STARTUP REPORT
GROUNDWATER REMEDIATION AT
CITY OF OAKLAND
MUNICIPAL SERVICES CENTER
7101 EDGEWATER DRIVE
OAKLAND, CALIFORNIA

Prepared for

City of Oakland
Public Works Agency
Environmental Services Division
250 Frank H. Ogawa Plaza, Suite 5301
Oakland, CA94612

June 2006

Prepared by

OTG
Enviroengineering
Solutions, Inc.

464 19th Street, Suite 206
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OTG **EnviroEngineering** *Solutions, Inc.*

June 20, 2006

Mr. Farhad Azimzadeh
Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, CA 94612

Reference: RWQCB Order No. 01-100, NPDES Permit #CAG912002

Subject: Start-up Report
Groundwater Remediation at 7101 Edgewater Drive, Oakland, CA

Dear Mr. Azimzadeh:

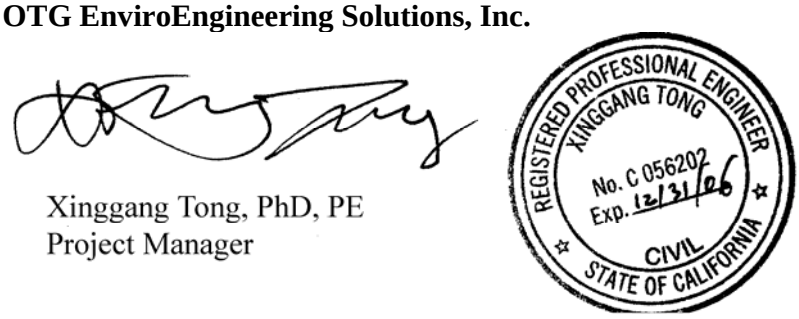
On behalf of the City of Oakland, OTG Enviroengineering Solutions, Inc. (OTG) is pleased to submit this Start-up Report for a groundwater extraction, treatment and discharge system at the City of Oakland Municipal Services Center (MSC) located at 7101 Edgewater Drive, Oakland, California. No violations of RWQCB Order No. 01-100 and NPDES Permit #CAG912002 were identified during this reporting period of time.

Certification

I certify under penalty of law that this document and all attachments are prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who managed the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Please contact the undersigned at (510) 465-8982 if you have questions or comments.

Sincerely,
OTG EnviroEngineering Solutions, Inc.



Xinggang Tong, PhD, PE
Project Manager

cc: Mr. Gopal Nair, City of Oakland
Mr. Barney Chan, Alameda County Department of Environmental Health

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1 INTRODUCTION

The City of Oakland Municipal Services Center (MSC) is located at 7101 Edgewater Drive, Oakland, CA (Figure 1). The site was originally part of a waterfront tidal marsh complex, which was filled between 1950 and 1971. The MSC occupies an area of approximately 17 acres. The City leased the land from the Port of Oakland for use as a corporation yard. Bordering the MSC site to the west and the north is the Martin Luther King Regional Shoreline Park. This park land is also owned by the Port of Oakland. Damon Slough is located to the north, and commercial developments are located to the east and south.

The MSC site has been the subject of numerous environmental investigations starting in about 1989. The suspected sources of on-site contamination include releases from underground storage tanks (USTs), gasoline and diesel fuel hydrant system, and the floor drain waste collection pits formerly located adjacent to Building No. 5. In addition, some or all of the material used to fill the site may have been waste or contaminated prior to placement at the site. A comprehensive investigation conducted by Baseline in 2000 identified the existence of free-phase petroleum hydrocarbon product at four separate areas within the MSC. They are labeled as Plumes A through D on Figure 2. Baseline's investigation is documented in the report of *Site History and Characterization* (January 2001).

Groundwater monitoring has been conducted quarterly from the fourth Quarter of 1989 through the third quarter of 2002 and then semi-annually to current. Shallow groundwater elevation varies from 2 to 10 feet below ground surface and is partially subject to tidal influence. Shallow groundwater flow is toward the southwest to the nearest shoreline along San Leandro Bay across much of the site. In the northern portion of the MSC, groundwater flows in a more northerly direction toward the curving shoreline and Damon Slough (Baseline , January 2001)

Pilot-scale Dual-Phase Extraction (DPE) tests were conducted in 2002 to enhance the removal of free-phase petroleum product from the four identified areas (Cambria, August 13, 2002 and URS, August 29, 2002). Extracted groundwater was treated on-site through two 2,000-lb granular activated carbon units connected in series and discharged to on-site storm drain via a NPDES permit granted by the San Francisco Bay Regional Water Quality Control Board (NPDES Permit No. CAG912002). Based on the pilot test result, the City retained Cambria in May 2003 to design a full-scale application of product recovery and groundwater/soil vapor extraction at Plumes C and D. Cambria's design was revised in October 2005 by Groundwater and Environmental Services (GES) to focus the first phase of product removal in Plume D. The final design drawings are included in Appendix A. Chemical oxidation and enhanced bioremediation through periodic injections of hydrogen peroxide have been implemented in Plumes A, B and C since July 2004.

In March 2006, the City retained URS Corporation and its subcontractor ERRG to construct the GES' revised remediation system of product recovery and groundwater/soil vapor extraction.

The construction was completed in early May 2006. On May 22, 2006, the product recovery and groundwater extraction portion of the remediation system was turned on.

2. DESCRIPTION OF REMEDIATION SYSTEM

As detailed in design drawings in Appendix A, the remediation system consists of extraction of liquid (petroleum product and groundwater) and soil vapor from seven (7) wells located in Plume D area (Figure 3), separation of petroleum product from groundwater, treatment of groundwater by activated carbon, discharge of treated water to local storm drain via a NPDES permit, treatment of soil vapor, and discharge of treated vapor to the atmosphere via an air discharge permit. A process and instrumentation diagram of the remediation system is illustrated on Figure 4.

The seven wells are: RW-D1, RW-D2, RW-D3, RW-D4, RW-D5, TBW-5 and RW-1. Their locations are shown on Figure 3. RW-D1 through RW-D5 were constructed in December 2001 specifically for remediation purposes, and RW-1 and TBW-5 were placed during backfilling of the excavation of former fuel hydrant lines in the early 1990s. Each well is equipped with a total fluid recovery pneumatic pump specifically designed for viscous petroleum product recovery. The pump is manufactured by Clean Environment Equipment in Oakland and has the Model # AP-Custom. An Ingersoll-Rand air compressor (model # SSR UP6-10) provides compressed air to the pneumatic pumps. Each well is also piped into a high vacuum extraction unit that can produce up to 28 inches of mercury vacuum. This vacuum unit can be operated at either mode of soil vapor extraction only or soil vapor and liquid simultaneous extraction. The pneumatic pumps and the vacuum extraction unit can be operated independently.

The liquid extracted by the pneumatic pumps and the vacuum unit is pumped into an oil/water separator (Model # AGM-3SS-90V, Hydro Quip, Inc.). Recovered oil is contained in 55-gallon drums, which are sent to an off-site oil recycling facility. Groundwater is treated through three (3) granular activated carbon (GAC) units connected in series (Model #ASC-2000, U.S.Filter/Westates Carbons) before been discharged into local storm drain. Each GAC unit contains 2,000 lbs of GAC. Figure 5 illustrates the groundwater treatment portion of the remediation system and identifies sampling ports.

A 40 hp liquid-ring vacuum pump capable of 500 ACFM and up to 28” Hg extracts soil vapor and liquid from the seven wells. The vapor is abated by a combination of thermal and catalytic oxidizer. At low vapor organic concentrations, activated carbon can also be used for vapor abatement.

3 OPERATIONS AND MAINTENANCE

On May 22, 2006, the pneumatic pumps were turned on to start the remediation process. The vacuum extraction portion remained off line. Because the free-phase product appears to be a mixture of gasoline, diesel, and some other highly viscous organics (petroleum tank bottom or coal tar like material), the vacuum extraction, if turned on, will vaporize gasoline and a portion of the diesel and will make the removal of the viscous product even more difficult. The plan is

to first use the pneumatic pumps to remove the free-phase product as much as practically achievable and then to use the vacuum extraction system to enhance the removal of the remaining petroleum hydrocarbons.

The liquid extraction by the pneumatic pumps started at approximately 7:00 am of May 22, 2006. The extracted liquid was first processed through the oil/water separator, where oil is automatically skimmed into an oil reservoir. The groundwater was pumped out of the oil/water separator and treated through the three carbon units in sequence. The treated water was stored in an effluent holding tank. Water samples were collected between 11:30 am and 12:00 noon at the sampling port of E-1 (effluent, after the third carbon unit), Btw-1 (after the first carbon unit), and I-1 (influent) for the NPDES permit required monitoring. On-site measurement included temperature, pH, and electric conductivity using an Oakton pH/Con 10 meter (Serial #311648) and turbidity using an Oakton T-100 meter (Serial #316738). Before measurement, the pH probe was calibrated with standard solutions of pH 4.00, 7.00, and 10.00; the electric conductivity probe calibrated with 1413 ug/cm standard solution; and the turbidity meter calibrated with standards of 0.02, 20.0, 100, and 800 NTUs. The system was turned off at 2:15 pm when the effluent holding tank was near its capacity of 1,100 gallons.

Chemical analyses were performed by Curtis & Tompkins, Ltd of Berkeley and Caltest of Napa. Both laboratories are certified by the State of California for water, wastewater and solid wastes analyses. Curtis & Tompkins provided the critical analyses for TPH gas, diesel, BTEX, and MTBE within 48-hour turnaround time, which is required by the NPDES permit. Caltest was unable to provide 48-hr turnaround time analysis, but was able to achieve lower detection limits for metals and cyanide and thus provided these analyses.

On May 24, 2006, the pneumatic pumps were turned on again after the result of the Day 1 samples met the discharge limit (details discussed in Section 4). The system ran continuously for another five days and was then sampled again following the NPDES permit requirement (Day 5 sampling). Curtis & Tompkins again provided the analysis for TPH gas, diesel, BTEX, MTBE, VOCs (EPA 8260), fuel oxygenates, effluent hardness and influent metals within 48-hr turnaround time and Caltest conducted the analysis for cyanide, SVOCs (EPA 625), PAHs (EPA 610), and effluent metals. The pneumatic pumps and the treatment system have been operated continuously and the treated groundwater discharged into the storm drain since receiving the Day 1 sample results.

4 DISCHARGE MONITORING

Field measured data and laboratory analysis results are summarized in the following tables:

- Table 1 – Summary of Laboratory Analytical Procedures
- Table 2 – Summary of Operational Data and Field Measured Parameters
- Table 3 – Summary of Petroleum Hydrocarbon Analytical Data
- Table 4 – Summary of Analytical Data for Inorganic Constituents
- Table 5 – Summary of Analytical Data for Organic Constituents

The data received from both laboratories were found to be of acceptable quality. All analyses were performed within the holding time required by each EPA specified analytical method. Surrogate recovery, matrix spike/matrix spike duplicate (MS/MSD) and relative percent difference (RPD) were within the laboratory established criteria.

At the time of the fifth day samples were collected, a total of 12,841 gallons of groundwater had been extracted, treated, and discharged into the local storm drain (Table 2). The extracted groundwater (I-1) had a pH between 7.0 and 7.1 and electric conductivity between 8.32 and 10.2 ms/cm. After treatment, the effluent (E-1) had a pH between 7.5 and 8.3 and electric conductivity between 8.25 and 8.81 ms/cm. It appears that the activated carbon removed some dissolved solids/ions from the groundwater, resulting in a reduction of the electric conductivity in the effluent.

As summarized in Table 3, the Day 1 effluent sample (E-1) had TPH gas, diesel, BTEX, and MTBE concentrations below their respective laboratory reporting limits. The influent (I-1) is saturated with floating product and had TPH gas of 52 mg/L, TPH diesel of 25 mg/L, and benzene of 6.1 mg/L. MTBE was below the reporting limit in both the influent and the effluent samples. TPH gas, BTEX and MTBE were again below their reporting limits in the Day 5 effluent sample (E-1). However, non-standard, but within diesel range TPH was reported in the Day 5 effluent sampling at 130 ug/L. The activated carbon has much stronger adsorption affinity with diesel than with gasoline. If it were an adsorption breakthrough of the carbon columns, benzene and TPH gas would be first detected in the effluent. Since BTEX and TPH gas were below their reporting limits in the same effluent sample, the reported low level of TPH diesel was suspected to be either a laboratory error or cross contamination from the influent sample. Nevertheless, confirmation samples were collected immediately after receiving the Day 5 laboratory data. Three additional samples, one from each of E-1 (effluent), Btw-1 (after the first carbon unit), and Btw-2 (after the second carbon unit), were collected on June 2 and were analyzed for TPH diesel under 48-hr turnaround schedule. TPH diesel was below the reporting limit of 50 ug/L in each of the three confirmation samples. The confirmation sampling result is also summarized in Table 3. It is, therefore, concluded that the discharge did not violate the limit imposed by the NPDES permit for TPH diesel.

Metals and other inorganic constituents (cyanide and hardness) are presented in Table 4. The gram per day discharge for each inorganic constituent was calculated based on the actual measured effluent concentration of the constituent and the monthly average discharge rate (gallons per minute, Table 2). None of the inorganic constituents had daily mass discharge exceed its limit for the category of less than 10 gallon per minute (gpm).

Organic chemicals analyzed by EPA Methods 8260, 8310 (610), and 8270 (625) are listed in Table 5. Those organic chemicals that have defined discharge limits given in Table B.1 of the NPDES permit (Page 7) are first listed in the Table 5, followed by fuel oxygenates, PAHs, and other SVOCs. No organic chemicals were detected at or above their respective reporting limits in the May 30 effluent sample (E-1). All organic chemicals detected in the May 30 influent

sample (I-1) were related to either gasoline or diesel and no fuel oxygenates were reported. A sample collected from Btw-1 (after the first carbon unit) on May 30 was also analyzed for VOCs by EPA 8260 and none of the VOCs was reported at or above its reporting limit. Breakthrough at the first carbon vessel has not yet to occur.

5 REFERENCES

Baseline Environmental Consulting, Site *History and Characterization*, January 2001

Cambria Environmental Technology, Inc. *TPE Pilot Test and Feasibility Report*, August 13, 2002.

California Regional Water Quality Control Board – San Francisco Bay Region, *Authorization to Discharge Treated Groundwater Under the Requirements of Order No. 01-100, NPDES Permit No. CAG 912002*, April 23, 2002.

OTG Enviroengineering Solutions, Inc. *Operation & Maintenance Manual for Groundwater Remediation System at City of Oakland Municipal Services Center, Draft*, July 2006

URS Corporation, *Results of Dual-Phase Extraction Pilot Test for Plumes A & B, City of Oakland Municipal Services Center*, August 29, 2002.

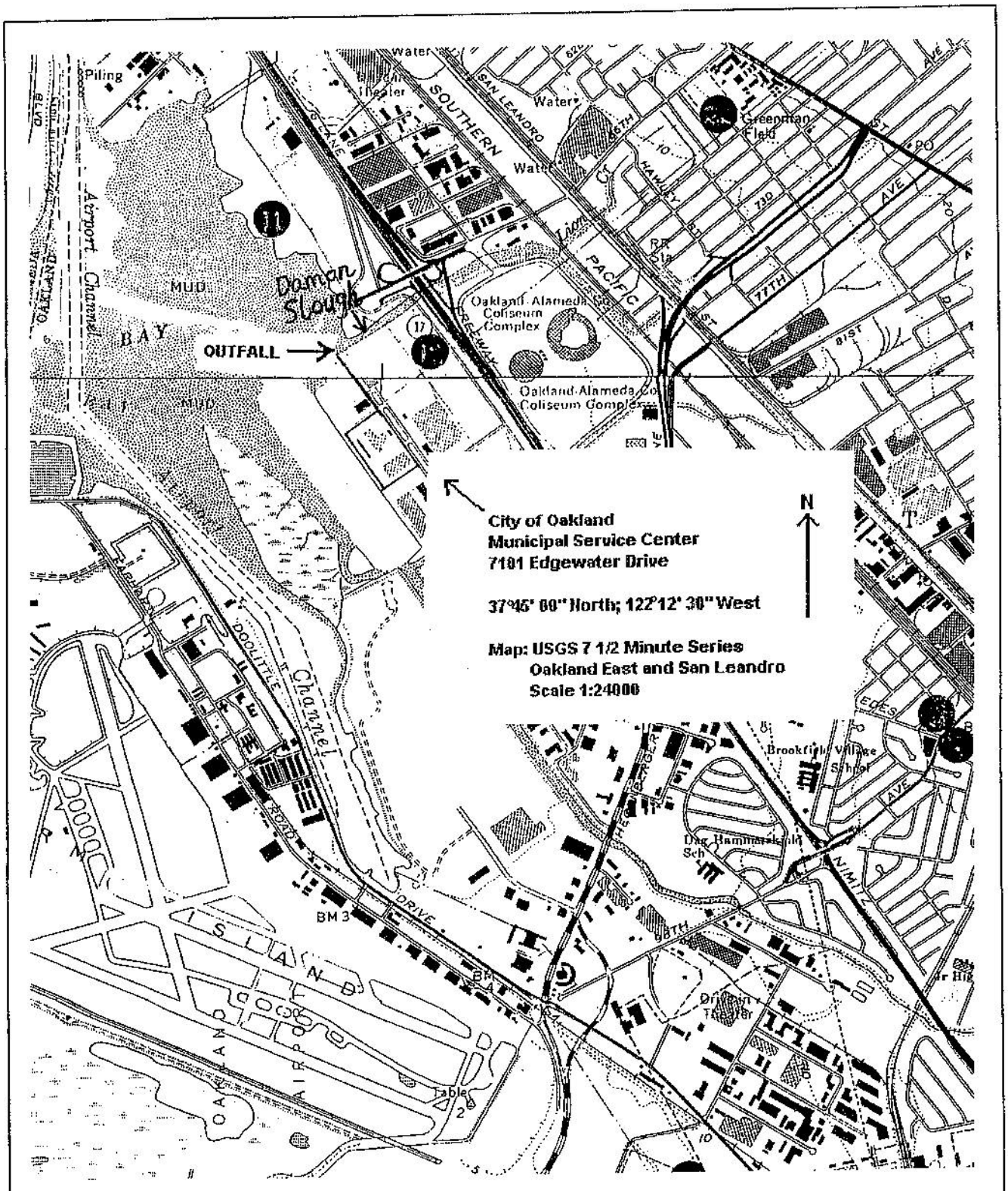


FIGURE 1 SITE LOCATION AND DISCHARGE LOCATION

EnviroEngineering Solutions, Inc.	City of Oakland Municipal Service Center 7101 EdgeWater Drive, Oakland, CA

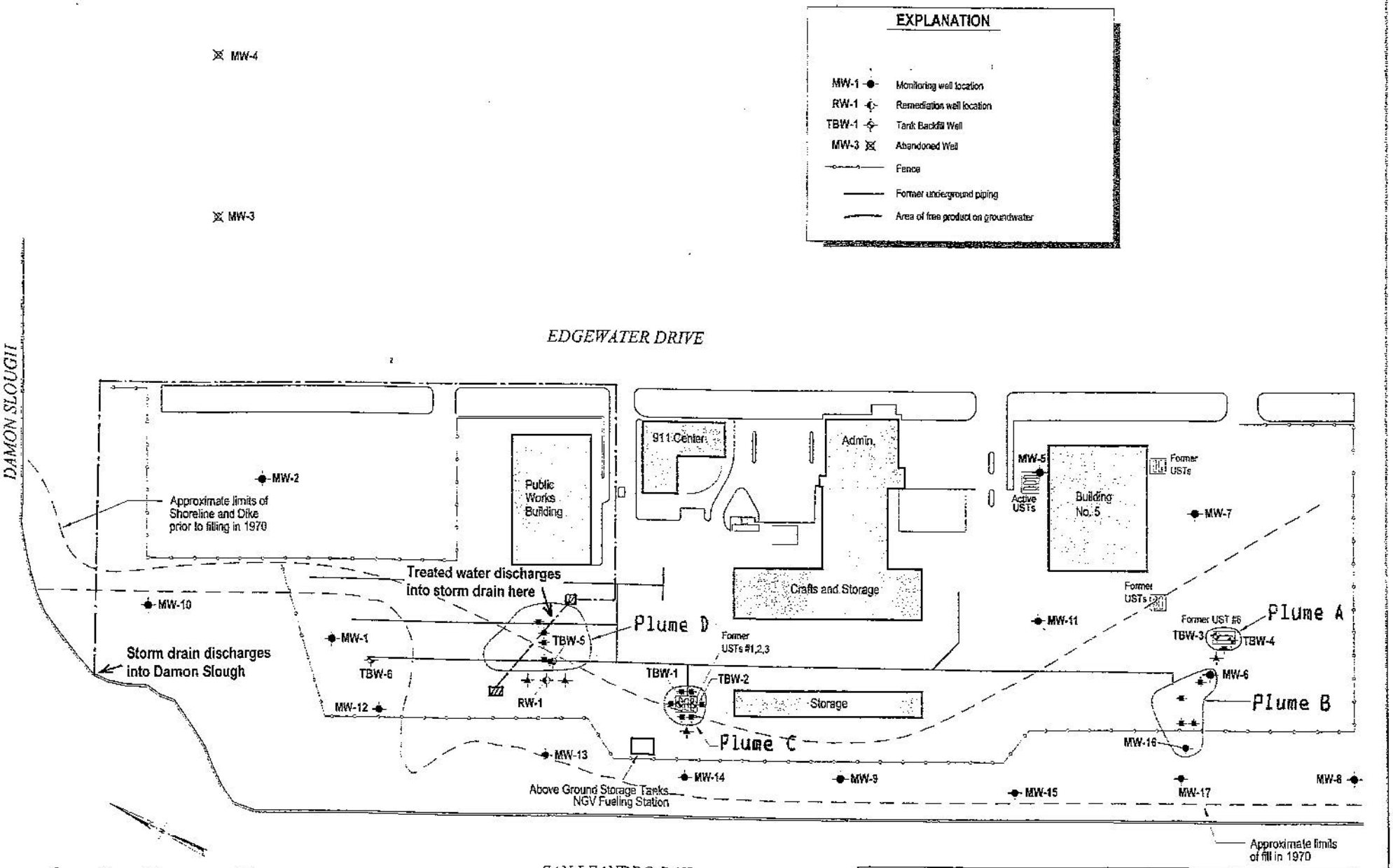


FIGURE 2 Identification of Free-Phase Petroleum Product Locations

EnviroEngineering Solutions, Inc.

City of Oakland Municipal Services Center
7101 Edgewater Drive, Oakland, CA

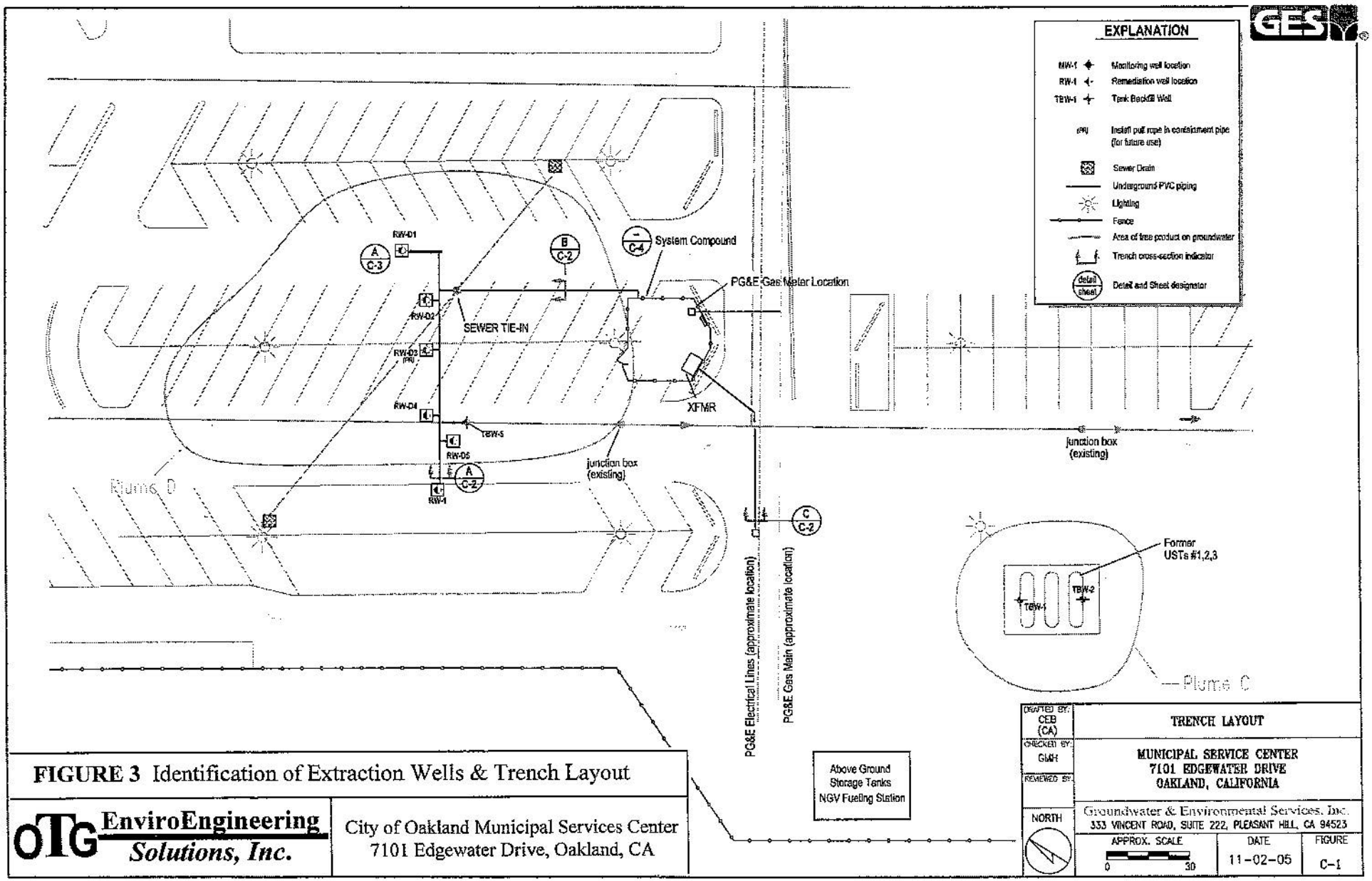
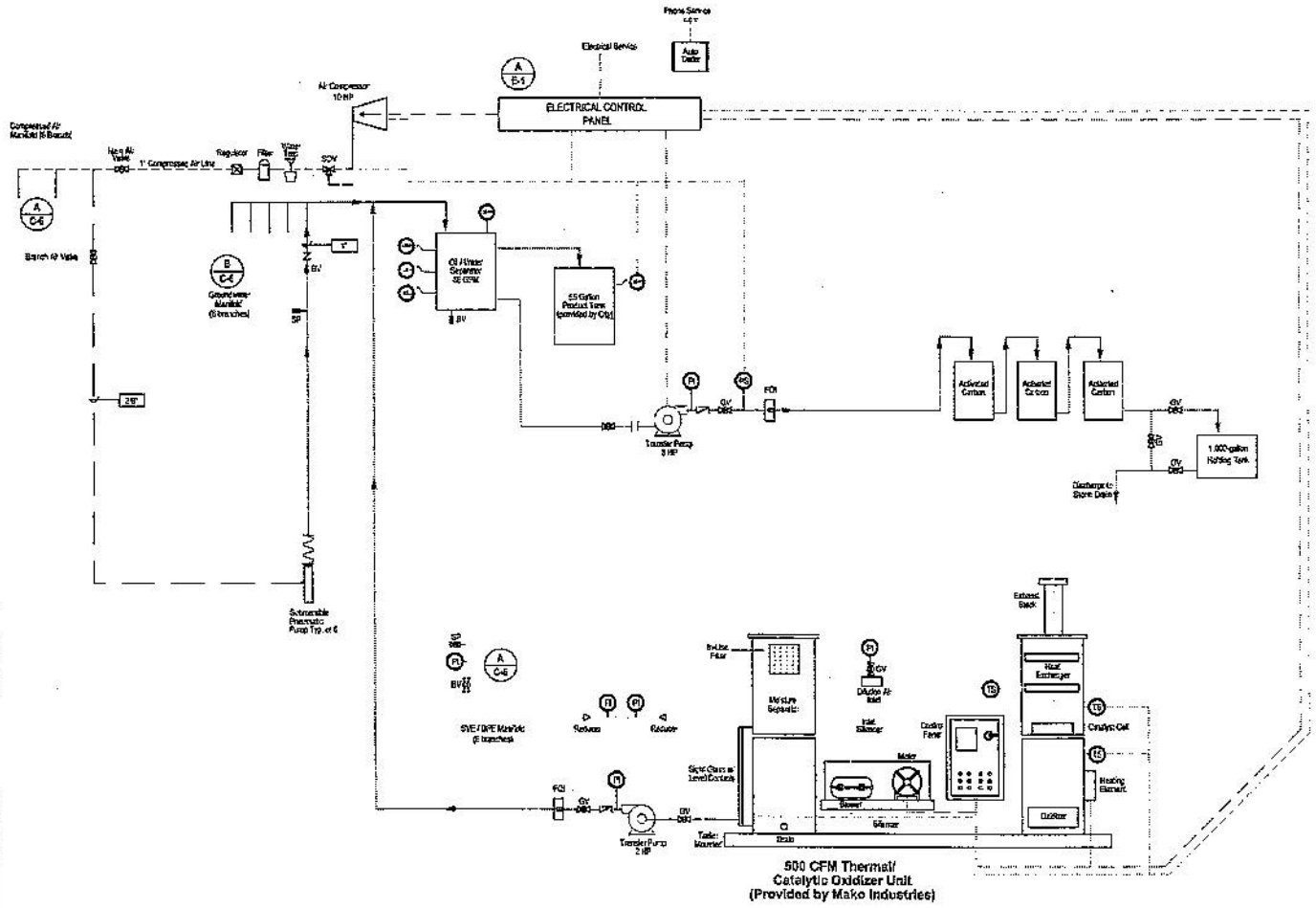


FIGURE 3 Identification of Extraction Wells & Trench Layout

EnviroEngineering Solutions, Inc.

City of Oakland Municipal Services Center
7101 Edgewater Drive, Oakland, CA



EXPLANATION

- Flowmeter/Indicator
- BV = Ball Valve
- GV = Gate Valve
- Sample Port
- Flexible Hose
- Pressure Transmitting Switch
- Flow Indicator
- Temperature Sensor
- Pressure Indicator
- Missing or Needs Replacement On Existing Equipment
- Vacuum Breaker
- Quick Disconnect
- Check Valve
- Solenoid Valve
- SVE Piping
- Electrical Control Wiring
- Electrical Power Wiring
- Compressed Air Line
- Groundwater Piping

FIGURE 4 Remediation System Process & Instrumentation Diagram

EnviroEngineering Solutions, Inc.

City of Oakland Municipal Services Center
7101 Edgewater Drive, Oakland, CA

DRAFTED BY: CEB (CA)	PROCESS AND INSTRUMENTATION DIAGRAM
CHECKED BY: GMH	MUNICIPAL SERVICE CENTER 7101 EDGEWATER DRIVE OAKLAND, CALIFORNIA
REVIEWED BY:	
NORTH	Groundwater & Environmental Services, Inc. 333 VINCENT ROAD, SUITE 222, PLEASANT HILL, CA 94523
NOT TO SCALE	DATE: 11-02-05 / FIGURE: M-1

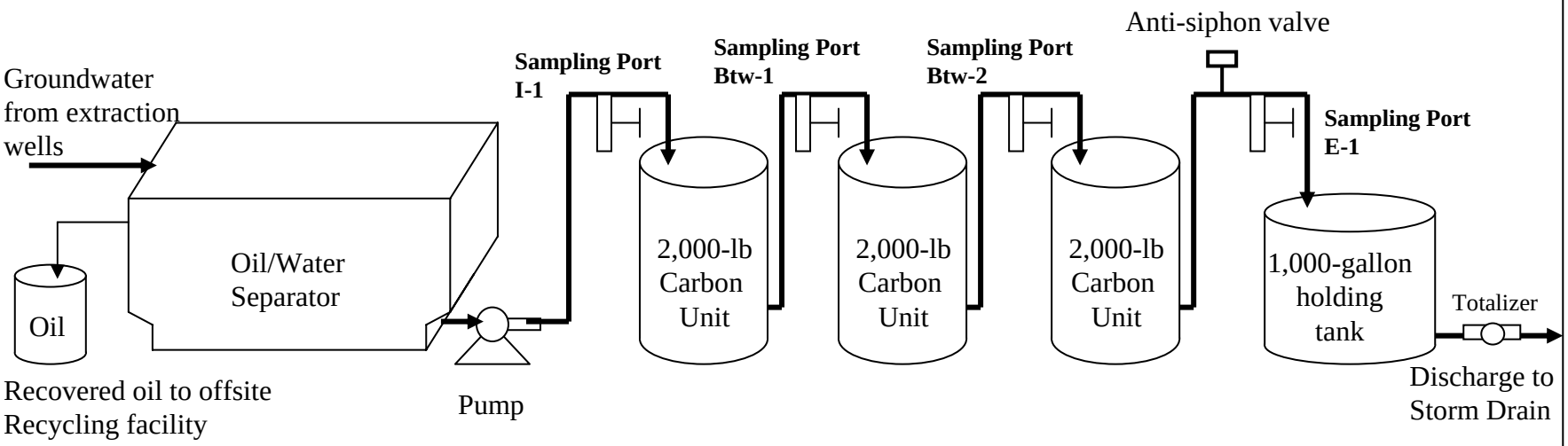


FIGURE 5 Schematic of Groundwater Treatment System and Sampling Locations

June 2006

EnviroEngineering Solutions, Inc.

City of Oakland Municipal Services Center
7101 Edgewater Drive, Oakland, CA

Table 1 - Summary of Laboratory Analytical Procedures
City of Oakland Municipal Services Center Groundwater Remediation Project

	5/22/06	5/30/06	6/26/06	7/25/06	9/5/06	
				& 8/11/06		
Flow rate	onsite totalizer	onsite totalizer	onsite totalizer	onsite totalize	onsite totalizer	
Turbidity	on-site	on-site	on-site	on-site	on-site	
Fish bioassay			EPA/821/R-02/012		EPA/821/R-02/012	
pH	on-site	on-site	on-site	on-site	on-site	
DO						
Temperature	on-site	on-site	on-site	on-site	on-site	
E. conductivity	on-site	on-site	on-site	on-site	on-site	
Benzene	EPA 8021B	EPA 8021B	EPA 8021B	EPA 8021B	EPA 8260B	
Toluene	EPA 8021B	EPA 8021B	EPA 8021B	EPA 8021B	EPA 8260B	
Ethylbenzene	EPA 8021B	EPA 8021B	EPA 8021B	EPA 8021B	EPA 8260B	
Total xylenes	EPA 8021B	EPA 8021B	EPA 8021B	EPA 8021B	EPA 8260B	
MTBE	EPA 8021B	EPA 8021B	EPA 8021B	EPA 8021B	EPA 8260B	
TPH g&d	EPA 8015B	EPA 8015B	EPA 8015B	EPA 8015B	EPA 8015B	
EDB		EPA 8260B			EPA 8260B	
VOCs		EPA 8260B			EPA 8260B	
TAME		EPA 8260B			EPA 8260B	
DIPE		EPA 8260B			EPA 8260B	
ETBE		EPA 8260B			EPA 8260B	
TBA		EPA 8260B			EPA 8260B	
Ethanol		EPA 8015B			EPA 8260B	
Methanol		EPA 8015B			EPA 8015B	
SVOCs		EPA 625			EPA 8270C	
PAHs		EPA 610			EPA 8310	
Hardness	SM 2340B	SM 2340B	SM 2340B		SM 2340B	
Antimony	EPA 200.8	EPA 200.8	EPA 6020		EPA 6020	
Arsenic	EPA 200.8	EPA 200.8	EPA 6020		EPA 6020	
Beryllium	EPA 200.8	EPA 200.8	EPA 6020		EPA 6020	
Cadmium	EPA 200.8	EPA 200.8	EPA 6020		EPA 6020	
Chromium	EPA 200.8	EPA 200.8	EPA 6020		EPA 6020	
Cr +6	EPA 7196	EPA 7196	EPA 7199		EPA 7199	
Copper	EPA 200.8	EPA 200.8	EPA 6020		EPA 6020	
Cyanide	EPA 335.2	EPA 335.2	EPA 335.2		EPA 335.2	
Lead	EPA 200.8	EPA 200.8	EPA 6020		EPA 6020	
Mercury	EPA 245.1	EPA 245.1	EPA 7470A		EPA 7470A	
Nickel	EPA 200.8	EPA 200.8	EPA 6020		EPA 6020	
Selenium	EPA 200.8	EPA 200.8	EPA 6020		EPA 6020	
Silver	EPA 200.8	EPA 200.8	EPA 6020		EPA 6020	
Thallium	EPA 200.8	EPA 200.8	EPA 6020		EPA 6020	
Zinc	EPA 200.8	EPA 200.8	EPA 6020		EPA 6020	
pH/Conductivity/Tempt were measured on-site using a Oakton pH/Con 10 meter, Serial #311648,						
calibrated daily before use.						
Turbidity was measured on-site using a Oakton T-100 meter, Serial #316738, calibrated daily before use						

Table 2 - Summary of Operational Data and Field Measured Parameters
City of Oakland Municipal Services Center Groundwater Remediation Project

Date	Time	Effluent (E-1)				Influent (I-1)			Btw-1	Btw-2	Totalizer	Monthly	Monthly	Product	Notes
		pH	Tempt	E. conduc	Turbidity	pH	Tempt	E. cond.			Reading	Treated	ave. rate	recovered	
			(ºC)	(ms/cm)	(NTU)		(ºC)	(ms/cm)			(gallons)	(gallons)	(gal/min)	(gallons)	
5/22/2006	7:00										1,389				Before turn on system
5/22/2006	11:25	8.3	20.4	8.81	0.2	7.12	21.4	10.2	sampled		2,050				treated water held in tank
5/22/2006	14:15										2,414				stopped, waiting for analy data
5/24/2006	13:00										2,414				system on, start discharge
5/30/2006	12:30	7.48	19.4	8.25	0.04	6.98	23.1	8.32	sampled		14,230	12,841		20	
5/31/2006	10:00										18,980	17,591	1.705		
6/2/2006	16:30								sampled	sampled	31,080				
6/9/2006	8:30										48,610				
6/16/2006	10:20										67,755				
6/19/2006	9:40										74,670				
6/22/2006	11:00										90,480				
6/26/2006	9:00	7.32	22.3	13	0.1	7.37	23.3	13.4	sampled	sampled	106,950				Monthly monitoring
6/30/2006	9:00										122,860	103,880	2.405	100	
7/5/2006	10:00										140,500				two full drums of product
7/12/2006	9:30								sampled	sampled	163,230				
7/19/2006	9:30										182,740				
7/25/2006	9:30	7.35	23.6	12.5	0.04	7.4	24.2	13.1	sampled		197,030				Monthly monitoring
7/31/2006	19:30										212,010	89,150	1.997	155	
8/2/2006	19:30										216,790			165	**three full drums of product**
8/9/2006	9:00										233,260				**Morgan removed 3 drums proc**
8/11/2006	9:30	6.95	21.5	12.8	0.1	7.25	22.3	12.6	sampled	sampled	238,380				Monthly monitoring
8/14/2006	8:00										246,180				lowered pumps in wells
8/17/2006	11:30										255,030				
8/28/2006	11:30										283,080				
9/1/2006	18:30										294,910	82,900	1.801	220	one full drum of product
9/5/2006	11:00	7	19.7	12.3	0.1	7.1	22.8	11.5	sampled	sampled	301,450				Monthly & Qtrly monitoring
9/9/2006	18:00										310,750				
9/17/2006	13:00										333,310				
9/22/2006	13:30										349,210				
9/27/2006	10:00										364,350				
9/29/2006	15:00										371,290				
10/2/2006	14:30										380,360	85,450	1.925	245	
10/4/2006	11:00	7.1	19.4	12.67	0.04	7.3	21.5	12.22	sampled	sampled	386,160				monthly monitoring

Table 3 - Summary of Petroleum Hydrocarbon Analytical Data
City of Oakland Municipal Services Center Groundwater Remediation Project

Date	Effluent (E-1)							Influent (I-1)						
	TPH gas	TPHdiesel	benzene	toluene	ethyl benz	xylenes	MTBE	TPH gas	TPHdiesel	benzene	toluene	ethyl benz	xylenes	MTBE
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Eff. Limit	50	50	5	5	5	5	13							
5/22/2006	ND (50)	ND (50)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (2.0)	52,000	25,000 (h,l)	6,100	5,200	1,200	6,100	ND (100)
5/30/2006	ND (50)	130 (y, a1)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	57,000	9,200 (l,y)	4900	5300	1100	7100	ND (36)
6/2/2006		ND (50)												
6/26/2006	ND (50)	ND (50)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (2.0)	50,000	10,000(h,l,y)	4800	6900	1100	7200	ND (50)
7/25/2006	ND (50)	ND (50)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (2.0)	60,000	4,000(l,y)	5800	8800	1100	9000	ND (80)
8/11/2006	ND (50)	ND (50)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	4.6 (a1a)	59,000	4,100 (l,y)	4900	7300	930	7000	ND (100)
9/5/2006	ND (50)	ND (50)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (2.0)	44,000	4,800 (l,y)	4700	4800	1200	5400	ND (50)

(a1) - false positive detection, confirmed ND on 6/2/06 samples at E-1, Btw-1 & Btw-2

(a1a) - false positive, confirmed ND on 9/5/06 sample

(h) - heavier hydrocarbons contributed to the quantitation

(l) - lighter hydrocarbons contributed to the quantitation

(y) - sample exhibits chromatographic pattern which does not resemble standard

Table 3 - Summary of Petroleum Hydrocarbon Analytical Data
City of Oakland Municipal Services Center Groundwater Remediation Project

Date	After 1st Carbon Unit (Btw-1)							After 2nd Carbon Unit (Btw-2)						
	TPH gas	TPHdiesel	benzene	toluene	ethyl benz	xylenes	MTBE	TPH gas	TPHdiesel	benzene	toluene	ethyl benz	xylenes	MTBE
	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)	(ug/L)
Eff. Limit	50	50	5	5	5	5	13	50	50	5	5	5	5	13
5/22/2006	57 (y)		ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (2.0)							
5/30/2006	ND (50)		ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)							
6/2/2006	ND (50)	ND (50)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)		NA	ND (50)					
6/26/2006	ND (50)	ND (50)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (2.0)	ND (50)	NA	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (2.0)
7/12/2006	ND (50)	ND (50)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (2.0)	ND (50)	NA	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	3.9 (a2)
7/25/2006	ND (50)		ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	2.7							
8/11/2006	ND (50)	ND (50)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	5.1 (a2a)	ND (50)	NA	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	5.4 (a2a)
9/5/2006	ND (50)	ND (50)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (2.0)	NA	NA	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (2.0)

(a2) - false positive detection, confirmed ND after the first carbon unit

(a2a) - false positive detection, confirmed ND on 9/5/06 sample

(h) - heavier hydrocarbons contributed to the quantitation

(l) - lighter hydrocarbons contributed to the quantitation

(y) - sample exhibits chromatographic pattern which does not resemble standard

Table 4 - Summary of Analytical Data for Inorganic Constituents and Fish Bioassay
City of Oakland Municipal Services Center Groundwater Remediation Project

Constituen	Unit	Eff Limit	**Effluent (E-1)**										
		(<10 gpm)	5/22/06	5/30/06	6/26/06	9/5/06							
Antimony	ug/L		2.3	1.8	0.12	0.13							
	g/day	3	0.02137	0.01672	0.001572	0.00138							
Arsenic	ug/L		36	24	7	3							
	g/day	1	0.33444	0.22296	0.0917	0.03177							
Beryllium	ug/L		ND (0.35)	ND (0.5)	ND (0.055)	ND (0.12)							
	g/day	3											
Cadmium	ug/L		1	0.5	ND (0.14)	ND (0.17)							
	g/day	1	0.00929	0.00465									
Total Cr	ug/L		3.1	ND (0.5)	0.62	0.86							
	g/day	2	0.0288		0.008122	0.00911							
Cr +6	ug/L		ND (1.0)	ND (10)	ND (0.5)	ND (0.5)							
	g/day	2											
Copper	ug/L		1.3	0.9	1.3	1.5							
	g/day	3	0.01208	0.00836	0.01703	0.01589							
Lead	ug/L		ND (0.1)	ND (0.25)	0.26	0.3							
	g/day	5			0.003406	0.00318							
Mercury	ug/L		ND(0.008)	ND(0.2)	ND (0.2)	ND (0.06)							
	g/day	0.01											
Nickel	ug/L		11	67	15	9.6							
	g/day	5	0.10219	0.62243	0.1965	0.10166							
Selinium	ug/L		3	3	1.2	ND (0.35)							
	g/day	2	0.02787	0.02787	0.01572								
Silver	ug/L		ND (0.02)	ND (0.1)	ND (0.041)	ND (0.07)							
	g/day	1											
Thallium	ug/L		0.06	ND (0.1)	0.21	ND (0.03)							
	g/day	3	0.00056		0.002751								
Zinc	ug/L		2	ND (10)	44	11							
	g/day	10	0.01858		0.5764	0.11649							
Cyanide	ug/L		ND (0.8)	ND (3)	ND (10)	ND (10)							
	g/day												
Hardness	mg/LCaCO3		560	960	1100	1100							
Fish Bioassay -													
% survival of Rainbow Trout					100%	100%							

Table 4 - Summary of Analytical Data for Inorganic Constituents and Fish Bioassay
City of Oakland Municipal Services Center Groundwater Remediation Project

Inorganic	Unit	Eff Limit	**Influent (I-1)**										
		(<10 gpm)	5/22/06	5/30/06									
Antimony	ug/L		ND (60)	ND (1)									
	g/day	3											
Arsenic	ug/L		7.2	8.5									
	g/day	1	0.06689	0.07897									
Beryllium	ug/L		ND (2)	ND (1)									
	g/day	3											
Cadmium	ug/L		34	10									
	g/day	1	0.31586	0.0929									
Total Cr	ug/L		ND (10)	ND (1)									
	g/day	2											
Cr +6	ug/L		ND (0.5)	ND (0.5)									
	g/day	2											
Copper	ug/L		250	25									
	g/day	3	2.3225	0.23225									
Lead	ug/L		28	21									
	g/day	5	0.26012	0.19509									
Mercury	ug/L		ND (0.2)	ND (0.2)									
	g/day	0.01											
Nickel	ug/L		68	19									
	g/day	5	0.63172	0.17651									
Selinium	ug/L		9.4	ND (1)									
	g/day	2	0.08733										
Silver	ug/L		ND (5)	ND (1)									
	g/day	1											
Thallium	ug/L		25	ND (1)									
	g/day	3	0.23225										
Zinc	ug/L		31	57									
	g/day	10	0.28799	0.52953									
Cyanide	ug/L		10	10									
	g/day		0.0929	0.0929									

Table 5 - Summary of Analytical Data for Organic Constituents
City of Oakland Municipal Services Center Groundwater Remediation Project

		Effluent (E-1)						
	Max Daily	5/30/06	9/5/06					
	Eff. Limit							
	(ug/L)	(ug/L)	(ug/L)					
Benzene	5	ND (0.5)	ND (0.5)					
Carbon tetrachloride	5	ND (0.5)	ND (0.5)					
Chloroform	5	ND (0.5)	ND (0.5)					
1,1-Dichloroethane	5	ND (0.5)	ND (0.5)					
1,2-Dichloroethane	5	ND (0.5)	ND (0.5)					
1,1-dichloroethylene	5	ND (0.5)	ND (0.5)					
Ethylbenzene	5	ND (0.5)	ND (0.5)					
Methylene chloride	5	ND (0.5)	ND (0.5)					
Tetrachloroethylene	5	ND (0.5)	ND (0.5)					
Toluene	5	ND (0.5)	ND (0.5)					
c-1,2-Dichloroethylene	5	ND (0.5)	ND (0.5)					
t-1,2-Dichloroethylene	5	ND (0.5)	ND (0.5)					
1,1,1-Trichloroethane	5	ND (0.5)	ND (0.5)					
1,1,2-Trichloroethane	5	ND (0.5)	ND (0.5)					
Trichloroethylene	5	ND (0.5)	ND (0.5)					
vinyl chloride	5	ND (0.5)	ND (0.5)					
total xylenes	5	ND (0.5)	ND (0.5)					
MTBE	13	ND (0.5)	ND (0.5)					
Ethylene dibromide	5	ND (0.5)	ND (0.5)					
Trichlorotrifluoroethane	5	ND (5)	ND (5)					
TPH gas	50	ND (50)	ND (50)					
TPH diesel	50	ND (50)	ND (50)					
TAME		ND (0.5)	ND (0.5)					
DIPE		ND (0.5)	ND (0.5)					
ETBE		ND (0.5)	ND (0.5)					
TBA		ND (10)	ND (10)					
Ethanol		ND(1000)	ND(1000)					
Methanol		ND(1000)	ND(1000)					
Other VOCs (EPA 8260)		ND	ND					
PAHs (EPA 8310 or 610)								
All analytes		ND (1.0)	ND (0.1)					
SVOCs(EPA8270 or625)								
All analytes		ND (5.0)	ND (9.4)					

Table 5 - Summary of Analytical Data for Organic Constituents
City of Oakland Municipal Services Center Groundwater Remediation Project

		Influent (I-1)						
		5/30/06						
		(ug/L)						
Benzene		4900						
Carbon tetrachloride		ND (36)						
Chloroform		ND (36)						
1,1-Dichloroethane		ND (36)						
1,2-Dichloroethane		ND (36)						
1,1-dichloroethylene		ND (36)						
Ethylbenzene		1100						
Methylene chloride		ND (36)						
Tetrachloroethylene		ND (36)						
Toluene		5300						
c-1,2-Dichloroethylene		ND (36)						
t-1,2-Dichloroethylene		ND (36)						
1,1,1-Trichloroethane		ND (36)						
1,1,2-Trichloroethane		ND (36)						
Trichloroethylene		ND (36)						
vinyl chloride		ND (36)						
total xylenes		7100						
MTBE		ND (36)						
Ethylene dibromide		ND (36)						
Trichlorotrifluoroethane		ND (360)						
TPH gas		57000						
TPH diesel		9200						
TAME		ND (36)						
DIPE		ND (36)						
ETBE		ND (36)						
TBA		ND (710)						
Ethanol		ND(1000)						
Methanol		ND(1000)						
Other VOCs (EPA 8260)								
Isopropylbenzene		40						
Propylbenzene		120						
1,3,5-Trimethylbenzene		410						
1,2,4-Trimethylbenzene		1500						
Naphthalene		370						
PAHs (EPA 8310 or 610)								
Benzo(a)anthracene		1.7						
Benzo(a)pyrene		1.6						
Chrysene		2.6						
Fluoranthene		3.8						
Naphthalene		130						
Pyrene		3.3						
SVOCs(EPA8270 or625)								
Dimethylphthalate		28						
bis(2-Ethylhexyl)phthalate		12						
Naphthalene		290						
Phenol		13						

Table 5 - Summary of Analytical Data for Organic Constituents
City of Oakland Municipal Services Center Groundwater Remediation Project

		After First Carbon Unit (Btw-1)						
	Max Daily	5/30/06	9/5/06					
	Eff. Limit							
	(ug/L)	(ug/L)						
Benzene	5	ND (0.5)	ND (0.5)					
Carbon tetrachloride	5	ND (0.5)	NA					
Chloroform	5	ND (0.5)	NA					
1,1-Dichloroethane	5	ND (0.5)	NA					
1,2-Dichloroethane	5	ND (0.5)	NA					
1,1-dichloroethylene	5	ND (0.5)	NA					
Ethylbenzene	5	ND (0.5)	ND (0.5)					
Methylene chloride	5	ND (0.5)	NA					
Tetrachloroethylene	5	ND (0.5)	NA					
Toluene	5	ND (0.5)	ND (0.5)					
c-1,2-Dichloroethylene	5	ND (0.5)	NA					
t-1,2-Dichloroethylene	5	ND (0.5)	NA					
1,1,1-Trichloroethane	5	ND (0.5)	NA					
1,1,2-Trichloroethane	5	ND (0.5)	NA					
Trichloroethylene	5	ND (0.5)	NA					
vinyl chloride	5	ND (0.5)	NA					
total xylenes	5	ND (0.5)	ND (0.5)					
MTBE	13	ND (0.5)	ND (2)					
Ethylene dibromide	5	ND (0.5)	NA					
Trichlorotrifluoroethane	5	ND (5)	NA					
TPH gas	50	ND (50)	ND (50)					
TPH diesel	50	ND (50)	ND (50)					
TAME		ND (0.5)	NA					
DIPE		ND (0.5)	NA					
ETBE		ND (0.5)	NA					
TBA		ND (10)	NA					
Ethanol		NA	NA					
Methanol		NA	NA					
Other VOCs (EPA 8260)		ND	NA					
PAHs (EPA 8310 or 610)		NA						
SVOCs(EPA8270 or625)		NA						

Table 5 - Summary of Analytical Data for Organic Constituents
City of Oakland Municipal Services Center Groundwater Remediation Project

		After Second Carbon Unit (Btw-2)						
	Max Daily		9/5/06					
	Eff. Limit							
	(ug/L)		(ug/L)					
Benzene	5		ND (0.5)					
Carbon tetrachloride	5		ND (0.5)					
Chloroform	5		ND (0.5)					
1,1-Dichloroethane	5		ND (0.5)					
1,2-Dichloroethane	5		ND (0.5)					
1,1-dichloroethylene	5		ND (0.5)					
Ethylbenzene	5		ND (0.5)					
Methylene chloride	5		ND (0.5)					
Tetrachloroethylene	5		ND (0.5)					
Toluene	5		ND (0.5)					
c-1,2-Dichloroethylene	5		ND (0.5)					
t-1,2-Dichloroethylene	5		ND (0.5)					
1,1,1-Trichloroethane	5		ND (0.5)					
1,1,2-Trichloroethane	5		ND (0.5)					
Trichloroethylene	5		ND (0.5)					
vinyl chloride	5		ND (0.5)					
total xylenes	5		ND (0.5)					
MTBE	13		ND (0.5)					
Ethylene dibromide	5		ND (0.5)					
Trichlorotrifluoroethane	5		ND (5)					
TPH gas	50		NA					
TPH diesel	50		NA					
TAME			ND (0.5)					
DIPE			ND (0.5)					
ETBE			ND (0.5)					
TBA			ND (10)					
Ethanol			ND (1000)					
Methanol			NA					
Other VOCs (EPA 8260)			ND					
PAHs (EPA 8310 or 610)			NA					
SVOCs(EPA8270 or625)			NA					

APPENDIX A

Design Drawings of Remediation System

APPENDIX B

Laboratory Analytical Reports – May 22 & 30, June 2, 2006 Samples