

A Report Prepared for

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**SUMMARY REPORT
BIOREMEDIATION TREATABILITY STUDY
CITY BLUE PRODUCTION FACILITY**

HLA Job No. 18106,010.04

June 18, 1990

by:

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June 18, 1990

INTRODUCTION

This report summarizes the findings of Harding Lawson Associates' (HLA) evaluation study to assess the feasibility of using biological treatment to remediate contaminated groundwater at the City Blue Production Facility (CBPF) in Oakland, California.

The purpose of this study was to evaluate inorganic chemistry and microbiological constituents in groundwater that would require enhancement in order to optimize the biological degradation of total petroleum hydrocarbons (TPH) and the indicator compounds (benzene, toluene, ethylbenzene and xylenes; BTEX) present in groundwater, and to perform a laboratory-scale study to evaluate the effectiveness of the biological treatment process. The laboratory study was designed to:

- o Evaluate the existing microbial populations capable of degrading petroleum hydrocarbons (gasoline).
- o Evaluate groundwater chemistry factors that could influence the rate of biological degradation of petroleum hydrocarbons.
- o Perform a laboratory-scale simulation of the biological treatment process to evaluate TPH and BTEX removal efficiencies for several combinations of residence time and influent concentrations of TPH and BTEX.

SAMPLE ANALYSIS AND INTERPRETATION OF RESULTS

Sample Collection

Two groundwater samples, each approximately 5 gallons in volume, were collected from the site by HLA field personnel during a site visit on April 9, 1990. These samples were utilized in the microbial and groundwater chemistry evaluations and in the laboratory treatment simulation study.

Microbial Populations in Groundwater

Each groundwater sample was analyzed in HLA's bioremediation laboratory to estimate the total number of microorganisms per gram (milliliter) of sample and, of these, those microorganisms that have the metabolic capability to use hydrocarbons (gasoline) as a primary source of carbon and energy. Microorganisms capable of degrading hydrocarbons were present in each groundwater sample. The percentage of hydrocarbon-utilizers as a portion of the total population ranged from 0.6 percent to 3 percent. Results of the microbial evaluation of the groundwater samples are summarized in Table 1.

The results indicate that the existing microbial population in the groundwater contains a subpopulation of microorganisms capable of degrading hydrocarbons. Stimulation of the hydrocarbon-utilizing microorganisms with the proper nutrients should increase their percentage of the total microbial population and result in a significant decrease in the concentration of hydrocarbons in the groundwater.

Microenvironmental Factors in Groundwater

A groundwater chemistry profile, which included pH and concentrations of nitrogen as ammonia and nitrate, phosphorus as orthophosphate, sulfate and dissolved iron, manganese, magnesium, calcium, and potassium was developed for a composite groundwater sample. The results of the groundwater chemistry analysis are summarized in Table 2.

* Generally, acceptable concentrations of key inorganic nutrients necessary to sustain microbial metabolism are as follows:

- o Nitrogen as nitrate or ammonia - 20 milligrams (mg) per 100 mg hydrocarbon
- o Phosphorus as orthophosphate - 5 mg per 100 mg hydrocarbon.

Comparison of the analytical results to microbial growth requirements indicates that the low concentrations of nitrogen as nitrate or ammonia, and phosphorus as orthophosphate are probably limiting the potential for microbial degradation of the petroleum hydrocarbons. Therefore, stimulation of the indigenous microbial population capable of degrading petroleum hydrocarbons will require the addition of nitrate or ammonia and phosphorus in a form readily available to the microorganisms.

Biological Treatment Simulation

A laboratory scale treatment system was constructed to simulate conditions under which the bioremediation process would be operated in the field. The treatment system (Figure 1) consisted of a bench-scale bioreactor equipped with appurtenances for oxygen and nutrient additions. A composite groundwater sample containing petroleum hydrocarbons was pumped to the bioreactor at several specified rates over the three-week treatment period to determine the flow rate for optimum biological degradation of the petroleum hydrocarbons.

Daily influent samples to the bioreactor and effluent samples following biological treatment were collected and analyzed for TPH as gasoline and BTEX to determine the degradation efficiency of the bioreactor under specific operating conditions. Additionally, the bioreactor contents were sampled daily and analyzed for microbial populations. The results of the bioreactor study are summarized in Table 3.

Chemical analysis of the effluent quality from the bioreactor at a liquid retention time of 18 and 12 hours indicated that the total BTEX removal efficiency of the bioreactor was greater than 99.9 percent. Additionally, chemical analyses at a liquid retention time of 8 hours indicated that the total BTEX removal efficiency of the bioreactor ranged from 96.6 to greater than 99.9 percent.

SUMMARY AND CONCLUSIONS

The microbial evaluation indicates that the existing microbial population in CBPF groundwater contains a subpopulation of hydrocarbon-utilizing microorganisms.

The groundwater chemistry results indicate that low concentrations of the inorganic nutrients nitrogen and phosphorus could be limiting the metabolism of the existing microorganisms capable of degrading hydrocarbons in the groundwater environment. The addition of these limiting nutrients in conjunction with aeration should stimulate the growth of the hydrocarbon-utilizing microorganisms, resulting in a reduction in the concentration of hydrocarbons in the groundwater.

The laboratory simulation results indicate biological treatment of the groundwater resulted in a decrease in the total BTEX concentration of approximately 99 percent at liquid retention times of 18 and 12 hours. Influent groundwater having a dissolved TPH concentration ranging between 61 and 150 parts per million (ppm) may require post-treatment in a carbon adsorption system before the treated water may be discharged. Based on the bioreactor studies it is anticipated that at a liquid retention time of 12 hours, the maximum total BTEX loading from the treated effluent into the carbon adsorption system will not exceed 5 parts per billion (ppb). Continued groundwater extraction and operation of a full scale system should result in a decrease of influent TPH and BTEX concentrations; thus, a reduced hydrocarbon loading rate for the carbon adsorption system would be anticipated over the duration of the project. These results indicate that biological treatment of TPH and BTEX in groundwater at the site is technically feasible and effective. The process data generated from this study will serve as the basis for design of the full scale treatment system.

**Table 1. Enumeration of Total and Hydrocarbon-Utilizing
Microorganisms in Groundwater
City Blue Production Facility**

HLA Lab Number	Sample Designation	Total Microorganisms	Hydrocarbon-Utilizing Microorganisms	
90-1531	MW-1A	53,000 cfu/milliliter*	330 cfu/milliliter*	0.6%
90-1532	MW-4	880 cfu/milliliter*	24 cfu/milliliter*	2.7%

* cfu/milliliter. Colony forming units per milliliter.

**Table 2. Groundwater Chemistry Profile
City Blue Production Facility**

Parameter	Sample Designation Groundwater Composite ⁽¹⁾
pH	6.8
Ammonia-N (mg/l) ⁽²⁾	0.2
Nitrate-N (mg/l)	0.2
Orthophosphate (mg/l)	0.04
Sulfate (mg/l)	93
Dissolved Iron (mg/l)	17
Dissolved Manganese (mg/l)	5.1
Dissolved Magnesium (mg/l)	43
Dissolved Potassium (mg/l)	28
Dissolved Calcium (mg/l)	46

(1) Samples taken by HLA June 1, 1989, and analyzed by Pace Laboratories, Novato, California.

(2) Milligrams per liter - equivalent to parts per million.

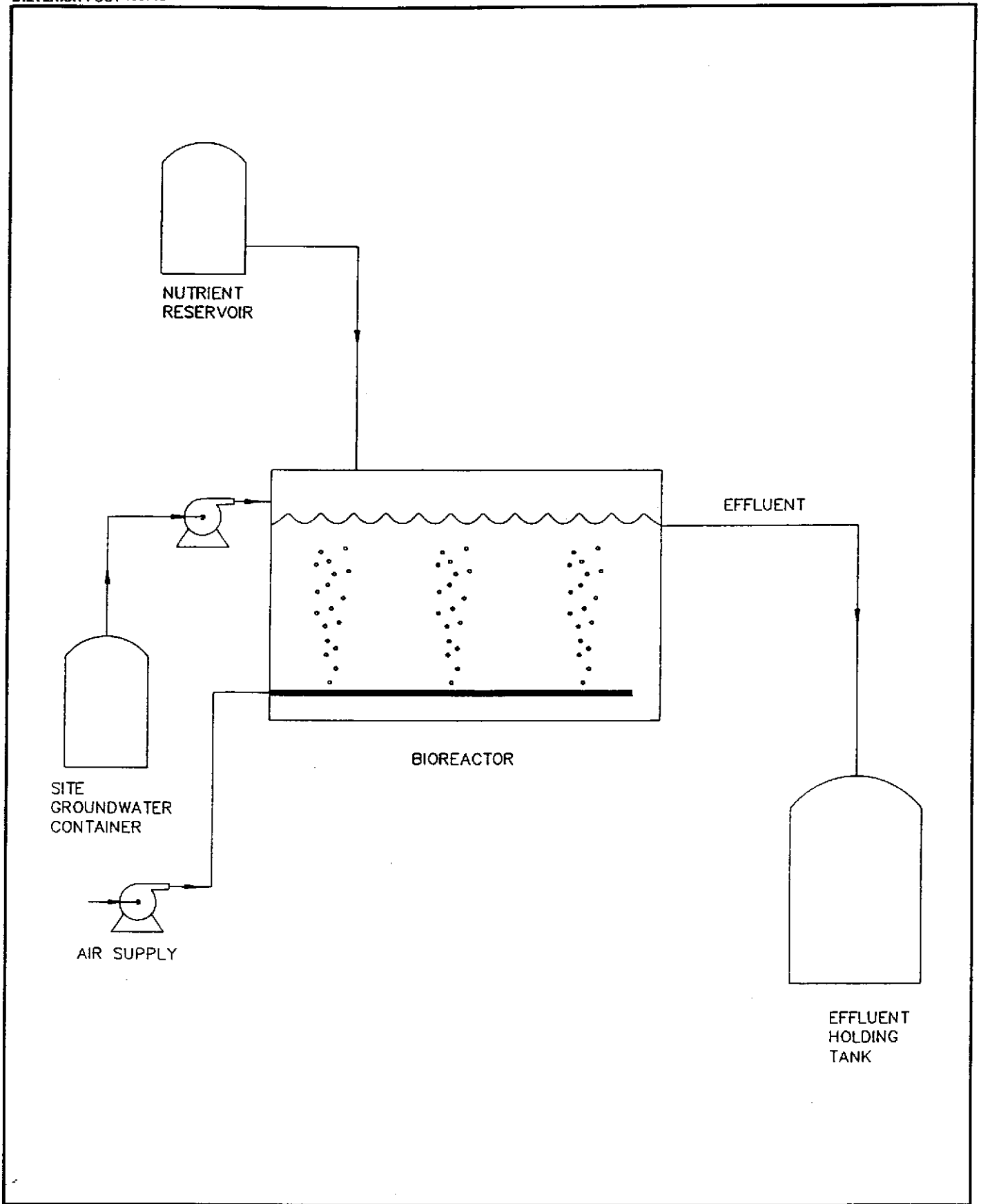
**Table 3. Bioreactor Process Summary
City Blue Production Facility**

Day	<u>Influent Concentration</u>		<u>Effluent Concentration</u>		BTEX Removal Efficiency	Liquid Retention Time (hours)
	TPH (mg/l)	Total BTEX (ug/l)	TPH (mg/l)	Total BTEX (ug/l)		
1	75	31,080	0.07	1.4	>99.9	18
2	150	27,280	(0.05)*	ND (0.5)**	>99.9	18
3	87	28,640	ND	ND	>99.9	18
4	110	28,340	ND	ND	>99.9	18
1	140	34,020	ND (0.05)*	ND (0.5)**	>99.9	12
2	73	26,030	ND	ND	>99.9	12
3	63	20,500	ND	ND	>99.9	12
4	130	25,540	ND	ND	>99.9	12
5	66	21,492	ND	ND	>99.9	12
6	81	20,040	ND	ND	>99.9	12
7	61	17,100	ND	ND	>99.9	12
1	74	17,400	0.08	1.1	>99.9	8
2	630	40,100	0.91	79.2	99.8	8
3	250	118,300	7.3	3,230	97.3	8
4	180	93,100	5.9	3,230	96.6	8
5	110	90,200	2.3	397.9	99.6	8
6	110	89,900	6.0	3060.0	96.6	8

* - Detection limit 0.05 mg/l.

** - Detection limit 0.5 ug/l.

NA Not Applicable.



Harding Lawson Associates
 Engineering and
 Environmental Services

LABORATORY BIOREACTOR TREATMENT SYSTEM
CITY BLUE PRODUCTION FACILITY
OAKLAND, CALIFORNIA

PLATE

1

DRAWN
S.S

JOB NUMBER
18106,010.04

APPROVED
DS

DATE
6/90

REVISED DATE

Client Acct: 281
Client Name: Harding Lawson Associates
NET Log No: 1604

Date: 04-27-90
Page: 2

Ref: City Blue Print, Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Reporting Limit	90160001	90160002	Units
		04-16-90 1700	04-16-90 1730	
		51034	51035	
PETROLEUM HYDROCARBONS		--	--	
VOLATILE (WATER)		--	--	
DILUTION FACTOR *		100	1	
DATE ANALYZED		04-19-90	04-19-90	
METHOD GC FID/5030		--	--	
as Gasoline	0.05	91	0.48	mg/L
METHOD 602		--	--	
DILUTION FACTOR *		250	1	
DATE ANALYZED		04-19-90	04-19-90	
Benzene	0.5	5,800	1.2	ug/L
Ethylbenzene	0.5	2,400	2.6	ug/L
Toluene	0.5	17,000	9.6	ug/L
Xylenes, total	0.5	14,000	17	ug/L

Client Acct: 281
Client Name: Harding Lawson Associates
NET Log No: 1604

Date: 04-27-90
Page: 3

Ref: City Blue Print, Job: 18106,010.04

QUALITY CONTROL RESULTS - TOTAL PETROLEUM HYDROCARBONS (water)

<u>Parameter</u>	<u>Reporting Limits</u>	<u>Units</u>	<u>Blank Results</u>	<u>Lab No. Spike and Spike Replicate Results (% Recovery)</u>		<u>RPD</u>
				<u>(-50916S)</u>	<u>(-50916SR)</u>	
as Gasoline	0.05	mg/L	ND	98	101	3
Benzene	0.5	ug/L	ND	93	97	4
Toluene	0.5	ug/L	ND	95	96	1

Client Acct: 281
 Client Name: Harding Lawson Associates
 NET Log No: 1661

Date: 05-02-90
 Page: 2

Ref: City Blue Print Bioreactor; Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Reporting Limit	90160003	90160004	90160005	90160006	Units
		04-18-90 1730	04-19-90 1245	04-20-90 1730	04-20-90 1735	
		51339	51340	51341	51342	
PETROLEUM HYDROCARBONS		—	—	—	—	
VOLATILE (WATER)		—	—	—	—	
DILUTION FACTOR *		1	100	100	1	
DATE ANALYZED		04-26-90	04-26-90	04-26-90	04-27-90	
METHOD GC FID/5030		—	—	—	—	
as Gasoline	0.05	0.10	110	75	0.07	mg/L
METHOD 602		—	—	—	—	
DILUTION FACTOR *		1	250	250	1	
DATE ANALYZED		04-26-90	04-27-90	04-27-90	04-27-90	
Benzene	0.5	1.0	5,600	5,500	0.6	ug/L
Ethylbenzene	0.5	ND	1,500	580	ND	ug/L
Toluene	0.5	2.5	16,000	15,000	ND	ug/L
Xylenes, total	0.5	1.0	12,000	10,000	0.8	ug/L

Client Acct: 281
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 NET Log No: 1661

Date: 05-02-90
 Page: 3

Ref: City Blue Print Bioreactor; Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Reporting Limit	90160007	90160008	90170001	90170002	Units
		04-21-90 1730	04-21-90 1740	04-22-90 1735	04-22-90 1745	
		51343	51344	51345	51346	
PETROLEUM HYDROCARBONS		—	—	—	—	
VOLATILE (WATER)		—	—	—	—	
DILUTION FACTOR *		100	1	100	1	
DATE ANALYZED		04-26-90	04-27-90	04-26-90	04-27-90	
METHOD GC FID/5030		—	—	—	—	
as Gasoline	0.05	150	ND	87	ND	mg/L
METHOD 602		—	—	—	—	
DILUTION FACTOR *		200	1	200	1	
DATE ANALYZED		04-27-90	04-27-90	04-27-90	04-27-90	
Benzene	0.5	4,800	ND	5,000	ND	ug/L
Ethylbenzene	0.5	380	ND	340	ND	ug/L
Toluene	0.5	13,000	ND	14,000	ND	ug/L
Xylenes, total	0.5	9,100	ND	9,300	ND	ug/L

Client Acct: 281
Client Name: Harding Lawson Associates
NET Log No: 1661

Date: 05-02-90
Page: 4

Ref: City Blue Print Bioreactor; Job: 18106,010.04

QUALITY CONTROL RESULTS - TOTAL PETROLEUM HYDROCARBONS (water)

<u>Parameter</u>	<u>Reporting Limits</u>	<u>Units</u>	<u>Blank Results</u>	<u>Lab No. Spike and Spike Replicate Results (% Recovery)</u>		<u>RPD</u>
				<u>(-51350S)</u>	<u>(-51350SR)</u>	
as Gasoline	0.05	mg/L	ND	97	94	3
Benzene	0.5	ug/L	ND	97	97	<1
Toluene	0.5	ug/L	ND	96	94	3

Client Acct: 281
 Client Name: Harding Lawson Associates
 NET Log No: 1730

Date: 05-10-90
 Page: 2

Ref: City Blue Print Bioreactor; Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Reporting Limit	90170003	90170004	90170005	90170006	Units
		04-23-90 1700	04-23-90 1705	04-24-90 1805	04-24-90 1810	
		51610	51611	51612	51613	
PETROLEUM HYDROCARBONS		—	—	—	—	
VOLATILE (WATER)		—	—	—	—	
DILUTION FACTOR *		200	1	200	1	
DATE ANALYZED		05-01-90	05-01-90	05-01-90	05-03-90	
METHOD GC FID/5030		—	—	—	—	
as Gasoline	0.05	110	ND	140	ND	mg/L
METHOD 602		—	—	—	—	
DILUTION FACTOR *		200	1	200	1	
DATE ANALYZED		05-01-90	05-01-90	05-01-90	05-03-90	
Benzene	0.5	4,800	ND	4,300	ND	ug/L
Ethylbenzene	0.5	540	ND	720	ND	ug/L
Toluene	0.5	13,000	ND	13,000	ND	ug/L
Xylenes, total	0.5	10,000	ND	16,000	ND	ug/L

Client Acct: 281
 Client Name: Harding Lawson Associates
 NET Log No: 1730

Date: 05-10-90
 Page: 3

Ref: City Blue Print Bioreactor; Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Reporting Limit	90170007	90170008	90170009	90170010	Units
		04-25-90 1800	04-25-90 1755	04-26-90 1725	04-26-90 1720	
		51614	51615	51616	51617	
PETROLEUM HYDROCARBONS		—	—	—	—	
VOLATILE (WATER)		—	—	—	—	
DILUTION FACTOR *		200	1	100	1	
DATE ANALYZED		05-01-90	05-03-90	05-01-90	05-01-90	
METHOD GC FID/5030		—	—	—	—	
as Gasoline	0.05	73	ND	63	ND	mg/L
METHOD 602		—	—	—	—	
DILUTION FACTOR *		200	1	100	1	
DATE ANALYZED		05-01-90	05-03-90	05-01-90	05-01-90	
Benzene	0.5	3,700	ND	3,300	ND	ug/L
Ethylbenzene	0.5	130	ND	100	ND	ug/L
Toluene	0.5	9,200	ND	7,200	ND	ug/L
Xylenes, total	0.5	13,000	ND	9,900	ND	ug/L

Ref: City Blue Print Bioreactor; Job: 18106,010.04

QUALITY CONTROL DATA

Parameter	Reporting Limits	Units	Cal Verf Stand % Recovery	Blank Data	Spike % Recovery	Duplicate Spike % Recovery	RPD
Gasoline	0.05	mg/L	104	ND	106	99	7
Benzene	0.5	ug/L	91	ND	103	97	7
Toluene	0.5	ug/L	92	ND	99	96	3

QUALITY CONTROL DATA

Parameter	Reporting Limits	Units	Cal Verf Stand % Recovery	Blank Data	Spike % Recovery	Duplicate Spike % Recovery	RPD
Gasoline	0.05	mg/L	101	ND	92	93	2
Benzene	0.5	ug/L	94	ND	93	93	<1
Toluene	0.5	ug/L	96	ND	92	94	1

Client No: 281
 Client Name: Harding Lawson Associates
 NET Log No: 1753

Date: 05-07-90

Page: 2

Ref: City Blue Print Bioreactor: Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Method	Reporting Limit	90170011	90170012	Units
			04-27-90 1645	04-27-90 1650	
			51747	51748	
PETROLEUM HYDROCARBONS			--	--	
VOLATILE (WATER)			--	--	
DILUTION FACTOR *			1	200	
DATE ANALYZED			05-02-90	05-03-90	
METHOD GC FID/5030			--	--	
as Gasoline		0.05	ND	130	mg/L
METHOD 602			--	--	
DILUTION FACTOR *			1	200	
DATE ANALYZED			05-02-90	05-03-90	
Benzene		0.5	ND	2,800	ug/L
Ethylbenzene		0.5	ND	440	ug/L
Toluene		0.5	ND	7,300	ug/L
Xylenes, total		0.5	ND	15,000	ug/L

Client No: 281
 Client Name: Harding Lawson Associates
 NET Log No: 1753

Date: 05-07-90
 Page: 3

Ref: City Blue Print Bioreactor: Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Method	Reporting Limit	90170013	90170014	Units
			04-28-90 1250	04-28-90 1255	
			51749	51750	
PETROLEUM HYDROCARBONS			--	--	
VOLATILE (WATER)			--	--	
DILUTION FACTOR *			1	100	
DATE ANALYZED			05-01-90	05-01-90	
METHOD GC FID/5030			--	--	
as Gasoline		0.05	ND	66	mg/L
METHOD 602			--	--	
DILUTION FACTOR *			1	100	
DATE ANALYZED			05-01-90	05-01-90	
Benzene		0.5	ND	2,700	ug/L
Ethylbenzene		0.5	ND	92	ug/L
Toluene		0.5	ND	6,700	ug/L
Xylenes, total		0.5	ND	12,000	ug/L

Client No: 281
Client Name: Harding Lawson Associates
NET Log No: 1753

Date: 05-07-90

Page: 4

Ref: City Blue Print Bioreactor: Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Method	Reporting Limit	90180001	90180002	Units
			04-29-90 2045	04-29-90 2050	
			51751	51752	
PETROLEUM HYDROCARBONS			--	--	
VOLATILE (WATER)			--	--	
DILUTION FACTOR *			1	100	
DATE ANALYZED			05-01-90	05-01-90	
METHOD GC FID/5030			--	--	
as Gasoline		0.05	ND	81	mg/L
METHOD 602			--	--	
DILUTION FACTOR *			1	100	
DATE ANALYZED			05-01-90	05-01-90	
Benzene		0.5	ND	2,400	ug/L
Ethylbenzene		0.5	ND	140	ug/L
Toluene		0.5	ND	5,500	ug/L
Xylenes, total		0.5	ND	12,000	ug/L

Client Acct: 281
Client Name: Harding Lawson Associates
NET Log No: 1753

Date: 05-07-90
Page: 5

Ref: City Blue Print Bioreactor: Job: 18106,010.04

QUALITY CONTROL DATA

Parameter	Reporting Limits	Units	Cal Verf Stand % Recovery	Blank Data	Spike % Recovery	Duplicate Spike % Recovery	RPD
Gasoline	0.05	mg/L	101	ND	92	93	2
Benzene	0.5	ug/L	94	ND	93	93	<1
Toluene	0.5	ug/L	96	ND	92	94	1

QUALITY CONTROL DATA

Parameter	Reporting Limits	Units	Cal Verf Stand % Recovery	Blank Data	Spike % Recovery	Duplicate Spike % Recovery	RPD
Gasoline	0.05	mg/L	95	0.06	98	95	4
Benzene	0.5	ug/L	87	ND	96	100	4
Toluene	0.5	ug/L	108	ND	91	97	6

Client Acct: 281
 Client Name: Harding Lawson Associates
 NET Log No: 1860

Date: 05-14-90
 Page: 2

Ref: City Blue Print Bioreactor; Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Reporting Limit	90180003	90180004	90180005	Units
		04-30-90 1745	04-30-90 1750	05-01-90 1645	
		52343	52344	52345	
PETROLEUM HYDROCARBONS		---	---	---	
VOLATILE (WATER)		---	---	---	
DILUTION FACTOR *		1	250	1	
DATE ANALYZED		05-09-90	05-09-90	05-09-90	
METHOD GC FID/5030		---	---	---	
as Gasoline	0.05	ND	61	0.08	mg/L
METHOD 602		---	---	---	
DILUTION FACTOR *		1	250	1	
DATE ANALYZED		05-09-90	05-09-90	05-09-90	
Benzene	0.5	ND	2,500	0.5	ug/L
Ethylbenzene	0.5	ND	ND	ND	ug/L
Toluene	0.5	ND	4,600	ND	ug/L
Xylenes, total	0.5	ND	10,000	0.6	ug/L

Client Acct: 281
 Client Name: Harding Lawson Associates
 NET Log No: 1860

Date: 05-14-90
 Page: 3

Ref: City Blue Print Bioreactor; Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Reporting Limit	90180006	90180007	90180008	Units
		05-01-90 1650	05-02-90 1725	05-02-90 1730	
		52346	52347	52348	
PETROLEUM HYDROCARBONS		--	--	--	
VOLATILE (WATER)		--	--	--	
DILUTION FACTOR *		250	1	250	
DATE ANALYZED		05-09-90	05-09-90	05-09-90	
METHOD GC FID/5030		--	--	--	
as Gasoline	0.05	74	0.91	630	mg/L
METHOD 602		--	--	--	
DILUTION FACTOR *		250	1	250	
DATE ANALYZED		05-09-90	05-09-90	05-09-90	
Benzene	0.5	1,800	1.8	1,900	ug/L
Ethylbenzene	0.5	ND	0.6	1,700	ug/L
Toluene	0.5	2,600	2.8	6,500	ug/L
Xylenes, total	0.5	13,000	74	30,000	ug/L

Client Acct: 281
Client Name: Harding Lawson Associates
NET Log No: 1860

Date: 05-14-90
Page: 4

Ref: City Blue Print Bioreactor; Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Reporting Limit	90180009	90180010	90180011	Units
		05-03-90 1745	05-03-90 1750	05-04-90 1815	
		52349	52350	52351	
PETROLEUM HYDROCARBONS		--	--	--	
VOLATILE (WATER)		--	--	--	
DILUTION FACTOR *		25	500	25	
DATE ANALYZED		05-10-90	05-10-90	05-10-90	
METHOD GC FID/5030		--	--	--	
as Gasoline	0.05	7.3	250	5.9	mg/L
METHOD 602		--	--	--	
DILUTION FACTOR *		25	500	250	
DATE ANALYZED		05-10-90	05-10-90	05-10-90	
Benzene	0.5	1,700	30,000	1,700	ug/L
Ethylbenzene	0.5	ND	4,300	ND	ug/L
Toluene	0.5	430	47,000	330	ug/L
Xylenes, total	0.5	1,100	37,000	1,200	ug/L

Client Acct: 281
Client Name: Harding Lawson Associates
NET Log No: 1860

Date: 05-14-90
Page: 5

Ref: City Blue Print Bioreactor; Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Reporting Limit	90180012 05-04-90 1820 52352	Units
PETROLEUM HYDROCARBONS		--	
VOLATILE (WATER)		--	
DILUTION FACTOR *		500	
DATE ANALYZED		05-10-90	
METHOD GC FID/5030		--	
as Gasoline	0.05	180	mg/L
METHOD 602		--	
DILUTION FACTOR *		500	
DATE ANALYZED		05-10-90	
Benzene	0.5	25,000	ug/L
Ethylbenzene	0.5	3,100	ug/L
Toluene	0.5	39,000	ug/L
Xylenes, total	0.5	26,000	ug/L

Client Acct: 281
Client Name: Harding Lawson Associates
NET Log No: 1860

Date: 05-14-90
Page: 6

Ref: City Blue Print Bioreactor; Job: 18106,010.04

QUALITY CONTROL DATA

Parameter	Reporting Limits	Units	Cal Verf Stand % Recovery	Blank Data	Spike % Recovery	Duplicate Spike % Recovery	RPD
Gasoline	0.05	mg/L	105	ND	99	95	4
Benzene	0.5	ug/L	90	ND	97	100	4
Toluene	0.5	ug/L	92	ND	96	97	1

Client Acct: 281
Client Name: Harding Lawson Associates
NET Log No: 1915

Date: 05-18-90
Page: 2

Ref: City Blue Print Bioreactor; Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Reporting Limit	90180013	90180014	Units
		05-05-90 2105	05-05-90 2110	
		52605	52606	
PETROLEUM HYDROCARBONS		--	--	
VOLATILE (WATER)		--	--	
DILUTION FACTOR *		5	100	
DATE ANALYZED		05-15-90	05-15-90	
METHOD GC FID/5030		--	--	
as Gasoline	0.05	2.3	110	mg/L
METHOD 602		--	--	
DILUTION FACTOR *		5	500	
DATE ANALYZED		05-15-90	05-16-90	
Benzene	0.5	2.7	25,000	ug/L
Ethylbenzene	0.5	ND	3,200	ug/L
Toluene	0.5	5.2	39,000	ug/L
Xylenes, total	0.5	390	23,000	ug/L

Client Acct: 281
Client Name: Harding Lawson Associates
NET Log No: 1915

Date: 05-18-90
Page: 3

Ref: City Blue Print Bioreactor; Job: 18106,010.04

Descriptor, Lab No. and Results

Parameter	Reporting Limit	90190001	90190002	Units
		05-06-90 1900	05-06-90 1905	
	52607	52608		
PETROLEUM HYDROCARBONS		--	--	
VOLATILE (WATER)		--	--	
DILUTION FACTOR *		20	100	
DATE ANALYZED		05-16-90	05-15-90	
METHOD GC FID/5030		--	--	
as Gasoline	0.05	6.0	110	mg/L
METHOD 602		--	--	
DILUTION FACTOR *		100	500	
DATE ANALYZED		05-15-90	05-16-90	
Benzene	0.5	810	25,000	ug/L
Ethylbenzene	0.5	ND	2,900	ug/L
Toluene	0.5	50	39,000	ug/L
Xylenes, total	0.5	2,200	23,000	ug/L

Ref: City Blue Print Bioreactor; Job: 18106,010.04

QUALITY CONTROL DATA

Parameter	Reporting Limits	Units	Cal Verf Stand % Recovery	Blank Data	Spike % Recovery	Duplicate Spike % Recovery	RPD
Gasoline	0.05	mg/L	103	ND	97	97	1
Benzene	0.5	ug/L	92	ND	93	93	<1
Toluene	0.5	ug/L	96	ND	95	93	2.1

QUALITY CONTROL DATA

Parameter	Reporting Limits	Units	Cal Verf Stand % Recovery	Blank Data	Spike % Recovery	Duplicate Spike % Recovery	RPD
Benzene	0.5	ug/L	88	ND	100	104	4
Toluene	0.5	ug/L	92	ND	97	101	4
Gasoline	0.05	mg/L	95	ND	94	104	10

KEY TO ABBREVIATIONS and METHOD REFERENCES

- < : Less than; when appearing in results column indicates analyte not detected at the value following, which supercedes the listed reporting limit.
- mean : Average; sum of measurements divided by number of measurements.
- mg/Kg (ppm) : Concentration in units of milligrams of analyte per kilogram of sample, wet-weight basis (parts per million).
- mg/L : Concentration in units of milligrams of analyte per liter of sample.
- mL/L/hr : Milliliters per liter per hour.
- MPN/100 mL : Most probable number of bacteria per one hundred milliliters of sample.
- N/A : Not applicable.
- NA : Not analyzed.
- ND : Not detected; the analyte concentration is less than applicable listed reporting limit.
- NTU : Nephelometric turbidity units.
- RPD : Relative percent difference, $100 \text{ [Value 1 - Value 2] / mean value}$.
- SNA : Standard not available.
- ug/Kg (ppb) : Concentration in units of micrograms of analyte per kilogram of sample, wet-weight basis (parts per billion).
- ug/L : Concentration in units of micrograms of analyte per liter of sample.
- unhos/cm : Microns per centimeter.

Method References

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

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

- * Reporting Limits are a function of the dilution factor for any given sample. To obtain the actual reporting limits for this sample, multiply the stated reporting limits by the dilution factor.