STID 4020
CS

ENVIRONMENTAL
RESTORATION
CAMBRIA
99 AUG 23 PM 3:25

To:	Mr. Tom Peacock
Organization:	ACDEH
Address:	1131 Harbor Bay Pkwy., 2nd Floor
	Alameda, CA 94502
Phone:	510-567-6782

From:	Bob Schultz
Phone:	(510) 420-3341
Date:	August 19, 1999
Re:	Remedial Evaluation/Workplan

Transmittal

Dear Mr. Peacock:

Please find our Remedial Evaluation Report and Revised Remedial Workplan enclosed. If you have any questions or comments, please do not hesitate to call me at (510) 420-3341.

Thank you,

Bob Schultz

Bob Schultz

Cambria Environmental Technology, Inc. 1144 65th Street Suite B Oakland CA 94608 Tel (510) 420-0700 Fax (510) 420-9170

CAMBRIA

August 13, 1999

Mr. Lee Douglas
Douglas Parking
1721 Webster Street
Oakland, California 94612

Re: **Remedial Evaluation and Revised Remedial Workplan**
Douglas Parking
1721 Webster Street
Oakland, California
Cambria Project# 580-0197

Dear Mr. Douglas:

This report evaluates the remedial work performed over a 6 week period in early 1999. The remedial work involved injecting hydrogen peroxide into site groundwater monitoring wells as proposed in our November 11, 1998 *Remedial Workplan*. **Because the hydrogen peroxide injection did not significantly decrease dissolved hydrocarbon concentrations, this report presents a revised remedial approach (biosparging) for the subject site.**

REMEDIAL EVALUATION (H_2O_2 INJECTION)

Cambria's November 11, 1998 remedial workplan evaluated several remedial alternatives and proposed hydrogen peroxide injection as the most cost-effective remedial approach. The goal of the hydrogen peroxide injection was to increase the levels of dissolved oxygen (DO) in site groundwater to stimulate hydrocarbon biodegradation, and to chemically oxidize residual hydrocarbons within the immediate vicinity of the former site underground storage tanks (USTs).

Hydrogen Peroxide Injection Procedures

Over the six week period from February 8 to March 17, 1999, Cambria added a total of 120 gallons of 7.5% hydrogen peroxide solution to site groundwater via site monitoring wells MW-2 and MW-3. The hydrogen peroxide injection dates and volumes of hydrogen peroxide injected into each well are presented in Table A below.

Oakland, CA
Sonoma, CA
Portland, OR
Seattle, WA

Cambria Environmental Technology, Inc.

1144 65th Street
Suite B
Oakland, CA 94608
Tel (510) 420-0700
Fax (510) 420-9170

Table A - Hydrogen Peroxide Injection Events

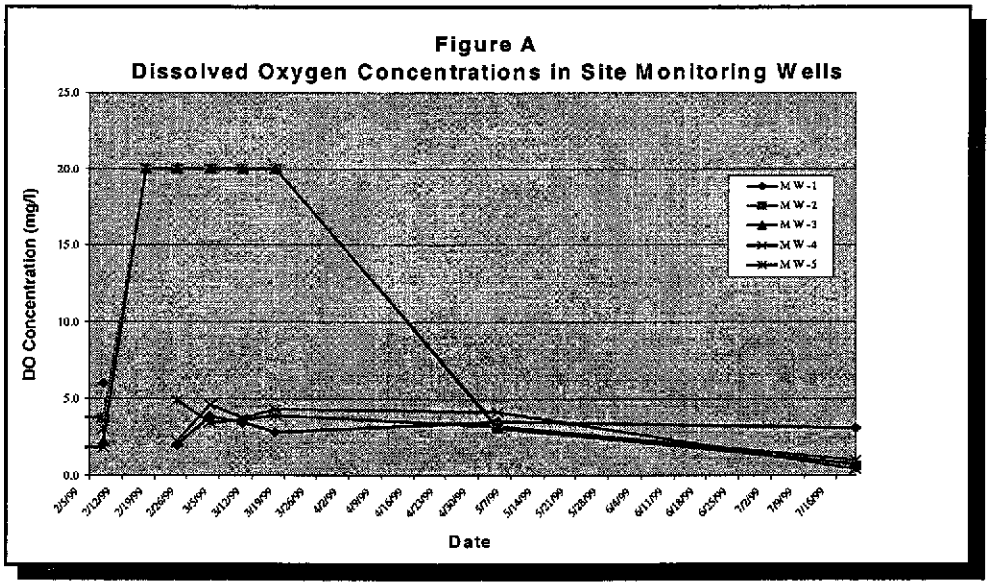
Injection Point	Volume of H_2O_2 Injected (gals) per Event	Injection Event Dates
MW-2	10	2/8/99, 2/17/99, 2/24/99, 3/3/99, 3/10/99, 3/17/99
MW-3	10	2/8/99, 2/17/99, 2/24/99, 3/3/99, 3/10/99, 3/17/99

Injection events were completed on a weekly basis so that DO concentrations in monitoring wells MW-2 and MW-3 were increased to >20 mg/l and maintained at elevated levels (Figure A). Maintenance of these levels throughout the injection period is expected to have allowed the hydrogen peroxide to permeate a significant portion of the site water-bearing zone.

Hydrogen Peroxide Injection Results

Hydrogen peroxide injection temporarily increased site groundwater DO concentrations; however, DO levels dropped rapidly once the injection period was complete (Figure A). The rapid decline of DO concentrations suggests that the residual hydrocarbon mass has not been significantly reduced.

Figure A
Dissolved Oxygen Concentrations in Site Monitoring Wells



Six weeks after the final hydrogen peroxide injection event, hydrocarbon concentrations in site groundwater increased to near of above historical high concentrations (Table 1). However, the increase appeared temporary since concentrations at the subsequent monitoring event returned to approximately the same levels witnessed prior to hydrogen peroxide injection.

Given the rapid decline of DO concentrations following enhancement with hydrogen peroxide and the lack of a significant change between third quarter 1999 hydrocarbon concentrations and historical hydrocarbon concentrations, Cambria recommends discontinuing hydrogen peroxide injection in favor of a more aggressive remedial alternative.

REVISED REMEDIAL WORKPLAN - BIOSPARGING/BIOVENTING

The remedial technique of biosparging/bioventing, also known as low-flow air sparging, was presented in Cambria's November 11, 1998 workplan as the next most cost-effective remedial approach after hydrogen peroxide injection. Cambria's table comparing remedial alternatives is included in Attachment A.

Biosparging/bioventing involves injecting air at low flow rates to provide oxygen to enhance biodegradation of hydrocarbons in groundwater, and to allow residual oxygen to enter the vadose zone to help bioremediate site soil. Historical site data and the relatively high permeability of the subsurface soil suggests that a bioventing/biosparging approach has an excellent chance to successfully remediate subsurface hydrocarbons. Injecting air at low flow rates also minimizes the potential for causing hydrocarbon dispersion.

To monitor for hydrocarbon migration in the vapor phase, Cambria proposes to install vadose zone monitoring wells in the same bore hole as the proposed biosparge wells. If vadose zone monitoring indicates that vapor-phase hydrocarbon concentrations are very low[1], Cambria would recommend increasing the air injection flow rates to accelerate site remediation and reduce lifecycle project cost. If vapor-phase concentrations are elevated or near the lower explosive limit for gasoline, Cambria would recommend performing short-term soil vapor extraction to reduce the vapor-phase hydrocarbons and to expedite site remediation.

---

1 When performing sparging, Cambria considers very low concentrations as concentrations that are well below the lower explosion limit (LEL) for gasoline of 13,000 parts per million by volume (ppmv)

Proposed Scope of Work

Our proposed scope of work for revised site remediation is described below.

Remediation Well Installation: Cambria will install two nested remediation wells adjacent to the former USTs (Figure 1). Cambria's standard field procedures for remediation well installation are included as Attachment B. Each well will consist of a sparge well, screened from 25 to 30 ft bgs, and a vapor monitoring well, screened from 10 to 20 ft bgs (Figure 1). If possible, Cambria will angle-install both nested wells allowing use of a single vault and eliminating the need for trenching in the sidewalk to a second well. The degree of incline of each boring will be such that the sparge well screen and, to the maximum extent possible, the vapor monitoring well screen will be beneath the two former UST locations and targeting the known extent of residual hydrocarbons.

Remediation System Installation: To minimize remediation cost, the remediation system will use an existing air compressor and use aboveground from the compressor to the property boundary. Underground piping will extend from the edge of the building to the anticipated remediation vault location and remediation wells approximately 10 feet away. Conveyance piping to the air sparge wells will be 1" diameter schedule 80 PVC. To facilitate vapor monitoring and short-term vapor extraction if needed, conveyance piping (2" diameter schedule 40 PVC) will be installed from inside the building to the vapor monitoring wells.

System Startup, Operation, and Monitoring: During startup of the biosparge/biovent system, Cambria plans to inject air at a flow rate of approximately 2 standard cubic feet per minute (scfm) in each well. To monitor for vapor-phase hydrocarbon migration, Cambria will analyze vapor concentrations before and during system startup in existing site monitoring wells MW-2 and MW-3 and in the proposed vadose zone monitoring wells. If vapor-phase hydrocarbon concentrations are approximately 2,000 ppmv or less, Cambria would continue sparging at 2 scfm in each well. If concentrations exceed 2,000 ppmv, Cambria would decrease the air injection flow rate and consider performing short-term vapor extraction to reduce the vapor-phase hydrocarbon concentrations.

Permits: Cambria will obtain the necessary permits for installation of the borings and wells from the Alameda County Public Works Agency and the City of Oakland. Encroachment and building permits will also be obtained from the City of Oakland as required.

Utility Location: Cambria will notify Underground Service Alert (USA) of our drilling activities. USA will identify underground utilities in the site vicinity. If necessary, Cambria will perform an underground utility survey using a private line locating firm. Utility location is a primary concern at this site since several utilities are present in the sidewalk and planned remediation vicinity.

Site Health and Safety Plan: Cambria will prepare a site safety plan to protect site workers. The plan will be kept onsite at all times and signed by all site workers.

Reporting: Reporting for the remedial action activities will be incorporated into the site monitoring reports. The remedial evaluation section of the monitoring report will contain, at a minimum:

- Descriptions of remedial parameters such as air injection flow rates and operation times;
- Tabulated dissolved oxygen and groundwater analytic data; and
- An evaluation of the effectiveness of the remedial action.

CLOSING

Upon workplan approval by the ACHCSA, Cambria will help Douglas Parking obtain pre-approval from the UST Cleanup Fund for implementation of the remedial workplan.

Cambria appreciates the opportunity to provide environmental consulting services to Douglas Parking. Please call if you have any questions or comments.

Sincerely,
Cambria Environmental Technology, Inc.

Robert W. Schultz
Senior Staff Geologist

Bob Clark-Riddell, PE
Principal Engineer

H:\SB-2004\DOUGLAS\1721 Webster\H2O2\remedeval.WPD

Attachments: A - Evaluation of Remedial Approaches and Estimated Costs
B - Standard Field Procedures for Remediation Well Installation

cc: Tom Peacock, ACHCSA, UST Local Oversight Program
1131 Harbor Bay Parkway, 2nd Floor, Alameda, CA 94502

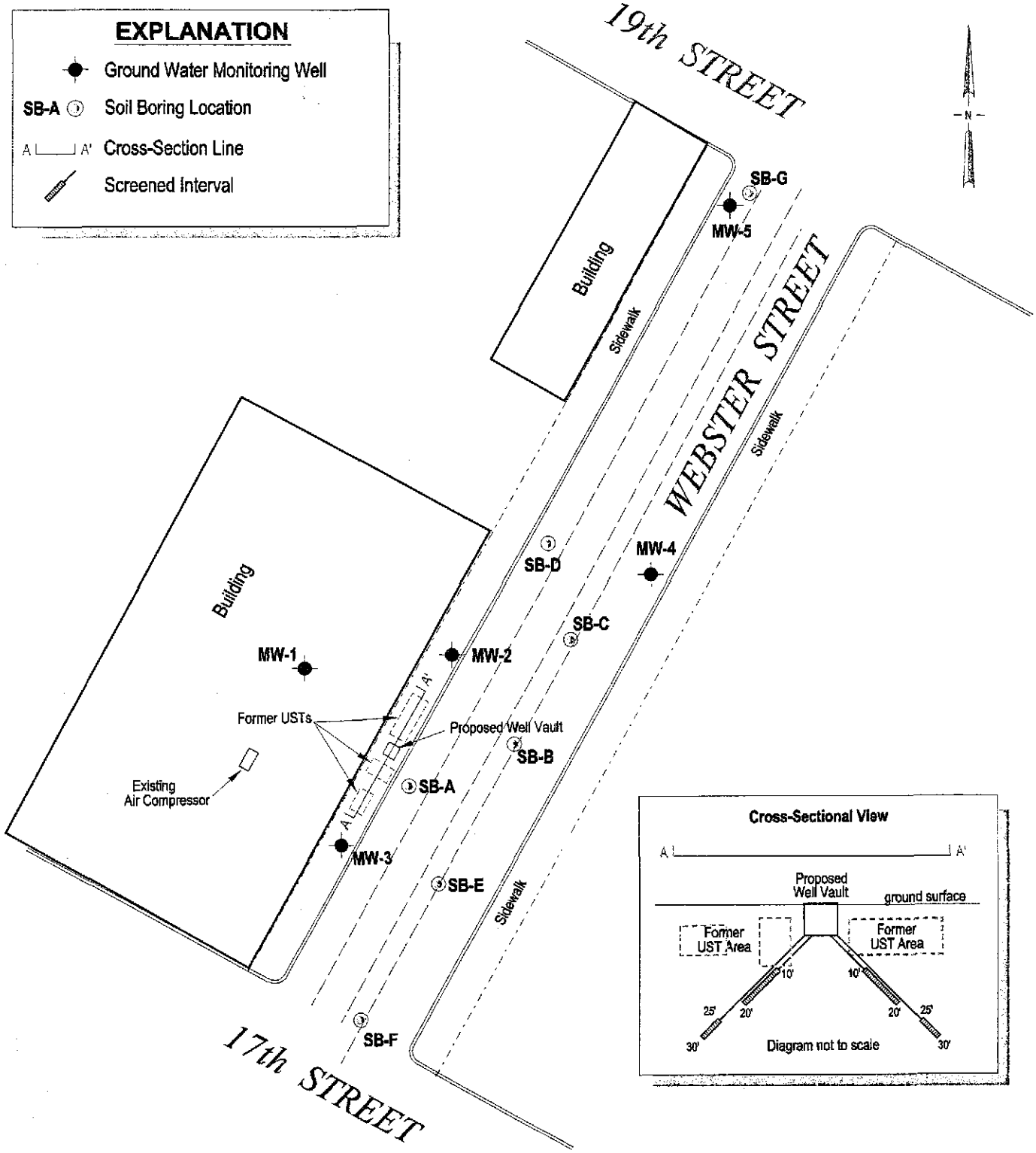


FIGURE
1

H:\SB-2004\DOUGLAS\FIGURES\ANGLE.DWG

Douglas Parking Facility

1721 Webster Street
Oakland, California

CAMBRIA

Proposed Remediation Well Locations

CAMBRIA

Table 1. Groundwater Elevation and Analytical Data - Douglas Parking Company, 1721 Webster Street, Oakland, CA

Well ID	Date	TOC Elevation (ft-msl)	Depth to Water (ft)	Groundwater Elevation (ft)	TPHg	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	DO (mg/L)	Notes
					<----------(Concentrations in µg/l)---------->							
MW-1	12/02/94	29.25	19.42	9.83	nd	nd	nd	nd	nd	-	-	1
	03/06/95	29.73	20.69	9.04	nd	nd	nd	nd	nd	-	-	1
	07/11/95	29.81	20.65	9.16	nd	nd	nd	nd	nd	-	-	
	05/10/96	29.81	20.80	9.01	nd	nd	nd	nd	nd	-	-	
	10/02/96	29.81	21.35	8.46	-	-	-	-	-	-	-	2
	02/28/97	29.81	20.57	9.24	-	-	-	-	-	-	-	2
	09/16/97	29.81	21.50	8.31	-	-	-	-	-	-	-	2
	02/05/98	29.81	20.91	8.90	-	-	-	-	-	-	1.9	2
	08/11/98	29.81	20.50	9.31	-	-	-	-	-	-	0.06	2
	02/08/99	29.81	21.42	8.39	-	-	-	-	-	-	6.0	2, 3
	02/24/99	29.81	22.99	6.82	-	-	-	-	-	-	2.0	2, 3
	03/03/99	29.81	20.84	8.97	-	-	-	-	-	-	3.8	2, 3
	03/10/99	29.81	20.89	8.92	-	-	-	-	-	-	3.4	2, 3
	03/17/99	29.81	20.84	8.97	-	-	-	-	-	-	2.8	2, 3
	05/04/99	29.81	20.80	9.01	-	-	-	-	-	-	3.5	2
	07/20/99	**29.81**	**21.25**	**8.56**	-	-	-	-	-	-	**3.1**	**2**
MW-2	12/02/94	27.10	19.50	7.60	61,300	3,000	3,900	160	4,500	-	-	1
	03/06/95	27.10	18.49	8.61	98,000	8,400	16,000	2,000	2,600	-	-	1
	07/11/95	27.40	18.45	8.95	38,000	3,100	7,500	940	3,700	-	-	
	05/10/96	27.40	18.56	8.84	63,000	7,400	16,000	1,500	6,000	-	-	
	10/02/96	27.40	19.15	8.25	21,000	2,200	3,400	430	1,600	-	-	
	02/28/97	27.40	18.43	8.97	39,000	4,700	9,600	950	4,200	nd	-	
	09/16/97	27.40	19.26	8.14	29,000	3,300	5,800	690	2,900	<620	-	
	02/05/98	27.40	18.66	8.74	10,000	1,000	2,000	170	860	<330	7.9	
	08/11/98	27.40	18.41	8.99	12,000	1,200	2,300	260	1,400	300	5.4	
	02/08/99	27.40	19.84	7.56	5,500	740	1,200	150	780	60	3.7	3
	02/17/99	27.40	18.94	8.46	-	-	-	-	-	-	>20	3
	02/24/99	27.40	20.76	6.64	-	-	-	-	-	-	>20	3
	03/03/99	27.40	18.55	8.85	-	-	-	-	-	-	>20	3
	03/10/99	27.40	20.74	6.66	-	-	-	-	-	-	>20	3
	03/17/99	27.40	18.57	8.83	-	-	-	-	-	-	>20	3
	05/04/99	27.40	18.55	8.85	90,000	9,200	21,000	1,600	10,000	560	3.2	
	07/20/99	**27.40**	**18.98**	**8.42**	**28,000**	**2,100**	**3,700**	**900**	**4,200**	**<860**	**0.6**	

CAMBRIA

Table 1. Groundwater Elevation and Analytical Data - Douglas Parking Company, 1721 Webster Street, Oakland, CA

Well ID	Date	TOC Elevation (ft-msl)	Depth to Water (ft)	Groundwater Elevation (ft)	TPHg	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	DO (mg/L)	Notes
					<----------(Concentrations in µg/l)---------->							
MW-3	12/02/94	29.50	22.15	7.35	394,000	1,200	nd	1,800	4,000	-	-	1
	03/06/95	29.25	20.09	9.16	21,000	400	150	24	62	-	-	1
	07/11/95	29.56	19.99	9.57	12,000	nd	10	16	99	-	-	
	05/10/96	29.56	20.24	9.32	8,600	nd	7.6	16	84	-	-	
	10/02/96	29.56	20.90	8.66	11,000	nd	7.4	19	92	-	-	
	02/28/97	29.56	20.12	9.44	6,000	nd	4.4	17	88	50	-	
	09/16/97	29.56	20.97	8.59	6,500	<0.5	1	1	7	<5.0	-	
	02/05/98	29.56	20.39	9.17	5,400	<0.5	6.3	15	86	<63	1.9	
	08/11/98	29.56	19.95	9.61	2,700	<0.5	3.5	3.2	12	<10	0.05	
	02/08/99	29.56	20.58	8.98	6,100	<0.5	8.1	18	80	<140	2.2	3
	02/17/99	29.56	20.53	9.03	-	-	-	-	-	-	>20	3
	02/24/99	29.56	22.53	7.03	-	-	-	-	-	-	>20	3
	03/03/99	29.56	20.28	9.28	-	-	-	-	-	-	>20	3
	03/10/99	29.56	22.45	7.11	-	-	-	-	-	-	>20	3
	03/17/99	29.56	20.26	9.30	-	-	-	-	-	-	>20	3
	05/04/99	29.56	20.24	9.32	11,000	<2	<2	9.8	140	<10	3.1	
	07/20/99	**29.56**	**20.68**	**8.88**	**11,000**	**<0.5**	**3.1**	**13**	**88**	**<80**	**0.8**	
MW-4	05/10/96	25.29	16.98	8.31	14,000	nd	1,200	720	3,100	-	-	
	10/02/96	25.29	17.65	7.64	12,000	nd	650	580	2,200	-	-	
	02/28/97	25.29	16.80	8.49	13,000	nd	1,100	750	2,700	110	-	
	09/17/97	25.29	17.93	7.36	13,000	<2.5	820	750	2,900	<190	-	
	02/05/98	25.29	16.78	8.51	13,000	<1.0	690	690	2,900	<170	2.1	
	08/11/98	25.29	16.59	8.70	15,000	<5	360	520	1,900	280	2.8	
	02/08/99	25.29	17.10	8.19	9,800	<5	680	770	2,200	300	1.8	3
	02/24/99	25.29	18.95	6.34	-	-	-	-	-	-	2.2	3
	03/03/99	25.29	16.80	8.49	-	-	-	-	-	-	4.6	3
	03/10/99	25.29	16.86	8.43	-	-	-	-	-	-	3.7	3
	03/17/99	25.29	16.82	8.47	-	-	-	-	-	-	4.3	3
	05/04/99	25.29	16.86	8.43	11,000	46	600	620	1,900	<100	4.1	
	07/20/99	**25.29**	**17.30**	**7.99**	**13,000**	**<0.5**	**470**	**7.0**	**2,000**	**<150**	**0.4**	
MW-5	05/10/96	21.97	14.60	7.37	nd	nd	nd	nd	nd	-	-	
	10/02/96	21.97	15.25	6.72	nd	nd	nd	nd	nd	-	-	
	02/28/97	21.97	14.31	7.66	nd	nd	nd	nd	nd	nd	-	

CAMBRIA

Table 1. Groundwater Elevation and Analytical Data - Douglas Parking Company, 1721 Webster Street, Oakland, CA

Well ID	Date	TOC Elevation (ft-msl)	Depth to Water (ft)	Groundwater Elevation (ft)	TPHg	Benzene	Toluene	Ethylbenzene	Xylenes	MTBE	DO (mg/L)	Notes
					<----------(Concentrations in µg/l)---------->							
	09/17/97	21.97	15.18	6.79	<0.5	<0.5	<0.5	<0.5	<0.5	<5.0	-	
	02/05/98	21.97	13.64	8.33	<50	<0.5	<0.5	<0.5	<0.5	<5.0	2.8	
	08/11/98	21.97	13.92	8.05	<50	<0.5	<0.5	<0.5	<0.5	<5.0	0.05	
	02/08/99	21.97	14.19	7.78	<50	<0.5	<0.5	<0.5	<0.5	<5.0	3.0	3
	02/24/99	21.97	16.18	5.79	-	-	-	-	-	-	4.9	3
	03/03/99	21.97	14.23	7.74	-	-	-	-	-	-	3.4	3
	03/10/99	21.97	14.32	7.65	-	-	-	-	-	-	3.6	3
	03/17/99	21.97	14.25	7.72	-	-	-	-	-	-	3.9	3
	05/04/99	21.97	14.41	7.56	<50	<0.5	<0.5	<0.5	<0.5	<5.0	3.2	
	07/20/99	**21.97**	**14.44**	**7.53**	**<50**	**<0.5**	**<0.5**	**<0.5**	**<0.5**	**<5.0**	**1.0**	

Notes and Abbreviations:

Benzene, Toluene, Ethylbenzene, and Xylenes by EPA Method 8020.

TPHg = Total petroleum hydrocarbons as gasoline by modified EPA Method 8015.

MTBE = methyl tertiary butyl ether by EPA Method 8020.

µg/L = micrograms per liter

mg/L = milligrams per liter

ft-msl = feet above mean sea level

TOC = top of casing

nd = not detected

DO = dissolved oxygen

1 = Data prior to 7/11/95 from Gen Tech and Piers Environmental Quarterly Groundwater Monitoring Reports dated December 2, 1994 and March 6, 1995, respectively.

2 = Sampling no longer required in well MW-1 per September 17, 1996, ACDEH letter to Douglas Parking.

3 = DO monitoring event, as described in November 11, 1998 Remedial Workplan.

ATTACHMENT A

Evaluation of Remedial Approaches and Estimated Costs

Table A
Evaluation of Remedial Approaches and Estimated Costs

Potentially Applicable Technology	Remedial Approach	Estimated Duration Until Closure (years)	Estimated Costs		
			Ground Water Monitoring (Annual)	Remedial Action	Total Project Cost
Natural Attenuation	Allow hydrocarbons to attenuate naturally. Assume 10 years until closure granted without active remediation.	10	4,000	0	40,000
Hydrogen Peroxide Injection	Inject H_2O_2 over 6-week period into wells MW-2 & MW-3, re-equilibrate for 6 weeks. (Upper cost range assumes another 6 week period of injection). Two total years of ground water monitoring before closure.	2	4,000	5,000 to 10,000	13,000 to 18,000
Biosparge	Convert well MW-2 for low-flow air injection, install air compressor, 1 year biosparge system operation, 2 total years of ground water monitoring.	2	4,000	19,000	27,000
AS	Convert wells MW-2 and MW-3 for air injection, install new air sparge well, 1 year air sparge operation, 2 total years of ground water monitoring.	2	4,000	34,000	42,000
SVE	Because the existing well screens are submerged, a new well is needed for SVE. Approach includes installation of one well, blower with activated carbon, SVE permit, 6 months SVE operation, 2 total years of ground water monitoring.	2	4,000	32,000	40,000
SVE/AS	Combine above SVE and AS approaches with 6 months operation, 2 total years of ground water monitoring.	2	4,000	42,000	50,000

AS = Air Sparging
SVE = Soil Vapor Extraction

ATTACHMENT B

Standard Field Procedures for Remediation Well Installation

CAMBRIA

STANDARD FIELD PROCEDURES FOR REMEDIATION WELL INSTALLATION

This document presents standard field methods for drilling and sampling soil borings and installing remediation wells. These procedures are designed to comply with Federal, State and local regulatory guidelines. Specific field procedures are summarized below.

SOIL BORING AND SAMPLING

Objectives

Soil samples are collected to characterize subsurface lithology, assess whether the soils exhibit obvious hydrocarbon or other compound vapor or staining, and to collect samples for analysis at a State-certified laboratory. All borings are logged using the Unified Soil Classification System by a trained geologist working under the supervision of a California Registered Geologist (RG) or a Certified Engineering Geologist (CEG).

Soil Boring and Sampling

Soil borings are typically drilled using hollow-stem augers or push technologies such as the Geoprobe. Soil samples are collected at least every five ft to characterize the subsurface sediments and for possible chemical analysis. Additional soil samples are collected near the water table and at lithologic changes. Samples are collected using lined split-barrel or equivalent samplers driven into undisturbed sediments at the bottom of the borehole.

Drilling and sampling equipment is steam-cleaned prior to drilling and between borings to prevent cross-contamination. Sampling equipment is washed between samples with trisodium phosphate or an equivalent EPA-approved detergent.

Sample Analysis

Sampling tubes chosen for analysis are trimmed of excess soil and capped with Teflon tape and plastic end caps. Soil samples are labeled and stored at or below 4°C on either crushed or dry ice, depending upon local regulations. Samples are transported under chain-of-custody to a State-certified analytic laboratory.

Field Screening

One of the remaining tubes is partially emptied leaving about one-third of the soil in the tube. The tube is capped with plastic end caps and set aside to allow hydrocarbons to volatilize from the soil. After ten to fifteen minutes, a portable photoionization detector (PID) measures volatile hydrocarbon vapor concentrations in the tube headspace, extracting the vapor through a slit in the

cap. PID measurements are used along with the field observations, odors, stratigraphy and ground water depth to select soil samples for analysis.

Grouting

If the borings are not completed as wells, the borings are filled to the ground surface with cement grout poured or pumped through a tremie pipe.

REMEDIATION WELL INSTALLATION

Well Construction

Remediation wells are installed for soil vapor extraction (SVE), ground water extraction (GWE), oxygenation, air sparging (AS) and for vapor monitoring (VM). Well depths and screen lengths will vary depending upon several factors including the intended use of the well, ground water depth, occurrence of hydrocarbons or other compounds in the borehole, stratigraphy and State and local regulatory guidelines.

Well casing and screen are typically one to four inch diameter flush-threaded Schedule 40 PVC. Screen slot size varies according to the sediments screened, but slots are generally 0.010 or 0.020 inches wide. A rinsed and graded sand occupies the annular space between the boring and the well screen to about one to two ft above the well screen. A two ft thick hydrated bentonite seal separates the sand from the overlying sanitary surface seal composed of Portland type I,II cement. Well-heads are typically connected remediation piping set in traffic-rated vaults finished flush with the ground surface. Typical well screen intervals for each type of well are as follows:

SVE Wells: SVE wells are screened in the vadose zone targeting horizons with the highest hydrocarbon concentrations. SVE wells are also occasionally screened as concurrent soil vapor and ground water extraction wells with screen interval above and below the water table.

GWE Wells: Ground water extraction wells are typically screened ten to fifteen ft below the first water-bearing zone encountered. The well screen may or may not be screened above the water table depending upon whether the water bearing zone is unconfined or confined.

Oxygenation Wells: Oxygenation wells are installed above or below the water table to supply oxygen and enhance naturally occurring hydrocarbon biodegradation. Oxygenation wells installed in the vadose zone typically have well screens that are two to ten feet long and target horizons with the highest hydrocarbon concentrations. Oxygenation wells installed below the water table typically have a two foot screen interval set ten to fifteen ft below the water table.

AS Wells: Air sparging wells are installed below the water table and typically have a two foot screen interval set ten to fifteen ft below the water table.

VM Wells: Vapor monitoring wells are installed in the vadose zone to check for hydrocarbon vapor migration during air injection. The wells are typically constructed with short screens to target horizons through which hydrocarbon vapor migration could occur. These wells can also be constructed in borings drilled using push technologies such as the Geoprobe by using non-collapsible Teflon tubing set in small sand packed regions overlain by grout.

Well Development

Ground water extraction wells are generally developed using a combination of ground water surging and extraction. Surging agitates the ground water and dislodges fine sediments from the sand pack. After about ten minutes of surging, ground water is extracted from the well using bailing, pumping and/or reverse air-lifting through an eductor pipe to remove the sediments from the well. Surging and extraction continue until at least ten well-casing volumes of ground water are extracted and the sediment volume in the ground water is negligible. This process usually occurs prior to installing the sanitary surface seal to ensure sand pack stabilization. If development occurs after surface seal installation, then development occurs 24 to 72 hours after seal installation to ensure that the Portland cement has set up correctly.

All equipment is steam-cleaned prior to use and air used for air-lifting is filtered to prevent oil entrained in the compressed air from entering the well. Wells that are developed using air-lift evacuation are not sampled until at least 24 hours after they are developed.