RO 265

ENVIRONMENTAL ENGINEERING, INC.
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April 22, 2005

Mr. Amir Gholami
Alameda County Environmental Health Services
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502

Re: Pilot Test and Design of Ozone System at
Tony's Express Auto Service
3609 International Boulevard, Oakland, California
Fuel Leak Case #RO0000265

Dear Mr. Gholami:

Based on the approval of the ACEHS, SOMA conducted a pilot test to evaluate the use of ozone sparging to actively remediate the groundwater at the above referenced site. The source area appears to have remained in the vicinity of wells MW-1, MW-3, and MW-6 (see Figure 1 for the locations of these wells). Therefore, by utilizing ozone sparging technology the concentration of contaminants within the source area in the groundwater should decrease.

On April 1, 2005, a pilot test was conducted on wells MW-1, MW-3, and MW-6. The test was conducted to determine the permeability of the soil with respect to air in the vicinity of these wells. Prior to the on-site test, SOMA contacted Piper Environmental Group (Piper), the manufacturer of the ozone sparging system, to obtain information on the procedures for the pilot test. SOMA used a test kit that was supplied by Piper. The test kit included a compressor, hoses, and a pressure regulator for adjusting the flow to the wellhead. Per the test kit's recommendation, the wellhead diameter was modified from a 2-inch (in wells MW-1 and MW-6) and 4-inch (in well MW-3) to a ½ inch diameter, by PVC fittings. Subsequently, compressed air was applied inside each well after the wellhead was reduced. While the pressure inside the well increased the flow rate in SCFH (standard cubic feet per hour), the pressure was recorded.

The sediment is determined to be permeable enough to allow for the operation of an ozone sparging system if the recoded flow rate reaches 180 SCFH. Table 1 presents the flow rate and recoded pressure heads during each test at different time intervals.

At wells MW-3 and MW-6, when the applied pressure reached approximately 14 pounds per square inch (PSI) the reported flow rate through the well screening reached approximately 180 SCFH. However, at well MW-1, due to the low permeability of the sediments or because of clogging the well screen at 30 PSI, the recoded flow rate was only 70 SCFH. As the geologic log of MW-1 shows, the saturated sediments are comprised of fine-grained material, mostly clayey silts. As part of the test procedure, depth to groundwater was measured prior to the test and after the test. Based on the field measurements, the water depths dropped considerably when compressed air was applied into each well. The drop in the well's water elevation allowed the compressed air to go through the well screen openings and enter the dewatered sediments.

Based on the test results, the ozone sparging technique could effectively be used to treat the large semi-saturated zone, as well as the groundwater that is produced when the compressed air applies to each well. As the results indicated, the soil permeability was more conducive to ozone sparging at wells MW-3 and MW-6. However, due to the low permeability of sediments around MW-1 or possibly because of a faulty well screen, this well may not be suitable for the ozone sparging technique.

The pilot test results provided reasonable assurance that the ozone sparging technique could effectively be used to treat the saturated sediments and groundwater beneath the site; therefore, the next step is to determine the extent of the chemical plume, mass of contaminants in the subsurface and amount of ozone gas needed to remediate the existing chemical plume beneath the site. Based on the previous quarterly monitoring data, the area of the chemical plume is well defined. It seems that the majority of the chemical mass resides in the form of dissolved and adsorbed phases in the saturated sediments, which has an approximate thickness of 12 feet. To calculate the total masses of TPH-g, benzene and MtBE in the saturated sediments, the following formula was used:

$$Chemical\ Mass = A \times B \times C_a \times Rd$$

Where:

A = area of chemical plume for each constituent,

B = average saturated thickness, was assumed to be 12 feet,

C_a = average concentration of constituent in groundwater, and

Rd = retardation coefficient of each constituent.

Including the retardation coefficient in calculating the chemical mass helps consider the dissolved and adsorbed chemical mass within the saturated thickness. As a rule of thumb, to degrade each pound of a petroleum hydrocarbon in the subsurface, approximately 10 pounds of ozone is needed. Table 3 presents the estimated average concentration of each chemical in the groundwater.

As shown in Table 2, the ozone requirement is based on the following factors:

1. The area impacted by each constituent of concern (TPH-g, benzene, and MtBE);
2. The thickness of the saturated zone (assumed at 12 feet per existing well logs);
3. The contaminant concentrations (based on the average contaminant concentrations over the five monitoring events at the relevant wells); and
4. The retardation coefficient for each constituent.

Figures 2 through 4 illustrate the impacted areas for each constituent, as well as the wells that are relevant to the computation of the average contamination. Tables 3 and 3a summarize the average concentrations of the target constituents from the five most recent monitoring events. As the calculation shows, approximately 16.39 pounds of ozone per day is needed. It is estimated that it would take approximately three years to achieve the cleanup goals set forth by the RWQCB, see Table 2. The cleanup goals for site closure are 500 ppb for MtBE, 100 ppb for benzene and 4,000 ppb for TPH-g. SOMA is planning to implement the ozone sparging system at the site upon your approval.

Thank you for taking the time to review this matter. Please do not hesitate to call me at (925) 244-6600, if you have any questions or comments.

Sincerely,

Mansour Sepehr, Ph.D., P.E.
Principal Hydrogeologist

REGISTERED PROFESSIONAL ENGINEER
MANSOUR SEPEHR
No. C042928
Exp. 3-31-06
CIVIL
STATE OF CALIFORNIA

cc: Abolghessem Razi

Attachments

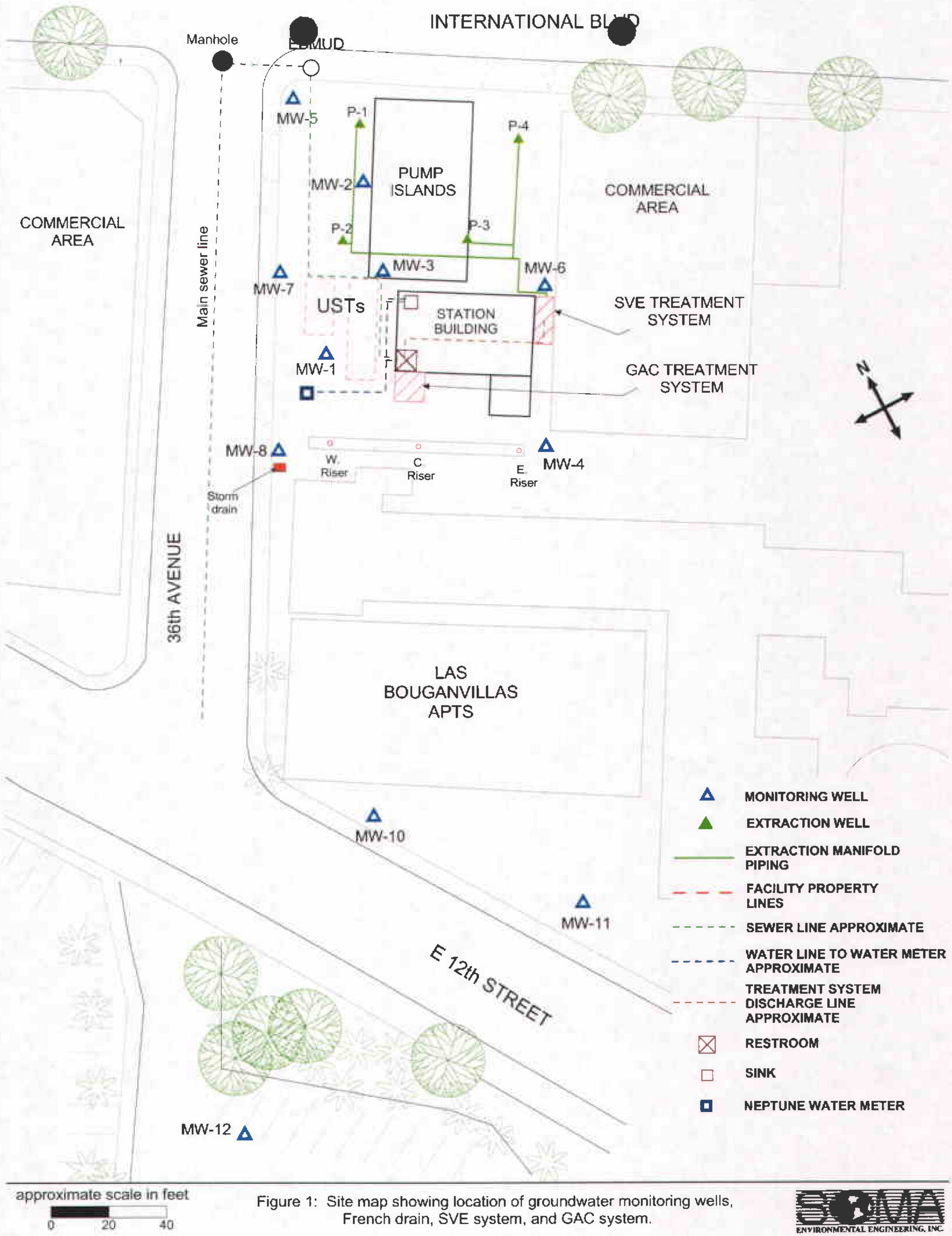

Figure 1: Site map showing location of groundwater monitoring wells, French drain, SVE system, and GAC system.

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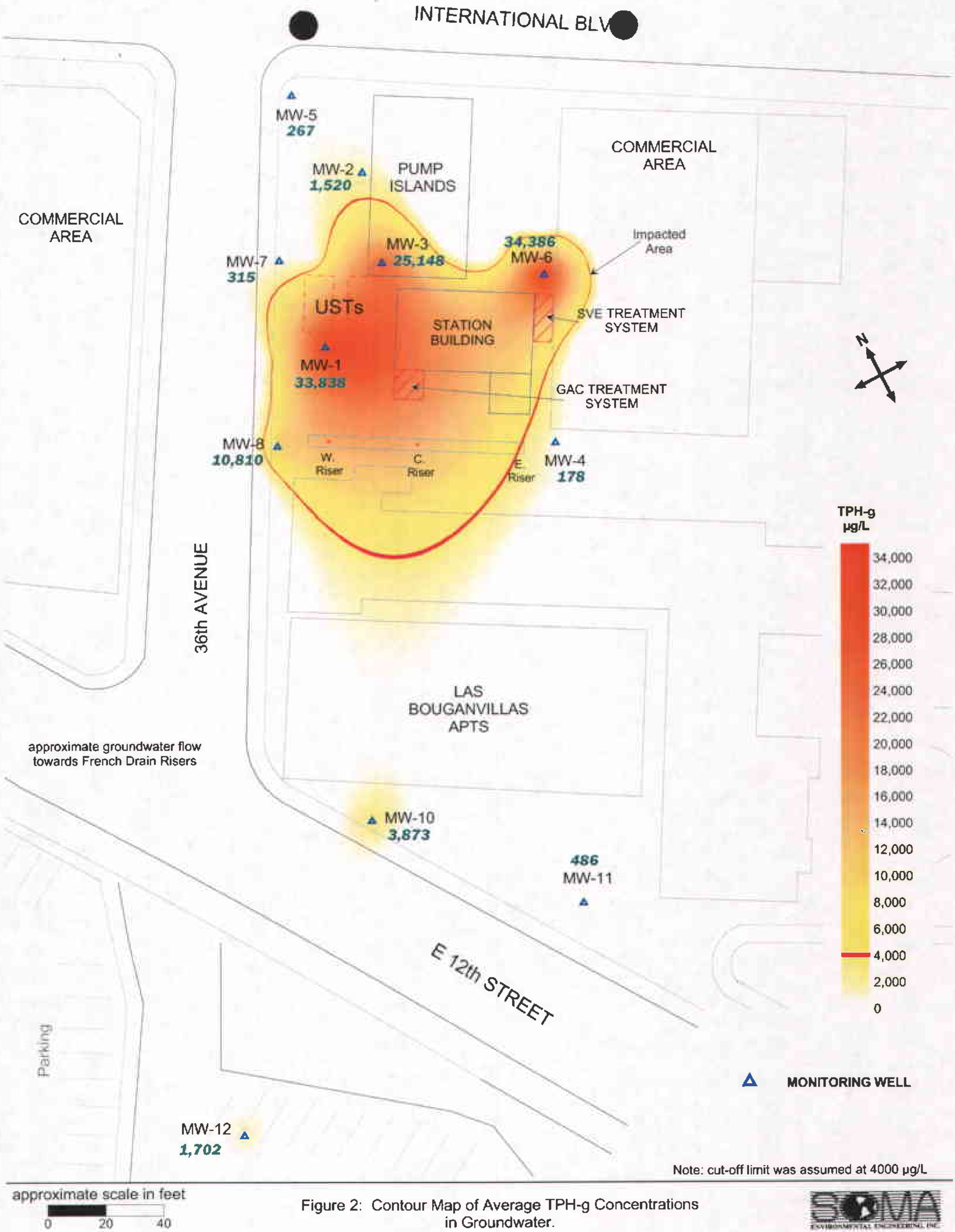


Figure 2: Contour Map of Average TPH-g Concentrations in Groundwater.

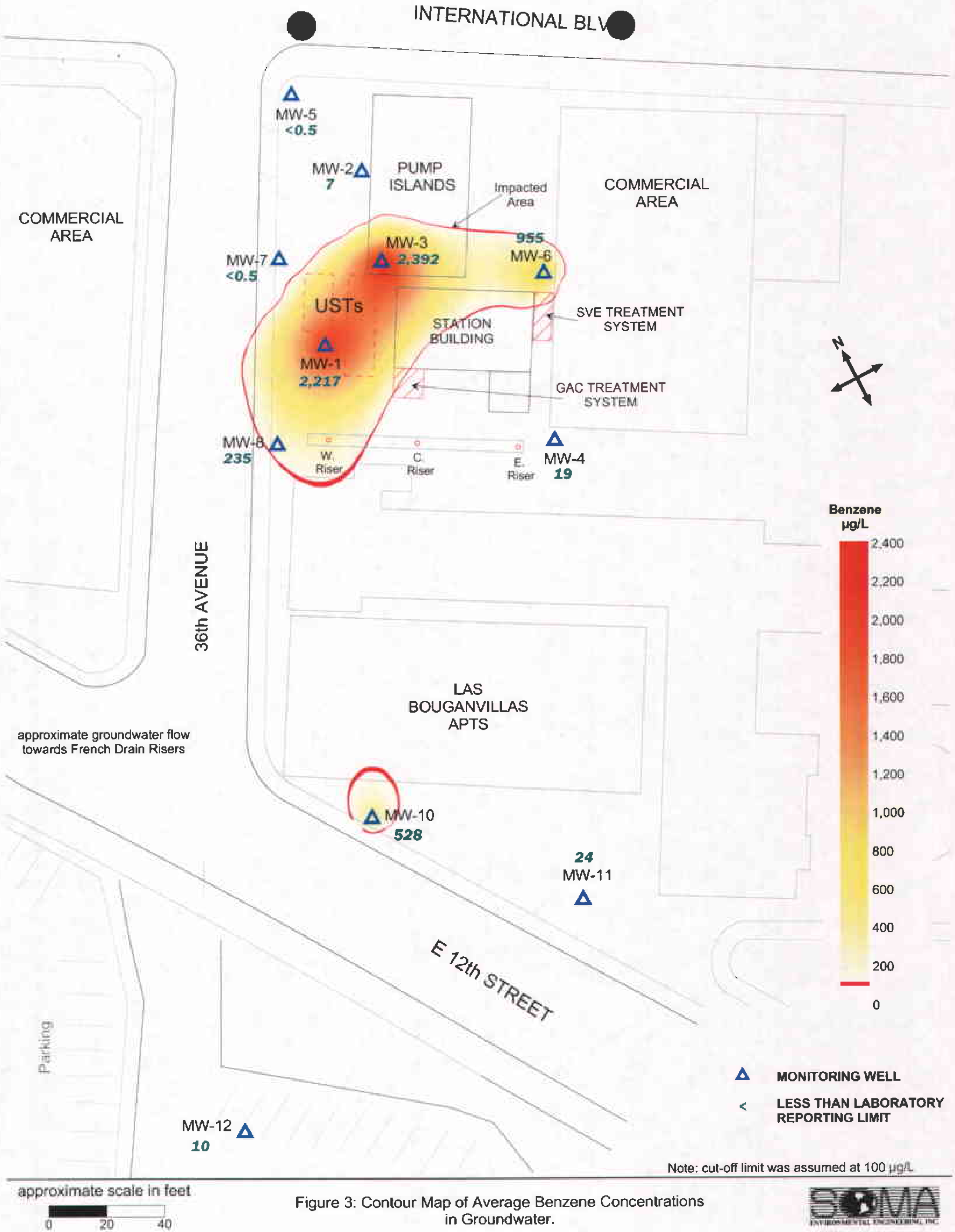
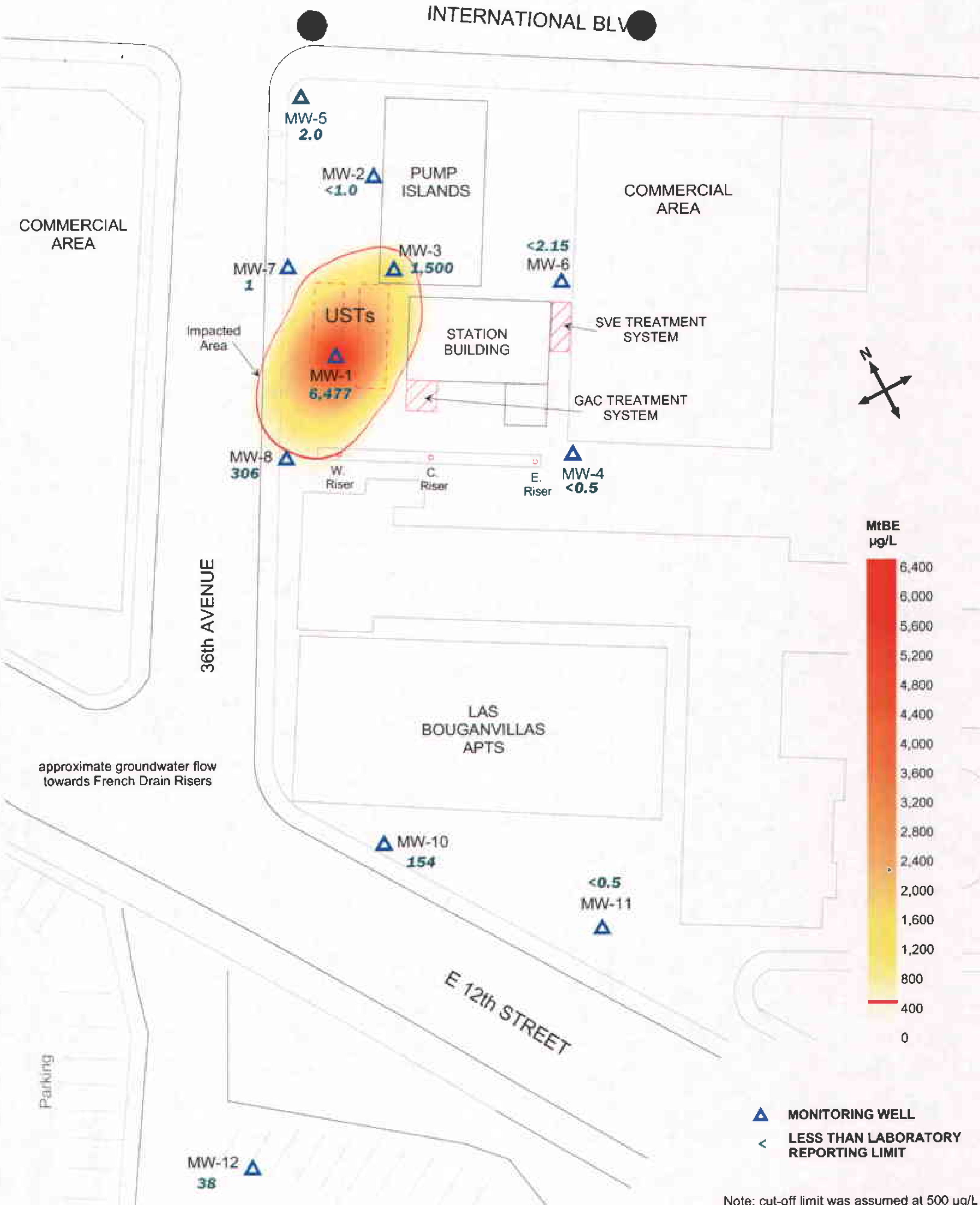


Figure 3: Contour Map of Average Benzene Concentrations in Groundwater.



approximate scale in feet

0 20 40

Figure 4: Contour Map of Average MtBE Concentrations in Groundwater.

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TABLE 1

Permeability Testing For Ozone System

3609 International Blvd, Oakland, CA

MW-1					
Date of Test	Time (During Test)	Depth to Water Pre-test (feet)	PSI (at wellhead)	SCFH (flow through wellscreen	Depth to Water Post-test (feet)
April 1, 2005	9:44 AM	8.68			
	9:45 AM	**start of pilot test**			
	9:46 AM		4	30	
	9:50 AM		9	50	
	9:53 AM		14	60	
	9:57 AM		20	65	
	10:03 AM		24	65	
	10:12 AM		30	70	
	10:16 AM		30	70	
	10:17 AM	**end of pilot test**			
	10:18 AM				13.11

MW-3					
Date of Test	Time (During Test)	Depth to Water Pre-test (feet)	PSI (at wellhead)	SCFH (flow through wellscreen	Depth to Water Post-test (feet)
April 1, 2005	10:32 AM	8.71			
	10:33 AM	**start of pilot test**			
	10:34 AM		3	40	
	10:35 AM		5	60	
	10:40 AM		6	80	
	10:48 AM		6	90	
	10:55 AM		6	100	
	11:01 AM		8	120	
	11:06 AM		10	140	
	11:10 AM		12	160	
	11:14 AM		14	180	
	11:15 AM	**end of pilot test**			
	11:16 AM				17.71

TABLE 1
Permeability Testing For Ozone System
3609 International Blvd, Oakland, CA

MW-6					
Date of Test	**Time (During Test)**	**Depth to Water Pre-test (feet)**	**PSI (at wellhead)**	**SCFH (flow through wellscreen**	**Depth to Water Post-test (feet)**
April 1, 2005	11:18 AM	8.91			
	11:19 AM	**start of pilot test**			
	11:20 AM		5	50	
	11:26 AM		6	75	
	11:31 AM		7	80	
	11:41 AM		8	85	
	11:45 AM		8	90	
	11:51 AM		8	96	
	12:00 PM		8	110	
	12:02 PM		11	125	
	12:07 PM		11	140	
	12:11 PM		13	160	
	12:13 PM		14	180	
	12:14 PM	**end of pilot test**			
	12:15 PM				13.11

Notes:
Test Equipment was supplied by Piper Environmental in Castroville, CA
PSI: Pounds per square inch
SCFH: Standard cubic feet per hour
Test was conducted by SOMA to ensure ozone sparging was feasible on site wells.
All breakthroughs occurred at 3 psi.

Table 2
Ozone Requirement
3609 International Boulevard, Oakland, California

	TPH-g	Benzene	MtBE
Log Koc	NA	1.69	1.3
Koc (cm^3/g)	NA	48.97	19.95
Kd	NA	0.245	0.0998
Rd	10*	2.143	1.47
Saturated Thickness (ft)	12	12	12
Average Concentration (µg/L)**	26,046.00	1,450.00	3,989.00
Impacted Area (ft^2)	9,087.36	5,370.25	2,710.37
Estimated Mass of Contaminant (lb)	1,770.14	12.48	11.89
Total Ozone Requirement per contaminant (lb)	17,701.42	124.80	118.86
Total Ozone Requirement (lb)	**17,945.08**		
Ozone Daily Requirement (18 month) (lb)	**34.71**		
Ozone Daily Requirement (30 month) (lb)	**19.68**		
Ozone Daily Requirement (36 month) (lb)	**16.39**		

Rd=1+(Kd*bulk density of porous medium/porosity of porous medium)

Mass (Constituent)=(Area*Saturated Thickness*Average Concentration)*Rd

Ozone Requirement= Mass (Constituent)*10

Koc- Organic carbon partition coefficient

Kd- Distribution coefficient

Rd- Retardation coefficient

Bulk density of porous medium =1.4

Porosity of porous medium =0.3

* Assumed retardation coefficient

** Average concentrations: (See Table 3)

- TPH-g (wells MW-1, MW-3, MW-6, MW-8)
- Benzene (wells MW-1, MW-3, MW-6, MW-8)
- MtBE (wells MW-1, MW-3)

Table 3
Calculation of Average Chemical Concentration in Groundwater
3609 International Boulevard, Oakland, California

Monitoring Well	Date	TPH-g (µg/L)	TPH-g (µg/L) Average	Benzene (µg/L)	Benzene (µg/L) Average	MtBE [2] EPA 8260B (µg/L)	MtBE [2] EPA 8260B (µg/L) Average
MW-1	Jan-04	39,000		3,100		8,500	
	Apr-04	41,000		1,200		4,300	
	Aug-04	22,000		2,000		6,900	
	Dec-04	22,790		1,634		5,504	
	Mar-05	**44,400**	**33,838**	**3,150**	**2,217**	**7,180**	**6,477**
MW-3	Jan-04	45,000		2,100		2,900	
	Apr-04	31,000		4,200		900	
	Aug-04	21,000		3,400		1,100	
	Dec-04	6,441		978		201	
	Mar-05	**22,300**	**25,148**	**1,280**	**2,392**	**2,400**	**1,500**
MW-6	Jan-04	30,000		1,300		<50	
	Apr-04	99,000		1,700		<50	
	Aug-04	12,000		580		<10	
	Dec-04	12,631		649		<2.15	
	Mar-05	**18,300**	**34,386**	**546**	**955**	**<2.15**	**NA**
MW-8	Jan-04	18,000		330		500	
	Apr-04	12,000		240		<4	
	Aug-04	6,000		310		<4	
	Dec-04	6,650		171		166	
	Mar-05	**11,400**	**10,810**	**125**	**235**	**865**	**NA**
Total Average	**Mar-05**		**26,046**		**1,450**		**3,989**

Notes:
2 MtBE was analyzed using the EPA Method 8021B and confirmed using 8260B.
NA: Not Applicable, concentrations are outside assumed cut-off limits.
ND, < : Not Detected above laboratory reporting limits.

Table 3a

Average Chemical Concentration in Groundwater

3609 International Boulevard, Oakland, California

Monitoring Well	Date	TPH-g (µg/L)	TPH-g (µg/L) Average	Benzene (µg/L)	Benzene (µg/L) Average	MtBE [2] EPA 8260B (µg/L)	MtBE [2] EPA 8260B (µg/L) Average
MW-1	Jan-04	39,000		3,100		8,500	
	Apr-04	41,000		1,200		4,300	
	Aug-04	22,000		2,000		6,900	
	Dec-04	22,790		1,634		5,504	
	Mar-05	**44,400**	**33,838**	**3,150**	**2,217**	**7,180**	**6,477**
MW-2	Jan-04	860		7.2		<2.0	
	Apr-04	730		6.6		<2.0	
	Aug-04	220		2.2		<0.5	
	Dec-04	99		1.7		<0.5	
	Mar-05	**5,690**	**1,520**	**18.7**	**7**	**<1.0**	**0**
MW-3	Jan-04	45,000		2,100		2,900	
	Apr-04	31,000		4,200		900	
	Aug-04	21,000		3,400		1,100	
	Dec-04	6,441		978		201	
	Mar-05	**22,300**	**25,148**	**1,280**	**2,392**	**2,400**	**1,500**
MW-4	Jan-04	230		18		<2.0	
	Apr-04	<50		3.8		<2.0	
	Aug-04	<50		1.6		<2.0	
	Dec-04	<50		1.3		<0.5	
	Mar-05	**661**	**178**	**72**	**19**	**<0.5**	**0.0**
MW-5	Jan-04	160		<0.5		0	
	Apr-04	280		<0.5		2.1	
	Aug-04	250		<0.5		2	
	Dec-04	150		<0.5		2.6	
	Mar-05	**496**	**267**	**<0.5**	**0**	**1.91**	**2**
MW-6	Jan-04	30,000		1,300		<50	
	Apr-04	99,000		1,700		<50	
	Aug-04	12,000		580		<10	
	Dec-04	12,631		649		<2.15	
	Mar-05	**18,300**	**34,386**	**546**	**955**	**<2.15**	**0**
MW-7	Jan-04	380		<0.5		<5.0	
	Apr-04	480		<0.5		0.62	
	Aug-04	410		<0.5		1.70	
	Dec-04	96		<0.5		<0.5	
	Mar-05	**209**	**315**	**<0.5**	**0.0**	**1.74**	**1**
MW-8	Jan-04	18,000		330		500	
	Apr-04	12,000		240		<4	
	Aug-04	6,000		310		<4	
	Dec-04	6,650		171		166	
	Mar-05	**11,400**	**10,818**	**125**	**235**	**865**	**306**
MW-10	Jan-04	4,000		600		110	
	Apr-04	5,100		580		160	
	Aug-04	3,400		550		100	
	Dec-04	2,524		556		144	
	Mar-05	**4,340**	**3,873**	**354**	**528**	**258**	**154**
MW-11	Jan-04	NA		NA		NA	
	Apr-04	NA		NA		NA	
	Aug-04	NA		NA		NA	
	Dec-04	486		24		<0.5	
	Mar-05	**NA**	**486**	**NA**	**24**	**NA**	**0**
MW-12	Jan-04	1,700		24		72	
	Apr-04	2,000		11		36	
	Aug-04	1,900		9		26	
	Dec-04	1,018		2		26	
	Mar-05	**1,890**	**1,702**	**4.25**	**10**	**30.6**	**38**

Notes:

[2] MtBE was analyzed using the EPA Method 8021B and confirmed using 8260B.

NA: Not Analyzed

NA: Not Applicable, Well/Drain did not exist at time of sampling

ND, < : Not Detected above laboratory reporting limits.