) by EPA Method 602, methyl tertiary butyl ether (MTBE), and TPH as diesel. AEI discontinued the analysis of samples for Total Petroleum Hydrocarbons as oil (TPHo) by EPA Methods 3510/8015 following the recommendations of the quarterly monitoring report dated March 20, 1996.

Additionally, McCampbell Analytical analyzed water samples from two of the wells for nitrate, sulfate, and phosphate.

Field Results

No free product was encountered during monitoring activities. Groundwater levels for July 3, 1997 range from 1.44 to 3.82 feet below mean sea level (msl). The groundwater level of MW-8 was well below the expected reading. AEI believe that MW-8 reacts more severely to tidal influences now that it is surrounded by a much more porous peagravel.

In calculating the groundwater flow direction and gradient AEI ignored MW-8. The groundwater flow direction appears to still be to the west and the gradient was calculated to be 0.006 ft/ft, which is slightly higher than gradients measured in past reports. Groundwater elevation data are summarized in Table 1 and shown in Figure 1. The groundwater elevation contours and the groundwater flow directions are shown in Figure 1. A summary of field parameters measured during sampling is presented in Table 2.

Groundwater Quality

In general, analysis of samples retrieved from wells MW-8 through MW-16 did not show a substantial increase or decrease in contamination levels. Contaminant concentrations did not change by a significant amount in relation to previous monitoring episodes. A summary of groundwater quality data, including available historic data, is presented in Table 3. Laboratory analysis data are presented in Appendix A.

A list of critical environmental factors affecting microbial activity for the biodegredation of hydrocarbon contamination is listed in Table 3-1 from EPA's handbook, "Ground Water Volume II: Methodology," dated July, 1991 included with this report in Appendix C. The table indicates that for hydrocarbon degradation to occur, a concentration of greater than 0.2 mg/L dissolved oxygen is typically required. This table also suggests that a redox potential of 50 mV or greater is conducive to biodegredation. The negative redox potential measured in the field would not be conducive to biodegredation. However, the levels pH and temperature do lie within the ranges favorable for microbial activity.

Conclusions / Recommendations

Contaminant concentrations appear to have stabilized in relation to the previous monitoring episode. AEI recommends continuing quarterly monitoring for TPH as gasoline, TPH as diesel, MTBE, and BTEX.

Oxygen deficient and strongly reducing conditions characterize the groundwater beneath the site. Bioactivity would be stimulated by increasing the concentration of dissolved oxygen. Additional oxygen would also raise the redox potential of groundwater and change the environment from reducing to oxidizing. Measurements of dissolved oxygen and redox potential should continue along with the other water quality parameters listed in Table 2.

Concentrations of nitrates were not detectable. As nitrogen is a necessary nutrient for bioremediation, the lack of nitrogen is inhibiting bioremediation. Phosphorous concentrations were low, but relatively little phosphorous is necessary for microbial activity.

Please do not hesitate to call either of the undersigned, if you have any questions.

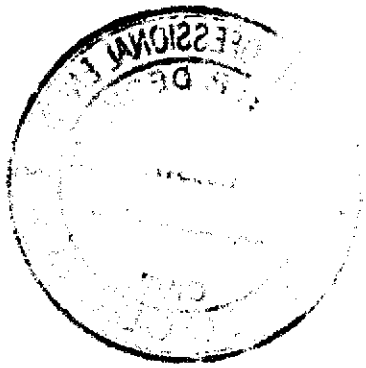
Sincerely,
All Environmental, Inc.

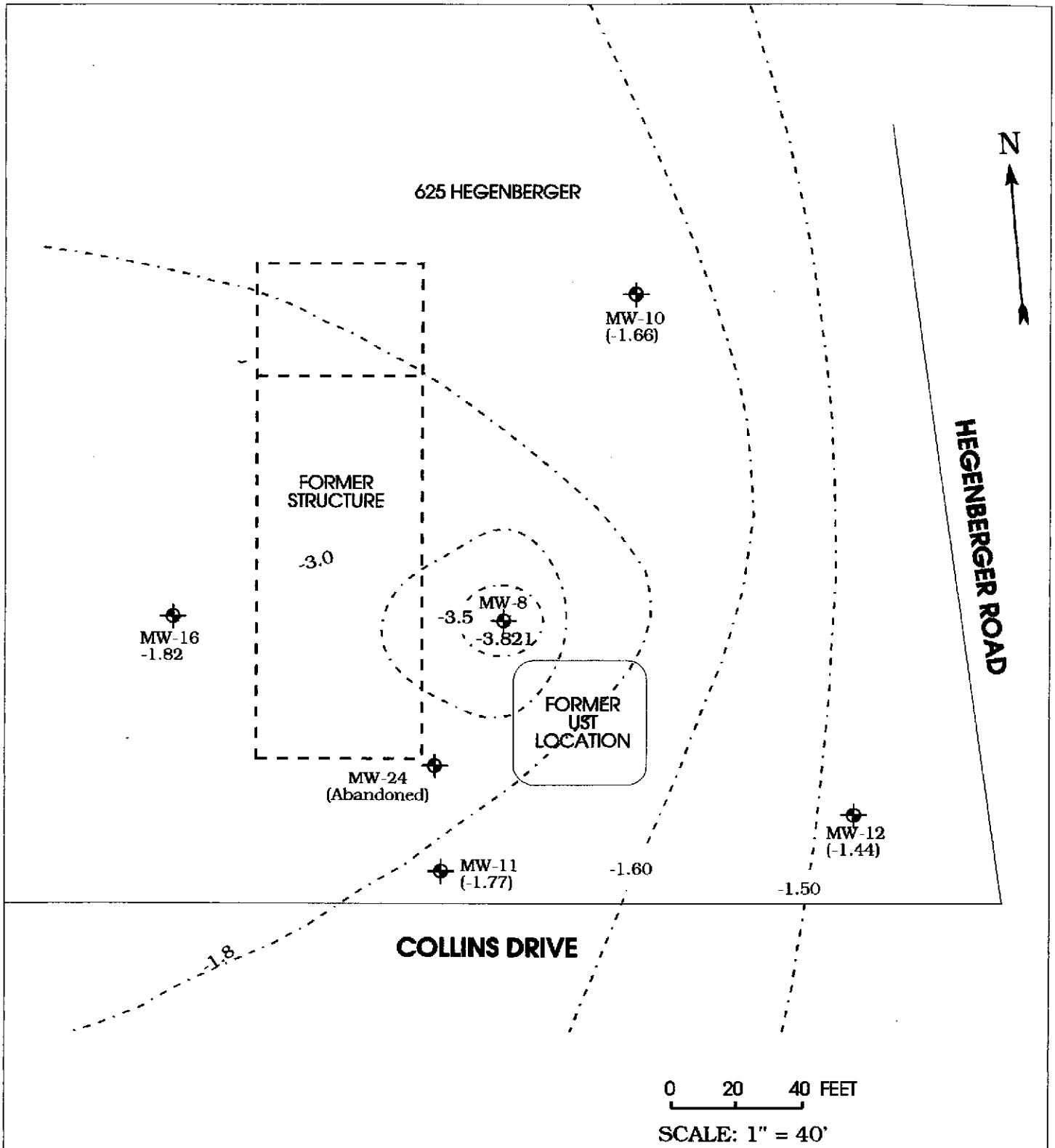
Bryan Campbell
Project Geologist

Joseph P. Derhake, PE, CAC
Senior Author

Attachments

cc: Dinesh Manner, Diversified Investment and Management Corp.
400 Oyster Point Boulevard, Suite 400, South San Francisco, CA 94080





Lines of Equal Groundwater Elevation (feet)

MW-8 Monitoring Well

ALL ENVIRONMENTAL, INC. 2641 CROW CANYON ROAD, SAN RAMON, CA		
DRAWN BY: E. OCHSNER		REVISED BY:
DATE: August 25, 1997		APPROVED BY:
POTENTIOMETRIC MAP		
625 Hegenberger Road, Oakland		FIGURE 1

Table 1
Groundwater Elevations
625 Hegenberger Road, Oakland, California

Well ID	Date	Well Elevation (ft msl)	Depth to Water (ft)	Groundwater Elevation (ft msl)
MW-8	12/22/93	4.88	6.72	-1.84
MW-10	12/22/93	4.21	6.00	-1.79
MW-11	12/22/93	5.04	6.84	-1.80
MW-12	12/22/93	4.58	6.07	-1.49
MW-16	12/22/93	5.53	7.48	-1.95
MW-8	6/30/94	4.88	6.55	-1.67
MW-10	6/30/94	4.21	5.79	-1.58
MW-11	6/30/94	5.04	6.73	-1.69
MW-12	6/30/94	4.58	6.06	-1.48
MW-16	6/30/94	5.53	7.28	-1.75
MW-8	9/27/94	4.88	7.20	-2.32
MW-10	9/27/94	4.21	6.39	-2.18
MW-11	9/27/94	5.04	7.41	-2.37
MW-12	9/27/94	4.58	6.57	-1.99
MW-16	9/27/94	5.53	7.93	-2.40
MW-8	1/4/95	4.88	6.21	-1.67
MW-10	1/4/95	4.21	5.42	-1.58
MW-11	1/4/95	5.04	6.45	-1.69
MW-12	1/4/95	4.58	5.50	-1.48
MW-16	1/4/95	5.53	7.03	-1.50
MW-8	1/10/95	4.88	5.09	-2.32
MW-10	1/10/95	4.21	4.67	-2.18
MW-11	1/10/95	5.04	5.72	-2.37
MW-12	1/10/95	4.58	4.46	-1.99
MW-16	1/10/95	5.53	6.21	-2.40
MW-24	1/10/95	5.49	5.97	-0.48
MW-8	10/2/95	4.88	7.66	-2.78
MW-10	10/2/95	4.21	6.87	-2.66
MW-11	10/2/95	5.04	7.85	-2.81
MW-12	10/2/95	4.58	6.99	-2.41
MW-16	10/2/95	5.53	8.40	-2.87
MW-24	10/2/95	5.49	8.31	-2.82
MW-8	1/8/96	4.88	7.45	-2.57
MW-10	1/8/96	4.21	6.82	-2.61
MW-11	1/8/96	5.04	7.91	-2.87
MW-12	1/8/96	4.58	6.65	-2.07
MW-16	1/8/96	5.53	8.23	-2.70
MW-24	1/8/96	5.49	8.08	-2.59
MW-8	4/25/96	4.88	7.32	-2.44
MW-10	4/25/96	4.21	7.48	-3.27
MW-11	4/25/96	5.04	7.51	-2.47
MW-12	4/25/96	4.58	6.56	-1.98
MW-16	4/25/96	5.53	8.06	-2.53
MW-8	3/25/97	4.88	6.75	-1.87
MW-10	3/25/97	4.21	5.83	-1.62
MW-11	3/25/97	5.04	6.83	-1.79
MW-12	3/25/97	4.58	6.03	-1.45
MW-16	3/25/97	5.53	7.35	-1.82
MW-8	7/3/97	4.88	8.70	-3.82
MW-10	7/3/97	4.21	5.87	-1.66
MW-11	7/3/97	5.04	6.83	-1.79
MW-12	7/3/97	4.58	6.03	-1.45
MW-16	7/3/97	5.53	7.35	-1.82

Notes:
All well elevations are measured from the top of casing.
ft msl = feet above mean sea level
NA = not available
All well elevation data was extracted from past Levine-Fricke reports.

Table 2
Water Quality Parameters
625 Hegenberger Road, Oakland, California

Well ID	Date	Well Volume (gallons)	Volume Withdrawn (gallons)	Well Volumes Withdrawn	Stabilized Temperature (deg. C)	Qualitative Tubidity	Stabilized pH	Stabilized Disolved Oxygen (mg/L)	Stabilized Redox Potential (mV)
MW-8	12/22/93	1.5	4.50	3.00	19.40	turbid*			
MW-10	12/22/93	1.6	7.00	4.38	20.80	moderately turbid			
MW-11	12/22/93	1.5	4.50	3.00	20.20	turbid			
MW-12	12/22/93	1.6	5.30	3.31	20.30	moderately turbid			
MW-16	12/22/93	1.1	4.50	4.09	20.50	turbid			
MW-8	6/30/94	1.5	8.00	5.33	21.00	turbid*			
MW-10	6/30/94	1.6	6.00	3.75	21.00	turbid			
MW-11	6/30/94	1.4	6.00	4.29	20.20	turbid			
MW-12	6/30/94	1.6	6.00	3.75	20.60	moderately turbid			
MW-16	6/30/94	1.1	4.50	4.09	21.80	turbid			
MW-8	9/27/94	1.4	4.50	3.21	21.60	turbid*			
MW-10	9/27/94	1.5	6.00	4.00	22.60	turbid			
MW-11	9/27/94	1.3	3.00	2.31	21.00	turbid			
MW-12	9/27/94	1.5	6.00	4.00	22.50	turbid			
MW-16	9/27/94	1.0	3.00	3.00	22.60	turbid			
MW-8	1/10/95	1.7	5.30	3.12	17.20	turbid*			
MW-10	1/10/95	1.8	6.00	3.33	19.50	turbid			
MW-11	1/10/95	1.6	5.30	3.31	18.60	turbid			
MW-12	1/10/95	1.8	6.00	3.33	19.30	turbid			
MW-16	1/10/95	1.2	6.00	5.00	19.30	turbid			
MW-24	1/10/95	4.9	41.00	8.37	18.90	turbid			
MW-8	10/2/95	1.1	11.00	10.00	22.80	moderately turbid	6.49		
MW-10	10/2/95	1.5	11.00	7.33	22.60	turbid	7.20		
MW-11	10/2/95	1.0	12.00	12.00	22.00	moderately turbid	6.85		
MW-12	10/2/95	1.3	11.00	8.46	22.90	turbid	7.20		
MW-16	10/2/95	1.1	11.00	10.00	22.60	turbid	7.20		
MW-24	10/2/95	3.4	20.00	5.88	22.80	turbid	7.10		
MW-8	1/8/96	1.1	12.00	10.91	17.30**	slightly turbid	6.74**		
MW-10	1/8/96	1.5	10.00	6.67	17.90**	slightly turbid	6.62**		
MW-11	1/8/96	1.0	5.50	5.50	17.60**	slightly turbid	6.65**		
MW-12	1/8/96	1.2	10.00	8.33	18.00**	slightly turbid	6.49**		
MW-16	1/8/96	0.9	5.00	5.56	19.00**	slightly turbid	7.50**		
MW-24	1/8/96	3.4	35.00	10.29	17.60**	slightly turbid	6.67**		
MW-8	4/25/96	1.1	5.00	4.55	21.11	clear	6.53		
MW-10	4/25/96	1.4	5.00	3.57	22.83	slightly turbid	6.70		
MW-11	4/25/96	1.1	5.50	5.00	21.39	clear	6.58		
MW-12	4/25/96	1.2	5.00	4.17	22.39	clear	6.50		
MW-16	4/25/96	1.2	5.00	4.17	25.33	slightly turbid	7.12		
MW-8	3/25/97	2.2	10.00	4.55	18.17	clear	6.67	0.23	-140.00
MW-10	3/25/97	3.4	12.00	3.57	19.72	slightly turbid	6.79	0.35	-131.00
MW-11	3/25/97	2.0	10.00	5.00	18.56	clear	6.64	0.19	-120.00
MW-12	3/25/97	2.4	10.00	4.17	18.44	clear	6.67	0.19	-79.00
MW-16	3/25/97	2.4	10.00	4.17	17.94	slightly turbid	7.02	0.10	-135.00
MW-8	7/3/97	1.1	12.00	10.91	19.58	clear	6.43	0.04	-99.00
MW-10	7/3/97	1.5	12.00	8.00	21.51	slightly turbid	6.67	0.17	-104.00
MW-11	7/3/97	1.4	12.00	8.57	19.38	clear	6.36	0.05	-84.00
MW-12	7/3/97	1.5	12.00	8.00	20.62	clear	6.50	0.10	-76.00
MW-16	7/3/97	1.0	12.00	12.00	19.66	clear	6.76	0.06	-103.00

Notes: * A slight hydrocarbon sheen was reported.
** Only one measurement collected.

TABLE 3
HISTORIC GROUNDWATER MONITORING DATA
625 HEGENBERGER ROAD
(concentrations in milligrams per liter) mg/L (ppm)

Well ID	Date	Consultant/ Lab		TPHg	MTBE	Benzene	Toluene		Ethyl-Benzene	Xylenes	TPHo	TPHd	Total Lead
MW-8	(1)	SUB	(2)	NA	NA	3.7	BDL		0.29	0.69	NA	NA	BDL
	5/28/93	HC/SUP		19	NA	6.4	0.028		0.16	0.036	NA	1	(3)
	12/22/93	LF/AEN	(4)	56	NA	16	5.9993	(5)	0.65	2.7	<0.2	0.3	<0.04
	6/30/94	LF/AEN	(4)	41	NA	11	4.8		2.2	8.2	0.5	<0.5	<0.04
	9/27/94	LF/AEN		28	NA	8.5	0.26		1.6	5.3	<0.2	0.62	<0.04
	1/10/95	LF/AEN		58	NA	10	11		2.4	12	<0.2	0.07	NA
	10/2/95	AEI/PEL		28	NA	0.051	0.016		0.054	0.08	<0.5	<0.05	NA
	1/8/96	AEI/MAI		72	NA	8.6	13		2.2	12	<0.25	3.7	NA
duplicate	1/8/96	AEI/MAI		62	NA	7.2	9.5		1.6	8	NA	NA	NA
	4/25/96	AEI/MAI		33	NA	7.6	2.3		1.5	4.8	NA	3.1	NA
	3/25/97	AEI/MAI		23	1.5	8.3	0.08		0.35	0.38	NA	1.9	NA
	7/3/97	AEI/MAI		14	1.3	6.6	0.032		0.19	0.1	NA	1.4	NA
duplicate	7/3/97	AEI/MAI		15	1.7	7.3	0.034		0.16	0.11	NA	1.4	NA
MW-10	(1)	SUB		NA	NA	0.0017	BDL		BDL	BDL	NA	NA	BDL
	5/28/93	HC/SUP		<0.05	NA	<0.0003	<0.0003		<0.0003	<0.0009	NA	0.054	(3)
	12/22/93	LF/AEN		<0.05	NA	<0.0005	<0.0007	(5)	<0.0005	<0.0002	<0.2	0.58	<0.04
	6/30/94	LF/AEN		<0.05	NA	<0.0005	<0.0005		<0.0005	<0.0002	0.6	<0.05	<0.04
	9/27/94	LF/AEN		<0.05	NA	<0.0005	<0.0005		<0.0005	<0.0002	<0.2	0.61	<0.04
	1/10/95	LF/AEN		<0.05	NA	<0.0005	<0.0005		<0.0005	<0.0002	<0.2	0.6	NA
	10/2/95	AEI/PEL		0.35	NA	0.0044	0.0026		0.0023	0.0064	<0.5	<0.05	NA
	1/8/96	AEI/MAI		0.05	NA	0.0058	0.0071		0.0012	0.0064	<0.25	<0.05	NA
	4/25/96	AEI/MAI		<0.05	NA	<0.0005	<0.0005		<0.0005	<0.0005	NA	<0.05	NA
	3/25/97	AEI/MAI		<0.05	<0.005	<0.0005	<0.0005		<0.0005	<0.0005	NA	<0.05	NA
	7/3/97	AEI/MAI		<0.05	<0.005	<0.0005	<0.0005		<0.0005	<0.0005	NA	<0.05	NA
MW-11	(1)	SUB	(6)	NA	NA	0.053	BDL		BDL	BDL	NA	NA	0.21
	5/28/93	HC/SUP		1.2	NA	0.45	0.017		0.0015	0.0021	NA	<0.05	(3)
	12/22/93	LF/AEN		9.2	NA	4.5	0.0383	(5)	0.012	0.043	<0.2	0.53	<0.04
	6/30/94	LF/AEN		8.8	NA	1.5	0.013		0.69	1.2	1.1	<0.05	<0.04
duplicate	6/30/94	LF/AEN		9.7	NA	1.7	0.014		0.73	1.3	NA	NA	NA
	9/27/94	LF/AEN		15	NA	6.5	0.026		0.87	0.59	<0.2	0.91	<0.04
	1/10/95	LF/AEN		14	NA	0.89	0.22		0.84	2.4	0.2	1.1	NA
	10/2/95	AEI/PEL		7.1	NA	0.047	0.0057		0.011	0.036	<0.5	<0.05	NA
	1/8/96	AEI/MAI		12	NA	1.2	0.099		0.79	1.4	<0.25	2	NA
	4/25/96	AEI/MAI		5.8	NA	0.23	0.059		0.2	0.77	NA	1.4	NA
	3/25/97	AEI/MAI		0.76	0.13	0.13	0.049		0.0029	0.001	NA	0.49	NA
	7/3/97	AEI/MAI		0.29	0.38	<0.0005	<0.0005		0.6	<0.0005	NA	<0.05	NA
MW-12	(1)	SUB		NA	NA	0.0017	BDL		BDL	BDL	NA	NA	BDL
	5/28/93	HC/SUP		<0.05	NA	<0.0003	<0.0003		<0.0003	<0.0009	NA	<0.05	(3)
	12/22/93	LF/AEN		0.05	NA	<0.0005	<0.0007	(5)	<0.0005	<0.0002	<0.2	0.3	<0.04
	6/30/94	LF/AEN		<0.05	NA	<0.0005	<0.0005		<0.0005	<0.0002	0.4	<0.05	<0.04
	9/27/94	LF/AEN		<0.05	NA	<0.0005	<0.0005		<0.0005	<0.0002	<0.2	0.4	<0.04
duplicate	9/27/94	LF/AEN		<0.05	NA	<0.0005	<0.0005		<0.0005	<0.0002	NA	NA	NA
	1/10/95	LF/AEN		<0.05	NA	<0.0005	<0.0005		<0.0005	<0.0002	<0.2	0.3	NA
	10/2/95	AEI/PEL		<0.05	NA	<0.0005	<0.0005		<0.0005	<0.0005	<0.5	<0.05	NA
	1/8/96	AEI/MAI		<0.05	NA	0.0024	0.0027		0.00054	0.0028	<0.25	<0.05	NA
	4/25/96	AEI/MAI		<0.05	NA	<0.0005	<0.0005		<0.0005	<0.0005	NA	<0.05	NA
	3/25/97	AEI/MAI		<0.05	16	<0.0005	<0.0005		<0.0005	<0.0005	NA	<0.05	NA
	7/3/97	AEI/MAI		<0.05	16	<0.0005	<0.0005		<0.0005	<0.0005	NA	<0.05	NA
MW-16	(1)	SUB	(7)	NA	NA	BDL	BDL		BDL	BDL	NA	NA	BDL
	5/28/93	HC/SUP		<0.05	NA	0.0028	<0.0003		<0.0007	<0.0009	NA	<0.05	(3)
	12/22/93	LF/AEN		2.2	NA	<0.0005	<0.0007	(5)	<0.0005	<0.0002	<0.2	0.52	<0.04
	6/30/94	LF/AEN		<0.05	NA	0.008	<0.0005		<0.0005	<0.0002	0.9	<0.05	<0.04
	9/27/94	LF/AEN		0.07	NA	0.017	<0.0005		<0.0005	<0.0002	<0.2	0.59	<0.04
	1/10/95	LF/AEN		0.3	NA	0.19	<0.0005		<0.0005	<0.0002	<0.2	0.7	NA
	10/2/95	AEI/PEL		0.55	NA	0.0077	0.0007		0.0035	0.013	<0.5	<0.05	NA
	1/8/96	AEI/MAI		0.36	NA	<0.0005	<0.0005		0.004	0.0097	<0.25	0.14	NA
	4/25/96	AEI/MAI		1.1	NA	0.39	0.0037		0.0032	0.014	NA	0.33	NA
	3/25/97	AEI/MAI		0.31	2.1	<0.0005	<0.0005		<0.0005	0.0014	NA	0.12	NA
	7/3/97	AEI/MAI		0.25	1.9	<0.0005	<0.0005		<0.0005	<0.0005	NA	0.13	NA
MW-24	1/10/95	LF/AEN		31	NA	12	1.9		1.1	1.3	0.2	0.9	NA
duplicate	1/10/95	LF/AEN		31	NA	12	2		1.1	1.3	0.2	0.8	NA
	10/2/95	AEI/PEL		8.6	NA	0.044	0.011		0.012	0.04	<0.5	<0.05	NA
	1/8/96	AEI/MAI	(8)	22	NA	8.8	0.14		0.5	0.28	<0.25	1.5	NA

TABLE 3
HISTORIC GROUNDWATER MONITORING DATA
625 HEGENBERGER ROAD
(concentrations in milligrams per liter)

Well ID	Date	Consultant/ Lab	TPHg	MTBE	Benzene	Toluene	Ethyl-Benzene	Xylenes	TPHo	TPHd	Total Lead
Blanks											
Trip Blank	5/28/93	HC/SUP	<0.05		<0.0003	<0.0003	<0.0003	<0.0009	NA	NA	BDL
MW-12-BB	12/22/93	LF/AEN	<0.05		<0.0005	0.0007	<0.0005	<0.0002	NA	NA	(3)
MW-16-BB	12/22/93	LF/AEN	NA		NA	NA	NA	NA	NA	NA	<0.04
MW-12-BB	6/30/94	LF/AEN	<0.05		<0.0005	<0.0005	<0.0005	<0.0002	NA	NA	<0.04
MW-12-BB	9/27/94	LF/AEN	<0.05		<0.0005	<0.0005	<0.0005	<0.0002	NA	NA	NA
Trip Blank	9/27/94	LF/AEN	<0.05		<0.0005	<0.0005	<0.0005	<0.0002	NA	NA	NA
MW-11-BB	1/10/95	LF/AEN	<0.05		<0.0005	<0.0005	<0.0005	<0.0002	NA	NA	NA

Notes

BDL	below detection limit
NA	not analyzed
NS	not sampled
TPHd	total petroleum hydrocarbons as diesel
TPHg	total petroleum hydrocarbons as gasoline
TPHo	total petroleum hydrocarbons as oil
MTBE	methyl tertiary butyl ether
AEN	American Environmental Networks, Pleasant Hill, California
HC	HartCrowser, San Francisco, California
LF	Levine Fricke, Emeryville, California
SUB	Subsurface Consultants, Oakland, California
SUP	Superior Analytical Laboratories, Martinez, California
AEI	All Environmental, Inc., San Ramon, California
PEL	Priority Analytical Laboratories, Milpitas, California
MAI	McCampbell Analytical Inc., Pacheco, California

(1) Date of groundwater sampling unavailable.
(2) 18 mg/ total volatile hydrocarbons also detected
(3) All May 1993 samples also analyzed for total organic lead (DHS Method). The compound was not detected above the detection limit of 4 mg/l.
(4) A slight hydrocarbon sheen was observed on the surface of the well water.
(5) Toluene detection for 22-Dec-93 were qualified using 0.0007 mg/l as a baseline. The bailer blank (MW-12-BB) contained toluene at 0.0007 mg/l.
(6) 0.24 mg/l total volatile hydrocarbons also detected
(7) 0.38 mg/l total volatile hydrocarbons also detected
(8) Well Mw-8 was abandoned on April 5, 1996.

Table 4
Nutrient Concentrations
625 Hegenberger Road, Oakland, California

Well ID	Date	Sulfate (Method 300) (mg/L)	Phosphate (Method 365.2) (mg/L)	Nitrate (Method 300) (mg/L)	Total Kjeldhal Nitrogen Method (350.3) (mg/L)
MW-8	12/22/93	82.00	1.80	ND	ND
MW-10	12/22/93	NA	NA	NA	NA
MW-11	12/22/93	1.00	1.30	ND	ND
MW-12	12/22/93	NA	NA	NA	NA
MW-16	12/22/93	NA	NA	NA	NA

Notes: NA = Not Analyzed
ND = Not Detected

APPENDIX A

FIELD DATA SHEETS

ALL ENVIRONMENTAL INC. - GROUNDWATER MONITORING WELL FIELD SAMPLING FORM

Monitoring Well Number: MW-8

Project Name: Hegenberger	Date of Sampling: 7/3/97
Job Number: 2169	Name of Sampler: Dusty Roy
Project Address: 625 Hegenberger Road	Oakland, CA

MONITORING WELL DATA

Well Casing Diameter (2"/4"/6")	2"
Seal at Grade -- Type and Condition	
Well Cap & Lock -- OK/Replace	
Elevation of Top of Casing	4.88
Depth of Well	
Depth to Water	8.70
Water Elevation	-3.82
Three Well Volumes (gallons)*	
2" casing: (TD - DTW)(0.16)(3)	
4" casing: (TD - DTW)(0.65)(3)	
6" casing: (TD - DTW)(1.44)(3)	
Actual Volume Purged (gallons)	12
Appearance of Purge Water	Clear

GROUNDWATER SAMPLES

Number of Samples/Container Size	2 X 40 ml VOAs; 2 X 1 liter

Time	Vol Remvd (gal)	Temp C	pH	Cond (mS)	Dissolved Oxygen (mg/L)	Redox Potential (mV)
	2	19.71	6.41	6537	0.08	-84
	4	19.63	6.41	6621	0..06	-88
	6	19.59	6.42	6696	0.05	-92
	8	19.58	6.42	6721	0.05	-95
	9	19.58	6.43	6732	0.04	-97
	10	19.58	6.43	6734	0.04	-97
	11	19.58	6.43	6669	0.04	-99
	12	19.58	6.43	6734	0.04	-99

COMMENTS (i.e., sample odor, well recharge time & percent, etc.)

TD - Total Depth of Well
DTW - Depth To Water

ALL ENVIRONMENTAL INC. – GROUNDWATER MONITORING WELL FIELD SAMPLING FORM

Monitoring Well Number: MW-10

Project Name: Hegenberger	Date of Sampling: 7/3/97
Job Number: 2169	Name of Sampler: Dusty Roy
Project Address: 625 Hegenberger Road	Oakland, CA

MONITORING WELL DATA

Well Casing Diameter (2"/4"/6")	2"
Seal at Grade -- Type and Condition	
Well Cap & Lock – OK/Replace	
Elevation of Top of Casing	4.21
Depth of Well	
Depth to Water	5.87
Water Elevation	-1.66
Three Well Volumes (gallons)*	
2" casing: (TD – DTW)(0.16)(3)	4.7
4" casing: (TD – DTW)(0.65)(3)	
6" casing: (TD – DTW)(1.44)(3)	
Actual Volume Purged (gallons)	12
Appearance of Purge Water	Greenish

GROUNDWATER SAMPLES

Number of Samples/Container Size	2 X 40 ml VOAs; 2 X 1 liter

Time	Vol Remvd (gal)	Temp C	pH	Cond (mS)	Dissolved Oxygen (mg/L)	Redox Potential (mV)
	2	21.44	6.68	3887	0.29	-58
	4	21.45	6.67	3930	0.23	-71
	6	21.47	6.67	3946	0.20	-79
	8	21.48	6.67	3813	0.18	-96
	9	21.49	6.67	3760	0.18	-98
	10	21.50	6.67	3549	0.18	-100
	11	21.50	6.67	3786	0.18	-102
	12	21.51	6.67	3657	0.17	-104

COMMENTS (i.e., sample odor, well recharge time & percent, etc.)

TD - Total Depth of Well
DTW - Depth To Water

ALL ENVIRONMENTAL INC. – GROUNDWATER MONITORING WELL FIELD SAMPLING FORM

Monitoring Well Number: MW-11

Project Name: Hegenberger	Date of Sampling: 7/3/97
Job Number: 2169	Name of Sampler: Dusty Roy
Project Address: 625 Hegenberger Road	Oakland, CA

MONITORING WELL DATA

Well Casing Diameter (2"/4"/6")	2"
Seal at Grade -- Type and Condition	
Well Cap & Lock – OK/Replace	
Elevation of Top of Casing	5.04
Depth of Well	
Depth to Water	6.81
Water Elevation	-1.77
Three Well Volumes (gallons)*	
2" casing: (TD – DTW)(0.16)(3)	4.1
4" casing: (TD – DTW)(0.65)(3)	
6" casing: (TD – DTW)(1.44)(3)	
Actual Volume Purged (gallons)	12
Appearance of Purge Water	

GROUNDWATER SAMPLES

Number of Samples/Container Size	2 X 40 ml VOAs; 2 X 1 liter

Time	Vol Remvd (gal)	Temp C	pH	Cond (mS)	Dissolved Oxygen (mg/L)	Redox Potential (Mv)
	2	20.99	6.45	2530	0.12	-52
	3	19.80	6.44	2415	0.09	-59
	4	19.64	6.40	2341	0.07	-70
	6	19.48	6.38	2304	0.06	-74
	8	19.44	6.36	2289	0.05	-74
	9	19.42	6.36	2240	0.05	-79
	10	19.40	6.36	2239	0.05	-82
	11	19.38	6.36	2250	0.05	-83
	12	19.38	6.36	2246	0.05	-84

COMMENTS (i.e., sample odor, well recharge time & percent, etc.)

TD - Total Depth of Well
DTW - Depth To Water

ALL ENVIRONMENTAL INC. - GROUNDWATER MONITORING WELL FIELD SAMPLING FORM

Monitoring Well Number: MW-12

Project Name: Hegenberger	Date of Sampling: 7/3/97
Job Number: 2169	Name of Sampler: Dusty Roy
Project Address: 625 Hegenberger Road	Oakland, CA

MONITORING WELL DATA

Well Casing Diameter (2"/4"/6")	2"
Seal at Grade – Type and Condition	
Well Cap & Lock – OK/Replace	
Elevation of Top of Casing	4.58
Depth of Well	
Depth to Water	6.02
Water Elevation	-1.44
Three Well Volumes (gallons)*	
2" casing: (TD – DTW)(0.16)(3)	4.6
4" casing: (TD – DTW)(0.65)(3)	
6" casing: (TD – DTW)(1.44)(3)	
Actual Volume Purged (gallons)	
Appearance of Purge Water	

GROUNDWATER SAMPLES

Number of Samples/Container Size	2 X 40 ml VOAs; 2 X 1 liter

Time	Vol Remvd (gal)	Temp C	pH	Cond (mS)	Dissolved Oxygen (mg/L)	Redox Potential (mV)
	2	20.77	6.51	2481	0.22	-68
	4	20.77	6.50	2461	0.15	-70
	6	20.77	6.50	2469	0.13	-74
	8	20.66	6.50	2437	0.13	-74
	9	20.64	6.50	2446	0.12	-75
	10	20.63	6.50	2481	0.12	-75
	11	20.60	6.50	2499	0.11	-76
	12	20.77	6.50	2503	0.11	-76

COMMENTS (i.e., sample odor, well recharge time & percent, etc.)

TD - Total Depth of Well
DTW - Depth To Water

ALL ENVIRONMENTAL INC. - GROUNDWATER MONITORING WELL FIELD SAMPLING FORM

Monitoring Well Number: MW-16

Project Name: Hegenberger	Date of Sampling: 7/3/97
Job Number: 2169	Name of Sampler: Dusty Roy
Project Address: 625 Hegenberger Road	Oakland, CA

MONITORING WELL DATA

Well Casing Diameter (2"/4"/6")	2"
Seal at Grade -- Type and Condition	
Well Cap & Lock – OK/Replace	
Elevation of Top of Casing	5.53
Depth of Well	
Depth to Water	7.35
Water Elevation	-1.82
Three Well Volumes (gallons)*	
2" casing: (TD – DTW)(0.16)(3)	3.0
4" casing: (TD – DTW)(0.65)(3)	
6" casing: (TD - DTW)(1.44)(3)	
Actual Volume Purged (gallons)	12
Appearance of Purge Water	

GROUNDWATER SAMPLES

Number of Samples/Container Size	2 X 40 ml VOAs; 2 X 1 liter

Time	Vol Remvd (gal)	Temp C	pH	Cond (mS)	Dissolved Oxygen (mg/L)	Redox Potential (mV)
	2	19.92	6.80	3412	0.27	-78
	4	19.74	6.77	3480	0.16	-89
	6	19.68	6.76	3577	0.12	-94
	8	19.67	6.76	3578	0.08	-98
	10	19.66	6.76	3574	0.07	-99
	12	19.66	6.76	3575	0.07	-101

COMMENTS (i.e., sample odor, well recharge time & percent, etc.)

TD - Total Depth of Well
DTW - Depth To Water

APPENDIX B

LABORATORY DATA

McCAMPBELL ANALYTICAL INC.
110 Second Avenue South, #D7, Pacheco, CA 94553
Telephone : 510-798-1620 Fax : 510-798-1622
http://www.mccampbell.com E-mail: main@mccampbell.com

All Environmental, Inc. 3364 Mt. Diablo Blvd. Lafayette, CA 94549	Client Project ID: #2-169; Hegenberger	Date Sampled: 07/02/97
		Date Received: 07/03/97
	Client Contact: Bryan Campbell	Date Extracted: 07/07/97
	Client P.O:	Date Analyzed: 07/07/97

Diesel Range (C10-C23) Extractable Hydrocarbons as Diesel *

EPA methods modified 8015, and 3550 or 3510; California RWQCB (SF Bay Region) method GCFID(3550) or GCFID(3510)

Lab ID	Client ID	Matrix	TPH(d)[1]	% Recovery Surrogate
78346	MW-8	W	1400,d	101
78347	MW-9	W	1300,d	101
78348	MW-10	W	ND	97
78349	MW-11	W	250,d,b	101
78350	MW-12	W	ND	100
78351	MW-16	W	130,d,b	100
Reporting Limit unless otherwise stated; ND means not detected above the reporting limit		W	50 ug/L	
		S	1.0 mg/kg	

* water and vapor samples are reported in ug/L, wipe samples in ug/wipe, soil and sludge samples in mg/kg, and all TCLP / STLC / SPLP extracts in ug/L

cluttered chromatogram resulting in coeluted surrogate and sample peaks, or; surrogate peak is on elevated baseline, or; surrogate has been diminished by dilution of original extract.

[1]The following descriptions of the TPH chromatogram are cursory in nature and McCampbell Analytical is not responsible for their interpretation: a) unmodified or weakly modified diesel is significant; b) diesel range compounds are significant; no recognizable pattern; c) aged diesel? is significant); d) gasoline range compounds are significant; e) medium boiling point pattern that does not match diesel (?); f) one to a few isolated peaks present; g) oil range compounds are significant; h) lighter than water immiscible sheen is present; i) liquid sample that contains greater than ~5 vol. % sediment.

DHS Certification No. 1644

Edward Hamilton, Lab Director

McCAMPBELL ANALYTICAL INC.
110 Second Avenue South, #D7, Pacheco, CA 94553
Telephone : 510-798-1620 Fax : 510-798-1622
http://www.mccampbell.com E-mail: main@mccampbell.com

All Environmental, Inc.	Client Project ID: #2-169; Hegenberger	Date Sampled: 07/02/97
3364 Mt. Diablo Blvd.		Date Received: 07/03/97
Lafayette, CA 94549	Client Contact: Bryan Campbell	Date Extracted: 07/07-07/08/97
	Client P.O:	Date Analyzed: 07/07-07/08/97

Gasoline Range (C6-C12) Volatile Hydrocarbons as Gasoline*, with Methyl tert-Butyl Ether* & BTEX*

EPA methods 5030, modified 8015, and 8020 or 602; California RWQCB (SF Bay Region) method GCFID(5030)

Lab ID	Client ID	Matrix	TPH(g)^	MTBE	Benzene	Toluene	Ethylben-zene	Xylenes	% Recovery Surrogate
78346	MW-8	W	14,000,a	1300	6600	32	190	100	103
78347	MW-9	W	15,000,a	1700	7300	34	160	110	104
78348	MW-10	W	ND	ND	ND	ND	ND	ND	105
78349	MW-11	W	290,b,j	380	ND	ND	0.60	ND	101
78350	MW-12	W	ND	16	ND	ND	ND	ND	106
78351	MW-16	W	250,j	1900	ND	ND	ND	ND	102
Reporting Limit unless otherwise stated; ND means not detected above the reporting limit		W	50 ug/L	5.0	0.5	0.5	0.5	0.5	
		S	1.0 mg/kg	0.05	0.005	0.005	0.005	0.005	

* water and vapor samples are reported in ug/L, wipe samples in ug/wipe, soil and sludge samples in mg/kg, and all TCLP and SPLP extracts in ug/L

^ cluttered chromatogram; sample peak coelutes with surrogate peak

"The following descriptions of the TPH chromatogram are cursory in nature and McCampbell Analytical is not responsible for their interpretation: a) unmodified or weakly modified gasoline is significant; b) heavier gasoline range compounds are significant(aged gasoline?); c) lighter gasoline range compounds (the most mobile fraction) are significant; d) gasoline range compounds having broad chromatographic peaks are significant; biologically altered gasoline?; e) TPH pattern that does not appear to be derived from gasoline (?); f) one to a few isolated peaks present; g) strongly aged gasoline or diesel range compounds are significant; h) lighter than water immiscible sheen is present; i) liquid sample that contains greater than ~5 vol. % sediment; j) no recognizable pattern.

DHS Certification No. 1644

Edward Hamilton, Lab Director

McCAMPBELL ANALYTICAL INC.
110 2nd Avenue South, #D7, Pacheco, CA 94553
Tele: 510-798-1620 Fax: 510-798-1622

QC REPORT FOR HYDROCARBON ANALYSES

Date: 07/07/97 Matrix: Water

Analyte	Concentration (mg/L) Sample #(78290)	MS	MSD	Amount Spiked	% Recovery MS	MSD	RPD
TPH (gas)	0.0	95.5	92.6	100.0	95.5	92.6	3.0
Benzene	0.0	9.7	9.4	10.0	97.0	94.0	3.1
Toluene	0.0	10.3	10.0	10.0	103.0	100.0	3.0
Ethyl Benzene	0.0	10.6	10.2	10.0	106.0	102.0	3.8
Xylenes	0.0	31.7	30.6	30.0	105.7	102.0	3.5
TPH (diesel)	0	151	146	150	101	98	3.5
TRPH (oil & grease)	N/A	N/A	N/A	N/A	N/A	N/A	N/A

% Rec. = (MS - Sample) / amount spiked x 100

RPD = (MS - MSD) / (MS + MSD) x 2 x 100

McCAMPBELL ANALYTICAL INC.
110 2nd Avenue South, #D7, Pacheco, CA 94553
Tele: 510-798-1620 Fax: 510-798-1622

QC REPORT FOR HYDROCARBON ANALYSES

Date: 07/08/97 Matrix: Water

Analyte	Concentration (mg/L) Sample #(78348)	MS	MSD	Amount Spiked	% Recovery MS	MSD	RPD
TPH (gas)	0.0	89.5	95.2	100.0	89.5	95.2	6.2
Benzene	0.0	9.4	9.6	10.0	94.0	96.0	2.1
Toluene	0.0	9.8	10.1	10.0	98.0	101.0	3.0
Ethyl Benzene	0.0	10.0	10.4	10.0	100.0	104.0	3.9
Xylenes	0.0	30.0	31.2	30.0	100.0	104.0	3.9
TPH (diesel)	0	153	147	150	102	98	3.7
TRPH (oil & grease)	0	23.5	23.8	23.7	99	100	1.3

% Rec. = (MS - Sample) / amount spiked x 100

RPD = (MS - MSD) / (MS + MSD) x 2 x 100

Chain of C' stody

ALL E.)IRONMENTAL, INC.
3364 Mt. Diablo Boulevard
Lafayette, CA 94549
(510) 283-6000 FAX: (510) 283-6121

DATE: 7/3/97 PAGE: 1 OF: 1

8980 XALE 170

AEI PROJECT MANAGER: Bryan Campbell
PROJECT NAME: Hegenberger
PROJECT NUMBER: 2-169
SIGNATURE: [signature]
TOTAL # OF CONTAINERS: 34
RECD. GOOD COND./COLD: yes

ANALYSIS REQUEST

SAMPLE I.D.	DATE	TIME	MATRIX	TPH-Gasoline (EPA 5030/8015)	TPH-Gasoline (EPA 5030/8015) w/ BTEX and MTBE (EPA 602/8020)	TPH-Diesel (EPA 3510/3550/8015)	PURGEABLE AROMATICS BTEX and MTBE (EPA 602/8020)	TOTAL OIL & GREASE (EPA 5520 E&F)	TOTAL LEAD (AA) (EPA 7420)	VOLATILE ORGANIC COMPOUNDS (EPA 8240)	LUFT Metals (EPA 7130,7190,7420,7520,7950)	STLC CAM 17 (EPA 1310/6010)	RCI REACTIVITY, CORROSIVITY, IGNITABILITY (Title 22, CCR 66261.21-3)	Sulfate, phosphates	Nitrate TKN		NUMBER OF CONTAINERS	
MW-8	7/2/97		Water		X	X								X	X		9	78346
MW-9	↓		↓		X	X											4	78347
MW-10	↓		↓		X	X								X	X		9	78348
MW-11	↓		↓		X	X											4	78349
MW-12	↓		↓		X	X											4	78350
MW-14	↓		↓		X	X											4	78351

samples on Hold until 7/7/97

ICE/T° ✓ PRESERVATION ✓ VOAS O&G METALS OTHER
GOOD CONDITION ✓ APPROPRIATE
HEAD SPACE ABSENT ✓ CONTAINERS ✓

ANALYTICAL LAB: McCampbell
ADDRESS:
PHONE: ( ) FAX: ( )
INSTRUCTIONS/COMMENTS:

RELINQUISHED BY: 1	RECEIVED BY: 1	RELINQUISHED BY: 2	RECEIVED BY: 2
[signature] Signature	[signature] Signature	Signature	Signature
Dustin Roy Printed Name	H. Rieca Printed Name	Printed Name	Printed Name
AEI Company	MAI Company	Company	Company
Time 5:20pm Date 7/3/97	Time 5:20 Date 7/3/97	Time Date	Time Date

TOTAL P.17

GeoAnalytical Laboratories, Inc.

1405 Kansas Avenue
Modesto, CA 95351

Phone (209) 572-0900
FAX (209) 572-0916

CERTIFICATE OF ANALYSIS

Report # I189-04
McCampbell Analytical
110 2nd Avenue #D7
Pacheco CA 94553

Date of Report: 07/15/97
Date Received: 07/08/97
Date Started: 07/08/97
Date Completed: 07/15/97

Project Name: A-Hegenberger

Project # 8980

Sample ID	Lab ID	Detection Limit	Method	Analyte	Results	Units mg/L
MW-8	I33360	1	300	Sulfate	82	
		0.01	365.2	Phosphate	1.8	
		0.5	350.3	Total Kjeldhal Nitrogen	ND	
MW-11	I33361	1	300	Sulfate	1	
		0.01	365.2	Phosphate	1.3	
		0.5	350.3	Total Kjeldhal Nitrogen	ND	

Ramiro Salgado
Chemist

Certification # 1157

Donna Keller
Laboratory Director

1405 Kansas Avenue
Modesto, CA 95351

Phone (209) 572-0900
FAX (209) 572-0916

CERTIFICATE OF ANALYSIS

Report # I190-01
McCampbell Analytical
110 2nd Avenue #D7
Pacheco CA 94553

Date of Report: 07/14/97
Date Received: 07/09/97
Date Started: 07/09/97
Date Completed: 07/14/97

Project Name: A-Hegenberger

Project # 8981

Sample ID	Lab ID	Detection Limit	Method	Analyte	Results	Units mg/L
MW-8	I33372	1.0	300	Nitrate	ND	
MW-11	I33373	1.0	300	Nitrate	ND	

Ramiro Salgado
Chemist

Certification # 1157

Donna Keller
Laboratory Director

60

I189-04

McCAMPBELL ANALYTICAL

110 2nd AVENUE, # D7
PACHECO, CA 94553

(510) 798-1620 FAX (510) 798-1622

CHAIN OF CUSTODY RECORD

TURN AROUND TIME: ☐ RUSH ☐ 24 HOUR ☐ 48 HOUR ☒ 5 DAY ☐ ROU

REPORT TO: Ed HAMILTON BILL TO: MAI

PROJECT NUMBER: 8980 PROJECT NAME: A- Hegenberger

PROJECT LOCATION:

SAMPLE ID	LOCATION	SAMPLING DATE	SAMPLING TIME	# CONTAINERS	TYPE CONTAINERS	MATRIX: WATER	SOIL	AIR	SLUDGE	OTHER	METHOD PRESERVED: HCL	HNO_3	ICE	OTHER	ANALYSIS REQUEST: EPA 601/8010	EPA 602/8020	EPA 608/8080	EPA 608/8080 – PCBs Only	EPA 624/8240/8260	EPA 625/8270	CAM – 17 Metals	EPA – Priority Pollutant Metals	LUFT Metals	LEAD (7240/7421/239.2/6010)	ORGANIC LEAD	RCI	OTHER: SULFATE	Phosphate	TKN	COMMENTS
MW-8		7/2/97		4	500 ml poly	X							X										33360			X	X	X	7834
MW-11		"		4	"	X							X										33361			X	X	X	7834

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
Ruth Rivera	7/7/97		Judy Ongera 7/8/97
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
RELINQUISHED BY:	DATE	TIME	RECEIVED BY LABORATORY:

REMARKS: 9:00AM

AUG-07-1997 16:26 AEI 15102836121 P.08

APPENDIX C

BIOREMEDIATION PARAMETERS

Environmental Factor	Optimum Levels
Available soil water	25-85% of water holding capacity; -0.01 MPa
Oxygen	Aerobic metabolism: Greater than 0.2 mg/l dissolved oxygen, minimum air-filled pore space of 10% by volume; Anaerobic metabolism: O_2 concentrations less than 1% by volume
Redox potential	Aerobes & facultative anaerobes: greater than 50 millivolts; Anaerobes: less than 50 millivolts
pH	pH values of 5.5 - 8.5
Nutrients	Sufficient nitrogen, phosphorus, and other nutrients so as to not limit microbial growth (Suggested C:N:P ratio of 120:10:1)
Temperature	15 - 45° C (Mesophiles)

Table 3-1. Critical Environmental Factors for Microbial Activity (Sims and others, 1984; Huddleston and others, 1986; Paul and Clark, 1989)