PHONE 285-2400
CABLE ADDRESS: TIMOIL
(FAX) 206-283-8036

SEATTLE
TACOMA
PORTLAND
STOCKTON
RENO
RICHMOND
LOS ANGELES

TIME OIL CO.

2737 WEST COMMODORE WAY SEATTLE, WA 98199-1233
P.O. BOX 24447 SEATTLE, WA 98124-0447

December 30, 1991

Washington State Department of Ecology
Attention: Joe Hickey
3190 160th Ave. S.E.
Bellevue, Wa 98008-5452

RE: Underground Storage Tank Site Check/Site Assessment at Seattle Terminal, 2737 West Commodore Way, Seattle, Wa - Property No. 01-228.

Dear Mr. Hickey:

This letter report is submitted to provide initial information on the removal of underground storage tanks at the above referenced site. The property is located at the north end of the community of Magnolia on the south shore of Salmon Bay in Seattle, Washington (Figure 1). The site is the location of Time Oil Co.'s Seattle Terminal which consists of a two-story office structure, warehouses and above ground storage tanks. Properties surrounding the site are light to heavy marine/industrial.

On September 16, 1991 four tanks were removed by Lee Morse Construction as part of a facility upgrade. They were 4,000, 2,500, 1,500 and 300 gallon capacity tanks that had contained unleaded gasoline, diesel fuel, regular leaded gasoline, and used oil, respectively. See Figures 2 and 3 for tank locations.

The removal of the tanks resulted in two excavations. The gasoline and diesel fuel tanks were removed from excavation #1 and the used oil tank was removed from excavation #2 (Figures 2 and 3).

One 4,000 gallon tank was installed in excavation #1, replacing the former gasoline and diesel fuel tank system. This tank is baffled to provide two compartments of 3,000 and 1,000 gallon capacities and is, therefore, registered as two tanks. The tanks contain regular unleaded gasoline and diesel fuel, respectively. Two new fuel dispensers were also installed replacing the old dispensers.

The following discusses tank removal and sample collection activities, and analytical results.

FIELD INVESTIGATION

The removal of contaminated soil and sample collection was based on organic vapor analysis readings. Soil samples were collected and placed in Zip-lock bags for headspace analysis using a Micro-tip organic vapor analyzer. When head space readings were below 50 parts per million or contaminated soil removal was not feasible, samples were collected.

Samples were collected from the excavation using a backhoe bucket. Each sample was taken from near the teeth of the backhoe after approximately 6 inches of soil was removed, then transferred to a 4 ounce jar and placed in an ice chest for delivery to Friedman and Bruya analytical laboratory. Sample equipment consisted of disposable latex gloves and a stainless steel spoon which was triple washed between each sampling.

Excavation #1

The 4,000, 2,500 and 1,500 gallon tanks were removed from excavation #1. The 2,500 and 1,500 gallon tanks were part of a 4,000 gallon baffled tank system that was installed in 1980. They were registered as individual tanks with the Department of Ecology. It is unknown when the 4,000 gallon unleaded gasoline tank was installed. The 4,000 gallon tank and the 2,500 and 1,500 gallon compartments of the baffled tank were tightness tested annually using the Petro-Tite testing system. They were last tested in September 1990 and found to be tight.

Areas of slight rusting and pitting were observed on the 4,000 gallon tank and the baffled tank system but no holes were noted. As the tanks were removed gasoline contamination was observed in the surrounding soil. This contamination is consistent with the nature of contamination found from years of tank overfills and spillage.

Soil encountered at the site consisted of artificial fill and natural material. Artificial fill was encountered from the surface to a depth of approximately 7 feet in the excavation and consisted of brown and grey sandy silt with gravel. Decaying organic material such as wood and grass, and metal debris was observed in the fill.

Natural soils were observed underlying the fill to a minimum depth of approximately 18 feet and was composed of brown sandy silt with gravel that graded to gray silty fine to medium sand with depth. Backfill material for the tank excavation generally consisted of imported sand and soil similar to the surrounding artificial fill. The soil appeared discolored and a hydrocarbon odor was encountered in the excavation during tank removal. Groundwater with a heavy hydrocarbon sheen was encountered at a depth of 18 feet below the ground surface in the excavation.

After the two 4,000 gallon tanks and associated backfill soils were removed, an attempt was made to assess the extent of contamination and remove it. Because of these efforts the excavation was extended to the north, east and west. However, due to high head space readings near the groundwater in the excavation and the proximity of the excavation to the Time Oil office building, excavating was abandoned and soil samples were collected. Approximately 140 cubic yards of soil was removed from the excavation and stockpiled on site.

A total of eight soil samples were collected from the sidewalls and floor within excavation #1 and the former location of the fuel dispensers (Figure 2 - Provides the location and depth of sampling points). A groundwater sample was not collected at the time of tank removal due to the presence of a heavy hydrocarbon sheen. The soil samples were submitted to the analytical laboratory for chemical testing for total petroleum hydrocarbons as gasoline (TPH-g) and diesel (TPH-d), benzene, toluene, ethylbenzene, xylenes (BTEX), and total lead using EPA methods 8015 (modified), 8020 and 7421, respectively.

Analytical results for these soil samples indicated TPH-g concentrations ranging from less than 2 parts per million (ppm) to 12,000 ppm. The highest TPH concentration of 12,000 ppm was encountered in the sample collected from the area of the fuel dispensers. TPH-d concentrations ranged from less than 50 ppm to 220 ppm. Table 1 provides a summary of soil samples and analytical results for excavation #1 soil samples. See the attached laboratory report for further information.

Excavation #2

The 300 gallon tank was removed from excavation #2. It is not known when the tank was installed. However, the tank was used for storing used oil collected during servicing of Time Oil fleet vehicles.

Areas of rusting and pitting were present on the tank and a pin-sized hole was observed after corrosion had been removed indicating that the tank may not have leaked under normal circumstances. As the tank was removed hydrocarbon contamination was observed in the surrounding soil. As in excavation #1, this contamination is also consistent with the nature of contamination found from years of tank overfills and spillage.

Artificial fill and natural soil was encountered in this excavation. The fill ranged in depth from the surface to 4.5 feet at the south end of the excavation and 1 foot at the north end. Natural soil consisting of brown and gray silty fine to medium sand was observed underlying the fill and extending to a minimum depth of groundwater. The soil appeared discolored and a hydrocarbon odor was encountered in the excavation during tank removal.

The depth to groundwater varied from 6 feet to 2 feet below the ground surface as the property sloped down to Salmon Bay to the north. A heavy sheen was observed on the groundwater.

After the 300 gallon tank and associated backfill were removed, an attempt was made to assess the extent of contamination and remove it. Because of these efforts the excavation was extended to the north toward Salmon Bay. When contamination was observed to be extensive, excavating was abandoned and soil samples were collected. A total of approximately 100 cubic yards of soil was removed from the excavation and stockpiled on site.

A total of four soil samples were collected from the sidewalls and floor within the excavation. Soil samples were not collected from the north end of the excavation because very strong hydrocarbon odors and gray discoloration was observed in that area. Instead, a test pit was dug between the excavation and the shoreline (Figure 3) to assess the horizontal extent of contamination. One sample was collected from that test pit. A groundwater sample was not collected at the time of tank removal due to the presence of a heavy hydrocarbon sheen.

The excavation and test pit samples were submitted for chemical analysis for total petroleum hydrocarbons as diesel (TPH-d) and motor oil (TPH-m) using EPA method 8015 (modified). Analytical results for excavation #2 and test pit samples indicated TPH-d concentrations ranging from less than 10 ppm to 310 ppm. TPH-m concentrations ranged from less than 10 ppm to 410 ppm.

Four soil samples were collected from stockpiled soil and combined to form one stockpile composite sample. The composite sample was tested for TCLP lead, halogenated volatile organic compounds using EPA method 8010, PCBs, TPH-d and TPH-m using EPA methods 8015 (modified) and 418.1, respectively. Chemical test results for the stockpile composite sample indicated TPH-d and TPH-m concentrations of 78 ppm and 1700 ppm, respectively.

Table 2 provides a summary of TPH analytical results for excavation #2, test pit and composite soil samples. See the attached laboratory report for the remaining chemical test results.

Time Oil is currently in the process of sending Request for Proposals for further site assessment to environmental consultants in the area. The next stage of work will address the contaminated soil stockpile, the extent of subsurface soil contamination at both excavations, the impact, if any, to the shallow ground water, and provide recommendations for cleanup, if necessary.

If there are any further questions regarding this site please contact me at (206) 286-4490.

Sincerely,

Liam Russell

Liam J. Russell
Geologist

Attachments:

- Table 1
- Table 2
- Figure 1
- Figure 2
- Figure 3
- Analytical Report

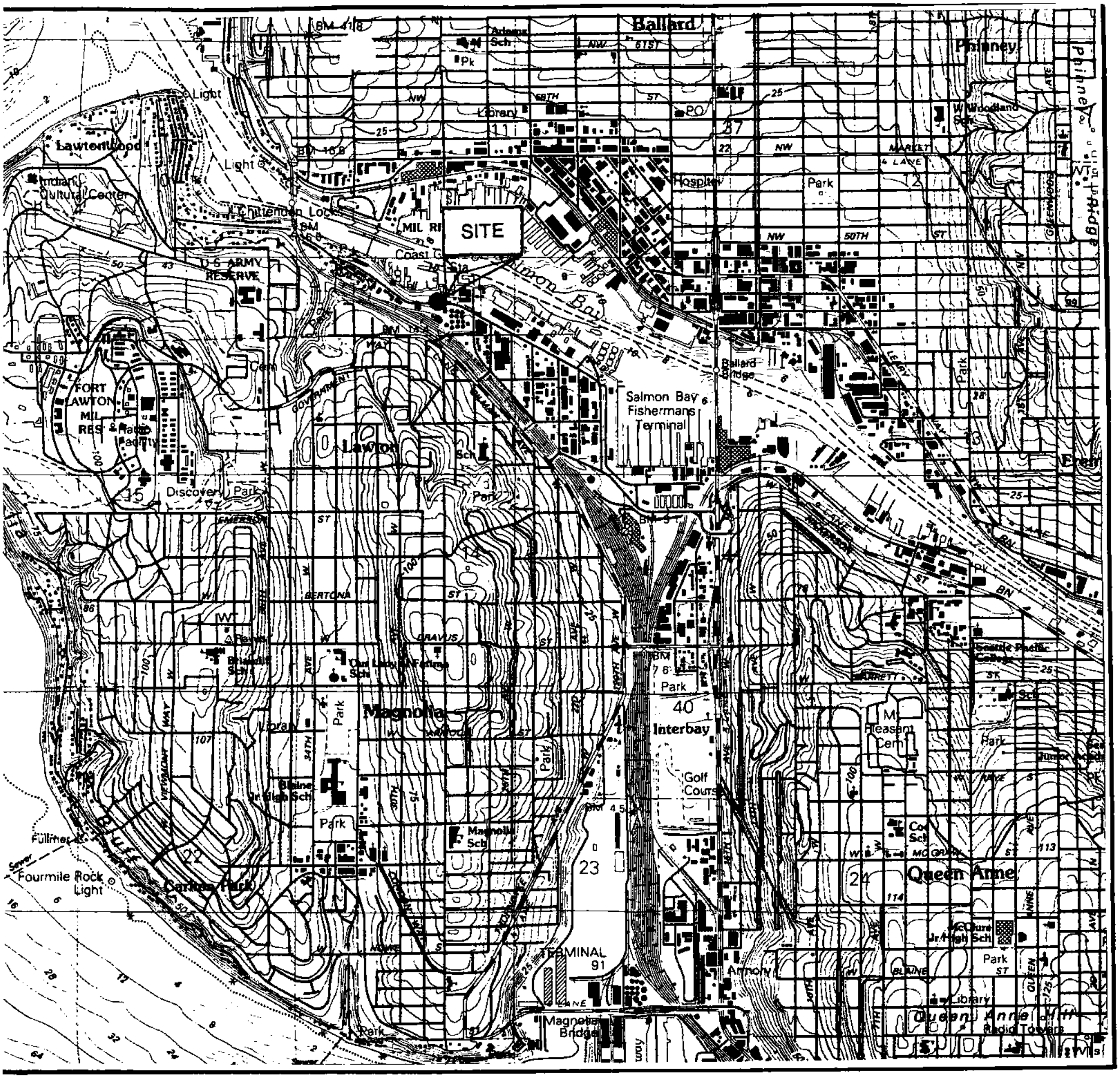
C:\WP51\LJR\DEC91\01-228A.DOE

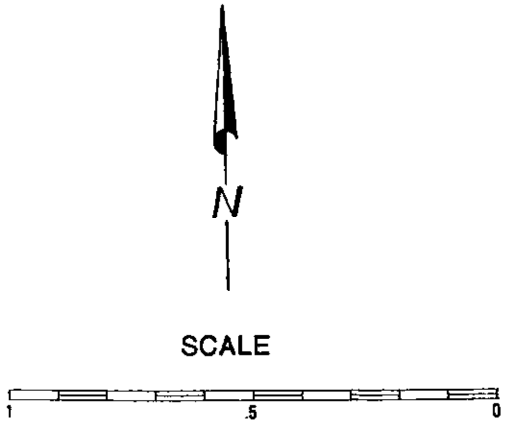
TABLE 1
SUMMARY OF SOIL SAMPLES AND ANALYTICAL RESULTS
(Excavation #1)

Sample I.D.	TPH g/d (ppm)	Benzene (ppm)	Toluene (ppm)	Ethylben (ppm)	xylenes (ppm)
1617-PI1	12,000/220	330	370	390	1600
1617-PI2	1,300/66	27	21	26	64
1500-N1	<2/17	0.003	0.003	<0.002	<0.006
0829-S1	19/76	<0.22	0.38	0.099	0.056
0834-E1	180/<50	<0.22	2.5	5.0	7.2
0839-W1	<2/<50	0.013	0.060	0.023	0.065
0845-Floor	120/200	1.1	1.3	3.2	12
0926-NW1	<2/<50	0.005	0.049	0.015	0.062

TABLE 2
SUMMARY OF SOIL SAMPLES AND ANALYTICAL RESULTS
(Excavation #2, Test Pit and Stockpile)

Sample I.D.	TPH-d(8015) (ppm)	TPH-m(8015) (ppm)	TPH-m(418.1) (ppm)
TPI-3	310	410	
TI-N-4	<10	<10	
TI-E-4	<10	<10	
TI-F-6	<10	200	
TI-W-4	<10	<10	
Pile Composite	78		1700



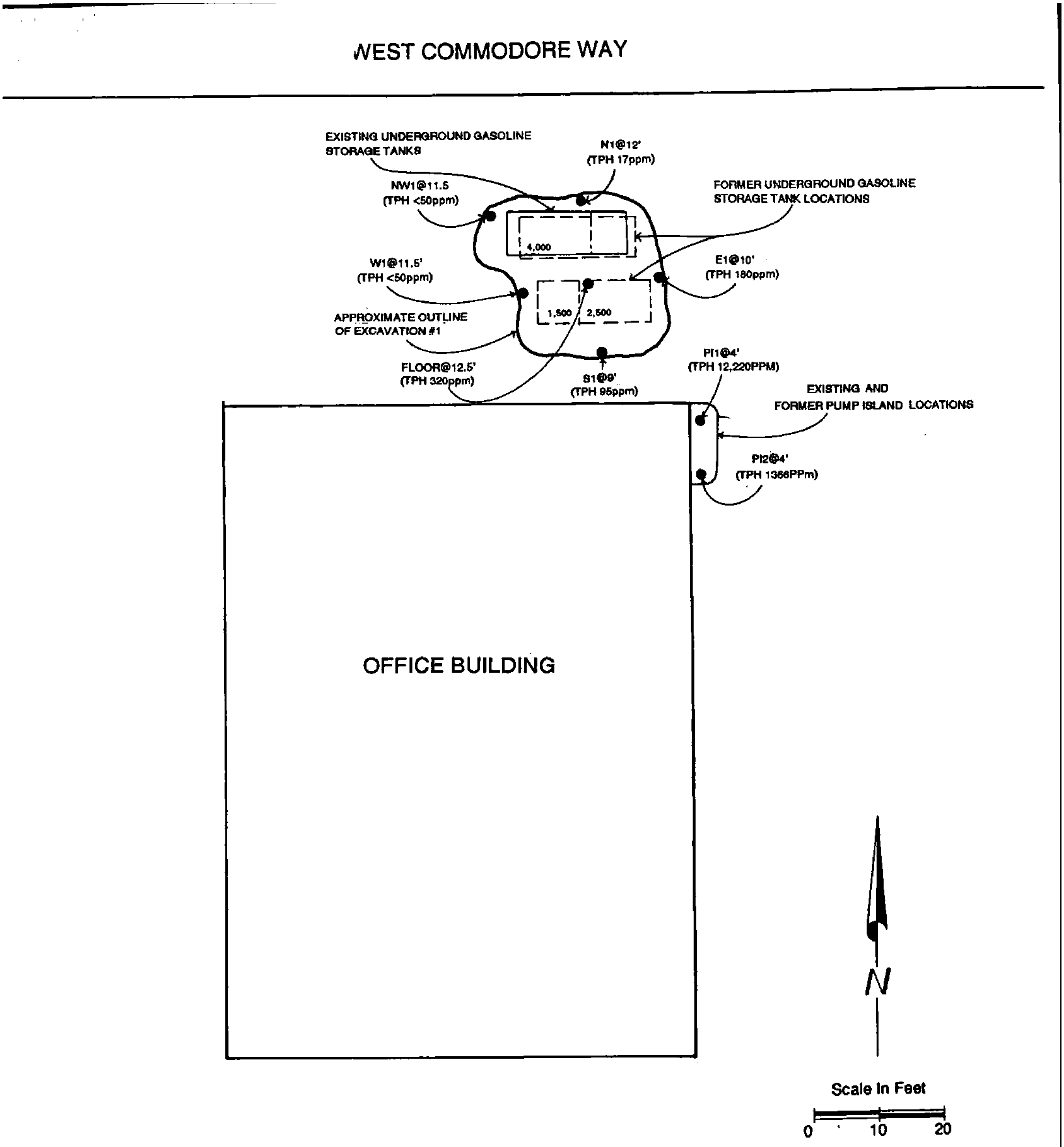


FROM U.S.G.S. SEATTLE NORTH, WASHINGTON QUADRANGLE N4737.5–W12215/7.5X15, 1983

TIME OIL CO.
2737 West Commodore Way

SEATTLE TERMINAL
2737 WEST COMMODORE WAY, SEATTLE, WA

VICINITY MAP



EXPLANATION

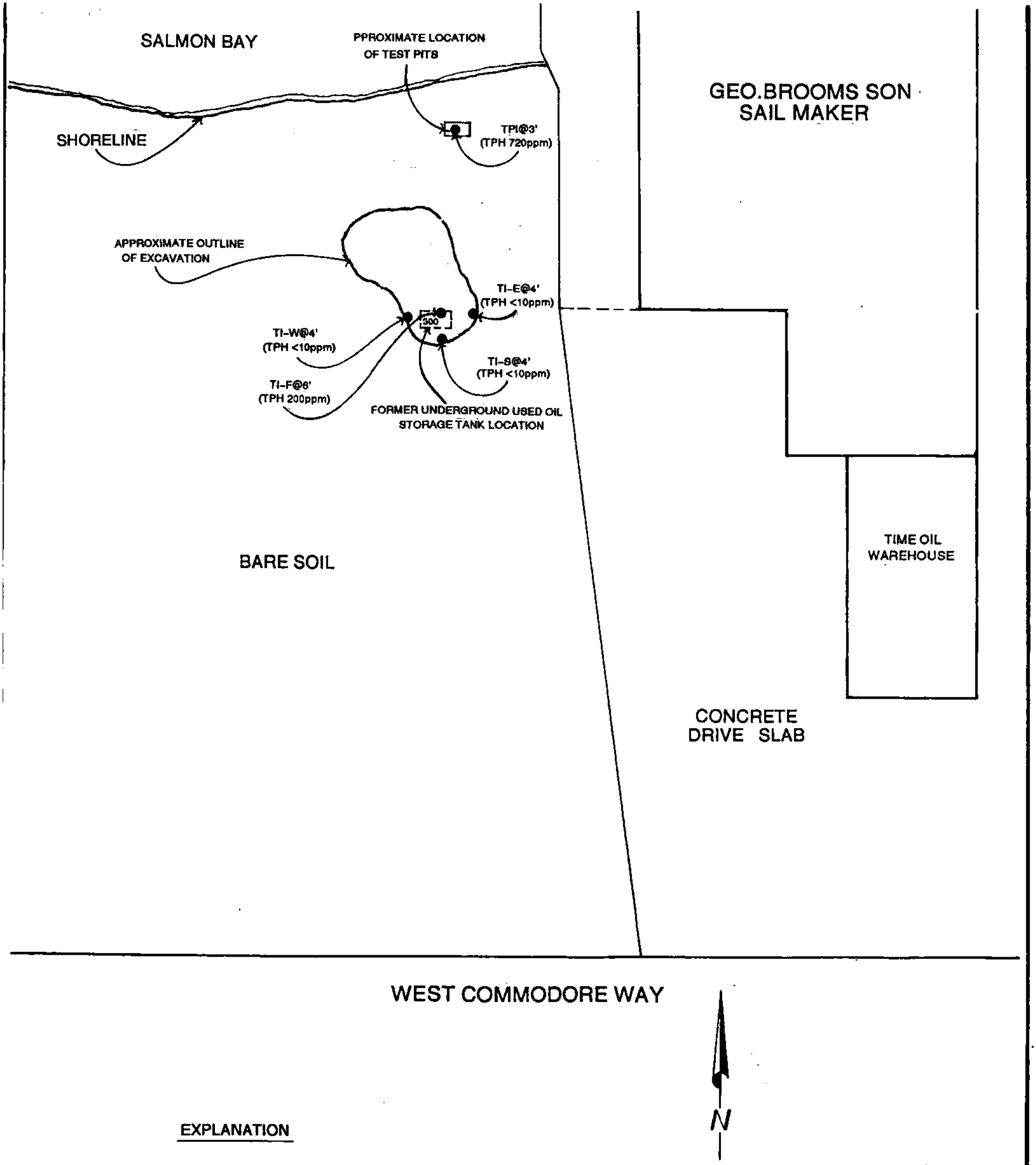
● N1@12' (TPH 17ppm) APPROXIMATE SAMPLE LOCATION WITH RESPECTIVE DEPTH AND TPH CONCENTRATION

FIGURE 2

TIME OIL CO.
2737 West Commodore Way

SEATTLE TERMINAL
2737 WEST COMMODORE WAY, SEATTLE, WA

SITE MAP



EXPLANATION

● TPI@3' (TPH 720ppm) APPROXIMATE SAMPLE LOCATION WITH RESPECTIVE DEPTH AND TPH CONCENTRATION'

SCALE: 1" = 30'

FIGURE 3

TIME OIL CO.
2737 West Commodore Way

SEATTLE TERMINAL
2737 WEST COMMODORE WAY, SEATTLE, WA

SITE MAP

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

October 9, 1991

Anne Duarte, Environmental Specialist
Time Oil Company
2737 West Commodore Way
Seattle, WA 98199

Dear Ms Duarte:

Enclosed are the results of the analyses of the samples submitted on October 3, 1991 from Project 01-228 Seattle Terminal, PO #19693.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

Elaine Zamora

Elaine K. Zamora, Chemist

EKZ/dp

Enclosures

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: October 9, 1991
Date Submitted: October 3, 1991
Project: 01-228 Seattle Terminal, PO #19693

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR NONHALOGENATED ORGANICS BY EPA METHOD 8015 (DIESEL AND MOTOR OIL)

Results Reported as µg/g (ppm)

Sample #	Diesel (ppm)	Motor Oil (ppm)
1228-1003-TPI-3	310	410
1228-1003-TI-N-4	<10	<10
1228-1003-TI-E-4	<10	<10
1228-1003-TI-F-6	<10	200
1228-1003-TI-W-4	<10	<10
Quality Assurance		
Method Blank	<10	<10
1228-1003-TI-W-4 (Duplicate)	<10	<10
1228-1003-TI-W-4 (Matrix Spike) Percent Recovery	98%	100%
1228-1003-TI-W-4 (Matrix Spike Duplicate) Percent Recovery	110%	97%
Spike Blank Percent Recovery	97%	89%
Spike Level	500	500

TIME OIL CO. SAMPLE LOG

[redacted]

Site Name: Seattle Terminal

Sampler: Anne Duarte

Purpose: waste oil tank clean up

Lab Name: Friedman and Bruya

Lab Address:

Prop. No: 01-228

Date: 10/03/91

Method: Grab ☒ S.Spoon ☐ Bailer ☐ Pump ☐

Preserved: Ice ☐ Acid ☐ None ☐

Address: 2737 W Commodore
Seattle, WA 98199

Phone: 285-8282

PO No.: 19693

	Sample #	Location/Description	Type*	Analysis Instructions	EPA Method
1	1228-1003	- TP1-3 23623	[✓ S] W P	TPH as diesel & motor oil	8015
2	1228-1003	- T1-N-4 23624	[✓ S] W P	↓	↓
3	1228-1003	- T1-E-4 23625	[✓ S] W P		
4	1228-1003	- T1-F-6 23626	[✓ S] W P		
5	1228-1003	- T1-W-4 23627	[✓ S] W P		
6		-	S W P		
7		-	S W P		
8		-	S W P		
9		-	S W P		
10		-	S W P		
11		-	S W P		
12		-	S W P		
13		-	S W P		
14		-	S W P		
15		-	S W P		
16		-	S W P		
17		-	S W P		
18		-	S W P		
19		-	S W P		
20		-	S W P		
21		-	S W P		
22		-	S W P		

Other Instructions:

Sample Count = 5 *Check sample jar count against Log!*

** S = Soil W = Water P = Product*

CHAIN OF CUSTODY RECORD

Relinquished By: Anne Duarte *Received By:* *Date & Time* 10-3-91 3:00pm

Relinquished By: *Received For Lab By:* *Date & Time:*

GENERAL LAB INSTRUCTIONS

Please provide the requested information

1. Sample numbers assigned by Lab: 23623 to 23627 Date Analyzed: 10/4/91
2. Person performing analysis: K. McMullen, E. Zamora Data Reviewer: A. Grey
3. Scheduled sample disposal date: 11-3-91 *NOTIFY TIME OIL CO. BEFORE DISPOSAL*
4. Provide copies of ALL chromatograms, including QA/QC runs.

IMPORTANT! PLEASE RETURN A COPY OF THIS FORM WITH YOUR REPORT TO TIME OIL CO.
Attn: Environmental Manager, PO Box 24447 Terminal Sta., Seattle, WA 98124 (206) 285-2400

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

October 3, 1991

Anne Duarte, Environmental Specialist
Time Oil Company
2737 West Commodore Way
Seattle, WA 98199

Dear Ms. Duarte:

Enclosed are the results of the analyses of the samples submitted on September 27, 1991 from Project 01-228 Seattle Terminal, PO #19691.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

Elaine Zamora

Elaine K. Zamora, Chemist

EKZ/dp

Enclosures

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: October 3, 1991
Date Submitted: September 27, 1991
Project: 01-228 Seattle Terminal, PO #19691

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR TCLP METALS IN ACCORDANCE WITH 40 CFR PART 261

Results Reported as mg/L (ppm)

Sample #	Lead (ppm)
Composite: 1228-0927-S1 1228-0927-S2 1228-0927-S3 1228-0927-S4	<0.5
Quality Assurance	
Method Blank	<0.5
Composite: 1228-0927-S1 1228-0927-S2 1228-0927-S3 1228-0927-S4 (Duplicate)	<0.5
Composite (Matrix Spike) Percent Recovery	10%[1r]
Spike Blank Percent Recovery	101%
Regulatory Level	5.0

[1r] - The low recovery reported is common following the TCLP procedure.

Date of Report: October 3, 1991
Date Submitted: September 27, 1991
Project: 01-228 Seattle Terminal, PO #19691

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR VOLATILE HALOGENATED ORGANIC COMPOUNDS USING EPA METHODS 5020 AND 8010

Results Reported as ng/g (ppb)

Sample #	S1, S2, S3, S4 Composite
Analyte:	
1,1-Dichloroethylene	<1
Methylene Chloride	<3
t-Dichloroethylene	<3
1,1-Dichloroethane	<30
Chloroform	<1
1,1,1-Trichloroethane	<1
Carbon Tetrachloride	<1
Trichloroethylene	<1
Tetrachloroethylene	<1

Date of Report: October 3, 1991
Date Submitted: September 27, 1991
Project: 01-228 Seattle Terminal, PO #19691

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR VOLATILE HALOGENATED ORGANIC COMPOUNDS USING EPA METHODS 5020 AND 8010

Results Reported as ng/g (ppb)

Quality Assurance

Sample #	Method Blank	S1, S2, S3, S4 Composite (Duplicate)
Analyte:		
1,1-Dichloroethylene	<1	<1
Methylene Chloride	<1	<3
t-Dichloroethylene	<1	<3
1,1-Dichloroethane	<30	<30
Chloroform	<1	<1
1,1,1-Trichloroethane	<1	<1
Carbon Tetrachloride	<1	<1
Trichloroethylene	<1	<1
Tetrachloroethylene	<1	<1

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: October 3, 1991
Date Submitted: September 27, 1991
Project: 01-228 Seattle Terminal, PO #19691

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR VOLATILE HALOGENATED ORGANIC COMPOUNDS USING EPA METHODS 5020 AND 8010

Results Reported as ng/g (ppb)

Quality Assurance

Sample # Analyte:	S1, S2, S3, S4 Composite Matrix Spike % Recovery	S1, S2, S3, S4 Composite Matrix Spike Duplicate % Recovery	Spike Level (ppb)
1,1-Dichloroethylene	110%	120%	1,000
Methylene Chloride	110%	120%	1,000
t-Dichloroethylene	100%	110%	1,000
1,1-Dichloroethane	98%	100%	1,000
Chloroform	120%	130%	1,000
1,1,1-Trichloroethane	80%	85%	1,000
Carbon Tetrachloride	110%	120%	1,000
Trichloroethylene	48%	52%	1,000
Tetrachloroethylene	92%	98%	1,000

FRIEDMAN & BRUYA, INC
ENVIRONMENTAL CHEMISTS

Date of Report: October 3, 1991
Date Submitted: September 27, 1991
Project: 01-228 Seattle Terminal, PO #19691

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR PCB AS AROCHLOR 1254 BY GC/ECD
Results Reported as µg/g (ppm)

Sample #	PCB (ppm)
Composite: 1228-0927-S1 1228-0927-S2 1228-0927-S3 1228-0927-S4	<1
Quality Assurance	
Method Blank	<1
Composite: 1228-0927-S1 1228-0927-S2 1228-0927-S3 1228-0927-S4 (Duplicate)	<1
Composite (Matrix Spike) Percent Recovery	150%
Composite (Matrix Spike Duplicate) Percent Recovery	150%
Spike Blank Percent Recovery	100%
Spike Level	5

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: October 3, 1991
Date Submitted: September 27, 1991
Project: 01-228 Seattle Terminal, PO #19691

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR TOTAL PETROLEUM HYDROCARBONS AS DIESEL BY GC/FID (MODIFIED 8015)

Results Reported as µg/g (ppm)

Sample #	Diesel (ppm)
Composite: 1228-0927-S1 1228-0927-S2 1228-0927-S3 1228-0927-S4	78id
Quality Assurance	
Method Blank	<50
Composite: 1228-0927-S1 1228-0927-S2 1228-0927-S3 1228-0927-S4 (Duplicate)	130id
Composite (Matrix Spike) Percent Recovery	81%
Composite (Matrix Spike Duplicate) Percent Recovery	81%
Spike Level	500

id - The material present appears to be indicative of a small amount of diesel and a much larger amount of MOTOR OIL

FRIEDMAN & BRUYA, INC
ENVIRONMENTAL CHEMISTS

Date of Report: October 3, 1991
Date Submitted: September 27, 1991
Project: 01-228 Seattle Terminal, PO #19691

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR TOTAL PETROLEUM HYDROCARBONS BY IR (EPA METHOD 418.1)
Results Reported as µg/g (ppm)

Sample #	Total Petroleum Hydrocarbons (ppm)
Composite: 1228-0927-S1 1228-0927-S2 1228-0927-S3 1228-0927-S4	1,700
Quality Assurance	
Method Blank	<10
Composite: 1228-0927-S1 1228-0927-S2 1228-0927-S3 1228-0927-S4 (Duplicate)	1,800
Composite (Matrix Spike) Percent Recovery	ai
Composite (Matrix Spike Duplicate) Percent Recovery	ai
Spike Blank Percent Recovery	70%
Spike Level	250

ai - The amount spiked was insufficient to give meaningful recovery data.

TIME OIL CO. SAMPLE LOG

9-EKZ-A

Seattle Terminal
Anne Duarte
se: stockpile characterization
Name: Friedman & Bruya
Lab Address:

Prop. No: 01-228
Date: 09/27/91
Method: Grab ☒ S.Spoon ☐ Bailer ☐ Pump ☐
Preserved: Ice ☐ Acid ☐ None ☐
Phone: 285-8282

Address: 2737 W Commodore
Seattle, WA
PO No.: 19691

	Sample #	Location/Description	Type*	Analysis Instructions	FBI #	EPA Method
1	1228-0927-S1	composite	[✓ S] W P	1 composite for:	23296	
2	1228-0927-S2		[✓ S] W P	① TCLP Lead	23297	1311
3	1228-0927-S3		[✓ S] W P	② PCBs	23298	8080
4	1228-0927-S4		[✓ S] W P	③ Volatile Organics	23299	8010
5	-		S W P	④ TPH-D		8015
6	-		S W P	⑤ TPH-oil		418.1
7	-		S W P			
8	-		S W P			
9	-		S W P			
10	-		S W P			
11	-		S W P			
12	-		S W P			
13	-		S W P			
14	-		S W P			
15	-		S W P			
16	-		S W P			
17	-		S W P			
18	-		S W P			
19	-		S W P			
20	-		S W P			
21	-		S W P			
22	-		S W P			

Other Instructions: 1 week Turn around

Sample Count = 4 *Check sample jar count against Log!* ** S = Soil W = Water P = Product*

CHAIN OF CUSTODY RECORD

Relinquished By: Anne Duarte *Received By:* *Date & Time*

Relinquished By: *Received For Lab By:* M.A. DANFORD FEB,I *Date & Time:* 9-27-91

GENERAL LAB INSTRUCTIONS

Please provide the requested information

1. Sample numbers assigned by Lab: 23296 to 23299 Date Analyzed: 9/29/91, 9/30
2. Person performing analysis: J. Dorr, A. Friedman, M. Perin, A. Ty Data Reviewer: E. Zamora, J. Sheldon, K. Mcl
3. Scheduled sample disposal date: 10-27-91 *NOTIFY TIME OIL CO. BEFORE DISPOSAL*
4. Provide copies of ALL chromatograms, including QA/QC runs.

IMPORTANT! PLEASE RETURN A COPY OF THIS FORM WITH YOUR REPORT TO TIME OIL CO.
Attn: Environmental Manager, PO Box 24447 Terminal Sta., Seattle, WA 98124 (206) 285-2400

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

October 4, 1991

Anne Duarte, Environmental Specialist
Time Oil Company
2737 West Commodore Way
Seattle, WA 98199

Dear Ms. Duarte:

Enclosed are the results of the analyses of the sample submitted on October 3, 1991 from Project 01-228, Seattle Terminal, PO#19000.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

Elaine Zamora

Elaine K. Zamora, Chemist

EKZ/dp

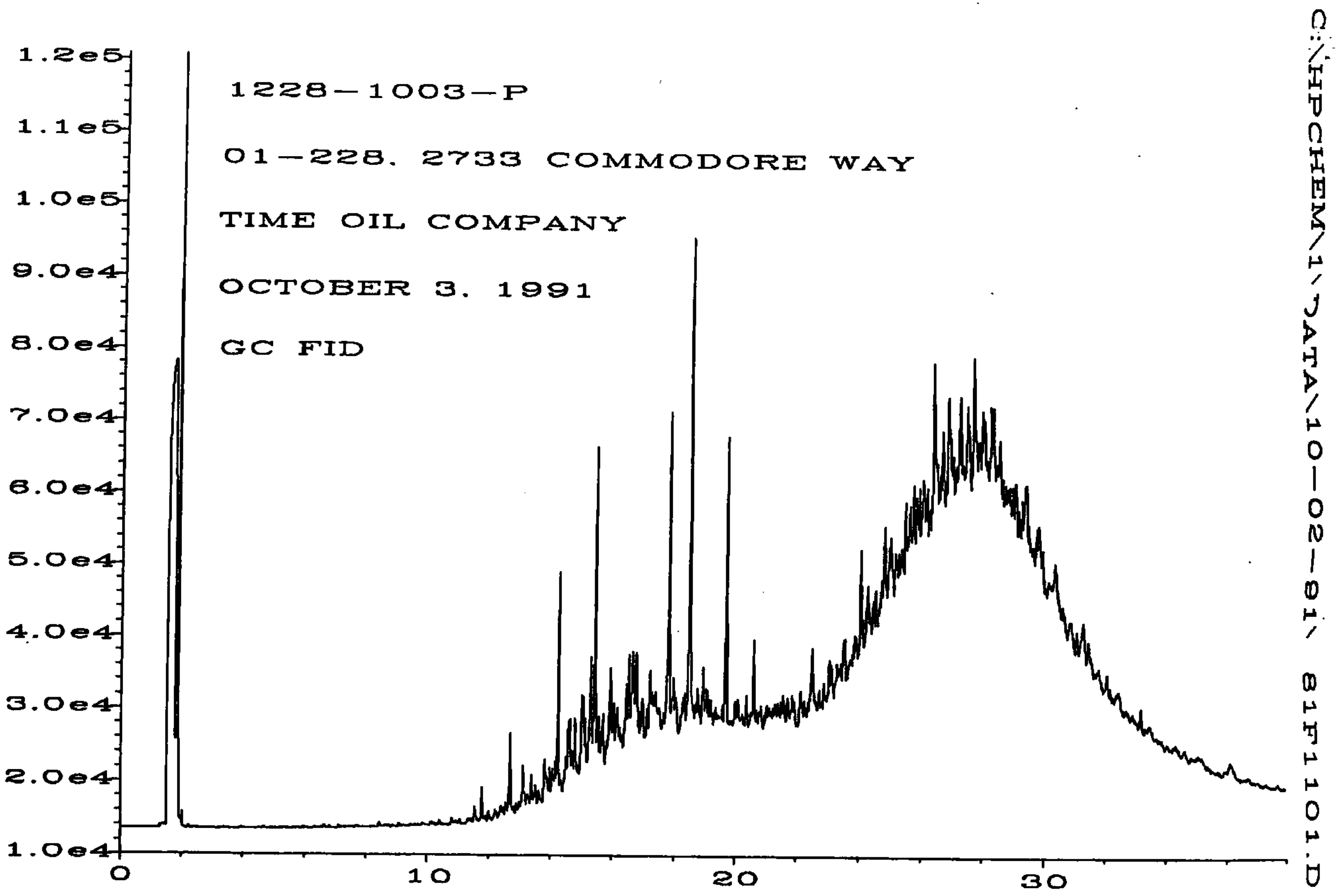
Enclosures

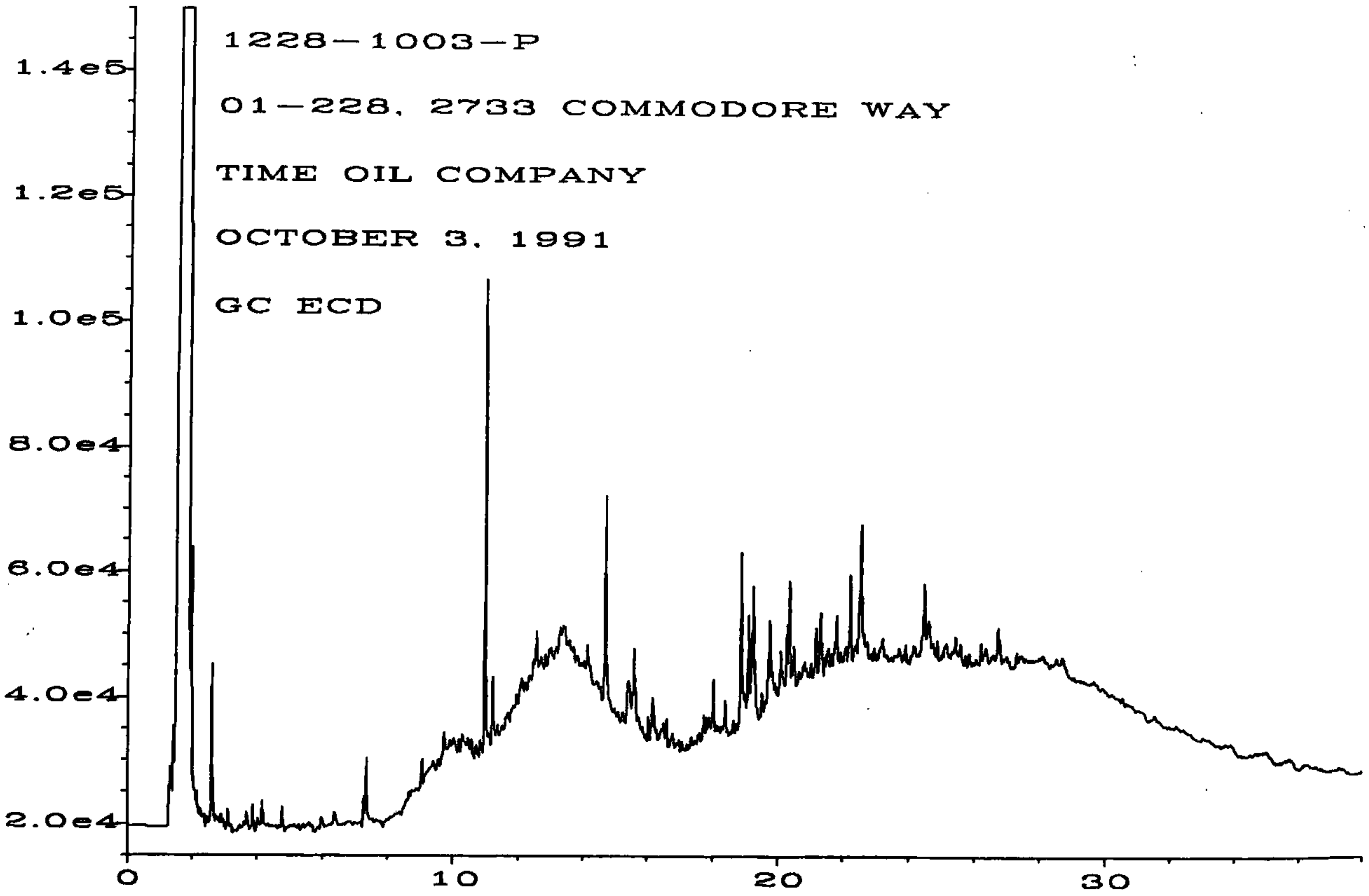
FRIEDMAN & BRUYA, INC
ENVIRONMENTAL CHEMISTS

Date of Report: October 4, 1991
Date Submitted: October 3, 1991
Project: 01-228, Seattle Terminal, PO#19000

RESULTS OF ANALYSES OF THE PRODUCT SAMPLE FOR FINGERPRINT CHARACTERIZATION BY CAPILLARY GAS CHROMATOGRAPHY

Sample #	GC Characterization
1228-1003-P	The gas chromatographic trace showed the presence of medium and high boiling compounds, such as those found in waste oil with a diesel input. This characterization is based on the presence of a relatively smooth envelope of peaks present from ca *n*-C12 to *n*-C20 with a maximum near *n*-C17, as well as a second envelope of peaks ca *n*-C20 to greater than *n*-C30 with a maximum near *n*-C27. The ECD trace indicated material is present which may be oxygenated.


C:\HPCHEM\1\DATA\10-02-91\ 81F1101.D
1228-1003-P
01-228. 2733 COMMODORE WAY
TIME OIL COMPANY
OCTOBER 3. 1991
GC FID
1.2e5
1.1e5
1.0e5
9.0e4
8.0e4
7.0e4
6.0e4
5.0e4
4.0e4
3.0e4
2.0e4
1.0e4
0
10
20
30



1228-1003-P

01-228. 2733 COMMODORE WAY

TIME OIL COMPANY

OCTOBER 3. 1991

GC ECD

C:\HPCHEM\1\DATA\10-02-91\ 81R1101.D

TIME OIL CO. SAMPLE LOG Rush

Site Name: Seattle Terminal
Sampler: Anne Duarte
Purpose: Waste Oil Tank Cleanup
Lab Name: Friedman & Bruya
Lab Address:

Proj. No: 01-228
Date: 10/03/91
Method: Grab ☒ S.Spoon ☐ Bailer ☐ Pump ☐
Preserved: Ice ☐ Acid ☐ None ☐
Phone: 285-8282

Address: 2737 W Commodore W
Seattle WA 98119
PO No.: 19000

Sample #	Location/Description	Type*	Analysis Instructions	EPA Meth
23514 ① 1228	- 1003-P	~~S~~ [✓ W] P	GC Product Characterization	
2	-	S W P		
3	-	S W P		
4	-	S W P		
5	-	S W P		
6	-	S W P		
7	-	S W P		
8	-	S W P		
9	-	S W P		
10	-	S W P		
11	-	S W P		
12	-	S W P		
13	-	S W P		
14	-	S W P		
15	-	S W P		
16	-	S W P		
17	-	S W P		
18	-	S W P		
19	-	S W P		
20	-	S W P		
21	-	S W P		
22	-	S W P		

Other instructions:

Sample Count = | *Check sample jar count against Log!*

** S = Soil W = Water P = Produ*

CHAIN OF CUSTODY RECORD

Relinquished By: Anne Duarte *Received By:* *Date & Time* 10/3/9

Relinquished By: *Received For Lab By:* *Date & Time:* 10/3/91 10

GENERAL LAB INSTRUCTIONS

Please provide the requested information

1. Sample numbers assigned by Lab: 23514 to 23514 Date Analyzed: 10-3-9
2. Person performing analysis: A. Friedman, ~~E~~ E.Zam Data Reviewer: J. Bruya
3. Scheduled sample disposal date: 11/3/91 *NOTIFY TIME OIL CO. BEFORE DISPOSA*
4. Provide copies of ALL chromatograms, including QA/QC runs.

IMPORTANT! PLEASE RETURN A COPY OF THIS FORM WITH YOUR REPORT TO TIME OI

Attn: Environmental Manager, PO Box 24447 Terminal Sta., Seattle, WA 98124 (206) 285-2400

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

September 19, 1991

Liam Russell, Environmental Specialist
Time Oil Company
2737 West Commodore Way
Seattle, WA 98199

Dear Mr. Russell:

Enclosed are the results of the analyses of the sample submitted on September 16, 1991 from Project 01-228, Seattle Terminal, PO #19685.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

Elaine Zamora

Elaine K. Zamora, Chemist

EKZ/sao

Enclosures

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: September 19, 1991
Date Submitted: September 16, 1991
Project: 01-228, Seattle Terminal, PO #19685

RESULTS OF ANALYSES OF THE SOIL SAMPLE FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND GASOLINE USING EPA METHODS 5030 COUPLED TO 8020 and 8015
Results Reported as mg/kg (ppm)

Sample #	Benzene	Toluene	Et-Benzene	Xylenes	Gasoline
01228-0991-1500-N1	0.003	0.003	<0.002	<0.006	<2
Quality Assurance					
Method Blank	<0.002	<0.002	<0.002	<0.006	<2
01228-0991-1500-N1 (Duplicate)	0.018	0.010	0.003	<0.006	<2
01228-0991-1500-N1 (Matrix Spike) Percent Recovery	86%	88%	92%	90%	88%
01228-0991-1500-N1 (Matrix Spike Duplicate) Percent Recovery	90%	93%	95%	94%	
Spike Blank Percent Recovery					110%
Spike Level	1	1	1	3	100

FRIEDMAN & BRUYA, INC
ENVIRONMENTAL CHEMISTS

Date of Report: September 19, 1991
Date Submitted: September 16, 1991
Project: 01-228, Seattle Terminal, PO #19685

RESULTS OF ANALYSES OF THE SOIL SAMPLE FOR TOTAL PETROLEUM HYDROCARBONS AS DIESEL BY GC/FID (MODIFIED 8015)

Results Reported as μg/g (ppm)

Sample #	Diesel (ppm)
01228-0991-1500-N1	17
Quality Assurance	
Method Blank	<10
01228-0991-1500-N1 (Duplicate)	<10
01228-0991-1500-N1 (Matrix Spike) Percent Recovery	110%
01228-0991-1500-N1 (Matrix Spike Duplicate) Percent Recovery	110%
Spike Level	500

TIME OIL CO. SAMPLE LOG

ne: SEATTLE TERM Prop. No: 01-228 Address: 2737 W. COMMODORE
pler: Liam Russell Date: 9-16-91 SEATTLE, WA 98199
urpose: UST REMOVAL S.A. Method: Grab ☒ S.Spoon ☐ Bailer ☐ Pump ☐
Lab Name: FRIEDMAN + BRUYA Preserved: Ice ☐ Acid ☐ None ☐
Lab Address:
Phone: 285-8282 PO No.: 19685

	Sample #	Location/Description	Type*	Analysis Instructions	EPA Method
1	01228-0991-1500-N1	22778-22779	[✓ S] W P	TPHd-g/BTEX (RUSH)	8015/8020
2	-		S W P	TCLP LEAD (HOLD)	
3	-		S W P		
4	-		S W P		
5	-		S W P		
6	-		S W P		
7	-		S W P		
8	-		S W P		
9	-		S W P		
10	-		S W P		
11	-		S W P		
12	-		S W P		
13	-		S W P		
14	-		S W P		
15	-		S W P		
16	-		S W P		
17	-		S W P		
18	-		S W P		
19	-		S W P		
20	-		S W P		
21	-		S W P		
22	-		S W P		

Other Instructions:

Sample Count = *Check sample jar count against Log!*

** S = Soil W = Water P = Product*

CHAIN OF CUSTODY RECORD

Relinquished By: *Received By:* *Date & Time*
Relinquished By: Liam Russell *Received For Lab By:* M.A. DANFORD FEB. 1 *Date & Time:* 9-16-91

GENERAL LAB INSTRUCTIONS

Please provide the requested information

1. Sample numbers assigned by Lab: 22778 to 22779 Date Analyzed: 9/16/91, 9/17/91
2. Person performing analysis: J. Shelton, K. Fichtner, E. Zamora Data Reviewer: A. Gray
3. Scheduled sample disposal date: 10-16-91 *NOTIFY TIME OIL CO. BEFORE DISPOSAL*
4. Provide copies of ALL chromatograms, including QA/QC runs.

IMPORTANT! PLEASE RETURN A COPY OF THIS FORM WITH YOUR REPORT TO TIME OIL CO.
Attn: Environmental Manager, PO Box 24447 Terminal Sta., Seattle, WA 98124 (206) 285-2400

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

October 9, 1991

Liam Russell, Environmental Specialist
Time Oil Company
2737 West Commodore Way
Seattle, WA 98199

Dear Mr. Russell:

Enclosed are the results of the analyses of the samples submitted on September 20, 1991 from Project 01-228 Seattle Terminal, PO #19687.

The values reported for the diesel analysis represent material that appears to be the late eluting fraction of gasoline. The results for the BTEX and Gasoline analysis are reported on two pages. Each page has its own quality assurance and represents analyses run on different days. The samples were diluted after the initial analysis and rerun. Interferences were present in sample 01228-0991-1617-PI1 so the original results are reported.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

Elaine Zamora

Elaine K. Zamora, Chemist

EKZ/dp

Enclosures

FRIEDMAN & BRUYA, INC
ENVIRONMENTAL CHEMISTS

Date of Report: October 9, 1991
Date Submitted: September 20, 1991
Project: 01-228 Seattle Terminal, PO #19687

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND GASOLINE USING EPA METHODS 5030 COUPLED TO 8020 and 8015

Results Reported as mg/kg (ppm)

Sample #	Benzene	Toluene	Et-Benzene	Xylenes	Gasoline
01228-0991 -1617-PI1	330	370	390	1,600	12,000
01228-0991 -1620-PI2	<19[ip]	<13[ip]	<20[ip]	<78[ip]	3,100
Quality Assurance					
Method Blank	<0.02	0.26	<0.02	<0.06	<2
01228-0991-1620-PI2 (Matrix Spike) Percent Recovery	96%	104%	106%	60%	ai
01228-0991-1620-PI2 (Matrix Spike Duplicate) Percent Recovery	104%	113%	114%	65%	ai
Spike Blank Percent Recovery					92%
Spike Level	150	150	150	450	2,500

ip - Interferences were present which prevented the identification and quantitation of the analyte at the established detection limit.

ai - The amount spiked was insufficient to give meaningful recovery data.

FRIEDMAN & BRUYA, INC
ENVIRONMENTAL CHEMISTS

Date of Report: October 9, 1991
Date Submitted: September 20, 1991
Project: 01-228 Seattle Terminal, PO #19687

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND GASOLINE USING EPA METHODS 5030 COUPLED TO 8020 and 8015
Results Reported as mg/kg (ppm)

Sample #	Benzene	Toluene	Et-Benzene	Xylenes	Gasoline
01228-0991 -1620-PI2	27	21	26	64	1,300
Quality Assurance					
Method Blank	<0.02	<0.02	<0.02	<0.06	<2
Spike Blank Percent Recovery	103%	106%	109%	100%	96%
Spike Level	1	1	1	3	100

Date of Report: October 9, 1991
Date Submitted: September 20, 1991
Project: 01-228 Seattle Terminal, PO #19687

RESULTS OF ANALYSES OF THE DIESEL SAMPLES FOR TOTAL PETROLEUM HYDROCARBONS AS DIESEL BY GC/FID (MODIFIED 8015)
Results Reported as µg/g (ppm)

Sample #	Diesel (ppm)
01228-0991-1617-PI1	220
01228-0991-1620-PI2	66

Quality Assurance	
Method Blank	<50
01228-0991-1620-PI2 (Duplicate)	86
01228-0991-1620-PI2 (Matrix Spike) Percent Recovery	90%
01228-0991-1620-PI2 (Matrix Spike Duplicate) Percent Recovery	96%
Spike Level	500

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: October 9, 1991
Date Submitted: September 20, 1991
Project: 01-228 Seattle Terminal, PO #19687

RESULTS OF ANALYSES OF THE SOIL SAMPLES
FOR TOTAL LEAD BY ICP (6010)
Results Reported as µg/g (ppm)

Sample #	Total Lead (ppm)
01228-0991-1617-PI1	36

Quality Assurance

Method Blank	<0.5
01228-0991-1617-PI1 (Duplicate)	38
01228-0991-1617-PI1 (Matrix Spike) Percent Recovery	80%
01228-0991-1617-PI1 (Matrix Spike Duplicate) Percent Recovery	78%
Spike Level	50

TIME OIL CO. SAMPLE LOG

9-EK3-B

Seattle Terminal — Prop. No: 01-228 — Address: 2737 W. Commodore
Sean Russell — Date: 9-20-91 — Seattle Wa
se: UST Removal S.A. — Method: Grab ☒ S.Spoon ☐ Bailer ☐ Pump ☐
ab Name: Friedman & Bruya — Preserved: Ice ☐ Acid ☐ None ☐
Lab Address: 3008-B 16th Ave W. Seattle Wa. — Phone: 285-8282 — PO No.: 19687

	Sample #	Location/Description		Type*	Analysis Instructions	EPA Method
1	01228-0991	-1617-PI1	22957/22958	[✓ S] W P	TPHg + d/BTEX	8015/8020
2	01228-0991	-1620-PI2	22959/22960	[✓ S] W P	}	
3		-		S W P		
4		-		S W P		
5		-		S W P		
6		-		S W P		
7		-		S W P		
8		-		S W P		
9		-		S W P		
10		-		S W P		
11		-		S W P		
12		-		S W P		
13		-		S W P		
14		-		S W P		
15		-		S W P		
16		-		S W P		
17		-		S W P		
18		-		S W P		
19		-		S W P		
20		-		S W P		
21		-		S W P		
22		-		S W P		

Other Instructions: Total Lead on sample with highest TPHg result.

Sample Count = *Check sample jar count against Log!* ** S = Soil W = Water P = Product*

CHAIN OF CUSTODY RECORD

Relinquished By: *Received By:* *Date & Time*

Relinquished By: Sean Russell *Received For Lab By:* *Date & Time:* 9-20-91 2:30

GENERAL LAB INSTRUCTIONS

Please provide the requested information

1. Sample numbers assigned by Lab: 22954 to 22957 Date Analyzed: 9/25, 9/27 10/9 10/2 10/9
2. Person performing analysis: A. Gray, M. Perin Data Reviewer: E. Zamora
3. Scheduled sample disposal date: 10-20-91 *NOTIFY TIME OIL CO. BEFORE DISPOSAL*
4. Provide copies of ALL chromatograms, including QA/QC runs.

IMPORTANT! PLEASE RETURN A COPY OF THIS FORM WITH YOUR REPORT TO TIME OIL CO.
Attn: Environmental Manager, PO Box 24447 Terminal Sta., Seattle, WA 98124 (206) 285-2400

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

September 24, 1991

Liam Russell, Environmental Specialist
Time Oil Company
2737 West Commodore Way
Seattle, WA 98199

Dear Mr. Russell:

Enclosed are the results of the analyses of the samples submitted on September 17, 1991 from Project 01-228, Seattle Term, PO #19685.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

Elaine Zamora

Elaine K. Zamora, Chemist

EKZ/sao

Enclosures

FRIEDMAN & BRUYA, INC
ENVIRONMENTAL CHEMISTS

Date of Report: September 24, 1991
Date Submitted: September 17, 1991
Project: 01-228, Seattle Term, PO #19685

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR TOTAL PETROLEUM HYDROCARBONS AS DIESEL BY GC/FID (MODIFIED 8015)

Results Reported as µg/g (ppm)

Sample #	Diesel (ppm)
01228-0991-0829-S1	76
01228-0991-0834-E1	<50
01228-0991-0839-W1	<50
01228-0991-0845-Floor	200
01228-0991-0926-NW1	<50
Quality Assurance	
Method Blank	<50
01228-0991-0926-NW1 (Duplicate)	<50
01228-0991-0926-NW1 (Matrix Spike) Percent Recovery	150%
01228-0991-0926-NW1 (Matrix Spike Duplicate) Percent Recovery	150%
Spike Blank Percent Recovery	99%
Spike Level	500

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: September 24, 1991
Date Submitted: September 17, 1991
Project: 01-228, Seattle Term, PO #19685

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND GASOLINE USING EPA METHODS 5030 COUPLED TO 8020 and 8015

Results Reported as mg/kg (ppm)

Sample #	Benzene	Toluene	Et-Benzene	Xylenes	Gasoline
01228-0991-0829-S1	<0.22ip	0.38	0.099	0.056	19
01228-0991-0834-E1	<0.22ip	2.5	5.0	7.2	180
01228-0991-0839-W1	0.013	0.060	0.023	0.065	<2
01228-0991-0845-Floor	1.1	1.3	3.2	12	120
01228-0991-0926-NW1	0.005	0.049	0.015	0.062	<2
Quality Assurance					
Method Blank	<0.002	<0.002	<0.002	<0.006	<2
01228-0991-0926-NW1 (Duplicate)	0.004	0.024	0.008	0.047	<2
01228-0991-0926-NW1 (Matrix Spike) Percent Recovery	100%	110%	110%	110%	120%
01228-0991-0926-NW1 (Matrix Spike Duplicate) Percent Recovery	100%	110%	110%	110%	120%
Spike Level	1	1	1	3	25

ip - Interferences were present which prevented the identification and quantitation of the analyte at the established detection limit.

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: September 24, 1991
Date Submitted: September 17, 1991
Project: 01-228, Seattle Term, PO #19685

RESULTS OF ANALYSES OF THE SOIL SAMPLE FOR TOTAL LEAD BY ICP (6010)

Results Reported as µg/g (ppm)

Sample #	Total Lead (ppm)
01228-0991-0834-E1	2.5

Quality Assurance	
Method Blank	<0.5
01228-0991-0834-E1 (Duplicate)	3.5
01228-0991-0834-E1 (Matrix Spike) Percent Recovery	90%
01228-0991-0834-E1 (Matrix Spike Duplicate) Percent Recovery	87%
Spike Level	50

TIME OIL CO. SAMPLE LOG 9-EKZ-B

Site Name: SEATTLE TERM
Prop. No: 01-228
Address: 2737 W. COMMODORE
SEATTLE, WA 98199
Sampler: Lian Russell
Date: 9-17-91
Purpose: UST REMOVAL S.A.
Method: Grab ☒ S.Spoon ☐ Bailer ☐ Pump ☐
Lab Name: FRIEDMAN + BRUYA
Preserved: Ice ☐ Acid ☐ None ☐
Lab Address:
Phone: 285-8282
PO No.: 19685

	Sample #	Location/Description	Type*	Analysis Instructions	FBI# ~~EPA Method~~
1	01228-0491	- 0829 - S1	[✓ S] W P	TPHG-D/BTEX	22789-90
2	"	- 0834 - E1	[✓ S] W P	TPHG-D/BTEX	22791-92
3	"	- 0839 - W1	[✓ S] W P	TPHG-D/BTEX	22793-94
4	"	- 0845 - FLOOR	[✓ S] W P	TPHG-D/BTEX	22795-96
5	"	- 0924 - NW1	[✓ S] W P	TPHG-D/BTEX	22797-98
6		-	S W P		
7		-	S W P		
8		-	S W P		
9		-	S W P		
10		-	S W P		
11		-	S W P		
12		-	S W P		
13		-	S W P		
14		-	S W P		
15		-	S W P		
16		-	S W P		
17		-	S W P		
18		-	S W P		
19		-	S W P		
20		-	S W P		
21		-	S W P		
22		-	S W P		

Analyze '0831-E1'
For total lead

Skip the TCLP lead
LB 9/19/91

run the sample
with the highest gas
value for total lead
as per Lian Russell
9.17.91

Other Instructions: ANALYSE TCLP LEAD ON THE HIGHEST TPH RESULT.

Sample Count = *Check sample jar count against Log!* ** S = Soil W = Water P = Product*

CHAIN OF CUSTODY RECORD

Relinquished By: Lian Russell *Received By:* FFB.I. M. Dianardo *Date & Time* 9-17-91

Relinquished By: *Received For Lab By:* *Date & Time:*

GENERAL LAB INSTRUCTIONS

Please provide the requested information

1. Sample numbers assigned by Lab: 22789 to 22798 Date Analyzed: 9/17/91, 9/18/91
2. Person performing analysis: A. Gray, E. Zamora, ~~[illegible]~~ Data Reviewer: K. McMullen
3. Scheduled sample disposal date: 10-17-91 *NOTIFY TIME OIL CO. BEFORE DISPOSAL*
4. Provide copies of ALL chromatograms, including QA/QC runs.

IMPORTANT! PLEASE RETURN A COPY OF THIS FORM WITH YOUR REPORT TO TIME OIL CO.
Attn: Environmental Manager, PO Box 24447 Terminal Sta., Seattle, WA 98124 (206) 285-2400

UNDERGROUND STORAGE TANK
Site Check/Site Assessment Checklist

The purpose of this form is to certify the proper investigation of an UST site for the presence of a release. These activities shall be conducted in accordance with Chapter 173.360 WAC. A description of the various situations requiring a site check or site assessment is provided in the guidance document for UST site checks and site assessments.

This Site Check/Site Assessment Checklist shall be completed and signed by a person registered with the Department of Ecology to perform site assessments.

Two copies of the results of the site check or site assessment should be included with this checklist according to the reporting requirements in the guidance document for UST site checks and site assessments.

For further information about completing this form, please contact the Department of Ecology UST Program.

The completed checklist should be mailed to the following address:

Underground Storage Tank Section
Department of Ecology
Mail Stop PV-11
Olympia, WA 98504-8711

1. UST SYSTEM OWNER AND LOCATION

UST Owner/Operator: TIME OIL CO.

Owners Address: 2737 WEST COMMODORE WY. (Street) (P.O. Box)
SEATTLE, WA (City) (State) 98199 (ZIP-Code)

Telephone: (206) 285-2400

Site ID Number (on invoice or available from Ecology if tank is registered): 004055

Site/Business Name: TIME OIL

Site Address: 2737 W. COMMODORE WAY (Street) KING (County)
SEATTLE, WA (City) (State) 98199 (ZIP-Code)

2. SITE CHECK/SITE ASSESSMENT CONDUCTED BY:

Registered Person: LIAM J. RUSSELL

Address: 2737 W. COMMODORE WAY (Street) (P.O. Box)
SEATTLE WA (City) (State) 98199 (ZIP-Code)

Telephone: (206) 286-4490

3. TANK INFORMATION

1. Tank ID Number (as registered with Ecology): 825
2. Year installed: UNKNOWN
3. Tank capacity in gallons: 4,000
4. Last substance stored: UNLEADED

4. REASON FOR CONDUCTING SITE CHECK/SITE ASSESSMENT

Check one:

______ Investigate suspected release due to on-site environmental contamination

______ Investigate suspected release due to off-site environmental contamination

______ Extend temporary closure of UST system for more than 12 months

______ UST system undergoing change-in-service

______ UST system permanently closed-in-place

✓ UST system permanently closed with tank removed

______ Required by Ecology or delegated agency for UST system closed before December 22, 1988

______ Other (describe): ______

5. CHECKLIST

Each item of the following checklist shall be initialed by the person registered with the Department of Ecology whose signature appears below.

	Yes	No
1. Has the site check/site assessment been conducted according to applicable procedures specified in the UST site check/site assessment guidance issued by the Department of Ecology?	✓	
2. Has a release from the UST system been confirmed? *NOTE: Owners/operators must report all confirmed releases to the Department of Ecology or delegated agency within 24 hours.*	✓	
3. Are the results of the site check/site assessment enclosed with this checklist? *NOTE: Two copies of the site check/site assessment results must be submitted to the Department of Ecology according to the reporting requirements specified in the UST site check/site assessment guidance.*	✓	

I hereby certify that I have been in responsible charge of performing the site check/site assessment described above. Persons submitting false information are subject to penalties under Chapter 173.360 WAC.

12-27-91
Date

Russell
Signature of Person Registered with Ecology

6. OWNER'S SIGNATURE

12/27/91
Date

Joseph D [illegible]
Signature of Tank Owner or Authorized Representative

3. TANK INFORMATION

1. Tank ID Number (as registered with Ecology): 824
2. Year installed: UNKNOWN
3. Tank capacity in gallons: 2500
4. Last substance stored: DIESEL

4. REASON FOR CONDUCTING SITE CHECK/SITE ASSESSMENT

Check one:

- ☐ Investigate suspected release due to on-site environmental contamination
- ☐ Investigate suspected release due to off-site environmental contamination
- ☐ Extend temporary closure of UST system for more than 12 months
- ☐ UST system undergoing change-in-service
- ☐ UST system permanently closed-in-place
- ☑ UST system permanently closed with tank removed
- ☐ Required by Ecology or delegated agency for UST system closed before December 22, 1988
- ☐ Other (describe): ______

5. CHECKLIST

Each item of the following checklist shall be initialed by the person registered with the Department of Ecology whose signature appears below.

	Yes	No
1. Has the site check/site assessment been conducted according to applicable procedures specified in the UST site check/site assessment guidance issued by the Department of Ecology?	LR	
2. Has a release from the UST system been confirmed? *NOTE: Owners/operators must report all confirmed releases to the Department of Ecology or delegated agency within 24 hours.*	LR	
3. Are the results of the site check/site assessment enclosed with this checklist? *NOTE: Two copies of the site check/site assessment results must be submitted to the Department of Ecology according to the reporting requirements specified in the UST site check/site assessment guidance.*	LR	

I hereby certify that I have been in responsible charge of performing the site check/site assessment described above. Persons submitting false information are subject to penalties under Chapter 173.360 WAC.

12-27-91
Date

Liam Russell
Signature of Person Registered with Ecology

6. OWNER'S SIGNATURE

12/27/91
Date

Joseph O
Signature of Tank Owner or Authorized Representative

3. TANK INFORMATION

1. Tank ID Number (as registered with Ecology): 736

2. Year installed: UNKNOWN

3. Tank capacity in gallons: 1500

4. Last substance stored: REGULAR.

4. REASON FOR CONDUCTING SITE CHECK/SITE ASSESSMENT

Check one:

☐ Investigate suspected release due to on-site environmental contamination
☐ Investigate suspected release due to off-site environmental contamination
☐ Extend temporary closure of UST system for more than 12 months
☐ UST system undergoing change-in-service
☐ UST system permanently closed-in-place
☑ UST system permanently closed with tank removed
☐ Required by Ecology or delegated agency for UST system closed before December 22, 1988
☐ Other (describe): ______

5. CHECKLIST

Each item of the following checklist shall be initialed by the person registered with the Department of Ecology whose signature appears below.

	Yes	No
1. Has the site check/site assessment been conducted according to applicable procedures specified in the UST site check/site assessment guidance issued by the Department of Ecology?	LR	
2. Has a release from the UST system been confirmed? *NOTE: Owners/operators must report all confirmed releases to the Department of Ecology or delegated agency within 24 hours.*	LR	
3. Are the results of the site check/site assessment enclosed with this checklist? *NOTE: Two copies of the site check/site assessment results must be submitted to the Department of Ecology according to the reporting requirements specified in the UST site check/site assessment guidance.*	LR	

I hereby certify that I have been in responsible charge of performing the site check/site assessment described above. Persons submitting false information are subject to penalties under Chapter 173.360 WAC.

12-27-91
Date

Liam Russell
Signature of Person Registered with Ecology

6. OWNER'S SIGNATURE

12/27/91
Date

Signature of Tank Owner or Authorized Representative

3. TANK INFORMATION

1. Tank ID Number (as registered with Ecology): 202
2. Year installed: UNKNOWN
3. Tank capacity in gallons: 300
4. Last substance stored: USED OIL

4. REASON FOR CONDUCTING SITE CHECK/SITE ASSESSMENT

Check one:

☐ Investigate suspected release due to on-site environmental contamination
☐ Investigate suspected release due to off-site environmental contamination
☐ Extend temporary closure of UST system for more than 12 months
☐ UST system undergoing change-in-service
☐ UST system permanently closed-in-place
☑ UST system permanently closed with tank removed
☐ Required by Ecology or delegated agency for UST system closed before December 22, 1988
☐ Other (describe):

5. CHECKLIST

Each item of the following checklist shall be initialed by the person registered with the Department of Ecology whose signature appears below.

	Yes	No
1. Has the site check/site assessment been conducted according to applicable procedures specified in the UST site check/site assessment guidance issued by the Department of Ecology?	LR	
2. Has a release from the UST system been confirmed? *NOTE: Owners/operators must report all confirmed releases to the Department of Ecology or delegated agency within 24 hours.*	LR	
3. Are the results of the site check/site assessment enclosed with this checklist? *NOTE: Two copies of the site check/site assessment results must be submitted to the Department of Ecology according to the reporting requirements specified in the UST site check/site assessment guidance.*	LR	

I hereby certify that I have been in responsible charge of performing the site check/site assessment described above. Persons submitting false information are subject to penalties under Chapter 173.360 WAC.

12-27-91
Date

Liam Russell
Signature of Person Registered with Ecology

6. OWNER'S SIGNATURE

12/27/91
Date

Joseph D. [illegible]
Signature of Tank Owner or Authorized Representative

SEATTLE
TACOMA
PORTLAND
STOCKTON
RENO
RICHMOND
LOS ANGELES

TIME
PRODUCTS TIME TESTED

TEN TO ONE IT'S TIME

PHONE 285-2400
CABLE ADDRESS TIMOIL
(FAX) 206-283-8036

TIME OIL CO.

2737 WEST COMMODORE WAY SEATTLE, WA 98199-1233
P.O. BOX 24447 SEATTLE, WA 98124-0447

September 22, 1992

Washington State Department of Ecology
Northwest Region
3190 160th SE
Bellevue, Washington 98008-5452
Attention: Mr. Joe Hickey

SUBJECT: Excavating Activities Conducted at Former Waste Oil Tank Location
Former Time Oil Co. Vehicle Maintenance Facility
2750 Commodore Way; Seattle, Washington

Dear Mr. Hickey,

This letter is to inform you of the findings of additional assessment activities conducted at the above referenced site. On July 28th and 29th, 1992 additional excavation was conducted in the former location of a waste oil tank which was removed in September 1991. Hydrocarbon contamination was discovered during removal of the tank; thus, this additional phase of excavation was undertaken in an attempt to remove remaining soil contamination.

A small amount of groundwater had pooled in the initial excavation associated with tank removal; therefore, lateral excavation was conducted in an attempt to define the limits of the contaminated area. Previous excavating activities had documented that soils located on the southern and western edges of the excavation did not contain hydrocarbons exceeding MTCA Method A Cleanup Levels; thus, the excavation was expanded primarily to the north and east.

After approximately 150 cubic yards of contaminated soil had been removed, excavating activities were terminated because field observations suggested that contaminant severity increased in an easterly direction, and excavation of the full extent of soil contamination did not appear to be feasible. The excavation was backfilled by placing crushed rock below the groundwater surface, installing a layer of 10-mil visqueen upon the crushed rock to reduce settling and surface water infiltration, and backfilling the remaining excavation with fine sand.

Six soil samples were collected from the limits of the northern and eastern sides of the excavation, directly above the groundwater surface, to assess remaining contaminant levels and evaluate the potential for a groundwater impact (See Figure 1 - Site Map for sample locations). The six samples were submitted to a State certified laboratory for hydrocarbon identification (WHCID) analysis to identify the hydrocarbons present. Hydrocarbons identified as gasoline, diesel, and mineral spirits were identified in samples A-1 @8', A-2 @9', and A-6 @3'. Motor oil was also detected in sample A-6 @3'. Additional analysis was conducted on the three samples in which hydrocarbons were detected to quantify levels of TPH and BTEX by the WTPH Method and EPA Method 8020. These three samples were found to contain levels of TPH-gasoline ranging from 60 to 290 parts per million (ppm), TPH-diesel ranging from 90 to 1,600 ppm, TPH-mineral spirits between 50 and 210 ppm, and 2,300 ppm TPH-motor oil was detected in sample A-6 @3' (See Table 1 - Analytical Results). Laboratory reports are attached.

Two additional soil samples were recovered from the vicinity of an area of visibly impacted soil located near the ground surface on the south side of the excavation. Sample WO-WC was recovered from material believed to represent "worst case" conditions in order to conduct disposal profiling. Sample WO @5' was collected from the same area at a depth of 5 feet below grade to verify removal of the impacted soil once field observations indicated that the visibly impacted area had been fully excavated. WHCID analysis on these two samples detected the presence of diesel fuel in Sample WO-WC and did not detect petroleum hydrocarbons in sample WO @5'. WTPH analysis conducted on Sample WO-WC detected 2,800 ppm TPH-diesel. Laboratory reports are attached.

These analytical results, in combination with field observations, indicate that petroleum hydrocarbon contamination remains beneath the site, and that an impact upon groundwater may have occurred. Time Oil Co. is in the process of submitting a request for proposals to environmental consultants for further assessment of this area. This next phase of assessment will include the installation of soil borings and groundwater monitoring wells to assess the extent of remaining soil contamination and the potential for an impact upon groundwater.

The excavated soil is currently stockpiled upon an adjacent property also owned by Time Oil Co. Samples of this material have been submitted for disposal profiling. Arrangements to recycle the soil will be made once analytical results are received.

If you have any questions regarding this site, please contact either myself at (206) 286-6457 or Liam Russell at (206) 286-4490. If we are not available, Kevin Murphy may be able to answer your questions.

Sincerely,

Scott B. Sloan

Scott B. Sloan
Geologist

<u>Enclosures:</u>
Table 1 - Analytical Results
Figure 1 - Site Map
Analytical Reports

C:\WP51\SCOTT\DOELTRS\DOCKSIDE.LTR

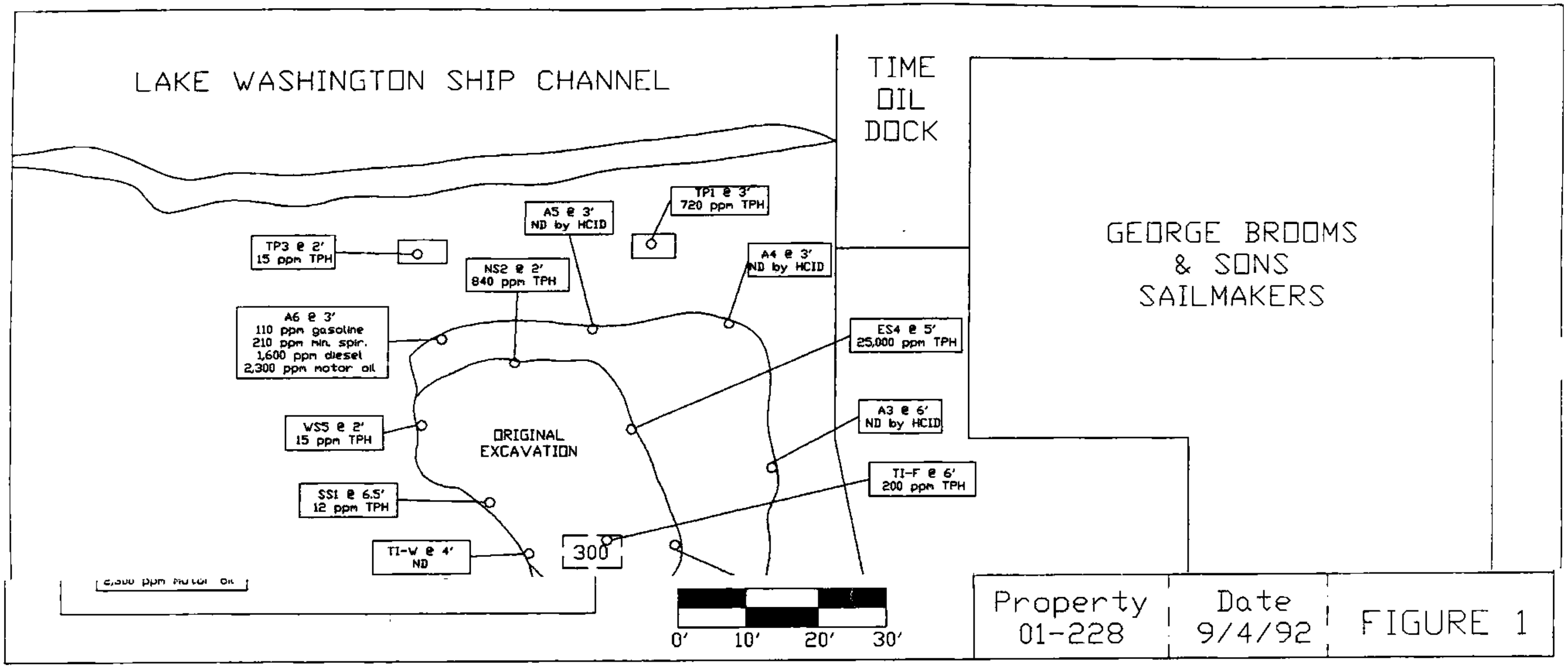
TABLE 1

Soil Analytical Results
Time Oil Co. Property No. 01-228
2750 Commodore Way; Seattle, Washington

Sample Number	Depth	TPH	Benzene	Toluene	Ethyl-benzene	Total Xylenes
Samples Collected 10/3/91						
TI-F	6'	200	NT	NT	NT	NT
TI-E	4'	ND	NT	NT	NT	NT
TI-S	4'	ND	NT	NT	NT	NT
TI-W	4'	ND	NT	NT	NT	NT
TP1	3'	720	NT	NT	NT	NT
Samples Collected 12/10/91						
SS1	6.5'	12	NT	NT	NT	NT
NS2	2'	840	NT	NT	NT	NT
ES4	5'	25,000	NT	NT	NT	NT
TP3	2'	15	NT	NT	NT	NT
Samples Collected 7/29/92						
A1	8'	60-g	ND	ND	ND	ND
		50-m	--	--	--	--
		90-d	--	--	--	--
A2	9'	290-g	ND	ND	ND	ND
		200-m	--	--	--	--
		330-d	--	--	--	--
A3	6'	ND*	NT	NT	NT	NT
A4	3'	ND*	NT	NT	NT	NT
A5	3'	ND*	NT	NT	NT	NT
A6	3'	110-g	0.16	0.14	2.6	4.9
		210-m	--	--	--	--
		1,600-d	--	--	--	--
		2,300-o	--	--	--	--
WO-WC	2'	2,800-d	NT	NT	NT	NT
WO @ 5'	5'	ND*	NT	NT	NT	NT

NOTES:

Results reported in milligrams per kilogram (mg/kg) of parts per million (ppm).
g = TPH as gasoline, d = TPH as diesel,
m = TPH as mineral spirits, o = TPH as motor oil.
Detection limit for benzene, toluene, and ethylbenzene = 0.02 ppm
Detection limit for total xylenes = 0.04 ppm.
Shading denotes sample with at least one constituent exceeding Method A Cleanup Standards.
NT = Sample not tested for this constituent.
ND = Not detected.
* = TPH analysis by HCID.



Property
01-228

Date
9/4/92

FIGURE 1

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

August 5, 1992

Scott Sloan, Environmental Specialist
Time Oil Company
2737 West Commodore Way
Seattle, WA 98199

Dear Mr. Sloan:

Enclosed are the results of the analyses of the samples submitted on July 30, 1992 from Project 01-228, Seattle Terminal Dockside.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

Amy Gray

Amy M. Gray
Chemist

AMG/dp

Enclosures

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: August 5, 1992
Date Submitted: July 30, 1992
Project: 01-228, Seattle Terminal Dockside

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR FINGERPRINT CHARACTERIZATION BY CAPILLARY GAS CHROMATOGRAPHY USING FLAME IONIZATION DETECTION (FID) AND ELECTRON CAPTURE DETECTION (ECD)

Sample #	GC Characterization
A-1@8' - SE Corner in Cap . Fringe	The gas chromatographic trace showed the presence of low and medium boiling compounds, such as those found in gasoline, mineral spirits and diesel. This characterization is based on material eluting in the gasoline range and with a gasoline pattern, as well as the presence of a relatively ragged envelope of peaks present from ca *n*-C_8 to *n*-C_{12} with a maximum near *n*-C_{10}, as well as a second continuing envelope of peaks from ca *n*-C_{18} to *n*-C_{22} with a maximum near *n*-C_{17}. Augmented levels of benzene, toluene, ethylbenzene and the xylenes were seen which is common to most gasolines. The lower boiling material appeared to be slightly weathered most likely by evaporation as evident in the relative lessening of earlier peaks. The medium boiling material appeared to be mostly weathered by biodegradation evident in the loss of *n*-alkane peaks. The ECD trace showed the possible presence of halogenated solvents. The large peak eluting at approximately 24 minutes represents our internal standard.

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: August 5, 1992
Date Submitted: July 30, 1992
Project: 01-228, Seattle Terminal Dockside

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR FINGERPRINT CHARACTERIZATION BY CAPILLARY GAS CHROMATOGRAPHY USING FLAME IONIZATION DETECTION (FID) AND ELECTRON CAPTURE DETECTION (ECD)

Sample #	GC Characterization
A-2@9' - SE Corner, 1' Lower	The gas chromatographic trace showed the presence of low and medium boiling compounds, such as those found in gasoline, mineral spirits and diesel. This characterization is based on material eluting in the gasoline range and with a gasoline pattern, as well as the presence of a relatively ragged envelope of peaks present from ca n-C_8 to n-C_{12} with a maximum near n-C_{10}, as well as a second continuing envelope of peaks from ca n-C_{18} to n-C_{22} with a maximum near n-C_{17}. Augmented levels of benzene, toluene, ethylbenzene and the xylenes were seen which is common to most gasolines. The lower boiling material appeared to be slightly weathered most likely by evaporation as evident in the relative lessening of earlier peaks. The medium boiling material appeared to be mostly weathered by biodegradation evident in the loss of n-alkane peaks. The ECD trace showed the possible presence of halogenated solvents. The large peak eluting at approximately 24 minutes represents our internal standard.
A-3@6' - E Side in Cap. Fringe	Both gas chromatographic traces show the absence of significant levels of volatile or semi-volatile compounds. The large peak eluting at approximately 24 minutes represents our internal standard.

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: August 5, 1992
Date Submitted: July 30, 1992
Project: 01-228, Seattle Terminal Dockside

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR FINGERPRINT CHARACTERIZATION BY CAPILLARY GAS CHROMATOGRAPHY USING FLAME IONIZATION DETECTION (FID) AND ELECTRON CAPTURE DETECTION (ECD)

Sample #	GC Characterization
A-4@3' - N in Cap. Fringe	Both gas chromatographic traces show the absence of significant levels of volatile or semi-volatile compounds. The large peak eluting at approximately 24 minutes represents our internal standard.
A-5@3' - NE Corner in Cap. Fringe	Both gas chromatographic traces show the absence of significant levels of volatile or semi-volatile compounds. The large peak eluting at approximately 24 minutes represents our internal standard.
A-6@3' - New Corner in Cap. Fringe	The gas chromatographic trace showed the presence of low, medium and high boiling compounds, such as those found in gasoline, mineral spirits, diesel, and motor oil with the most prominent material being diesel. This characterization is based on the presence of an envelope of peaks eluting in the gasoline range and with a gasoline-like pattern, a second envelope of peaks present from ca $n\text{-C}_{8}$ to $n\text{-C}_{12}$ with a maximum near $n\text{-C}_{10}$, a third continuing envelope of peaks from ca $n\text{-C}_{10}$ to beyond $n\text{-C}_{22}$ with a maximum near $n\text{-C}_{17}$ and a fourth envelope of peaks present from ca $n\text{-C}_{22}$ to beyond ca $n\text{-C}_{34}$, with a maximum near C_{28}. Augmented levels of benzene, toluene, ethylbenzene and the xylenes were seen which is common to most gasolines. The ECD trace showed the possible presence of halogenated solvents. The large peak eluting at approximately 24 minutes represents our internal standard.

2-AMG-A
7-30-92(3:48)

TIME OIL CO. SAMPLE LOG

Site Name: Seattle Terminal Dockside
Prop. No: 01-228
Address: 2737 W. Commodore
Seattle, WA
Sampler: Scott Sloan
Date: 7/30/92
Purpose: Excavation Assessment
Method: Grab ☒ S.Spoon ☐ Bailer ☐ Pump ☐
Lab Name: Friedman & Bruya
Preserved: Ice ☒ Acid ☐ None ☐
Lab Address:
Phone:
PO No.: ☐

	Sample #	Location/Description	Type*	Analysis Instructions	EPA Method
1	A-1@8'	- SE Corner in Cap. Fringe	[✓ S] W P	WTPH - HCID 31873	
2	A-2@9'	- '' , 1' lower	[✓ S] W P	↓ 31874	
3	A-3@6'	- E Side in Cap. Fringe	[✓ S] W P	↓ 31875	
4	A-4@3'	- N in Cap. Fringe	[✓ S] W P	↓ 31876	
5	A-5@3'	- NE Corner in Cap. Fringe	[✓ S] W P	↓ 31877	
6	A-6@3'	- NW Corner in Cap. Fringe	[✓ S] W P	↓ 31878	
7		-	S W P		
8		-	S W P		
9		-	S W P		
10		-	S W P		
11		-	S W P		
12		-	S W P		
13		-	S W P		
14		-	S W P		
15		-	S W P		
16		-	S W P		
17		-	S W P		
18		-	S W P		
19		-	S W P		
20		-	S W P		
21		-	S W P		
22		-	S W P		

Other Instructions: (S) Hold Samples for possible additional testing.

Sample Count = *Check sample jar count against Log!* ** S = Soil W = Water P = Product*

CHAIN OF CUSTODY RECORD

Relinquished By: *Received By:* [illegible] Martin *Date & Time* 7-30-92 2:25

Relinquished By: *Received For Lab By:* *Date & Time:*

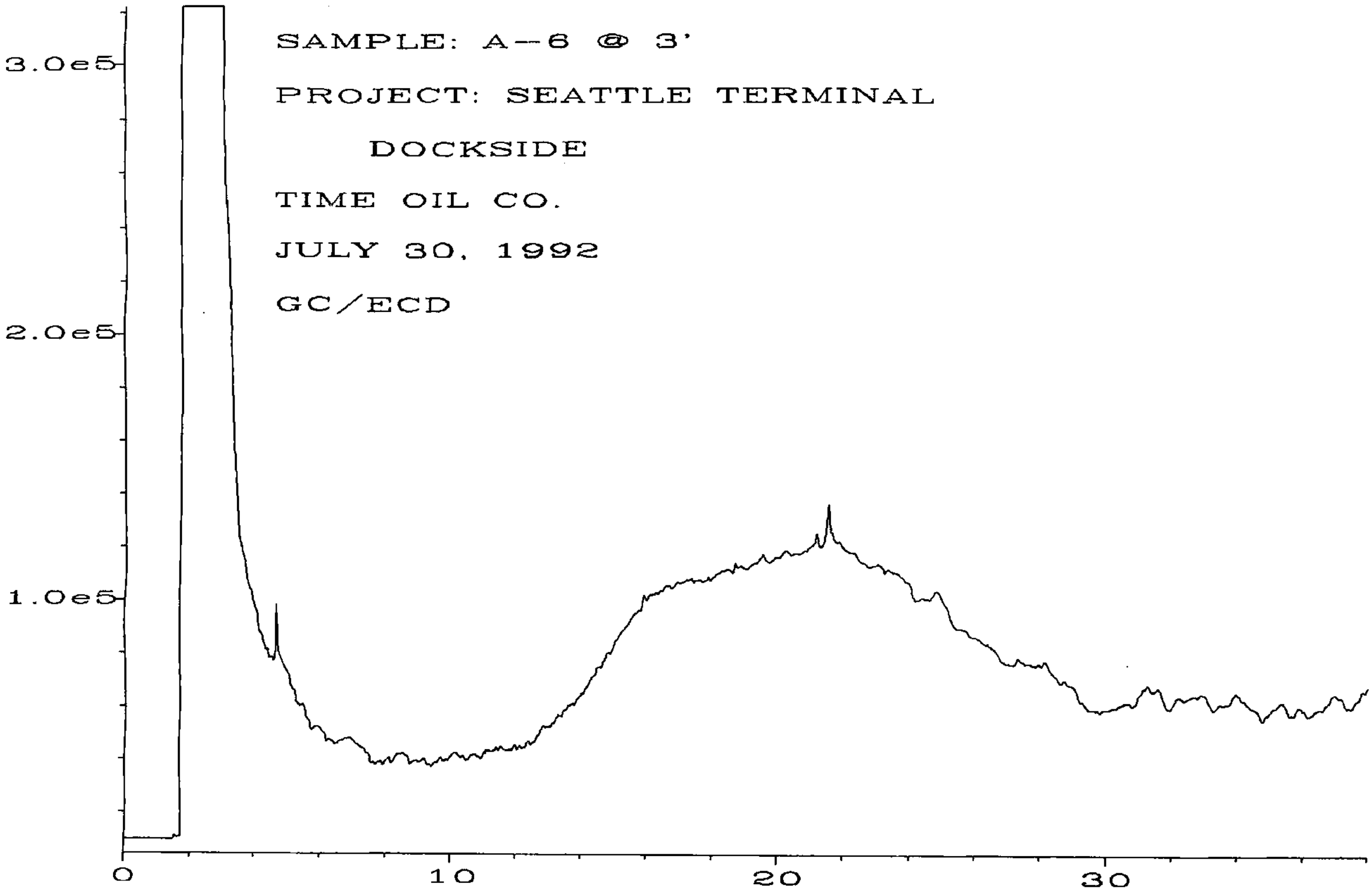
GENERAL LAB INSTRUCTIONS

Please provide the requested information

1. Sample numbers assigned by Lab: 31873 to 31878 Date Analyzed: 7-30-92
2. Person performing analysis: Andrew Friedman, Amy Gray Data Reviewer: Andrew Friedman
3. Scheduled sample disposal date: 8-30-92 *NOTIFY TIME OIL CO. BEFORE DISPOSAL*
4. Provide copies of ALL chromatograms, including QA/QC runs.

IMPORTANT! PLEASE RETURN A COPY OF THIS FORM WITH YOUR REPORT TO TIME OIL CO.

Attn: Environmental Manager, PO Box 24447 Terminal Sta., Seattle, WA 98124 (206) 285-2400



SAMPLE: A-6 @ 3'

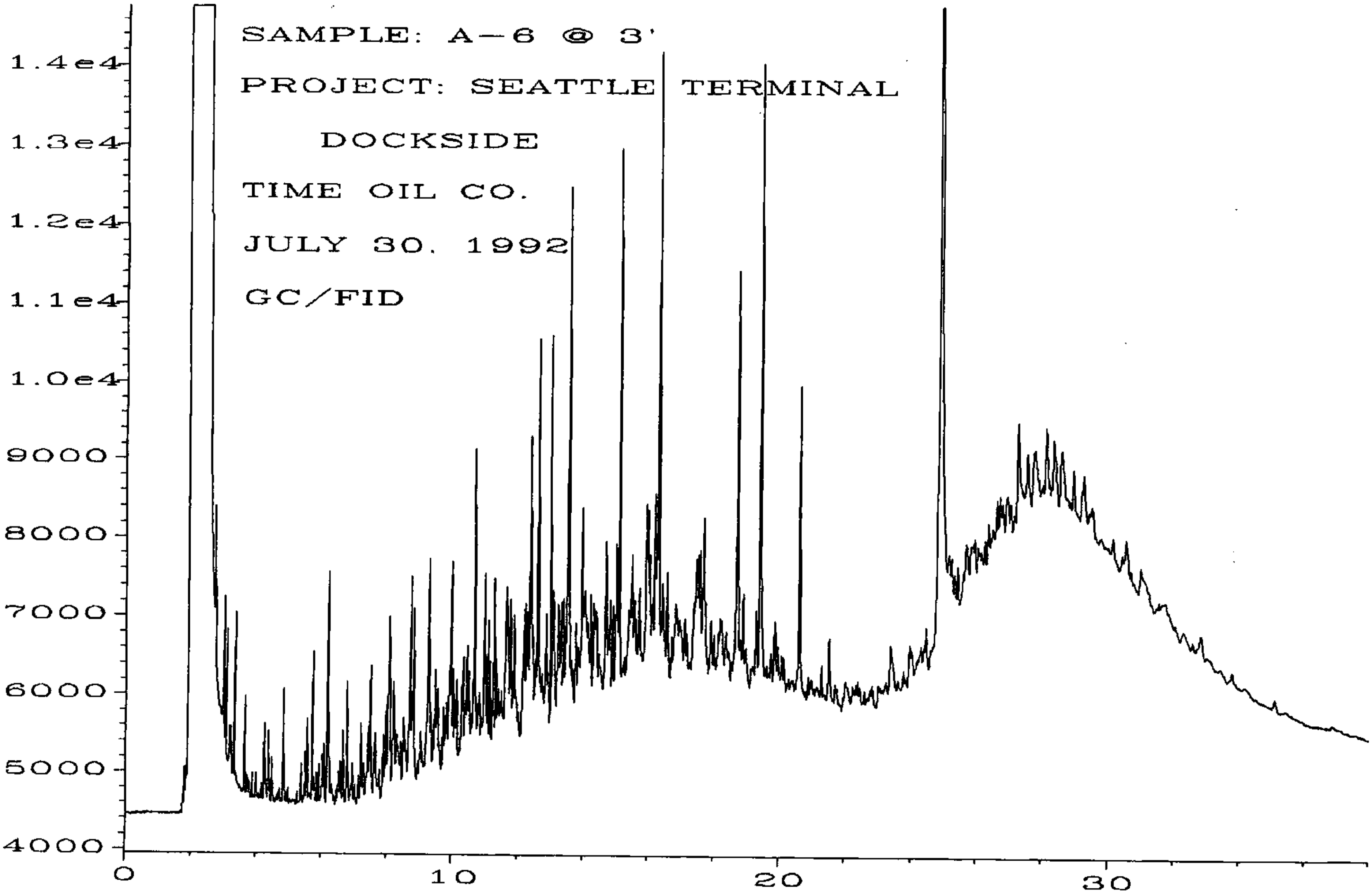
PROJECT: SEATTLE TERMINAL
DOCKSIDE

TIME OIL CO.

JULY 30, 1992

GC/ECD

Sig. 2 in C:\HPCHEM\4\DATA\07-30-92\031R1301.D



SAMPLE: A–6 @ 3'

PROJECT: SEATTLE TERMINAL

DOCKSIDE

TIME OIL CO.

JULY 30. 1992

GC/FID

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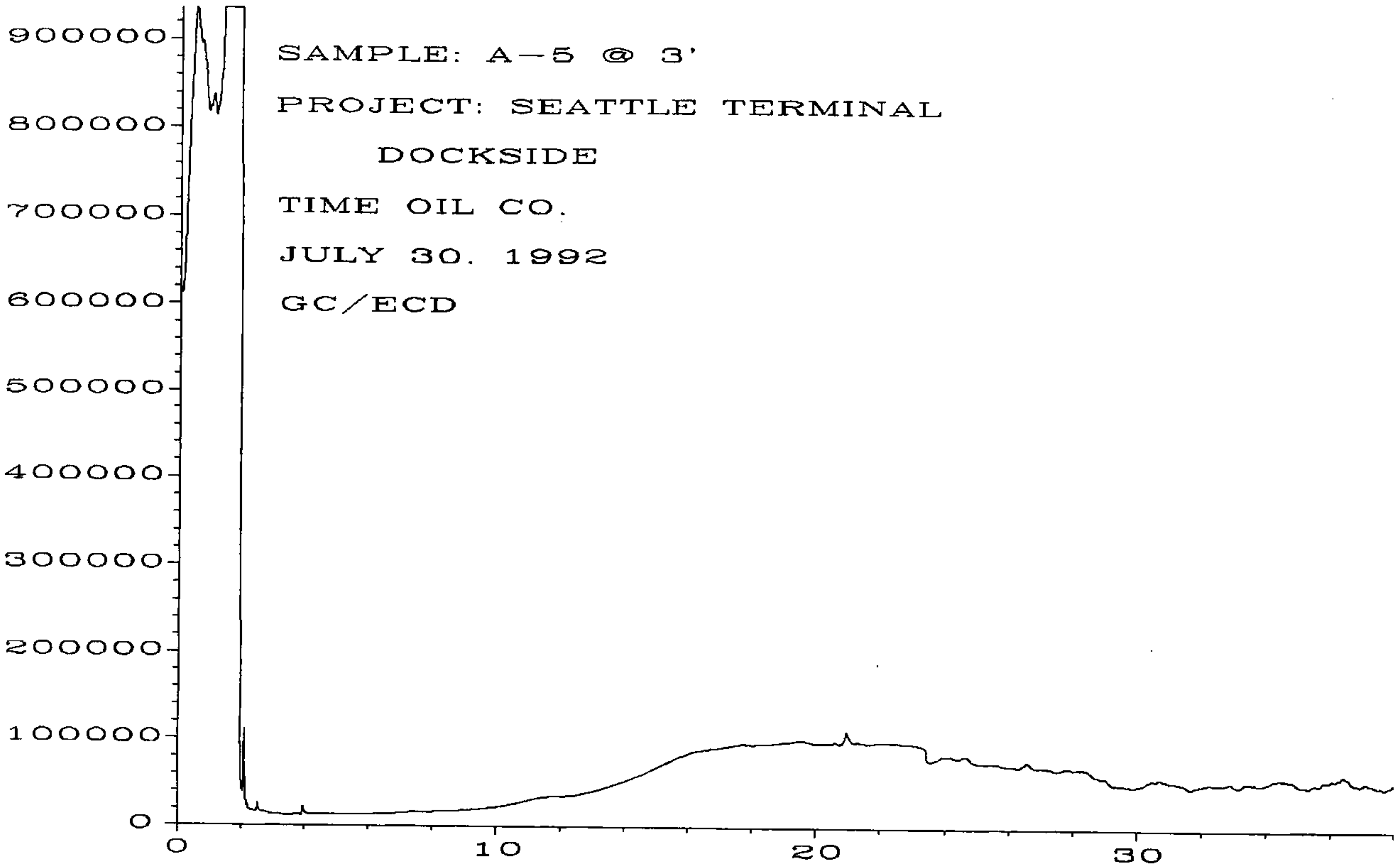

SAMPLE: A-5 @ 3'

PROJECT: SEATTLE TERMINAL

DOCKSIDE

TIME OIL CO.

JULY 30. 1992

GC/ECD

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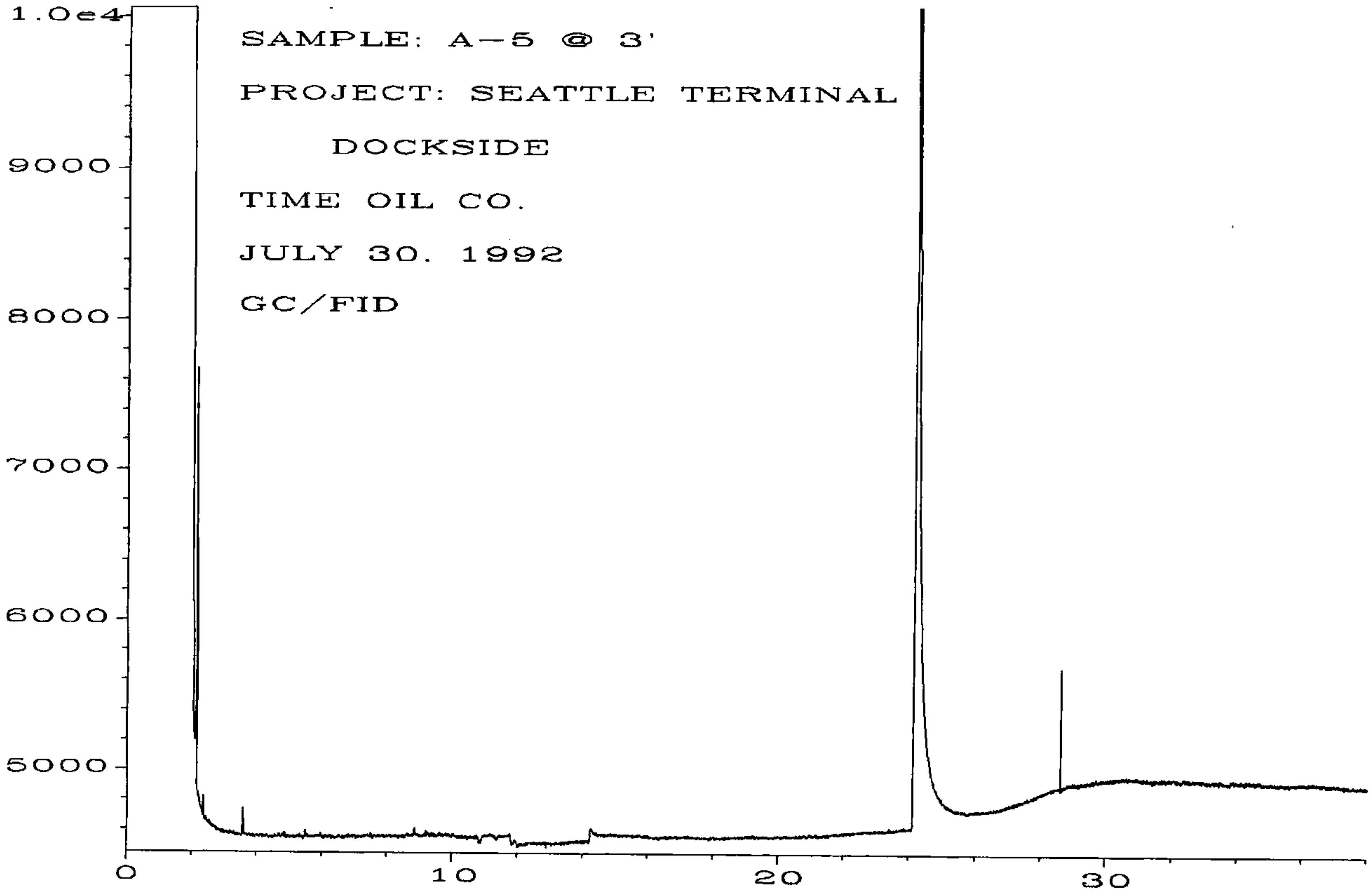

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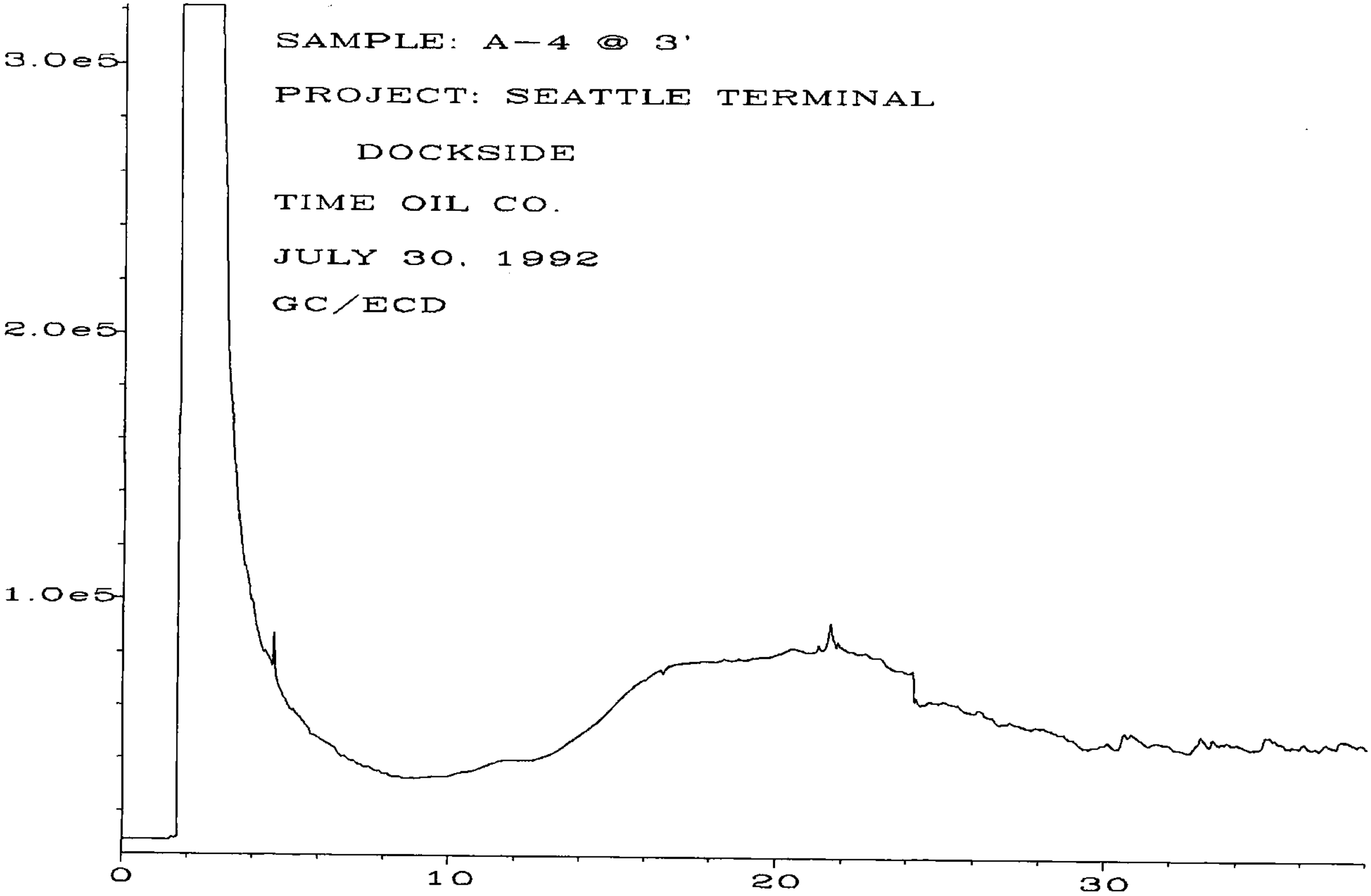

SAMPLE: A-4 @ 3'

PROJECT: SEATTLE TERMINAL

DOCKSIDE

TIME OIL CO.

JULY 30, 1992

GC/ECD

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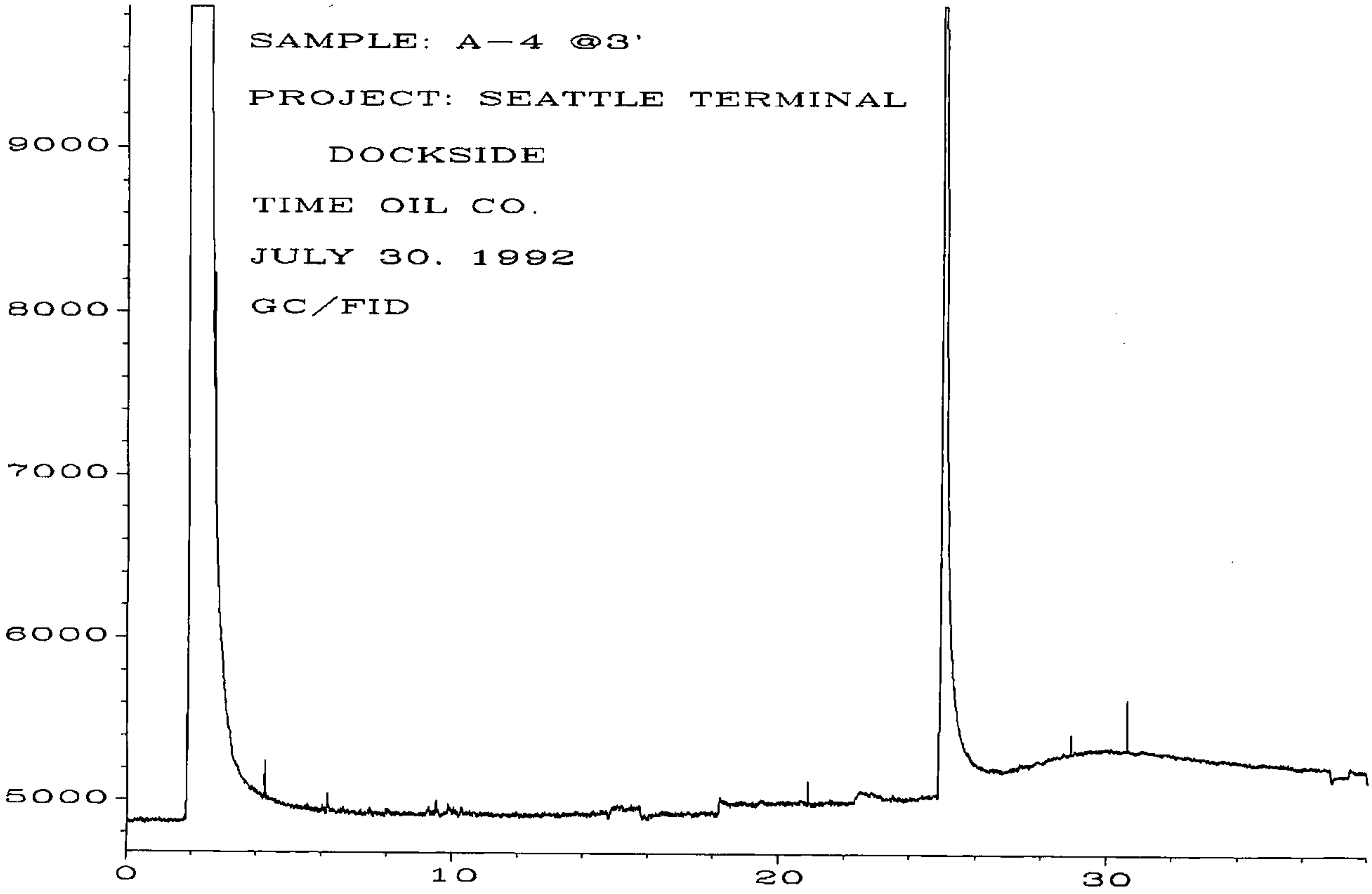

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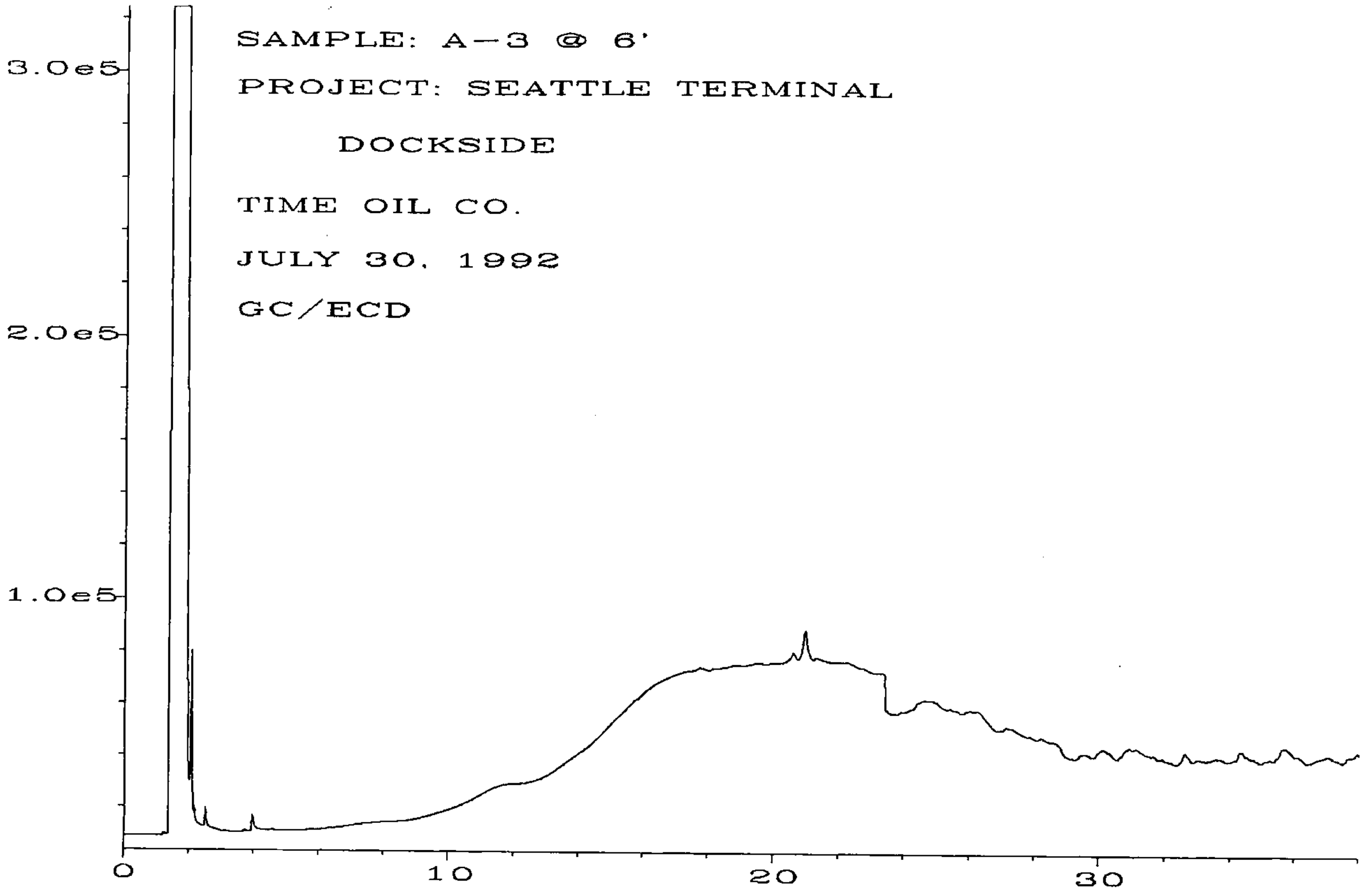

SAMPLE: A-3 @ 6'
PROJECT: SEATTLE TERMINAL
DOCKSIDE
TIME OIL CO.
JULY 30, 1992
GC/ECD

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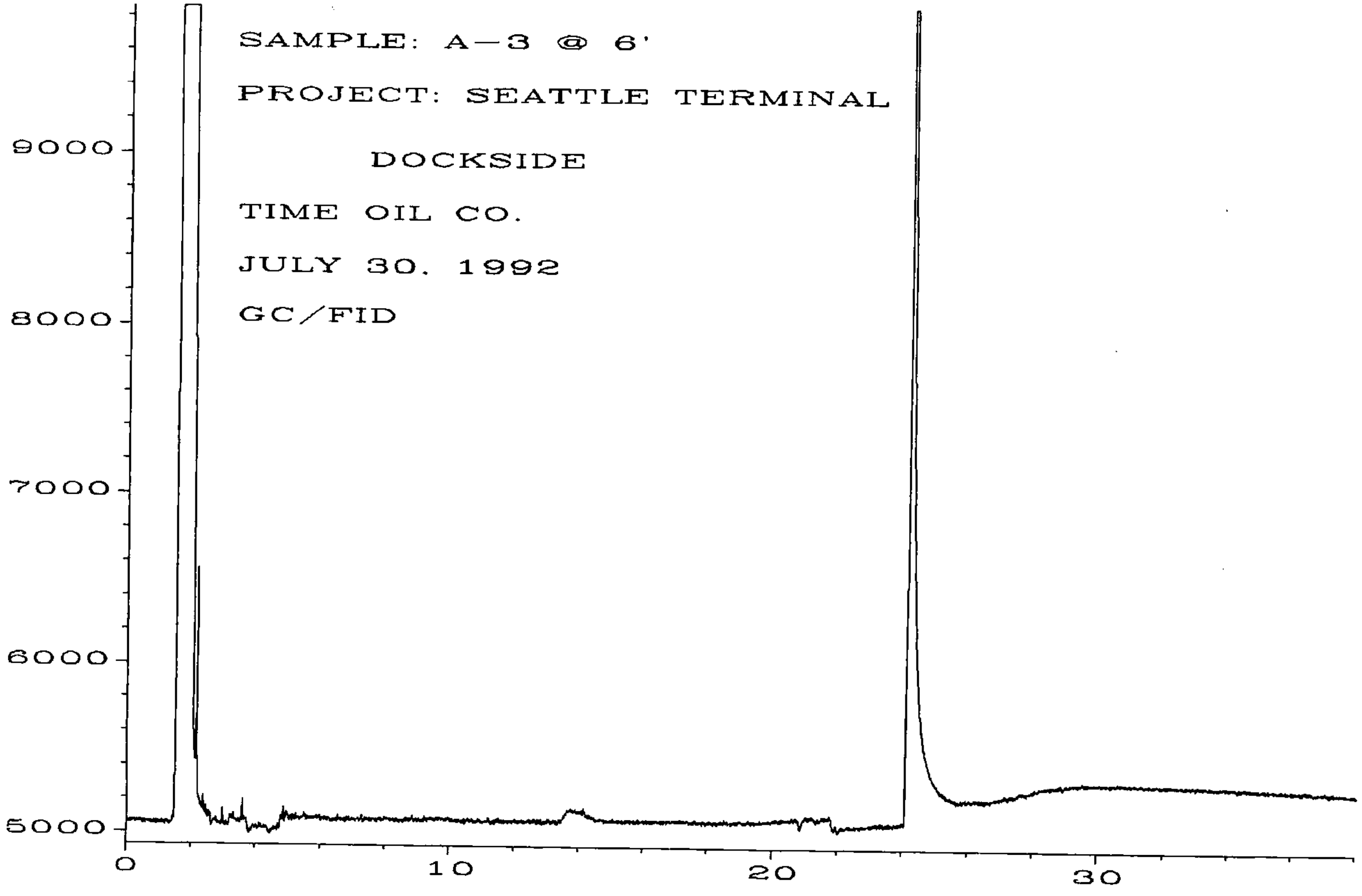

SAMPLE: A-3 @ 6'

PROJECT: SEATTLE TERMINAL

DOCKSIDE

TIME OIL CO.

JULY 30. 1992

GC/FID

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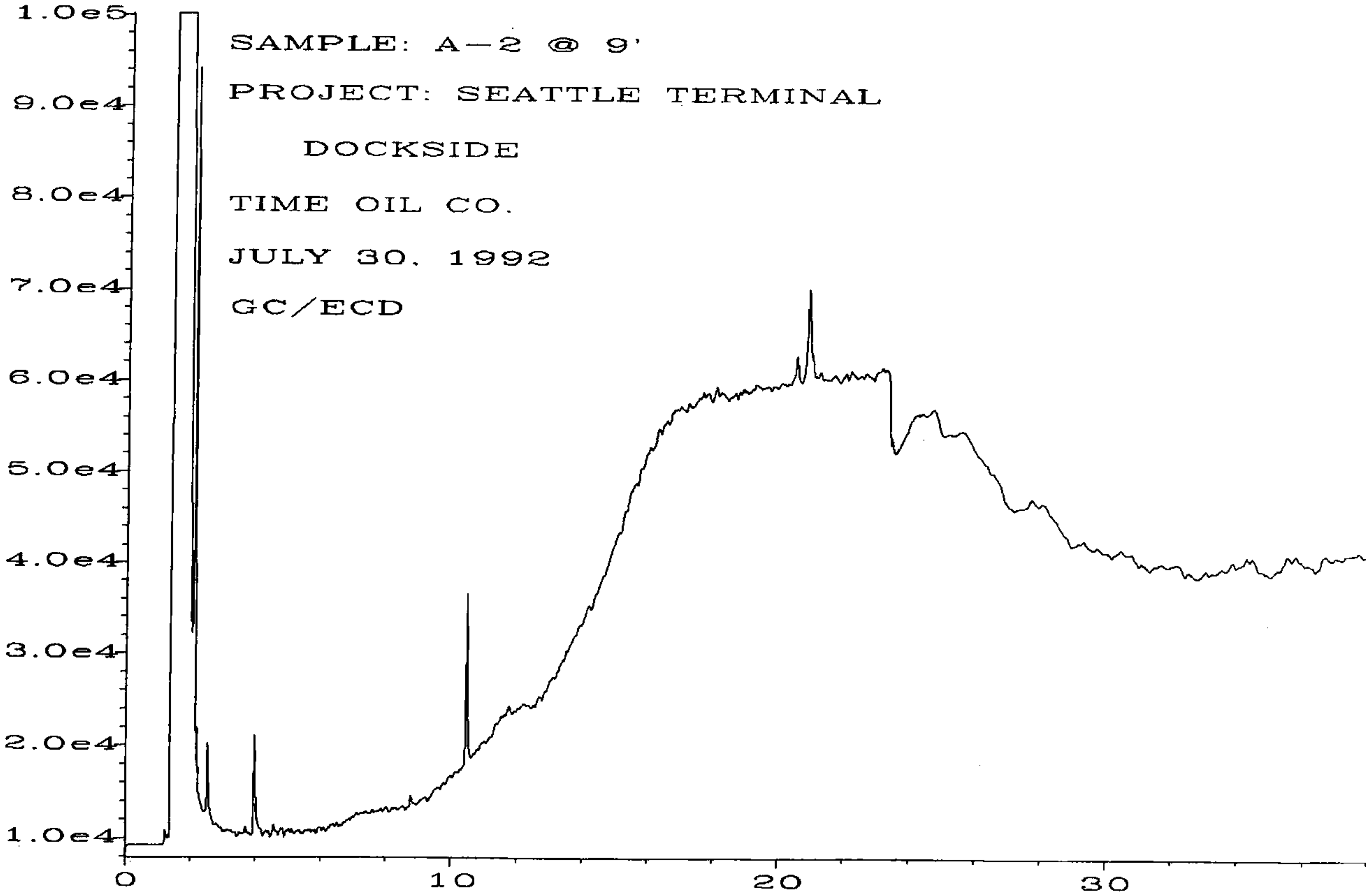

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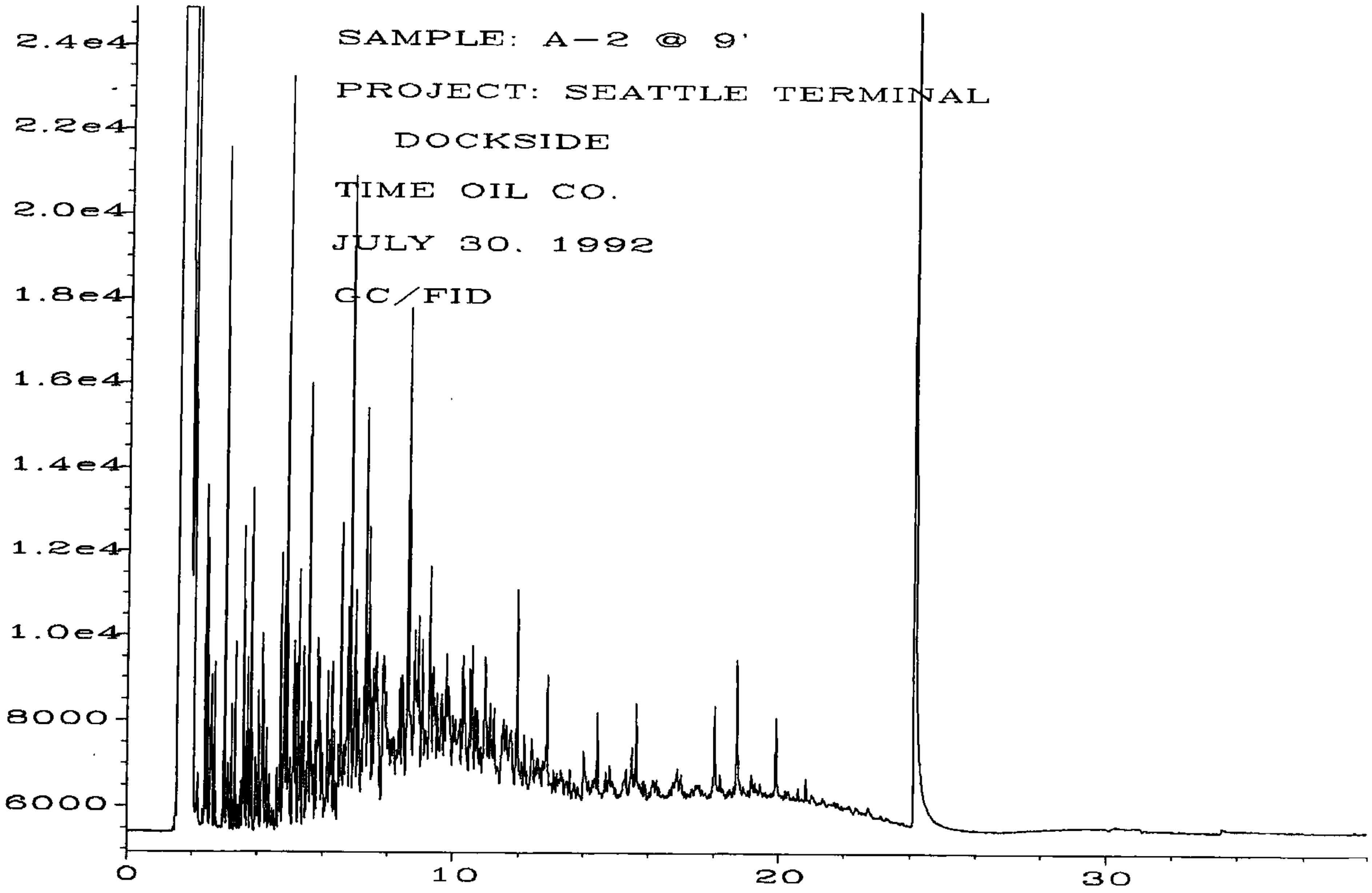

SAMPLE: A-2 @ 9'

PROJECT: SEATTLE TERMINAL
DOCKSIDE

TIME OIL CO.

JULY 30. 1992

GC/FID

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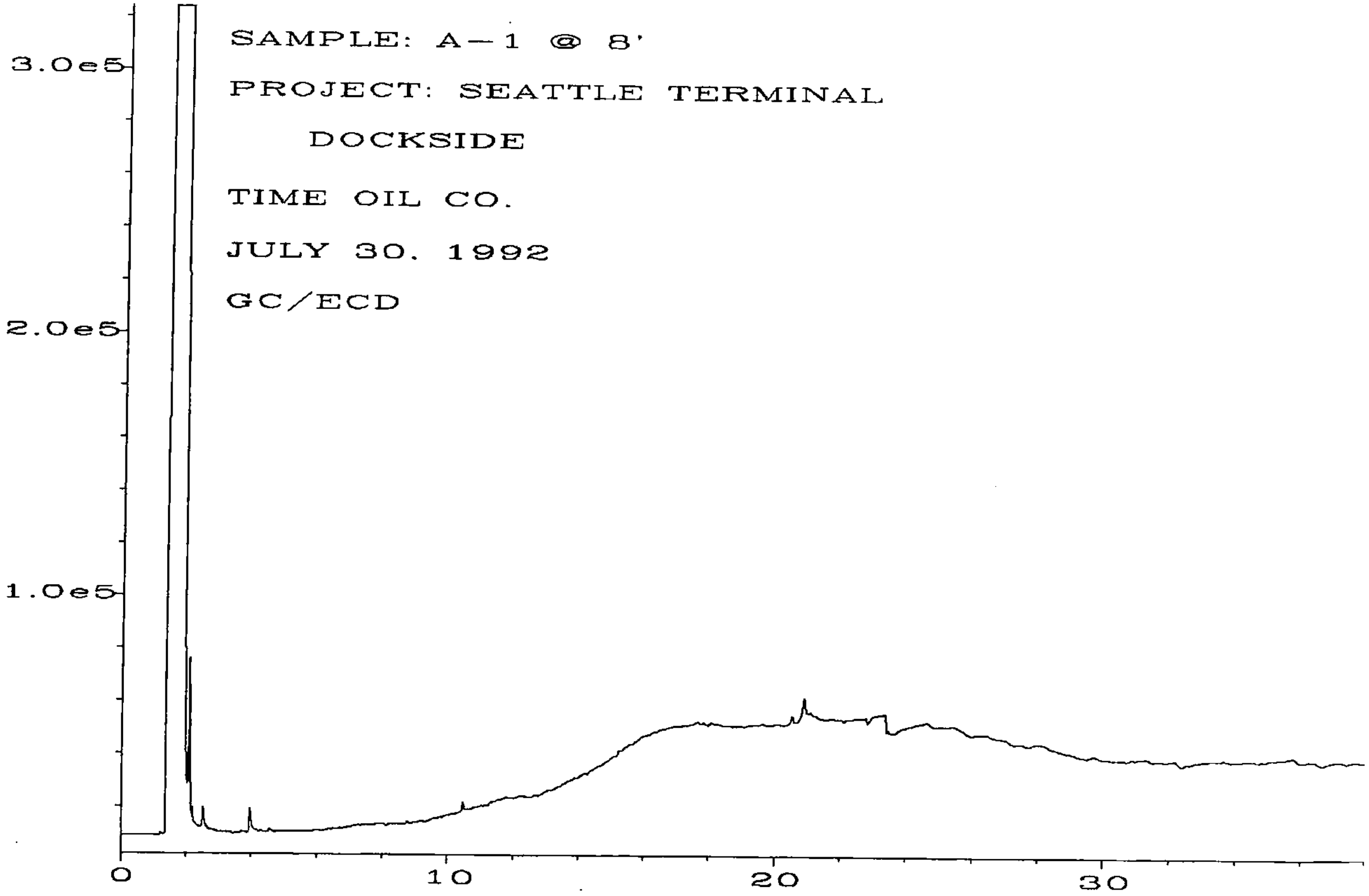


SAMPLE: A-1 @ 8'

PROJECT: SEATTLE TERMINAL

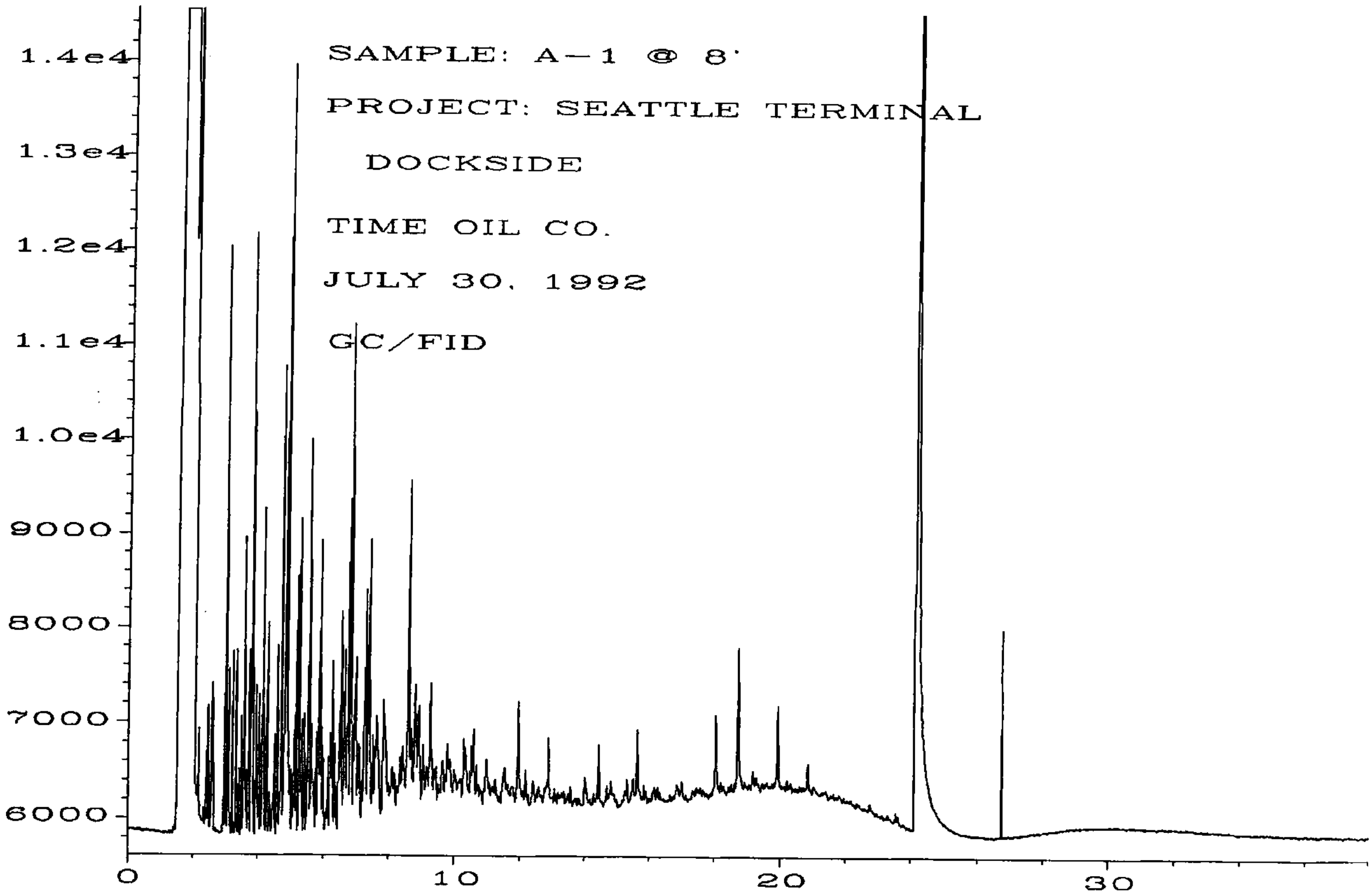
DOCKSIDE

TIME OIL CO.

JULY 30. 1992

GC/ECD

Sig. 2 in C:\HPCHEM\4\DATA\07-30-92\026R1101.D



SAMPLE: A-1 @ 8'

PROJECT: SEATTLE TERMINAL

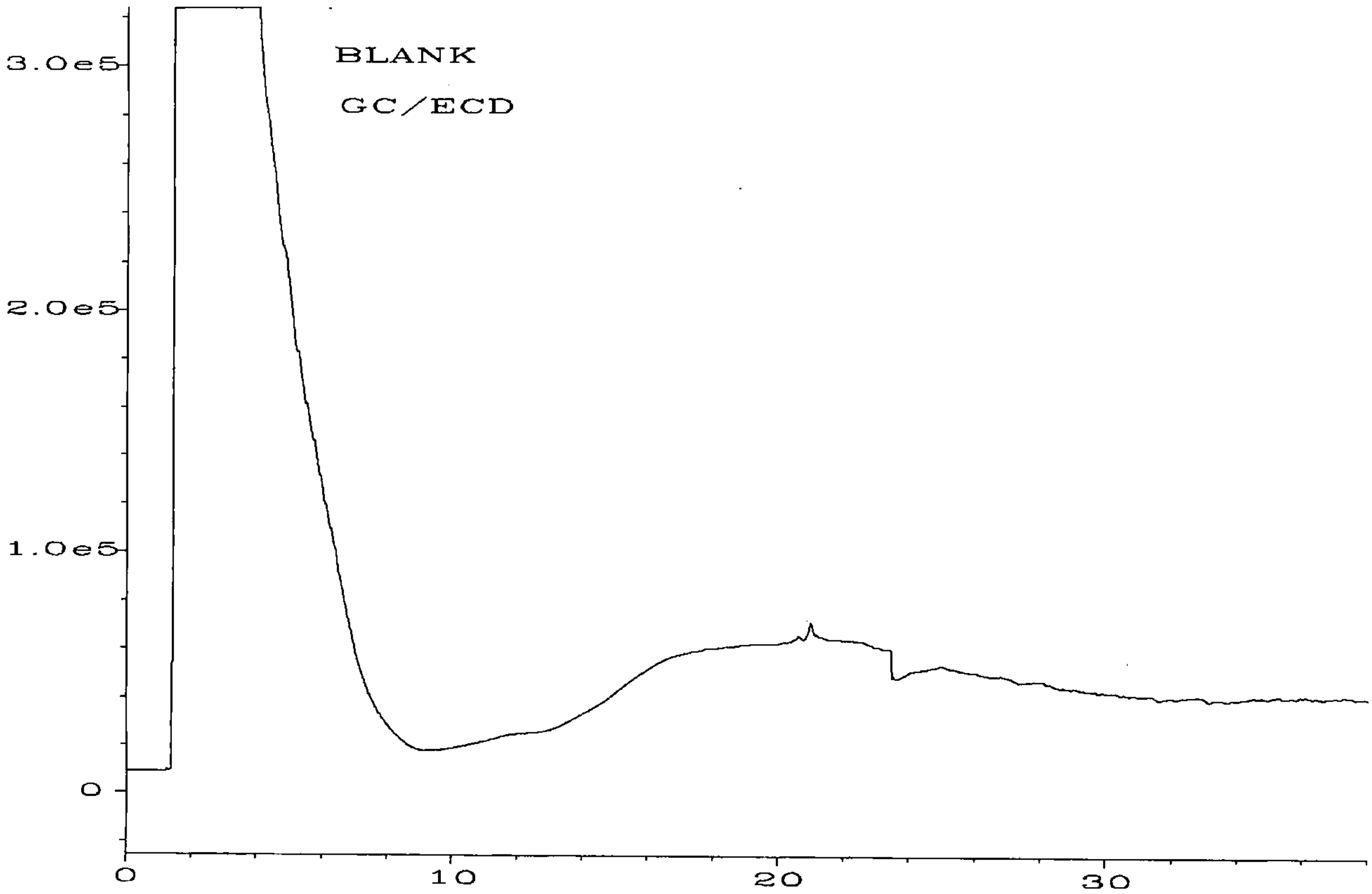
DOCKSIDE

TIME OIL CO.

JULY 30, 1992

GC/FID

Sig. 1 in C:\HPCHEM\4\DATA\07-30-92\026F1101.D



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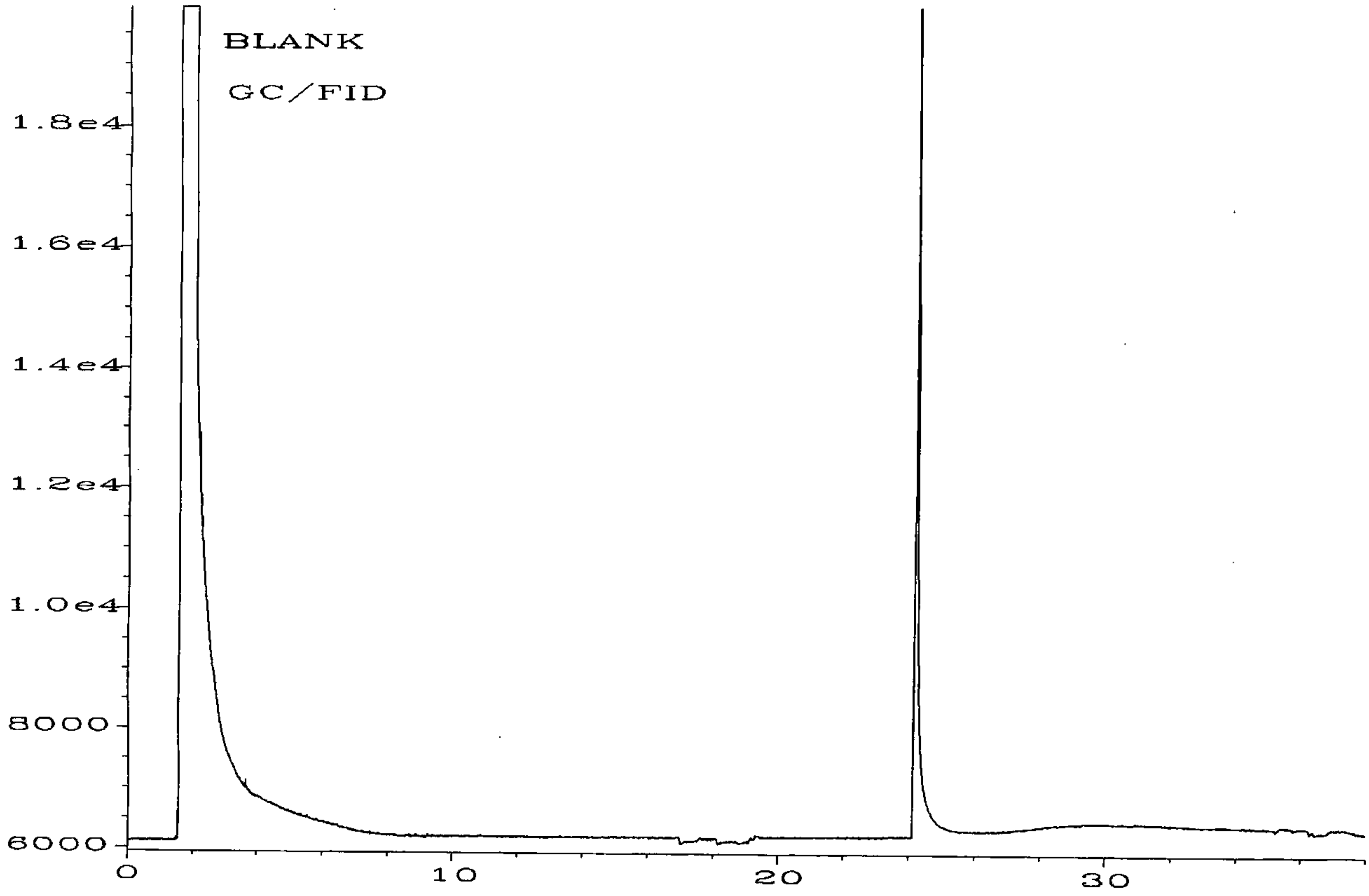


Sig. 1 in C:\HPCHEM\4\DATA\07-30-92\025F1101.D

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

August 10, 1992

Scott Sloan, Environmental Specialist
Time Oil Company
2737 West Commodore Way
Seattle, WA 98199

Dear Mr. Sloan:

Enclosed are the results of the analyses of the samples submitted on August 3, 1992 from Project 01-228, Commodore Way Dockside.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

[illegible] for Amy Gray

Amy M. Gray
Chemist

AMG/dp

Enclosures

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: August 10, 1992
Date Submitted: August 3, 1992
Project: 01-228, Commodore Way Dockside

RESULTS OF ANALYSES OF THE SOIL SAMPLE
FOR SELECTED METALS BY ICP (6010)
Results Reported as µg/g (ppm)

Sample #	Lead
WO-WC - Per Plan	18

Quality Assurance	
Method Blank	<0.5
WO-WC - Per Plan (Duplicate)	22
WO-WC - Per Plan (Matrix Spike) Percent Recovery	80%
WO-WC - Per Plan (Matrix Spike Duplicate) Percent Recovery	111%
Spike Blank Percent Recovery	107%
Spike Level	10

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 10, 1992
Date Submitted: August 3, 1992
Project: 01-228, Commodore Way Dockside

RESULTS OF ANALYSES OF THE SOIL SAMPLE FOR TOTAL PETROLEUM HYDROCARBONS AS DIESEL BY GC/FID (MODIFIED 8015)

Results Reported as μg/g (ppm)

Sample #	Diesel (ppm)	Internal Standard (% Recovery)
WO-WC - Per Plan	2,800	132%
Quality Assurance		
Method Blank	<10	100%
WO-WC - Per Plan (Duplicate)	4,070	125%
WO-WC - Per Plan (Matrix Spike) Percent Recovery	**ai**	134%
WO-WC - Per Plan (Matrix Spike Duplicate) Percent Recovery	**ai**	133%
Spike Blank Percent Recovery	100%	106%
Spike Level	500	

ai - The amount spiked was insufficient to give meaningful recovery data.

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 10, 1992
Date Submitted: August 3, 1992
Project: 01-228, Commodore Way Dockside

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR FINGERPRINT CHARACTERIZATION BY CAPILLARY GAS CHROMATOGRAPHY USING FLAME IONIZATION DETECTION (FID) AND ELECTRON CAPTURE DETECTION (ECD)

Sample #	GC Characterization
WO-WC - Per Plan	The gas chromatographic trace showed the presence of medium boiling compounds, such as those found in diesel. This characterization is based on the presence of a relatively smooth envelope of peaks present from ca n-C_{10} to n-C_{22} with a maximum near n-C_{17} The material appeared to be slightly weathered due to the ragged nature of the envelope. A peak eluting at approximately 4 minutes is most likely not due to contamination from the soil. The ECD trace showed the absence of significant levels of halogenated materials. The large peak eluting at approximately 24 minutes represents our internal standard.
WOO5' - Per Plan	The gas chromatographic trace showed an absence of significant levels of volatile or semi-volatile compounds. The large peak eluting at approximately 24 minutes represents our internal standard.

TIME O L CO. SAMPLE LO

180 0 AMCM

Site Name: Commodore Way Dockside Prop. No: 01-228 Address: 2737 W. Commodore
Sampler: Scott Sloan Date: 7/29/92 Seattle, WA
Purpose: Assessment Method: Grab ☒ S.Spoon ☐ Bailer ☐ Pump ☐
Lab Name: Friedman & Bruya Preserved: Ice ☒ Acid ☐ None ☐
Lab Address: Phone: PO No.: ☐

Sample #	Location/Description	Type*	Analysis Instructions	FBI ~~#~~ ~~EPA~~ Method
WD-WC	- Per Plan	[✓ S] W P	WTPH-HCID / Total Lead	31936
WD @ 5'	- "	[✓ S] W P	WTPH-HCID	31937
	-	S W P		
	-	S W P		
	-	S W P		
	-	S W P	Hold for further	
	-	S W P	analyses GB 8-3-92	
	-	S W P		
	-	S W P		
	-	S W P		
	-	S W P	call w/results to discuss	
	-	S W P	further analyses. GB	
	-	S W P		
	-	S W P		
	-	S W P		
	-	S W P		
	-	S W P		
	-	S W P		
	-	S W P		
	-	S W P		
	-	S W P		
	-	S W P		

Other Instructions: Hold Samples for possible additional analysis

Sample Count = 2 *Check sample jar count against Log!* ** S = Soil W = Water P = Product*

CHAIN OF CUSTODY RECORD

Relinquished By: *Received By:* Lisa Bentley *Date & Time* 8-3-92 12:35p.

Relinquished By: *Received For Lab By:* *Date & Time:*

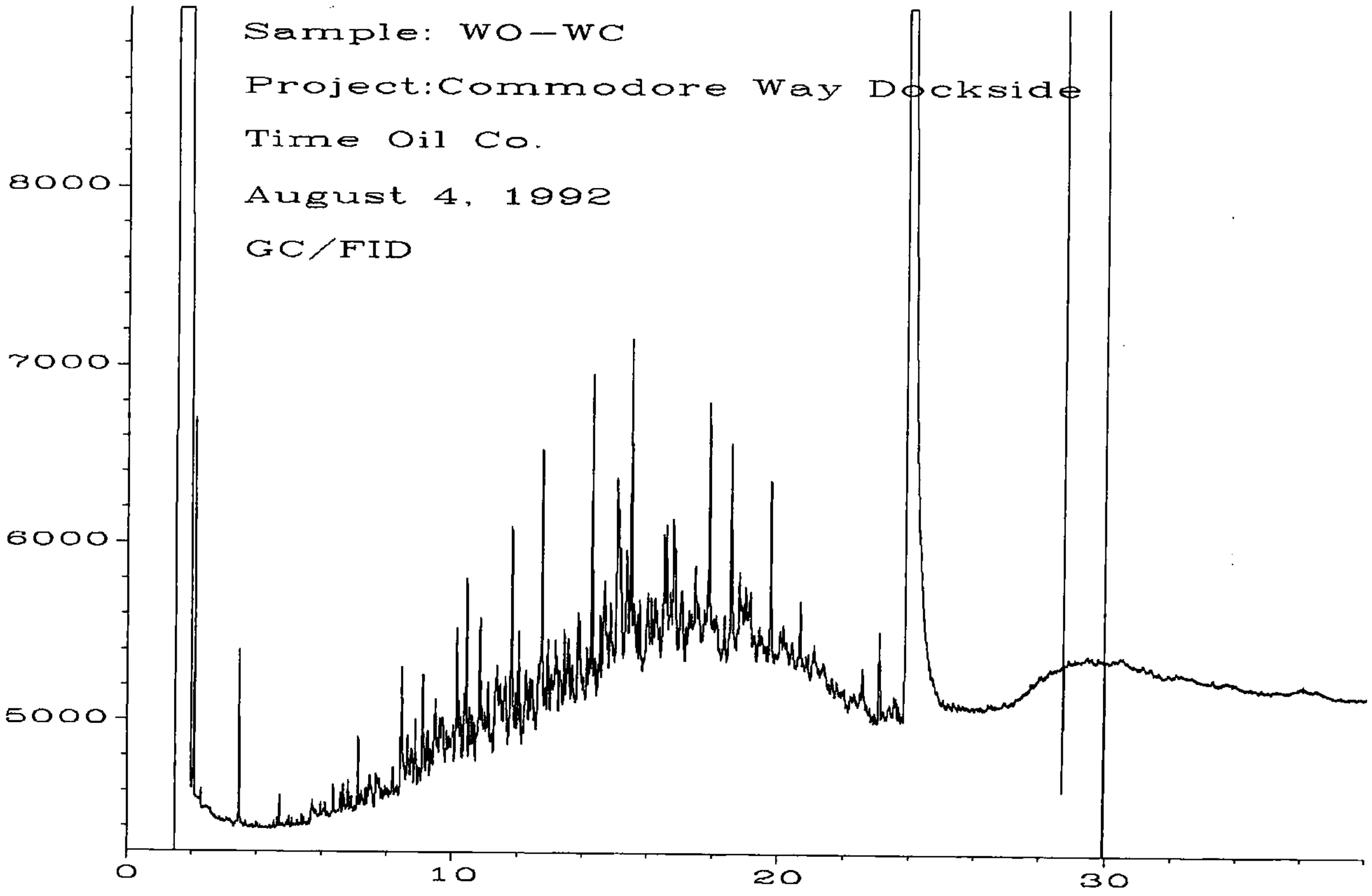
GENERAL LAB INSTRUCTIONS

Please provide the requested information

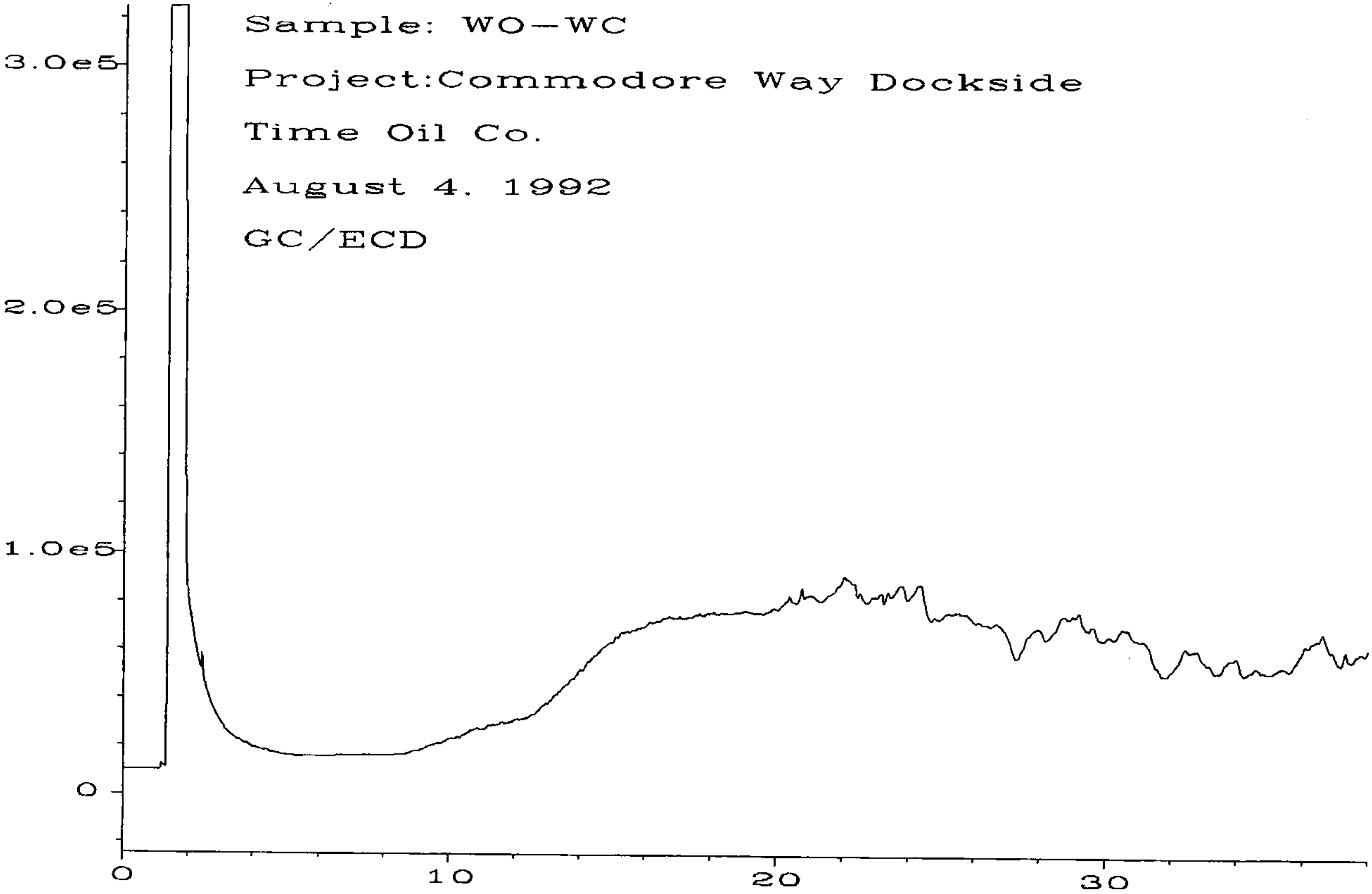
1. Sample numbers assigned by Lab: 31936 to 31937 Date Analyzed: 08-06-92
2. Person performing analysis: Melanie Kirol, Greg Monten Data Reviewer: Mark Perin, Amy Gray, Brook Sherfield
3. Scheduled sample disposal date: 9-3-92 *NOTIFY TIME OIL CO. BEFORE DISPOSAL*
4. Provide copies of ALL chromatograms, including QA/QC runs.

IMPORTANT! PLEASE RETURN A COPY OF THIS FORM WITH YOUR REPORT TO TIME OIL CO.

Attn: Environmental Manager, PO Box 24447 Terminal Sta., Seattle, WA 98124 (206) 285-2400



Sig. 1 in C:\HPCHEM\4\DATA\08—04—92\029F0201.D



Sample: WO—WC

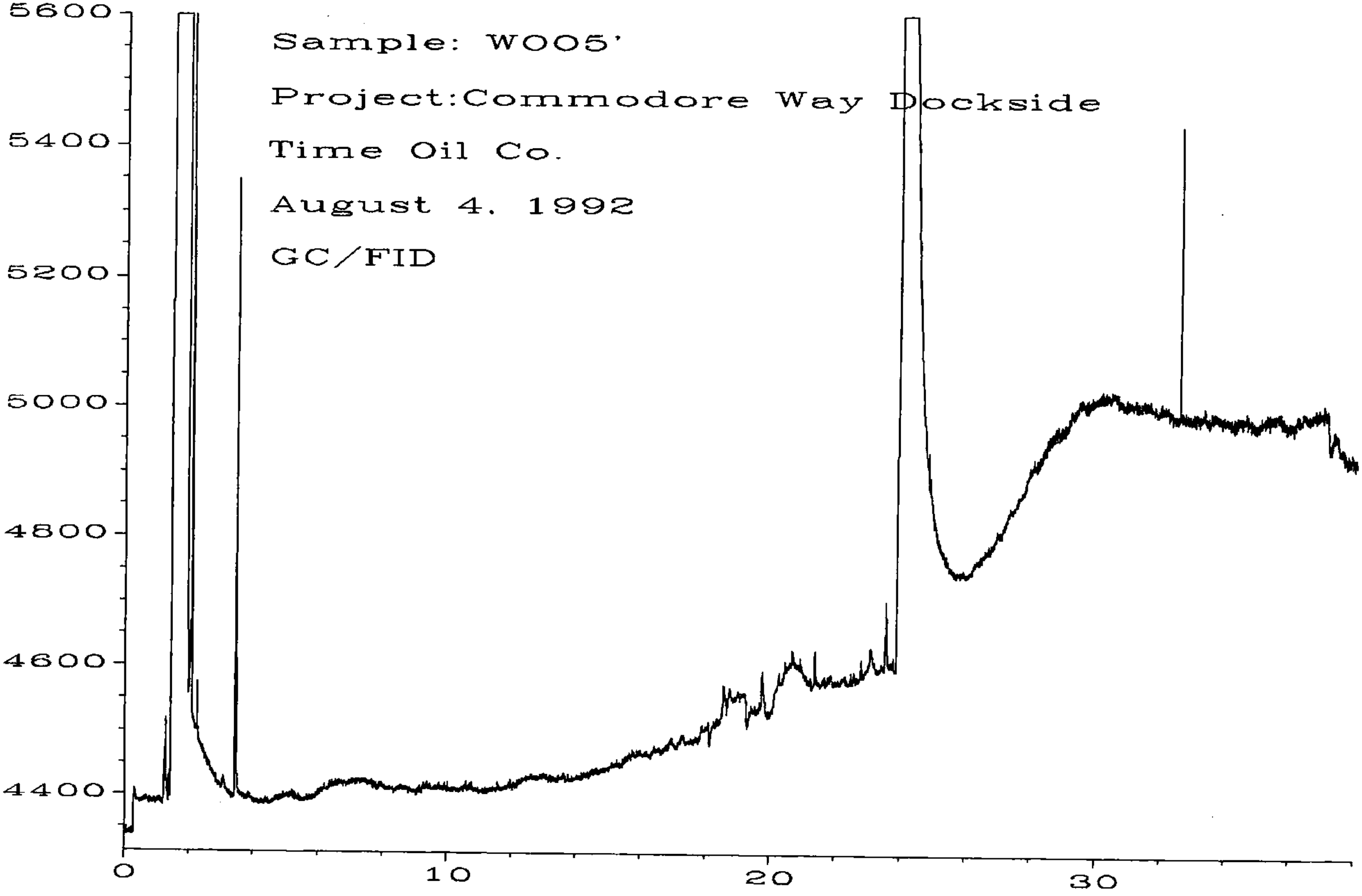
Project:Commodore Way Dockside

Time Oil Co.

August 4. 1992

GC/ECD

Sig. 2 in C:\HPCHEM\4\DATA\08-04-92\029R0201.D



Sample: W005'

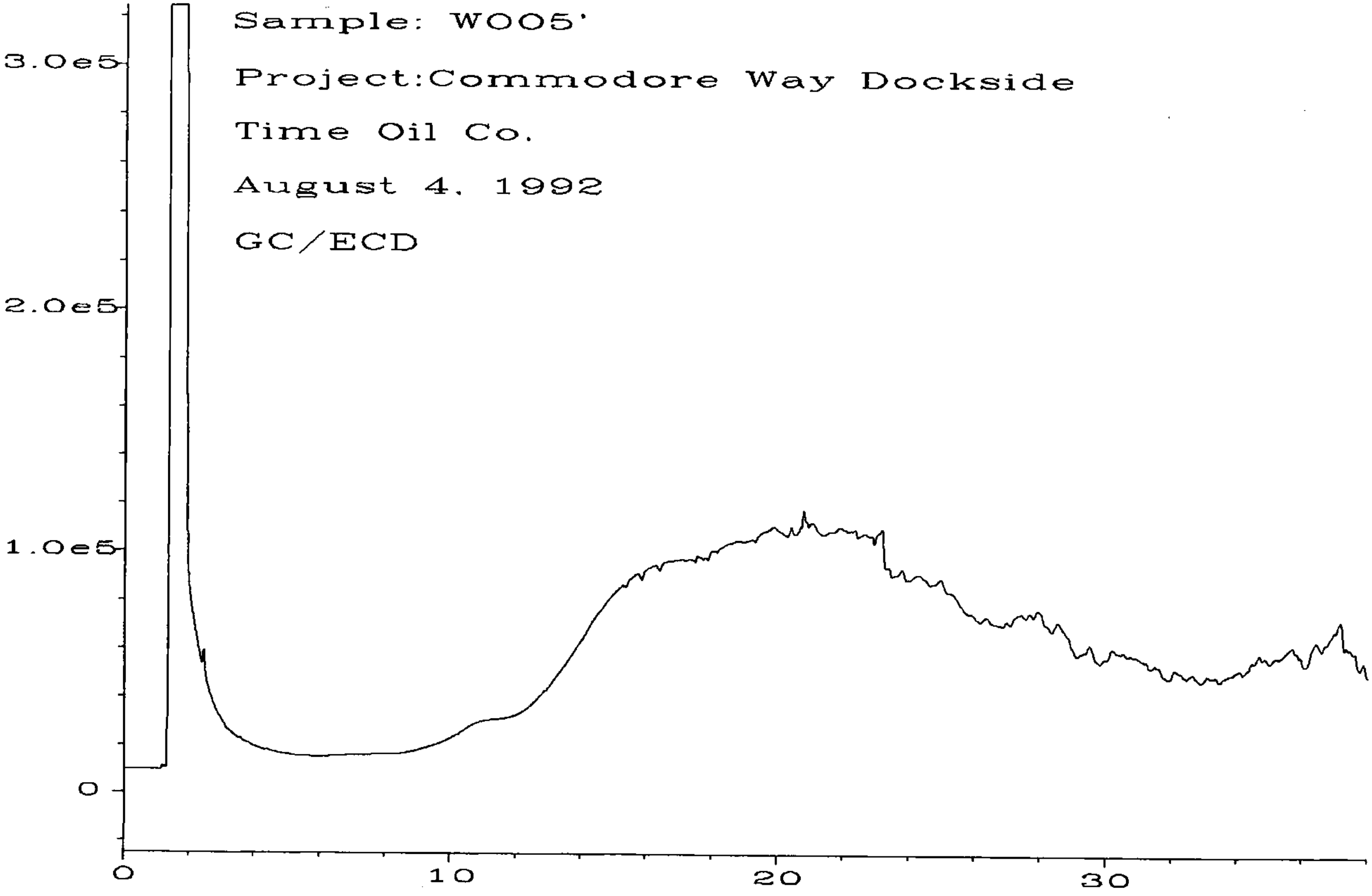
Project:Commodore Way Dockside

Time Oil Co.

August 4. 1992

GC/FID

Sig. 1 in C:\HPCHEM\4\DATA\08-04-92\030F0201.D


Sample: W005'

Project:Commodore Way Dockside

Time Oil Co.

August 4, 1992

GC/ECD

Sig. 2 in C:\HPCHEM\4\DATA\08-04-92\030R0201.D

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Andrew John Friedman
James E. Bruya, Ph.D.
(206) 285-8282

3008-B 16th Avenue West
Seattle, WA 98119
FAX: (206) 283-5044

August 18, 1992

Scott Sloan, Environmental Specialist
Time Oil Company
2737 West Commodore Way
Seattle, WA 98199

Dear Mr. Sloan:

Enclosed are the results of the analyses of the samples submitted on July 30, 1992 from Project 01-228, Seattle Terminal Dockside, PO #27608.

We appreciate this opportunity to be of service to you on this project. If you have any questions regarding this material, or if you just want to discuss any aspect of your projects, please do not hesitate to contact me.

Sincerely,

Kathy McMullen

Kathy McMullen
Chemist

KMC/dp

Enclosures

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 18, 1992
Date Submitted: July 30, 1992
Project: 01-228, Seattle Terminal Dockside, PO #27608

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND GASOLINE USING EPA METHODS 5030 COUPLED TO 8020 and 8015

Results Reported as mg/kg (ppm)

Sample #	A-1@8'	A-2@9'	A-6@3
Analyte:			
Benzene	<0.02	<0.02	0.16
Toluene	<0.02	<0.02	0.14
Ethylbenzene	<0.02	<0.02	2.6
Total Xylenes	<0.04	<0.04	4.9
Gasoline	60	290	110
Internal Standard (% Recovery)	87%	**ai, ip**	76%

ai - The amount spiked was insufficient to give meaningful recovery data.

ip - Interferences were present which prevented the identification and quantitation of the analyte at the established detection limit.

Date of Report: August 18, 1992
Date Submitted: July 30, 1992
Project: 01-228, Seattle Terminal Dockside, PO #27608

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND GASOLINE USING EPA METHODS 5030 COUPLED TO 8020 and 8015

Results Reported as mg/kg (ppm)

Quality Assurance

Sample #	Method Blank	A-6@3' (Duplicate)
Analyte:		
Benzene	<0.02	0.31
Toluene	<0.02	0.22
Ethylbenzene	<0.02	5.0
Total Xylenes	<0.04	9.5
Gasoline	<2	190
Internal Standard (% Recovery)	78%	91%

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: August 18, 1992
Date Submitted: July 30, 1992
Project: 01-228, Seattle Terminal Dockside, PO #27608

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND GASOLINE USING EPA METHODS 5030 COUPLED TO 8020 and 8015

Results Reported as mg/kg (ppm)

Quality Assurance

Sample # Analyte:	A-6@3' Matrix Spike % Recovery	A-6@3' Matrix Spike Duplicate % Recovery	Spike Level
Benzene	83%	88%	1
Toluene	73%	81%	1
Ethylbenzene	**ai**	**ai**	1
Total Xylenes	**ai**	**ai**	2
Internal Standard (% Recovery)	88%	102%	
Gasoline	50%	89%	100
Internal Standard (% Recovery)	88%	101%	

ai - The amount spiked was insufficient to give meaningful recovery data.

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: August 18, 1992
Date Submitted: July 30, 1992
Project: 01-228, Seattle Terminal Dockside, PO #27608

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR BENZENE, TOLUENE, ETHYLBENZENE, XYLENES AND GASOLINE USING EPA METHODS 5030 COUPLED TO 8020 and 8015

Results Reported as mg/kg (ppm)

Quality Assurance

Sample # Analyte:	Spike Blank % Recovery	Spike Level
Benzene	103%	1
Toluene	99%	1
Ethylbenzene	112%	1
Total Xylenes	118%	2
Internal Standard (% Recovery)	113%	
Gasoline	95%	100
Internal Standard (% Recovery)	130%	

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: August 18, 1992
Date Submitted: July 30, 1992
Project: 01-228, Seattle Terminal Dockside, PO #27608

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR TOTAL PETROLEUM HYDROCARBONS AS DIESEL AND MINERAL SPIRITS BY GC/FID (MODIFIED 8015)

Results Reported as μg/g (ppm)

Sample #	Mineral Spirits (ppm)	Diesel (ppm)
A-1@8'	50	90
A-2@9'	200	330
A-6@3'	210[a]	1,600
Quality Assurance		
Method Blank	<10	<10
A-1@8' (Duplicate)	20	40
A-1@8' (Matrix Spike) Percent Recovery	99%	111%
A-1@8' (Matrix Spike Duplicate) Percent Recovery	91%	115%
Spike Blank Percent Recovery	84%	107%
Spike Level	1,000	1,000

a - The material present may be indicative of diesel.

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 18, 1992
Date Submitted: July 30, 1992
Project: 01-228, Seattle Terminal Dockside, PO #27608

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR TOTAL PETROLEUM HYDROCARBONS AS MOTOR OIL BY GC/FID (MODIFIED 8015)

Results Reported as μg/g (ppm)

Sample #	Motor Oil (ppm)
A-1@8'	<100
A-2@9'	<100
A-6@3'	2,300

Quality Assurance	
Method Blank	<100
A-1@8' (Duplicate)	<100
A-1@8' (Matrix Spike) Percent Recovery	110%
A-1@8' (Matrix Spike Duplicate) Percent Recovery	111%
Spike Blank Percent Recovery	122%
Spike Level	1,000

FRIEDMAN & BRUYA, INC.
ENVIRONMENTAL CHEMISTS

Date of Report: August 18, 1992
Date Submitted: July 30, 1992
Project: 01-228, Seattle Terminal Dockside, PO #27608

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR FINGERPRINT CHARACTERIZATION BY INDUCTIVELY COUPLED PLASMA (ICP) EMISSION SPECTROSCOPY

Sample #	ICP Characterization
A-1@8'	The ICP emission spectroscopy trace showed the presence of the following metals at the approximate level indicated. Aluminum (25,000 ppm) Antimony (<1 ppm) Arsenic (<1 ppm) Barium (150 ppm) Berylium <10 ppm) Boron (<10 ppm) Cadmium (<10 ppm) Calcium (2,000 ppm) Chromium (25 ppm) Cobalt (10 ppm) Copper (10 ppm) Gold (<1 ppm) Iron (10,000 ppm) Lead (<1 ppm) Lithium (50 ppm) Magnesium (1,500 ppm) Manganese (200 ppm) Mercury (<1 ppm) Molybdenum (<1 ppm) Nickel (25 ppm) Palladium (<1 ppm) Phosphorous (<1 ppm) Platinum (<1 ppm) Potassium (1,500 ppm) Rhenium (<1 ppm) Selenium (<1 ppm) Silver (<1 ppm) Sodium (2,500 ppm) Strontium (1,000 ppm) Thallium (<1 ppm) Tin (<1 ppm) Titanium (2,000 ppm) Uranium (<1 ppm) Vanadium (1 ppm) Yttrium (50 ppm) Zinc (50 ppm) Zirconium (100 ppm)

FRIEDMAN & BRUYA, INC

ENVIRONMENTAL CHEMISTS

Date of Report: August 18, 1992
Date Submitted: July 30, 1992
Project: 01-228, Seattle Terminal Dockside, PO #27608

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR FINGERPRINT CHARACTERIZATION BY INDUCTIVELY COUPLED PLASMA (ICP) EMISSION SPECTROSCOPY

Sample #	ICP Characterization
A-2@9'	The ICP emission spectroscopy trace showed the presence of the following metals at the approximate level indicated.

Aluminum (25,000 ppm)
Antimony (<1 ppm)
Arsenic (<1 ppm)
Barium (150 ppm)
Berylium (<1 ppm)
Boron (<1 ppm)
Cadmium (<1 ppm)
Calcium (<1 ppm)
Chromium (25 ppm)
Cobalt (10 ppm)
Copper (10 ppm)
Gold (<1 ppm)
Iron (10,000 ppm)
Lead (<1 ppm)
Lithium (50 ppm)
Magnesium (1,500 ppm)
Manganese (200 ppm)
Mercury (<1 ppm)
Molybdenum (<1 ppm)
Nickel (25 ppm)
Palladium (<1 ppm)
Phosphorous (<1 ppm)
Platinum (<1 ppm)
Potassium (1,500 ppm)
Rhenium (<1 ppm)
Selenium (<1 ppm)
Silver (<1 ppm)
Sodium (2,500 ppm)
Strontium (1,000 ppm)
Thallium (<1 ppm)
Tin (<1 ppm)
Titanium (2,000 ppm)
Uranium (<1 ppm)
Vanadium (1 ppm)
Yttrium (50 ppm)
Zinc (50 ppm)
Zirconium (100 ppm)

FRIEDMAN & BRUYA, INC.

ENVIRONMENTAL CHEMISTS

Date of Report: August 18, 1992
Date Submitted: July 30, 1992
Project: 01-228, Seattle Terminal Dockside, PO #27608

RESULTS OF ANALYSES OF THE SOIL SAMPLES FOR FINGERPRINT CHARACTERIZATION BY INDUCTIVELY COUPLED PLASMA (ICP) EMISSION SPECTROSCOPY

Sample #	ICP Characterization
A-6@3'	The ICP emission spectroscopy trace showed the presence of the following metals at the approximate level indicated. Aluminum (25,000 ppm) Antimony (<1 ppm) Arsenic (<1 ppm) Barium (150 ppm) Berylium (<10 ppm) Boron (<1 ppm) Cadmium (<1 ppm) Calcium (<1 ppm) Chromium (25 ppm) Cobalt (10 ppm) Copper (10 ppm) Gold (<1 ppm) Iron (10,000 ppm) Lead (<1 ppm) Lithium (50 ppm) Magnesium (1,000 ppm) Manganese (200 ppm) Mercury (<1 ppm) Molybdenum (<1 ppm) Nickel (25 ppm) Palladium (<1 ppm) Phosphorous (<1 ppm) Platinum (<1 ppm) Potassium (1,500 ppm) Rhenium (<1 ppm) Selenium (<1 ppm) Silver (<1 ppm) Sodium (2,500 ppm) Strontium (1,000 ppm) Thallium (<1 ppm) Tin (<1 ppm) Titanium (2,000 ppm) Uranium (<1 ppm) Vanadium (1 ppm) Yttrium (50 ppm) Zinc (50 ppm) Zirconium (100 ppm)

AMG-A
7-30-92 (3:48)

TIME C . CO. SAMPLE LO

Site Name: Seattle Terminal Dockside
Sampler: Scott Sloan
Purpose: Excavation Assessment
Lab Name: Friedman & Bruya
Lab Address:

Prop. No: 01-228
Date: 7/30/92
Address: 2737 W. Commodore
Seattle, WA
Phone: # 27608

Method: Grab ☒ S.Spoon ☐ Bailer ☐ Pump ☐
Preserved: Ice ☒ Acid ☐ None ☐
PO No.:

Sample #	Location/Description	Type*	Analysis Instructions	EPA Method
A-1@8'	- SE Corner in Cap. Fringe	[✓ S] W P	WTPH - HCID 31873	
A-2@9'	- " , 1' lower	[✓ S] W P	31874	
A-3@6'	- E Side in Cap. Fringe	[✓ S] W P	31875	
A-4@3'	- N in Cap. Fringe	[✓ S] W P	31876	
A-5@3'	- NE Corner in Cap. Fringe	[✓ S] W P	31877	
A-6@3'	- NW Corner in Cap. Fringe	[✓ S] W P	31878	
	-	S W P		
	-	S W P		
	-	S W P		
	-	S W P		
	-	S W P		
	-	S W P	WTPH analysis requested	
	-	S W P	in addition per Scott	
	-	S W P	Sloan - BTEX gasoline and	
	-	S W P	8015 thru motor	oil range
	-	S W P	on A1A-2 ~~and~~	
	-	S W P	08-06-92 AG 1000 AM	
	-	S W P	And total metal scans per	
	-	S W P	Scott Sloan 08-06-92 1200	noon
	-	S W P	AG	
	-	S W P		
	-	S W P		

Other Instructions: Hold Samples for possible additional testing.

Sample Count = Check sample jar count against Log!

* S = Soil W = Water P = Product

CHAIN OF CUSTODY RECORD

Relinquished By: Received By: [illegible] Minter Date & Time: 7-30-92 2:25

Relinquished By: Received For Lab By: Date & Time:

GENERAL LAB INSTRUCTIONS

Please provide the requested information

1. Sample numbers assigned by Lab: 31873 to 31878 Date Analyzed: 7-30-92
2. Person performing analysis: Andrew Friedman, Amy Gray Data Reviewer: Andrew Friedman
3. Scheduled sample disposal date: 8-30-92 NOTIFY TIME OIL CO. BEFORE DISPOSAL
4. Provide copies of ALL chromatograms, including QA/QC runs.

MPORTANT! PLEASE RETURN A COPY OF THIS FORM WITH YOUR REPORT TO TIME OIL C
Attn: Environmental Manager, PO Box 24447 Terminal Sta., Seattle, WA 98124 (206) 285-2400

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Chemical Contaminants in Salmon Bay Sediments

Results of Phase II Sampling

November 1996

Publication No. 96-343

printed on recycled paper

For additional copies of this publication,
please contact:

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Publications Distributions Office
P. O. Box 47600
Olympia, Washington 98504-7600
(360) 407-7472

Refer to Publication Number 96-343

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Chemical Contaminants in Salmon Bay Sediments

Results of Phase II Sampling

by
Dave Serdar
and
James Cubbage

Environmental Investigations and Laboratory Services Program
Olympia, Washington 98504-7710

November 1996

Water Body No. WA-08-9340

Publication No. 96-343
printed on recycled paper

Table of Contents

List of Figures

List of Tables

Abstract

During 1995, the Washington State Department of Ecology conducted a survey of chemical contaminants in bottom sediments from 29 areas throughout Salmon Bay. Sediments were analyzed for metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc), semivolatile organics, PCBs, and butyltins. Chemical data were compared to earlier studies in the basin and areal distributions were evaluated. Data were also compared to criteria to assess potential effects on aquatic organisms. Recommendations for further actions are included

The survey was the second phase in a study of Salmon Bay: Phase I study evaluated the potential for contamination based on visual observation of sediments; Phase III will likely include both intensive chemistry and bioassay testing in contaminated areas. The overall objectives of the Salmon Bay study are to delineate areas of contaminated sediments, evaluate their toxicity, identify the contaminants contributing to sediment toxicity, and if possible, identify likely historical and current sources of contaminants to the problem areas.

Summary of Findings

Salmon Bay is a narrow body of water in Seattle, Washington located between Lake Union to the east and Puget Sound to the west. The numerous industries located along the shores of Salmon Bay, in addition to marinas, dock facilities, and combined sewer overflows (CSOs), have all contributed to contamination of Salmon Bay sediments. However, little was known about the nature and extent of this contamination. The Salmon Bay Phase II study was designed to fill that void.

Objectives of the Salmon Bay study were to:

- Identify areas of contaminated sediment in Salmon Bay
- Evaluate the toxicity of these problem areas
- Identify the contaminants contributing to sediment toxicity
- To the extent possible, identify likely historical and current sources of contaminants to these problem areas

Phase II of the Salmon Bay study consisted of sampling bottom sediments from 29 areas throughout Salmon Bay. Sediments were analyzed for metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc), semivolatile organics, PCBs, and butyltins.

The eight metals analyzed were detected at all sample stations except for cadmium, which was below detectable levels at five stations. Median concentrations of metals in Salmon Bay were similar to those previously reported for the Ship Canal area, but arsenic, mercury, lead, cadmium, and zinc were 2 to 4 times higher in Lake Union sediments. Metals in Salmon Bay sediments were found at the following dry weight concentrations:

	Median	Range
Arsenic	20 mg/Kg	1.6 - 210 mg/Kg
Cadmium	0.6 mg/Kg	<0.3 - 3.2 mg/Kg
Chromium	60 mg/Kg	14 - 380 mg/Kg
Copper	319 mg/Kg	7.7 - 2,200 mg/Kg
Lead	151 mg/Kg	3.5 - 530 mg/Kg
Mercury	0.8 mg/Kg	0.01 - 5.0 mg/Kg
Nickel	48 mg/Kg	21 - 480 mg/Kg
Zinc	319 mg/Kg	27 - 2,000 mg/Kg

Less than half of the 74 semivolatile organic compounds analyzed were detected. With few exceptions, however, all ten high molecular weight polycyclic aromatic hydrocarbons (PAHs) and seven low molecular weight PAHs were detected at all sample stations. Median PAH concentrations in the present study are higher than those previously reported for either the Ship Canal or Lake Union (outside of the Gas Works Park area). Other semivolatile organics frequently detected include dibenzofuran, retene, 4-methylphenol, 3β-coprostanol, and butylbenzylphthalate. All other semivolatile organics were detected at fewer than 60% of the stations, and at concentrations generally less than 1,000 μg/Kg.

PCBs were detected at 26 of the 29 sample stations. Median PCB concentrations were similar to those in Ship Canal and Lake Union sediments. Tributyltin (TBT), once a principal component of anti-fouling paints, was found at all but one station. The major classes of organic compounds were detected at the following organic carbon-normalized (PAH and PCB) or dry weight (TBT) concentrations:

	Median	Range
Total PAH	490 mg/Kg OC	107 - 2,300 mg/Kg OC
Total PCB	4.8 mg/Kg OC	nd - 150 mg/Kg OC
TBT	326 μg/Kg	nd - 6,500 μg/Kg

Results of the study indicate there are no clear areal gradients throughout Salmon Bay for any of the chemicals analyzed. Instead, contaminant concentrations tend to show a "patchy" distribution which suggests that local conditions are the major determinant of concentration. With one possible exception, there is also a lack of gradation or geographical pattern with respect to clean sediments. However, the cleanest area appears to be at the terminus of the Ship Canal in the easternmost section of Salmon Bay.

Of the 29 stations sampled, 21 were located adjacent to marinas, boat repair facilities, marine terminals (including Fisherman's Terminal), shipyards, or other vessel-related facilities. Proximity to these facilities alone did not appear to dictate concentrations of TBT. Two of the six stations with TBT levels greater than 1,000 μg/Kg were not adjacent to these facilities while seven of eight sites with TBT less than 100 μg/Kg were located adjacent to areas with marinas, etc. Stations located near vessel-related facilities were, however, more likely to have high metals concentrations. There is also mixed evidence that CSO discharges account for a substantial portion of the contamination in Salmon Bay.

The biological significance of chemical concentrations in Salmon Bay sediments was evaluated by comparing them to guidelines for freshwater sediment quality, Ecology's Marine Sediment Management Standards, and Puget Sound Dredged Disposal Analysis (PSDDA) screening level. Based on these comparisons, sediments in most areas of Salmon Bay can be expected to have some degree of adverse impact on benthic organisms.

Tributyltin may pose the most serious threat to aquatic life in Salmon Bay due to its toxicity and high concentrations in sediments. All but five stations exceeded the PSDDA sediment screening level (SL) for TBT (73 µg/kg), and 30% of the stations had TBT concentrations elevated one to two orders of magnitude above the SL. However, recent work by the PSDDA agencies indicates that sediment concentrations are poor predictors of TBT bioavailability and toxicity to aquatic life. Therefore, additional studies may be needed in Phase III to assess the actual toxicity of TBT in Salmon Bay.

Chemicals other than TBT likely to harm aquatic life at one or more stations include copper, mercury, arsenic, lead, nickel, zinc, chromium, benzyl alcohol, 4-methylphenol, bis(2-ethylhexyl)phthalate, benzo(g,h,i)perylene, indeno(1,2,3-c,d)pyrene, 1,4-dichlorobenzene, and PCB-1260.

Recommendations for the near term include conducting further investigations of chemical concentrations in the vicinity of the most contaminated stations, as well as identifying and prioritizing the needs for aquatic life protection in Salmon Bay in order to select appropriate biological tests to confirm predicted adverse impacts. It is also recommended that, for the long term, the translocation of sediments within Salmon Bay should be studied especially in areas considered for cleanup actions where on-site or off-site movement of sediments may be an important factor in selection of cleanup alternatives.

Recommendations

- Results of the Phase II study indicate that distribution of contaminants throughout Salmon Bay is spotty, although some highly contaminated locations have been identified. This raises questions about the areal extent of the contamination around the sample locations. Do nearby sediments contain similar contaminant levels? Do the sediments adjacent to the Phase II stations exhibit areal concentration gradients? If so, does the gradient suggest a particular contaminant source? The answer to these questions is an immediate concern to parties involved in efforts to cleanup or control contamination sources to Salmon Bay. With these considerations in mind, a near-term recommendation is for Ecology to conduct or oversee further investigations of chemical concentrations in the vicinity of the most contaminated stations. At least one relatively clean area should also be examined in such a manner.

- The Phase II study provides a fairly thorough characterization of chemical concentrations in sediments throughout Salmon Bay. However, essentially nothing is known about the toxicity of Salmon Bay sediments to aquatic organisms. Toxicity is difficult to predict based on available literature or criteria because of 1) the combination of chemicals present, and 2) the influence of saltwater in Salmon Bay. The toxicity, bioavailability, or bioaccumulation potential of tributyltin may be especially difficult to surmise because of the possibility that at least some of the tributyltin is in paint-chip form. Given the complex nature of these issues, a toxicity bioassessment of Salmon Bay sediments would require a large expenditure of time and money. Therefore it is recommended that the focus of toxicity testing be narrowed considerably. This can be achieved by first identifying and prioritizing the needs for aquatic life protection in Salmon Bay. Toxicity testing can then be designed to match the need for ecological resource protection. Agencies and tribes responsible for protecting or otherwise managing aquatic biota in Salmon Bay should be asked for input. Any information they can share about aquatic life implications based on Phase II results would be useful.

- Once contaminated areas are better characterized with respect to chemical concentrations and toxicity, it will be useful to understand the extent to which sediments are translocated within Salmon Bay. This is especially important in areas considered for cleanup actions where on-site or off-site movement of sediments may be an important factor in selection of cleanup alternatives. Therefore, a recommendation for the long term is to study the translocation of sediments within Salmon Bay. Sediment traps have been used successfully in Puget Sound to assess the transport of sediment-bound contaminants. Chemical and radionuclide examination of sediment cores may be a useful means to determine sedimentation rates.

Credits

- *Project Officer* - James Cubbage
- *Field Sampling* - James Cubbage, Dale Norton, Rick Huey, and Joanne Polayse-Wien
- *Sample Handling and Tracking* - Will White and Pam Covey
- *Lab Contracts* - Karin Feddersen
- *Lab Analyses* - Randy Knox, Jim Ross, Myrna McIntosh, Dickey Huntamer, Roy Araki (EPA), and Bob Reick (EPA)
- *Data Quality Reviews* - Stew Lombard, Pam Covey, Karin Feddersen, Myrna McIntosh, Bill Kammin, and Dickey Huntamer
- *Report Preparation* - Dave Serdar and James Cubbage
- *Report Review* - Dale Norton, Larry Goldstein, Teresa Michelsen, and Dan Cargill
- *Report Proofreading and Formatting* - Joan LeTourneau

Introduction

Background

Salmon Bay and the Lake Washington Ship Canal comprise a narrow body of water in Seattle, Washington connecting Lake Union to the east with Puget Sound to the west, through the Hiram Chittenden Locks (Figure 1). Salmon Bay was originally a salt water bay which was inundated with freshwater in 1914 when the locks were constructed to the west of Salmon Bay and connected to Lake Union through the Lake Washington Ship Canal. The Ship Canal is a narrow channel with some shallow embayments on the southern shoreline near the west end of the canal.

Numerous industries have been located along the shores of Salmon Bay and the Ship Canal, including shipyards, marinas, bulk fuel plants, fish processing, wood treating, lumber mills and plywood plants, bulk materials handling facilities, a large steel manufacturing plant, and an asphalt plant. In addition, stormwater from urbanized areas including the Ballard Bridge, Fremont Bridge, and combined sewer overflows (CSOs) discharge into Salmon Bay and the Ship Canal. These various sources have contributed to contamination in Salmon Bay and the west end of the Ship Canal, but the nature and extent and specific sources of contamination are not well defined. This lack of information has hampered attempts at source control and associated improvements in sediment quality.

Detailed studies of nearby Lake Union, including both chemistry and bioassays, have been conducted in the past by the Environmental Investigations and Laboratory Services (EILS) Program at Ecology, Municipality of Metropolitan Seattle (METRO), the City of Seattle, and others. These studies are summarized in *Survey of Contaminants in Sediments in Lake Union and Adjoining Waters* (Cubbage, 1992). However, few samples have been collected in Salmon Bay or the Ship Canal. In addition, the presence or absence of butyltins has not been evaluated in previous studies, and could be a significant source of toxicity in sediments given the ubiquitous presence of vessel traffic, shipyards, and marinas.

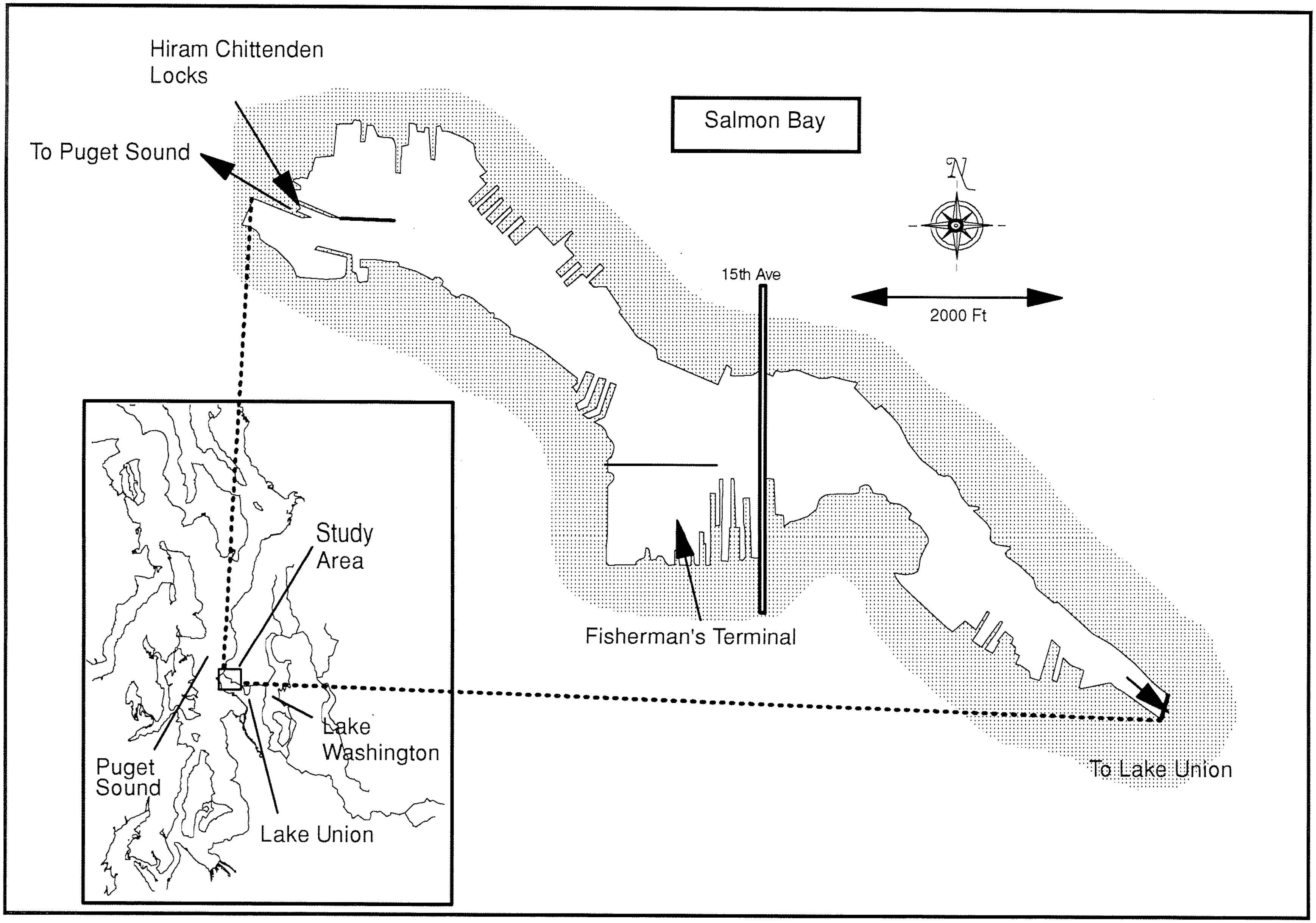


Figure 1. Study area and vicinity.

Objectives

The overall objectives of the Salmon Bay study are:

- Identify areas of contaminated sediment in Salmon Bay and nearshore areas of the Ship Canal.

- Evaluate the toxicity of these problem areas to determine whether they exceed the narrative cleanup screening levels (minor adverse effect on aquatic marine life) of the Sediment Management Standards (SMS; WAC 173-204) or freshwater sediment quality guidelines.

- Identify the contaminants contributing to sediment toxicity in the problem areas, including an evaluation of butyltins to determine whether this class of contaminant should be included in routine (*e.g.* NPDES) sediment analyses for Lake Union, Salmon Bay, and the Ship Canal.

- To the extent possible, identify likely historical and current sources of contaminants to these problem areas.

The study will provide the following benefits to the cleanup and source control programs:

- Identify areas that require cleanup and provide some indication of their relative priority. In addition, identify chemicals of concern to better focus source control efforts.

- Streamline dredging, construction, and NPDES permit processing for areas that are identified as clean. Provide justification for discharge and baseline sediment monitoring as part of the NPDES permitting program for areas that are identified as contaminated.

- Begin identifying areas that require additional stormwater or CSO control to prevent recontamination of areas targeted for dredging or cleanup.

- Contribute synoptic chemistry and bioassay data to help evaluate the toxicity of butyltin compounds.

These objectives are being addressed in three phases:

1. Phase I reconnaissance sampling was completed during April 1995, and consisted of visual examination of sediments from 81 stations evenly distributed throughout Salmon Bay and the Ship Canal. Samples were inspected for grain size (sand, silt, clay, etc.), evidence of contamination (oil, wood debris, paint chips), and biological organisms. Results (shown in Appendix A) were used to identify the more contaminated areas.

2. Detailed chemical analyses of potentially contaminated areas were conducted during Phase II, and are the subject of the present report.

3. Phase III will likely include both chemistry and biological testing to evaluate the toxicity of areas identified as contaminated during Phase II.

Methods

Sampling Strategy

The study area extends from the locks on the west to the western end of the Ship Canal. Results of the reconnaissance (Phase I) study indicated that most sediments in the vicinity of the eastern Ship Canal are coarse-grained which suggests little deposition of fine material. Little visible oil or other evidence of contamination was seen in this area as well. Based on these observations, this area was excluded from further investigation during Phase II.

Phase II focused on areas where visual contamination or depositional areas were observed during the reconnaissance study. Because the SMS requires at least three stations for any regulatory decisions, three or more stations were grouped in each major zone of concern and/or natural geographical feature (Figure 2). Sample stations were generally placed nearshore to CSOs, marinas, and shipyards. One sample zone was placed in the center channel to provide a sense of the ambient chemical concentrations in sediments. A description of each sampling station is included in Appendix B.

Sampling Methods

Sampling methods were consistent with the Puget Sound Estuary Program (PSEP) protocols (EPA, 1986a) as modified by the SMS (Ecology, 1991) and sampling methods used in previous Lake Union and Lake Washington studies conducted by EILS. However, to support evaluation of historical contamination and the cleanup program, the top 10 cm of sediment was sampled. This layer includes most of the biologically active zone in fresh water.

Samples were collected from Ecology's 20-foot skiff equipped with a 0.1 m^2 stainless steel Van Veen grab sampler. Stations were recorded using a Magellan® GPS (Global Positioning System) receiver with differential correction as well as from sightings on nearby landmarks. A grab was considered adequate if it was filled with sediment and both the grab as well as access doors on top of the grab were closed tightly (see PSEP protocols for full description). For each grab, the overlying water was siphoned off and the top 10 cm of sediment not touching the walls of the grab was scooped out of the top doors and placed in a stainless steel beaker.

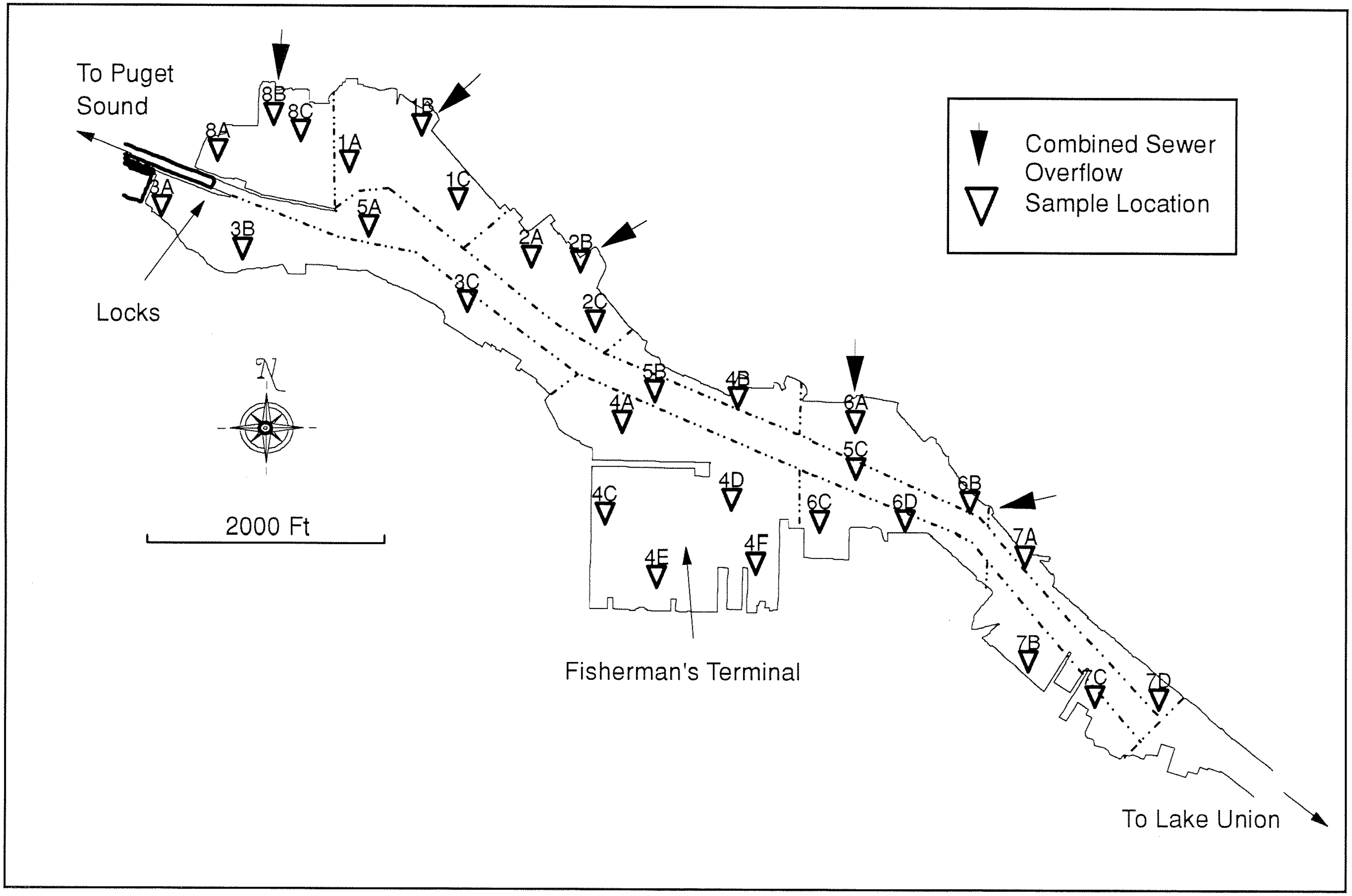


Figure 2. Sample stations and sample zones.

Prior to sampling, all stainless steel tools (grab, beakers, and spoons) were decontaminated with the following procedure:

- wash in hot water and Liquinox® detergent
- rinse in tap water
- rinse in 10% nitric acid
- rinse with deionized water
- rinse with pesticide analysis grade acetone
- air dry
- wrap in aluminum foil

The beaker contents were homogenized, and subsamples for metals and organics analysis were dispensed into separate 8-oz priority pollutant-clean jars capped with teflon lid liners. Samples for organic carbon analysis were placed in 4-oz jars. Grain size samples were placed in Whirl-Pak® bags. If oil was visible in the sample, the sampler was washed with detergent and the sample was disposed into a drum onboard. Between samples, the grab sampler was thoroughly brushed and rinsed with on-site water.

Chemical Analysis

Samples were analyzed for the following parameters:

- Grain size
- Total Organic Carbon (TOC)
- Percent Solids
- Metals, including mercury
- Semivolatile Organics (targeting PAHs, phthalates, and phenols)
- PCBs
- Butyltins

Grain size analysis was done by Soil Technology, Inc. on Bainbridge Island, WA. TOC analysis was done by Weyerhaeuser Analytical and Testing Services, Tacoma, WA. Analysis for metals, organics, and percent solids was conducted at the Ecology/EPA Manchester Environmental Laboratory in Manchester, WA. Analytical methods and target detection limits are shown in Appendix C.

Care was taken to achieve the SMS detection limits for "difficult" chemicals such as methylated phenols, since these are common constituents of plywood manufacturing facilities, and waste piles of glue are known to be present along the shoreline in some areas.

Data Quality

Quality of the data was determined by the analysis of laboratory QA/QC samples. Bias was evaluated through the analysis of check standards (metals), certified reference materials (PAHs and PCBs), uncertified reference sediment (butyltins), and matrix spikes. Precision was assessed through blind field splits, as well as duplicate analysis of reference materials and laboratory spikes. Method blanks were also analyzed to determine the effects of laboratory contamination. Appendix D includes complete results of these analyses as well as narrative quality assurance reviews by Manchester staff.

Table 1 shows a summary of the data quality for the project. Quality assurance results are compared to the data quality objectives outlined in the project plan (Cubbage and Michelsen, 1995). These quality requirements (termed QA1) are to be met in order for the data to be validated for use in sediment management decisions based on Puget Sound Dredged Disposal Analysis (PSDDA) conventions (Ecology, 1991), and are in most cases consistent with EPA Contract Laboratory Program (CLP) requirements.

Overall, quality of the data obtained for this project could be characterized as good. Quality of the metals data was generally better than the organics data, with a few exceptions. Spike recoveries for some of the lead and chromium results were slightly lower than acceptance limits, and were therefore given "N" qualifiers. Results for mercury are considered estimates ("J") because of poor spike recoveries. However, check standard recoveries for all metals averaged 92%, indicating a low level of bias for sample analysis.

Analysis of standard reference materials for PAHs and PCBs gave the best measure of bias for analysis of these compounds. Only slightly more than half of the compounds in NRCC HS6 (PAH in marine sediment) were within certified values. Aside from acenaphthylene, however, most compounds were not substantially outside of the certified ranges. The average recovery for acenaphthylene was approximately 300%.

Matrix spike recoveries for semivolatile organics analysis also indicated low bias overall. Only 5% of the spiked samples were outside of the 50-150% recovery window, although the average spike recovery was somewhat low (83%). For PCBs, recoveries for both the standard reference material (NRCC HS2, PCBs in marine sediment) and matrix spikes were very good.

It was somewhat difficult to assess bias of the butyltin data. Analysis of a reference material (Sequim Bay sediment) yielded poor recoveries for tributyltin (average of 39%). However, no value or range of values has been established for tributyltin concentration in this material. Matrix spike recovery data did not contribute much to determining bias since one of the spiked samples contained high native concentrations of butyltins. Fortunately, an additional spiked sample yielded good recovery data.

Table 1. Functional quality assurance elements required for QA1 review and acceptance under Sediment Management Standards[1].

	Conventionals		Metals		Organics: semivolatiles, PCBs, butyltins	
Parameter	Target	% Achieved	Target	% Achieved	Target	% Achieved
Matrix Spikes (*5% of samples*)	NA	NA	75-125% recovery	75%	50-150% recovery	SVOs - 95% PCBs - 100% Butyltins - 58%
Certified Reference Materials (*CRM; 2/ study*)	NA	NA	80-120% recovery	88%	95% confidence interval	PAHs - 62% Other SVOs - NA PCBs - 100% Butyltins - NA
Surrogate Spikes[2] (*added to each sample*)	NA	NA	NA	NA	>50% recovery; PCBs >60%	SVOs - >99% PCBs - 14% Butyltins - 84%[3]
Analytical Replicates (*5% of samples; spike duplicates for conventionals, CRMs for others*)	20% RPD	100%	20% RPD	100%	35% RPD or Coefficient of Variation	PAHs - 100% Other SVOs - NA PCBs - 100% Butyltins - 100%
Blanks (*1/extraction batch or in a 12 hour period*)	NA	NA	< detection limit	62%	Phthalates: 5 µg, others 2.5 µg or <5% of analyte concentration	Phthalates -100% Other SVOs->99%; PCBs - 100%; Butyltins - 97%
Holding Times (*until extraction*)	TOC 14 days @ 4°C	0%	6 months @ 4°C	100%	14 days @ 4°C Butyltins - freeze within 24 hrs of collection	SVOs - 0% PCBs - 0% Butyltins - 100%

[1] Source: Ecology, 1995

[2] EPA (SW 846; EPA, 1986b) control limit criteria are considered acceptable where reported.

[3] Only 68% of surrogate spikes had recoveries between 50% and 200%.

RPD=Relative Percent Difference

NA=Not Analyzed

Duplicate analysis of matrix spikes and reference materials yielded results which indicated fairly good precision for the lab work. In addition, two samples were split in the field to assess overall precision, a measure of sampling plus laboratory precision. Overall precision for all but butyltin data was generally less than 30% relative percent difference.

Precision for butyltins was poor and it is impossible to determine the source(s) of error with the available data. If paint chips were present, the sample would likely have been non-homogeneous which could account for poor agreement between split samples. However, since the factors affecting butyltin precision are not known, the butyltin data should be viewed with caution.

As for laboratory contamination, copper and zinc were detected at low levels (0.6-1.3 mg/Kg) in blank samples. Since these levels were less than 20% of sample results in all cases (and <1% in most cases), they do not compromise the reported values. Phthalates were the most common class of organic compounds detected in laboratory blanks, as is commonly the case due to their use as plasticizers. Butyltins were also frequently detected in lab blanks at levels generally <5% of associated sample results. However, none of the sample results were void due to blank contamination.

None of the samples for TOC, semivolatiles, or PCB analysis met the holding time requirement of 14 days from collection until extraction. Samples designated for TOC analysis were held unfrozen for 42 days which may have resulted in the loss of some components. TOC data and TOC-normalized data were therefore flagged with an "H" for holding time exceedance. Semivolatile organics and PCBs were extracted 21 days after collection. Considering the relatively stable nature of these compounds, exceeding the holding time requirements probably did not affect the results. Butyltins were kept frozen following PSEP guidelines and extracted seven weeks after collection.

Results and Discussion

Conventional Characteristics of Sediments

The general characteristics of Salmon Bay sediments (TOC, solids, and grain size) are presented in Table 2. TOC, which has been known to correlate well with non-polar organic compounds, ranged from 0.1% to 13.9%. Grain size analysis showed that sediments from all stations were made up of mostly sand or silt (Figure 3). Sediments from Stations 5B and 2B were the sandiest with 93% and 90% sand, respectively. Clay-sized particles were found at substantial proportion at one station only (7B with 46%). Percent fines, the fraction of sediment less than 63 µm (*i.e.*, silt + clay) varied from 0% to 88%. Contaminant concentrations in sediments are often correlated with percent fines since fine material provides more surface area for binding. Eighty percent of the stations had 5% or less gravel, and only one station had more than 10% gravel (Station 3A).

Chemical Concentrations in Sediments

Metals

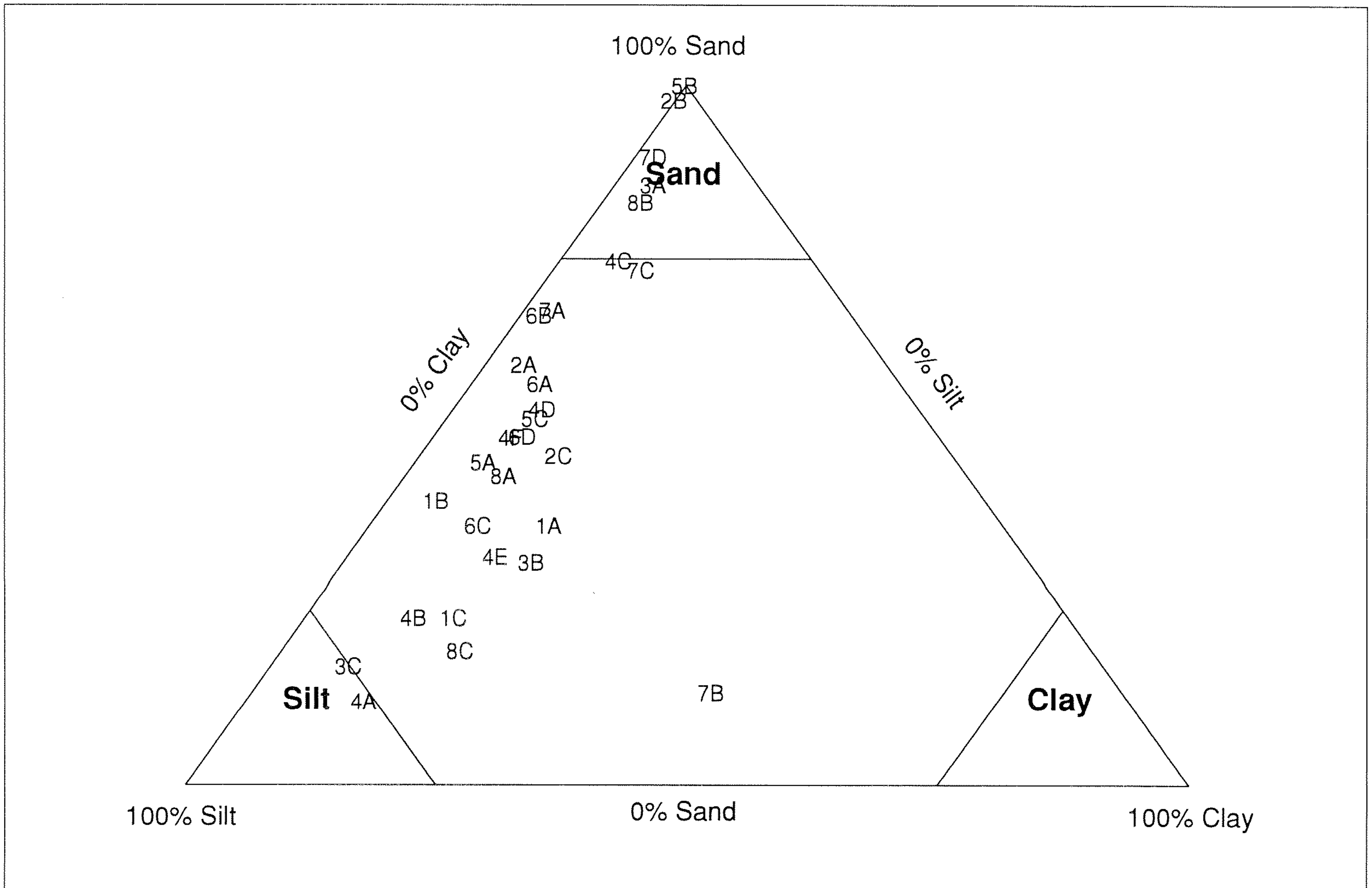
Concentrations of metals are presented in Figures 4 through 11, and in Appendix E. The eight metals analyzed were detected at all sample stations, except for cadmium which was below detectable levels at five stations. Median concentrations of copper and zinc were highest among metals, followed in decreasing order by lead, chromium, nickel, arsenic, mercury, and cadmium. The correlation matrix shown in Table 3 indicates a pattern of significant positive correlations among all metals except nickel and chromium. A strong correlation exists between nickel and chromium concentrations, and both have a moderately strong correlation with copper. Copper is significantly correlated with every other metal except mercury and lead. All metals demonstrated a weak positive link to percent fines and a weak negative relationship to percent sand.

Stations were ranked according to metals concentrations in order to determine which areas were most contaminated (Table 4). Station 1B, where arsenic, mercury, lead, cadmium, and zinc were all found at the highest concentrations, had the greatest overall metals contamination. The second most metals-contaminated station was 4F where all but nickel and chromium concentrations were high. Nickel, chromium, and copper were the highest in sediments from Station 6B, yet this station was only ranked tenth overall due to relatively low concentrations of mercury, lead, and zinc.

Table 2. Conventional characteristics of Salmon Bay sediments.

			Grain Size				
Site:	% TOC (dry)	% Solids	% Gravel (>2000μm)	% Sand (2000-63μm)	% Silt (62-4μm)	% Clay (<4μm)	Total % Fines (<63μm)
1A	8.4 H	32.2	2	36	44	18	62
1B	6.7 H	26.8	0	40	54	5	59
1C	5.8 H	23.0	0	24	61	15	76
2A	5.8 H	32.7	0	60	36	4	40
2B	1.1 H	75.8	8	90	2	0	2
2C	6.2 H	30.6	9	42	35	14	49
3A	1.9 H	51.6	12	75	9	4	13
3B	6.0 H	30.8	4	30	47	19	66
3C	5.4 H	26.5	0	17	75	8	83
4A	4.8 H	17.5	0	12	76	12	88
4B	7.0 H	28.0	0	24	65	11	76
4C	1.6 H	58.3	1	74	19	6	25
4D	5.3 H	38.6	1	53	37	9	46
4E	5.9 H	23.1	1	32	52	15	67
4F	6.7 H	29.2	1	49	42	8	50
5A	3.4 H	42.3	0	46	47	7	54
5B	0.1 H	80.3	7	93	0	0	0
5C	13.7 H	29.2	4	50	37	9	46
6A	13.9 H	26.8	7	53	33	7	40
6B	2.3 H	51.8	0	67	31	2	33
6C	8.6 H	27.8	2	36	51	11	62
6D	10.8 H	23.1	5	47	39	9	48
7A	5.2 H	37.6	1	67	29	3	32
7B	1.2 H	73.2	1	13	40	46	86
7C	0.7 H	65.1	3	71	17	9	26
7D	0.8 H	68.5	3	87	8	2	10
8A	3.9 H	40.0	0	44	46	10	56
8B	1.3 H	49.8	6	78	12	4	16
8C	6.6 H	26.0	1	19	62	18	80

H=Result may be biased due to excessive holding time prior to analysis.



SAND = 2000-63µm SILT = 62-4µm CLAY < 4µm

Figure 3. Relative grain size composition of Salmon Bay sediments.

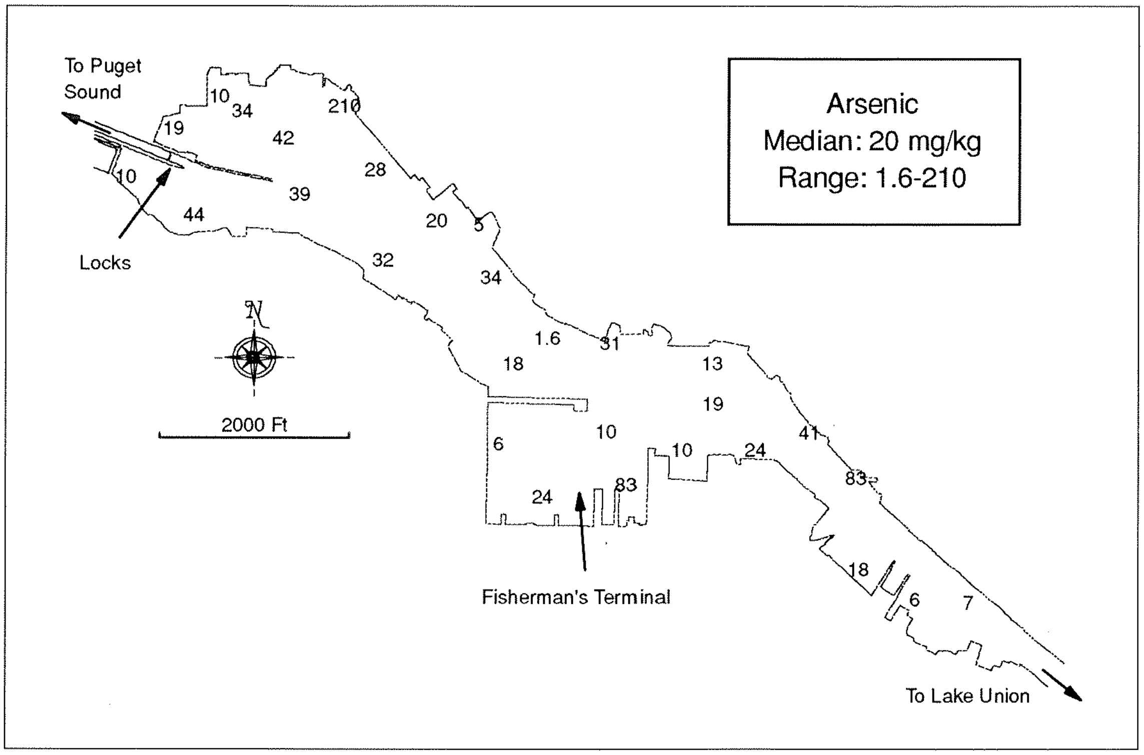


Figure 4. Arsenic concentrations at sample stations. All values mg/kg dry weight.

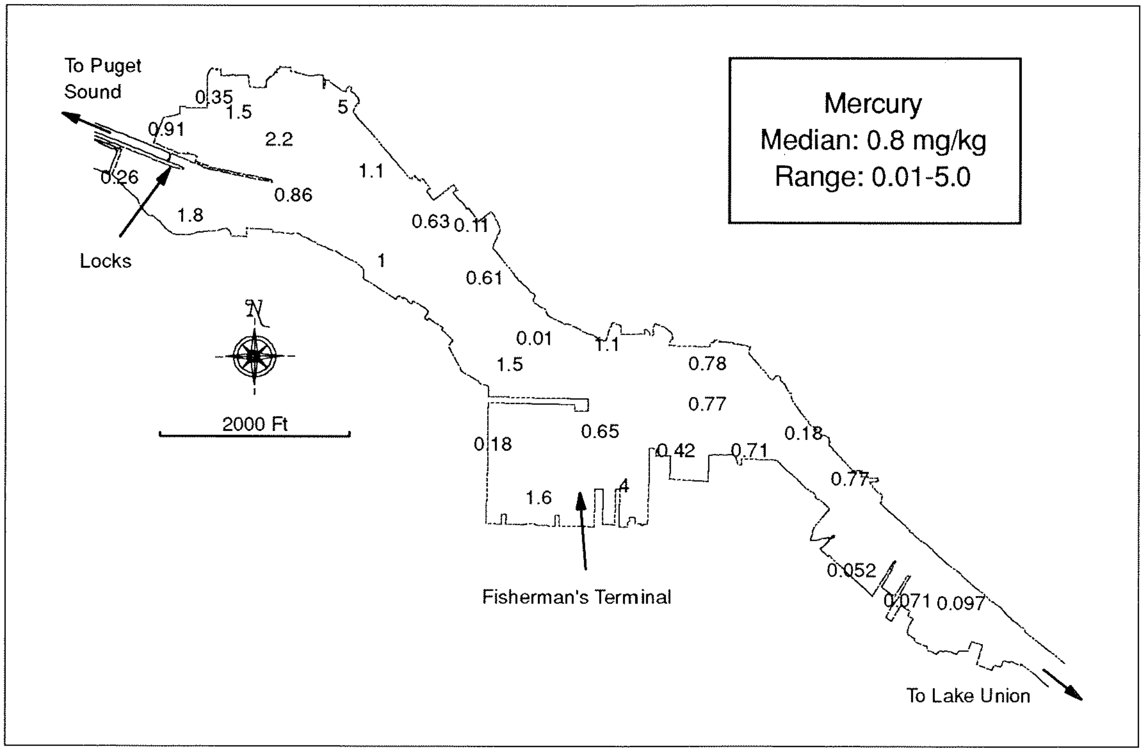


Figure 5. Mercury concentrations at sample stations. All values mg/kg dry weight.

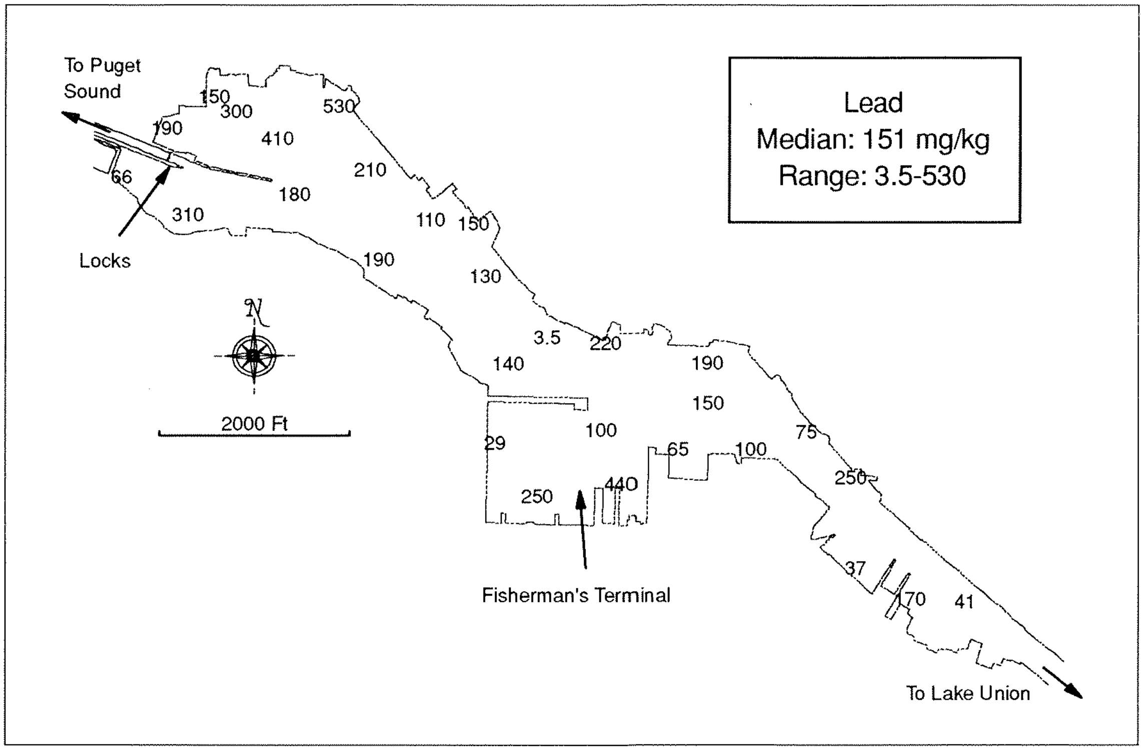


Figure 6. Lead concentrations at sample stations. All values mg/kg dry weight.

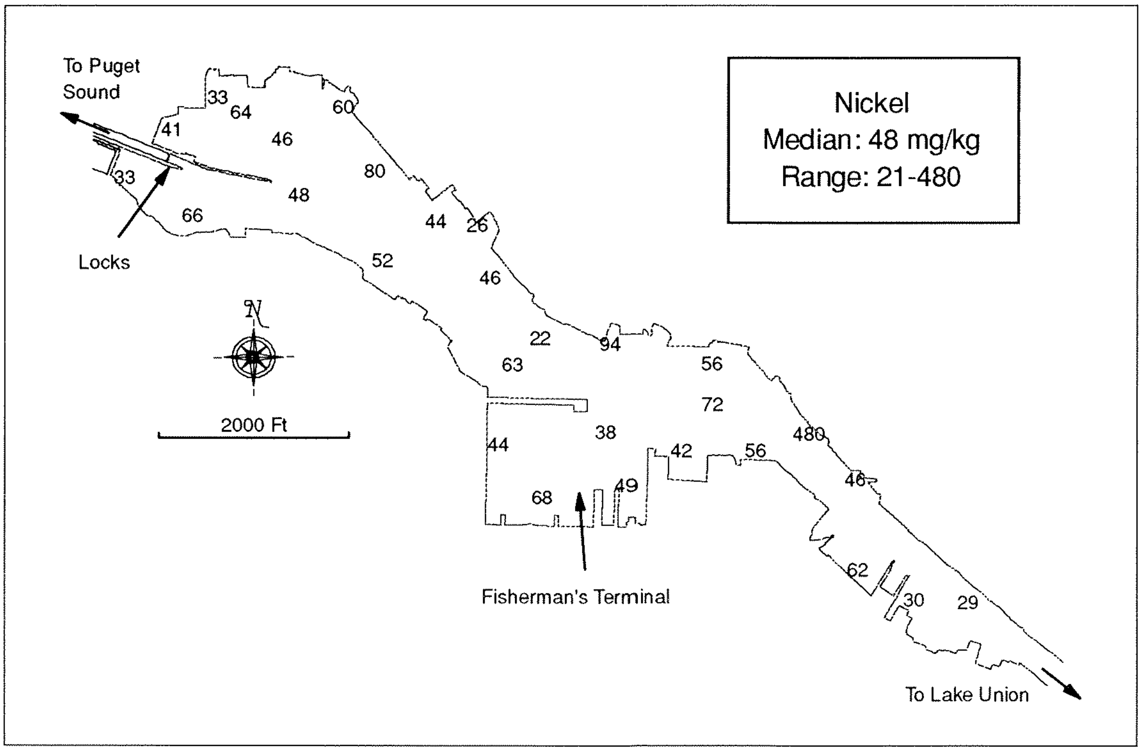


Figure 7. Nickel concentrations at sample stations. All values mg/kg dry weight.

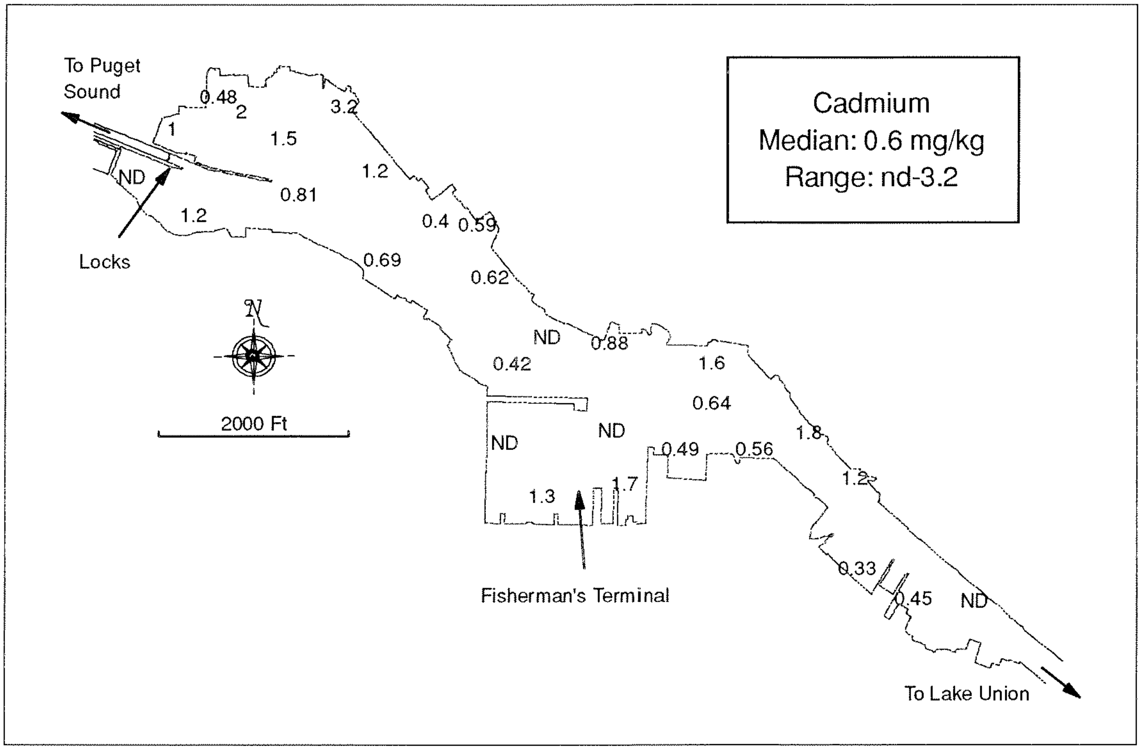


Figure 8. Cadmium concentrations at sample stations. All values mg/kg dry weight.

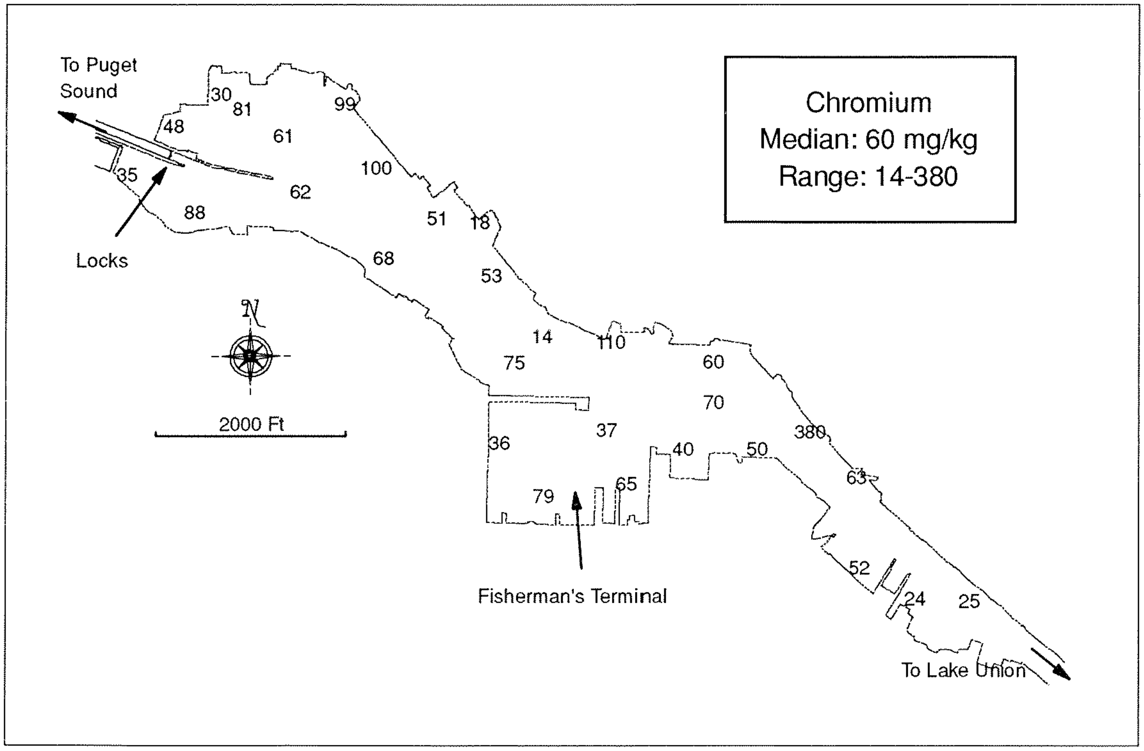


Figure 9. Chromium concentrations at sample stations. All values mg/kg dry weight.

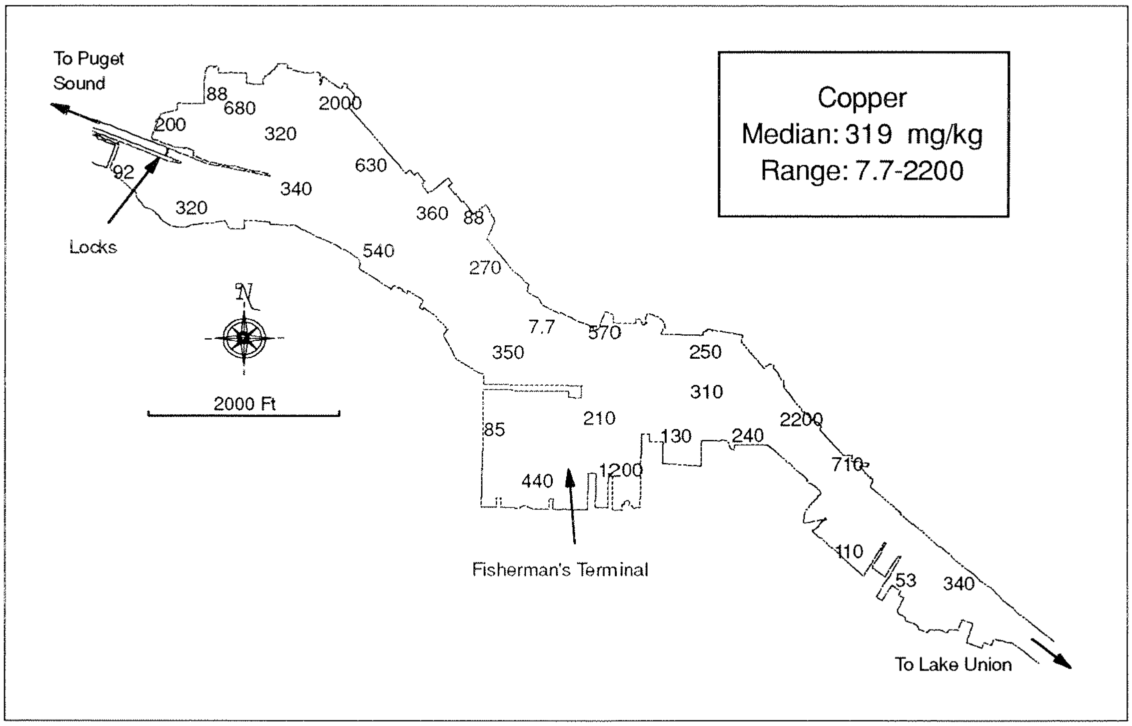


Figure 10. Copper concentrations at sample stations. All values mg/kg dry weight.

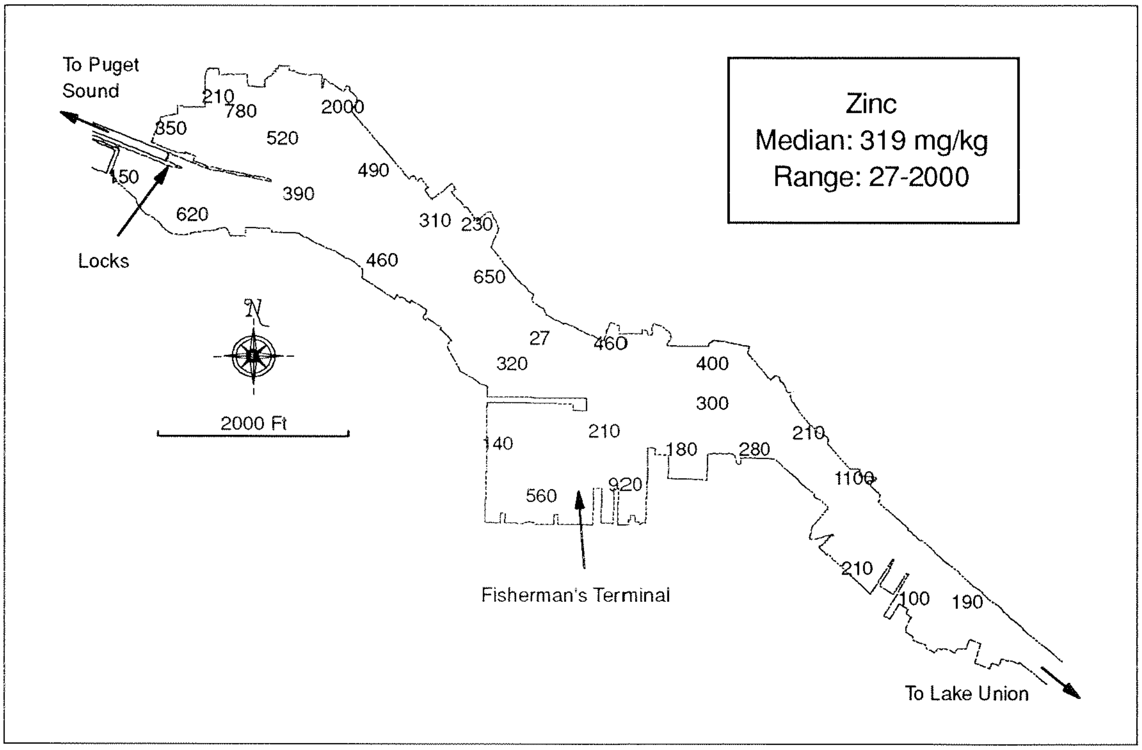


Figure 11. Zinc concentrations at sample stations. All values mg/kg dry weight.

Table 3. Correlations between major parameters in Salmon Bay sediments (Pearson correlation coefficient, n=29).

	As	Hg	Pb	Ni	Cd	Cr	Cu	Zn	totPAH	totPCB	totBT	% Fines	% Sand
Hg	0.84												
Pb	0.77	0.91											
Ni	0.10	-0.07	-0.08										
Cd	0.79	0.77	0.83	0.33									
Cr	0.25	0.11	0.10	0.97	0.48								
Cu	0.74	0.59	0.50	0.69	0.77	0.78							
Zn	0.95	0.84	0.83	-0.04	0.81	0.13	0.63						
totPAH	0.71	0.87	0.85	-0.09	0.71	0.07	0.46	0.73					
totPCB	0.44	0.21	0.34	-0.05	0.30	0.03	0.26	0.55	0.27				
totBT	0.84	0.82	0.72	-0.04	0.76	0.11	0.61	0.83	0.70	0.19			
% Fines	0.23	0.40	0.38	0.04	0.36	0.19	0.17	0.31	0.43	0.02	0.29		
% Sand	-0.21	-0.39	-0.37	-0.01	-0.35	-0.16	-0.13	-0.30	-0.42	0.01	-0.27	-0.99	
TOC	0.19	0.35	0.36	-0.04	0.38	0.05	0.09	0.29	0.54	0.09	0.20	0.41	-0.43

☐ Significant at p<0.01 (Bonferroni probability)

☐ Significant at p<0.05 (Bonferroni probability)

Table 4. Stations ranked according to metals concentrations (lower rank = higher concentration).

Rank	As	Hg	Pb	Ni	Cd	Cr	Cu	Zn	Overall Rank
1	1B	1B	1B	6B	1B	6B	6B	1B	1B
2	4F	4F	4F	4B	8C	4B	1B	7A	4F
3	7A	1A	1A	1C	6B	1C	4F	4F	8C
4	3B	3B	3B	5C	4F	1B	7A	8C	3B
5	1A	4E	8C	4E	6A	3B	8C	2C	1C
6	6B	4A	7A	3B	1A	8C	1C	3B	4E
7	5A	8C	4E	8C	4E	4E	4B	4E	4B
8	2C	1C	4B	4A	1C	4A	3C	1A	7A
9	8C	4B	1C	7B	3B	5C	4E	1C	1A
10	3C	3C	3C	1B	7A	3C	2A	3C	6B
11	4B	5A	6A	6D	8A	4F	4A	4B	3C
12	1C	8A	8A	6A	4B	7A	5A	6A	5A
13	4E	6A	5A	3C	5A	5A	7D	5A	6A
14	6D	5C	7C	4F	3C	1A	1A	8A	5C
15	2A	7A	2B	5A	5C	6A	3B	4A	4A
16	5C	4D	5C	2C	2C	2C	5C	2A	2C
17	8A	6D	8B	1A	2B	7B	2C	5C	8A
18	7B	2A	4A	7A	6D	2A	6A	6D	6D
19	4A	2C	2C	4C	6C	6D	6D	2B	2A
20	6A	6C	2A	2A	8B	8A	4D	7B	7B
21	4D	3A	6D	6C	7C	6C	8A	6B	4D
22	6C	8B	4D	8A	4A	4D	6C	4D	6C
23	8B	4C	6B	4D	2A	4C	7B	8B	8B
24	3A	6B	3A	8B	7B	3A	3A	7D	2B
25	7D	2B	6C	3A	3A	8B	2B	6C	7D
26	7C	7B	7D	7C	4C	7D	8B	3A	3A
27	4C	7C	7B	7D	4D	7C	4C	4C	7C
28	2B	7D	4C	2B	5B	2B	7C	7C	4C
29	5B	5B	5B	5B	7D	5B	5B	5B	5B

Semivolatile Organics

Sediments were analyzed for 74 semivolatile organic compounds of which less than half were detected (Appendix E). Polycyclic aromatic hydrocarbons (PAHs) were the most frequently detected class of semivolatiles. Figure 12 depicts the detection frequency for all organic compounds found. With few exceptions, all ten high molecular weight PAHs (HPAHs) and seven low molecular weight PAHs (LPAHs) were detected at all stations. Incomplete combustion of fossil fuels is probably the major source of environmental PAHs, yet some of these compounds, especially LPAHs, may be present in uncombusted petroleum products (PTI Environmental Services, 1991).

Total dry weight PAH concentrations (Appendix E; the sum of HPAH and LPAH), were greatest at Station 4F (84,200 μg/Kg), followed in decreasing order by Stations 1B (77,700 μg/Kg) and 1A (56,900 μg/Kg). Total PAHs were lowest at Stations 5B (100 μg/Kg), 7C (2,800 μg/Kg), and 3A (3,400 μg/Kg).

PAHs have a high affinity to carbon-containing sediments (Callahan *et al.*, 1979), although concentrations of HPAH were not significantly correlated with TOC. To examine factors influencing PAH levels other than sediment TOC, HPAH and LPAH concentrations were normalized to organic carbon (Figures 13 and 14). Station 2B had the highest organic carbon-normalized concentration of total PAH in sediment (2,280 mg PAH/Kg OC), followed by Station 7B (1,930 mg PAH/Kg OC). Station 5B had the lowest OC-normalized PAH level (107 mg PAH/Kg OC) despite its low TOC content (0.1%).

In addition to PAHs, dibenzofuran and retene were detected at all stations, followed in frequency by 4-methylphenol, 3β-coprostanol, and butylbenzylphthalate. All other semivolatile organics were detected at fewer than 60% of stations, and at dry weight concentrations generally less than 1,000 μg/Kg.

PCBs

PCB concentrations normalized to organic carbon are shown in Figure 15. PCBs were detected at 26 of the 29 sample stations. Of the seven PCB mixtures analyzed, only PCB-1242,-1254, and -1260 were detected; PCB-1242 was detected at one station only (Appendix E). Other PCB mixtures were not detected at quantitation limits of 48-160 μg/Kg.

Total PCBs, the sum of all PCB mixtures, ranged from non-detectable levels at Stations 3A, 5B, and 7C to a dry weight concentration of 7,600 μg/Kg at Station 7A. The median total PCB concentration was comparatively low on both a dry weight (260 μg/Kg) and organic carbon basis (4.8 mg PCB/Kg OC).

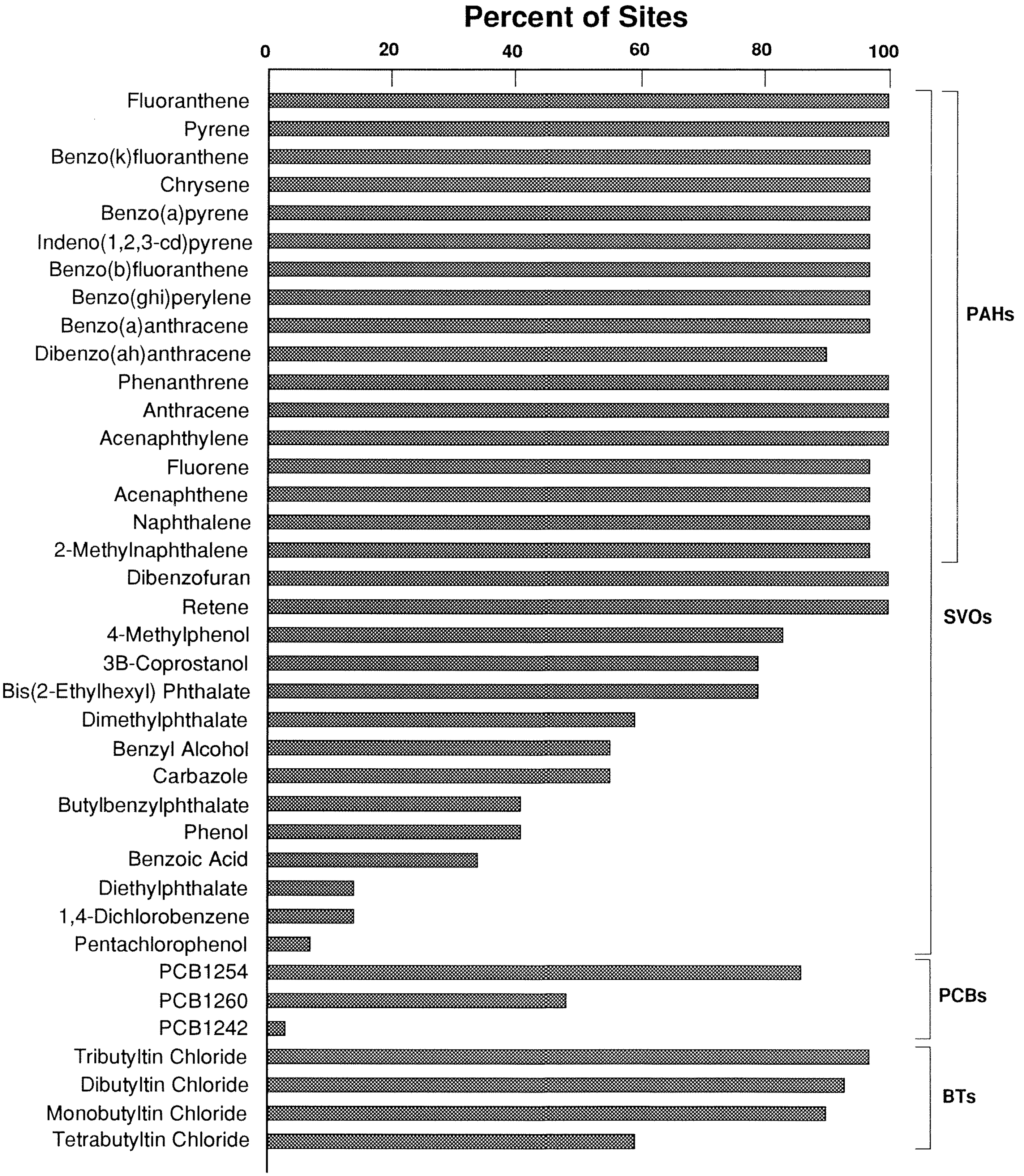


Figure 12. Frequency of detection for organic compounds in sediment.

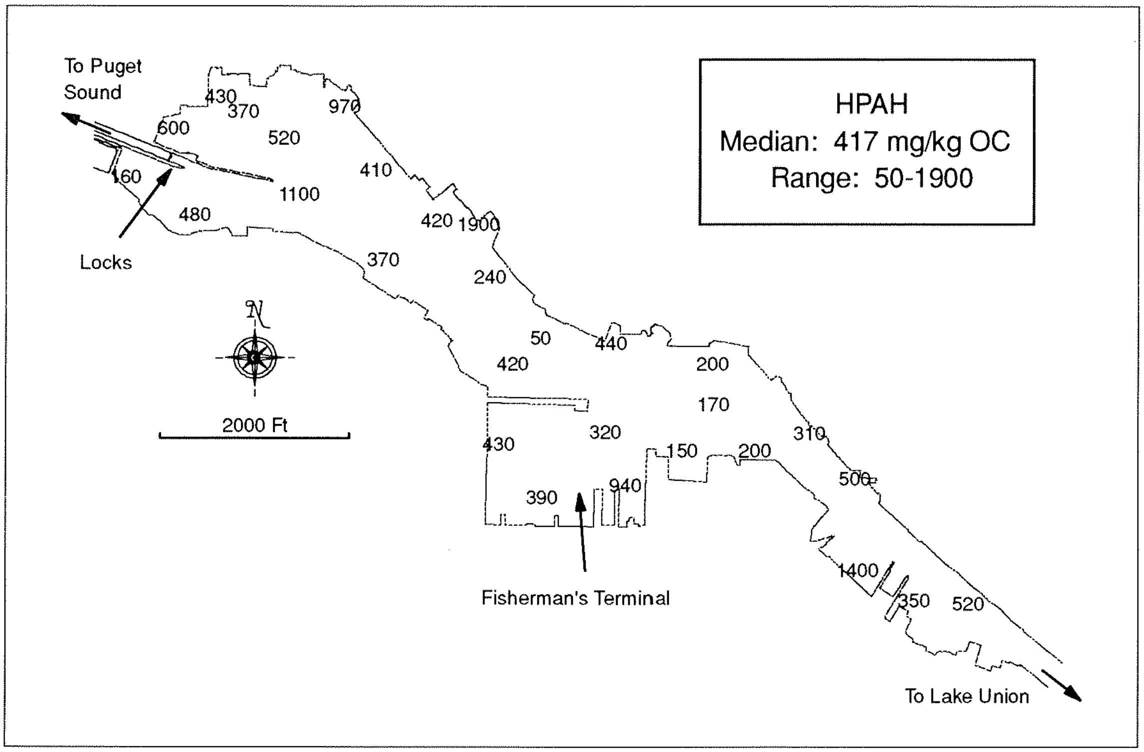


Figure 13. HPAH concentrations at sample stations. All values mg/kg organic carbon.

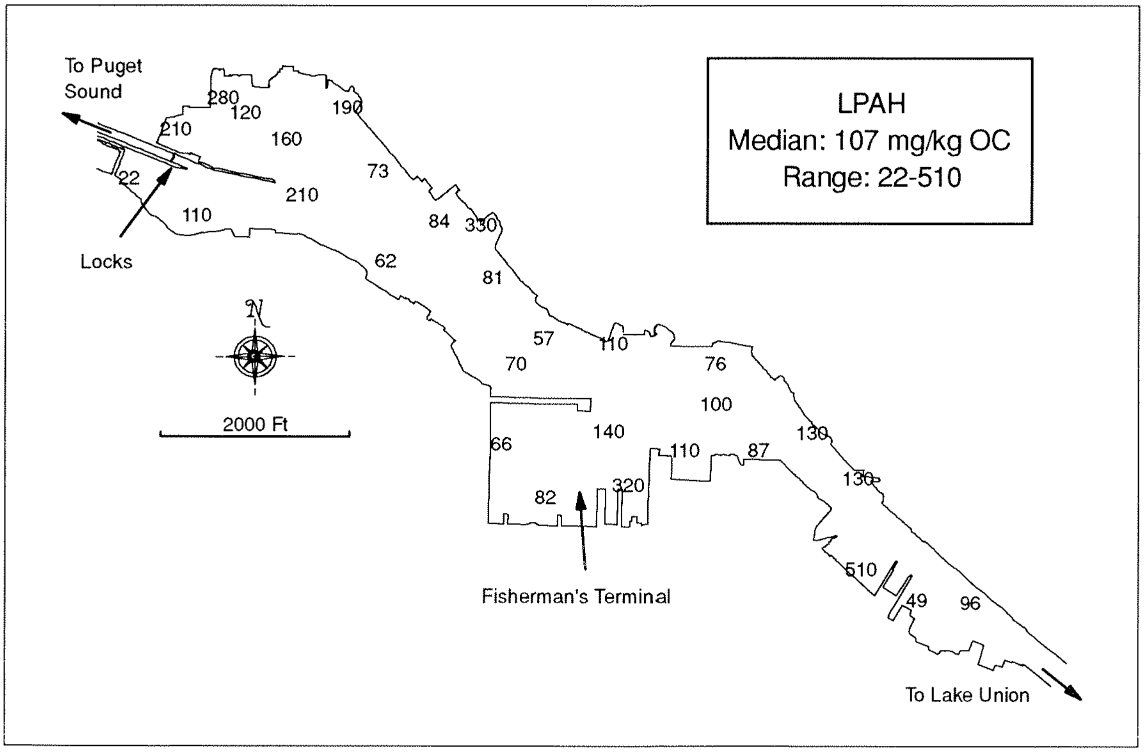


Figure 14. LPAH concentrations at sample stations. All values mg/kg organic carbon.

Butyltins

Butyltin chlorides were detected at all stations except 5B, ranging in concentration from less than 6 µg/Kg to more than 9,000 µg/Kg total butyltins chlorides at Station 1B (Appendix E). Tributyltin chloride (TBT-Cl) was the most frequently detected butyltin congener and accounted for 63% of overall butyltin chloride concentrations on average. The median concentrations of total butyltin chlorides and TBT-Cl were 671 and 366 µg/Kg, respectively. As mentioned previously, the butyltin data should be viewed with caution due to a low degree of precision.

Butyltin chloride concentrations were significantly correlated to PAH concentrations and, like PAHs, they were also significantly correlated to arsenic, mercury, lead, cadmium, and zinc. They were generally associated with fine-grained organic carbon containing sediments, although less so than PAHs. Butyltins were also positively correlated to copper concentrations, although this correlation was not strong.

Figure 16 shows TBT concentrations throughout the study area. These concentrations are expressed as the TBT ion rather than TBT-Cl to maintain consistency with current PSDDA and SMS reporting conventions. TBT is an active ingredient in anti-fouling paint applied to boat and ship hulls. Although the use of TBT for most pleasure boat and ship applications was outlawed in the U.S. in 1988, it may yet be present on hulls with aged paint, on foreign-flagged vessels, and still has limited legal uses in the U.S. (on aluminum hulls for instance). TBT is by far the most toxic among the four congeners analyzed. Mono- and dibutyltin are metabolites formed during the progressive debutylation of TBT to inorganic tin, while tetrabutyltin may be an impurity during TBT manufacturing or possibly formed photolytically or microbially from lesser butylated congeners.

Areal Distribution of Contaminants

Figures 4 through 11 and 13 through 16 indicate there are no clear areal gradients for any of the chemicals analyzed. This is to be somewhat expected since the study area contains numerous potential sources of contamination rather than one or two large sources.

Figures 17 and 18 show how metals and organics co-occur, respectively. The stations most contaminated with arsenic, mercury, lead, cadmium, zinc, and TBT can be found at Station 1B in the northernmost section of the study area, and at Station 4F located in the eastern portion of Fisherman's Terminal. Station 6B stands out as the most contaminated with nickel, chromium, and copper. Station 7A, which is near 6B, also has relatively high concentrations of metals, although the pattern of contamination is different suggesting two distinct sources of metals.

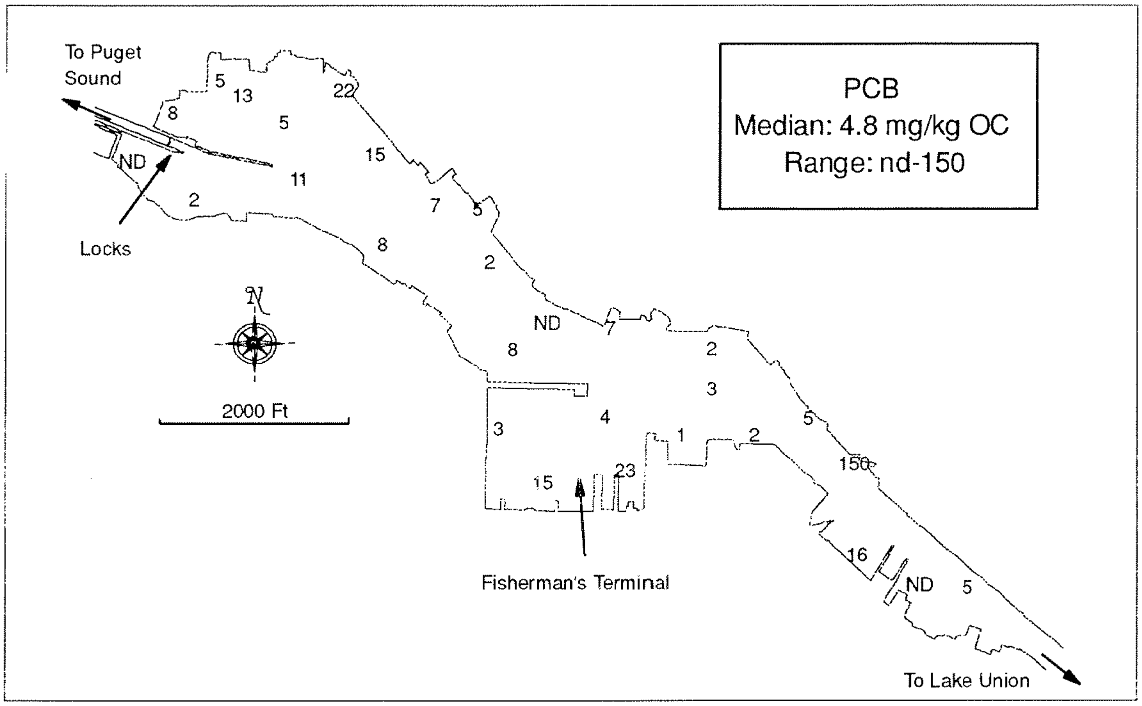


Figure 15. PCB concentrations at sample stations. All values mg/kg organic carbon.

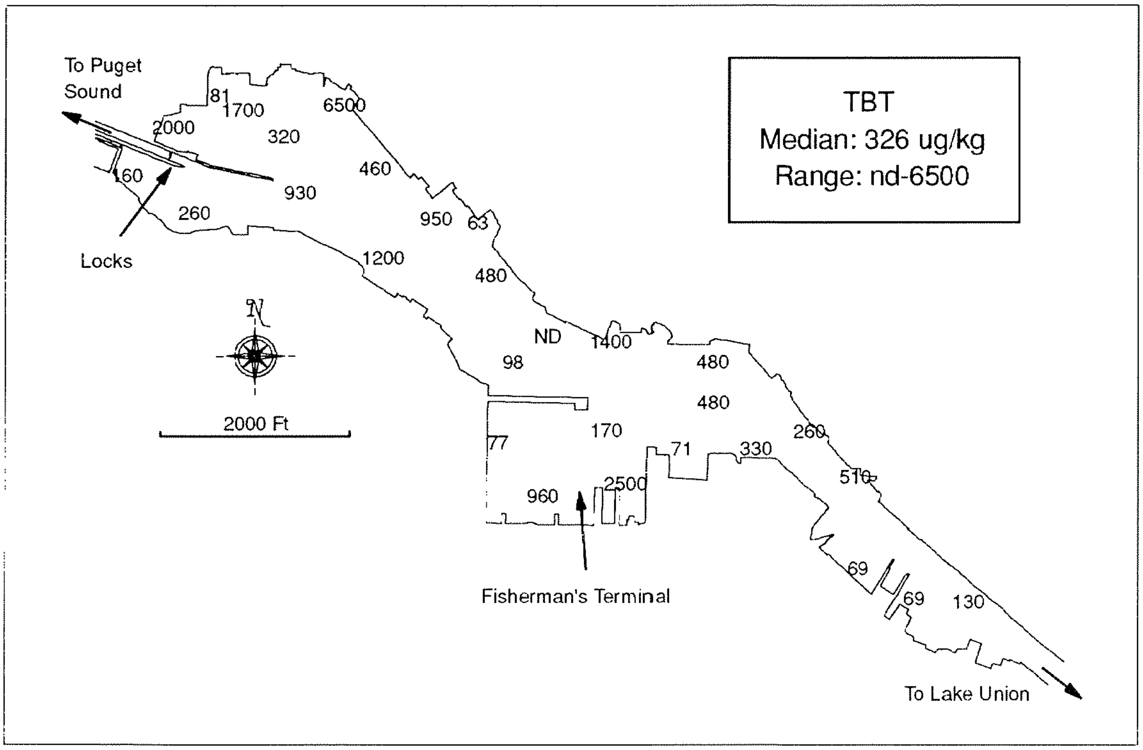


Figure 16. TBT concentrations at sample stations. All values ug/kg dry weight.

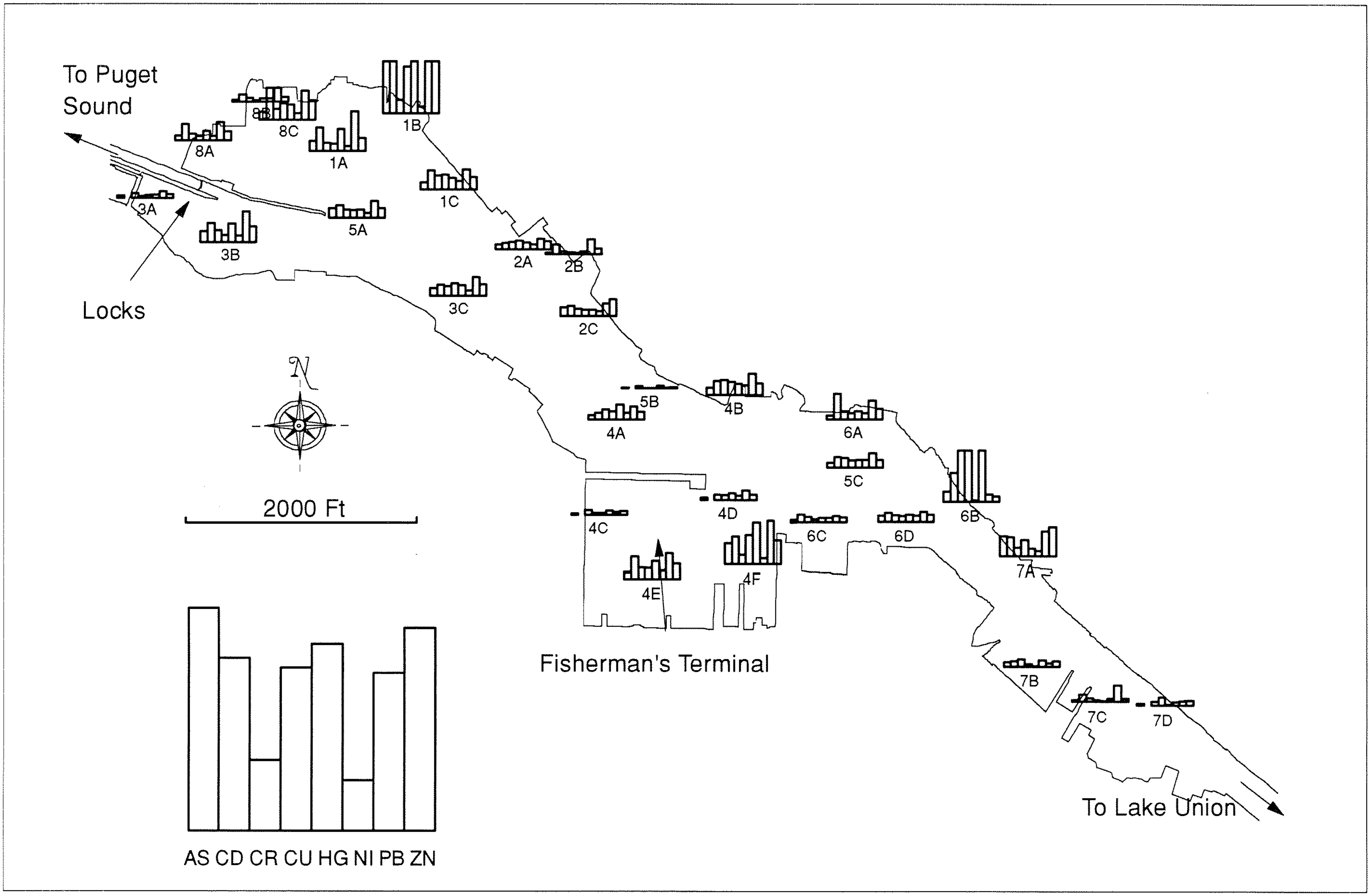


Figure 17. Comparison among metals concentrations at all sites. Concentrations of metals are standardized as a percent of the highest concentration for each metal.

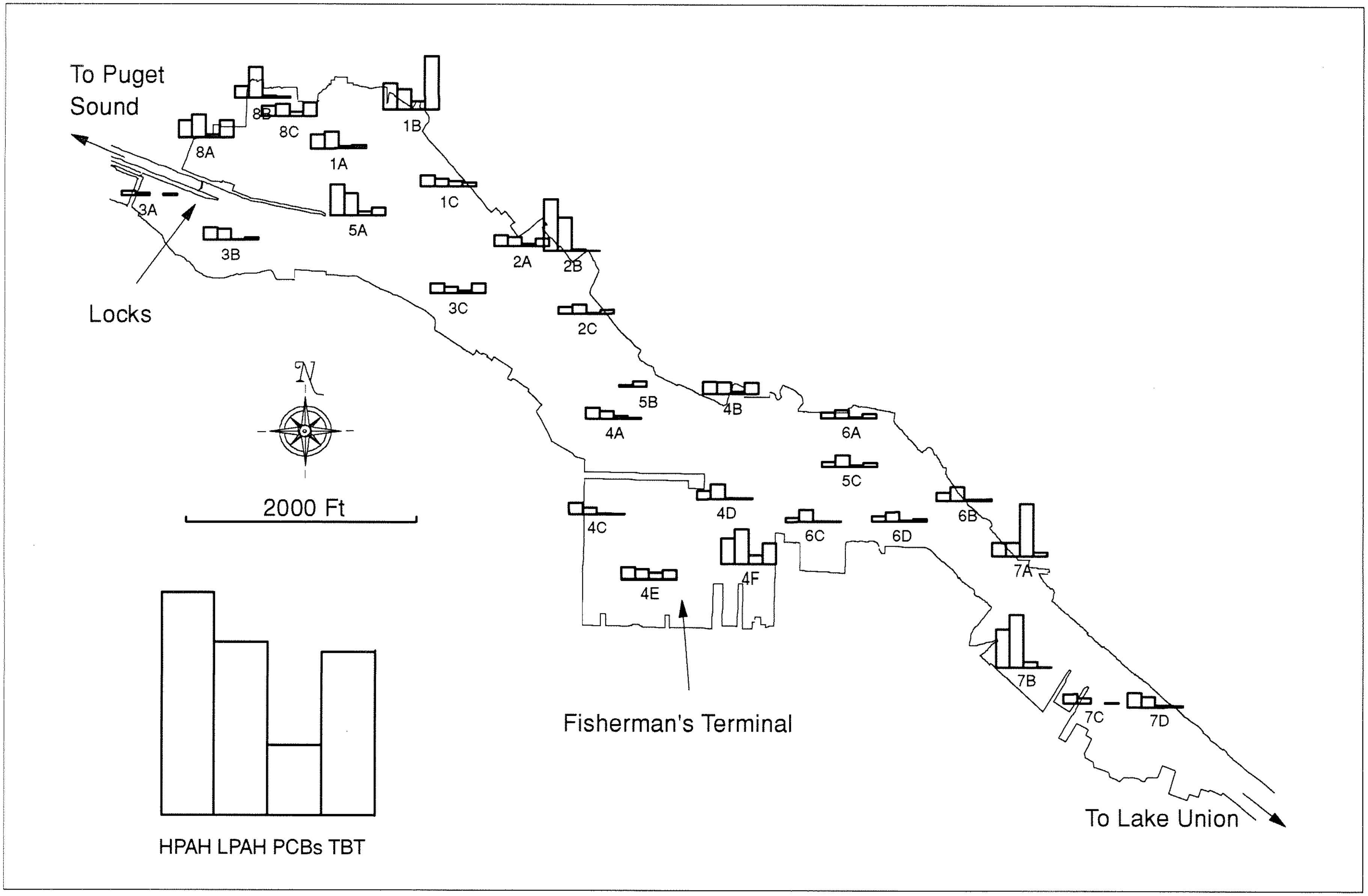


Figure 18. Comparison among groups of organics concentrations at all sites. Concentrations of organics are standardized as a percent of the highest concentration for each group. HPAH, LPAH, and PCBs are on organic carbon basis. TBT is on dry weight basis.

With one possible exception, there is also a lack of gradation or geographical pattern with respect to clean sediments. The cleanest area appears to be at the terminus of the Ship Canal in the easternmost section of Salmon Bay. Station 5B, located near the longitudinal center of the study area, has the lowest overall contamination.

Aside from the northernmost area of Salmon Bay, PAH concentrations normalized to organic carbon tend to show a "patchy" distribution, suggesting localized sources. Three of the four stations with the highest PAH concentrations -- 2B, 7B, and 4F -- have neighboring stations with relatively low PAH levels.

This independent nature of station-to-station contaminant distribution appears to hold true for all chemicals analyzed. It is perhaps best illustrated for PCBs, where a very high concentration at Station 7A apparently has no effect on concentrations at nearby stations. Sediments at 7A were collected just off of the Union Bay Ship Building and Salmon Bay Steel plants. Another example is in sample zone 8 where sediments from Station 8C, found to have some of the worst overall contamination, were collected within 300 feet of one of the cleanest sample stations (8B).

As mentioned under the description of sampling strategy, stations were grouped in each major area of concern and/or natural geographical feature. These zones were chosen to represent groups of industries and combined sewer overflows (CSOs) or areas that were thought to possibly have similar contaminant levels.

Because of the areal variability of contaminant levels, stations within each zone were rarely uniform. To test for differences among zones, chemical concentrations (including OC-normalized organics) in each zone were compared using the Kruskal-Wallis one-way analysis of variance ($p<0.05$). This is a non-parametric test that compares the sum of ranks and assumes the test statistic approximates a chi-square distribution. There was no difference among zones for any of the metals, total PAH, total PCB, or TBT.

Relationship to Sources

The contaminant data were considered in context of their possible sources, *i.e.* potential sources in close proximity to the sample stations. Since the study area is heavily industrialized, not every source was considered. Instead, major groups such as marinas and CSOs were considered.

PAHs, phthalates, lead, and copper are among the most prevalent chemicals in stormwater and CSO discharges (METRO, 1988). In some cases, their concentrations in receiving waters may be useful in estimating the extent to which stormwater and CSO discharges contribute to contamination of a specific area.

In Salmon Bay there is mixed evidence that CSO discharges account for a substantial portion of the contamination. Of the six stations adjacent to CSO outfalls -- 1B, 2B, 6A, 6B, 8B, and 8C -- two stations (1B and 8C) had high overall concentrations of metals, including lead. Station 6B had high concentrations of copper, as did Stations 1B and 8C, yet other stations located near the CSO outfalls had relatively low-to-moderate metals levels. Sediments from Station 2B had the highest organic carbon-normalized PAH concentrations, and Stations 1B, 6A, and 8C had the three highest concentrations of bis(2-ethylhexyl)phthalate. However, organic carbon-normalized PAHs from three stations -- 8C, 6B, and 6A -- were at or below the median PAH concentration. All six stations near CSOs tended to have relatively high levels of 3β-coprostanol, a compound found in the feces of humans and carnivorous animals (Merck, 1976) and therefore a likely indicator of CSO discharge.

Although Stations 1B and 8C had elevated levels of lead, copper, and bis(2-ethylhexyl)phthalate, and were located near CSO outfalls, there remains some question as to the source of these chemicals. Sediments from these stations had elevated TBT levels when compared to other sites, yet CSOs are an unlikely delivery mechanism for TBT unless they receive drainage from upland boatyards. These stations also had some of the highest PCB concentrations. Since high concentrations of TBT and PCBs are not normally associated with CSO discharge, Stations 1B and 8C probably receive contamination from one or more additional source.

Perhaps the best indicators of remarkable PAH and/or PCB contamination were observations made during sample collection. Sediments with a moderate-to-heavy oil sheen, a petroleum odor, or both, were twice as likely to have PAH levels in the top quartile than the middle two quartiles, and were four times less likely to be in the bottom quartile. The same pattern was even more pronounced with regard to PCB concentrations, but oil sheen/odor did not yield a good indication of high TBT or metals concentrations.

Of the 29 stations sampled, 21 were located adjacent to marinas, boat repair facilities, marine terminals (including Fisherman's Terminal), shipyards, or vessel-related facilities. Two of the six stations (8A and 4B) with TBT levels greater than 1,000 μg/Kg were not adjacent to these facilities, while seven of eight sites with TBT less than 100 μg/Kg were adjacent to areas with marinas, etc. Proximity to these facilities alone did not appear to dictate concentrations of TBT. Instead, high TBT concentrations in sediments can probably be traced to individual facilities which do a poor job of containing paints, scrapings, and sand-blast grit on-site. For instance, the station with the highest TBT concentration (Station 1B) is located just offshore of Alaska Pacific Fisheries and Pacific Fisherman, Inc., both with a history of poor "housekeeping." Station 4F, with the second highest TBT concentration, is adjacent to a facility operated by Fishing Vessel Owners Marine Ways. Containment of sand-blast grit from this facility has allegedly been so bad in the past that grit deposition has caused shallowing of the vessel slip, and clouds of airborne particles have drawn complaints from motorists (Dan Cargill, Washington State Department of Ecology Toxics Cleanup Program, personal communication). Stations located near vessel-related facilities were, however, more likely to have high metals concentrations.

Comparison to Criteria

Metals, Semivolatile Organics, and PCBs

To evaluate the biological significance of chemicals in Salmon Bay sediments, concentrations were compared to guidelines for freshwater sediment quality and Ecology's Marine Sediment Management Standards (SMS; Ch. 173-204 WAC) shown in Table 5.

Ecology is currently developing criteria for freshwater sediments. In the interim, Batts and Cubbage (1995) have reviewed guidelines proposed by various government agencies in the U.S. and Canada. These guidelines vary a great deal because of 1) the scientific approaches used to develop them, and 2) their proposed regulatory applications.

The Ontario guidelines were developed using a screening level approach wherein *in situ* impacts are measured along with contaminant concentrations in sediment. The Ontario "severe effects levels" are contaminant concentrations which are tolerated by only 5% of the benthic infaunal species examined (10% for PCBs).

The Environment Canada (EC) guidelines have been proposed as a tool for screening sediments throughout Canada and, by design, are somewhat conservative. EC guidelines were derived using existing studies from a variety of sources and using different scientific approaches. "No effects" and "effects" data sets were subsequently used to derive the intermediate EC "probable effects levels" (see Batts and Cubbage, 1995 for more details concerning the EC approach). As implied, adverse biological effects are expected to occur above the probable effects levels.

Table 5 contains two sets of chemical criteria from the SMS. The "no adverse effects levels" are the marine sediment quality standards -- chemical concentrations that have no adverse impacts on biological resources and no significant health risks to humans. The "minor adverse effects levels" correspond to the cleanup screening levels and the minimum cleanup levels. These are chemical concentrations used to identify "station clusters" of potential concern (Ch. 173-204-510 WAC defines a station cluster as "any number of stations ... that are determined to be spatially and chemically similar"). Stations clusters which are found to be of potential concern may subsequently undergo a hazard assessment to determine whether they should be listed on the contaminated sediment site list and to develop the site rank.

Table 5. Freshwater guidelines and marine standards for sediment quality.

	FRESHWATER		MARINE	
	Ontario Provincial Guidelines Severe Effect Levels	Environment Canada Probable Effect Levels	Ecology SMS No Adverse Effect Levels[1]	Ecology SMS Minor Adverse Effect Levels[2]
METALS	mg/Kg, dry	mg/Kg, dry	mg/Kg, dry	mg/Kg, dry
Arsenic	33	17.0	57	93
Mercury	2	0.486	0.41	0.59
Lead	250	91.3	450	530
Nickel	75	35.9	ne	ne
Cadmium	10	3.53	5.1	6.7
Chromium	110	90.0	260	270
Copper	110	196.6	390	390
Zinc	820	314.8	410	960
PAHs	mg/Kg OC[3]	µg/Kg, dry	mg/Kg OC	mg/Kg OC
Anthracene	370	ne	220	1200
Acenaphthylene	ne	ne	66	66
Acenaphthene	ne	ne	16	57
Phenanthrene	950	514.9	100	480
Fluorene	160	ne	23	79
Naphthalene	ne	ne	99	170
2-Methylnaphthalene	ne	ne	38	64
LPAH[4]	ne	ne	370	780
Pyrene	850	875.0	1,000	1400
Benzo(g,h,i)perylene	320	ne	31	78
Indeno(1,2,3-c,d)pyrene	320	ne	34	88
Benzo(b)fluoranthene	ne	ne	ne	ne
Benzo(k)fluoranthene	1,340	ne	ne	ne
Benzofluoranthene(s)	ne	ne	230	450
Fluoranthene	1,020	2354.9	160	1200
Chrysene	460	861.7	110	460
Benzo(a)pyrene	1,440	782.0	99	210
Dibenzo(a,h)anthracene	130	ne	12	33
Benzo(a)anthracene	1,480	384.7	110	270
HPAH[5]	ne	ne	960	5300
PAH (Total)	10,000	ne	ne	ne
PHTHALATES AND OTHER SEMIVOLATILE ORGANICS			mg/Kg OC	mg/Kg OC
Bis(2-Ethylhexyl) phthalate	ne	ne	47	78
Dimethylphthalate	ne	ne	53	53
Diethylphthalate	ne	ne	61	110
Butylbenzylphthalate	ne	ne	4.9	64
1,4-Dichlorobenzene	ne	ne	3.1	9
Dibenzofuran	ne	ne	15	58
			µg/Kg, dry	µg/Kg, dry
Benzyl Alcohol	ne	ne	57	73
4-Methylphenol	ne	ne	670	670
Phenol	ne	ne	420	1200
Benzoic Acid	ne	ne	650	650
Pentachlorophenol	ne	ne	360	690
PCBs	mg/Kg OC[3]	µg/Kg, dry	mg/Kg OC	mg/Kg OC
PCB-1254	34	ne	ne	ne
PCB-1260	24	ne	ne	ne
PCBs (total)	530	277.2	12	65

ne=not established

[1] These levels are also the SMS marine sediment quality standards

[2] These levels are also the SMS cleanup screening levels and minimum cleanup levels

[3] To a maximum of 10% OC

[4] Represents the sum of Anthracene, Acenaphylene, Acenaphthene, Phenanthrene, Fluorene, and Naphthalene. The LPAH criterion is not the sum of the criterion values for the individual LPAH as listed.

[5] Represents the sum of Pyrene, Benzo(g,h,i)perylene, Indeno(1,2,3-c,d)pyrene, Benzofluoranthene(s), Fluoranthene, Chrysene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, and Benzo(a)anthracene. The HPAH criterion is not the sum of the criterion values for the individual HPAH as listed.

The reader should be aware that the marine standards described above are not directly applicable to Salmon Bay sediments. Chapter 173-204-510 WAC defines marine sediments as those which have pore water salinity greater than 25 parts per thousand (ppt). Freshwater sediments are defined as having less than 0.5 ppt salinity. "Low salinity" sediments, for which standards have also not been established, are those with pore water salinity between 0.5 and 25 ppt. Benthic salinity at the Ballard (15th Ave.) Bridge is less than 0.5 ppt approximately 62% of the time and exceeds 5 ppt only about one day per year (Marian Valentine, U.S. Army Corps of Engineers, written communication).

All 29 stations had at least one chemical exceeding criteria listed in Table 5. Seventy-two percent of the stations had one or more contaminants at concentrations expected to have pronounced effects on benthic organisms based on a comparison to the Ontario severe effects levels. Eighty-six percent of the stations would be expected to have at least minor adverse effects on benthic organisms in a marine environment.

Figure 19 shows stations that exceed either the freshwater severe effects levels or the minor adverse effects levels for marine sediments. Figure 20 compares stations based on the number of chemicals exceeding these criteria. These comparisons suggest that sediments in most areas of Salmon Bay can be expected to have some degree of adverse impact on benthic organisms. Only three stations -- 5B, 7C, and 8B -- are not shown on this list because they do not exceed any of these levels.

Of the chemicals listed in Table 5, copper poses the most serious threat to aquatic life in Salmon Bay. Other chemicals likely to harm aquatic life at a substantial number of stations (*i.e.* more than 25%) include mercury, benzyl alcohol, 4-methylphenol, arsenic, and bis(2-ethylhexyl)phthalate.

TBT

No TBT criteria were included in the freshwater guidelines reviewed by Batts and Cubbage (1995), nor have numerical criteria been promulgated under Ecology's marine standards. However, the high degree of toxicity associated with TBT is well regarded and it is recognized as a chemical of special concern under the PSDDA program. In 1988, an interim PSDDA screening level (SL) of 73 µg/Kg (as TBT, dry) was developed using an equilibrium partitioning approach which predicts the TBT concentrations of interstitial water based upon sediment concentrations.

The PSDDA agencies have recently conducted a review of several TBT-related issues, including the appropriateness of the interim SL for sediments (Michelsen et al., 1996). Although the interim SL for sediments is not unreasonable based on an equilibrium partitioning approach, it has become apparent that this approach does not accurately predict partitioning between TBT in sediments and overlying water. TBT is introduced into the environment in many different forms with differing degrees of bioavailability.

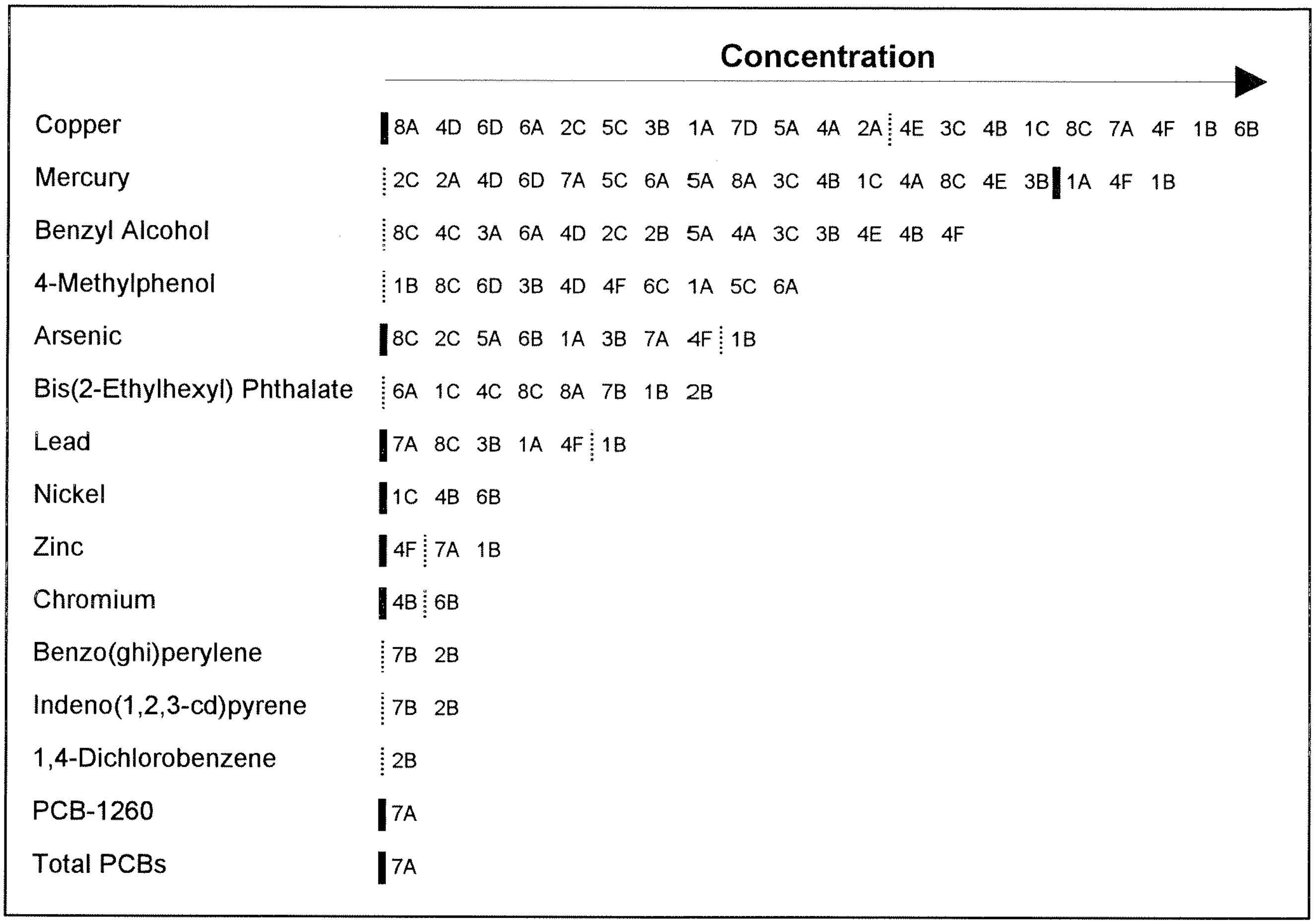


Figure 19. Stations that exceed either Severe Effects Levels for Freshwater Sediments (bold line) or Minor Adverse Effects Levels for Marine Sediments (dotted line). See Table 5 for numerical criteria.

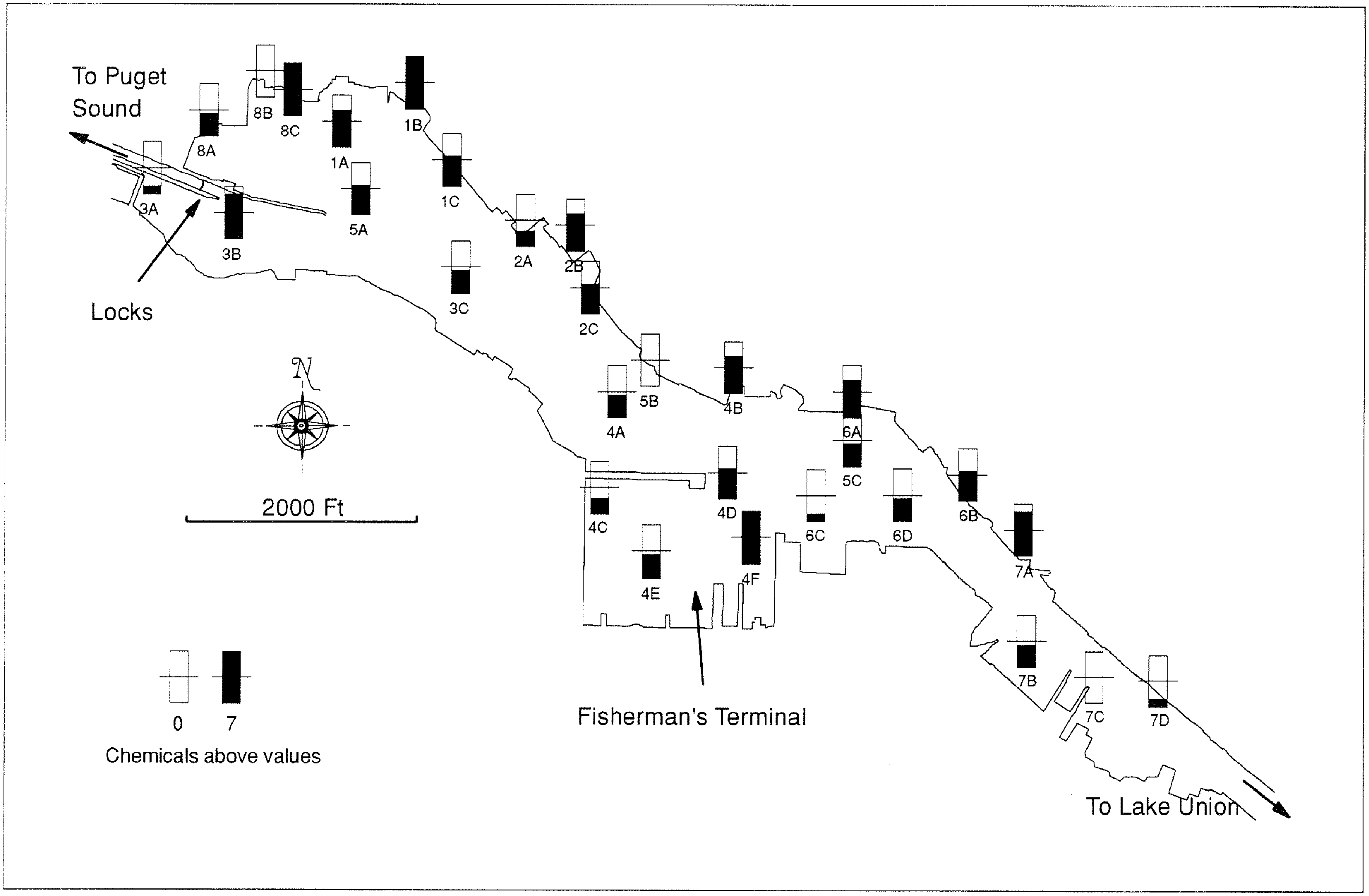


Figure 20. Comparison among sites of number of chemicals that exceed either Severe Effects Levels for Freshwater Sediments or minor Adverse Effects Levels for Marine Sediments.

Its partitioning is also very complex, and is strongly affected by factors such as pH, salinity, and chemical form. The PSDDA agencies have determined that an SL based on concentrations in interstitial water is more appropriate than a sediment SL for use in regulatory decision-making.

No interstitial water or tissue data currently exist for TBT in Salmon Bay. For this report, the sediments SL will be used for comparison. However, Phase III data should include collection of TBT in interstitial water or tissues, to provide a better indication of actual toxicity due to TBT in sediments. In Salmon Bay, all but five stations -- 2B, 5B, 6B, 7B, and 7C -- exceeded the SL. Thirty percent of the stations had TBT concentrations elevated one-to-two orders of magnitude above the SL, with TBT in sediments from 1B the highest by far (6,460 µg/Kg). Median TBT concentrations (326 µg/Kg) were four and one-half times the SL.

Of all chemicals analyzed for the present study, only TBT is elevated to the same degree above one or more associated criteria. This suggests that overall TBT could have a greater impact on aquatic organisms, but this should be confirmed with a more direct measure of toxicity. Consideration should also be given to the variability among criteria due to differing assumptions and approaches used in their development, and the different effects levels at which they are set.

Comparison to Earlier Surveys

Little effort had previously been committed to studying chemicals in Salmon Bay and Lake Washington Ship Canal sediments and, as a result, there are few available data. Cubbage (1992) analyzed metals, PAHs, and PCBs in sediments from 22 locations well-distributed throughout Lake Union and adjoining waters, including five from the Ship Canal. These data are summarized in Tables 6 and 7. Data from the main body of Lake Union are also shown for comparison.

Metals

Median concentrations of all metals in Salmon Bay sediments from the present study are similar to those reported by Cubbage (1992), although the range is greater, probably due to the larger sample size. In contrast, median concentrations of arsenic, mercury, lead, cadmium, and zinc were 2 to 4 times higher in Lake Union sediments. Lead levels were especially high in Lake Union sediments where median concentrations were elevated above all Salmon Bay/Ship Canal samples. The same pattern can be seen to a lesser degree in data reported by Hileman *et al.* (1984), although their sampling was focused primarily in the vicinity of Gas Works Park and therefore less representative of the entire lake.

Table 6. Comparison of metals concentrations in sediments from Salmon Bay/Ship Canal and Lake Union (mg/Kg, dry).

	As	Hg	Pb	Ni	Cd	Cr	Cu	Zn
SALMON BAY AND SHIP CANAL								
This Study (n=29)								
Range	1.6 - 210	0.01 - 5.0	3.5 - 534	22 - 484	<0.3 - 3.2	14 - 376	7.7 - 2210	27 - 2020
85th Percentile	42	1.6	289	68	1.6	86	671	641
75th Percentile	34	1.1	219	62	1.2	75	516	516
Median	20	0.8	151	48	0.6	60	319	319
Cubbage, 1992 (n=5)								
Range	<20 - 52	0.1 - 1.9	33 - 366	45 - 91	<0.5	48 - 124	51 - 638	87 - 685
Median	29	1.4	163	47	<0.5	66	275	368
LAKE UNION								
Cubbage, 1992 (n=13)*								
Range	<20 - 1150	0.5 - 2.9	124 - 831	37 - 133	<0.5 - 2.3	19 - 113	68 - 599	250 - 904
Median	61	1.7	641	57	1.4	58	310	533
Hileman et al., 1984 (n=33)**								
Range	0 - 284	0.03 - 4.3	28 - 962	47 - 291	0.1 - 2.4	14 - 87	23 - 587	51 - 1058
Median	28	1.1	319	92	1.5	54	168	382

*Does not include four sites in Portage Bay area

**Most samples (24 of 33) were collected within 500 feet of Gas Works Park

Table 7. Comparison of PAH and PCB concentrations in sediments from Salmon Bay/Ship Canal and Lake Union.

	Total PAHs (µg/Kg, dry)	mg PAH/Kg OC	Total PCBs (µg/Kg, dry)	mg PCBs/Kg OC
		SALMON BAY AND SHIP CANAL		
This Study (n=29)				
Range	107 - 84200	107 - 2280	nd - 7600	nd - 146
85th Percentile	38600	1090	868	14.8
75th Percentile	35200	677	420	10.6
Median	27800	489	260	4.8
Cubbage, 1992 (n=5)				
Range	540 - 24300	67 - 587	nd - 240	nd - 5.1
Median	11700	238	210	4.5
		LAKE UNION		
Cubbage, 1992 (n=10 for PAH, 8 for PCB)*				
Range	13600 - 135000	138 - 1120	200 - 640	3.8 - 11.2
Median	22800	353	360	5.4
Hileman et al., 1984 (n=8)**				
Range	nd - 198000	nr	nr	nr
Median	8660	nr	nr	nr

OC=Organic Carbon

*Does not include four sites in Portage Bay area and samples collected within 500 feet of Gas Works Park

**Does not include samples collected within 500 feet of Gas Works Park

nd=not detected

nr=not reported

Organics

Previous studies of Lake Union sediments (Hileman *et al.*, 1984; Cubbage, 1992) have centered around Gas Works Park, the site of a former coal gasification plant which has caused extreme PAH contamination of nearby sediments. Data from sediments collected within 500 feet of Gas Works Park were therefore not included in the comparison of organic compounds shown in Table 7.

Median PAH concentrations in the present study are higher than those previously reported for either the Ship Canal or Lake Union. The relative differences remain consistent when PAHs are compared on an organic carbon-normalized basis, suggesting that differences are not solely due to carbon content of the sediments. Median PCB concentrations show more similarities between studies and waterbodies, although the range of PCB concentrations was much broader than those reported by Cubbage (1992).

Elevated concentrations of butyltins in sediments have been reported in several studies of Puget Sound marinas, including portions of Elliott Bay and Fisherman's Terminal in Salmon Bay. Krone *et al.* (1989a) analyzed sediments from seven areas in Puget Sound for the PSDDA Program and found levels to vary widely based on the proximity to boat maintenance and repair facilities. For instance, sediments collected from an area within the Shilshole Bay Marina moorage area had TBT concentrations of 16 µg/Kg (dry) while sediments from the repair area of the same marina had an average concentration of 8,000 µg/Kg. Fisherman's Terminal was an exception to this contamination pattern with concentrations of TBT in the moorage area higher than those in the boat repair area (1,440 vs. 1,200 µg/Kg, respectively). A non-urban reference area had no measurable level of butyltins (<1 µg/Kg).

Keithly *et al.* (1995) conducted long-term monitoring of TBT in four regions of the country, including Puget Sound. They compared TBT concentrations in sediments representing four site types: commercial harbors, shipyards/drydocks, marinas, and ecologically significant areas. Sample size for each site type ranged from 14 to 18 samples. In Puget Sound, they found shipyard/drydock areas to have the highest mean TBT concentrations in sediments (1,200 µg/Kg, dry), followed by commercial harbors (620 µg/Kg) and marinas (410 µg/Kg). Ecologically significant areas, which were not adjacent to any vessel-related facilities but were within several miles of marinas, had a mean TBT concentration in sediments of 0.4 µg/Kg. These results support the findings of Krone *et al.* (1989a) with respect to TBT levels in relation to the type of activity or facility.

Krone *et al.* (1991) reported a summary of TBT concentrations in fish livers and sediments collected during 1986-1990 as part of the National Benthic Surveillance Project (NBSP), a component of NOAA's National Status and Trends Program. Most of the NBSP samples were collected from urban embayments. Sediments from Elliott

Bay (exact location not specified) had wet weight TBT concentrations of 700 μg/Kg in 1986, declining to 300 μg/Kg in 1990. These were the highest TBT concentrations found in any of the 23 NBSP sample locations nationwide, although the reporting of these concentrations on a wet weight basis limits their comparability among NBSP stations. Wet weight TBT concentrations in the present study ranged from non-detectable levels to 1,730 μg/Kg, with a median value of 106 μg/Kg. Krone *et al.* (1991) also found TBT to be the predominant butyltin, accounting for more than 50% of the total butyltin concentration in most areas. This pattern was also observed by Krone *et al.* (1989) and Keithly *et al.* (1995), and is consistent with the findings reported here.

Conclusions

- Results of this study indicate there are no clear areal gradients throughout Salmon Bay for any of the chemicals analyzed. Instead, local conditions and sources appeared to be the major determinant with respect to chemical concentrations.

- The most contaminated stations were 1B and 8C, located in the northernmost portion of Salmon Bay, and 4F in the Fisherman's Terminal area. Arsenic, mercury, lead, cadmium, zinc, and tributyltin (TBT) concentrations in sediments from these stations were the highest or among the highest of all 29 stations sampled.

- The cleanest stations were 5B, 7C, and 8B, located in the central, eastern, and western portions of the study area, respectively. With one possible exception, there is also a lack of gradation or geographical pattern with respect to clean sediments. However, the cleanest area appears to be at the terminus of the Ship Canal in the easternmost section of Salmon Bay.

- Dividing the study area into zones based on major areas of concern and/or natural geographical features did not generally yield within-zone samples with similar contaminant concentrations. There was no statistically significant difference among zones for metals, total PAH, total PCB, or TBT concentrations.

- Based on comparisons to freshwater sediment quality guidelines and marine sediment quality standards, contaminated sediments from all but three sample stations in Salmon Bay can be expected to have some degree of adverse impact on benthic organisms. Of the 29 stations sampled, 23 have two or more chemicals expected to cause adverse impacts, and 21 stations have three or more chemicals expected to cause adverse impacts.

- Tributyltin probably poses the most serious threat to aquatic life in Salmon Bay due to its toxicity and high concentrations in sediments. All but five sample stations exceeded the Puget Sound Dredged Disposal Analysis Program sediment screening level (SL) for TBT. Median TBT concentrations (326 µg/Kg) were four and one-half times the SL, and 30% of the sample stations had TBT concentrations elevated one-to-two orders of magnitude above the SL.

- Chemicals other than TBT likely to harm aquatic life at one or more stations include copper, mercury, arsenic, lead, nickel, zinc, chromium, benzyl alcohol, 4-methylphenol, bis(2-ethylhexyl)phthalate, benzo(g,h,i)perylene, indeno(1,2,3-c,d)pyrene, 1,4-dichlorobenzene, and PCB-1260.

- In Salmon Bay there is mixed evidence that combined sewer overflow (CSO) discharges account for a substantial portion of the contamination. Half of the stations adjacent to the five CSO outfalls had high concentrations of metals, PAHs, and bis(2-ethylhexyl)phthalate normally found in stormwater and CSO discharges, yet other stations located near the CSO outfalls had relatively low-to-moderate levels of these compounds.

- Proximity of sample stations to marinas, boat repair facilities, marine terminals (including Fisherman's Terminal), shipyards, or vessel-related facilities alone did not appear to dictate concentrations of TBT. Instead, high TBT concentrations in sediments can probably be traced to individual facilities which do a poor job of containing paints, scrapings, and sand-blast grit on-site. Stations 1B and 4F appear to be two examples. Sediments from these stations had the highest TBT concentrations and the history of nearby facilities indicate they have poor "housekeeping" and containment practices. Stations located near vessel-related facilities were, however, more likely to have high metals concentrations.

- Observations made during sample collection, especially of heavy oil sheen and petroleum odor, may provide the best indicators of noteworthy PAH and/or PCB contamination in sediments.

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Appendices

APPENDIX A

RESULTS OF PHASE I STUDY

Phase 1 Review

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office, 3190 - 160th Ave S.E. • Bellevue, Washington 98008-5452 • (206) 649-7000

July 14, 1995

To Interested Persons:

Provided with this letter are the results from Phase I sampling of Salmon Bay and the Ship Canal area by Ecology in April, 1995. Included is a map of stations, a table of station locations, and station logs describing landmarks, water depth, sediment type, evidence of contamination, and any aquatic life present in the sediments.

These station descriptions were used in narrowing down the study area and in selecting stations for Phase II sampling and laboratory analysis. Phase II sampling was completed during the last week of June, and samples have been sent to the Ecology laboratory. Due to the time required to analyze the samples, perform quality assurance, and write up the results, results from Phase II sampling may not be available until December of 1995. You have been placed on a mailing list for the data and will automatically receive this report once it is available. Phase II results will be used to select stations for Phase III sampling and biological testing to determine the toxicity of sediments. This work will likely take place sometime next spring.

When reviewing the station logs, keep in mind that not all contamination is visible, and only what could be seen was recorded. Metals contamination, in particular, is hard to identify by visual inspection. This is one reason that these areas are being resampled for chemical analysis. However, the presence of paint chips and metal debris is one indicator that metals contamination may be present.

Oily contamination of the samples was recorded as high/heavy, medium/moderate, light/low, and very light. Very light oil means that very small droplets of oil could be seen. Most sediment from urban areas would meet this description. Light oil means that larger droplets were present, mainly on the surface of the sample. Medium oil means that oil patches were present throughout the sample and that a sheen could be seen on water from the sample. Heavy oil means the the sample was thoroughly contaminated with oil or free product was present. A notation that "organic matter" was present may be an indication that sewage or other organic wastes are present, but it is usually not possible to identify specifically without analysis.

In general, areas along the shorelines were more heavily contaminated than areas in the center channel. Areas west of Ballard Bridge were typically more contaminated than areas east of Ballard Bridge, with some exceptions. The southern shoreline near the locks appeared relatively clean, as did areas east of Ballard Bridge along the main channel of the Ship Canal. Sediments high in silt and organic matter generally also had the most oil.

Thank you for your interest in the Salmon Bay Study. If you have any questions on the information provided, please contact me at 649-7257.

Sincerely,

T. Mich

Dr. Teresa Michelsen
Sediment Cleanup Specialist

STATION LOCATIONS

Station	Water Depth (feet)	Latitude (degrees/minutes)	Longitude (degrees/minutes)
0	25	47° 39.510	122° 22.596
1	24	47° 40.014	122° 23.357
2	18	47° 39.959	122° 23.601
3	18	47° 39.991	122° 23.448
4	24	47° 39.958	122° 23.379
5	21	47° 39.985	122° 23.239
6	19	47° 39.910	122° 23.698
7	52	47° 39.899	122° 23.559
8	30	47° 39.910	122° 23.483
9	31	47° 39.897	122° 23.361
10	26	47° 39.891	122° 23.250
11	19	47° 39.909	122° 23.137
12	18	47° 39.843	122° 23.568
13	16	47° 39.858	122° 23.359
14	44	47° 39.827	122° 23.242
15	35	47° 39.831	122° 23.144
16	15	47° 39.825	122° 23.036
17	35	47° 39.739	122° 23.122
18	41	47° 39.766	122° 23.029
19	36	47° 39.753	122° 22.898
20	26	47° 39.685	122° 22.913
21	20	47° 39.714	122° 22.807
22	33	47° 39.604	122° 22.810
23	29	47° 39.621	122° 22.657
24	28	47° 39.637	122° 22.588
25	10	47° 39.632	122° 22.451
26	17	47° 39.622	122° 22.367
27	19	47° 39.601	122° 22.257
28	31	47° 39.542	122° 22.812
29	26	47° 39.565	122° 22.701
30	17	47° 39.557	122° 22.570
31	14	47° 39.546	122° 22.481
32	30	47° 39.551	122° 22.323
33	30	47° 39.546	122° 22.251
34	17	47° 39.534	122° 22.138
35	21	47° 39.468	122° 22.807
36	16	47° 39.455	122° 22.689
37	24	47° 39.460	122° 22.528
38	23	47° 39.473	122° 22.353
39	32	47° 39.476	122° 22.145

Station	Water Depth (feet)	Latitude (degrees/minutes)	Longitude (degrees/minutes)
40	17	47° 39.448	122° 22.003
41	15	47° 39.389	122° 22.809
42	15	47° 39.372	122° 22.683
43	16	47° 39.375	122° 22.565
44	29	47° 39.435	122° 22.005
45	6	47° 39.372	122° 22.121
46	16	47° 39.365	122° 22.012
47	33	47° 39.352	122° 21.899
48	22	47° 39.281	122° 21.806
49	26	47° 39.247	122° 21.700
50	9.5	47° 39.216	122° 21.835
51	12	47° 39.187	122° 21.656
52	30	47° 39.210	122° 21.618
53	33	47° 39.123	122° 21.463
54	36	47° 39.028	122° 21.266
55	36	47° 38.967	122° 21.154
56	36	47° 38.908	122° 21.007
57	38	47° 38.841	122° 20.858
58A	24	47° 39.284	122° 21.844
58B	24	47° 39.278	122° 21.861
59	25	47° 39.310	122° 22.007
60	23	47° 39.289	122° 21.958
61	22	47° 39.364	122° 21.868
62	10	47° 39.427	122° 21.940
63	20	47° 39.456	122° 22.423
64	16	47° 39.363	122° 22.532
65	------	------	------
66	16	47° 39.664	122° 22.574
67	20	47° 39.572	122° 22.847
68	8	47° 39.673	122° 22.962
69	36	47° 39.727	122° 23.046
70	15	47° 39.809	122° 22.874
71	13	47° 39.879	122° 22.955
72	17	47° 39.881	122° 23.050
73	16	47° 39.798	122° 23.270
74	18	47° 39.843	122° 23.465
75	------	------	------
76	16	47° 40.042	122° 23.293
77	8	47° 40.025	122° 23.505
78	18	47° 39.963	122° 23.653
79	8.5	47° 39.835	122° 23.648
80	14	47° 39.436	122° 22.869

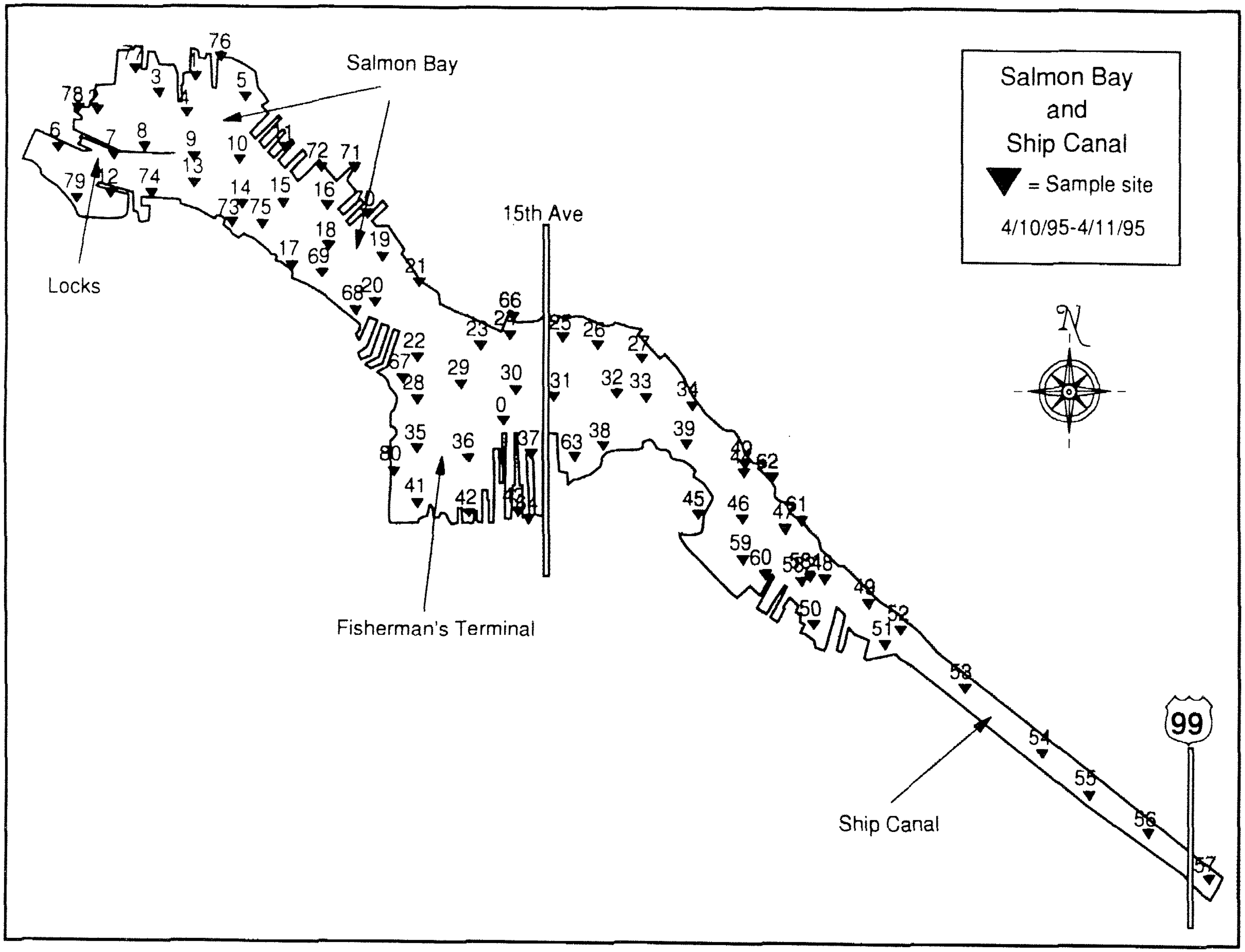

Figure 1. Sample sites for preliminary examination of sediments.

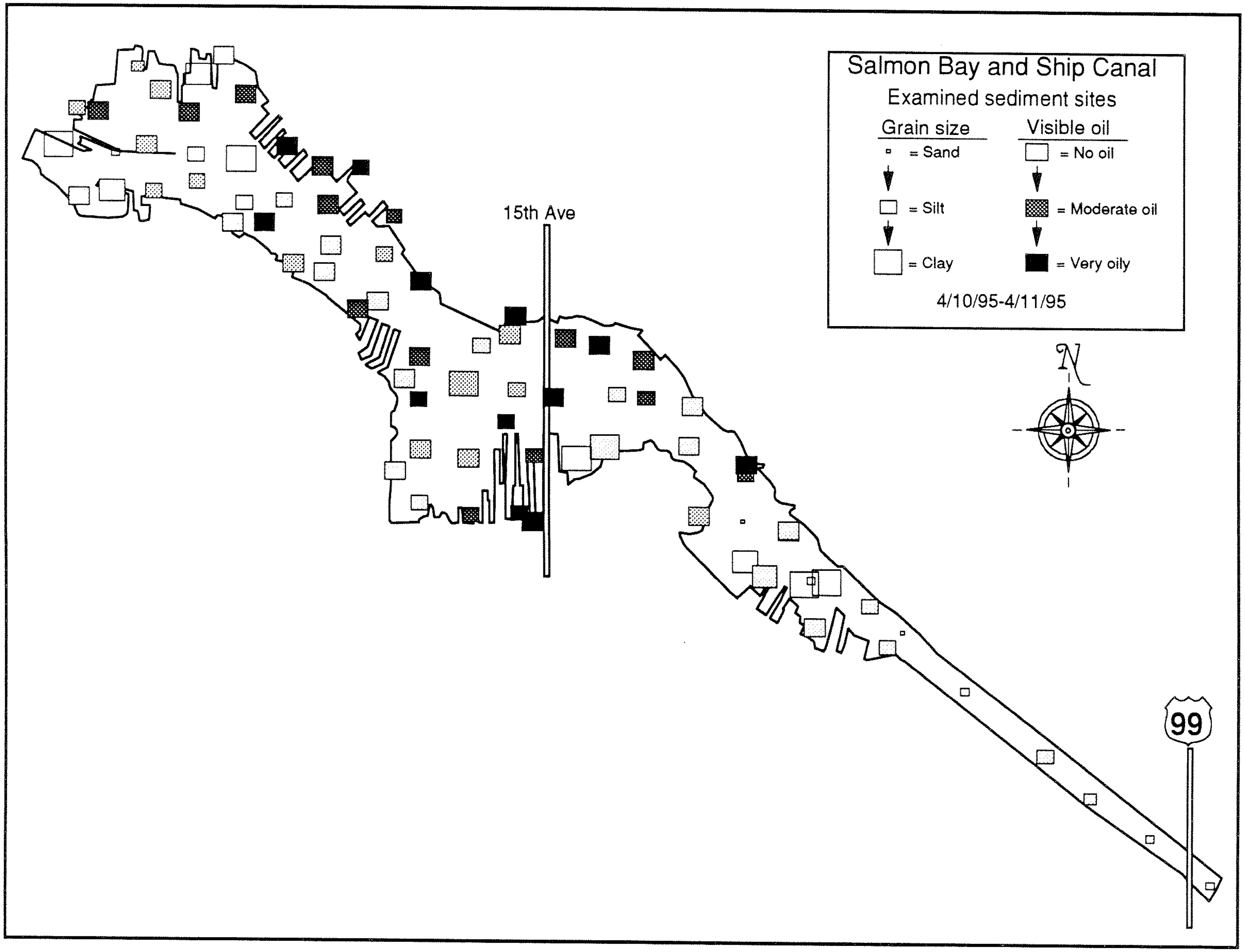

Figure 2. Results of visual inspection of sediment condition during Phase I

STATION LOG - SALMON BAY STUDY, PHASE I

STATION 0

Landmarks Near end of fuel dock at Fisherman's Terminal

Water Depth (feet) 25

Sediment Description 2 cm brown silty sand over black oily silt

Evidence of Contamination Moderate/high oil, some paint chips

Aquatic life. Tubeworms

STATION 1

Landmarks: At end of Mobile fuel dock

Water Depth: 24

Sediment Description: Thin oxidized layer on grey sandy clay

Evidence of Contamination: Metal and wood debris, no visible oil

STATION 2

Landmarks: N of locks, near west shore

Water Depth: 18

Sediment Description: Grey/black silt over grey clay

Evidence of Contamination: Moderate oil

STATION 3

Landmarks: In marina north of barge (5320 28th NW)

Water Depth: 18

Sediment Description. Brown silt over black silt

Evidence of Contamination Low/medium oil, slight petroleum odor

STATION 4

Landmarks W end of Pacific Fishermen

Water Depth 24

Sediment Description Brown/green silt over black sandy silt

Evidence of Contamination Moderate oil

STATION 5

Landmarks Just S of 24th Ave landing dock near Yankee Diner

Water Depth 21

Sediment Description. Brown silt over black sandy silt

Evidence of Contamination Moderate oil, slight petroleum odor

STATION 6

Landmarks: Near yellow end of concrete wall at locks

Water Depth: 19

Sediment Description: Grey-brown clay

Evidence of Contamination: None

STATION 7

Landmarks: S of locks wing wall, E of blue sign

Water Depth: 52

Sediment Description: Brown sand

Evidence of Contamination: None

Aquatic Life Large clumps of saltwater mussels, aquatic plants

STATION 8

Landmarks N of Army Corps barges at lock wall

Water Depth 30

Sediment Description Brown silt over black silt

Evidence of Contamination Rocks, wood

STATION 9

Landmarks: NE of end of lock wall

Water Depth: 31

Sediment Description: Grey/brown silty sand

Evidence of Contamination: Wood chips

STATION 10

Landmarks: S of Stimson Marina

Water Depth: 26

Sediment Description: Grey clay

Evidence of Contamination: None

STATION 11

Landmarks: Stimson Marina between rows C&D, halfway in

Water Depth: 19

Sediment Description: Brown sandy silt over black sandy silt

Evidence of Contamination: Low/moderate oil

STATION 12

Landmarks Inside Time Oil dock near manifold

Water Depth 18

Sediment Description Brown clayey silt

Evidence of Contamination Very little oil

STATION 13

Landmarks: E of Maritime Industrial Center, nearshore

Water Depth 16

Sediment Description Brown silt over black silty sand

Evidence of Contamination Low/moderate oil, lots of paint chips, wood

STATION 14

Landmarks: Between Anderson dry dock and Stimson Marina

Water Depth: 44

Sediment Description: Brown silt over black silty sand, some gravel

Evidence of Contamination: Low oil

STATION 15

Landmarks: Between Maney Seafoods (?) and Stimson Marina, mid-channel

Water Depth: 35

Sediment Description: Brown silt over black sandy silt

Evidence of Contamination: Low oil, wood chunks

Aquatic Life: Tube worms

STATION 16

Landmarks Just E of gravel dock

Water Depth 15

Sediment Description Thin brown layer over black silt

Evidence of Contamination Moderate oil, paint flecks, organic matter

STATION 17

Landmarks W of Marco along shoreline

Water Depth 35

Sediment Description: Brown silt over black sandy silt

Evidence of Contamination: low/moderate oil, plastic, algae

STATION 18

Landmarks: Mid-channel between Marco and Canal Marina

Water Depth: 41

Sediment Description: Brown silt over black sandy silt

Evidence of Contamination: Droplets of oil, organic matter

STATION 19

Landmarks: Just W of Seaview Marina, center of large moored ships

Water Depth: 36

Sediment Description: Green/black silty sand

Evidence of Contamination: Low/moderate oil, lots of wood debris, paint chips

STATION 20

Landmarks: Just N of Salmon Bay Marina

Water Depth: 26

Sediment Description: Brown silt over black silt

Evidence of Contamination: Low oil

STATION 21

Landmarks: Seaview Marina entrance

Water Depth: 20

Sediment Description: Brown silt over black sandy silt

Evidence of Contamination: Moderate oil, paint chips, wood fragments, rocks

STATION 22

Landmarks: Between NWII North Pier and leased dock, halfway in

Water Depth: 33

Sediment Description: Thin brown silt over black silt

Evidence of Contamination: Moderate oil

STATION 23

Landmarks: S of pallet storage, center channel

Water Depth: 29

Sediment Description: Brown layer over black silty sand

Evidence of Contamination: Low oil, wood debris

Aquatic Life: Tube worms

STATION 24

Landmarks Northshore north of E end of Fisherman's Terminal

Water Depth 28

Sediment Description Brown silt over black silt

Evidence of Contamination. Low/moderate oil, organic debris

STATION 25

Landmarks: S of Maritime Training Center, E of Ballard Bridge

Water Depth: 10

Sediment Description. Grey/black silt

Evidence of Contamination: Moderate oil, lots of wood debris, high organic content

STATION 26

Landmarks: S of Community College

Water Depth: 17

Sediment Description: Grey-green silt

Evidence of Contamination: Low/moderate oil, lots of organic matter, wood

STATION 27

Landmarks: S of Duncan Engine Co.

Water Depth: 19

Sediment Description: Grey/brown silt over dark grey silt

Evidence of Contamination: Medium oil, organic matter

STATION 28

Landmarks Just S of E/W Pier, Fisherman's Terminal

Water Depth 31

Sediment Description Brown sand over black silty sand

Evidence of Contamination: Medium/high oil, metals debris

STATION 29

Landmarks: N of 325' marker on E/W Pier, Fisherman's Terminal

Water Depth: 26

Sediment Description: Light grey clay

Evidence of Contamination: Low/moderate sheen

STATION 30

Landmarks: Mid-channel W of Ballard Bridge

Water Depth: 17

Sediment Description: Brown silty sand over grey clay

Evidence of Contamination: Low oil, wood debris

STATION 31

Landmarks: E of Ballard Bridge near S shore

Water Depth: 14

Sediment Description: Brownish-black silty sand

Evidence of Contamination: Medium oil

STATION 32

Landmarks Mid-channel N of Salmon Bay Terminal

Water Depth 30

Sediment Description Black/brown silty sand

Evidence of Contamination Light oil, lots of wood debris, organic matter

STATION 33

Landmarks: S of Canal Boatyard in channel

Water Depth: 30

Sediment Description Black/brown sandy silt

Evidence of Contamination: Light/medium oil

STATION 34

Landmarks: E end of Canal Boatyard

Water Depth: 17

Sediment Description: Green-black silt

Evidence of Contamination: Light oil, paint chips, wood chunks

STATION 35

Landmarks: Between end of Piers 9&10 Fisherman's Terminal

Water Depth: 21

Sediment Description: Brown silt over black silt, some brown clay

Evidence of Contamination: Light/moderate oil, metal debris, organic matter, wood

STATION 36

Landmarks At ends of docks 7&8, Fisherman's Terminal

Water Depth 16

Sediment Description Brown sandy silt over black sandy silt

Evidence of Contamination Light/moderate oil

STATION 37

Landmarks Fisherman's Terminal E side

Water Depth 24

Sediment Description Brown/grey silt

Evidence of Contamination: Moderate oil, organic matter

STATION 38

Landmarks: E end of Salmon Bay Terminal

Water Depth: 23

Sediment Description: Brown clay

Evidence of Contamination: Light oil, wood debris

STATION 39

Landmarks: N of WA Fish & Oyster

Water Depth: 32

Sediment Description: Brown sandy silt over black sandy silt

Evidence of Contamination: Light oil, wood chips, organic matter

STATION 40

Landmarks Off Union Bay Shipbuilding pier

Water Depth 17

Sediment Description Grey/black silt

Evidence of Contamination Heavy oil, organic matter

STATION 41

Landmarks: Nearshore between Piers 9&10, Fisherman's Terminal

Water Depth: 15

Sediment Description: Brown silty sand

Evidence of Contamination: Light oil, some organic matter

STATION 42

Landmarks: Between docks 7&8 nearshore

Water Depth: 15

Sediment Description: Brown sandy silt over black silt and grey clay

Evidence of Contamination: Moderate oil

STATION 43

Landmarks: Fishing Vessel Owner's Marine Ways Inc, near bulkhead

Water Depth: 16

Sediment Description: Grey/black silt, some brown clay

Evidence of Contamination: Heavy oil, paint chips

STATION 44

Landmarks S of Union Bay Shipbuilding in channel

Water Depth 29

Sediment Description Light brown sand over organic black silt

Evidence of Contamination Medium oil, wood debris

STATION 45

Landmarks Just E of LeClerq Marina near shoreline

Water Depth 6

Sediment Description Brownish black silt

Evidence of Contamination: Medium oil, hydrogen sulfide odor, lots of organic matter

STATION 46

Landmarks: S of Trident, NW of Foss, near dolphins

Water Depth: 16

Sediment Description: Gravel

Evidence of Contamination: Wood chips

STATION 47

Landmarks: S of Trident, N of Foss

Water Depth: 33

Sediment Description: Gravel over silty black sand w/light grey clay

Evidence of Contamination: Light oil

STATION 48

Landmarks: Between Foss Tug and Empire Alaska Seafoods

Water Depth: 22

Sediment Description: Light grey clay

Evidence of Contamination: None

STATION 49

Landmarks: S of Flohr Metal Fabricators

Water Depth: 26

Sediment Description: Brown sand and gravel over black silty sand

Evidence of Contamination: Light oil

STATION 50

Landmarks: Foss near S shoreline

Water Depth: 9.5

Sediment Description: Brown silty sand over black silt

Evidence of Contamination: Light oil

STATION 51

Landmarks: Just inside marina

Water Depth: 12

Sediment Description: Brown sand over black sandy silt

Evidence of Contamination: Light oil

STATION 52

Landmarks: S of gravel plant, N of W end of Metro lab

Water Depth: 30

Sediment Description: Gravel

Evidence of Contamination: None

STATION 53

Landmarks: S of Prolab, N of E end of park

Water Depth: 33

Sediment Description: Brown sand, shell, gravel

Evidence of Contamination: None

STATION 54

Landmarks: S of grey building, N of office buildings

Water Depth: 36

Sediment Description: Brown sand over black silt

Evidence of Contamination: Very light oil

STATION 55

Landmarks: Between electric towers near Red Hook Brewery

Water Depth: 36

Sediment Description: Brown sand over grey silt

Evidence of Contamination: very light oil, some wood debris

Aquatic Life: Small freshwater mussels and clams

STATION 56

Landmarks S of center of brown warehouse. N of cinderblock wall

Water Depth 36

Sediment Description Brown and grey sand w/pebbles

Evidence of Contamination Very light oil

STATION 57

Landmarks Just E of Fremont bridge, center channel

Water Depth 38

Sediment Description Brown and grey sand, some gravel

Evidence of Contamination: Very light oil

STATION 58A

Landmarks: E of Foss drydocks nearshore

Water Depth: 24

Sediment Description: Grey and brown sand and gravel

Evidence of Contamination: Paint chips and metal debris

STATION 58B

Landmarks: Offshore of 58A near moored tugs

Water Depth: 24

Sediment Description: grey and brown gravel over light grey clay

Evidence of Contamination: Paint chips and metal debris

STATION 59

Landmarks Between Foss drydocks 1&2

Water Depth 25

Sediment Description Medium grey clay w/gravel

Evidence of Contamination: None

STATION 60

Landmarks W of Foss drydocks near shoreline

Water Depth 23

Sediment Description Brown sand over light grey clay

Evidence of Contamination Very light oil

STATION 61

Landmarks: Just off Trident Seafoods, W end of grey bulkhead

Water Depth: 22

Sediment Description: Gravel and cobble

Evidence of Contamination: Wood and metal debris

STATION 62

Landmarks: Just W of Trident along shoreline

Water Depth: 10

Sediment Description: Riprap and gravel

Evidence of Contamination: Couldn't get a sample

STATION 63

Landmarks: Salmon Bay Terminal near center of bulkhead

Water Depth: 20

Sediment Description: Grey clay, shells

Evidence of Contamination: Blackened wood

STATION 64

Landmarks: Under Ballard Bridge near S shore

Water Depth: 16

Sediment Description: Brown/black silty clay

Evidence of Contamination: High oil, organic matter

STATION 65

Not Collected

STATION 66

Landmarks: W end of Ballard Bridge near marina on N shore

Water Depth: 16

Sediment Description: Brown/black silt

Evidence of Contamination: Heavy oil

STATION 67

Landmarks: Salmon Bay Boatyard just N of E/W Pier

Water Depth: 20

Sediment Description: Brown silt over black silt

Evidence of Contamination: Light oil

STATION 68

Landmarks E end of Marco

Water Depth 8

Sediment Description Brown silt over black sandy silt

Evidence of Contamination Moderate oil, organic matter

Aquatic Life Aquatic plants

STATION 69

Landmarks Just E of Marco drydocks

Water Depth: 36

Sediment Description Brown silt over black silt

Evidence of Contamination Light oil

STATION 70

Landmarks: E end of Canal Marina near shoreline

Water Depth: 15

Sediment Description: Brown silt over black sandy silt

Evidence of Contamination: Moderate oil

STATION 71

Landmarks: Near Standard Marina

Water Depth: 13

Sediment Description: Black silty sand

Evidence of Contamination Moderate/high oil, rope, debris, plastic, wood

STATION 72

Landmarks W of gravel dock near shoreline, Stimson Marina

Water Depth 17

Sediment Description Brown silt over black silt

Evidence of Contamination: Moderate oil

STATION 73

Landmarks: W of Anderson drydock nearshore

Water Depth: 16

Sediment Description: Brown/black sandy silt

Evidence of Contamination: Light oil

STATION 74

Landmarks: Offshore of Time Oil, Maple Bay Boat Co.

Water Depth: 18

Sediment Description: Grey silty sand

Evidence of Contamination: Light/moderate oil, wood debris, paint chips

STATION 75

Not Collected

STATION 76

Landmarks: Just E of Yankee Diner at shoreline

Water Depth: 16

Sediment Description: Black silt

Evidence of Contamination: Moderate/heavy oil, petroleum odor, wood chunks, plastic

STATION 77

Landmarks Sea & Shore Construction (5355 28th NW)

Water Depth 8

Sediment Description Black sand

Evidence of Contamination: Light/moderate oil, lots of paint chips

STATION 78

Landmarks: Near Corps carpenter shop at locks

Water Depth: 18

Sediment Description: Black sandy silt

Evidence of Contamination: Light/moderate oil, wood chips, rocks

STATION 79

Landmarks: Lockhaven Marina E side

Water Depth: 8.5

Sediment Description: Thin brown silt over black sandy silt

Evidence of Contamination: Light oil

Aquatic Life: Aquatic plants

STATION 80

Landmarks: W bulkhead of Fisherman's Terminal near 175' mark

Water Depth: 14

Sediment Description: Green sandy silt

Evidence of Contamination: light oil, chunks of wood fibers

APPENDIX B

DESCRIPTION OF SAMPLE STATIONS

Table B-1. Description of sample stations for Phase II.

Station:	Sample No.	Date and Time	Depth (ft)	Latitude (47-)	Longitude (122-)	Remarks
1A	8230	6/26/96 14:25	18	39.958	23.367	
1B	8231	6/26/96 14:47	20	40.010	23.225	west side of Ballard dock near CSO 152
1C	8232	6/26/96 15:11	19	39.911	23.148	between boathouse C&D
2A	8233	6/26/96 15:31	29	39.835	23.000	off Chevron dock
2B	8234	6/26/96 16:08	24	39.830	22.901	off CSO
2C	8235	6/26/96 16:22	20	39.749	22.869	
3A	8236	6/26/96 12:08	16	39.892	23.740	
3B	8237	6/26/96 12:20	17	39.836	23.576	Time Oil dock
3C	8238	6/26/96 12:40	36	39.772	23.125	
4A	8239	6/26/96 16:37	33	39.614	22.811	east of first main dock
4B	8240	6/27/96 10:25	13	39.649	22.580	
4C	8241	6/27/96 9:14	21	39.489	22.841	
4D	8242	6/27/96 10:00	21	39.512	22.588	off fuel dock
4E	8243	6/27/96 9:41	14	39.408	22.735	4th slip from west-halfway down
4F	8244	6/27/96 10:12	24	39.429	22.538	
5A	8245	6/26/96 11:56	45	39.871	23.326	
5B	8246	6/26/96 11:40	28	39.656	22.747	
5C	8247	6/26/96 11:29	30	39.558	22.342	
6A	8248	6/27/96 11:06	14	39.621	22.345	
6B	8249	6/27/96 12:34	16	39.516	22.113	
6C	8250	6/27/96 10:44	18	39.485	22.412	
6D	8251	6/27/96 10:22	20	39.488	22.241	Ocean Beaty Seafoods
7A	8252	6/27/96 13:15	17	39.446	22.001	Union Bay Shipbuilders
7B	8253	6/27/96 13:40	22	39.305	21.990	west side of Foss
7C	8254	6/27/96 14:48	23	39.260	21.855	
7D	8255	6/27/96 14:40	33	39.257	21.728	
8A	8256	6/26/96 13:29	18	39.969	23.630	
8B	8257	6/26/96 13:43	18	40.021	23.520	
8C	8258	6/26/96 14:02	18	39.998	23.466	

APPENDIX C

ANALYTICAL METHODS

Table C-1. Analytical methods used for Phase II.

Analysis	Method	Reference	Target Detection Limit
Total organic carbon (TOC)	PSEP Method	EPA, 1986a	
Grain size	ASTM D-422		
% Solids	Gravimetric - EPA Method 160.3	EPA, 1986b	
Arsenic	GFAA - EPA Method 206.2	EPA, 1986b	1 mg/Kg
Cadmium	ICAP - EPA Method 200.7	EPA, 1986b	1 mg/Kg
Chromium	ICAP - EPA Method 200.7	EPA, 1986b	1 mg/Kg
Copper	ICAP - EPA Method 200.7	EPA, 1986b	1 mg/Kg
Mercury	CVAA - EPA Method 245.5	EPA, 1986b	0.1 mg/Kg
Lead	ICAP - EPA Method 200.7	EPA, 1986b	1 mg/Kg
Nickel	ICAP - EPA Method 200.7	EPA, 1986b	1 mg/Kg
Zinc	ICAP - EPA Method 200.7	EPA, 1986b	1 mg/Kg
Semivolatile organics	GC/MS - EPA Method 8270	EPA, 1986b	100 µg/Kg
PCBs	GC/EC - EPA Method 8080	EPA, 1986b	50 µg/Kg
Butyltins	GC/MS - NOAA Method	Krone *et al*., 1989b	20 µg/Kg

APPENDIX D

QA/QC RESULTS

DEPARTMENT OF ECOLOGY

July 18, 1996

TO: Stewart Lombard, QA Section

FROM: Dave Serdar, Toxics Section

SUBJECT: Review of Salmon Bay Data

Stew, thanks for agreeing to take a look at the Salmon Bay data. I've enclosed the entire data package for the project as well as a copy of our draft report. The draft report has a digestion of the QA results in Appendix D and a discussion of data quality on pages 11-13. There is also a comparison to acceptance limits for QA1 review in Table 1.

The major concerns about the data quality are as follows:

- The holding time requirements for TOC were exceeded by 28 days. Semivolatiles and PCBs were extracted seven days after the holding time limit of 14 days. Butyltins were not extracted until seven weeks after collection, although they were held frozen during that time.

- There were some problems with the butyltin analysis. The low precision resulting from analysis of field splits may have been due to the presence of paint chips which would yield non-homogeneous samples (see Table D-3 of the draft report). Recovery of TBT in the Sequim Bay Reference material and matrix spikes were also poor (see Tables D-1 and D-2 in draft report and the Manchester case narrative for butyltins).

- About one-third of the PAH reference material analyses were outside the acceptable recovery windows (see Table D-2).

- Matrix spike recoveries for mercury, lead, and chromium were outside the acceptance windows (see Table D-1 and Manchester case narrative).

- I'm also wondering if the data should have additional flags or qualifiers.

As I mentioned during our phone conversation, I'd like to shoot for a turnaround time of no longer than one month. I know that time has become especially valuable these days so again, I appreciate your help. Let me know if you have any questions. My number is 407-6772.

DS:jl

DEPARTMENT OF ECOLOGY
ENVIRONMENTAL INVESTIGATIONS AND LABORATORY SERVICES PROGRAM

August 30, 1996

TO: Dave Serdar
Toxics Investigations Section

THROUGH: Cliff Kirchmer
QA Section Manager

FROM: Stewart Lombard
QA Section

SUBJECT: Salmon Bay Sediments Data QC

I have reviewed your report and the analytical data reports and case narratives for the Salmon Bay sediments study. I have attempted to address below the concerns which you expressed in your cover memo.

Failure to meet sample preservation and holding time specifications compromises the representativeness, comparability and accuracy of the analytical results. Organic compounds in sediment samples are subject to volatilization, oxidation and biodegredation during storage.

The samples for TOC analysis were not preserved according to the PESP protocol. There is no way to determine whether the results are actually affected by the sample storage procedures. The analytical procedure includes drying the samples at 70°C and treating them with acid. Obviously, the results are not intended to include volatile compounds or those susceptible to acid hydrolysis.

I recommend qualifying the organic carbon and carbon-normalized results because of the non-standard storage procedure. However, I think that the TOC results are suitable for the purpose of comparing carbon-normalized results for organic contaminants to sediment criteria. Obviously, when the results are close to the criteria, you can not determine from these data whether the criteria have been exceeded.

I agree with the conclusion in the report that PCBs and PAHs are among the more stable organic contaminants and the results for these compounds are probably not affected significantly by the extended holding times.

The analytical quality control results for the PAH analyses reflect the inherent variability in this determination. The recoveries for the D10-pyrene surrogate for the 31 samples ranged from 63 to 92% with a mean of 82% and standard deviation of 6.5%. The D10-pyrene surrogate is not included in Method 8270, so there are no specified recovery limits for it. To the extent that this surrogate is representative of the 16 PAH compounds, these data suggest that the analytical system was in good control.

The median values of the matrix spike recoveries for the 16 PAH compounds were 88% (Range = 69% to 120%) and 90.5% (Range = 74% to 130%) for the two spiked samples, respectively. These are good results for organic matrix spikes.

Relative to the certified values, the median value of the "recoveries" for 15 of the 16 PAHs in the reference sediment (calculated from the means of the duplicate results) is 100% with a range of 72% to 155%. These results also suggest that the analytical system was in good control. The results for acenaphthylene are a problem. You may wish to discuss them with the analyst. I hesitate to recommend qualifying any results for the project sediment samples on the basis of this single apparent anomaly in the results for the reference sediment.

The Relative Standard Deviations (RSD) for the PAH results for the two pairs of field split samples range from 0 to 40% with a median value of 7.4%. I consider that to be good precision. I wonder how much variability true field replicates would have exhibited.

The situation with the mercury results is unfortunate. Since the second matrix spike/matrix spike duplicate pair did not produce useable results, we are left with just one pair of spike results, one of which is very high. The other QC results for the mercury analyses indicate that the system was in good control. The recoveries for the laboratory control samples (LCS) are 92% and 93%, the method blanks produced no measurable response and the agreement between the field split results for the two duplicate pairs is excellent, 1.3% and 4.5% RSD, respectively. I do not recommend qualifying your mercury results on the basis of a single matrix spike recovery. The method specifies that, if any results are to be qualified solely on the basis of MS/MSD recoveries, only the results for the sample used for the MS/MSD ought to be qualified.

The QC data for chromium and lead do indicate a negative bias, but there is not sufficient data to quantify that bias. The recoveries for the two laboratory control samples (LCS) are 79% and 81% for chromium and both are 85% for lead. The recoveries for the two MS/MSD pairs for chromium are 79% and 85%, 69% and 74%. The recoveries for lead were not calculated for the first pair and were 65% and 66% for the second. The two method blank results showed no measurable levels of either chromium or lead and the results for the two pairs of field split samples showed good agreement (all less than 10% RSD).

These QC data indicate good precision for chromium and lead results and the possibility of a negative bias of, perhaps, 20% to 40%.

The organo-tin results are certainly of concern. There is a preponderance of evidence that organo-tin compounds are present at significant levels in most of the sediment samples. Your conclusion that organo-tin compounds are the major contaminant of concern in Salmon Bay sediments is justified. However, the QC results indicate that the analytical system was not in good control with these samples and these results should not be used as the basis for any comparisons to criteria or to other data.

I am concerned about some of the entries in Table 1 of your report. The table indicates that the surrogate recovery target of >50% was achieved for 96% of the butyltin results. By my calculations, surrogate recoveries for the original extracts of 21 of the 31 samples were between 50% and 200%. The case narrative states that surrogate recoveries over 200% were due to chromatographic interference. I think it is deceptive to indicate that surrogate recoveries were satisfactory for 96% of the butyltin results.

The PSEP protocols recommend freezing samples for organo-tin analyses within 24 hours of collection and does not specify a holding time. Therefore, I don't think it is justified to indicate in Table 1 that 0% of the butyltin samples met holding time requirements.

I hope these comments are helpful to you. Let me know if you have any questions. I would be happy to discuss any specific issues with these data in more detail.

SML:sml

cc: Larry Goldstein
Bill Kammin

State of Washington Department of Ecology
Manchester Environmental Laboratory
7411 Beach Dr. East Port Orchard WA. 98366

July 261995

Project: Salmon Bay

Samples: 26-8230-8258, 26-8260-61

Laboratory: Soil Technology

By: Pam Covey

Case Summary

The ~~Sound Refining~~ samples required thrirty one (31) Grain Size analyses on sediment using ASTM D-422 modified with wet preparation.

These samples were received at the Manchester Environmental Laboratory on June 28, 1995 and transported to Soil Technology on June 29, 1995 for Grain Size analyses. These analyses were reviewed for qualitative and quantitative accuracy, validity and usefullness.

The results are acceptable for use as reported.

State of Washington Department of Ecology
Manchester Environmental Laboratory
7411 Beach Dr. East Port Orchard WA. 98366
August 8, 1995

Project: **Salmon Bay/Ship Canal**

Samples: 268230 through 268261

Laboratory: Weyerhaeuser Analytical and Testing Services 18303

By: Karin Feddersen KF

These samples were received at the Manchester Environmental Laboratory (MEL) on June 27, 1995, and were sent to Weyerhaeuser Analytical and Testing Services on June 28, 1995, for TOC analysis using PSEP.

HOLDING TIMES

The holding time for frozen sediments is six (6) months. There have been no studies performed to indicate the effect of holding time on samples that have not been stored frozen prior to analysis. Therefore an evaluation of the results with regard to holding time is not feasible. All samples were stored in the proper containers at 4 degrees C until analysis. All analyses were performed within forty-two (42) days of collection.

PROCEDURAL BLANKS

The procedural blanks associated with these samples demonstrated that the processes were free from contamination. For consistency, all non-detect results have been qualified with a "U" to conform to the Manchester Laboratory reporting format.

INITIAL CALIBRATION

The % Relative Standard Deviations (%RSD) were within QC limits of 20%.

CHECK STANDARDS

All Check Standard recoveries are reasonable, acceptable, and within QC limits of 90% to 110% of the expected result.

TRIPLICATE

Sample 268230 was analyzed in triplicate on July 18. The carbon peak areas were higher than that of the highest concentration standard. The triplicate analysis was repeated on July 26. The Relative Percent Difference (RPD) of the triplicate analyses to the original analyses are within QC limits of 10% for both days.

SUMMARY

All non-detect results have been qualified with a "U" (not detected at or above the reporting limit) for consistency with MEL's reporting format. This data is acceptable for use as amended.

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
MANCHESTER ENVIRONMENTAL LABORATORY
7411 Beach Drive East • Port Orchard, Washington 98366-8204 • (360) 871-8860 • FAX (360) 871-8850

August 22, 1995

To: Jim Cubbage, Project Officer

From: Myrna McIntosh, Metals Chemist

Subject: Metals Quality Assurance Memo for the Salmon Bay, sediment samples
Sample Numbers: 95268230 - 95268261

QUALITY ASSURANCE SUMMARY

Data quality for this project is generally very good.

The mercury results are qualified with "J" because of negative spike recoveries. This is usually the case when mercury is not homogeneously distributed throughout the subsamples.

The other metal analytes were digested in two batches. The recoveries of lead and chromium in the second digestion batch are low. All lead and chromium results from this digestion are qualified with "N". These low recoveries are probably unique to the sample chosen rather than the whole batch. Although it is lab policy to qualify on the basis of one set of spikes per batch, since the recoveries are in the 60 % - 70 % range the results need not be estimated.

SAMPLE INFORMATION

The samples from the Salmon Bay project were received by the Manchester Laboratory on 6/28/95 in good condition.

HOLDING TIMES

All analysis were performed within the USEPA Contract Laboratory Program (CLP) holding times for metals analysis (28 days for mercury, 180 days for all other metals).

INSTRUMENT CALIBRATION

Instrument calibration was performed before each analytical run and checked by initial calibration verification standards and blanks. Continuing calibration standards and blanks were analyzed at a frequency of 10% during the run and again at the end of the analytical run. All initial and continuing calibration verification standards are within the relevant USEPA (CLP) control limits. AA calibration gave a correlation coefficient (r) of 0.995 or greater, also meeting CLP calibration requirements.

PROCEDURAL BLANKS

The procedural blanks associated with these samples show no significant amounts of contamination.

SPIKED SAMPLE ANALYSIS

Spiked sample analysis were performed on this data set. All spike recoveries, except mercury (all), lead and chromium (digestion batch #2) are within the CLP acceptance limits of +/- 25 %. All lead and chromium results in digestion batch #2 are qualified with "N". All mercury results are qualified with "J".

PRECISION DATA

All precision results except for mercury were within the CLP limits of +/- 20% RSD.

LABORATORY CONTROL SAMPLE (LCS) ANALYSIS

LCS analysis are within the windows established for each parameter.

Please call Bill Kammin at SCAN 360-871-8801 to further discuss this project.

MMM:mmm

MANCHESTER ENVIRONMENTAL LABORATORY
7411 Beach Drive E , Port Orchard Washington 98366

CASE NARRATIVE

October 11, 1995

Subject: Salmon Bay

Samples: 95 - 268230 to -268258, -268260 and -268261

Case No. 1961-95

Officer: Jim Cubbage

By: Dickey D. Huntamer
Organics Analysis Unit

SEMIVOLATILE ORGANICS

ANALYTICAL METHODS:

The semivolatile soil samples were extracted with acetone following the Manchester modification of the EPA CLP and SW 846 8270 procedure with capillary GC/MS analysis of the sample extracts. Normal QA/QC procedures were performed with the analyses except that only one matrix spike was analyzed with each extraction batch.

HOLDING TIMES:

All sample and extraction holding times were within the recommended limits.

BLANKS:

Low levels of some target compounds were detected in the laboratory blanks. The EPA five times rule was applied to all target compounds which were found in the blank. Compounds that were found in the sample and in the blank were considered real and not the result of contamination if the levels in the sample are greater than or equal to five times the amount of compounds in the associated method blank.

SURROGATES:

The normal Manchester Laboratory surrogates were added to the sample prior to extraction. All surrogate recoveries were within acceptable limits except for nitrobenzene-d5 in samples -268231 and -268238 and -268249. Samples -268231 and -269238 less than 3% low whereas sample -268249 had less than 10% recovery. Since all of the other surrogates in these samples were acceptable no additional qualifiers were added to the data.

MATRIX SPIKE AND MATRIX SPIKE DUPLICATE:

At the project officers request only one matrix spike (LMX1) was analyzed with each batch of samples extracted. Consequently no duplicate spikes and Relative Percent Differences (RPD) data is available.

Matrix spike recoveries were low for 1,3-dichlorobenzene, N-nitrosodinpropylamine, hexchloroethane, 4-chloroaniline, 3-nitroaniline in sample -268246 (LMX1). For the other matrix spike sample, -268234 (LMX1) hexchloroethane, 2-nitrophenol, 3- and 4-nitroanilines had low recoveries. The "J" qualifier was added to the results for these compounds. Hexachlorocylcopentadiene and 4-chloroaniline recoveries were less than 10% in sample, -268234 (LMX1) and the data for these compounds were rejected, "REJ" in the matrix spike source sample. In sample, -268246 (LMX1) only hexachlorocylcopentadiene was less than 10% and data for this compound was also rejected.

ANALYTICAL COMMENTS:

No special analytical problems were encountered in the semivolatile analyses. The data is acceptable for use as qualified.

One Canadian reference material sample, HS-6, for polynuclear aromatic hydrocarbons was prepared and analyzed with each batch of samples. These are identified as HS652431 and HS652485.

DATA QUALIFIER CODES:

U	-	The analyte was not detected at or above the reported value.
J	-	The analyte was positively identified. The associated numerical value is an <u>estimate</u>.
UJ	-	The analyte was not detected at or above the reported estimated result.
REJ	-	The data are <u>unusable</u> for all purposes.
EXP	-	The result is equal to the number before EXP times 10 to the power of the number after EXP. As an example 3EXP6 equals 3 X 10^6.
NAF	-	Not analyzed for.
N	-	For organic analytes there is evidence the analyte is present in this sample.
NJ	-	There is evidence that the analyte is present. The associated numerical result is an estimate.
E	-	This qualifier is used when the concentration of the associated value exceeds the known calibration range.
bold	-	The analyte was present in the sample. (Visual Aid to locate detected compound on report sheet.)

Manchester Environmental Laboratory

7411 Beach Dr E
Port Orchard Washington 98366
September 19, 1995

Project: **Salmon Bay**

Samples: 95268230 through 268261

By: Karin Feddersen KF

These samples were analyzed by EPA Method 8080 for Polychlorinated Biphenyls (PCBs) employing the dual column confirmation technique.

Holding Times:

These samples were extracted six days past the method holding time of fourteen days. PCBs are extremely stable. Therefore, extraction beyond the holding time should not affect the results. The samples were analyzed within the method holding time of forty days from extraction.

Method Blanks:

No analytes of interest were detected in the method blanks.

Initial Calibration:

The % Relative Standard Deviations were within the maximum of 30% for all target analytes.

Continuing Calibration:

The Percent Differences between the initial and continuing calibrations were within the maximum of 25% for all target analytes.

Surrogates:

Four surrogates were added to each sample. The recommended range for surrogate recovery is between 60% and 150%. Dibutylchlorendate (DBC) recoveries were low in almost all samples. An acid cleanup was performed on these samples. DBC is very susceptible to degradation by acid. Since PCBs are not susceptible to acid degradation, and because the other surrogates demonstrated acceptable recoveries, qualification of the results is not required. Recoveries were acceptable for three of the surrogates in all samples except the 1:100 dilution of sample 268252. The surrogates were most likely not detected as a result of the dilution performed. Non-detected surrogates have been qualified with "REJ". However, the associated sample results do not need qualification.

Matrix Spikes (MS/MSD):

All matrix spike recoveries were between 75% and 100%. These recoveries are reasonable and acceptable.

Sample Results:

When the RPD between the two columns was greater than 30% for an analyte, the result was qualified with a "J".

The PCB - 1254 and -1260 results for sample 268252 exceeded the calibration curve. Therefore, two dilutions were required. Use the results from the first dilution (DIL1) for PCB - 1260. Use the results from the second dilution (DIL2) for PCB - 1254. Use the undiluted sample results for all non-detects.

This data is acceptable for use with the qualifications mentioned.

DATA QUALIFIER CODES:

U - The analyte was not detected at or above the reported value.

J - The analyte was positively identified. The associated numerical value is an estimate.

UJ - The analyte was not detected at or above the reported estimated result.

NJ - There is evidence that the analyte is present. The associated numerical result is an estimate.

NAF - Not analyzed for.

REJ - The data are unusable for all purposes.

MANCHESTER ENVIRONMENTAL LABORATORY

7411 Beach Drive E , Port Orchard Washington 98366

CASE NARRATIVE

December 18, 1995

Subject: Salmon Bay

Samples: 95 - 268230 to -268258, -268260 and -268261

Case No. 1961 -95

Officer: Jim Cubbage

By: Dickey D. Huntamer
Organics Analysis Unit

TRIBUTYL TINS

ANALYTICAL METHODS:

The samples were extracted following the methods given in Puget Sound Estuary Program (PSEP) "Recommended Guidelines for Measuring Organic Compounds in Puget Sound Sediment and Tissue Samples" Recommended Methods for Organotin Compounds. The samples were Soxhlet extracted with acetone and tropolone, 0.2% by weight, solvent exchanged to hexane and dried using sodium sulfate. The organotin compounds were hexylated using the Grignard reaction given in Krone et al (1989) including the silica gel/alumina cleanup. Analysis was done by capillary Gas Chromatography using Single Ion Monitoring (SIM) mode GC/MS. All samples are reported on a dry weight basis.

HOLDING TIMES:

The samples were stored frozen following PSEP Guidelines until extraction. After extraction all samples were analyzed within the recommended 40 day extract time.

BLANKS:

Some low levels of organo tin compounds were detected in the laboratory blanks. The EPA five times rule was applied to all target compounds which were found in the blank. Compounds that were found in the sample and in the blank were considered real and not the result of contamination if the levels in the sample are greater than or equal to five times the amount of compounds in the associated method blank.

SURROGATES:

Recovery of the surrogate spike, tripropyltin, ranged from 30% to 125% for most of the samples. Two sample dilutions, -268239 DIL1 and -268249 DIL1 had recoveries less than 20%. Since the surrogate recoveries in the undiluted samples were 48% and 76% respectively no qualifiers were added. Several other samples had recoveries greater than 200% due to chromatographic interference with the tripropyltin quantitation ion. No surrogate recovery QC limits have been established for this method and no qualifiers were added due to high surrogate recoveries.

MATRIX SPIKE AND MATRIX SPIKE :

At the request of the project officer only one matrix spike was run with each extraction batch. Consequently no matrix spike duplicate analysis are available. The sample choice for the first matrix spike, -268231, was unfortunate since this sample was very high in native organotin compounds. Consequently no useful recovery information could be obtained even after correction for the native amounts except for the tetrabutyltin recovery of 67%.

Reprocessing the sample as a duplicate sample instead of a matrix spike gives tetrabutyltin, 221 ug/Kg, tributyltin, 7620 ug/kg, dibutyltin 1680 ug/kg and monobutyltin, 143 ug/kg which is comparable to the results for sample -268231.

The second matrix spike sample, -268246, had lower native amounts and recoveries ranged from 75% to 98%. Chromatographic interference with the monobutyltin peak in the matrix spike sample prevented recovery calculation for the monobutyltin and the data was rejected , "REJ". The interference is also the reason for the higher quantitation limit for monobutyltin in sample -268246.

ANALYTICAL COMMENTS:

Some samples had chromatographic interference's with the organotin peaks, particularly monobutyltin.

Nearly all of the samples required dilution to bring the samples within the linear calibration range of the GC/MS . The sample results which are outside the calibration range are flagged "E". The results for the dilution are also reported and are indicated by "DIL1" or "DIL2" after the sample number. The results for the undiluted analysis should be reported except where the "E" flag is used. The result for the corresponding compound in the diluted sample should then be used in place of the "E" flagged compound result.

Two additional samples were analyzed with the sediment samples. This was a Sequim Bay Reference Sediment which presumably was spiked with 100 ng/gm (100 ug/Kg) wet weight of tributyltin. No value for tributyltin has been established for the Sequim Bay Reference Sediment so the accuracy of the analysis cannot be determined. The amounts reported below, although within the observed range for Sequim Bay Reference Sediments for organo tin, are on the low side of the range. These samples are identified as SBR52794 and SBR53642.

SBR52794	35	ug/Kg (wet weight)	Tributyltin	% solids 66.4
SBR53642	43	ug/Kg (wet weight)	Tributyltin	% solids 61.6

Note that the data sheets report these values as dry weight.

DATA QUALIFIER CODES:

U - The analyte was not detected at or above the reported value.

J - The analyte was positively identified. The associated numerical value is an estimate.

UJ - The analyte was not detected at or above the reported estimated result.

REJ - The data are unusable for all purposes.

EXP - The result is equal to the number before EXP times 10 to the power of the number after EXP. As an example 3EXP6 equals 3 X 10^6.

NAF - Not analyzed for.

N - For organic analytes there is evidence the analyte is present in this sample.

NJ - There is evidence that the analyte is present. The associated numerical result is an estimate.

E - This qualifier is used when the concentration of the associated value exceeds the known calibration range.

bold - The analyte was present in the sample. (Visual Aid to locate detected compound on report sheet.)

CN_SALMT.DOC

Table D-1. Results of spiked sample analysis (% recovery).

1. Metals

Sample No.:	8233	8233	RPD	8244	8244	RPD	8261	8261	RPD
Mercury	84	175	-70%	N/A	N/A		N/A	N/A	
Arsenic	N/A	N/A		NC	N/A		NC	N/A	
Lead	N/A	N/A		NC	NC		65	66	-2%
Nickel	N/A	N/A		89	88	1%	79	81	-3%
Cadmium	N/A	N/A		107	85	23%	95	81	16%
Chromium	N/A	N/A		76	77	-1%	69	74	-7%
Copper	N/A	N/A		NC	NC		NC	NC	
Zinc	N/A	N/A		NC	NC		NC	NC	

2. Semivolatile Organics

Sample No.:	8234	8246
4-Nitroaniline	37	52
4-Nitrophenol	99	99
Benzyl Alcohol	73	79
4-Bromophenyl-Phenylether	98	90
2,4-Dimethylphenol	96	86
4-Methylphenol	84	83
1,4-Dichlorobenzene	67	55
4-Chloroaniline	REJ	21
Phenol	84	82
Pyridine	N/A	N/A
Bis(2-Chloroethyl)Ether	76	79
Bis(2-Chloroethoxy)Methane	80	79
Bis(2-Ethylhexyl) Phthalate	75	77
Di-N-Octyl Phthalate	130	120
Hexachlorobenzene	92	87
Anthracene	88	88
1,2,4-Trichlorobenzene	73	69
2,4-Dichlorophenol	81	80
2,4-Dinitrotoluene	74	85
Hydrazine, 1.2-Diphenyl-	N/A	N/A
Pyrene	81	81
Dimethylphthalate	96	92
Dibenzofuran	100	92
Benzo(ghi)perylene	70	110
Indeno(1,2,3-cd)pyrene	100	120
Benzo(b)fluoranthene	69	120
Fluoranthene	88	93
Benzo(k)fluoranthene	110	130
Acenaphthylene	91	87
Chrysene	79	81
3B-Coprostanol	N/A	N/A
Bis(2-Chloroisopropyl)Ether	79	78
Retene	N/A	N/A
Benzo(a)pyrene	74	120
2,4-Dinitrophenol	51	69
4,6-Dinitro-2-Methylphenol	54	75
Dibenzo(a,h)anthracene	120	120
1,3-Dichlorobenzene	63	48
Benzo(a)anthracene	84	85
Caffeine	N/A	N/A
4-Chloro-3-Methylphenol	82	79
2,6-Dinitrotoluene	79	87
N-Nitroso-Di-N-Propylamine	91	250

Sample No.:	8234	8246
Aniline	N/A	N/A
N-Nitrosodimethylamine	N/A	N/A
Benzoic Acid	60	58
Hexachloroethane	26	22
4-Chlorophenyl-Phenylether	97	88
Hexachlorocyclopentadiene	REJ	REJ
Isophorone	76	75
Acenaphthene	97	90
Diethylphthalate	95	87
Di-N-Butylphthalate	96	91
Phenanthrene	87	89
Butylbenzylphthalate	80	81
N-Nitrosodiphenylamine	92	87
Fluorene	96	91
Carbazole	N/A	N/A
Hexachlorobutadiene	73	59
Pentachlorophenol	78	78
2,4,6-Trichlorophenol	98	90
2-Nitroaniline	93	89
2-Nitrophenol	50	73
Naphthalene	76	74
2-Methylnaphthalene	80	75
2-Chloronaphthalene	96	86
3,3'-Dichlorobenzidine	N/A	N/A
Benzidine	N/A	N/A
2-Methylphenol	84	83
1,2-Dichlorobenzene	60	50
2-Chlorophenol	84	84
2,4,5-Trichlorophenol	95	90
Nitrobenzene	68	74
3-Nitroaniline	20	43
Semivolatile Organic Surrogate Recoveries (%)		
D14-Terphenyl	94	77
D10-Pyrene	95	79
1,2-Dichlorobenzene-D4	68	50
2-Fluorobiphenyl	100	87
2-Fluorophenol	80	79
D5-Nitrobenzene	73	73
D5-Phenol	87	82
D4-2-Chlorophenol	84	80

Table D-1 (Cont'd). Results of spiked sample analysis (% recovery).

3. PCBs

Sample No.:	8234	8246
PCB - 1260	89	91
PCB - 1254	N/A	N/A
PCB - 1221	N/A	N/A
PCB - 1232	N/A	N/A
PCB - 1248	N/A	N/A
PCB - 1016	N/A	N/A
PCB - 1242	92	83
PCB Surrogate Recoveries (%)		
4,4-Dibromooctafluorobiphenyl	102	80
Dibutylchlorendate	56	64
Decachlorobiphenyl	90	90
Tetrachloro-m-xylene	100	85

4. Butyltins

Sample No.:	8231	8246
Monobutyltin Chloride	$\boxed{231}$	REJ
Tributyltin Chloride	$\boxed{595}$	75.8
Tetrabutyltin Chloride	67.3	75.7
Dibutyltin Chloride	$\boxed{538}$	97.5
Butyltin Surrogate Recoveries (%)		
Tripopropyltin Chloride	NC	87

RPD=Relative Percent Difference of duplicate analysis
N/A=Not Analyzed
NC=Not Calculated
REJ=Rejected, data are unusable
☐ Outside of acceptable recovery window

Table D-2. Results of check standard and reference material analysis.

1. Metals (% Recovery of Check Standards)

Sample No.:	27052400	27052401	RPD	ERA52387	ERA52389	RPD
Mercury	92	93	-1%	N/A	N/A	
Arsenic	N/A	N/A		122	109	11%
Lead	N/A	N/A		85	85	0%
Nickel	N/A	N/A		91	93	-2%
Cadmium	N/A	N/A		93	93	0%
Chromium	N/A	N/A		81	79	3%
Copper	N/A	N/A		92	91	1%
Zinc	N/A	N/A		85	85	0%

2. Semivolatile Organics (PAH Standard Reference Material NRCC HS-6; µg/Kg, dry)

Sample No.:	HS652431	HS652485	RPD	NRCC HS-6 Certified Values
Anthracene	1000	1100	-10%	1100 ± 400
Pyrene	$\boxed{2300}$	2400	-4%	3000 ± 600
Benzo(ghi)perylene	2100	2200	-5%	1780 ± 720
Indeno(1,2,3-cd)pyrene	2400	2500	-4%	1950 ± 580
Benzo(b)fluoranthene	$\boxed{4100}$	$\boxed{4600}$	-11%	2800 ± 600
Fluoranthene	3400	3600	-6%	3540 ± 650
Benzo(k)fluoranthene	$\boxed{1900}$	$\boxed{1900}$	0%	1430 ± 150
Acenaphthylene	$\boxed{550}$	$\boxed{580}$	-5%	190 ± 50
Chrysene	2000	2100	-5%	2000 ± 300
Benzo(a)pyrene	2100	2200	-5%	2200 ± 400
Dibenzo(a,h)anthracene	650 J	$\boxed{660}$ J	-2%	490 ± 160
Benzo(a)anthracene	$\boxed{1400}$	$\boxed{1400}$	0%	1800 ± 300
Acenaphthene	160 J	170 J	-6%	230 ± 70
Phenanthrene	3000	3200	-6%	3000 ± 600
Fluorene	470	460	2%	470 ± 120
Naphthalene	3400	3600	-6%	4100 ± 1100
Semivolatile Surrogate Recoveries (%)				
D14-Terphenyl	83	80	4%	
D10-Pyrene	82	83	-1%	
1,2-Dichlorobenzene-D4	68	64	6%	
2-Fluorobiphenyl	93	97	-4%	
2-Fluorophenol	82	87	-6%	
D5-Nitrobenzene	75	80	-6%	
D5-Phenol	85	90	-6%	
D4-2-Chlorophenol	83	87	-5%	

3. PCBs (Standard Reference Material NRCC HS-2; µg/Kg, dry)

Sample No.:	HS252430	HS252484	RPD	NRCC HS-6 Certified Values
PCB - 1254	110	113	-3%	111.8 ± 2.5
PCB Surrogate recoveries (%)				
4,4-Dibromooctafluorobiphenyl	123	105	16%	
Dibutylchlorendate	44	70	-46%	
Decachlorobiphenyl	129	101	24%	
Tetrachloro-m-xylene	102	100	2%	

4. Butyltins (Sequim Bay Reference Sediment [SBRS]; µg/Kg, wet)

Sample No.:	SBR52794	SBR53642	RPD	SBRS Reported Value*
Tributyltin Chloride	35	43	-21%	100
Butyltin Surrogate Recoveries (%)				
Tripropyltin Chloride	152	62	84%	

RPD=Relative Percent Difference of duplicate analysis
N/A=Not Analyzed
J=Estimated concentration
☐ Outside certified range of values
*No value for tributyltin has been established for this material

Table D-3. Analytical results of split field samples.

Station:	1A					8C				
Sample No.:	8230		8260		RPD	8258		8261		RPD
1. Conventionals										
% TOC (dry)	8.1		8.7		-7%	6.7		6.4		5%
% Solids	31.6		32.8		-4%	28.5		23.6		19%
% Gravel (>2000µm)	1		2		-67%	2		0		200%
% Sand (2000-63µm)	34		37		-8%	19		19		0%
% Silt (62-4µm)	45		44		2%	60		63		-5%
% Clay (<4µm)	20		17		16%	19		18		5%
2. Metals (mg/Kg, dry)										
Arsenic	38.5		44.9		-15%	34.5		33.2		4%
Mercury	2.3	J	2.2	J	2%	1.3	J	1.7	J	-25%
Lead	441		385	N	14%	298	N	297	N	0%
Nickel	44.6		46.6		-4%	64.8		63.5		2%
Cadmium	1.3	P	1.7	P	-27%	2.2	P	1.7	P	26%
Chromium	60.7		61.8	N	-2%	80.8	N	80.4	N	0%
Copper	317		330		-4%	702		663		6%
Zinc	530		501		6%	778		776		0%
3. Semivolatile Organics (µg/Kg, dry)										
4-Methylphenol	1700		1800		-6%	820		930		-13%
Phenol	250	UJ	340		-31%	270		240	J	12%
Bis(2-Ethylhexyl) Phthalate	340	UJ	480	UJ		6700		6800		-1%
Anthracene	1200		1400		-15%	1100		990		11%
Pyrene	9100		11000		-19%	4200		4300		-2%
Dimethylphthalate	190	U	200	U		170	J	190	J	-11%
Dibenzofuran	570		720		-23%	400		590		-38%
Benzo(ghi)perylene	3400		3300		3%	1900		2100		-10%
Indeno(1,2,3-cd)pyrene	2800		2700		4%	1800		1900		-5%
Benzo(b)fluoranthene	4700		4500		4%	3300		3500		-6%
Fluoranthene	11000		13000		-17%	5400		5600		-4%
Benzo(k)fluoranthene	1600		1800		-12%	1400		1300		7%
Acenaphthylene	740		850		-14%	270		330		-20%
Chrysene	2700		2900		-7%	2200		2200		0%
3B-Coprostanol	3700	UJ	4000	UJ		11000	J	12000	J	-9%
Retene	1100		1500		-31%	960		960		0%
Benzo(a)pyrene	3700		3800		-3%	2200		2300		-4%
Dibenzo(a,h)anthracene	550	J	520	J	6%	450	J	420	J	7%
Benzo(a)anthracene	2000		2100		-5%	1400		1400		0%
Benzoic Acid	3700	UJ	410	J		480	J	600	J	-22%
Acenaphthene	1200		1700		-34%	510		580		-13%
Phenanthrene	4800		6400		-29%	3600		4600		-24%
Butylbenzylphthalate	930	U	990	U		190	J	330	J	-54%
Fluorene	1200		1600		-29%	690		910		-28%
Carbazole	190	U	200	U		340		250	U	31%
Naphthalene	2500		3000		-18%	620		1100		-56%
2-Methylnaphthalene	650		890		-31%	300		450		-40%
Semivolatile Surrogate Recoveries (%)										
D14-Terphenyl	72		79		-9%	75		78		-4%
D10-Pyrene	77		80		-4%	76		80		-5%
1.2-Dichlorobenzene-D4	53		61		-14%	39		59		-41%
2-Fluorobiphenyl	94		100		-6%	88		95		-8%
2-Fluorophenol	86		81		6%	77		79		-3%
D5-Nitrobenzene	54		58		-7%	32		35		-9%
D5-Phenol	90		82		9%	81		82		-1%
D4-2-Chlorophenol	88		83		6%	81		85		-5%

Table D-3 (Cont'd). Analytical results of split field samples.

Station:	1A					8C			
Sample No.:	8230		8260		RPD	8258		8261	RPD
4. PCBs (µg/Kg, dry)									
PCB - 1260	200		300		-40%	420		370	13%
PCB - 1254	250		250		0%	480		500	-4%
PCB Surrogate Recoveries (%)									
4,4-Dibromooctafluorobiphenyl	95		107		-12%	123		124	-1%
Dibutylchlorendate	65		53		20%	35		34	3%
Decachlorobiphenyl	112		119		-6%	123		127	-3%
Tetrachloro-m-xylene	94		105		-11%	124		124	0%
5. Butyltins (µg/Kg, dry)									
Monobutyltin Chloride	9	U	168		-180%	2030		1040	64%
Tributyltin Chloride	324		404		-22%	656		3130	-131%
Tetrabutyltin Chloride	9.4	U	9.3	U		15	U	46	-102%
Dibutyltin Chloride	9.1	U	20		-75%	77		827	-166%
Butyltin Surrogate Recoveries (%)									
Tripropyltin Chloride	56		89		-46%	248		101	84%

RPD=Relative Percent Difference
J=Estimated concentration
N=Low matrix spike recoveries associated with this result
P=The analyte was detected below the minimum quantitation limit
U=The analyte was not detected at or above the value shown

Table D-4 Results of laboratory blank analysis.

1. Metals (mg/Kg, dry)

Sample No.:	BLN52402	BLN52403	BLN52386	BLN52388
Mercury	0.005	0.005	N/A	N/A
Arsenic	N/A	N/A	0.3 U	0.3 U
Lead	N/A	N/A	2 U	2 U
Nickel	N/A	N/A	1 U	1 U
Cadmium	N/A	N/A	0.3 U	0.3 U
Chromium	N/A	N/A	0.5 U	0.5 U
Copper	N/A	N/A	0.62 P	1.3 P
Zinc	N/A	N/A	0.66 P	0.49 P

2. Semivolatile Organics (µg/Kg, dry)

Sample No.:	BLN52428	BLN52429	BLN52482	BLN52483
4-Nitroaniline	840 U	840 U	840 U	840 U
4-Nitrophenol	840 U	840 U	840 U	840 U
Benzyl Alcohol	170 U	170 U	170 U	170 U
4-Bromophenyl-Phenylether	170 U	170 U	170 U	170 U
2,4-Dimethylphenol	170 U	170 U	170 U	170 U
4-Methylphenol	170 U	170 U	170 U	170 U
1,4-Dichlorobenzene	170 U	170 U	170 U	170 U
4-Chloroaniline	170 U	170 U	170 U	170 U
Phenol	100 J	82 J	170 U	170 U
Pyridine	840 U	840 U	840 U	840 U
Bis(2-Chloroethyl)Ether	170 U	170 U	170 U	170 U
Bis(2-Chloroethoxy)Methane	170 U	170 U	170 U	170 U
Bis(2-Ethylhexyl) Phthalate	63 J	140 J	59 J	40 J
Di-N-Octyl Phthalate	840 U	840 U	840 U	840 U
Hexachlorobenzene	170 U	170 U	170 U	170 U
Anthracene	170 U	170 U	170 U	170 U
1,2,4-Trichlorobenzene	170 U	170 U	170 U	170 U
2,4-Dichlorophenol	170 U	170 U	170 U	170 U
2,4-Dinitrotoluene	840 U	840 U	840 U	840 U
Hydrazine, 1,2-Diphenyl-	170 U	170 U	170 U	170 U
Pyrene	170 U	170 U	170 U	170 U
Dimethylphthalate	170 U	170 U	170 U	170 U
Dibenzofuran	170 U	170 U	170 U	170 U
Benzo(ghi)perylene	170 U	170 U	170 U	170 U
Indeno(1,2,3-cd)pyrene	170 U	170 U	170 U	170 U
Benzo(b)fluoranthene	170 U	170 U	170 U	170 U
Fluoranthene	170 U	170 U	170 U	170 U
Benzo(k)fluoranthene	170 U	170 U	170 U	170 U
Acenaphthylene	170 U	170 U	170 U	170 U
Chrysene	170 U	170 U	170 U	170 U
3B-Coprostanol	3400 UJ	3400 UJ	3400 UJ	3400 UJ
Bis(2-Chloroisopropyl)Ether	170 U	170 U	170 U	170 U
Retene	170 U	170 U	170 U	170 U
Benzo(a)pyrene	170 U	170 U	170 U	170 U
2,4-Dinitrophenol	6700 UJ	6700 UJ	6700 UJ	6700 UJ
4,6-Dinitro-2-Methylphenol	3400 U	3400 U	3400 U	3400 U
Dibenzo(a,h)anthracene	170 UJ	170 UJ	170 UJ	170 UJ
1,3-Dichlorobenzene	170 U	170 U	170 U	170 U
Benzo(a)anthracene	170 U	170 U	170 U	170 U
Caffeine	170 U	170 U	170 U	170 U
4-Chloro-3-Methylphenol	170 U	170 U	170 U	170 U
2,6-Dinitrotoluene	840 U	840 U	840 U	840 U
N-Nitroso-Di-N-Propylamine	170 U	170 U	170 U	170 U
Aniline	170 U	170 U	170 U	170 U
N-Nitrosodimethylamine	840 UJ	840 UJ	840 UJ	840 UJ
Benzoic Acid	120 J	3400 UJ	3400 UJ	3400 UJ
Hexachloroethane	170 U	170 U	170 U	170 U
4-Chlorophenyl-Phenylether	170 U	170 U	170 U	170 U
Hexachlorocyclopentadiene	3400 UJ	3400 UJ	3400 UJ	3400 UJ
Isophorone	170 U	170 U	170 U	170 U
Acenaphthene	170 U	170 U	170 U	170 U
Diethylphthalate	140 J	42 J	170 U	170 U
Di-N-Butylphthalate	1200	160 J	87 J	170 U

Table D-4 (Cont'd). Results of laboratory blank analysis.

2. Semivolatile Organics (µg/Kg, dry)

Sample No.:	BLN52428	BLN52429	BLN52482	BLN52483
Phenanthrene	170 U	170 U	170 U	170 U
Butylbenzylphthalate	840 U	840 U	840 U	840 U
N-Nitrosodiphenylamine	170 U	170 U	170 U	170 U
Fluorene	170 U	170 U	170 U	170 U
Carbazole	170 U	170 U	170 U	170 U
Hexachlorobutadiene	170 U	170 U	170 U	170 U
Pentachlorophenol	840 U	840 U	840 U	840 U
2,4,6-Trichlorophenol	340 U	340 U	340 U	340 U
2-Nitroaniline	340 U	340 U	340 U	340 U
2-Nitrophenol	170 U	170 U	170 U	170 U
Naphthalene	170 U	170 U	170 U	170 U
2-Methylnaphthalene	170 U	170 U	170 U	170 U
2-Chloronaphthalene	170 U	170 U	170 U	170 U
3,3'-Dichlorobenzidine	340 U	340 U	340 U	340 U
Benzidine	340 UJ	340 UJ	340 UJ	340 UJ
2-Methylphenol	170 U	170 U	170 U	170 U
1,2-Dichlorobenzene	170 U	170 U	170 U	170 U
2-Chlorophenol	170 U	170 U	170 U	170 U
2,4,5-Trichlorophenol	170 U	170 U	170 U	170 U
Nitrobenzene	170 U	170 U	170 U	170 U
3-Nitroaniline	840 U	840 U	840 U	840 U
Semivolatile Organic Surrogate Recoveries (%)				
D14-Terphenyl	82	80	80	82
D10-Pyrene	79	77	78	81
1,2-Dichlorobenzene-D4	70	73	71	73
2-Fluorobiphenyl	95	94	93	98
2-Fluorophenol	74	78	80	88
D5-Nitrobenzene	69	65	72	74
D5-Phenol	86	87	87	93
D4-2-Chlorophenol	81	82	85	92

3. PCBs (µg/Kg, dry)

Sample No.:	BLN52428	BLN52429	BLN52482	BLN52483
PCB - 1260	34 U	34 U	34 U	34 U
PCB - 1254	34 U	34 U	34 U	34 U
PCB - 1221	34 U	34 U	34 U	34 U
PCB - 1232	34 U	34 U	34 U	34 U
PCB - 1248	34 U	34 U	34 U	34 U
PCB - 1016	34 U	34 U	34 U	34 U
PCB - 1242	34 U	34 U	34 U	34 U
PCB Surrogate Recoveries (%)				
4,4-Dibromooctafluorobiphenyl	91	92	85	97
Dibutylchlorendate	55	54	52	62
Decachlorobiphenyl	107	101	102	106
Tetrachloro-m-xylene	95	92	85	95

4. Butyltins (µg/Kg, dry)

Sample No.:	BLN52792	BLN52793	BLN53640	BLN53641	BLN54110
Monobutyltin Chloride	7 U	7 U	0.4 J	7 U	0.7 J
Tributyltin Chloride	2.9 J	7.6 U	2.4 J	1.6 J	2.2 J
Tetrabutyltin Chloride	7.4 U	7.4 U	7.4 U	7.4 U	7.4 U
Dibutyltin Chloride	7.1 U	7.1 U	0.49 J	7.1 U	0.98 J
Butyltin Surrogate Recoveries (%)					
Tripropyltin Chloride	36	50	56	60	53

☐ Analyte was detected in laboratory blank

N/A=Not Analyzed

U=The analyte was not detected at or above the value shown

P=Analyte was detected below the numerical quantitation limit

J=Estimated concentration

APPENDIX E

CHEMICAL CONCENTRATIONS IN SEDIMENTS

Table E-1. Concentration of metals in sediments (mg/Kg, dry).

Station	As	Hg	Pb	Ni	Cd	Cr	Cu	Zn
1A	42	2.2 J	413 N	46	1.5 P	61 N	324	516
1B	210	5.0 J	534	60	3.2	99	2000	2020
1C	28	1.1 J	208	80	1.2 P	101	629	492
2A	20	0.63 J	107	44	0.40 P	51	358	311
2B	5.0	0.11 J	151	26	0.59 P	18	88	225
2C	34	0.61 J	131	46	0.62 P	53	268	646
3A	9.5	0.26 J	66	33	0.30 U	35	92	147
3B	44	1.8 J	314	66	1.2 P	88	318	619
3C	32	1.0 J	193	52	0.69 P	68	539	462
4A	18	1.5 J	137	63	0.42 P	75	354	319
4B	31	1.1 J	219	94	0.88 P	114	565	459
4C	5.7	0.18 J	29	44	0.30 U	36	85	136
4D	10	0.65 J	100	38	0.30 U	37	207	206
4E	24	1.6 J	250	68	1.3 P	79	436	562
4F	83	4.0 J	444	49	1.7 P	65	1230	921
5A	39	0.86 J	175 N	48	0.81 P	62 N	340	388
5B	1.6	0.01 J	3.5 J	22	0.30 U	14 N	7.7	27
5C	19	0.77 J	147 N	72	0.64 P	70 N	310	302
6A	13	0.78 J	190 N	56	1.6 P	60 N	246	403
6B	41	0.18 J	75 N	484	1.8 P	376 N	2210	207
6C	10	0.42 J	65 N	42	0.49 P	40 N	128	183
6D	24	0.71 J	101 N	56	0.56 P	50 N	244	283
7A	83	0.77 J	254 N	46	1.2 P	63 N	709	1140
7B	18	0.052 J	37 N	62	0.33 P	52 N	107	210
7C	6.2	0.071 J	169 N	30	0.45 P	24 N	53	100
7D	6.8	0.097 J	41 N	29	0.30 U	25 N	335	185
8A	19	0.91 J	186 N	41	1.0 P	48 N	197	350
8B	9.8	0.35 J	146 N	33	0.48 P	30 N	88	205
8C	34	1.5 J	298 N	64	2.0 P	81 N	682	777

J=Estimated concentration
N=Low matrix spike recoveries associated with this result
P=The analyte was detected below the minimum quantitation limit
U=The analyte was not detected at or above the value shown

Table E-2. Semivolatile organics not detected in sediments.

Compound	Quantitation Limits (µg/Kg)
4-Nitroaniline	490 - 1600
4-Nitrophenol	490 - 1600
4-Bromophenyl-Phenylether	97 - 320
2,4-Dimethylphenol	97 - 320
4-Chloroaniline	97 - 320
Pyridine	490 - 1600
Bis(2-Chloroethyl)Ether	97 - 320
Bis(2-Chloroethoxy)Methane	97 - 320
Di-N-Octyl Phthalate	97 - 1600
Hexachlorobenzene	97 - 320
1,2,4-Trichlorobenzene	97 - 320
2,4-Dichlorophenol	97 - 320
2,4-Dinitrotoluene	490 - 1600
Hydrazine, 1,2-Diphenyl-	97 - 320
Bis(2-Chloroisopropyl)Ether	97 - 320
2,4-Dinitrophenol	3900 - 13000
4,6-Dinitro-2-Methylphenol	1900 - 6400
1,3-Dichlorobenzene	97 - 320
Caffeine	97 - 320
4-Chloro-3-Methylphenol	97 - 320
2,6-Dinitrotoluene	490 - 1600
N-Nitroso-Di-N-Propylamine	97 - 320
Aniline	97 - 320
N-Nitrosodimethylamine	490 - 1600
Hexachloroethane	97 - 320
4-Chlorophenyl-Phenylether	97 - 320
Hexachlorocyclopentadiene	2100 - 6400
Isophorone	97 - 320
Di-N-Butylphthalate	97 - 1200
N-Nitrosodiphenylamine	97 - 320
Hexachlorobutadiene	97 - 320
2,4,6-Trichlorophenol	190 - 640
2-Nitroaniline	190 - 640
2-Nitrophenol	97 - 320
2-Chloronaphthalene	97 - 320
3,3'-Dichlorobenzidine	190 - 640
Benzidine	190 - 640
2-Methylphenol	97 - 320
1,2-Dichlorobenzene	97 - 320
2-Chlorophenol	97 - 320
2,4,5-Trichlorophenol	97 - 320
Nitrobenzene	97 - 320
3-Nitroaniline	490 - 1600

Table E-3. Concentration of PAHs and other semivolatile organics detected in sediments (µg/Kg, dry).

Station	Pyrene	Benzo(ghi)perylene	Indeno(1,2,3-cd)pyrene	Benzo(b)fluoranthene	Fluoranthene	Benzo(k)fluoranthene	Chrysene	Benzo(a)pyrene	Dibenzo(a,h)anthracene	Benzo(a)anthracene	Anthracene	Acenaphthylene	Acenaphthene	Phenanthrene	Fluorene	Naphthalene	2-Methylnaphthalene	Benzyl Alcohol
1A	10050	3350	2750	4600	12000	1700	2800	3750	535 J	2050	1300	795	1450	5600	1400	2750	770	190 U
1B	11000	4500	4800	8900	14000	3700	5900	6200	1100 J	4800	2100	300	1000	7200	1300	880	650	240 U
1C	3500	2600	2300	3700	3800	1300	1900	2700	490 J	1300	650	320	280	1800	440	740	260	240 U
2A	4700	1600	1600	3200	6000	1100	1700	2300	350 J	1700	760	270	560	1900	560	810	350	180 U
2B	3400	1500	1700	3200	4300	1200	1900	2300	350 J	1500	600	44 J	190	2500	280	64 J	64 J	300
2C	2600	1300	1200	2000	3000	750	1200	1500	250 J	830	660	330	320	2200	540	1000	310	240
3A	370	370	330	510	360	190	220	390	71 J	170	77 J	44 J	24 J	170	40 J	72 J	25 J	130
3B	4600	2800	2600	4400	4600	1400	2400	3500	540 J	1900	900	710	320	2600	510	1400	370	420
3C	2800	1900	1800	3400	3200	1100	1700	2300	350 J	1300	600	240	220 J	1500	290	510	170 J	420
4A	2800	2400	2100	3000	3100	1100	1500	2400	400 J	1200	610	280	240	1300	320	590	240	410
4B	5300	2000	2000	4200	6900	1400	3600	2800	430 J	2100	1100	420	510	3600	870	1200	510	680
4C	1500	320	310	740	2200	270	550	490	67 J	490	180	56 J	92 J	430	170	130	55 J	120
4D	3800	1200	1000 J	1900	4000	750	1300	1600	200 J	970	780	460	540	3000	740	1800	760	180
4E	3400	2500	2200 J	3500	3700	1400	2000	2600	460 J	1300	860	430	300 J	1800	500	950	340	470
4F	11000	4900	4600 J	8800	13000	3000	5800	6300	1000 J	4500	3100	1100	2000	9300	2700	3100	1800	1000
5A	6700	2500	2500 J	5700	8600	2500	3300	3800	640 J	2700	770	300	490	3700	560	1200	390	410
5B	25 J	97 U	97 U	97 U	25 J	97 U	97 U	97 U	97 U	97	8.1 J	9.6 J	97 U	39 J	97 U	97 U	97 U	24 J
5C	5600	1200	1000 J	2400	6000	800	2000	1800	250 U	1900	1300	1000	1300	4800	1400	3900	1600	250 U
6A	5600	2000	1700 J	3700	6500	1300	2800	2500	370 J	1600	1100	620	700	4600	950	2600	1200	150 J
6B	1500	510	420 J	830	1600	290	720	630	130 U	470	340	110 J	290	1600	390	320	180	130 U
6C	3200	870	640 J	1300	3500	460	1100	1100	91 J	660	820	500	1000	3500	1000	2600	1000	210 U
6D	3900	1400	1200 J	2800	4900	1100	2000	2100	270 J	1600	970	440	1000	3700	1300	2000	800	300 U
7A	4500	1600	1600 J	3400	5700	1500	2600	2700	370 J	2000	990	180	520	3700	650	590	270	180 U
7B	2800	990	1100 J	2200	4300	900	1500	1700	290 J	1200	720	39 J	460	4200	600	140	150	120 U
7C	350	180	190 J	360	390	130	250	320	54 J	210	64 J	26 J	26 J	160	31 J	39 J	22 J	110 U
7D	670	330	300 J	560	820	220	390	470	65 J	320	140	50 J	80 J	330	75 J	93 J	56 J	110 U
8A	4400	1500	1300 J	3000	6100	1100	2200	2000	290	1700	1100	320	800	2700	1200	2200	470	170 U
8B	1200	300	270	610	1600	250	490	420	64 J	370	290	120	660	1600	570	420	280	50 J
8C	4250	2000	1850	3400	5500	1350	2200	2250	435 J	1400	1045	300	545	4100	800	860	375	110 J

J=Estimated concentration

U=The analyte was not detected at or above the value shown

Table E-3 (Cont'd). Concentration of PAHs and other semivolatile organics detected in sediments (µg/Kg, dry).

Station	4-Methylphenol	1,4-Dichlorobenzene	Phenol	Bis(2-EH) Phthalate	Dimethylphthalate	Dibenzofuran	3B-Coprostanol	Retene	Benzoic Acid	Diethylphthalate	Butylbenzylphthalate	Carbazole	Pentachlorophenol
1A	1750	150 J	232 J	340 UJ	190 U	645	3700 UJ	1300	410 J	190 U	930 U	190 U	930 U
1B	830	420	243 UJ	14000	240 U	840	51000 J	3500	1220 UJ	240 U	390 J	620	1200 U
1C	340	16 J	240 UJ	5100	280	280	6000 J	9700	1200 UJ	240 U	180 J	180 J	1200 U
2A	580	180 U	182 UJ	2700	230	480	3300 J	580	913 UJ	180 U	910 U	170 J	910 U
2B	93 J	110	100 UJ	3300	71 J	130	5700 J	150	500 UJ	100 UJ	290 J	320	500 U
2C	330	200 U	200 UJ	2100	160 J	370	5100 J	1200	1000 UJ	200 U	1000 U	120 J	1000 U
3A	110 U	110 U	108 UJ	538 UJ	110 U	32 J	1100 J	63 J	538 UJ	110 U	540 U	110 U	540 U
3B	900	240 U	241 UJ	1200 UJ	160 J	330	4800 UJ	600	1210 UJ	240 U	1200 U	240 U	1200 U
3C	200 J	220 U	219 UJ	3200	190 J	220	6800 J	720	1100 UJ	220 U	1100 U	220 U	1100 U
4A	190 J	220 U	224 UJ	3200	210 J	260	8200 J	1500	1120 UJ	220 U	1100 U	220 U	1100 U
4B	560	230 U	231 UJ	5100	230	540	8700 J	4200	1150 UJ	230 U	170 J	230 U	340 J
4C	41 J	110 U	109 UJ	1600	42 J	95 J	1300 J	140	2200 UJ	110 U	550 U	110 U	550 U
4D	930	180 U	210 UJ	1200 UJ	60 J	400	4200	2800	3500 UJ	176 UJ	880 U	130 J	880 U
4E	310 J	320 U	319 UJ	4100	340	350	6300 J	720	1590 UJ	320 U	1600 U	320 U	1600 U
4F	1100	190 U	200 UJ	3500	310	1400	5900	5400	960 UJ	190 U	160 J	510	960 U
5A	510	170 U	169 UJ	2100	85 J	380	2800 J	480	846 UJ	170 U	76 J	420	850 U
5B	97 U	97 U	37 J	97 UJ	97 U	6.8 J	1900 U	22 J	26 J	96 J	490 U	97 U	490 U
5C	2600	250 U	290	1800	190 J	700	3000 J	52000	380 J	250 U	1200 U	250	1200 U
6A	2700	280 U	320	12000	280 U	620	7900	11000	450 J	280 U	620 J	400	1400 U
6B	300	130 U	110 J	1700	130 U	240	8900	780	2500 UJ	130 U	130 J	130 U	630 U
6C	1600	210 U	180 J	1400	210 U	790	2700 J	74000 J	190 J	210 U	1100 U	210 U	1100 U
6D	900	300 U	220 J	2000	140 J	790	3300 J	8100	300 J	300 U	1500 U	170 J	1500 U
7A	220	180 U	210	2100	140 J	380	2500 J	650	170 J	77 J	900 U	280	900 U
7B	120 U	120 U	200	1300	120 U	370	2400 U	71 J	68 J	44 J	590 U	400	590 U
7C	110 U	110 U	110 U	210 UJ	110 U	19 J	2100 U	26 J	2100 U	110 U	530 U	110 U	530 U
7D	110 U	110 U	55 J	430 J	110 U	41 J	2100 U	60 J	100 J	110 U	130 J	110 U	530 U
8A	360	170 U	130 J	4100	170 U	710	1900 J	760	220 J	170 U	99 J	180	840 U
8B	430	110 U	79 J	730	110 U	390	2900 J	320	2200 UJ	40 J	35 J	62 J	550 U
8C	875	240 U	240 J	6750	180 J	495	11500 J	960	540 J	240 U	260 J	232 J	220 J

J=Estimated concentration

U=The analyte was not detected at or above the value shown

Table E-4. Concentration of PAHs in sediments.

Station	Total HPAH[1] (µg/Kg, dry)	mg HPAH/Kg OC	Total LPAH[2] (µg/Kg, dry)	mg LPAH/Kg OC	TOTAL PAHs[3] (µg/Kg, dry)	mg TOTAL PAH/Kg OC
1A	43585 J	519 JH	13295	158	56880 J	677 JH
1B	64900 J	969 JH	12780	191	77680 J	1159 JH
1C	23590 J	407 JH	4230	73	27820 J	480 JH
2A	24250 J	418 JH	4860	84	29110 J	502 JH
2B	21350 J	1941 JH	3678 J	334 JH	25028 J	2275 JH
2C	14630 J	236 JH	5050	81	19680 J	317 JH
3A	2981 J	157 JH	427 J	22 JH	3408 J	179 JH
3B	28740 J	479 JH	6440	107	35180 J	586 JH
3C	19850 J	368 JH	3360 J	62 JH	23210 J	430 JH
4A	20000 J	417 JH	3340	70	23340 J	486 JH
4B	30730 J	439 JH	7700	110	38430 J	549 JH
4C	6937 J	434 JH	1058 J	66 JH	7995 J	500 JH
4D	16720 J	315 JH	7320	138	24040 J	454 JH
4E	23060 J	391 JH	4840 J	82 JH	27900 J	473 JH
4F	62900 J	939 JH	21300	318	84200 J	1257 JH
5A	38940 J	1145 JH	7020	206	45960 J	1352 JH
5B	50 J	50 JH	57 J	57 JH	107 J	107 JH
5C	22700 J	166 JH	13700	100	36400 J	266 JH
6A	28070 J	202 JH	10570	76	38640 J	278 JH
6B	6970 J	303 JH	3050 J	133 JH	10020 J	436 JH
6C	12921 J	150 JH	9420	110	22341 J	260 JH
6D	21270 J	197 JH	9410	87	30680 J	284 JH
7A	25970 J	499 JH	6630	128	32600 J	627 JH
7B	16980 J	1415 JH	6159 J	513 JH	23139 J	1928 JH
7C	2434 J	348 JH	346 J	49 JH	2780 J	397 JH
7D	4145 J	518 JH	768 J	96 JH	4913 J	614 JH
8A	23590 J	605 JH	8320	213	31910 J	818 JH
8B	5574 J	429 JH	3660	282	9234 J	710 JH
8C	24635 J	373 JH	7650	116	32285 J	489 JH

[1] Sum of Pyrene, Benzo(g,h,i)perylene, Indeno(1,2,3-c,d)pyrene, Benzo(b)fluoranthene, Fluoranthene, Benzo(k)fluoranthene, Chrysene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, and Benzo(a)anthracene

[2] Sum of Anthracene, Acenaphthylene, Acenaphthene, Phenanthrene, Fluorene, and Naphthalene

[3] Sum of HPAH and LPAH

OC=Organic Carbon

J=Estimated concentration

H=Result may be biased due to excessive holding time for TOC

Table E-5. Concentration of PCBs in sediments (µg/Kg, dry).

Station	PCB-1016	PCB-1221	PCB-1232	PCB-1242	PCB-1248	PCB-1254	PCB-1260	TOTAL PCBs	mg TOTAL PCB/Kg OC
1A	93 U	93 U	93 U	93 U	93 U	250	150	400	4.8 H
1B	120 U	120 U	120 U	160	120 U	800	500	1460	22 H
1C	120 U	120 U	120 U	120 U	120 U	410 J	450	860 J	15 JH
2A	91 U	91 U	91 U	91 U	91 U	200	190 J	390 J	6.7 JH
2B	50 U	50 U	50 U	50 U	50 U	52	50 U	52	4.7 H
2C	100 U	100 U	100 U	100 U	100 U	140	100 U	140	2.3 H
3A	54 U	54 U	54 U	54 U	54 U	54 U	54 U	nd	nd
3B	120 U	120 U	120 U	120 U	120 U	110 J	120 U	110 J	1.8 JH
3C	110 U	110 U	110 U	110 U	110 U	240	180	420	7.8 H
4A	110 U	110 U	110 U	110 U	110 U	210	150	360	7.5 H
4B	115 U	115 U	115 U	115 U	115 U	280	220 J	500 J	7.1 JH
4C	55 U	55 U	55 U	55 U	55 U	52 J	55 U	52 J	3.3 JH
4D	88 U	88 U	88 U	88 U	88 U	130	100	230	4.3 H
4E	160 U	160 U	160 U	160 U	160 U	490	380	870	15 H
4F	96 U	96 U	96 U	96 U	96 U	630	920	1550	23 H
5A	85 U	85 U	85 U	85 U	85 U	210	150	360	11 H
5B	48 U	48 U	48 U	48 U	48 U	48 U	48 U	nd	nd
5C	120 U	120 U	120 U	120 U	120 U	350	120 U	350	2.6 H
6A	140 U	140 U	140 U	140 U	140 U	260 J	140 U	260 J	1.9 JH
6B	63 U	63 U	63 U	63 U	63 U	110	63 U	110	4.8 H
6C	60 U	60 U	60 U	60 U	60 U	120	60 U	120	1.4 H
6D	150 U	150 U	150 U	150 U	150 U	200	150 U	200	1.9 H
7A	90 U	90 U	90 U	90 U	90 U	9000 U	7600	7600	146 H
7B	59 U	59 U	59 U	59 U	59 U	190	59 U	190	16 H
7C	53 U	53 U	53 U	53 U	53 U	53 U	53 U	nd	nd
7D	53 U	53 U	53 U	53 U	53 U	36 J	53 U	36 J	4.5 JH
8A	84 U	84 U	84 U	84 U	84 U	180	130	310	7.9 H
8B	55 U	55 U	55 U	55 U	55 U	62	55 U	62	4.8 H
8C	120 U	120 U	120 U	120 U	120 U	490	395	885	13 H

OC=Organic Carbon

U=The analyte was not detected at or above the value shown

H=Result may be biased due to excessive holding time for TOC

J=Estimated concentration

nd=not detected

Table E-6. Concentration of butyltins in sediments (µg/Kg, dry).

Station	Monobutyltin Chloride	Dibutyltin Chloride	Tributyltin Chloride	Tetrabutyltin Chloride	TOTAL BUTYLTIN CHLORIDES	Tributyltin Chloride as Sn	Tributyltin Chloride as TBT$^+$
1A	86 J	12 J	364	9.3 U	462 J	133	324
1B	199 J	1380	7260	185 J	9024 J	2648	6461
1C	26	163	516	22	727	188	459
2A	158	455	1070	25	1708	390	952
2B	4.7 U	2.6 J	71	5 U	74 J	26	63
2C	60	225	537	17	839	196	478
3A	166	82	179	1.6 J	429 J	65	159
3B	83	72	295	17	467	108	263
3C	32	283	1390	32	1737	507	1237
4A	19	41	110	20	190	40	98
4B	30	450	1520	37	2037	554	1353
4C	9.5	27	87	7.9 U	124	32	77
4D	24	59	195	9.2 U	278	71	174
4E	428	387	1080	17	1912	394	961
4F	57	1170	2830	71	4128	1032	2519
5A	562	178	1040	9 J	1789 J	379	926
5B	540 UJ	5.7 U	6.1 UJ	5.9 U	nd	nd	nd
5C	57	261	535	23	876	195	476
6A	1180 UJ	250	540	7.2 J	797 J	197	481
6B	31	75	287	8.2 U	393	105	255
6C	69	24	80	13 U	173	29	71
6D	131	174	366	20 U	671	134	326
7A	135	130	577	9.8 J	852 J	210	514
7B	50	7 U	78	7.3 U	128	28	69
7C	17	58	78	6.5 U	153	28	69
7D	285	65	141	6.9 U	491	51	125
8A	734	456	2260	11	3461	824	2011
8B	86	22	91	12	211	33	81
8C	1535	452	1893	27 J	3907 J	690	1685

J=Estimated concentration

U=The analyte was not detected at or above the value shown

nd=not detected

SITE ASSESSMENT REPORT
TIME OIL CO. SITE 2750
2750 WEST COMMODORE WAY
SEATTLE, WASHINGTON

Project 783336

March 8, 2000

Prepared for:

Mr. Scott B. Sloan
Time Oil Co.
2737 West Commodore Way
Seattle, Washington 98199

Submitted by:
IT Corporation

Chris N. Storey
Chris Storey
Associate Engineer

Approved by:
IT Corporation

Chris N. Storey for:
Gerald Harris
Project Manager

EXECUTIVE SUMMARY

IT Corporation conducted a subsurface investigation at the Time Oil Co. property located at 2750 West Commodore Way in Seattle, Washington. The investigation area included the former location of an underground storage tank (UST) removed from the site in September of 1991. The UST was reported to have been used to store waste oil. The purpose of the investigation was to assess soil and groundwater for substances regulated by the current Washington State Model Toxics Control Act[1] (MTCA) Method A Compliance Cleanup Levels (Jan. 1996 revision). Tasks performed during the assessment included: 1) locating underground utilities; 2) drilling nine soil borings to a maximum depth of 26.5 feet below grade (bg) at strategic locations; 3) drilling and installing five groundwater monitoring wells; 4) collecting twenty-eight soil samples from the soil borings (continuously in soil boring 02SB-01 and at approximate 5-foot intervals in remaining borings and fifteen soil sample from the monitoring wells; 5) collecting eight soil boring water samples (one each from borings 02SB-02 through 02SB-09); 6) developing the wells and sampling the groundwater in each; 7) performing quantitative chemical analyses on the soil and water samples collected; 8) interpreting the information obtained; and 9) compiling and arranging the data for this report.

Observations and findings:

- Sediments observed underlying the site include orange brown to gray green sands and silts with varying amounts of clay and gravel predominating the site from the surface to a depth of approximately ten to fifteen feet below grade (bg). A very dense, dry gray clay underlies the sand/silt unit. This unit acts as an apparent aquitard at the site. Existing data show that the hydraulic conductivity of the clay is 1.7×10^{-8} cm/s (IT Corp., 2000).

- Two soil samples (02SB-01 at 3.5 ft below grade [bg] and 02SB-01 at 6 ft bg) contained TPH-D and TPH-O at concentrations that exceeded the 200 mg/kg MTCA CCL(a) for TPH as diesel and heavier oils. A third sample (02SB-08 at 3.5 feet below grade) contained TPH-O at a concentration of 426 mg/kg. This level exceeds the MTCA (CCL[a]. No other soil samples contained regulated substances in concentrations that exceeded the MTCA CCL(a)s.

- Soil sample 02SB-08 collected at a depth of 3.5 feet bg was also analyzed for total metals, organochlorine pesticides and PCBs, and volatile organic compounds due to its location down gradient of the former used oil tank. All regulated compounds were reported to be either not detected at the method reporting limit, or below their respective MTCA method A or method B guidelines.

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[1] Washington Department of Ecology (WAC 173-340), revised Jan. 1996

- Groundwater was encountered in eight of the nine borings and all of the groundwater monitoring wells. Groundwater was reported during drilling at depths of two to 23 feet bg. Boring 02SB-01 was discontinued before water was reached. The stabilized depth to groundwater in the monitoring wells ranged from 6.09 to 17.85 feet bg. Groundwater flow is to the north at a gradient of 0.007 feet per foot.

- Soil Boring Water Samples - Total petroleum hydrocarbons as gasoline (TPH-G) were reported to be above the CCL(a) in water samples 02SB-02H2O and 02SB-09H2O at concentrations of 8.26 milligrams per liter (mg/L) and 1.36 mg/L, respectively. TPH-D was reported to be above the CCL(a) in samples 02SB-02H2O, 02SB-03H2O, and 02SB-07H2O at concentrations ranging from 1.07 to 3.12 mg/l. Benzene was reported to be above the CCL(a) in samples 02SB-02H2O through 02SB-05H2O, and 02SB-09H2O at concentrations ranging from 6.64 micrograms per liter (ug/L) to 639 ug/L. Dissolved lead in the soil boring water samples was either not present or present below the CCL(a).

- Groundwater Monitoring Well Water Samples - The monitoring wells were sampled September 28, 1999. The TPH-G concentrations in the monitoring wells were similar to the concentrations found in the soil boring water samples: Two wells did not contain detectable TPH-G (02MW-02 and 02MW-05), two wells had TPH-G concentrations below the CCL(a), and remaining well (02MW-04) had a TPH-G concentration of 3.7 mg/l. Neither TPH-D nor TPH-O was detected in any of the wells. Benzene was not detected in wells 02MW-02 and 02MW-04 but was present in wells 02MW-01 and 02MW-03 at concentrations of 72.9 and 56.7 ug/l, respectively. These levels exceed the CCL(a) for benzene. Total lead exceeded the CCL(a) in unfiltered water samples collected from all wells except 02MW-03 (<1.00 ug/l). The highest total lead concentration was detected in 02MW-02 (133 ug/l).

CONTENTS

Figures

Tables

Appendices

1.0 INTRODUCTION/BACKGROUND

This report presents the work steps and results associated with subsurface investigation work conducted by IT Corporation at the Time Oil Co. property located at 2750 West Commodore Way in Seattle, Washington (Figure 1, Site Location Map). The work was conducted to assess the subsurface extent and concentration of substances regulated under the Washington Department of Ecology (WDOE) Model Toxics Control Act (MTCA; revised Jan. 1996). IT Corporation conducted this investigation at the request of the Time Oil Co.

1.1 Work Scope

The following outline summarizes the specific work conducted during the investigation:

- Reviewed the results of the previous investigation of the subject property.
- Located subsurface utilities.
- Drilled and sampled nine soil borings.
- Drilled, installed and developed five groundwater monitoring wells.
- Analyzed forty-three soil samples for petroleum compounds.
- Gauged, sampled and analyzed eight soil boring water samples and five groundwater monitoring well water samples for petroleum hydrocarbons and lead.
- Performed total metals, organochlorine pesticides and PCBs, and volatile organic compounds analysis on one soil sample.
- Evaluated, summarized and presented the information obtained in report form.

1.2 Background

The subject property (Figure 2) was the former site of a 300-gallon underground storage tank (UST). The UST location is shown in Figure 3. The UST stored used oil. This UST tank was removed from the site on September 16, 1991. Discolored soil and a petroleum odor were noted during the UST removal. An attempt was made to over-excavate hydrocarbon-affected soils after the UST was removed. Over-excavation activities were discontinued after approximately 100 cubic yards of affected soil had been removed. The resulting excavation measured approximately 35 feet by 20 feet and varied in depth from 2 to 6 feet. The northern boundary of the excavation appeared most heavily impacted and a hydrocarbon sheen was observed upon groundwater pooled in the excavation. A test pit was excavated approximately 20 feet north of the excavation in an effort to assess the lateral limits of the hydrocarbon impacts.

During the 1991 UST removal five soil samples were collected from the limits of the excavation and the test pit. The north sidewall of the excavation was not sampled due to the presence of visible hydrocarbon impacts. The soil samples were analyzed for TPH-diesel and TPH-motor oil. TPH-motor oil and/or diesel results in two of the five samples were equal to or exceeded the MTCA Soil Cleanup Levels were reported by the analytical laboratory (Appendix A, Table 2). Additional soil samples were collected from the limits of the excavation on December 10, 1991. The samples collected from the east and north sidewalls contained TPH concentrations exceeding MTCA Method A Soil Cleanup

Levels. TPH concentrations exceeding the CCL(a) ranged from 200 mg/kg to 25,000 mg/kg in soil samples 02-TIF, 02-TP1, 02-NS2, and 02-ES4 (Figure 3).

Additional excavation activities were conducted on July 28 and 29, 1992 in an effort to define and remove hydrocarbon-affected soils. Excavating activities were terminated on July 29, 1992 because observed impacts appeared to be increasing in severity to the east and excavation of the full extent of affected soils did not appear feasible. Approximately 150 cubic yards of soil were removed during the additional excavating activities. The excavation was backfilled by placing crushed rock from the bottom of the excavation to the top of the saturated zone. The crushed rock was then covered with a layer of 10-mil visqueen. The remaining excavation was backfilled with clean, imported fill sand.

During the 1992 excavation activities, eight soil samples were recovered from the limits of the expanded excavation (Figure 3). HCID analyses determined that TPH chromatogram patterns typical of gasoline, diesel, motor oil and mineral spirits were present in four of the soil samples. Follow-up analysis determined that BTEX concentrations appeared minimal but that TPH impacts (as gasoline, diesel, motor oil and mineral spirits) in excess of MTCA Soil Cleanup Levels were present in three samples (02-A2, 02-A6, and 02-WOWC). Concentrations ranged from 110 mg/kg to 2,800 mg/kg.

Details of work conducted in association with the UST removal conducted in September 1991, and the additional excavating activities conducted in July 1992, are presented respectively in Time Oil Co. reports dated December 30, 1991 and September 22, 1992 (Appendix A). Tank removal work conducted at the 2750 W. Commodore Way property is referenced as Excavation #2 in the December 1991 report. Since fuel service USTs were removed from 2737 W. Commodore Way on the same day, results of that UST removal are discussed as Excavation #1 in the same report. Work referenced as Excavation #1 is not applicable to the 2750 W. Commodore Way site.

2.0 GEOLOGY/HYDROGEOLOGY

The site is located on the south shore of Salmon Bay abutting the bay. The site topography slopes to the north from Commodore Way to the shoreline. The site has approximately 15 feet of relief from the southern high at Commodore Way to the shoreline. Sediments observed underlying the site include brown to gray green sands and silts with varying amounts of clay and gravel predominating the site from the surface to depths of approximately ten to thirty-five ft below grade (bg) depending upon location relative to the shoreline. A very dense, dry gray clay of unknown thickness underlies the site beginning at approximately 15 feet MSL (10-30 ft bg, depending on proximity to the shoreline). This unit is an apparent aquitard for the water table aquifer in this area.

Groundwater was encountered in eight of the nine the borings during drilling, excluding 02SB-01. The depth to groundwater was generally between 2 and 23 feet below grade. The stabilized depth to water in the groundwater monitoring wells ranged from 6.09 to 17.85 feet below grade. Groundwater flows to the north at a gradient of 0.007 feet per foot as measured on September 28, 1999 (Figure 5).

3.0 ASSESSMENT ACTIVITY

IT Corporation developed a work plan to install nine soil borings and five groundwater monitoring wells at strategic locations to assess subsurface conditions with respect to petroleum hydrocarbons (Figure 4). The locations of these borings were based on the findings of the underground storage tank (UST) decommissioning and excavation activities conducted by Time Oil Co. (Appendix A) and on site access considerations (underground utilities, fences, etc.). The monitoring wells were sited based upon the results of the soil boring phase of work.

Prior to the initiation of drilling activities, IT contracted Applied Professional Services (APS) to clear the proposed drilling area for underground utilities. In addition, IT contracted Apollo Geophysics to conduct an electromagnetic resonance and ground penetrating radar survey of the site to define any subsurface utilities noted during the APS work and to better define the area containing the terminals underground product lines. The product lines run northwesterly along the eastern edge of the site driveway (Figure 2).

3.1 Soil Borings

Nine soil borings were drilled on June 7 and June 11, 1999 by Cascade Drilling Inc. (Cascade) of Woodinville, Washington. The borings were advanced by hollow stem auger to depths ranging from 9 to 26.5 feet bg. A complete description of the exploration depths for each soil boring is shown in Table 1a, Drilling Summary. Boring locations are shown on Figure 4. Each boring was sampled using a 2-inch inside diameter, split-spoon sampler. An IT Corporation engineer supervised the drilling and maintained a log of the materials encountered in accordance with the Unified Soil Classification System (Appendix B, Drill Logs).

Soil samples were collected continuously in soil boring 02SB-01 and at approximate five-foot intervals in soil borings 02SB-02 through 02SB-09. Each soil sample was screened in the field for volatile hydrocarbons using a photo-ionization detector (PID). PID results are noted on the drill logs. Twenty-eight soil samples collected from the nine borings were submitted for laboratory analysis. Analytical methods and procedures are discussed in the following section. The drilling and soil sampling activities were conducted in accordance with the Standard Operating Procedures (SOP) presented in Appendix C.

Soil encountered in borings 02SB-01 through 02SB-09 were orange brown to gray green sands and silts with varying amounts of clay and gravel predominating the site from the surface to a depth of approximately ten to fifteen feet bg. A very dense, dry gray clay underlies the sand/silt unit. Cross sections of the site detailing the stratigraphy are shown in Figures 9 through 11.

Water was observed in all soil borings except 02SB-01. Depth to water ranged from approximately 2 to 20 feet bg.

3.2 Groundwater Monitoring Wells

Five groundwater monitoring wells were drilled and installed on September 13, 1999 by Cascade Drilling Inc. (Cascade) of Woodinville, Washington. The borings were advanced by hollow stem auger to a maximum depth of 35 feet bg. All of the wells were terminated near the upper boundary of the dense clay that underlies the site at a depth of 10-35 feet bg depending upon location. A description of the construction details for each well is shown in Table 1b. Well locations are shown on Figure 4. Wells 02-MW01, 02MW-04 and 02MW-05 were sampled at five-foot intervals using a 2-inch inside diameter, split-spoon sampler. Two wells (02MW-02, and -03) were drilled without sampling due to their proximity to the recently drilled soil borings. An IT Corporation engineer supervised the drilling and well installation. A log of the materials encountered and well as-built data is included in Appendix B, Drill Logs).

Soil samples were screened in the field for volatile hydrocarbons using a photo-ionization detector (PID). Fifteen soil samples collected from wells 02MW-01, 02MW-04, and 01MW-05 were submitted for laboratory analysis. Analytical methods and procedures are discussed in the following section.

The drilling and soil sampling activities were conducted in accordance with the Standard Operating Procedures (SOP) presented in Appendix C.

Soils encountered during the drilling of the monitoring wells were similar to those observed in the soil borings. In wells 02MW-01, -04 and –05 the dense, dry clay was encountered at 19, 19.5, and 35 ft bg, respectively.

Water was encountered in all five wells. The stabilized depth to water ranged from 6.09 to 17.85 feet bg. The direction of groundwater flow at the site was to the north at a gradient of 0.007 feet per foot between wells 02MW-02 and 02MW-05.

4.0 RESULTS

Soil and groundwater samples were collected during the drilling of the nine boreholes and five monitoring wells. These samples were collected using standard IT sampling protocols. The samples were stored on ice under chain of custody protocols for shipment to the project laboratory (North Creek Analytical). North Creek Analytical (NCA) is a Washington State certified laboratory. The results of the sampling effort are discussed below. Laboratory analytical results are referenced against the current MTCA Method A Compliance Cleanup Levels (Jan. 1996 revision).

4.1 Gauging Results

The wells were installed on September 11, 1999. After well development and prior to sampling, the wells were gauged for depth to water and apparent product thickness on September 28, 1999. The gauging results are summarized in Table 2. The depth to groundwater was generally between 14 and 19 feet below grade.

The stabilized depth to water in the groundwater monitoring wells ranged from 6.09 to 17.85 feet below grade. Groundwater flows to the north at a gradient of 0.007 feet per foot as measured on September 28, 1999 (Figure 5).

4.2 Soil

A total of 43 soil samples (28 from the soil borings, 15 from the monitoring wells) were selected for laboratory analysis during the project. The soil samples were analyzed by North Creek Analytical of Bothell, WA. Samples were analyzed for BTEX by EPA method 8021B, TPH-G by Method NWTPH-Gx, TPH-D and TPH-O by Method NWTPH-Dx and total lead by EPA Method 6000/7000. One soil sample was also analyzed for VOCs (EPA 8260B), pesticides/PCBs (EPA8081/8082), and RCRA metals (EPA 6000/7000 series methods).

4.2.1 Soil Boring Soil Samples

Two soil samples (02SB-01 at 3.5 ft below grade [bg] and 02SB-01 at 6 ft bg) contained TPH-D and TPH-O at concentrations that exceeded the 200 mg/kg MTCA CCL(a) for TPH as diesel and heavier oils. A third sample (02SB-08 at 3.5 feet below grade) contained TPH-O at a concentration of 426 mg/kg. This level exceeds the MTCA (CCL[a]. All other analyte concentrations, including the VOCs, PEST/PCBs, and RCRA metals in sample 02SB-08 were reported to be either below the CCL(a)/CCL(b) or reported as not detected at the method reporting limit. The additional analyses (VOCs, PEST/PCBs/RCRA metals) were run on sample 02SB-08 only due to the samples' TPH-O concentration and the borings' location down gradient of the former used oil tank. Chemical analytical results and CCL(a)s for soil are summarized in Tables 3 through 6. Complete laboratory reports for soil samples are contained in Appendix D.

4.2.2 Monitoring Well Soil Samples

None of the monitoring well soil samples contained TPH or BTEX concentrations that exceeded the CCL(a)s. Complete laboratory reports for soil samples are contained in Appendix D.

4.3 Water

Water samples were analyzed North Creek Analytical of Bothell, Washington. Eight soil boring water samples and five groundwater monitoring well water samples were analyzed for BTEX by EPA Method 8020, TPH-G by Method NWTPH-Gx, TPH-D and TPH-O by Method NWTPH-Dx, and total/dissolved lead by EPA 6020.

The water samples collected from the soil borings were collected using a stainless steel screen set in the open borehole. The results of the soil boring water samples were used to site the monitoring wells. Soil boring water samples are not considered to be representative of groundwater conditions. Water samples collected from the monitoring wells were collected according to standard IT Corporation procedures. These samples are considered to be representative of water quality at the site.

4.3.1 Soil Boring Water Samples

Total petroleum hydrocarbons as gasoline (TPH-G) were reported to be above the CCL(a) in water samples 02SB-02H2O and 02SB-09H2O at concentrations of 8.26 milligrams per liter (mg/L) and 1.36 mg/L, respectively. TPH-D was reported to be above the CCL(a) in samples 02SB-02H2O, 02SB-03H2O, and 02SB-07H2O at concentrations ranging from 1.07 to 3.12 mg/l. Benzene was reported to be above the CCL(a) in samples 02SB-02H2O through 02SB-05H2O, and 02SB-09H2O at concentrations ranging from 6.64 micrograms per liter (ug/L) to 639 ug/L. Dissolved lead in the soil boring water samples was either not present or present below the CCL(a). A summary of the water sample analytical results can be found in Table 7. Laboratory reports of the water analyses are contained in Appendix D.

4.3.2 Groundwater Monitoring Well Water Samples

The monitoring wells were sampled September 28, 1999. The TPH-G concentrations in the monitoring wells were similar to the concentrations found in the soil boring water samples: Two wells did not contain detectable TPH-G (02MW-02 and 02MW-05), two wells had TPH-G concentrations below the CCL(a), and remaining well (02MW-04) had a TPH-G concentration of 3.7 mg/l (Figure 6). Neither TPH-D nor TPH-O was detected in any of the wells. Benzene was not detected in wells 02MW-02 and 02MW-04 but was present in wells 02MW-01 and 02MW-03 at concentrations of 72.9 and 56.7 ug/l, respectively (Figure 7). These levels exceed the CCL(a) for benzene. Well 02MW-05 contained benzene at a concentration that was below the CCL(a). Total lead exceeded the CCL(a) in unfiltered samples collected from all wells except 02MW-03 (<1.00 ug/l; Figure 8). The highest total lead concentration was detected in 02MW-02 (133 ug/l). Dissolved lead samples were not collected from the monitoring wells. A summary of the analytical results can be found in Table 7. Laboratory reports of the water analyses are contained in Appendix D.

5.0 CONCLUSIONS

Nine soil borings and five groundwater monitoring wells were drilled in strategic locations to assess the subsurface conditions at Time Oil Co. Seattle Terminal Site 2750. The work was conducted during June and September, 1999.

Groundwater was encountered at depths of two to 23 feet bg during drilling. Static water levels at the site ranged from 6.02 to 17.85 feet bg in the groundwater monitoring wells.

With the exception of one soil sample from boring 02SB-08 and two samples from 02SB-01, the site soils are in compliance with the MTCA CCL(a)s for all site contaminants of concern. The three samples cited above all contained non-compliant levels of TPH-D or TPH-O only.

Site groundwater is impacted with gasoline range hydrocarbons, and benzene. The impacts appear to be restricted to the site wells located in the middle and upgradient of the site relative to the original site work performed in 1991-2. Total lead in the groundwater exceed the CCL(a), however, dissolved lead samples collected from soil boring water samples indicates that the lead at the site is due to suspended sediments.

6.0 RECOMMENDATIONS

IT recommends additional assessment of the groundwater conditions at the site. This includes monitoring of the newly installed wells and the installation of additional borings/wells to define the extent of the groundwater impacts to the south, east, and west of the study area.

7.0 REFERENCES

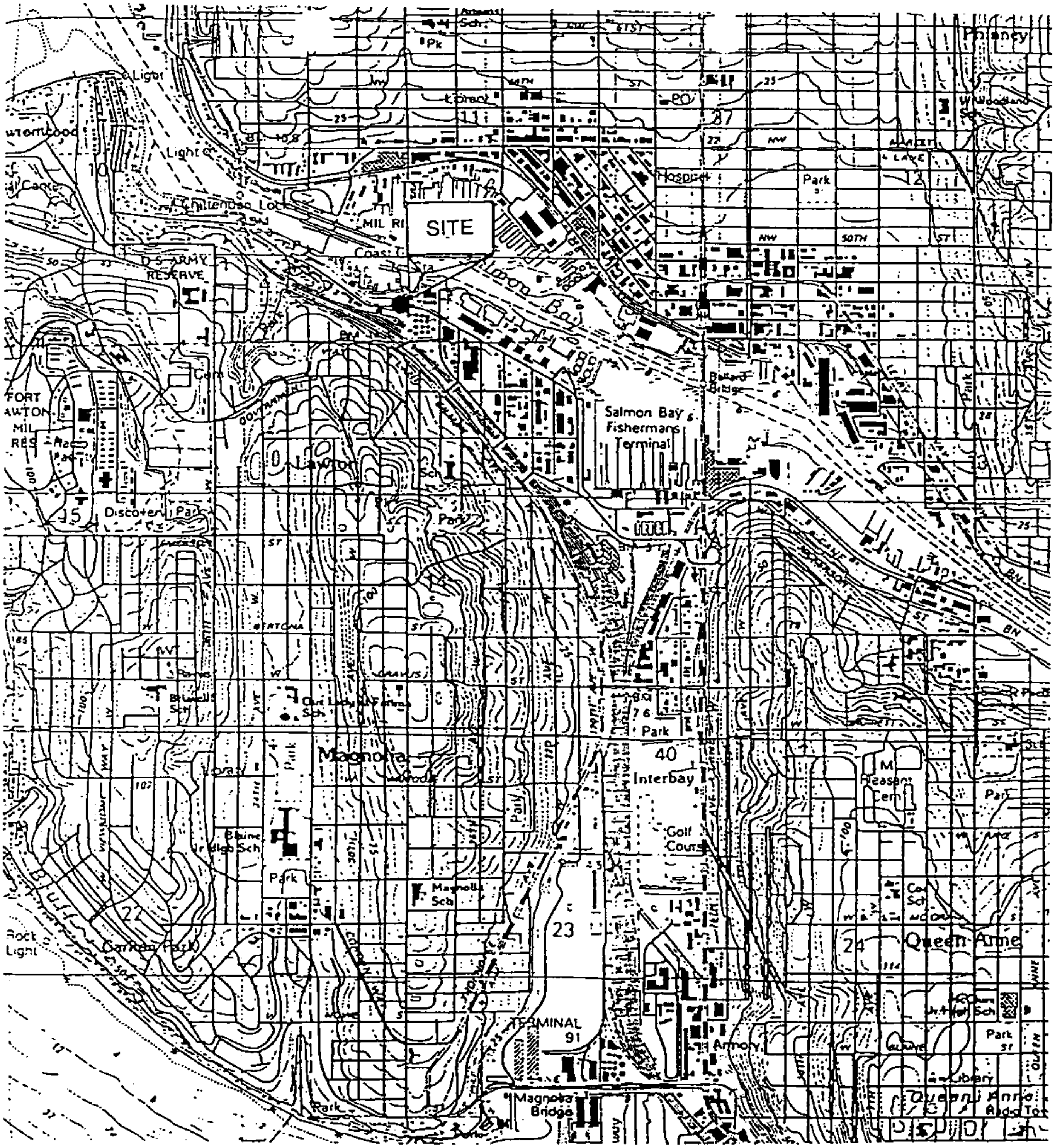
IT Corp., 2000. Site Assessment Report – Time Oil Co. Site 2737, 2737 West Commodore Way, Seattle, Washington. January 26, 2000.

Sloan, Scott B., 1991. Letter report "Underground Storage Tank Site Check/Site Assessment as Seattle Terminal", Time Oil Co. Company. December 30, 1991.

Sloan, Scott B., 1992. Letter report "Excavating Activities Conducted at Former Waste Oil Tank Location Former Time Oil Co. Maintenance Facility", Time Oil Co. Company. September 22, 1992.

Washington State Department of Ecology. Model Toxics Control Act, WAC 173-340. Revised Jan. 1996.

FIGURES



IT CORPORATION

SOURCE: U.S.G.S. 7.5' QUAD SHEET
Seattle North, Washington
Photorevised 1983

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SCALE:
0 FEET 2000

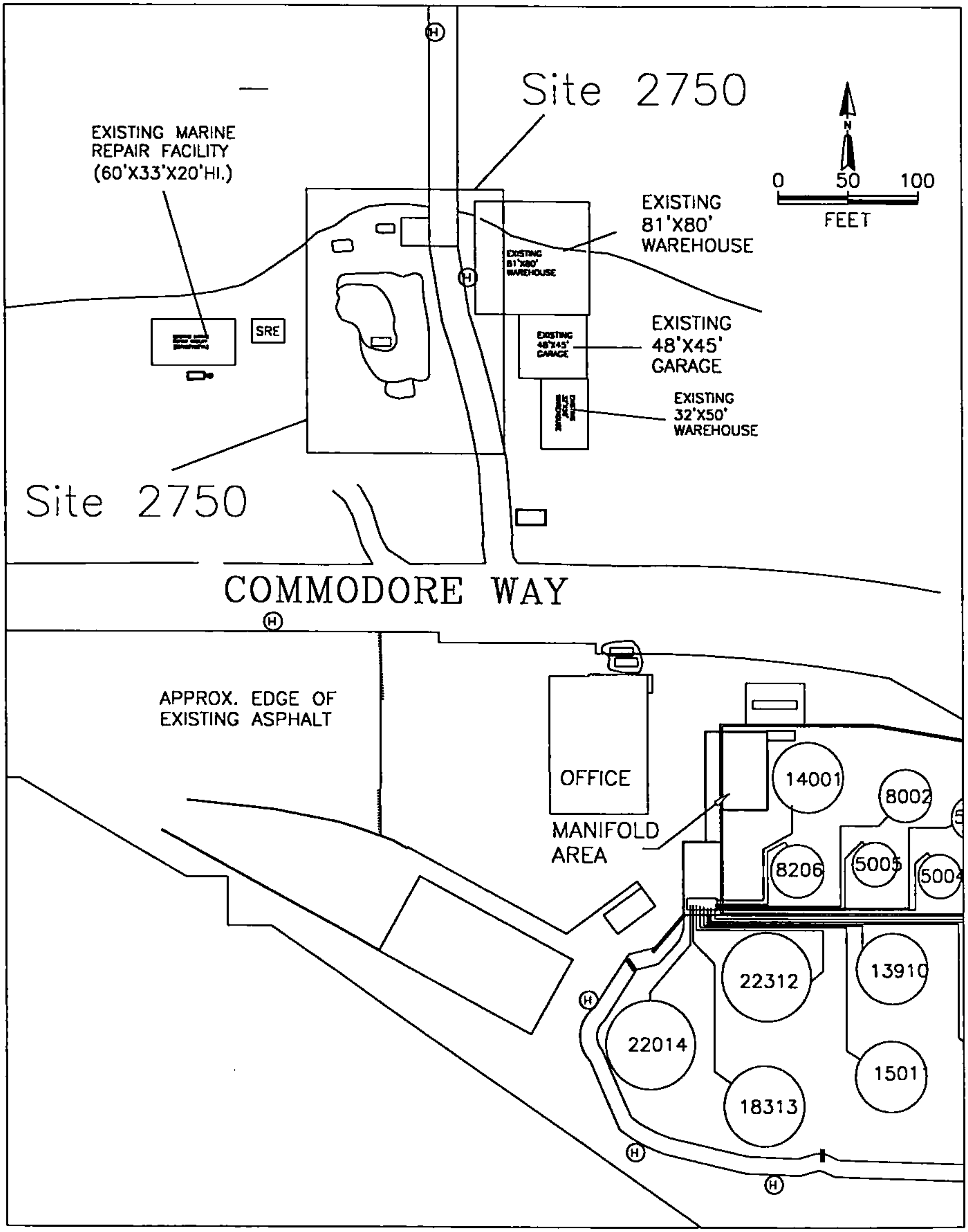
SITE LOCATION MAP

CLIENT:
Time Oil Co.

DATE:
7/28/99

LOCATION:
2737–3031 West Commodore Way
Seattle, Washington

FIGURE:
1

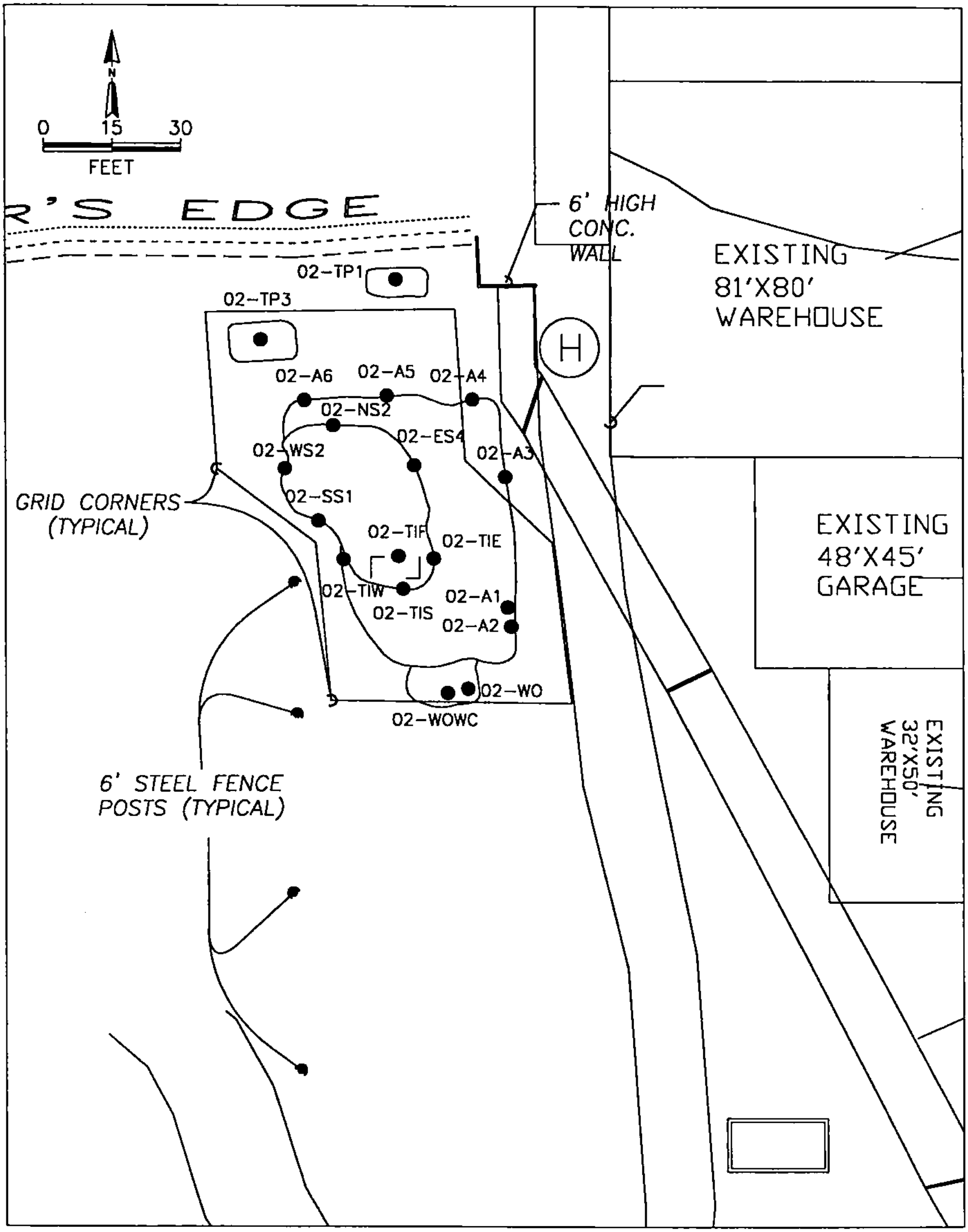


IT CORPORATION

TITLE:
Vicinity Map
Time Oil Co. Site 2750
Seattle, Washington

DWN:
DES.: jh
CHKD:
APPD:
DATE: 7/28/99
REV.: 1

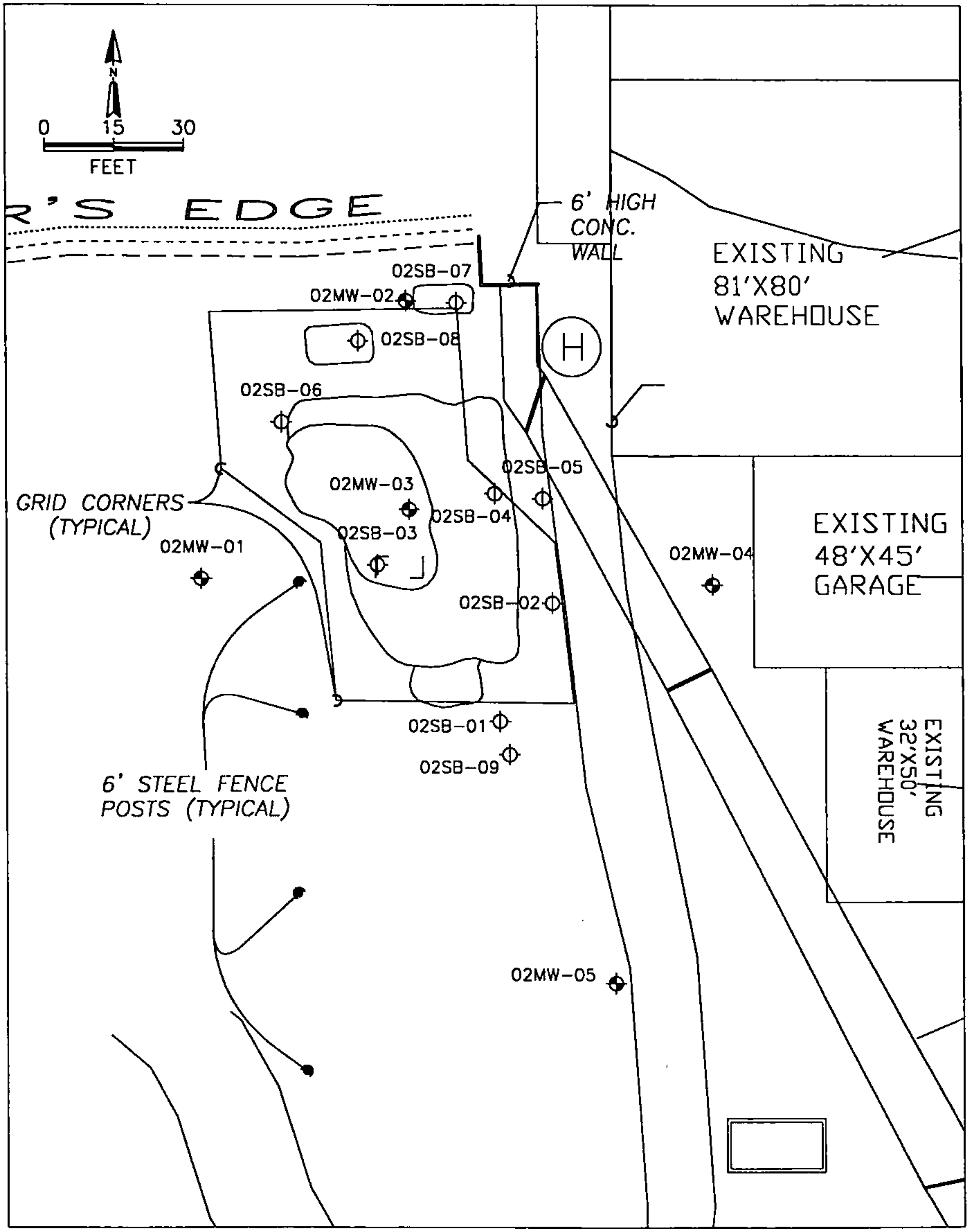
PROJECT NO.: 783336
FIGURE NO.: 2



IT CORPORATION

TITLE:
Historical Sample Locations
Seattle Terminal Site 2750
Time Oil Co., Seattle, Washington

DWN: jh	DES.: jh	PROJECT NO.: 783336
CHKD:	APPD:	
DATE: 1/25/00	REV.: 2	FIGURE NO.: 3



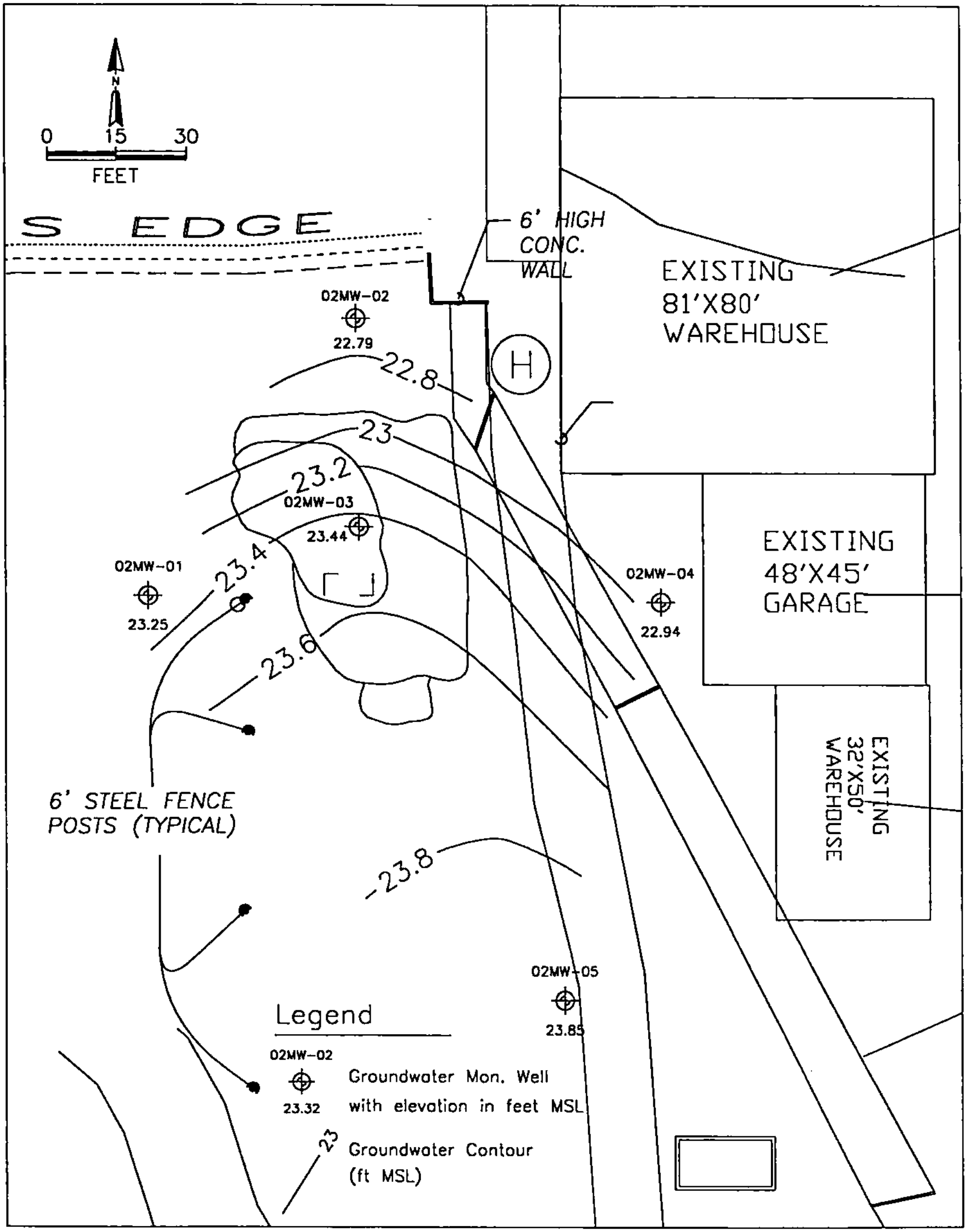
IT CORPORATION

TITLE:
1999 Sample Locations
Seattle Terminal Site 2750
Time Oil Co., Seattle, Washington

DWN: jh
DES.: jh
CHKD:
APPD:
DATE: 1/25/00
REV.: 1

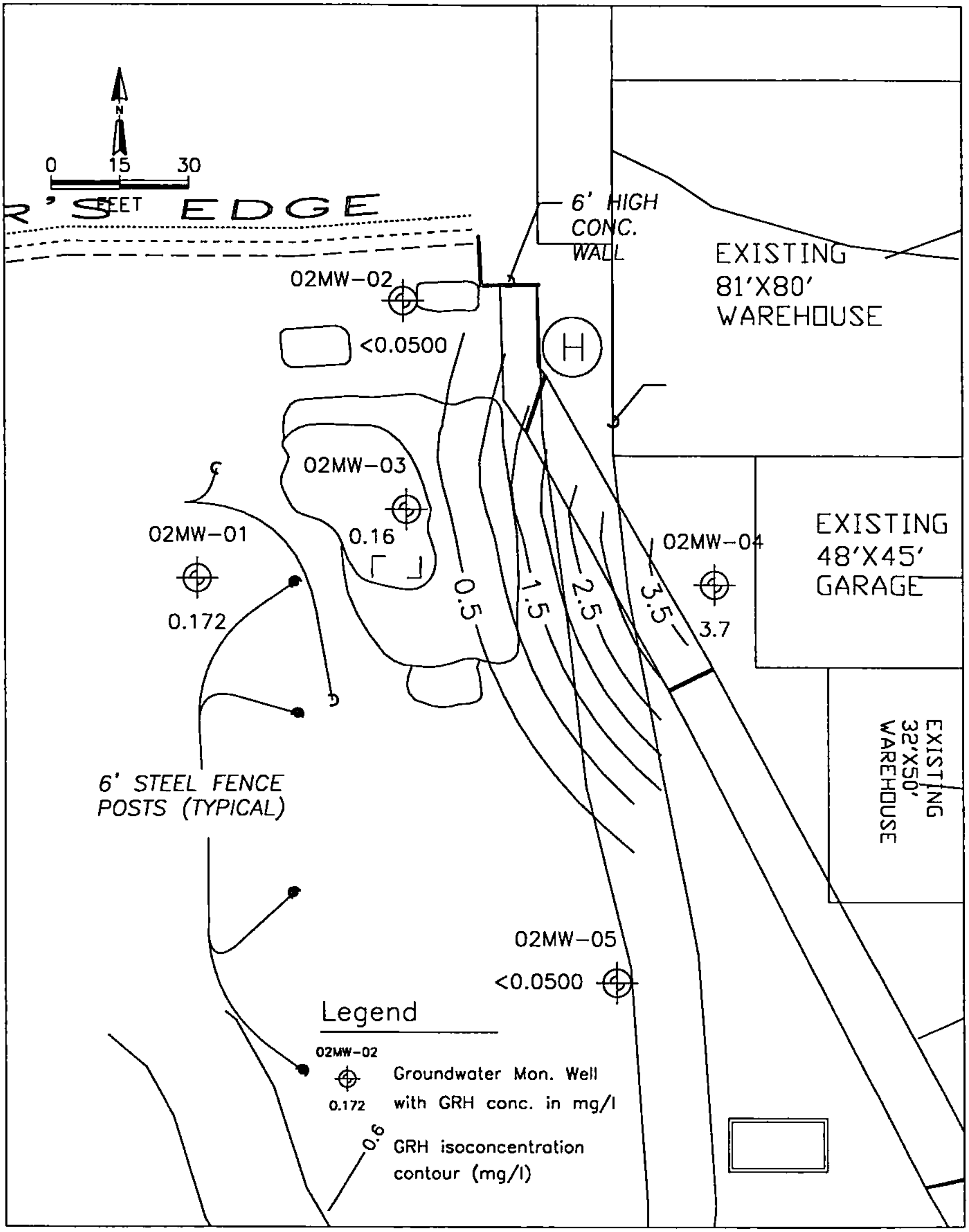
PROJECT NO.: 783336

FIGURE NO.: 4



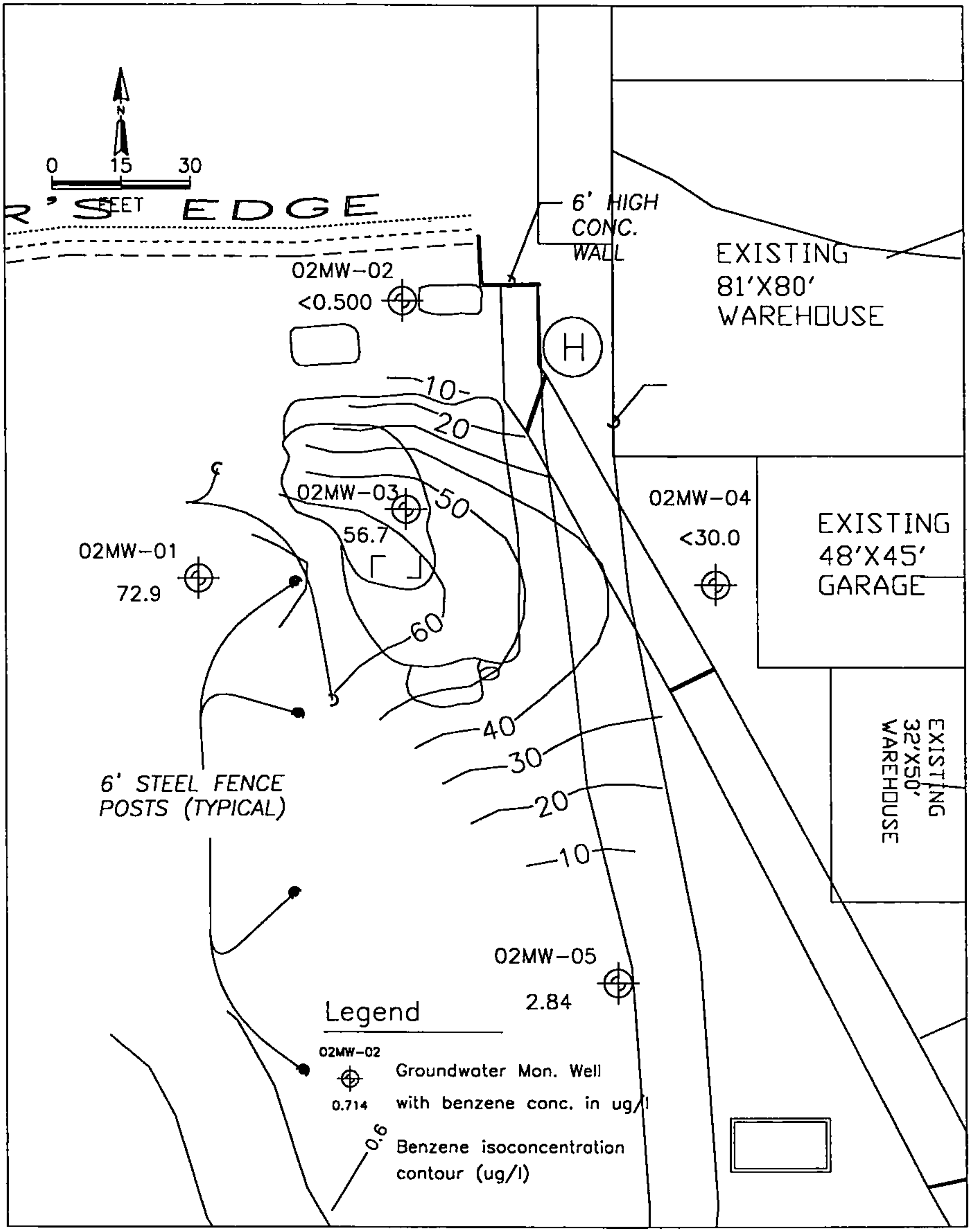
IT CORPORATION

TITLE: Groundwater Contour Map Seattle Terminal Site 2750 Time Oil Co., Seattle, WA	DWN:	DES.:	PROJECT NO.: 783336
	CHKD:	APPD:	
	DATE: 1/7/00	REV.: 1	FIGURE NO.: 5



IT CORPORATION

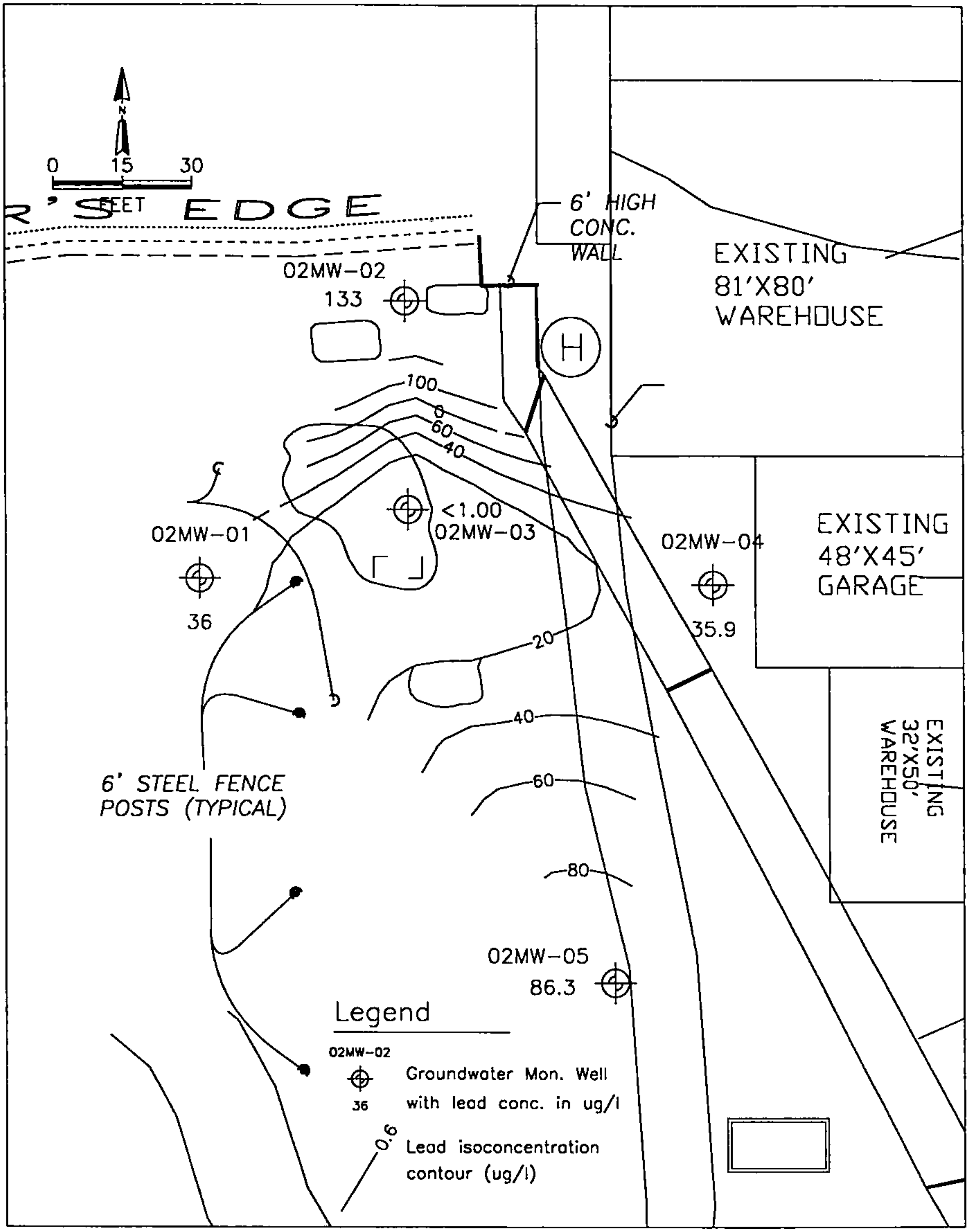
TITLE: GRH in Groundwater (ug/l) Seattle Terminal Site 2750 Time Oil Co., Seattle, Washington	DWN: jh	DES.: jh	PROJECT NO.: 783336
	CHKD:	APPD:	FIGURE NO.: 6
	DATE: 1/20/00	REV.: 1	



IT CORPORATION

TITLE:
Benzene in Groundwater (ug/l)
Seattle Terminal Site 2750
Time Oil Co., Seattle, Washington

DWN: jh	DES.: jh	PROJECT NO.: 783336
CHKD:	APPD:	
DATE: 1/20/00	REV.: 1	FIGURE NO.: 7

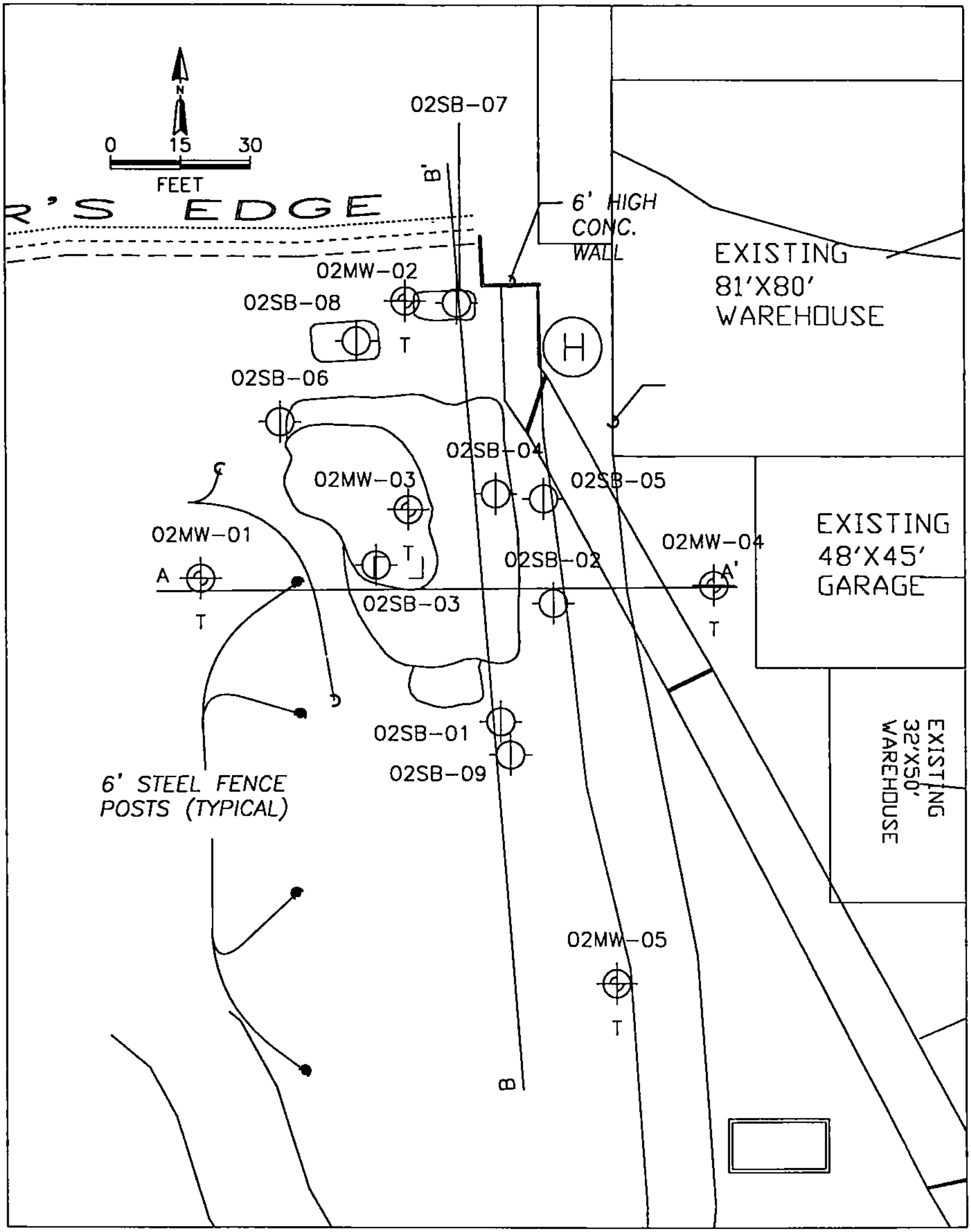


IT CORPORATION

TITLE:
Lead in Groundwater (ug/l)
Seattle Terminal Site 2750
Time Oil Co., Seattle, Washington

DWN: jh
DES.: jh
CHKD:
APPD:
DATE: 1/20/00
REV.: 1

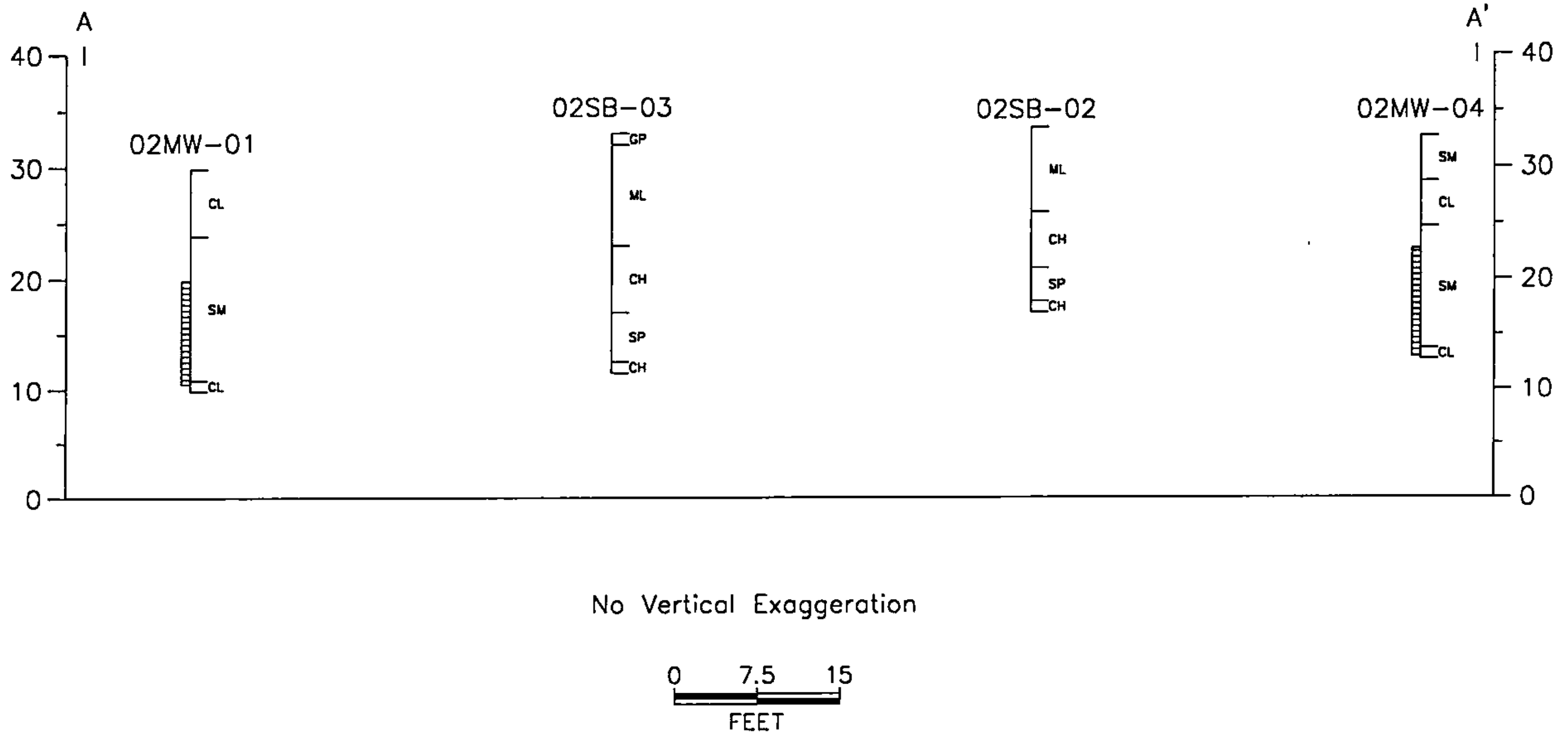
PROJECT NO.: 783336
FIGURE NO.: 8



IT CORPORATION

TITLE:
Cross Section Location Map
Seattle Terminal Site 2750
Time Oil Co., Seattle, Washington

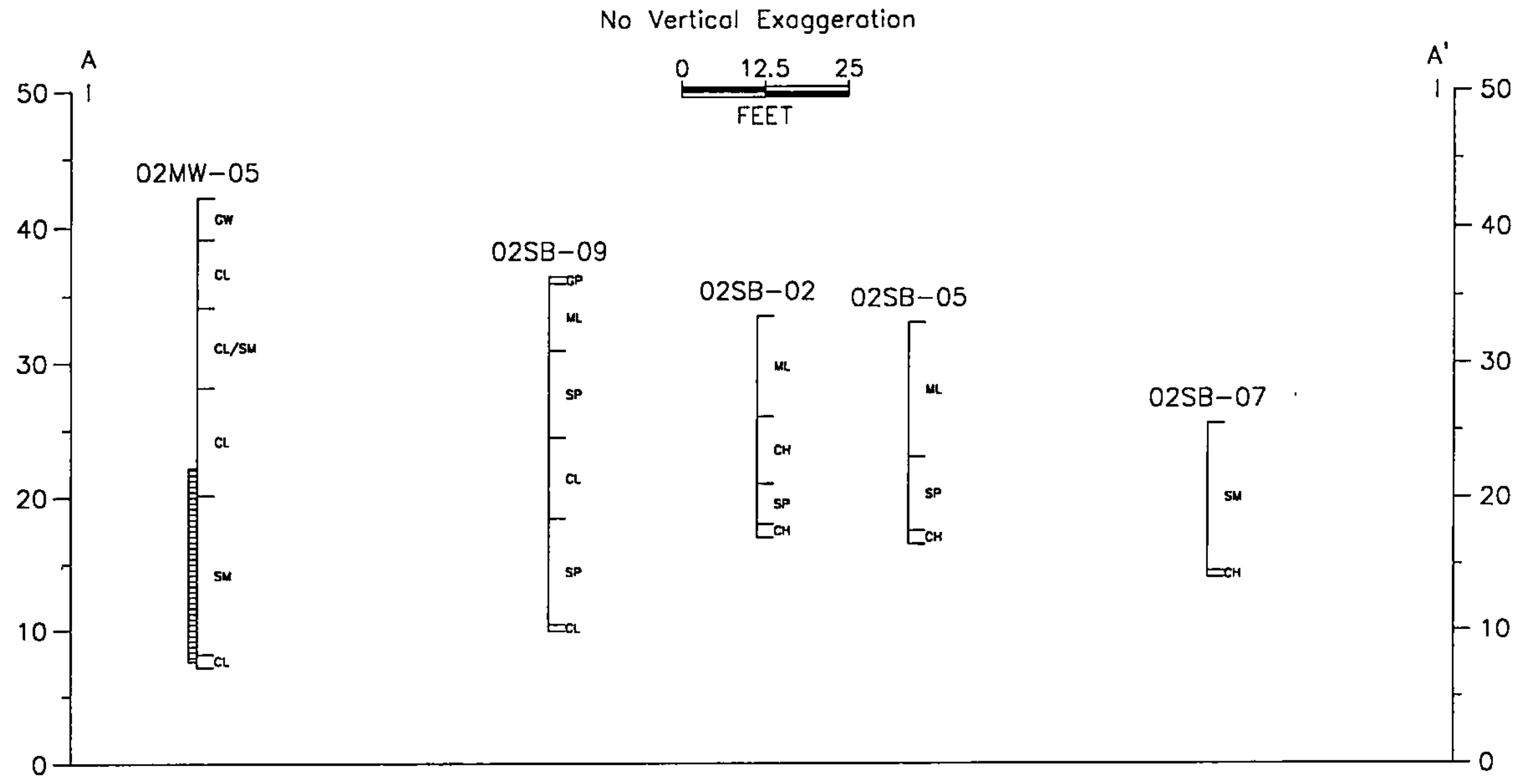
DWN: jh	DES.: jh	PROJECT NO.: 783336
CHKD:	APPD:	FIGURE NO.: 9
DATE: 1/25/00	REV.: 2	



IT CORPORATION

TITLE:
Cross Section A–A'
Seattle Terminal Site 2750
Time Oil Co., Seattle, Washington

DWN: jh	DES.: jh	PROJECT NO.: 783336
CHKD:	APPD:	
DATE: 1/25/00	REV.: 2	FIGURE NO.: 10



IT CORPORATION

TITLE:
Cross Section B–B'
Seattle Terminal Site 2750
Time Oil Co., Seattle, Washington

DWN: jh	DES.: jh	PROJECT NO.: 783336	
CHKD:	APPD:	FIGURE NO.: 11	
DATE: 1/25/00	REV.: 2		

TABLES

Table 1a.
Drilling Summary for Soil Borings
Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, WA

SITE	SURVEY COORDINATES			BORE DEPTH TOTAL (feet bgs)	DATE	DRILLING METHOD	DRILLER	CONSULTANT
	X	Y	Z					
02SB-01	4176.5	5448.0	0.00	14.00	06/07/99	Hollow Stem Auger	CASCADE	IT
02SB-02	4187.8	5473.7	0.00	16.50	06/07/99	Hollow Stem Auger	CASCADE	IT
02SB-03	4149.8	5481.9	0.00	21.50	06/07/99	Hollow Stem Auger	CASCADE	IT
02SB-04	4175.5	5497.3	0.00	16.50	06/07/99	Hollow Stem Auger	CASCADE	IT
02SB-05	4185.8	5496.3	0.00	16.50	06/07/99	Hollow Stem Auger	CASCADE	IT
02SB-06	4129.2	5512.7	0.00	11.50	06/07/99	Hollow Stem Auger	CASCADE	IT
02SB-07	4167.2	5538.4	0.00	11.50	06/07/99	Hollow Stem Auger	CASCADE	IT
02SB-08	4145.7	5530.2	0.00	9.00	06/07/99	Hollow Stem Auger	CASCADE	IT
02SB-09	4178.6	5440.8	0.00	26.50	06/11/99	Hollow Stem Auger	CASCADE	IT

Table 1b.
Drilling Summary for Monitoring Wells
Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, Washington

SITE	WELL DEPTH (feet bgs)	TOTAL DEPTH (feet bgs)	GROUND SURFACE ELEVATION (feet)	MP ELEVATION (feet)	CASING DIAMETER (inches)	SCREENS (feet bgs)		ANNULAR FILLS (feet bgs)	
						INTERVAL	DESCRIPTION	INTERVAL	TYPE
02MW-01	19.33	20.00	0.00	29.34	2.00	10.0-19.3	Slotted PVC		
02MW-02	9.82	10.00	0.00	25.20	2.00	5.0-9.8	Slotted PVC		
02MW-03	19.80	20.00	0.00	33.02	4.00	10.0-19.8	Slotted PVC		
02MW-04	19.80	20.00	0.00	32.31	2.00	10.0-19.8	Slotted PVC		
02MW-05	34.54	35.00	0.00	41.70	2.00	20.0-34.5	Slotted PVC		

Table 2
Monitoring Well Gauging Results
Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, Washington

DATE	SITE	MP ELEVATION	TIME	DEPTH TO WATER	FLOATING PRODUCT THICKNESS	WATER ELEV.	CHANGE IN WATER ELEV.	EQUIV. FRESH WATER HEAD
9/28/99	02MW-01	29.34	10:05	6.09	0	23.25	NA	23.25
9/28/99	02MW-02	25.20	9:55	2.41	0	22.79	NA	22.79
9/28/99	02MW-03	33.02	10:00	9.58	0	23.44	NA	23.44
9/28/99	02MW-04	32.31	9:50	9.37	0	22.94	NA	22.94
9/28/99	02MW-05	41.70	9:45	17.85	0	23.85	NA	23.85

All Measurements in Feet Based on Mean Sea Level

Table 3
Soil Sample Analytical Results - NWTPH/BTEX/Lead
Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, WA

SITE	DATE	DEPTH (ft)	Gasoline Range Hydrocarbons (mg/kg)	Diesel Range Hydrocarbons (mg/kg)	Heavy Oil Range Hydrocarbons (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (total) (mg/kg)
MTCA/A/U			100	200	200	0.5	40	20	20
02MW-01	09/13/99	5.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-01	09/13/99	10.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-01	09/13/99	15.00	<5.00	10.5	27.7	<0.0500	<0.0500	<0.0500	<0.100
02MW-01	09/13/99	19.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-04	09/13/99	2.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-04	09/13/99	5.00	6.88	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-04	09/13/99	10.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-04	09/13/99	15.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-04	09/13/99	19.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-05	09/13/99	5.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-05	09/13/99	10.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-05	09/13/99	15.00	<5.00	10.3	37.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-05	09/13/99	20.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-05	09/13/99	25.00	<5.00	<10.0	<25.0	0.222	<0.0500	<0.0500	<0.100
02MW-05	09/13/99	30.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02MW-05	09/13/99	34.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-01	06/07/99	3.50	<5.00	540	1320	<0.0500	<0.0500	<0.0500	<0.100
02SB-01	06/07/99	6.00	<5.00	285	712	<0.0500	<0.0500	<0.0500	<0.100
02SB-01	06/07/99	8.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-01	06/07/99	10.50	<5.00	<10.0	31.2	<0.0500	<0.0500	<0.0500	<0.100
02SB-01	06/07/99	12.50	<5.00	<10.0	<25.0	<0.0500	0.0596	<0.0500	<0.100
02SB-02	06/07/99	3.50	<5.00	14	42.7	<0.0500	<0.0500	<0.0500	<0.100
02SB-02	06/07/99	8.50	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-02	06/07/99	13.50	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-02	06/07/99	15.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-03	06/07/99	5.50	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100

Values represent total concentrations unless noted < =Not detected at indicated reporting limit --- =Not analyzed

Limit 2 is used for results comparison For RCL REPT_01S MTCA/A/U = MTCA Method A Cleanup Levels (revised 1/96)

Table 3
Soil Sample Analytical Results - NWTPH/BTEX/Lead
Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, WA

SITE	DATE	DEPTH (ft)	Lead (mg/kg)
MTCA/A/U			250
02MW-01	09/13/99	5.00	3.86
02MW-01	09/13/99	10.00	3.59
02MW-01	09/13/99	15.00	1.81
02MW-01	09/13/99	19.00	6.46
02MW-04	09/13/99	2.00	5.04
02MW-04	09/13/99	5.00	7.15
02MW-04	09/13/99	10.00	2.47
02MW-04	09/13/99	15.00	2.26
02MW-04	09/13/99	19.00	6.77
02MW-05	09/13/99	5.00	6.91
02MW-05	09/13/99	10.00	2.82
02MW-05	09/13/99	15.00	6.92
02MW-05	09/13/99	20.00	3.97
02MW-05	09/13/99	25.00	1.69
02MW-05	09/13/99	30.00	3.37
02MW-05	09/13/99	34.00	3.46
02SB-01	06/07/99	3.50	11.1
02SB-01	06/07/99	6.00	15.1
02SB-01	06/07/99	8.00	2.8
02SB-01	06/07/99	10.50	6.03
02SB-01	06/07/99	12.50	6.18
02SB-02	06/07/99	3.50	22.8
02SB-02	06/07/99	8.50	5
02SB-02	06/07/99	13.50	2.79
02SB-02	06/07/99	15.00	2.29
02SB-03	06/07/99	5.50	4.49

Values represent total concentrations unless noted   < = Not detected at indicated reporting limit   --- = Not analyzed

Limit 2 is used for results comparison   For RCL REPT_01S   MTCA/A/U = MTCA Method A Cleanup Levels (revised 1/96)

Table 3

Soil Sample Analytical Results - NWTPH/BTEX/Lead

Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, WA

SITE	DATE	DEPTH (ft)	Gasoline Range Hydrocarbons (mg/kg)	Diesel Range Hydrocarbons (mg/kg)	Heavy Oil Range Hydrocarbons (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (total) (mg/kg)
MTCA/A/U			100	200	200	0.5	40	20	20
02SB-03	06/07/99	11.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-03	06/07/99	16.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-03	06/07/99	20.00	<5.00	11.3	38.8	<0.0500	<0.0500	<0.0500	<0.100
02SB-04	06/07/99	10.50	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-04	06/07/99	15.00	<5.00	15.2	62.5	<0.0500	<0.0500	<0.0500	<0.100
02SB-05	06/07/99	6.00	<5.00	17.6	64.5	<0.0500	<0.0500	<0.0500	<0.100
02SB-05	06/07/99	11.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-05	06/07/99	15.50	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-06	06/07/99	5.50	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-06	06/07/99	10.50	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-07	06/07/99	5.50	<5.00	61.8	53.1	<0.0500	<0.0500	<0.0500	0.134
02SB-07	06/07/99	10.50	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-08	06/07/99	3.50	72.6	127	428	<0.0500	<0.0500	<0.0800	<0.570
02SB-08	06/07/99	8.50	<5.00	<10.0	38.1	<0.0500	<0.0500	<0.0500	<0.100
02SB-09	06/11/99	6.00	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-09	06/11/99	10.00	<5.00	<10.0	<25.0	<0.0500	0.0699	<0.0500	<0.100
02SB-09	06/11/99	15.50	<5.00	<10.0	<25.0	<0.0500	<0.0500	<0.0500	<0.100
02SB-09	06/11/99	20.50	<5.00	11	<25.0	<0.0500	<0.0500	<0.0500	<0.100

Values represent total concentrations unless noted   < = Not detected at indicated reporting limit   --- = Not analyzed

Limit 2 is used for results comparison   For RCL REPT_01S   MTCA/A/U = MTCA Method A Cleanup Levels (revised 1/96)

Table 3
Soil Sample Analytical Results - NWTPH/BTEX/Lead
Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, WA

SITE	DATE	DEPTH (ft)	Lead (mg/kg)
MTCA/A/U			250
02SB-03	06/07/99	11.00	6.16
02SB-03	06/07/99	16.00	2.99
02SB-03	06/07/99	20.00	3.5
02SB-04	06/07/99	10.50	2.57
02SB-04	06/07/99	15.00	2.97
02SB-05	06/07/99	6.00	18
02SB-05	06/07/99	11.00	3.72
02SB-05	06/07/99	15.50	4.23
02SB-06	06/07/99	5.50	2.78
02SB-06	06/07/99	10.50	2.2
02SB-07	06/07/99	5.50	7.85
02SB-07	06/07/99	10.50	2.4
02SB-08	06/07/99	3.50	10.6
02SB-08	06/07/99	8.50	3.02
02SB-09	06/11/99	6.00	---
02SB-09	06/11/99	10.00	---
02SB-09	06/11/99	15.50	---
02SB-09	06/11/99	20.50	---

Values represent total concentrations unless noted < = Not detected at indicated reporting limit --- = Not analyzed

Limit 2 is used for results comparison For RCL REPT_01S MTCA/A/U = MTCA Method A Cleanup Levels (revised 1/96)

Table 4
Soil Sample Analytical Results - VOCs
Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, WA

CONSTITUENT (Units in mg/kg)	
SITE	**02SB-08**
SAMPLE ID	**02SB-08A**
DATE	**06/07/99**
DEPTH (ft)	**3.50**
Carbon tetrachloride	<0.100
Acetone	<2.00
Chloroform	<0.100
Benzene	---
1,1,1-Trichloroethane	<0.100
Bromomethane	<0.100
Chloromethane	<0.500
Dibromomethane	<0.100
Bromochloromethane	<0.100
Chloroethane	<0.100
Vinyl chloride	<0.100
Methylene chloride	<1.00
Carbon disulfide	<0.100
Bromoform	<0.100
Bromodichloromethane	<0.100
1,1-Dichloroethane	<0.100
1,1-Dichloroethene	<0.100
Trichlorofluoromethane	<0.100
Dichlorodifluoromethane	<0.100
1,2-Dichloropropane	<0.100
2-Butanone	<1.00
1,1,2-Trichloroethane	<0.100
Trichloroethene	<0.100
1,1,2,2-Tetrachloroethane	<0.100
1,2,3-Trichlorobenzene	<0.100
Hexachlorobutadiene	<0.100
Naphthalene	<0.100
o-Xylene	<0.100
2-Chlorotoluene	<0.100
1,2-Dichlorobenzene	<0.100
1,2,4-Trimethylbenzene	0.102
1,2-Dibromo-3-chloropropane	<0.500
1,2,3-Trichloropropane	<0.100

Values represent total concentrations unless noted < = Not detected at indicated reporting limit --- = Not analyzed

Limit 2 is used for results comparison For RCL 8260BNCAB

Table 4
Soil Sample Analytical Results - VOCs
Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, WA

CONSTITUENT (Units in mg/kg)	SITE SAMPLE ID DATE DEPTH (ft)	02SB-08 02SB-08A 06/07/99 3.50
tert-Butylbenzene		<0.100
Isopropylbenzene		<0.100
p-Isopropyltoluene		<0.100
4-Nitroaniline		<0.200
Ethylbenzene		---
Styrene		<0.100
n-Propylbenzene		<0.100
n-Butylbenzene		<0.100
4-Chlorotoluene		<0.100
1,4-Dichlorobenzene		<0.100
1,2-Dibromoethane		<0.100
1,2-Dichloroethane		<0.100
4-Methyl-2-pentanone		<1.00
1,3,5-Trimethylbenzene		<0.100
Bromobenzene		<0.100
Toluene		---
Chlorobenzene		<0.100
1,2,4-Trichlorobenzene		<0.100
Dibromochloromethane		<0.100
Tetrachloroethene		<0.100
sec-Butylbenzene		<0.100
1,3-Dichloropropane		<0.100
cis-1,2-Dichloroethene		<0.100
trans-1,2-Dichloroethene		<0.100
1,3-Dichlorobenzene		<0.100
1,1-Dichloropropene		<0.100
2,2-Dichloropropane		<0.100
2-Hexanone		<1.00
1,1,1,2-Tetrachloroethane		<0.100
Methyl tert-butyl ether		---
cis-1,3-Dichloropropene		<0.100
trans-1,3-Dichloropropene		<0.100

Values represent total concentrations unless noted   < = Not detected at indicated reporting limit   --- = Not analyzed

Limit 2 is used for results comparison   For RCL 8260BNCAB

Table 5
Soil Sample Analytical Results - PEST/PCBs
Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, WA

CONSTITUENT (Units in ug/kg)		
	SITE	02SB-08
	SAMPLE ID	02SB-08A
	DATE	06/07/99
	DEPTH (ft)	3.50
4,4'-DDT		<1.00
CHLORDANE		<1.00
gamma-BHC (Lindane)		<1.00
DIELDRIN		<2.00
ENDRIN		<2.00
Methoxychlor		<4.00
4,4'-DDD		<1.00
4,4'-DDE		<1.00
HEPTACHLOR		<1.00
ALDRIN		<1.00
alpha-BHC		<0.500
beta-BHC		<0.900
delta-BHC		<0.600
Endosulfan I		<1.00
Heptachlor epoxide		<1.00
Endosulfan sulfate		<1.00
alpha-Chlordane		<0.800
gamma-Chlordane		<0.700
Endrin aldehyde		<2.00
Toxaphene		<50.0
Aroclor 1260		<50.0
Aroclor 1254		<50.0
Aroclor 1268		<50.0
Aroclor 1221		<50.0
Aroclor 1232		<50.0
Aroclor 1248		<50.0
Aroclor 1016		<50.0
Endosulfan II		<2.00
Aroclor 1262		<50.0
Aroclor 1242		<50.0

Values represent total concentrations unless noted < = Not detected at indicated reporting limit --- = Not analyzed

Limit 2 is used for results comparison For RCL 8081A/8082

Table 6
Soil Sample Analytical Results - RCRA Metals
Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, WA

CONSTITUENT (Units in mg/kg)	SITE SAMPLE ID DATE DEPTH (ft)	02SB-08 02SB-08A 06/07/99 3.50	02SB-08 02SB-08B 06/07/99 8.50
Arsenic		4.78	---
Barium		86.3	---
Cadmium		<0.500	---
Chromium		33.1	---
Lead		10.6	3.02
Mercury		---	---
Selenium		<0.500	---
Silver		<0.500	---

Values represent total concentrations unless noted < = Not detected at indicated reporting limit --- = Not analyzed

Limit 2 is used for results comparison For RCL 6020NCAB

Table 7
Groundwater Sample Analytical Results
Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, WA

SITE	DATE	Gasoline Range Hydrocarbons (mg/l)	Diesel Range Hydrocarbons (mg/l)	Heavy Oil Range Hydrocarbons (mg/l)	Benzene (ug/l)	Toluene (ug/l)	Ethylbenzene (ug/l)	Xylenes (total) (ug/l)	Total Lead (ug/l)
MTCA/A/U		1.0000	1.0000	1.0000	5.0	40.0	30.0	20.0	5.0
02MW-01	09/28/99	0.172	<0.250	<0.500	72.9	0.811	<0.500	<1.00	36
02MW-02	09/28/99	<0.0500	<0.250	<0.500	<0.500	<0.500	<0.500	<1.00	133
02MW-03	09/28/99	0.16	<0.250	<0.500	56.7	1.13	<0.500	1.14	<1.00
02MW-04	09/28/99	3.7	<0.250	<0.500	<30.0	185	226	473	35.9
02MW-05	09/28/99	<0.0500	<0.250	<0.500	2.84	<0.500	<0.500	<1.00	86.3
02SB-02	06/07/99	8.26	3.12	<0.500	214	155	459	1110	---
02SB-03	06/07/99	<0.0500	1.07	<0.500	6.64	1.36	0.617	1.93	---
02SB-04	06/07/99	0.0556	0.867	0.503	59.8	2.28	1.62	8.18	---
02SB-05	06/07/99	0.685	0.865	<0.500	19.9	4.18	19.9	20.2	---
02SB-06	06/07/99	0.103	0.456	<0.500	<0.500	1.11	0.585	4.03	---
02SB-07	06/07/99	<0.0500	1.07	0.626	<0.500	<0.500	<0.500	<1.00	---
02SB-08	06/07/99	0.128	0.668	<0.500	1.59	1.25	<0.500	2.78	---
02SB-09	06/11/99	1.36	0.617	<0.500	639	1.89	1.31	9.66	---

Values represent total concentrations unless noted < = Not detected at indicated reporting limit --- = Not analyzed

Limit 2 is used for results comparison For RCL REPT_02W MTCA/A/U = MTCA Method A Cleanup Levels (revised 1/96)

Table 7
Groundwater Sample Analytical Results
Time Oil Co. Site 2750
2750 West Commodore Way, Seattle, WA

SITE	DATE	Dissolved Lead (ug/l)
MTCA/A/U		5.0
02MW-01	09/28/99	---
02MW-02	09/28/99	---
02MW-03	09/28/99	---
02MW-04	09/28/99	---
02MW-05	09/28/99	---
02SB-02	06/07/99	---
02SB-03	06/07/99	<1.00
02SB-04	06/07/99	<1.00
02SB-05	06/07/99	1.29
02SB-06	06/07/99	<1.00
02SB-07	06/07/99	<1.00
02SB-08	06/07/99	<1.00
02SB-09	06/11/99	---

Values represent total concentrations unless noted < = Not detected at indicated reporting limit --- = Not analyzed

Limit 2 is used for results comparison For RCL REPT_02W MTCA/A/U = MTCA Method A Cleanup Levels (revised 1/96)

APPENDIX A
PREVIOUS REPORTS

ENCLOSURE 1

PHONE 285-2400
CABLE ADDRESS: TIMOIL
(FAX) 206-283-8036

SEATTLE
TACOMA
PORTLAND
STOCKTON
RENO
RICHMOND
LOS ANGELES

TEN TO ONE ITS TIME

TIME OIL CO.

2737 WEST COMMODORE WAY SEATTLE, WA 98199-1233
P.O. BOX 24447 SEATTLE, WA 98124-0447

December 30, 1991

Washington State Department of Ecology
Attention: Joe Hickey
3190 160th Ave. S.E.
Bellevue, Wa 98008-5452

RE: Underground Storage Tank Site Check/Site Assessment at Seattle Terminal, 2737 West Commodore Way, Seattle, Wa - Property No. 01-228.

Dear Mr. Hickey:

This letter report is submitted to provide initial information on the removal of underground storage tanks at the above referenced site. The property is located at the north end of the community of Magnolia on the south shore of Salmon Bay in Seattle, Washington (Figure 1). The site is the location of Time Oil Co.'s Seattle Terminal which consists of a two-story office structure, warehouses and above ground storage tanks. Properties surrounding the site are light to heavy marine/industrial.

On September 16, 1991 four tanks were removed by Lee Morse Construction as part of a facility upgrade. They were 4,000, 2,500, 1,500 and 300 gallon capacity tanks that had contained unleaded gasoline, diesel fuel, regular leaded gasoline, and used oil, respectively. See Figures 2 and 3 for tank locations.

The removal of the tanks resulted in two excavations. The gasoline and diesel fuel tanks were removed from excavation #1 and the used oil tank was removed from excavation #2 (Figures 2 and 3).

One 4,000 gallon tank was installed in excavation #1, replacing the former gasoline and diesel fuel tank system. This tank is baffled to provide two compartments of 3,000 and 1,000 gallon capacities and is, therefore, registered as two tanks. The tanks contain regular unleaded gasoline and diesel fuel, respectively. Two new fuel dispensers were also installed replacing the old dispensers.

The following discusses tank removal and sample collection activities, and analytical results.

FIELD INVESTIGATION

The removal of contaminated soil and sample collection was based on organic vapor analysis readings. Soil samples were collected and placed in Zip-lock bags for headspace analysis using a Micro-tip organic vapor analyzer. When head space readings were below 50 parts per million or contaminated soil removal was not feasible, samples were collected.

Samples were collected from the excavation using a backhoe bucket. Each sample was taken from near the teeth of the backhoe after approximately 6 inches of soil was removed, then transferred to a 4 ounce jar and placed in an ice chest for delivery to Friedman and Bruya analytical laboratory. Sample equipment consisted of disposable latex gloves and a stainless steel spoon which was triple washed between each sampling.

Excavation #1

The 4,000, 2,500 and 1,500 gallon tanks were removed from excavation #1. The 2,500 and 1,500 gallon tanks were part of a 4,000 gallon baffled tank system that was installed in 1980. They were registered as individual tanks with the Department of Ecology. It is unknown when the 4,000 gallon unleaded gasoline tank was installed. The 4,000 gallon tank and the 2,500 and 1,500 gallon compartments of the baffled tank were tightness tested annually using the Petro-Tite testing system. They were last tested in September 1990 and found to be tight.

Areas of slight rusting and pitting were observed on the 4,000 gallon tank and the baffled tank system but no holes were noted. As the tanks were removed gasoline contamination was observed in the surrounding soil. This contamination is consistent with the nature of contamination found from years of tank overfills and spillage.

Soil encountered at the site consisted of artificial fill and natural material. Artificial fill was encountered from the surface to a depth of approximately 7 feet in the excavation and consisted of brown and grey sandy silt with gravel. Decaying organic material such as wood and grass, and metal debris was observed in the fill.

Natural soils were observed underlying the fill to a minimum depth of approximately 18 feet and was composed of brown sandy silt with gravel that graded to gray silty fine to medium sand with depth. Backfill material for the tank excavation generally consisted of imported sand and soil similar to the surrounding artificial fill. The soil appeared discolored and a hydrocarbon odor was encountered in the excavation during tank removal. Groundwater with a heavy hydrocarbon sheen was encountered at a depth of 18 feet below the ground surface in the excavation.

After the two 4,000 gallon tanks and associated backfill soils were removed, an attempt was made to assess the extent of contamination and remove it. Because of these efforts the excavation was extended to the north, east and west. However, due to high head space readings near the groundwater in the excavation and the proximity of the excavation to the Time Oil office building, excavating was abandoned and soil samples were collected. Approximately 140 cubic yards of soil was removed from the excavation and stockpiled on site.

A total of eight soil samples were collected from the sidewalls and floor within excavation #1 and the former location of the fuel dispensers (Figure 2 - Provides the location and depth of sampling points). A groundwater sample was not collected at the time of tank removal due to the presence of a heavy hydrocarbon sheen. The soil samples were submitted to the analytical laboratory for chemical testing for total petroleum hydrocarbons as gasoline (TPH-g) and diesel (TPH-d), benzene, toluene, ethylbenzene, xylenes (BTEX), and total lead using EPA methods 8015 (modified), 8020 and 7421, respectively.

Analytical results for these soil samples indicated TPH-g concentrations ranging from less than 2 parts per million (ppm) to 12,000 ppm. The highest TPH concentration of 12,000 ppm was encountered in the sample collected from the area of the fuel dispensers. TPH-d concentrations ranged from less than 50 ppm to 220 ppm. Table 1 provides a summary of soil samples and analytical results for excavation #1 soil samples. See the attached laboratory report for further information.

Excavation #2

The 300 gallon tank was removed from excavation #2. It is not known when the tank was installed. However, the tank was used for storing used oil collected during servicing of Time Oil fleet vehicles.

Areas of rusting and pitting were present on the tank and a pin-sized hole was observed after corrosion had been removed indicating that the tank may not have leaked under normal circumstances. As the tank was removed hydrocarbon contamination was observed in the surrounding soil. As in excavation #1, this contamination is also consistent with the nature of contamination found from years of tank overfills and spillage.

Artificial fill and natural soil was encountered in this excavation. The fill ranged in depth from the surface to 4.5 feet at the south end of the excavation and 1 foot at the north end. Natural soil consisting of brown and gray silty fine to medium sand was observed underlying the fill and extending to a minimum depth of groundwater. The soil appeared discolored and a hydrocarbon odor was encountered in the excavation during tank removal.

The depth to groundwater varied from 6 feet to 2 feet below the ground surface as the property sloped down to Salmon Bay to the north. A heavy sheen was observed on the groundwater.

After the 300 gallon tank and associated backfill were removed, an attempt was made to assess the extent of contamination and remove it. Because of these efforts the excavation was extended to the north toward Salmon Bay. When contamination was observed to be extensive, excavating was abandoned and soil samples were collected. A total of approximately 100 cubic yards of soil was removed from the excavation and stockpiled on site.

A total of four soil samples were collected from the sidewalls and floor within the excavation. Soil samples were not collected from the north end of the excavation because very strong hydrocarbon odors and gray discoloration was observed in that area. Instead, a test pit was dug between the excavation and the shoreline (Figure 3) to assess the horizontal extent of contamination. One sample was collected from that test pit. A groundwater sample was not collected at the time of tank removal due to the presence of a heavy hydrocarbon sheen.

The excavation and test pit samples were submitted for chemical analysis for total petroleum hydrocarbons as diesel (TPH-d) and motor oil (TPH-m) using EPA method 8015 (modified). Analytical results for excavation #2 and test pit samples indicated TPH-d concentrations ranging from less than 10 ppm to 310 ppm. TPH-m concentrations ranged from less than 10 ppm to 410 ppm.

Four soil samples were collected from stockpiled soil and combined to form one stockpile composite sample. The composite sample was tested for TCLP lead, halogenated volatile organic compounds using EPA method 8010, PCBs, TPH-d and TPH-m using EPA methods 8015 (modified) and 418.1, respectively. Chemical test results for the stockpile composite sample indicated TPH-d and TPH-m concentrations of 78 ppm and 1700 ppm, respectively.

Table 2 provides a summary of TPH analytical results for excavation #2, test pit and composite soil samples. See the attached laboratory report for the remaining chemical test results.

Time Oil is currently in the process of sending Request for Proposals for further site assessment to environmental consultants in the area. The next stage of work will address the contaminated soil stockpile, the extent of subsurface soil contamination at both excavations, the impact, if any, to the shallow ground water, and provide recommendations for cleanup, if necessary.

If there are any further questions regarding this site please contact me at (206) 286-4490.

Sincerely,

Liam Russell

Liam J. Russell
Geologist

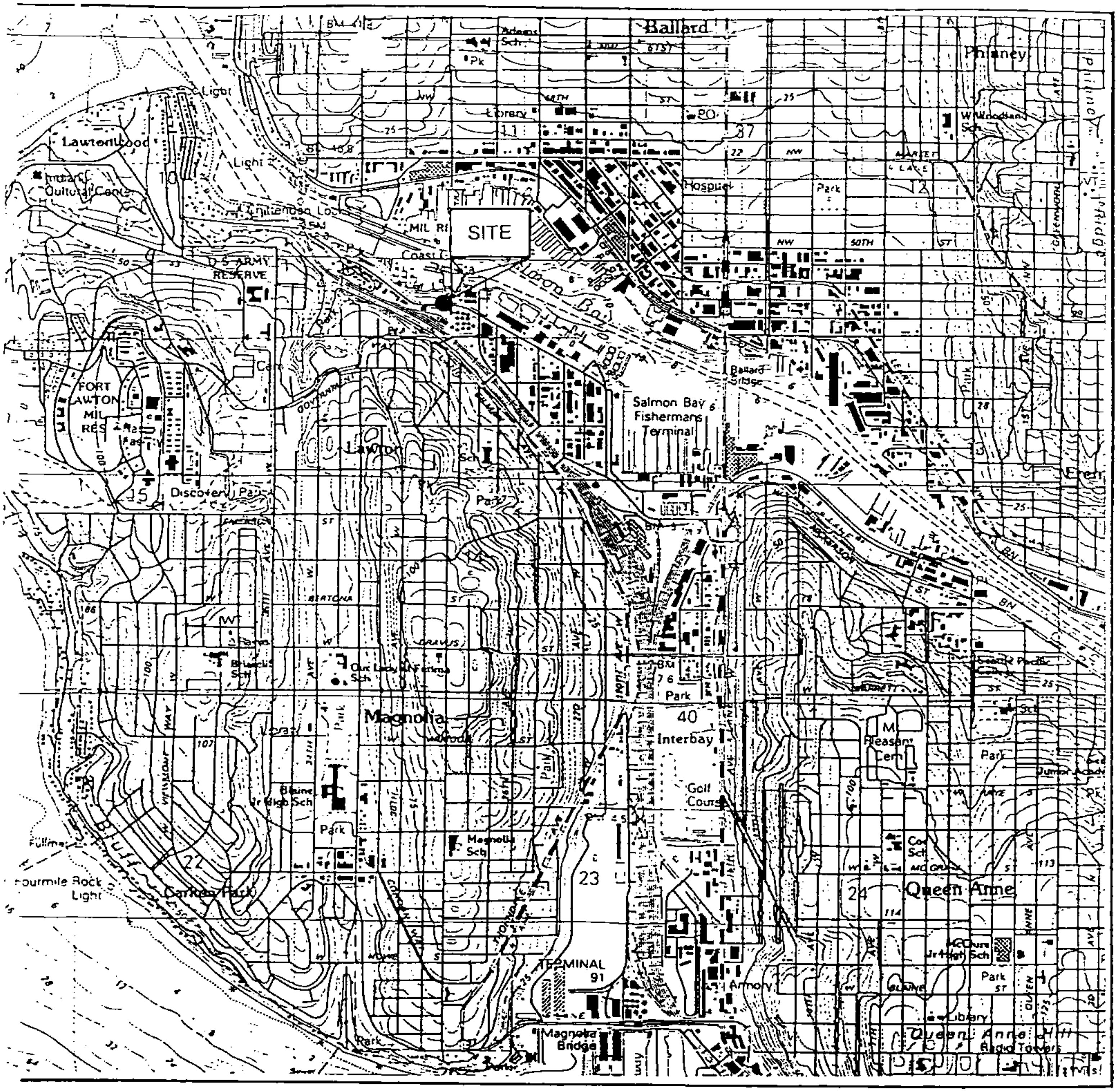
Attachments:
- Table 1
- Table 2
- Figure 1
- Figure 2
- Figure 3
- Analytical Report

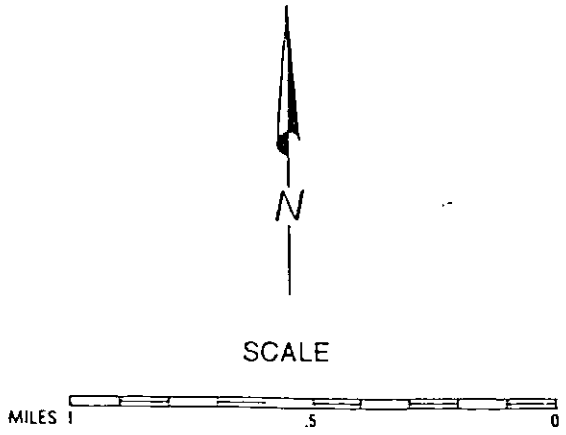
TABLE 1
SUMMARY OF SOIL SAMPLES AND ANALYTICAL RESULTS
(Excavation #1)

Sample I.D.	TPH g/d (ppm)	Benzene (ppm)	Toluene (ppm)	Ethylben (ppm)	xylenes (ppm)
1617-PI1	12,000/220	330	370	390	1600
1617-PI2	1,300/66	27	21	26	64
1500-N1	<2/17	0.003	0.003	<0.002	<0.006
0829-S1	19/76	<0.22	0.38	0.099	0.056
0834-E1	180/<50	<0.22	2.5	5.0	7.2
0839-W1	<2/<50	0.013	0.060	0.023	0.065
0845-Floor	120/200	1.1	1.3	3.2	12
0926-NW1	<2/<50	0.005	0.049	0.015	0.062

TABLE 2
SUMMARY OF SOIL SAMPLES AND ANALYTICAL RESULTS
(Excavation #2, Test Pit and Stockpile)

Sample I.D.	TPH-d(8015) (ppm)	TPH-m(8015) (ppm)	TPH-m(418.1) (ppm)
TPI-3	310	410	
TI-N-4	<10	<10	
TI-E-4	<10	<10	
TI-F-6	<10	200	
TI-W-4	<10	<10	
Pile Composite	78		1700

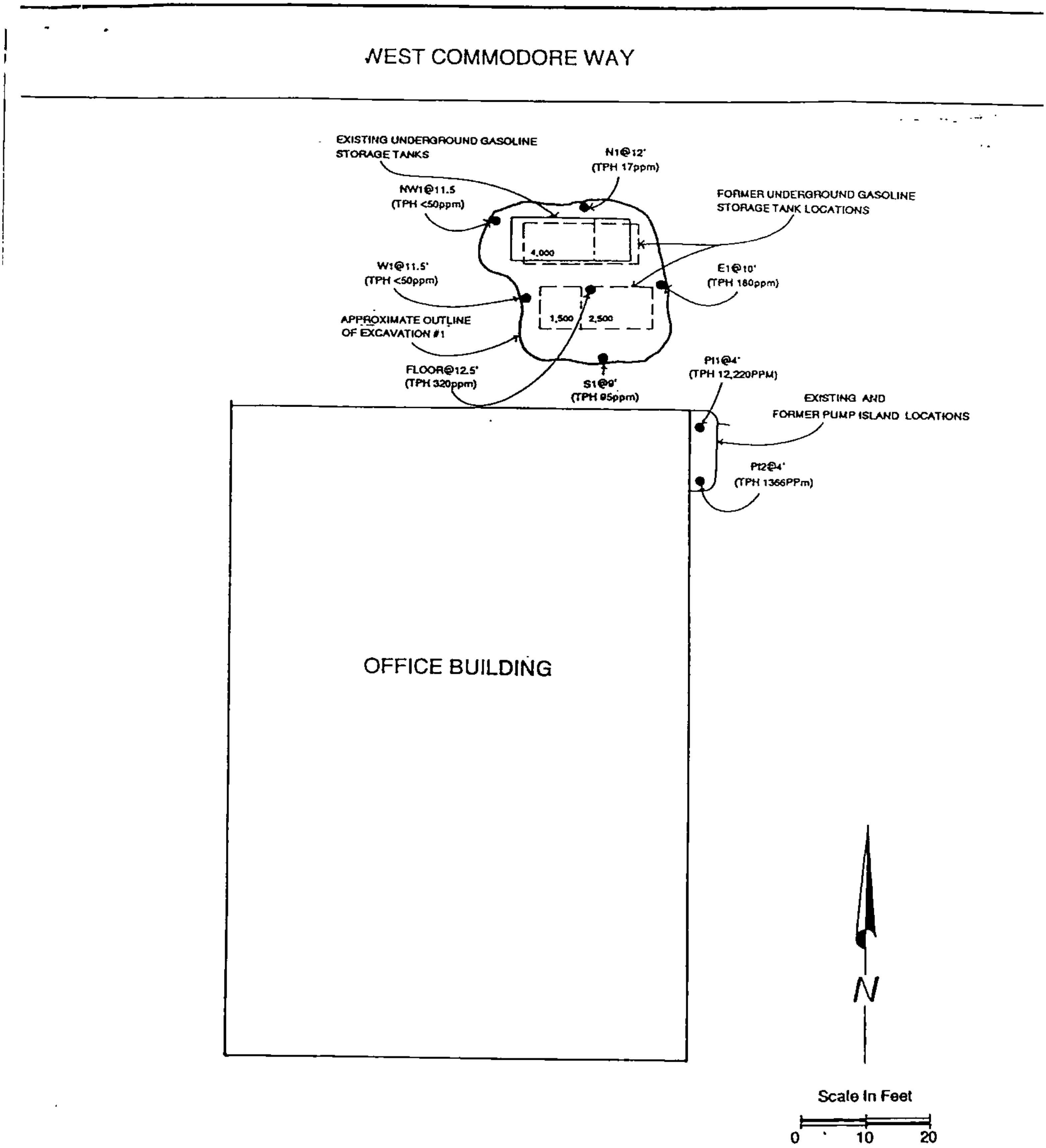




TIME OIL CO.

2737 West Commodore Way

SEATTLE TERMINAL



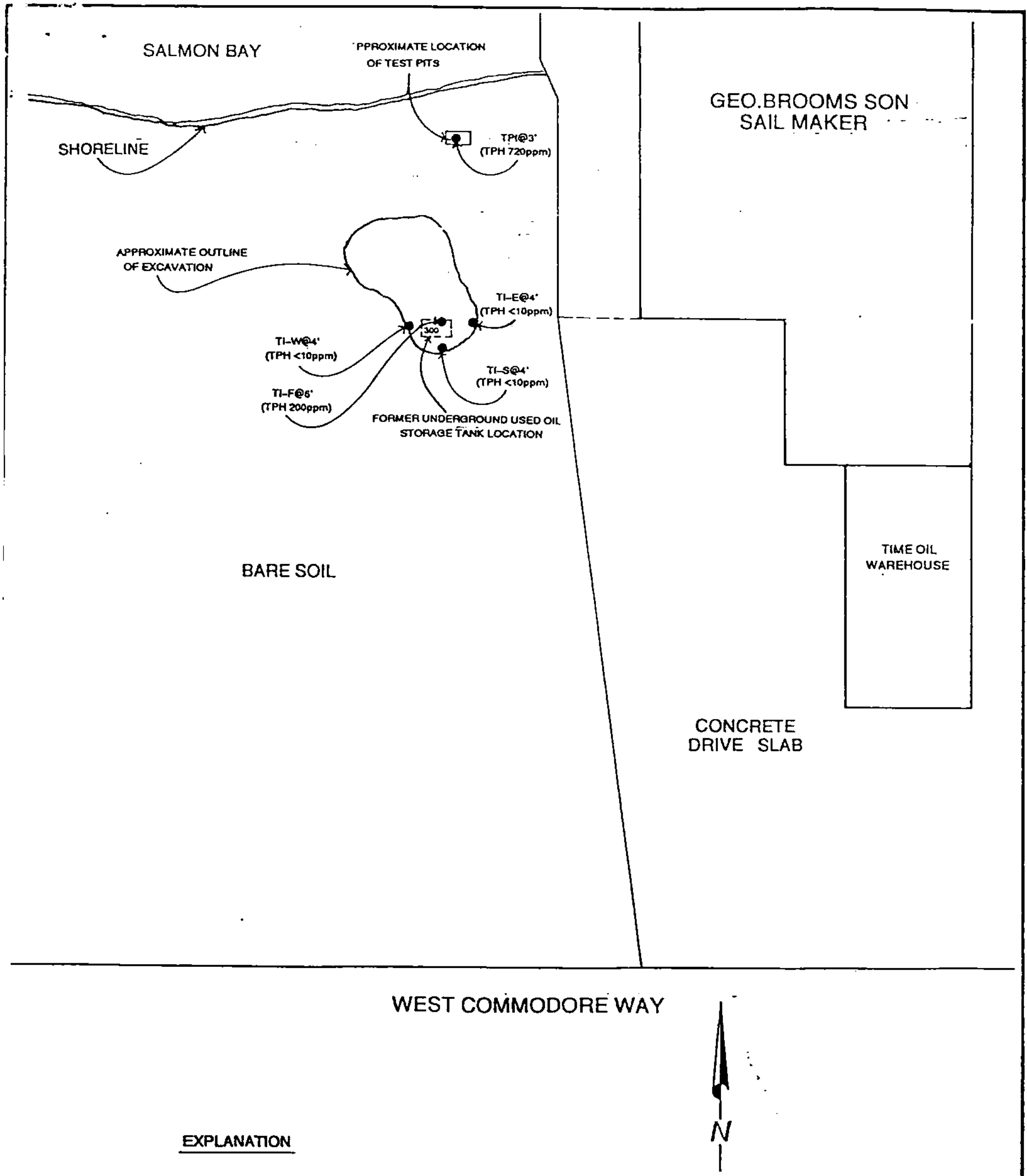
EXPLANATION

● N1@12' (TPH 17ppm)	APPROXIMATE SAMPLE LOCATION WITH RESPECTIVE DEPTH AND TPH CONCENTRATION

FIGURE 2

TIME OIL CO.
2737 West Commodore Way

SEATTLE TERMINAL



EXPLANATION

● TP1@3' (TPH 720ppm)	APPROXIMATE SAMPLE LOCATION WITH RESPECTIVE DEPTH AND TPH CONCENTRATION'

SCALE: 1" = 30'

FIGURE 3

TIME OIL CO.
2737 West Commodore Way

SEATTLE TERMINAL
2737 WEST COMMODORE WAY, SEATTLE, WA

ENCLOSURE 2

PHONE 285-2400
CABLE ADDRESS TIMOIL
(FAX) 206-283-8036

SEATTLE
TACOMA
PORTLAND
STOCKTON
RENO
RICHMOND
LOS ANGELES

TIME OIL CO.

2737 WEST COMMODORE WAY SEATTLE, WA 98199-1233
P.O. BOX 24447 SEATTLE, WA 98124-0447

September 22, 1992

Washington State Department of Ecology
Northwest Region
3190 160th SE
Bellevue, Washington 98008-5452
Attention: Mr. Joe Hickey

SUBJECT: Excavating Activities Conducted at Former Waste Oil Tank Location
Former Time Oil Co. Vehicle Maintenance Facility
2750 Commodore Way; Seattle, Washington

Dear Mr. Hickey,

This letter is to inform you of the findings of additional assessment activities conducted at the above referenced site. On July 28th and 29th, 1992 additional excavation was conducted in the former location of a waste oil tank which was removed in September 1991. Hydrocarbon contamination was discovered during removal of the tank; thus, this additional phase of excavation was undertaken in an attempt to remove remaining soil contamination.

A small amount of groundwater had pooled in the initial excavation associated with tank removal; therefore, lateral excavation was conducted in an attempt to define the limits of the contaminated area. Previous excavating activities had documented that soils located on the southern and western edges of the excavation did not contain hydrocarbons exceeding MTCA Method A Cleanup Levels; thus, the excavation was expanded primarily to the north and east.

After approximately 150 cubic yards of contaminated soil had been removed, excavating activities were terminated because field observations suggested that contaminant severity increased in an easterly direction, and excavation of the full extent of soil contamination did not appear to be feasible. The excavation was backfilled by placing crushed rock below the groundwater surface, installing a layer of 10-mil visqueen upon the crushed rock to reduce settling and surface water infiltration, and backfilling the remaining excavation with fine sand.

Six soil samples were collected from the limits of the northern and eastern sides of the excavation, directly above the groundwater surface, to assess remaining contaminant levels and evaluate the potential for a groundwater impact (See Figure 1 - Site Map for sample locations). The six samples were submitted to a State certified laboratory for hydrocarbon identification (WHCID) analysis to identify the hydrocarbons present. Hydrocarbons identified as gasoline, diesel, and mineral spirits were identified in samples A-1 @8', A-2 @9', and A-6 @3'. Motor oil was also detected in sample A-6 @3'. Additional analysis was conducted on the three samples in which hydrocarbons were detected to quantify levels of TPH and BTEX by the WTPH Method and EPA Method 8020. These three samples were found to contain levels of TPH-gasoline ranging from 60 to 290 parts per million (ppm), TPH-diesel ranging from 90 to 1,600 ppm, TPH-mineral spirits between 50 and 210 ppm, and 2,300 ppm TPH-motor oil was detected in sample A-6 @3′ (See Table 1 - Analytical Results). Laboratory reports are attached.

Two additional soil samples were recovered from the vicinity of an area of visibly impacted soil located near the ground surface on the south side of the excavation. Sample WO-WC was recovered from material believed to represent "worst case" conditions in order to conduct disposal profiling. Sample WO @5′ was collected from the same area at a depth of 5 feet below grade to verify removal of the impacted soil once field observations indicated that the visibly impacted area had been fully excavated. WHCID analysis on these two samples detected the presence of diesel fuel in Sample WO-WC and did not detect petroleum hydrocarbons in sample WO @5′. WTPH analysis conducted on Sample WO-WC detected 2,800 ppm TPH-diesel. Laboratory reports are attached.

These analytical results, in combination with field observations, indicate that petroleum hydrocarbon contamination remains beneath the site, and that an impact upon groundwater may have occurred. Time Oil Co. is in the process of submitting a request for proposals to environmental consultants for further assessment of this area. This next phase of assessment will include the installation of soil borings and groundwater monitoring wells to assess the extent of remaining soil contamination and the potential for an impact upon groundwater.

The excavated soil is currently stockpiled upon an adjacent property also owned by Time Oil Co. Samples of this material have been submitted for disposal profiling. Arrangements to recycle the soil will be made once analytical results are received.

If you have any questions regarding this site, please contact either myself at (206) 286-6457 or Liam Russell at (206) 286-4490. If we are not available, Kevin Murphy may be able to answer your questions.

Sincerely,

Scott B. Sloan

Scott B. Sloan
Geologist

Enclosures:
Table 1 - Analytical Results
Figure 1 - Site Map
Analytical Reports

C:\WP51\SCOTT\DOELTRS\DOCKSIDE.LTR

TABLE 1

Soil Analytical Results
Time Oil Co. Property No. 01-228
2750 Commodore Way; Seattle, Washington

Sample Number	Depth	TPH	Benzene	Toluene	Ethyl-benzene	Total Xylenes
Samples Collected 10/3/91						
TI-F	6'	200	NT	NT	NT	NT
TI-E	4'	ND	NT	NT	NT	NT
TI-S	4'	ND	NT	NT	NT	NT
TI-W	4'	ND	NT	NT	NT	NT
TP1	3'	720	NT	NT	NT	NT
Samples Collected 12/10/91						
SS1	6.5'	12	NT	NT	NT	NT
NS2	2'	840	NT	NT	NT	NT
ES4	5'	25,000	NT	NT	NT	NT
TP3	2'	15	NT	NT	NT	NT
Samples Collected 7/29/92						
A1	8'	60-g	ND	ND	ND	ND
		50-m	—	—	—	—
		90-d	—	—	—	—
A2	9'	290-g	ND	ND	ND	ND
		200-m	—	—	—	—
		330-d	—	—	—	—
A3	6'	ND*	NT	NT	NT	NT
A4	3'	ND*	NT	NT	NT	NT
A5	3'	ND*	NT	NT	NT	NT
A6	3'	110-g	0.16	0.14	2.6	4.9
		210-m	—	—	—	—
		1,600-d	—	—	—	—
		2,300-o	—	—	—	—
WO-WC	2'	2,800-d	NT	NT	NT	NT
WO @ 5'	5'	ND*	NT	NT	NT	NT

NOTES:

Results reported in milligrams per kilogram (mg/kg) of parts per million (ppm).

g = TPH as gasoline, d = TPH as diesel,

m = TPH as mineral spirits, o = TPH as motor oil.

Detection limit for benzene, toluene, and ethylbenzene = 0.02 ppm

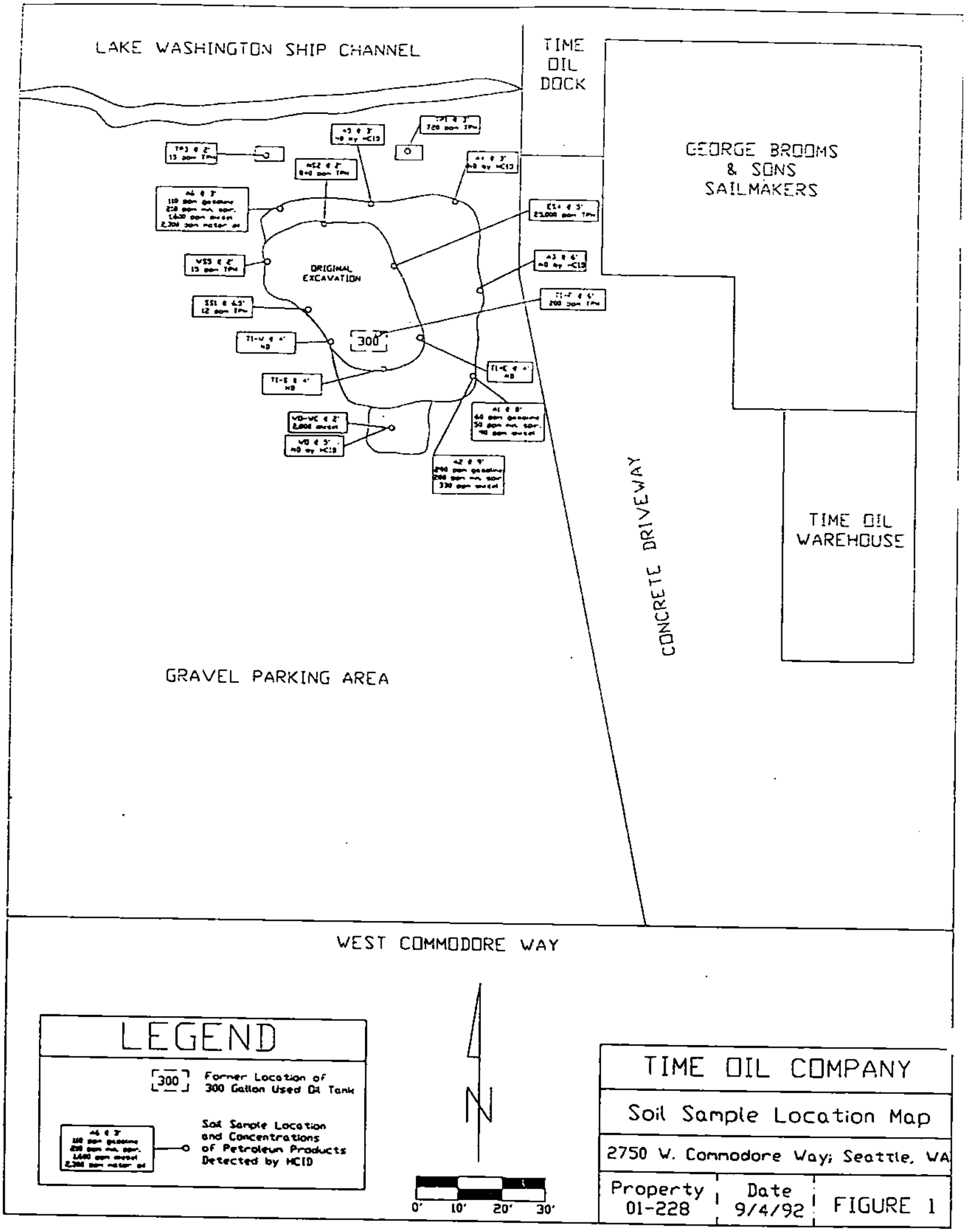
Detection limit for total xylenes = 0.04 ppm.

Shading denotes sample with at least one constituent exceeding Method A Cleanup Standards.

NT = Sample not tested for this constituent.

ND = Not detected.

* = TPH analysis by HCID.



TIME OIL COMPANY

Soil Sample Location Map

2750 W. Commodore Way; Seattle, WA

Property 01-228	Date 9/4/92	FIGURE 1

APPENDIX B
DRILL LOGS

IT CORPORATION

Drilling Log

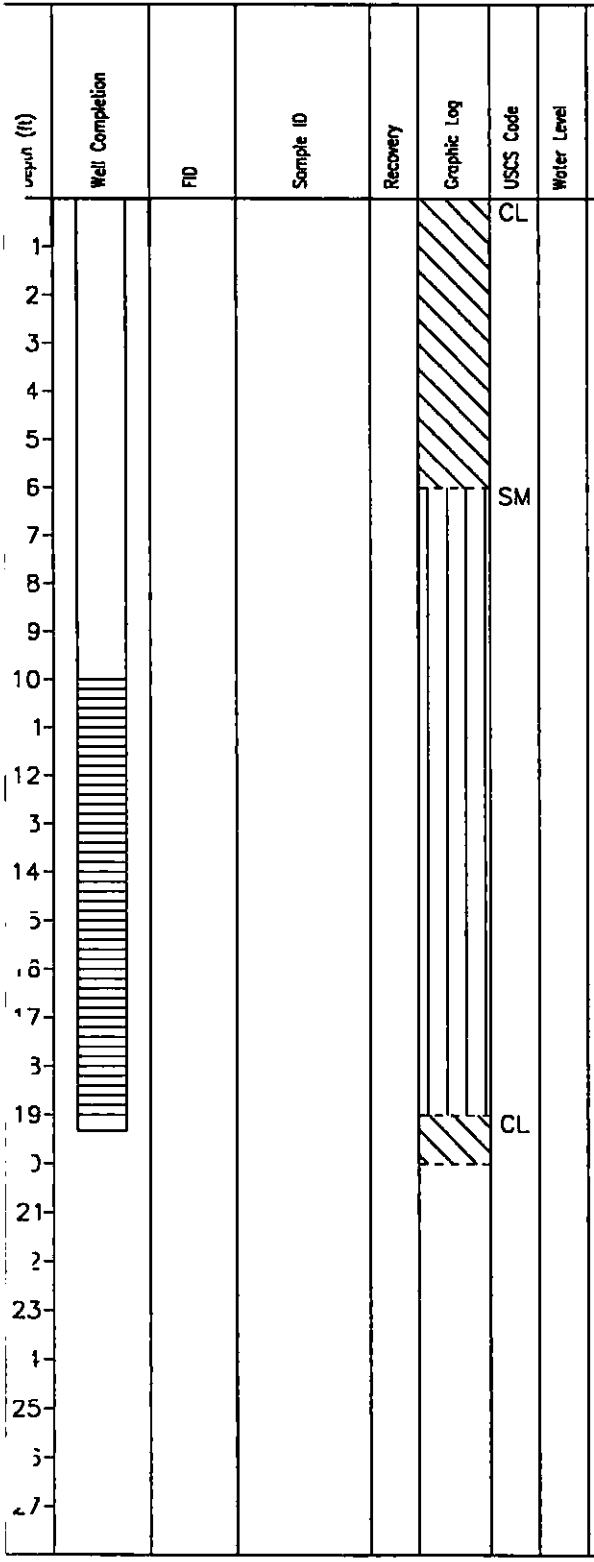
Site ID: 02MW-01

Project Name: Time Oil Co. Seattle Terminal
ocation:
urface Elevation: 0.00'
Borehole Diameter: 8.00in
lank Casing:
pe: PVC dia: 2.00in fm: 0.0' to: 10.00'
creens:
type: Slotted size: 0.020in dia: 2.00in fm: 10.00' to: 19.33'
Drilling Company:
ogged By:
necked By:

Project Number:
Total Hole Depth: 20.00'
Top of Casing: 29.34'
Static Water Level:
Annular Fill:
type: fm: to:
type: fm: to:
type: fm: to:
Method: Hollow Stem Auger
Date Started: / /
Permit #:

See Site Map For Boring Location

Comments:



Description

Gravel base/fill

Brown soft clay with gray fine grained sand. No odor. Damp.

Gray fine grained sand with little silt. Dry, no odor.

Grades to coarse grained sand, wet.

Dry, gray hard clay, no odor.#

IT CORPORATION

Drilling Log

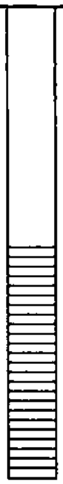
Site ID: 02MW-02

Project Name: Time Oil Co. Seattle Terminal
ocation:
Surface Elevation: 0.00'
Borehole Diameter: 8.00in
Blank Casing:
ype: PVC dia: 2.00in fm: 0.0' to: 5.00'
Screens:
type: Slotted size: 0.020in dia: 2.00in fm: 5.00' to: 9.82'
Drilling Company:
ogged By:
hecked By:

Project Number:
Total Hole Depth: 10.00'
Top of Casing: 25.20'
Static Water Level:
Annular Fill:
type: fm: to:
type: fm: to:
type: fm: to:
Method: Hollow Stem Auger
Date Started: / /
Permit #:

See Site Map For Boring Location

Comments:

Depth (ft)	Well Completion	FID	Sample ID	Recovery	Graphic Log	USCS Code	Water Level	Description
1								Gravel base/fill
2								
3								Hole not sampled – see log for 02SB-07 for stratigraphy#
4								WATER
5								
6								
7								
8								
9								
10								
11								
12								
3								
14								
5								
6								
17								
8								
19								
0								
21								
2								
23								
4								
25								
6								
7								

IT CORPORATION

Drilling Log

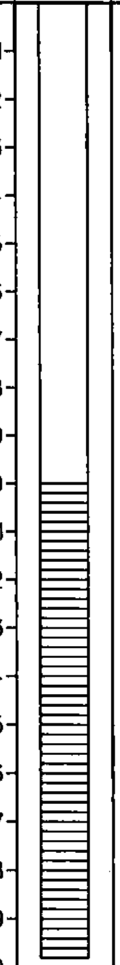
Site ID: 02MW-03

Project Name: Time Oil Co. Seattle Terminal
ocation:
urface Elevation: 0.00'
Borehole Diameter: 12.00in
onk Casing:
pe: PVC dia: 4.00in fm: 0.0' to: 10.00'
reens:
type: Slotted size: 0.020in dia: 4.00in fm: 10.00' to: 19.80'
Drilling Company:
gged By:
ecked By:

Project Number:
Total Hole Depth: 20.00'
Top of Casing: 33.02'
Static Water Level:
Annular Fill:
type: fm: to:
type: fm: to:
type: fm: to:
Method: Hollow Stem Auger
Date Started: / /
Permit #:

See Site Map For Boring Location

Comments:



(ft)	Well Completion	FID	Sample ID	Recovery	Graphic Log	USCS Code	Water Level	Description
1								Gravel base/fill
2								
3								Hole not sampled – see log for 02SB-03 for stratigraphy#
4								WATER
5								
6								
7								
8								
9								
10								
1								
12								
3								
14								
5								
16								
17								
3								
19								
)								
21								
2								
23								
1								
25								
5								
27								

IT CORPORATION

Drilling Log

Site ID: 02MW-04

Project Name: Time Oil Co. Seattle Terminal
ocation:
urface Elevation: 0.00'
Borehole Diameter: 8.00in
lank Casing:
ype: PVC dia: 2.00in fm: 0.0' to: 10.00'
creens:
type: Slotted size: 0.020in dia: 2.00in fm: 10.00' to: 19.80'
Drilling Company:
ogged By:
hecked By:

Project Number:
Total Hole Depth: 20.00'
Top of Casing: 32.31'
Static Water Level:
Annular Fill:
type: fm: to:
type: fm: to:
type: fm: to:
Method: Hollow Stem Auger
Date Started: / /
Permit #:

See Site Map For Boring Location

Comments:

Depth (ft)	Well Completion	FID	Sample ID	Recovery	Graphic Log	USCS Code	Water Level	Description
						SM		
1								Concrete
2								Hand dig/hand auger to 5 ft.
3								
4						CL		
5								Orange to blue gray clay, moist with gray fine grained sand stringers. No odor. Damp.
6								
7								
8						SM		
9								
10								Gray to brown, med. grained sand. Moist to wet, no odor.
1								
12								
3								
14								
5								Gray sand, wet.
6								
7								
8								
19						CL		
0								Dry, gray hard clay, with sand/silt stringers, no odor.#
21								
2								
23								
4								
25								
6								
27								

IT CORPORATION

Drilling Log

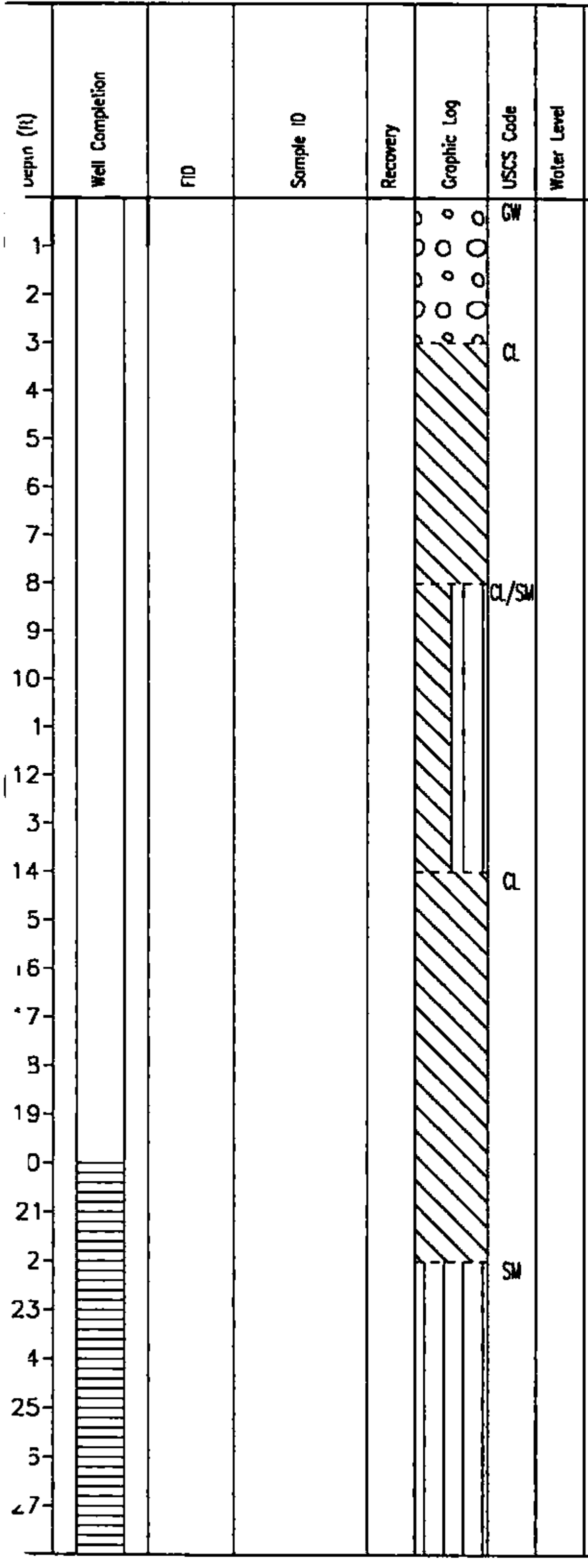
Site ID: 02MW-05

Project Name: Time Oil Co. Seattle Terminal
ocation:
urface Elevation: 0.00'
Borehole Diameter: 8.00in
lank Casing:
pe: PVC dia: 2.00in fm: 0.0' to: 20.00'
creens:
type: Slotted size: 0.020in dia: 2.00in fm: 20.00' to: 34.54'
Drilling Company:
ogged By:
hecked By:

Project Number:
Total Hole Depth: 35.00'
Top of Casing: 41.70'
Static Water Level:
Annular Fill:
type: fm: to:
type: fm: to:
type: fm: to:
Method: Hollow Stem Auger
Date Started: / /
Permit #:

See Site Map For Boring Location

Comments:



Description

Gravel

Hand dig/hand auger to 5 ft.

Orange to blue gray clay, moist with gray fine grained sand stringers. No odor. Damp.

Grades to brown clay, gray sand stringers. Damp, no odor. Black, thick fluid adhering to soil.

Soft gray clay, dry, no odor.

Gray, med. to coarse grained sand. Wet, no odor.

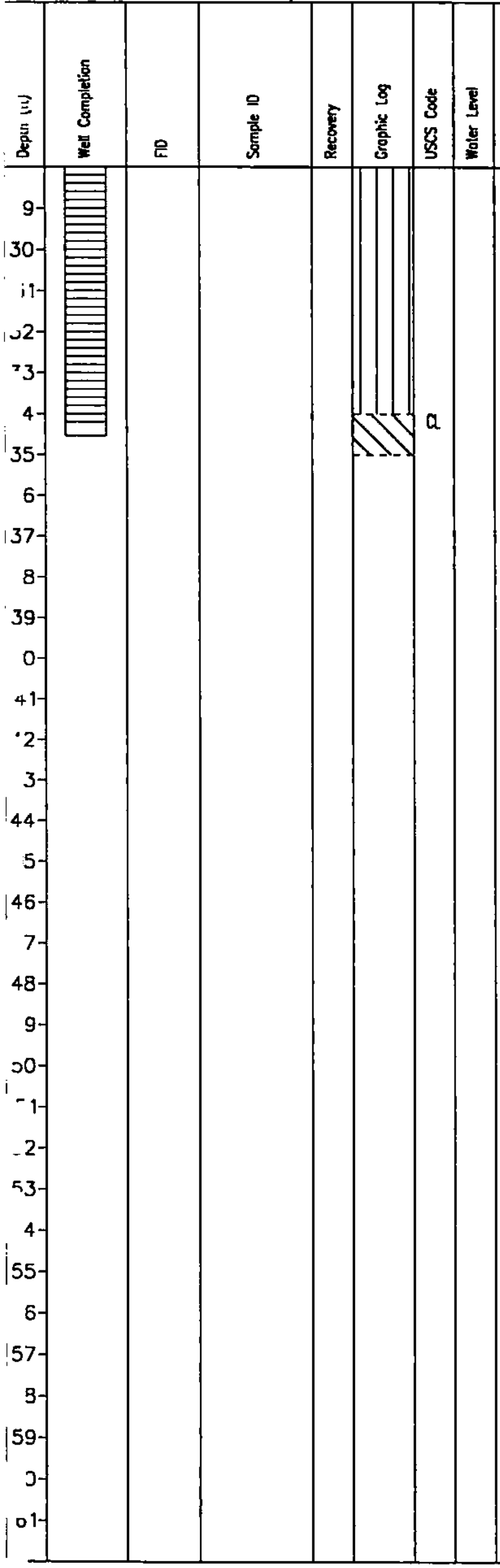
IT CORPORATION

Drilling Log

Site ID: 02MW-05

Project Name: Time Oil Co. Seattle Termi Project Number:

Location:



Description

Gray wet sand, no odor.

Dry, gray hard clay, no odor.

IT CORPORATION

Drilling Log

Site ID: 02SB-01

See Site Map For Boring Location

Project Name: **Time Oil Co. Seattle Terminal**
Location:
Surface Elevation: **0.00'**
Borehole Diameter: **6.00in**
Drilling Company: **CASCADE**
Logged By: **CNS**
Checked By:

Project Number:
Total Hole Depth: **14.00'**
Static Water Level:

Method: **Hollow Stem Auger**
Date Started: **06/07/99**
Permit #:

Comments:

Depth (ft)	FID	Sample ID	Recovery	Graphic Log	USCS Code	Water Level	Description
					GP		
1					ML		Surficial covering of gravel and sand. Hand dug to 24"
2							Brown Silt, some clay, dry, slight odor
3							
4							
5							Grades lighter brown, moist to dry
6							
7							Brown orange medium grain Sand, very damp to wet, slight odor
8					SP		
9							
10					CH		Soft gray Clay, dry, no to slight odor
11						▽	
12							Water level at 11.50 feet IP
13							Grades hard, dry–moist, no odor
14							End borehole
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							

IT CORPORATION

Drilling Log

Site ID: 02SB–02

Project Name: **Time Oil Co. Seattle Terminal**
Location:
Surface Elevation: **0.00'**
Borehole Diameter: **6.00in**
Drilling Company: **CASCADE**
Logged By: **CNS**
Checked By:

Project Number:
Total Hole Depth: **16.50'**
Static Water Level:

Method: **Hollow Stem Auger**
Date Started: **06/07/99**
Permit #:

See Site Map For Boring Location

Comments:

Depth (ft)	FID	Sample ID	Recovery	Graphic Log	USCS Code	Water Level	Description
1					ML		Hand dug to 24"
2							Dark brown Silt and sand, some gravel up to 1/2", dry, no odor
3							Grades brownish gray, bits of brick, moist to damp
4							
5							
6							
7							Blueish gray and orange soft Clay, some silt, damp, slight odor
8					CH		
9							
10							
11							
12						▽	Gray medium grain Sand, wet. Water level at ~12.50 feet IP
13					SP		Grades slight odor
14							
15							
16					CH		Gray Clay
17							End borehole
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							

IT CORPORATION

Drilling Log

Site ID: 02SB-03

Project Name: **Time Oil Co. Seattle Terminal**
Location:
Surface Elevation: **0.00'**
Borehole Diameter: **6.00in**
Drilling Company: **CASCADE**
Logged By: **CNS**
Checked By:

Project Number:
Total Hole Depth: **21.50'**
Static Water Level:
Method: **Hollow Stem Auger**
Date Started: **06/07/99**
Permit #:

See Site Map For Boring Location

Comments:

Depth (ft)	FID	Sample ID	Recovery	Graphic Log	USCS Code	Water Level	Description
					GP		
1					ML		Surficial covering of brown Gravel and sand. Hand dug to 24"
2							
3							
4							
5							Light brown Silt, some sand, damp to moist, no odor
6							
7							
8							
9							
10					CH		Light brown and blue Clay, dry no odor
11							
12							
13							
14							
15							
16					SP		Gray Sand, wet, no odor
17							
18							
19							Water level at ~19.50 feet IP
20						▽	
21					CH		Gray Clay, very wet
22							End borehole
23							
24							
25							
26							
27							

IT CORPORATION

Drilling Log

Site ID: 02SB-04

Project Name: **Time Oil Co. Seattle Terminal**
Location:
Surface Elevation: **0.00'**
Borehole Diameter: **6.00in**
Drilling Company: **CASCADE**
Logged By: **CNS**
Checked By:

Project Number:
Total Hole Depth: **16.50'**
Static Water Level:
Method: **Hollow Stem Auger**
Date Started: **06/07/99**
Permit #:

See Site Map For Boring Location

Comments:

Depth (ft)	FID	Sample ID	Recovery	Graphic Log	USCS Code	Water Level	Description
1					SP		Light brown Gravel and sand. Hand dug to 24"
2							
3							
4							
5							
6							
7							
8							
9							Plastic sheet from bottom of former tank pit discovered on auger flight
10					ML	∇	Gray Silt, wet, no odor. Water level at ~10.00 feet IP
11							
12							
13							
14							
15							
16							Driller reported contact with Clay. Clay not found in sampler
17							End borehole
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							

IT CORPORATION

Drilling Log

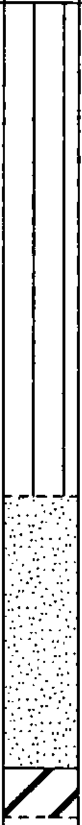
Site ID: 02SB-05

See Site Map For Boring Location

Comments:

Project Name: **Time Oil Co. Seattle Terminal**
Location:
Surface Elevation: **0.00'**
Borehole Diameter: **6.00in**
Drilling Company: **CASCADE**
Logged By: **CNS**
Checked By:

Project Number:
Total Hole Depth: **16.50'**
Static Water Level:
Method: **Hollow Stem Auger**
Date Started: **06/07/99**
Permit #:

Depth (ft)	FID	Sample ID	Recovery	Graphic Log	USCS Code	Water Level	Description
					ML		
1							Surficial covering of Gravel and sand. Hand dug to 24"
2							Light brown Silt, some sand, little gravel, dry, no odor
3							
4							
5							Grades dark gray, no gravel, damp, slight odor
6							
7							
8							
9							
10					SP		Gray Sand, moist to damp, odor
11							
12							
13							Water level at ~13.50 feet IP
14						▽	
15					CH		Grades orange, wet, slight odor
16							Gray Clay, damp, no odor
17							End borehole
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							

IT CORPORATION

Drilling Log

Site ID: **02SB-06**

See Site Map For Boring Location

Comments:

Project Name: **Time Oil Co. Seattle Terminal**
Location:
Surface Elevation: **0.00'**
Borehole Diameter: **6.00in**
Drilling Company: **CASCADE**
Logged By: **CNS**
Checked By:

Project Number:
Total Hole Depth: **11.50'**
Static Water Level:

Method: **Hollow Stem Auger**
Date Started: **06/07/93**
Permit #:

Depth (ft)	FID	Sample ID	Recovery	Graphic Log	USCS Code	Water Level	Description
1					SM		Surficial covering of sand and gravel. Hand dug to 24"
2							
3						▽	Water level at ~3.00 feet IP
4							
5							Orange brown Sand, little silt, wet, no odor
6							
7							
8							
9							
10							
11					CH		Gray Clay, trace gravel, dry to moist, no odor
12							End borehole
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							

IT CORPORATION

Drilling Log

Site ID: 02SB-07

See Site Map For Boring Location

Project Name: **Time Oil Co. Seattle Terminal**
Location:
Surface Elevation: **0.00'**
Borehole Diameter: **6.00in**
Drilling Company: **CASCADE**
Logged By: **CNS**
Checked By:

Project Number:
Total Hole Depth: **11.50'**
Static Water Level:

Method: **Hollow Stem Auger**
Date Started: **06/07/99**
Permit #:

Comments:

Depth (ft)	FID	Sample ID	Recovery	Graphic Log	USCS Code	Water Level	Description
				▒	SM		
1				▒			Hand dug to 24"
2				▒		▽	Dark brown Sand, dry, no odor. Water level at ~1.72 feet IP
3				▒			
4				▒			
5				▒			Grades gray green and brown, fine to medium grain, little silt, wet, no odor
6				▒			
7				▒			
8				▒			
9				▒			
10				▒			Grades no silt
11				▨	CH		Gray Clay, damp, no odor
12							End borehole
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							

IT CORPORATION

Drilling Log

Site ID: 02SB-08

See Site Map For Boring Location

Comments:

Project Name: **Time Oil Co. Seattle Terminal**
Location:
Surface Elevation: **0.00'**
Borehole Diameter: **6.00in**
Drilling Company: **CASCADE**
Logged By: **CNS**
Checked By:

Project Number:
Total Hole Depth: **9.00'**
Static Water Level:

Method: **Hollow Stem Auger**
Date Started: **06/07/99**
Permit #:

Depth (ft)	FID	Sample ID	Recovery	Graphic Log	USCS Code	Water Level	Description
					SM		
1							Hand dug to 24"
2							Light brown Sand and silt, some gravel, dry, no odor
3							Grades moist to damp, odor
4						▽	Water level at ~4.00 feet IP
5							
6							
7							Gray brown medium grain Sand, little silt, wet, no odor
8							
9							End borehole
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							

IT CORPORATION

Drilling Log

Site ID: 02SB-09

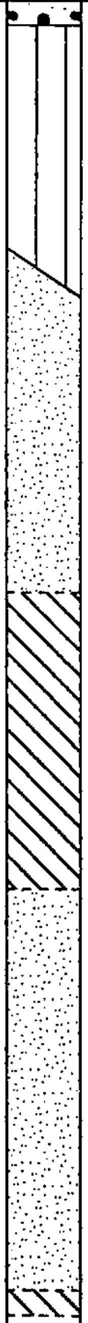
Project Name: **Time Oil Co. Seattle Terminal**
Location:
Surface Elevation: **0.00'**
Borehole Diameter: **6.00in**
Drilling Company: **CASCADE**
Logged By: **JH**
Checked By:

Project Number:
Total Hole Depth: **26.50'**
Static Water Level:

Method: **Hollow Stem Auger**
Date Started: **06/11/99**
Permit #:

See Site Map For Boring Location

Comments:

Depth (ft)	FID	Sample ID	Recovery	Graphic Log	USCS Code	Water Level	Description
1					GP ML		Surficial covering of gray Gravel 6". Hand dug to 24"
2							Brown Silt and gravel, dry
3							
4							
5							Tan to brown very fine grain Sand, very little silt, no gravel, dry, no odor
6					SP		
7							
8							
9							
10							Grades gray, little fines, wet, odor
11							
12					CL		
13							
14							
15							Gray soft Clay and silt, moderately dense, no odor
16							
17							
18					SP		
19							
20							Gray fine to medium grain Sand, little fines, no odor
21							
22							
23							
24							
25							
26					CL		Gray hard Clay
27							End borehole

1.0 DRILLING

1.1 The principle reason for requiring on-site drilling supervision is to acquire reliable information.

1.2 While supervising a test boring or well installation, the geologist should always make certain that the driller is making accurate depth measurements by ruler and not by visually "eyeballing" the measurements (five foot auger lengths or drill rods may vary in length by +/- .75 feet.

1.3 Discrepancies between the driller's statements of depth and the geologist's should be immediately clarified by remeasurement so that the driller and geologist are in agreement.

1.4 Note lithologic changes that occur between sampling depths. Lithologic changes can be estimated by: noting changes in the rate of penetration of the drilling tools; noting color and/or soil-type changes in the drill cuttings; and, noting the soil on the auger flights.

1.5 Samples obtained by split-spoon sampler should follow the standard penetration test procedure (see Section 2.0).

1.6 For each soil sample taken, the following information must be recorded on the well/boring log:

- sample depth
- sample number
- sampling method: split-spoon (SS), wash sample, auger flight sample, drill cutting sample.
- blow counts for every 6 inches penetration of the split-spoon sampler
- sample description should follow the Unified Soil Classification System.

1.7 The sample brass tubes must be labeled with the following information

- job number
- date and time
- well/boring number
- sample number
- sample depth
- name of sampler

1.8 Insure that samples are sealed in brass tubes as nearly intact and undisturbed as possible. Soil structure can be an important feature in interpreting the subsurface geology.

1.9 Seal the ends of the brass tubes with aluminum foil or teflon tape prior to placing on the air tight cap. Place the sealed and labeled tube on ice in a cooler for shipment to the lab along with a chain-of-custody.

1.10 Seal the contents of a second brass tube in a plastic sample bag for vapor level measurements.

1.11 Measure vapor levels with a photoionization detector (PID) when the samples reach room temperature (70 degrees F). Otherwise keep the samples cool until an instrument is available. Bring the samples to room temperature prior to measuring the vapor levels.

1.12 Attempt to determine the depth to groundwater as drilling progresses. After a well has been installed, measure the initial groundwater level. If no well has been installed, measure the water level in the boring prior to removing all of the auger flights or casing and backfilling the borehole.

1.13 When drilling in soils such as loose sands and silts, which tend to run up into the borehole, whether it is stabilized with casing or augers or not, the driller should maintain a positive head of water in the borehole (that is above the water table) at ALL times.

1.14 All pertinent data concerning drilling method, groundwater, penetration resistance, soil description, etc. should be entered onto the well/boring log.

1.15 Locate each well/boring location by taping the distances to at least three permanent physical features at the site. These may include any feature that is shown on the site plan provided, such as building corners, pump island, light standards, fences, planters, etc. DO NOT measure to another well/boring as one of the three measurements unless it is absolutely necessary. DO include measurements between well/borings as additional location information. This information, entered onto the well/boring log, will be used in conjunction with survey data to complete the site map and to generate groundwater contour and petroleum distribution maps.

1.16 At the completion of drilling, arrange to survey the well/boring locations and elevations.

1.17 Groundwater Technology does not assume the responsibility of directing the operations of independent contractors or insuring the safety of their workmen. Inform the contractor of the project requirements. Do not drive contractor trucks or operate or borrow his equipment.

1.18 Comply with all applicable articles of the Occupational Safety and Health Act of 1970, (OSHA).

2.0 STANDARD PENETRATION TEST

2.1 The standard split-spoon sampler consists of a 2-inch O.D. by 1-3/8-inch I.D., 18-inch minimum length, heat treated, case hardened, steel head, split-spoon and shoe assembly.

2.2 The head is vented to prevent pressure buildup during sampling and must be kept clean. A ball check valve is located in the head to prevent downward water pressure during sampling and sample retrieval. Removal of the water check valve often results in sample loss.

2.3 The drive rods which connect the split-spoon must have a stiffness equal or greater than an A-rod. In order to reduce rod deflection, especially in deep holes, it may be preferable to use larger diameter rods. The size of the drive rods must be consistent throughout a specific exploration as the energy absorbed will vary with the size and the weight of the rods used. The type of drive rod should be noted on the well/boring log.

2.4 The drive head consists of a guide rod to give the drop hammer a free fall in order to strike the anvil attached to the lower end of the assembly. The rod must be a minimum of 3-1/2 feet in length to insure the correct 30-inch hammer drop.

2.5 The drop hammer must weigh 140 pounds and have a 2-1/2-inch diameter hole through the center for the passage of the drive head rod.

2.6 The hammer is raised with a rope activated by the drill rig cathead. No more than two turns of rope should be allowed on the cathead.

2.7 A 30-inch free hammer drop is mandatory and extreme care should be exercised to insure consistent results.

2.8 Automatic trip hammers are available which insure a 30-inch, free-fall drop. These are recommended when retaining soil-structure data is critical, such as in liquefaction studies.

2.9 Attach the split-spoon sampler to the drill rods and lower the assembly to the bottom of the hole. Measure the drill rod stickup to determine if the bottom of the sampler is resting on the bottom of the hole. If the sampler is not on the bottom (ex. blow-up of the stratum being sampled), remove the assembly and clean out the hole to the appropriate sampling depth.

2.10 Note any penetration of the sampler/rod assembly due to the weight of the rods. Do not drop the assembly to the bottom of the hole.

2.11 Raise the 140-pound hammer 30 inches above the drivehead anvil and then allow it to drop, free-fall, and strike the anvil. This procedure is repeated until the sampler has been driven 18 inches into the stratum at the bottom of the hole (a 24-inch sampler may be driven 24 inches).

2.12 The number of blows of the hammer required for each 6 inches of penetration of the sampler is counted and recorded.

2.13 A penetration rate of 100 blows per foot is normally considered refusal; however, this criterion may be varied depending on the nature of the project and the desired information.

2.14 The penetration resistance, density, is calculated by adding together the second and the third resistance blowcounts. (Ex: for blow counts 2-6-6, density = 12.)

2.15 The sampler is then withdrawn form the borehole, preferably by pulling the rope rather than by bumping it out using the cathead and hammer in reverse.

2.16 Keeping the casing/augers/borehole full of water when removing the sampler will enhance sample recovery. however, this practice may not be appropriate when drilling at contamination sites.

2.17 When sampling soils where recovery is poor, lining the sampler with a flexible material such as plastic wrap or placing a sand catch in the shoe will often increase sample recovery.

2.18 Careful measurement of all drilling tools, samplers, casing, etc. must be exercised throughout all phases of the test boring operation.

2.19 Carefully open the sampler and describe the contents, noting soil structure, color, characteristics, etc. following the Unified Soils Classification System.

2.20 All pertinent data concerning sampling activities including sampling, interval, blow counts and sample recovery should be entered on the well/boring log.

3.0 WATER QUALITY SAMPLING

3.1 Water samples should not be taken from the stagnant water in the well.

3.2 Water samples should be taken in triplicate.

3.3 Remove 3 to 5 volumes of water in the well prior to sampling. The water may be removed by bailing, submersible pump, or purge system. Wells with a slow recovery period should be bailed dry and then sampled within 1 hour or when recovered to 80%. Monitor pH, temperature and specific conductivity with each well volume to insure water quality stabilization has occurred. However, this is not necessary at every well or in all circumstances.

3.4 Use only Teflon, stainless steel, or glass bailers to obtain the sample. Use Teflon only for sampling water containing chlorinated compounds and also for bacteriological samples. PVC bailers can be used for one-time sampling for other than EPA 624 analysis. Using a bailer for a one-time sampling reduces the possibility for cross-contamination.

3.5 When sampling, avoid stirring up any sediments in the well and agitating the water to reduce volitization of any dissolved compounds that may be present.

3.6 All sampling equipment must be cleaned following the appropriate procedure to avoid cross contamination from site to site and sample to sample. The sampling equipment should be cleaned before each well sampling, between each sampling, and at the end of each sampling round.

3.7 Monitoring wells should be gauged prior to sampling.

3.8 If possible, the monitoring wells should be sampled starting with the cleanest well and ending with the most contaminated well.

3.9 Wells containing free-phase contaminants should not be sampled.

3.10 When filling out the chain of custody form:
- enter the samples in the order in which they were collected;
- make a note as to the cleaning fluid used to clean the sampling equipment;
- attempt to identify which samples are the most contaminated;
- complete all other requested information.

3.11 The laboratory sample identification label should be filled out with a waterproof pen and firmly affixed to each sample container. Typically, identification labels require that the following information be supplied:
- job name
- job number
- sampler's name
- sample identification
- date sampled and time
- analysis requested

3.12 Acidification is required for samples that will be analyzed by the EPA 624 method. (see Acidification Procedure in this section)

3.13 Acidification is recommended for EPA method 601 and 602 samples to preserve them and increase their holding life. (see Acidification Procedure in this section)

3.14 Field blanks should be taken as part of each sampling round. A field blank consists of a sample of distilled water which has been collected by putting the distilled water into a sampling bailer after the bailer has been cleaned following the procedure used to clean that bailer during the sampling round. The field blank is stored with the samples. It is not analyzed unless requested by the Project Manager. The field blank should not be identified as such to the laboratory.

3.15 Handling of decontaminated equipment:

- Always use "pristine" gloves (latex, solvex, etc.).
- Place decontaminated bailers on clean surface (plastic).
- Do not wipe down bailer with paper towels or cloth.
- Follow decontamination procedure.

3.16 Sample accuracy can be adversely affected by the entrainment of sediment in wells which have not been properly developed. Contaminants adhering to the sediments can be released when samples are acidified for preservation. Therefore, if sediments are present, field filtering of the samples is recommended.

3.17 Chemical changes can take place because the sample was oxidized during sampling. It is critical to avoid oxidation of samples when sampling for volatile organic compounds (VOC). Therefore, take care to insure minimal agitation occurs during sampling.

3.18 All samples should be <u>properly</u> and <u>promptly</u> preserved.

3.19 All samples should be analyzed quickly; arrangements should be made with the testing laboratory to insure prompt analysis is performed within the allowable times for the specific analyses to be done.

3.20 Bailer strings that have contacted water or contaminants should be replaced between each well to avoid contamination from a bailer string which has absorbed contamination. A good practice is to replace the string between wells. <u>Caution</u>: some bailer strings are treated with a fungicide which may be detected in priority pollutant analysis.

3.21 Notify laboratory that samples are being shipped in advance of sampling to insure proper delivery and turnaround.

3.22 On the chain of custody, note what type of decontamination or preservation fluids, chemicals were used.

4.0 ACIDIFICATION PROCEDURE (EPA Methods 601,602, and 624)

4.1 At the start of each sampling round, the amount of acid required to lower a sampling container of water to be sampled to a pH of less than 2 should be determined.

4.2 After removing 3 to 5 well volumes from the first well to be sampled, put 5-10 drops of 50% HCL into a 40 ml sample vial (larger sampling container will require more acid) and fill the vial with water form the well; determine the pH of water in the vial with pH paper; if the pH is too high, repeat the procedure using 15-20 drops of acid in the vial; repeat until the pH of the water in the sample vial is a pH of less than 2 on the pH paper. Note the amount of acid required to lower the pH of the volume of water in the sampling vial. (pH paper should not be placed into sampling container. Pour sample onto pH paper to check for proper pH.)

4.3 Discard the practice acidified sample.

4.4 Once the amount of acid required to reach a pH of <2 is known, the acid can be routinely added to each sample container directly; the water to be analyzed is added to vial or container containing the appropriate amount of acid.

4.5 Note that the amount of acid required is site specific and should be noted on the Chain of Custody form.

4.6 The procedure should be repeated for each site at the start of each sampling round.

4.7 Equipment

- Bailer or other means to remove 3 to 5 well volumes
- Sampling bailer
- Polyethylene squirt bottle of 50% hydrochloric (HCL) acid
- Narrow range pH paper (1.0 - 2.5 pH range)
- Paper towels
- Waterproof pen
- Laboratory sample identification labels
- Cooler with ice
- Chain of custody forms
- Sample containers (usually 40 ml glass vials with teflon faced septums)
- Alconox solution and/or methanol
- Distilled water
- Safety equipment (gloves, etc.)
- Dissolved oxygen meter (sometimes used in limited biorec projects in conjunction with bacteriological testing)

5.0 SURVEYING

5.1 Equipment Handling

- The level/transit is a sensitive, expensive instrument, handle it accordingly. Keep it dry and clean as possible. Never carry the instrument in the back of the truck.

- Never leave the instrument on the tripod without securely attaching it.

- Make sure that the tripod is stable at all times.

- Always setup the tripod and instrument so that it is easily seen.

- Never leave a tripod and instrument unattended when surveying in an area with vehicular traffic. Place protective cones around the survey station.

- Keep an eye on the equipment at all times.

- Keep the survey rod free of dirt and grit.

5.2 Leveling the Instrument

- Center the level and screw it into the tripod.

- Firmly plant the tripod legs.

- Use foot screw to level the instrument. The bubble must be within the setting circle in order for the instrument the be level.

- Rotate the level 360 degrees, checking to be sure that the bubble remains inside the circle at every point.

5.3 Focusing the Cross Hairs and Siting

- To focus the cross hairs, look through the instrument and turn the ring around the eyepiece until the hairs come into focus.

- Relax your eye while looking through the eyepiece.

- Use a sun shade.

5.4 Rod

- Be careful when using a rod around overhead power and utility lines.

- The rod is graduated into hundredths of a foot. The bottom of each black line is an odd hundredth; the top of each black line is an even hundredth.

- When surveying to the rod, the rod should be slowly rocked forward and back to determine the lowest, and most accurate, reading.

5.5 Stadia Surveys

- Readings should be taken at the intersection of the vertical cross hair with the three horizontal cross hairs. (A level survey requires reading only the center cross hair.)

- Distance (D) calculation:

  D = (High Stadia - Low Stadia) x 100

  ex:
  High Stadia = 8.87 D = (8.87 - 8.29) x 100
  Low Stadia = 8.29 D = 58.0

- Check the accuracy of your readings as you survey. An acceptable error is .01 feet difference between calculations per siting.

- Check Readings: high - mid = mid - low

5.6 Bench Marks

- Clearly note the location and type of the bench mark used for each survey. The location should be marked permanently in the field so that it may be reused.

- If an existing bench mark with a known elevation is within a reasonable distance of the site, the surveyors should attempt to use it as the bench mark for the survey. possible existing bench marks are sewer manhole rims, storm drains, USGS (from topo map)

- If there is no known bench mark in the area, a bench mark must be created arbitrarily.

- Use the following guidelines for establishing an arbitrary bench mark:

  a) use permanent physical features such as the corner of a pump island, a cement floor slab, manhole or sewer <u>rim.</u>
  b) assign an elevation to the bench mark; if the nearest 10-foot contour is known, use it as the BM elevation; if the contour elevation is not known, assign an arbitrary elevation.
  c) clearly note the location and elevation of the BM in the field and on all site plans.
  d) <u>DO NOT USE MONITORING OR RECOVERY WELLS AS BENCH MARKS</u>.

5.7 Level Surveys

- When surveying wells, make certain to choose a survey point that can be used when gauging the well; if the top of the PVC casing is greater than 6 inches below the ground surface, do not use it as the survey point, instead use the lip or rim of the protective casing. Clearly note the survey point of each well in the survey notes.

- Obtain the following for each monitoring well survey location:

  a) the elevation of the top of the well casing (T.O.C.);
  b) the elevation of the lip or rim of the protective casing (T.O.R.)

- Permanently mark the survey point with paint or permanent marker.

- Place the rod on the survey point and hold it vertical; move it backwards and forwards to determine the most accurate reading.

- Calculate the elevation from the middle cross hair reading.

- Limit the number of times the instrument must be moved.

- After completing level readings at each set up, shoot back to two or more wells to close the level run.

- In a multiple-station survey, always shoot at least two known points for each station.

- Where there is a significant topographic change across a site, additional survey information will be required in order to document the ground surface elevation differences; this information is critical when drawing cross-sections and in planning trenching and infiltration gallery installations.

- Calculate elevations before moving instrument to determine if there are any irregularities or errors.

5.8 Turning Points

- A TP (turning point) is used when all of the survey points cannot be seen form one instrument position and the instrument must be moved.

- The TP essentially establishes a new bench mark from which a new height of instrument is calculated.

- A TP can be a permanent structure, a PK, the original BM or a well. (A PK is a surveyor's nail driven into the ground/asphalt to create a hub for the rod to rest upon.)

- Complete the following steps to create a TP:

  a) take a FS (foresight) on the TP and record the measurement under the FS column in the field book;
  b) the FS is subtracted from the HI (height of instrument) for the current instrument location to determine the elevation of the TP;
  c) the instrument is then moved to a new location and leveled;
  d) a BS (backsight) reading is taken to the TP and entered in the BS column in the field book;
  e) the BS is added to the TP to determine the new HI elevation;
  f) NOTE: the TP entry in the survey data in the field book will always have _4_ entries: BS, FS, HI, and elevation.

5.9 Taping locations

- Use a tape to verify distances that were surveyed with the instrument.

- Obtain three measurements for each location.

- Pull the tape tightly between points being measured.

- Measure dimensions of buildings on site to confirm base maps.

7.0 EXCAVATION AND TRENCH SOIL SAMPLING

7.1 Purpose

Underground Storage Tank (UST) decommissioning requires documentation of soil conditions. If tank closure is accomplished by excavation, removal and destruction of the tanks and lines, collection of representative samples for subsequent analysis is imperative. Utilizing the following procedures enables Groundwater Technology to secure the best possible retrieval of observations and samples.

7.2 Equipment

- Field Book, standard Surveyor's, waterproof, 5" x 7"
- Pencils
- Clipboard
- 6' folding ruler
- 50' cloth or fiberglass tape with weight
- Interface probe
- PID or other organic vapor screening device
- Sampling jars with air-tight Teflon lids, brass liners, 2" dia. x 6" long
- Aluminum foil or Teflon tape
- Bailer
- Rags probe wipers
- Alconox solution, distilled water, and H_2O
- Contract Documents, site plan, site sampling plan (QAPP), Site Safety Plan
- Lumber crayon or waterproof marking pen
- Safety equipment such as hard hat, appropriate footwear, respirator, goggles, ear plugs, gloves
- Copies of maps such as topographic or site vicinity
- Pocket knife
- Camera

7.3 Procedure

There are a number of preparations to be made by the Geologist/ Environmental Scientist before a site investigation begins. Attending to these preparations can increase the efficiency and quality of the work to be accomplished.

Before going into the field, each Geologist/Environmental Scientist should be completely familiar with the long and short term project objectives. He or she should review all of the available information about a site including site geology and the nature of the project. He or she should be familiar with all installation and sampling procedures that will be required.

It is the responsibility of the Project Manager to clearly describe the nature of each project and the amount of and type of work to be performed at a site. It is the responsibility of the Geologist/Environmental Scientist to make certain they understand what they are being asked to find out or do and, if they do not understand, then to ASK QUESTIONS.

The importance of communication <u>and</u> documentation cannot be stressed enough. What is not written down is often lost. What is written down and not pointed out may be inadvertently overlooked.

7.3.1 The principle reason for requiring excavation supervision is to acquire reliable information.

7.3.2 While supervising a tank or piping excavation, the Geologist should always make certain that accurate depth measurements are made by ruler and not by visually ``eyeballing" the measurements.

7.3.3 Discrepancies between the excavator's statements of depth and the Geologist's should be immediately clarified by remeasurement so that the operator and the Geologist are in agreement.

7.3.4 Note strata changes that occur during excavation. Strata changes can be estimated by observing changes in color, soil-type, or the ease of excavation.

7.3.5 Photographic records of site conditions are an important tool for filling in narrative discussion. Do not hesitate to take pictures of all site activities before, during, and after. Label and record each photograph in your field notes according to procedures similar to section 7.4.1 (b).

7.4 Sample Collection Methods

7.4.1 The following information must be kept during the sampling events:

(a) A sketch of the site must be made which clearly shows all of the sample locations and identifies each location with a unique sample identification code.

(b) Each soil and water sample must be clearly labeled with its sample identification code. A written record must be maintained which includes, but is not limited to: the date, time and location of the sample collection; the name of the person collecting the sample; how the sample was collected; and any unusual or unexpected problems encountered during the sample collection which may have affected the sample integrity.

(c) Formal chain-of-custody records must be maintained for each sample.

7.4.2 If soil samples cannot be safely collected from the excavation, a backhoe may be used to remove a bucket of native soil from each of the sample areas. The soil is to be brought rapidly to the surface where samples are to be immediately taken from the soil in the bucket.

7.4.3 The following procedures must be used for the collection of soil samples from open pits or trenches:

(a) Just prior to collecting each soil sample, approximately three inches of soil must be rapidly scraped away from the surface of the sample location.

(b) To minimize the loss of volatile materials, it is recommended that samples be taken using a driven-tube type sampler. A clean brass or stainless steel tube of at least one inch in diameter and three inches in length may be used for this purpose. The tube should be driven into the soil with a suitable instrument such as a wooden mallet or hammer.

(c) The ends of the sample-filled tube must be immediately covered with clean aluminum foil or Teflon^R tape. The foil must be held in place by plastic end caps which are then sealed onto the tube with a suitable tape.

(d) Alternatively, samples may be taken with a minimum amount of disturbance and packed in a clean wide-mouth glass jar leaving as little headspace as possible. The jar must then be immediately sealed with a teflon-lined screw cap.

(e) After the samples are properly sealed, they are to be immediately placed on ice and maintained at a temperature of no greater than 4°C (39°F) until being prepared for analysis by the laboratory. All samples must be analyzed within 14 days of collection.

APPENDIX D
LABORATORY ANALYTICAL REPORTS

www.ncalabs.com

Seattle 18939 120th Avenue NE, Suite 101, Bothell, WA 98011-9508
425.420.9200 fax 425.420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20354 Empire Avenue, Suite E-9, Bend, OR 97708-1883
541.383.9310 fax 541.382.7588

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 6/7/99
Received: 6/8/99
Reported: 6/25/99 11:31

ANALYTICAL REPORT FOR SAMPLES:

Sample Description	Laboratory Sample Number	Sample Matrix	Date Sampled
02SB-07A	B906234-01	Soil	6/7/99
02SB-07B	B906234-02	Soil	6/7/99
02SB-08A	B906234-03	Soil	6/7/99
02SB-08B	B906234-04	Soil	6/7/99
02SB-06A	B906234-05	Soil	6/7/99
02SB-06B	B906234-06	Soil	6/7/99
02SB-01A	B906234-07	Soil	6/7/99
02SB-01B	B906234-08	Soil	6/7/99
02SB-01C	B906234-09	Soil	6/7/99
02SB-01D	B906234-10	Soil	6/7/99
02SB-01E	B906234-11	Soil	6/7/99
02SB-02A	B906234-12	Soil	6/7/99
02SB-02B	B906234-13	Soil	6/7/99
02SB-02C	B906234-14	Soil	6/7/99
02SB-02D	B906234-15	Soil	6/7/99
02SB-05A	B906234-16	Soil	6/7/99
02SB-05B	B906234-17	Soil	6/7/99
02SB-05C	B906234-18	Soil	6/7/99
02SB-04B	B906234-19	Soil	6/7/99
02SB-04C	B906234-20	Soil	6/7/99

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Joy B Chang, Project Manager

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	6/8/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	6/25/99 11:31

ANALYTICAL REPORT FOR SAMPLES:

Sample Description	Laboratory Sample Number	Sample Matrix	Date Sampled
02SB-03A	B906234-21	Soil	6/7/99
02SB-03B	B906234-22	Soil	6/7/99
02SB-03C	B906234-23	Soil	6/7/99
02SB-03D	B906234-24	Soil	6/7/99
02SB-08H2O	B906234-25	Water	6/7/99
02SB-07H2O	B906234-26	Water	6/7/99
02SB-06H2O	B906234-27	Water	6/7/99
02SB-02H2O	B906234-28	Water	6/7/99
02SB-05H2O	B906234-29	Water	6/7/99
02SB-04H2O	B906234-30	Water	6/7/99
02SB-03H2O	B906234-31	Water	6/7/99

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Joy B Chang, Project Manager

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	6/8/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	6/25/99 11:31

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-07A			**B906234-01**				**Soil**	
Gasoline Range Hydrocarbons	0690370	6/11/99	6/21/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	**0.134**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*92.5*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*94.9*	"	
02SB-07B			**B906234-02**				**Soil**	
Gasoline Range Hydrocarbons	0690370	6/11/99	6/21/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*85.4*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*88.5*	"	
02SB-08A			**B906234-03**				**Soil**	
Gasoline Range Hydrocarbons	0690370	6/11/99	6/21/99		5.00	**72.6**	mg/kg dry	1
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0800	ND	"	2
Xylenes (total)	"	"	"		0.570	ND	"	2
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*126*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*98.5*	"	
02SB-08B			**B906234-04**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*75.8*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*92.0*	"	
02SB-06A			**B906234-05**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-06A (continued)			**B906234-05**				**Soil**	**3**
Toluene	0690523	6/16/99	6/23/99		0.0500	ND	mg/kg dry	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*83.8*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*88.2*	"	
02SB-06B			**B906234-06**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*78.8*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*85.6*	"	
02SB-01A			**B906234-07**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*85.0*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*90.7*	"	
02SB-01B			**B906234-08**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*84.6*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*92.3*	"	
02SB-01C			**B906234-09**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-01C (continued)			**B906234-09**				**Soil**	**3**
Xylenes (total)	0690523	6/16/99	6/23/99		0.100	ND	mg/kg dry	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*83.3*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*94.8*	"	
02SB-01D			**B906234-10**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*88.6*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*102*	"	
02SB-01E			**B906234-11**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	**0.0596**	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*89.4*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*101*	"	
02SB-02A			**B906234-12**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*79.7*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*91.4*	"	
02SB-02B			**B906234-13**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*80.4*	%	

**Refer to end of report for text of notes and definitions.*

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-02B (continued)			**B906234-13**				**Soil**	**3**
Surrogate: 4-BFB (PID)	*0690523*	*6/16/99*	*6/23/99*	*50.0-150*		*96.5*	*%*	
02SB-02C			**B906234-14**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/22/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*79.3*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*86.2*	"	
02SB-02D			**B906234-15**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*83.2*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*90.6*	"	
02SB-05A			**B906234-16**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*85.1*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*92.7*	"	
02SB-05B			**B906234-17**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/22/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*80.0*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*89.2*	"	

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	6/8/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	6/25/99 11:31

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-03B (continued)			**B906234-22**				**Soil**	**3**
Toluene	0690523	6/16/99	6/23/99		0.0500	ND	mg/kg dry	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*74.7*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*99.2*	"	
02SB-03C			**B906234-23**				**Soil**	**3**
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*78.6*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*92.7*	"	
02SB-03D			**B906234-24**				**Soil**	
Gasoline Range Hydrocarbons	0690565	6/17/99	6/24/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*85.1*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*91.6*	"	

**Refer to end of report for text of notes and definitions.*

IT Corporation - Renton	Project: Time Oil #2750	Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received:	6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported:	6/25/99 11:31

Semivolatile Petroleum Products by NWTPH-Dx (w/o Acid/Silica Gel Clean-up)
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-07A			**B906234-01**				**Soil**	
Diesel Range Hydrocarbons	0690406	6/11/99	6/13/99		10.0	**61.8**	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	**53.1**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*110*	%	
02SB-07B			**B906234-02**				**Soil**	
Diesel Range Hydrocarbons	0690406	6/11/99	6/13/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*64.0*	%	
02SB-08A			**B906234-03**				**Soil**	
Diesel Range Hydrocarbons	0690406	6/11/99	6/13/99		10.0	**127**	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	**428**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*107*	%	
02SB-08B			**B906234-04**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/16/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	**38.1**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*69.0*	%	
02SB-06A			**B906234-05**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*83.7*	%	
02SB-06B			**B906234-06**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*69.1*	%	
02SB-01A			**B906234-07**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/18/99		30.0	**540**	mg/kg dry	4
Lube Oil Range Hydrocarbons	"	"	"		75.0	**1320**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*93.7*	%	
02SB-01B			**B906234-08**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/18/99		30.0	**285**	mg/kg dry	4
Lube Oil Range Hydrocarbons	"	"	"		75.0	**712**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*82.9*	%	

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Semivolatile Petroleum Products by NWTPH-Dx (w/o Acid/Silica Gel Clean-up)
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-01C			**B906234-09**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*78.5*	%	
02SB-01D			**B906234-10**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/18/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	**31.2**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*104*	%	
02SB-01E			**B906234-11**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*78.2*	%	
02SB-02A			**B906234-12**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/17/99		10.0	**14.0**	mg/kg dry	4
Lube Oil Range Hydrocarbons	"	"	"		25.0	**42.7**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*75.2*	%	
02SB-02B			**B906234-13**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*90.0*	%	
02SB-02C			**B906234-14**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*59.4*	%	
02SB-02D			**B906234-15**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*89.4*	%	
02SB-05A			**B906234-16**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/17/99		10.0	**17.6**	mg/kg dry	4
Lube Oil Range Hydrocarbons	"	"	"		25.0	**64.5**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*67.9*	%	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Semivolatile Petroleum Products by NWTPH-Dx (w/o Acid/Silica Gel Clean-up)
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-05B			**B906234-17**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*94.1*	%	
02SB-05C			**B906234-18**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/11/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*68.6*	%	
02SB-04B			**B906234-19**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/16/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*90.4*	%	
02SB-04C			**B906234-20**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/16/99	6/17/99		10.0	**15.2**	mg/kg dry	4
Lube Oil Range Hydrocarbons	"	"	"		25.0	**62.5**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*76.4*	%	
02SB-03A			**B906234-21**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/16/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*84.6*	%	
02SB-03B			**B906234-22**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/16/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*68.9*	%	
02SB-03C			**B906234-23**				**Soil**	
Diesel Range Hydrocarbons	0690536	6/16/99	6/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*92.0*	%	
02SB-03D			**B906234-24**				**Soil**	
Diesel Range Hydrocarbons	0690555	6/17/99	6/19/99		10.0	**11.3**	mg/kg dry	4
Lube Oil Range Hydrocarbons	"	"	"		25.0	**38.8**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*71.8*	%	

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Semivolatile Petroleum Products by NWTPH-Dx (w/o Acid/Silica Gel Clean-up)
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-08H2O			**B906234-25**				**Water**	
Diesel Range Hydrocarbons	0690369	6/11/99	6/14/99		0.250	**0.668**	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*71.6*	%	
02SB-07H2O			**B906234-26**				**Water**	
Diesel Range Hydrocarbons	0690369	6/11/99	6/14/99		0.250	**1.07**	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	**0.626**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*108*	%	
02SB-06H2O			**B906234-27**				**Water**	
Diesel Range Hydrocarbons	0690369	6/11/99	6/14/99		0.250	**0.456**	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*72.8*	%	
02SB-02H2O			**B906234-28**				**Water**	
Diesel Range Hydrocarbons	0690369	6/11/99	6/14/99		0.250	**3.12**	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*117*	%	
02SB-05H2O			**B906234-29**				**Water**	
Diesel Range Hydrocarbons	0690369	6/11/99	6/14/99		0.250	**0.865**	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*69.9*	%	
02SB-04H2O			**B906234-30**				**Water**	
Diesel Range Hydrocarbons	0690369	6/11/99	6/14/99		0.250	**0.867**	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	**0.503**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*109*	%	
02SB-03H2O			**B906234-31**				**Water**	
Diesel Range Hydrocarbons	0690419	6/12/99	6/14/99		0.250	**1.07**	mg/l	5
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*87.7*	%	

IT Corporation - Renton	Project: Time Oil #2750	Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received:	6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported:	6/25/99 11:31

Total Metals by EPA 6000/7000 Series Methods
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Specific Method	Reporting Limit	Result	Units	Notes*
02SB-07A			**B906234-01**				**Soil**	
Lead	0690627	6/19/99	6/21/99	EPA 6020	0.500	**7.85**	mg/kg dry	
02SB-07B			**B906234-02**				**Soil**	
Lead	0690627	6/19/99	6/21/99	EPA 6020	0.500	**2.40**	mg/kg dry	
02SB-08A			**B906234-03**				**Soil**	
Lead	0690627	6/19/99	6/21/99	EPA 6020	0.500	**10.6**	mg/kg dry	
02SB-08B			**B906234-04**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**3.02**	mg/kg dry	
02SB-06A			**B906234-05**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**2.78**	mg/kg dry	
02SB-06B			**B906234-06**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**2.20**	mg/kg dry	
02SB-01A			**B906234-07**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**11.1**	mg/kg dry	
02SB-01B			**B906234-08**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**15.1**	mg/kg dry	
02SB-01C			**B906234-09**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**2.80**	mg/kg dry	
02SB-01D			**B906234-10**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**6.03**	mg/kg dry	
02SB-01E			**B906234-11**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**6.18**	mg/kg dry	
02SB-02A			**B906234-12**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**22.8**	mg/kg dry	
02SB-02B			**B906234-13**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**5.00**	mg/kg dry	

**Refer to end of report for text of notes and definitions.*

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	6/8/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	6/25/99 11:31

Total Metals by EPA 6000/7000 Series Methods
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Specific Method	Reporting Limit	Result	Units	Notes*
02SB-02C			**B906234-14**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**2.79**	mg/kg dry	
02SB-02D			**B906234-15**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**2.29**	mg/kg dry	
02SB-05A			**B906234-16**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**18.0**	mg/kg dry	
02SB-05B			**B906234-17**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**3.72**	mg/kg dry	
02SB-05C			**B906234-18**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**4.23**	mg/kg dry	
02SB-04B			**B906234-19**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**2.57**	mg/kg dry	
02SB-04C			**B906234-20**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**2.97**	mg/kg dry	
02SB-03A			**B906234-21**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**4.49**	mg/kg dry	
02SB-03B			**B906234-22**				**Soil**	
Lead	0690627	6/19/99	6/21/99	EPA 6020	0.500	**6.16**	mg/kg dry	
02SB-03C			**B906234-23**				**Soil**	
Lead	0690627	6/19/99	6/21/99	EPA 6020	0.500	**2.99**	mg/kg dry	
02SB-03D			**B906234-24**				**Soil**	
Lead	0690627	6/19/99	6/22/99	EPA 6020	0.500	**3.50**	mg/kg dry	

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Dissolved Metals by EPA 6000/7000 Series Methods
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Specific Method	Reporting Limit	Result	Units	Notes*
02SB-08H2O			**B906234-25**				**Water**	
Lead	0690388	6/11/99	6/15/99	EPA 6020	0.00100	ND	mg/l	
02SB-07H2O			**B906234-26**				**Water**	
Lead	0690388	6/11/99	6/15/99	EPA 6020	0.00100	ND	mg/l	
02SB-06H2O			**B906234-27**				**Water**	
Lead	0690388	6/11/99	6/15/99	EPA 6020	0.00100	ND	mg/l	
02SB-05H2O			**B906234-29**				**Water**	
Lead	0690388	6/11/99	6/15/99	EPA 6020	0.00100	**0.00129**	mg/l	
02SB-04H2O			**B906234-30**				**Water**	
Lead	0690388	6/11/99	6/15/99	EPA 6020	0.00100	ND	mg/l	
02SB-03H2O			**B906234-31**				**Water**	
Lead	0690388	6/11/99	6/15/99	EPA 6020	0.00100	ND	mg/l	

**Refer to end of report for text of notes and definitions.*

IT Corporation - Renton	Project: Time Oil #2750	Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received:	6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported:	6/25/99 11:31

Gasoline Hydrocarbons per NWTPH-Gx Method and BTEX per EPA Method 8020A
North Creek Analytical - Spokane

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-08H2O			**B906234-25**				**Water**	
Benzene	0690058	6/17/99	6/18/99		0.500	**1.59**	ug/l	
Toluene	"	"	"		0.500	**1.25**	"	
Ethylbenzene	"	"	"		0.500	ND	"	
Xylenes (total)	"	"	"		1.00	**2.78**	"	
Gasoline Range Hydrocarbons	"	"	"		50.0	**128**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*98.0*	%	
Surrogate: 4-BFB (PID)	"	"	"	*53.0-142*		*74.8*	"	
02SB-07H2O			**B906234-26**				**Water**	
Benzene	0690058	6/17/99	6/18/99		0.500	ND	ug/l	
Toluene	"	"	"		0.500	ND	"	
Ethylbenzene	"	"	"		0.500	ND	"	
Xylenes (total)	"	"	"		1.00	ND	"	
Gasoline Range Hydrocarbons	"	"	"		50.0	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*87.2*	%	
Surrogate: 4-BFB (PID)	"	"	"	*53.0-142*		*86.0*	"	
02SB-06H2O			**B906234-27**				**Water**	
Benzene	0690058	6/17/99	6/18/99		0.500	ND	ug/l	
Toluene	"	"	"		0.500	**1.11**	"	
Ethylbenzene	"	"	"		0.500	**0.585**	"	
Xylenes (total)	"	"	"		1.00	**4.03**	"	
Gasoline Range Hydrocarbons	"	"	"		50.0	**103**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*95.2*	%	
Surrogate: 4-BFB (PID)	"	"	"	*53.0-142*		*68.8*	"	
02SB-02H2O			**B906234-28**				**Water**	
Benzene	0690058	6/17/99	6/18/99		50.0	**214**	ug/l	
Toluene	"	"	"		50.0	**155**	"	
Ethylbenzene	"	"	"		50.0	**459**	"	
Xylenes (total)	"	"	"		100	**1110**	"	
Gasoline Range Hydrocarbons	"	"	"		5000	**8260**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*104*	%	
Surrogate: 4-BFB (PID)	"	"	"	*53.0-142*		*85.6*	"	
02SB-05H2O			**B906234-29**				**Water**	
Benzene	0690058	6/17/99	6/18/99		0.500	**19.9**	ug/l	
Toluene	"	"	"		0.500	**4.18**	"	

**Refer to end of report for text of notes and definitions.*

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Gasoline Hydrocarbons per NWTPH-Gx Method and BTEX per EPA Method 8020A
North Creek Analytical - Spokane

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-05H2O (continued)			**B906234-29**				**Water**	
Ethylbenzene	0690058	6/17/99	6/18/99		0.500	**19.9**	ug/l	
Xylenes (total)	"	"	"		1.00	**20.2**	"	
Gasoline Range Hydrocarbons	"	"	"		50.0	**685**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*NR*	%	*6*
Surrogate: 4-BFB (PID)	"	"	"	*53.0-142*		*122*	"	
02SB-04H2O			**B906234-30**				**Water**	
Benzene	0690058	6/17/99	6/18/99		0.500	**59.8**	ug/l	
Toluene	"	"	"		0.500	**2.28**	"	
Ethylbenzene	"	"	"		0.500	**1.62**	"	
Xylenes (total)	"	"	"		1.00	**8.18**	"	
Gasoline Range Hydrocarbons	"	"	"		50.0	**55.6**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*79.2*	%	
Surrogate: 4-BFB (PID)	"	"	"	*53.0-142*		*67.6*	"	
02SB-03H2O			**B906234-31**				**Water**	
Benzene	0690058	6/17/99	6/18/99		0.500	**6.64**	ug/l	
Toluene	"	"	"		0.500	**1.36**	"	
Ethylbenzene	"	"	"		0.500	**0.617**	"	
Xylenes (total)	"	"	"		1.00	**1.93**	"	
Gasoline Range Hydrocarbons	"	"	"		50.0	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*81.2*	%	
Surrogate: 4-BFB (PID)	"	"	"	*53.0-142*		*66.4*	"	

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton 555 South Renton Village Place, Ste 700 Renton, WA 98055	Project: Time Oil #2750 Project Number: 783336 Project Manager: Jerry Harris	Sampled: 6/7/99 Received: 6/8/99 Reported: 6/25/99 11:31

Dry Weight Determination
North Creek Analytical - Bothell

Sample Name	Lab ID	Matrix	Result	Units
02SB-07A	B906234-01	Soil	78.7	%
02SB-07B	B906234-02	Soil	76.6	%
02SB-08A	B906234-03	Soil	83.4	%
02SB-08B	B906234-04	Soil	79.8	%
02SB-06A	B906234-05	Soil	80.1	%
02SB-06B	B906234-06	Soil	80.0	%
02SB-01A	B906234-07	Soil	84.5	%
02SB-01B	B906234-08	Soil	88.2	%
02SB-01C	B906234-09	Soil	83.5	%
02SB-01D	B906234-10	Soil	82.9	%
02SB-01E	B906234-11	Soil	81.6	%
02SB-02A	B906234-12	Soil	81.9	%
02SB-02B	B906234-13	Soil	83.4	%
02SB-02C	B906234-14	Soil	78.9	%
02SB-02D	B906234-15	Soil	81.9	%
02SB-05A	B906234-16	Soil	78.5	%
02SB-05B	B906234-17	Soil	80.2	%
02SB-05C	B906234-18	Soil	81.7	%
02SB-04B	B906234-19	Soil	79.6	%

North Creek Analytical - Bothell

Joy B Chang, Project Manager

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	6/8/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	6/25/99 11:31

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-05C			**B906234-18**				**Soil**	3
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*81.8*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*96.5*	"	
02SB-04B			**B906234-19**				**Soil**	3
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*75.1*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*91.1*	"	
02SB-04C			**B906234-20**				**Soil**	3
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*70.2*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*84.7*	"	
02SB-03A			**B906234-21**				**Soil**	3
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*74.0*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*91.9*	"	
02SB-03B			**B906234-22**				**Soil**	3
Gasoline Range Hydrocarbons	0690523	6/16/99	6/23/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 6/7/99
Received: 6/8/99
Reported: 6/25/99 11:31

Dry Weight Determination
North Creek Analytical - Bothell

Sample Name	Lab ID	Matrix	Result	Units
02SB-04C	B906234-20	Soil	77.6	%
02SB-03A	B906234-21	Soil	83.2	%
02SB-03B	B906234-22	Soil	81.5	%
02SB-03C	B906234-23	Soil	78.4	%
02SB-03D	B906234-24	Soil	76.2	%

IT Corporation - Renton	Project: Time Oil #2750		Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336		Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris		Reported: 6/25/99 11:31

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0690370	**Date Prepared: 6/11/99**				**Extraction Method: EPA 5030B (MeOH)**					
Blank	**0690370-BLK1**									
Gasoline Range Hydrocarbons	6/20/99			ND	mg/kg dry	5.00				
Benzene	"			ND	"	0.0500				
Toluene	"			ND	"	0.0500				
Ethylbenzene	"			ND	"	0.0500				
Xylenes (total)	"			ND	"	0.100				
Surrogate: 4-BFB (FID)	*"*	*4.00*		*4.06*	*"*	*50.0-150*	*101*			
Surrogate: 4-BFB (PID)	*"*	*4.00*		*4.21*	*"*	*50.0-150*	*105*			
LCS	**0690370-BS1**									
Gasoline Range Hydrocarbons	6/20/99	25.0		23.8	mg/kg dry	70.0-130	95.2			
Surrogate: 4-BFB (FID)	*"*	*4.00*		*4.20*	*"*	*50.0-150*	*105*			
Duplicate	**0690370-DUP1**		**B906191-01**							
Gasoline Range Hydrocarbons	6/21/99		5.14	ND	mg/kg dry			50.0		
Surrogate: 4-BFB (FID)	*"*	*4.92*		*4.15*	*"*	*50.0-150*	*84.3*			
Duplicate	**0690370-DUP2**		**B906191-08**							
Gasoline Range Hydrocarbons	6/22/99		5.39	ND	mg/kg dry			50.0		
Surrogate: 4-BFB (FID)	*"*	*4.84*		*3.94*	*"*	*50.0-150*	*81.4*			
Matrix Spike	**0690370-MS1**		**B906191-07**							
Benzene	6/22/99	0.612	ND	0.499	mg/kg dry	60.0-140	81.5			
Toluene	"	0.612	ND	0.497	"	60.0-140	81.2			
Ethylbenzene	"	0.612	ND	0.521	"	60.0-140	85.1			
Xylenes (total)	"	1.84	ND	1.52	"	60.0-140	82.6			
Surrogate: 4-BFB (PID)	*"*	*4.90*		*4.29*	*"*	*50.0-150*	*87.6*			
Matrix Spike Dup	**0690370-MSD1**		**B906191-07**							
Benzene	6/22/99	0.612	ND	0.513	mg/kg dry	60.0-140	83.8	20.0	2.78	
Toluene	"	0.612	ND	0.499	"	60.0-140	81.5	20.0	0.369	
Ethylbenzene	"	0.612	ND	0.516	"	60.0-140	84.3	20.0	0.945	
Xylenes (total)	"	1.84	ND	1.53	"	60.0-140	83.2	20.0	0.724	
Surrogate: 4-BFB (PID)	*"*	*4.90*		*4.20*	*"*	*50.0-150*	*85.7*			
Batch: 0690523	**Date Prepared: 6/16/99**				**Extraction Method: EPA 5030B (MeOH)**					
Blank	**0690523-BLK1**									
Gasoline Range Hydrocarbons	6/23/99			ND	mg/kg dry	5.00				

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Blank (continued)	**0690523-BLK1**									
Benzene	6/23/99			**ND**	mg/kg dry	**0.0500**				
Toluene	"			**ND**	"	**0.0500**				
Ethylbenzene	"			**ND**	"	**0.0500**				
Xylenes (total)	"			**ND**	"	**0.100**				
Surrogate: 4-BFB (FID)	"	*4.00*		*3.43*	"	*50.0-150*	*85.8*			
Surrogate: 4-BFB (PID)	"	*4.00*		*4.02*	"	*50.0-150*	*100*			
LCS	**0690523-BS1**									
Gasoline Range Hydrocarbons	6/23/99	25.0		19.7	mg/kg dry	70.0-130	78.8			
Surrogate: 4-BFB (FID)	"	*4.00*		*3.82*	"	*50.0-150*	*95.5*			
Duplicate	**0690523-DUP1**		**B906234-17**							
Gasoline Range Hydrocarbons	6/23/99		ND	ND	mg/kg dry			50.0		
Surrogate: 4-BFB (FID)	"	*4.99*		*3.88*	"	*50.0-150*	*77.8*			
Duplicate	**0690523-DUP2**		**B906234-14**							
Gasoline Range Hydrocarbons	6/23/99		ND	ND	mg/kg dry			50.0		
Surrogate: 4-BFB (FID)	"	*5.07*		*3.76*	"	*50.0-150*	*74.2*			
Matrix Spike	**0690523-MS1**		**B906234-04**							
Benzene	6/23/99	0.626	ND	0.522	mg/kg dry	60.0-140	**83.4**			
Toluene	"	0.626	ND	0.560	"	60.0-140	**89.5**			
Ethylbenzene	"	0.626	ND	0.567	"	60.0-140	**90.6**			
Xylenes (total)	"	1.88	ND	1.69	"	60.0-140	**89.9**			
Surrogate: 4-BFB (PID)	"	*5.01*		*4.56*	"	*50.0-150*	*91.0*			
Matrix Spike Dup	**0690523-MSD1**		**B906234-04**							
Benzene	6/23/99	0.626	ND	0.512	mg/kg dry	60.0-140	**81.8**	20.0	**1.94**	
Toluene	"	0.626	ND	0.542	"	60.0-140	**86.6**	20.0	**3.29**	
Ethylbenzene	"	0.626	ND	0.549	"	60.0-140	**87.7**	20.0	**3.25**	
Xylenes (total)	"	1.88	ND	1.63	"	60.0-140	**86.7**	20.0	**3.62**	
Surrogate: 4-BFB (PID)	"	*5.01*		*4.36*	"	*50.0-150*	*87.0*			
Batch: 0690565	**Date Prepared: 6/17/99**				**Extraction Method: EPA 5030B (MeOH)**					
Blank	**0690565-BLK1**									
Gasoline Range Hydrocarbons	6/23/99			**ND**	mg/kg dry	**5.00**				
Benzene	"			**ND**	"	**0.0500**				
Toluene	"			**ND**	"	**0.0500**				

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	**Reporting Limit** Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Blank (continued)	**0690565-BLK1**									
Ethylbenzene	6/23/99			**ND**	mg/kg dry	**0.0500**				
Xylenes (total)	"			**ND**	"	**0.100**				
Surrogate: 4-BFB (FID)	*"*	*4.00*		*3.85*	*"*	*50.0-150*	*96.2*			
Surrogate: 4-BFB (PID)	*"*	*4.00*		*4.12*	*"*	*50.0-150*	*103*			
LCS	**0690565-BS1**									
Gasoline Range Hydrocarbons	6/21/99	25.0		20.5	mg/kg dry	70.0-130	82.0			
Surrogate: 4-BFB (FID)	*"*	*4.00*		*4.00*	*"*	*50.0-150*	*100*			
Duplicate	**0690565-DUP1**		**B906371-01**							
Gasoline Range Hydrocarbons	6/21/99		ND	ND	mg/kg dry			50.0		
Surrogate: 4-BFB (FID)	*"*	*4.45*		*4.03*	*"*	*50.0-150*	*90.6*			
Matrix Spike	**0690565-MS1**		**B906302-05**							
Benzene	6/21/99	0.568	ND	0.443	mg/kg dry	60.0-140	**78.0**			
Toluene	"	0.568	ND	0.471	"	60.0-140	**82.9**			
Ethylbenzene	"	0.568	0.0532	0.481	"	60.0-140	**75.3**			
Xylenes (total)	"	1.70	ND	1.43	"	60.0-140	**84.1**			
Surrogate: 4-BFB (PID)	*"*	*4.54*		*4.17*	*"*	*50.0-150*	*91.9*			
Matrix Spike Dup	**0690565-MSD1**		**B906302-05**							
Benzene	6/22/99	0.568	ND	0.451	mg/kg dry	60.0-140	**79.4**	20.0	**1.78**	
Toluene	"	0.568	ND	0.477	"	60.0-140	**84.0**	20.0	**1.32**	
Ethylbenzene	"	0.568	0.0532	0.477	"	60.0-140	**74.6**	20.0	**0.934**	
Xylenes (total)	"	1.70	ND	1.41	"	60.0-140	**82.9**	20.0	**1.44**	
Surrogate: 4-BFB (PID)	*"*	*4.54*		*4.08*	*"*	*50.0-150*	*89.9*			

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Semivolatile Petroleum Products by NWTPH-Dx (w/o Acid/Silica Gel Clean-up)/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0690369	**Date Prepared: 6/11/99**				**Extraction Method: EPA 3520C/600 Series**					
Blank	**0690369-BLK1**									
Diesel Range Hydrocarbons	6/14/99			ND	mg/l	0.250				
Lube Oil Range Hydrocarbons	"			ND	"	0.500				
Surrogate: 2-FBP	"	*0.325*		*0.388*	"	*50.0-150*	*119*			
LCS	**0690369-BS1**									
Diesel Range Hydrocarbons	6/13/99	2.00		1.78	mg/l	60.0-140	89.0			
Surrogate: 2-FBP	"	*0.325*		*0.249*	"	*50.0-150*	*76.6*			
LCS Dup	**0690369-BSD1**									
Diesel Range Hydrocarbons	6/14/99	2.00		1.80	mg/l	60.0-140	90.0	40.0	1.12	
Surrogate: 2-FBP	"	*0.325*		*0.342*	"	*50.0-150*	*105*			
Batch: 0690406	**Date Prepared: 6/11/99**				**Extraction Method: EPA 3550B**					
Blank	**0690406-BLK1**									
Diesel Range Hydrocarbons	6/13/99			ND	mg/kg dry	10.0				
Lube Oil Range Hydrocarbons	"			ND	"	25.0				
Surrogate: 2-FBP	"	*10.7*		*11.8*	"	*50.0-150*	*110*			
LCS	**0690406-BS1**									
Diesel Range Hydrocarbons	6/13/99	66.7		56.6	mg/kg dry	60.0-140	84.9			
Surrogate: 2-FBP	"	*10.7*		*7.49*	"	*50.0-150*	*70.0*			
Duplicate	**0690406-DUP1**		**B906279-01**							
Diesel Range Hydrocarbons	6/13/99		740	507	mg/kg dry			50.0	37.4	
Lube Oil Range Hydrocarbons	"		2730	1520	"			50.0	56.9	7
Surrogate: 2-FBP	"	*11.4*		*6.64*	"	*50.0-150*	*58.2*			
Duplicate	**0690406-DUP2**		**B906235-04**							
Diesel Range Hydrocarbons	6/13/99		17.0	13.4	mg/kg dry			50.0	23.7	
Lube Oil Range Hydrocarbons	"		37.0	ND	"			50.0		
Surrogate: 2-FBP	"	*13.5*		*9.41*	"	*50.0-150*	*69.7*			
Batch: 0690419	**Date Prepared: 6/12/99**				**Extraction Method: EPA 3520C/600 Series**					
Blank	**0690419-BLK1**									
Diesel Range Hydrocarbons	6/14/99			ND	mg/l	0.250				
Lube Oil Range Hydrocarbons	"			ND	"	0.500				
Surrogate: 2-FBP	"	*0.325*		*0.244*	"	*50.0-150*	*75.1*			

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Semivolatile Petroleum Products by NWTPH-Dx (w/o Acid/Silica Gel Clean-up)/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
LCS	**0690419-BS1**									
Diesel Range Hydrocarbons	6/14/99	2.00		1.66	mg/l	60.0-140	83.0			
Surrogate: 2-FBP	*"*	*0.325*		*0.334*	*"*	*50.0-150*	*103*			
LCS Dup	**0690419-BSD1**									
Diesel Range Hydrocarbons	6/14/99	2.00		1.69	mg/l	60.0-140	84.5	40.0	1.79	
Surrogate: 2-FBP	*"*	*0.325*		*0.257*	*"*	*50.0-150*	*79.1*			
Batch: 0690536	**Date Prepared: 6/16/99**				**Extraction Method: EPA 3550B**					
Blank	**0690536-BLK1**									
Diesel Range Hydrocarbons	6/17/99			ND	mg/kg dry	10.0				
Lube Oil Range Hydrocarbons	"			ND	"	25.0				
Surrogate: 2-FBP	*"*	*10.8*		*6.86*	*"*	*50.0-150*	*63.5*			
LCS	**0690536-BS1**									
Diesel Range Hydrocarbons	6/17/99	66.7		55.2	mg/kg dry	60.0-140	82.8			
Surrogate: 2-FBP	*"*	*10.8*		*9.58*	*"*	*50.0-150*	*88.7*			
Duplicate	**0690536-DUP1**		**B906234-23**							
Diesel Range Hydrocarbons	6/17/99		ND	12.4	mg/kg dry			50.0		8
Lube Oil Range Hydrocarbons	"		ND	29.0	"			50.0		8
Surrogate: 2-FBP	*"*	*13.8*		*8.96*	*"*	*50.0-150*	*64.9*			
Duplicate	**0690536-DUP2**		**B906234-05**							
Diesel Range Hydrocarbons	6/17/99		ND	ND	mg/kg dry			50.0		
Lube Oil Range Hydrocarbons	"		ND	ND	"			50.0		
Surrogate: 2-FBP	*"*	*13.5*		*12.6*	*"*	*50.0-150*	*93.3*			
Batch: 0690555	**Date Prepared: 6/17/99**				**Extraction Method: EPA 3550B**					
Blank	**0690555-BLK1**									
Diesel Range Hydrocarbons	6/18/99			ND	mg/kg dry	10.0				
Lube Oil Range Hydrocarbons	"			ND	"	25.0				
Surrogate: 2-FBP	*"*	*10.8*		*6.84*	*"*	*50.0-150*	*63.3*			
LCS	**0690555-BS1**									
Diesel Range Hydrocarbons	6/18/99	66.7		55.0	mg/kg dry	60.0-140	82.5			
Surrogate: 2-FBP	*"*	*10.8*		*9.21*	*"*	*50.0-150*	*85.3*			

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	6/8/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	6/25/99 11:31

Semivolatile Petroleum Products by NWTPH-Dx (w/o Acid/Silica Gel Clean-up)/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Duplicate	**0690555-DUP1**		**B906373-01**							
Diesel Range Hydrocarbons	6/18/99		ND	ND	mg/kg dry			50.0		
Lube Oil Range Hydrocarbons	"		36.9	ND	"			50.0		
Surrogate: 2-FBP	*"*	*13.6*		*7.64*	*"*	*50.0-150*	*56.2*			

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Total Metals by EPA 6000/7000 Series Methods/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0690627	**Date Prepared: 6/19/99**				**Extraction Method: EPA 3050B**					
Blank	**0690627-BLK1**									
Lead	6/21/99			ND	mg/kg dry	0.500				
Blank	**0690627-BLK2**									
Lead	6/21/99			ND	mg/kg dry	0.500				
Blank	**0690627-BLK3**									
Lead	6/22/99			ND	mg/kg dry	0.500				
LCS	**0690627-BS1**									
Lead	6/22/99	25.0		19.9	mg/kg dry	80.0-120	79.6			9
LCS	**0690627-BS2**									
Lead	6/22/99	25.0		20.0	mg/kg dry	80.0-120	80.0			
Matrix Spike	**0690627-MS1**		**B906234-11**							
Lead	6/21/99	29.7	6.18	29.2	mg/kg dry	70.0-130	77.5			
Matrix Spike	**0690627-MS2**		**B906234-15**							
Lead	6/22/99	25.0	2.29	22.1	mg/kg dry	70.0-130	79.2			
Matrix Spike Dup	**0690627-MSD1**		**B906234-11**							
Lead	6/22/99	25.3	6.18	35.6	mg/kg dry	70.0-130	116	20.0	39.8	7
Matrix Spike Dup	**0690627-MSD2**		**B906234-15**							
Lead	6/22/99	26.8	2.29	21.8	mg/kg dry	70.0-130	72.8	20.0	8.42	

Refer to end of report for text of notes and definitions.

Joy B Chang/Project Manager

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 6/7/99
Received: 6/8/99
Reported: 6/25/99 11:31

Dissolved Metals by EPA 6000/7000 Series Methods/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0690388	**Date Prepared: 6/11/99**				**Extraction Method: EPA 3005A**					
Blank	**0690388-BLK1**									
Lead	6/14/99			**ND**	mg/l	**0.00100**				
LCS	**0690388-BS1**									
Lead	6/14/99	0.200		0.196	mg/l	80.0-120	98.0			
Matrix Spike	**0690388-MS1**		**B906257-01**							
Lead	6/14/99	0.200	ND	0.199	mg/l	75.0-125	99.5			
Matrix Spike Dup	**0690388-MSD1**		**B906257-01**							
Lead	6/14/99	0.200	ND	0.196	mg/l	75.0-125	98.0	20.0	1.52	

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Gasoline Hydrocarbons per NWTPH-Gx Method and BTEX per EPA Method 8020A/Quality Control
North Creek Analytical - Spokane

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0690058	**Date Prepared: 6/17/99**				**Extraction Method: GC Volatiles**					
Blank	**0690058-BLK1**									
Benzene	6/18/99			**ND**	ug/l	**0.500**				
Toluene	"			**ND**	"	**0.500**				
Ethylbenzene	"			**ND**	"	**0.500**				
Xylenes (total)	"			**ND**	"	**1.00**				
Gasoline Range Hydrocarbons	"			**ND**	"	**50.0**				
Surrogate: 4-BFB (FID)	*"*	*25.0*		*27.1*	*"*	*50.0-150*	*108*			
Surrogate: 4-BFB (PID)	*"*	*25.0*		*22.9*	*"*	*53.0-142*	*91.6*			
LCS	**0690058-BS1**									
Gasoline Range Hydrocarbons	6/18/99	1000		829	ug/l	70.0-150	82.9			
Surrogate: 4-BFB (FID)	*"*	*25.0*		*32.9*	*"*	*50.0-150*	*132*			
LCS	**0690058-BS2**									
Benzene	6/18/99	10.0		8.96	ug/l	80.0-120	89.6			
Toluene	"	10.0		10.2	"	80.0-120	102			
Ethylbenzene	"	10.0		8.71	"	80.0-120	87.1			
Xylenes (total)	"	30.0		26.7	"	80.0-120	89.0			
Surrogate: 4-BFB (PID)	*"*	*25.0*		*22.2*	*"*	*53.0-142*	*88.8*			
Duplicate	**0690058-DUP1**		**B906234-27**							
Gasoline Range Hydrocarbons	6/18/99		103	82.2	ug/l			60.0	22.5	
Surrogate: 4-BFB (FID)	*"*	*25.0*		*24.4*	*"*	*50.0-150*	*97.6*			
Surrogate: 4-BFB (PID)	*"*	*25.0*		*18.1*	*"*	*53.0-142*	*72.4*			
Duplicate	**0690058-DUP2**		**S906060-04**							
Gasoline Range Hydrocarbons	6/18/99		ND	ND	ug/l			60.0		
Surrogate: 4-BFB (FID)	*"*	*25.0*		*22.5*	*"*	*50.0-150*	*90.0*			
Surrogate: 4-BFB (PID)	*"*	*25.0*		*18.8*	*"*	*53.0-142*	*75.2*			
Matrix Spike	**0690058-MS1**		**S906060-04**							
Gasoline Range Hydrocarbons	6/18/99	1000	ND	451	ug/l	70.0-130	**45.1**			10
Surrogate: 4-BFB (FID)	*"*	*25.0*		*14.2*	*"*	*50.0-150*	*56.8*			
Matrix Spike	**0690058-MS2**		**S906060-04**							
Benzene	6/18/99	10.0	ND	7.96	ug/l	54.0-143	79.6			
Toluene	"	10.0	ND	8.77	"	48.0-145	87.7			
Ethylbenzene	"	10.0	0.518	7.64	"	49.0-142	71.2			

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 11:31

Gasoline Hydrocarbons per NWTPH-Gx Method and BTEX per EPA Method 8020A/Quality Control
North Creek Analytical - Spokane

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Matrix Spike (continued)	0690058-MS2		S906060-04							
Xylenes (total)	6/18/99	30.0	2.05	21.9	ug/l	55.0-140	**66.2**			
Surrogate: 4-BFB (PID)	"	*25.0*		*20.2*	"	*53.0-142*	*80.8*			

IT Corporation - Renton	Project:	Time Oil #2750		Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number:	783336		Received:	6/8/99
Renton, WA 98055	Project Manager:	Jerry Harris		Reported:	6/25/99 11:31

Notes and Definitions

#	Note
1	The chromatogram for this sample does not resemble a typical gasoline pattern.
2	The reporting limit for this analyte has been raised to account for interference from coeluting organic compounds present in the sample.
3	Samples were extracted within hold time, but due to an extraction anomaly no surrogate was added. Samples were re-extracted outside of hold time and analyzed. The samples were similar for both extracts.
4	Results in the diesel organics range are primarily due to overlap from a heavy oil range product.
5	The sample chromatographic pattern does not resemble the fuel standard used for quantitation.
6	The surrogate recovery for this sample cannot be accurately quantified due to interference from coeluting organic compounds present in the sample.
7	The RPD value for this QC sample is above the established control limit. Review of associated QC indicates the high RPD does not represent an out-of-control condition for the batch.
8	Analyses are not controlled on RPD values from sample concentrations less than 10 times the reporting limit.
9	The spike recovery for this QC sample is outside of established control limits. Review of associated batch QC indicates the recovery for this analyte does not represent an out-of-control condition for the batch.
10	The spike recovery for this QC sample is outside of NCA established control limits. Alternate sources of QC have been used to validate the batch.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
Recov.	Recovery
RPD	Relative Percent Difference

North Creek Analytical - Bothell

Joy B Chang, Project Manager

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CHAIN OF CUSTODY REPORT

Work Order #: B906234

CLIENT: IT Corporation
REPORT TO: Jerry Harris
ADDRESS: 555 S. Renton Village Place #700
Renton, WA 98055
PHONE: 425-228-9645 FAX: 425-228-9993
PROJECT NAME: Time oil 2750
PROJECT NUMBER: 783336
SAMPLED BY: CNS

INVOICE TO: Connie Hofmar
" "

P.O. NUMBER:

TURNAROUND REQUEST in Business Days*
Organic & Inorganic Analyses
☒ STD. ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1
Petroleum Hydrocarbon Analyses
☐ 5 STD. ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1
☐ OTHER Please Specify
*Turnaround Requests less than standard may incur Rush Charges.

CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	REQUESTED ANALYSES TPH-G	TPH-Dext	BTEX	Lead		MATRIX (W, S, O)	# OF CONT.	COMMENTS	NCA WO ID
025B-07A	6/7/99 11:23	X	X	X	X	B906234-01	Soil	1	NW Method	
025B-07 B	11:29					-02				
025B-08A	11:50					-03				
025B-08 B	11:58					-04				
025B-06 A	12:37					-05				
025B-06B	12:40					-06				
025B-01A	1:39					-07				
025B-01 B	1:45					-08				
025B-01 C	1:53					-09				
025B-01 D	1:56					-10				
025B-01 E	2:04					-11				
025B-02 A	2:55					-12				
025B-02 B	3:01					-13				
025B-02 C	3:12					-14				
025B-02 D	3:20					-15				

RELINQUISHED BY: Chris N. Storey DATE: 6/7/99
PRINT NAME: Chris N. Storey FIRM: IT Corp. TIME: 9:20
RECEIVED BY: BILL K
PRINT NAME: FIRM: DATE: 6-8-99 TIME: 14:40

RELINQUISHED BY: BILL K NCA DATE: 6-8-99
PRINT NAME: FIRM: TIME: 15:20
RECEIVED BY:
PRINT NAME: FRANY TONTY FIRM: NCA DATE: 6/8/99 TIME: 14:45

ADDITIONAL REMARKS: W/O 11.2
TEMP:
PAGE 1 OF 3

'OC REV 3/99

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☒
☐
☐

CHAIN OF CUSTODY REPORT

Work Order #:

LIENT: IT Corporation
EPORT TO: Jerry Garcia
DDRESS: 555 S. Renton Village Place #700
Renton, WA 98055
HONE: 425-228-9645 FAX: 425-228-9793
ROJECT NAME: Time Oil 2750
ROJECT NUMBER: 783336
AMPLED BY: C/N/S

INVOICE TO: Connie Hofnar
" "

P.O. NUMBER:

TURNAROUND REQUEST in Business Days*

Organic & Inorganic Analyses: ☒ 10 (STD.) ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1

Petroleum Hydrocarbon Analyses: ☐ 5 (STD.) ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1

OTHER Please Specify

*Turnaround Requests less than standard may incur Rush Charges.

CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	TPH-G	TPH-Dext	BTEX	Lead	REQUESTED ANALYSES	MATRIX (W, S, O)	# OF CONT.	COMMENTS	NCA WO ID
Ø25B-Ø5A	6/7/99 3:44	X	X	X	X	6906234-16	Soil	1	NW Methods	
Ø25B-Ø5B	↓ 3:51	↓	↓	↓	↓	-17	↓	↓	↓	
Ø25B-Ø5C	↓ 3:58	↓	↓	↓	↓	-18	↓	↓	↓	
Ø25B-Ø~~4~~4 B	↓ 4:36	↓	↓	↓	↓	-19	↓	↓	↓	
Ø25B-Ø4 C	↓ 4:43	↓	↓	↓	↓	-20	↓	↓	↓	
Ø25B-Ø3A	↓ 5:06	↓	↓	↓	↓	-21	↓	↓	↓	
Ø25B-Ø3 B	↓ 5:12	↓	↓	↓	↓	-22	↓	↓	↓	
Ø25B-Ø3 C	↓ 5:20	↓	↓	↓	↓	-23	↓	↓	↓	
Ø25B-Ø3 D	↓ 5:30	↓	↓	↓	↓	-24	↓	↓	↓	
Ø25B-Ø8H2O	↓ 12:26	X	X	X	X	-25	Water	4	Please Filter Lead	
Ø25B-Ø7H2O	↓ 12:48	↓	↓	↓	↓	-26	↓	4	Please Filter Lead	
Ø25B-Ø6H2O	↓ 1:21	↓	↓	↓	↓	-27	↓	4	Please Filter Lead	
Ø25B-Ø2H2O	↓ 3:48	↓	↓	↓		-28	↓	3	~~Please Filter Lead~~	
Ø25B-Ø5H2O	↓ 4:37	↓	↓	↓	X	-29	↓	4	Please Filter Lead	
Ø25B-Ø4H2O	↓ 5:10	↓	↓	↓	|	-30	↓	4	Please Filter Lead	

ELINQUISHED BY: Chris N. Storey
RINT NAME: Chris N. Storey FIRM: IT Corp DATE: 6/7/99 TIME: 9:20
RECEIVED BY: S Tonty
PRINT NAME: PRAM TONTY FIRM: NCA DATE: 6/8/99 TIME: 1520

ELINQUISHED BY: BILL K
RINT NAME: FIRM: NCA DATE: 6-8-99 TIME: 15:20
RECEIVED BY:
PRINT NAME: FIRM: DATE: TIME:

DDITIONAL REMARKS: W/O 11.2

TEMP:

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CHAIN OF CUSTODY REPORT

Work Order #:

CLIENT: IT Corporation
REPORT TO: Jerry Harris
ADDRESS: 555 S. Renton Village PL #700
Renton WA 98055
PHONE: 425-228-9645 FAX: 425-228-9793
PROJECT NAME: Tire Oil 2750
PROJECT NUMBER: 783336
SAMPLED BY: CNS

INVOICE TO: Connie Hofman
" "

P.O. NUMBER:

TURNAROUND REQUEST in Business Days*

Organic & Inorganic Analyses
☐ 10 ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1
STD.

Petroleum Hydrocarbon Analyses
☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1
STD.

OTHER Please Specify ______

*Turnaround Requests less than standard may incur Rush Charges.

CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	REQUESTED ANALYSES: TPH-G	TPH-Dext	BTEX	Lead										MATRIX (W, S, O)	# OF CONT.	COMMENTS	NCA WO ID
025B-03H₂O	6/7/99 5:57	X	X	X	X		B906234-31								Water	4	MW Methods Please Filter Lead.	
0.																		
1.																		
2.																		
3.																		
4.																		
5.																		

RELINQUISHED BY: Chris N. Storey
PRINT NAME: Chris N. Storey FIRM: IT Corp DATE: 6/8/99 TIME: 9:20
RECEIVED BY: BILL E
PRINT NAME: FIRM: NCA DATE: 6-8-99 TIME: 14:45

RELINQUISHED BY: BILL E
PRINT NAME: FIRM: NCA DATE: 6-8-99 TIME: 1520
RECEIVED BY:
PRINT NAME: FIRM: DATE: TIME:

ADDITIONAL REMARKS: W/n 11·2

TEMP:

PAGE 3 OF 3

NORTH CREEK ANALYTICAL
Environmental Laboratory Services

Request for additional Analyses on samples already in NCA possession

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CHAIN OF CUSTODY REPORT

Work Order #

REPORT TO: Jerry Harris
ATTENTION:
ADDRESS: IT Corp. 5555 S. Renton Village Place Ste 700
Renton WA 98055
PHONE: 425 228 9645 FAX: 425 228 9793
PROJECT NAME: Time Oil Co Seattle Terminal
PROJECT NUMBER:
SAMPLED BY:

INVOICE TO: Time Oil Co ~~#~~
ATTENTION: Scott Sloan
ADDRESS: 2737 W Commodore Way
Seattle WA
P.O. NUMBER:
NCA QUOTE #:

TURNAROUND REQUEST in Business Days *
Organic & Inorganic Analyses: ☐ 10 (Standard) ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Same Day
Fuels & Hydrocarbon Analyses: ☐ 5 (Standard) ☐ 3-4 ☐ 2 ☐ 1 ☐ Same Day
☐ OTHER Specify:
* Turnaround Requests less than standard may incur Rush Charges.

B906191 —

CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	NCA SAMPLE ID (Laboratory Use Only)	Total lead (EPA 742[illegible])	VOCs (EPA 8260)	Pest/PCBs (EPA 8080)	Total Metals - see comments for TAL	EPH/GCMS SIM	& NWTPH-Dx ext with silica gel cleanup	MATRIX (W, S, A, O)	# OF CONTAINERS	COMMENTS
1. 01SB-09B	6/6/99 1048	-6191-11 6/21	X	} already logged in for 6020? Do not run again							
2. 01SB-08B	6/6/99 1156	-6191-31 ↓	X								
3. 02SB-08A	6/7/99 1150	B906234-03 6/15		X	X	X					FAST APPROACHING HOLD TIME for VOCs
4. 03SB-07B	6/7/99 1010	B906235-08 6/15	X				X & run EPH MTCA per Jerry Harris 6/18				
5. 03SB-09A	6/7/99 1029	B906235-07	X				X				
6. 03SB-07 H2O	6/7/99 1120	B906235-10						X	W		
7. 03SB-08 H2O	6/7/99 1040	B906235-09						X	W		
8. 03SB-09 H2O	6/7/99 1140	-11 ↓						X	W		
9.											
10.											

RELINQUISHED BY (Signature): DATE: 6/18/99
PRINT NAME: Gerald W. Harris FIRM: IT CORP TIME:
RECEIVED BY (Signature): DATE:
PRINT NAME: FIRM: TIME:
RELINQUISHED BY (Signature): DATE:
PRINT NAME: FIRM: TIME:
RECEIVED BY (Signature): DATE:
PRINT NAME: FIRM: TIME:

ADDITIONAL REMARKS: ① Invoice separately by prefix: 01SB-xx on one invoice; 02SB-xx on second; 03SB-xx on third.
② Total metals target list is arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver

PAGE 1 OF 1

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Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20354 Empire Avenue, Suite E-9, Bend, OR 97708-1883
541.383.9310 fax 541.382.7588

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	6/8/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	6/30/99 09:27

ANALYTICAL REPORT FOR SAMPLES:

Sample Description	Laboratory Sample Number	Sample Matrix	Date Sampled
02SB-08A	B906234-03	Soil	6/7/99

North Creek Analytical - Bothell

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Joy B Chang, Project Manager

North Creek Analytical, Inc.
Environmental Laboratory Network

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 6/7/99
Received: 6/8/99
Reported: 6/30/99 09:27

Total Metals by EPA 6000/7000 Series Methods
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Specific Method	Reporting Limit	Result	Units	Notes*
<u>**02SB-08A**</u>			<u>B906234-03</u>				<u>**Soil**</u>	
Arsenic	0690738	6/23/99	6/24/99	EPA 6020	0.500	**4.78**	mg/kg dry	
Barium	"	"	"	EPA 6020	5.00	**86.3**	"	
Cadmium	"	"	"	EPA 6020	0.500	ND	"	
Chromium	"	"	"	EPA 6020	0.500	**33.1**	"	
Lead	0690627	6/19/99	6/21/99	EPA 6020	0.500	**10.6**	"	
Selenium	0690738	6/23/99	6/24/99	EPA 6020	0.500	ND	"	
Silver	"	"	"	EPA 6020	0.500	ND	"	
Mercury	0690817	6/24/99	6/25/99	EPA 7471A	0.100	ND	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received:	6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported:	6/30/99 09:27

Organochlorine Pesticides and PCBs by EPA Method 8081A and 8082
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-08A			**B906234-03**				**Soil**	
Aldrin	0690668	6/21/99	6/24/99		1.00	ND	ug/kg dry	
alpha-BHC	"	"	"		0.500	ND	"	
beta-BHC	"	"	"		0.900	ND	"	
delta-BHC	"	"	"		0.600	ND	"	
gamma-BHC (Lindane)	"	"	"		1.00	ND	"	
Chlordane (tech)	"	"	"		1.00	ND	"	
alpha-Chlordane	"	"	"		0.800	ND	"	
gamma-Chlordane	"	"	"		0.700	ND	"	
4,4'-DDD	"	"	"		1.00	ND	"	
4,4'-DDE	"	"	"		1.00	ND	"	
4,4'-DDT	"	"	"		1.00	ND	"	
Dieldrin	"	"	"		2.00	ND	"	
Endosulfan I	"	"	"		1.00	ND	"	
Endosulfan II	"	"	"		2.00	ND	"	
Endosulfan sulfate	"	"	"		1.00	ND	"	
Endrin	"	"	"		2.00	ND	"	
Endrin aldehyde	"	"	"		2.00	ND	"	
Heptachlor	"	"	"		1.00	ND	"	
Heptachlor epoxide	"	"	"		1.00	ND	"	
Methoxychlor	"	"	"		4.00	ND	"	
Toxaphene	"	"	"		50.0	ND	"	
Aroclor 1016	"	"	6/25/99		50.0	ND	"	
Aroclor 1221	"	"	"		50.0	ND	"	
Aroclor 1232	"	"	"		50.0	ND	"	
Aroclor 1242	"	"	"		50.0	ND	"	
Aroclor 1248	"	"	"		50.0	ND	"	
Aroclor 1254	"	"	"		50.0	ND	"	
Aroclor 1260	"	"	"		50.0	ND	"	
Aroclor 1262	"	"	"		50.0	ND	"	
Aroclor 1268	"	"	"		50.0	ND	"	
Surrogate: TCX	*"*	*"*	*6/24/99*	*40.0-130*		*48.1*	*%*	

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/30/99 09:27

Volatile Organic Compounds by EPA Method 8260B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-08A			**B906234-03**				**Soil**	
Acetone	0690688	6/21/99	6/21/99		2.00	ND	mg/kg dry	
Benzene	"	"	"		0.100	ND	"	
Bromobenzene	"	"	"		0.100	ND	"	
Bromochloromethane	"	"	"		0.100	ND	"	
Bromodichloromethane	"	"	"		0.100	ND	"	
Bromoform	"	"	"		0.100	ND	"	
Bromomethane	"	"	"		0.100	ND	"	
2-Butanone	"	"	"		1.00	ND	"	
n-Butylbenzene	"	"	"		0.100	ND	"	
sec-Butylbenzene	"	"	"		0.100	ND	"	
tert-Butylbenzene	"	"	"		0.100	ND	"	
Carbon disulfide	"	"	"		0.100	ND	"	
Carbon tetrachloride	"	"	"		0.100	ND	"	
Chlorobenzene	"	"	"		0.100	ND	"	
Chloroethane	"	"	"		0.100	ND	"	
Chloroform	"	"	"		0.100	ND	"	
Chloromethane	"	"	"		0.500	ND	"	
2-Chlorotoluene	"	"	"		0.100	ND	"	
4-Chlorotoluene	"	"	"		0.100	ND	"	
Dibromochloromethane	"	"	"		0.100	ND	"	
1,2-Dibromo-3-chloropropane	"	"	"		0.500	ND	"	
1,2-Dibromoethane	"	"	"		0.100	ND	"	
Dibromomethane	"	"	"		0.100	ND	"	
1,2-Dichlorobenzene	"	"	"		0.100	ND	"	
1,3-Dichlorobenzene	"	"	"		0.100	ND	"	
1,4-Dichlorobenzene	"	"	"		0.100	ND	"	
Dichlorodifluoromethane	"	"	"		0.100	ND	"	
1,1-Dichloroethane	"	"	"		0.100	ND	"	
1,2-Dichloroethane	"	"	"		0.100	ND	"	
1,1-Dichloroethene	"	"	"		0.100	ND	"	
cis-1,2-Dichloroethene	"	"	"		0.100	ND	"	
trans-1,2-Dichloroethene	"	"	"		0.100	ND	"	
1,2-Dichloropropane	"	"	"		0.100	ND	"	
1,3-Dichloropropane	"	"	"		0.100	ND	"	
2,2-Dichloropropane	"	"	"		0.100	ND	"	
1,1-Dichloropropene	"	"	"		0.100	ND	"	
cis-1,3-Dichloropropene	"	"	"		0.100	ND	"	
trans-1,3-Dichloropropene	"	"	"		0.100	ND	"	

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/30/99 09:27

Volatile Organic Compounds by EPA Method 8260B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-08A (continued)			**B906234-03**				**Soil**	
Ethylbenzene	0690688	6/21/99	6/21/99		0.100	ND	mg/kg dry	
Hexachlorobutadiene	"	"	"		0.100	ND	"	
2-Hexanone	"	"	"		1.00	ND	"	
Isopropylbenzene	"	"	"		0.100	ND	"	
p-Isopropyltoluene	"	"	"		0.100	ND	"	
Methylene chloride	"	"	"		1.00	ND	"	
4-Methyl-2-pentanone	"	"	"		1.00	ND	"	
Naphthalene	"	"	"		0.100	ND	"	
n-Propylbenzene	"	"	"		0.100	ND	"	
Styrene	"	"	"		0.100	ND	"	
1,1,1,2-Tetrachloroethane	"	"	"		0.100	ND	"	
1,1,2,2-Tetrachloroethane	"	"	"		0.100	ND	"	
Tetrachloroethene	"	"	"		0.100	ND	"	
Toluene	"	"	"		0.100	ND	"	
1,2,3-Trichlorobenzene	"	"	"		0.100	ND	"	
1,2,4-Trichlorobenzene	"	"	"		0.100	ND	"	
1,1,1-Trichloroethane	"	"	"		0.100	ND	"	
1,1,2-Trichloroethane	"	"	"		0.100	ND	"	
Trichloroethene	"	"	"		0.100	ND	"	
Trichlorofluoromethane	"	"	"		0.100	ND	"	
1,2,3-Trichloropropane	"	"	"		0.100	ND	"	
1,2,4-Trimethylbenzene	"	"	"		0.100	**0.102**	"	
1,3,5-Trimethylbenzene	"	"	"		0.100	ND	"	
Vinyl chloride	"	"	"		0.100	ND	"	
m,p-Xylene	"	"	"		0.200	ND	"	
o-Xylene	"	"	"		0.100	ND	"	
Surrogate: 2-Bromopropene	"	"	"	*70.0-130*		*86.2*	%	
Surrogate: 1,2-DCA-d4	"	"	"	*70.0-130*		*77.9*	"	
Surrogate: Toluene-d8	"	"	"	*70.0-130*		*83.3*	"	
Surrogate: 4-BFB	"	"	"	*70.0-130*		*82.5*	"	

IT Corporation - Renton	Project:	Time Oil #2750		Sampled:	6/7/99
555 South Renton Village Place, Ste 700	Project Number:	783336		Received:	6/8/99
Renton, WA 98055	Project Manager:	Jerry Harris		Reported:	6/30/99 09:27

Dry Weight Determination
North Creek Analytical - Bothell

Sample Name	Lab ID	Matrix	Result	Units
02SB-08A	B906234-03	Soil	83.4	%

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/30/99 09:27

Total Metals by EPA 6000/7000 Series Methods/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0690627	**Date Prepared: 6/19/99**				**Extraction Method: EPA 3050B**					
Blank	**0690627-BLK1**									
Lead	6/21/99			ND	mg/kg dry	0.500				
Blank	**0690627-BLK2**									
Lead	6/21/99			ND	mg/kg dry	0.500				
Blank	**0690627-BLK3**									
Lead	6/22/99			ND	mg/kg dry	0.500				
LCS	**0690627-BS1**									
Lead	6/22/99	25.0		19.9	mg/kg dry	80.0-120	79.6			1
LCS	**0690627-BS2**									
Lead	6/22/99	25.0		20.0	mg/kg dry	80.0-120	80.0			
Matrix Spike	**0690627-MS1**		**B906234-11**							
Lead	6/21/99	29.7	6.18	29.2	mg/kg dry	70.0-130	77.5			
Matrix Spike	**0690627-MS2**		**B906234-15**							
Lead	6/22/99	25.0	2.29	22.1	mg/kg dry	70.0-130	79.2			
Matrix Spike Dup	**0690627-MSD1**		**B906234-11**							
Lead	6/22/99	25.3	6.18	35.6	mg/kg dry	70.0-130	116	20.0	39.8	2
Matrix Spike Dup	**0690627-MSD2**		**B906234-15**							
Lead	6/22/99	26.8	2.29	21.8	mg/kg dry	70.0-130	72.8	20.0	8.4	
Batch: 0690738	**Date Prepared: 6/23/99**				**Extraction Method: EPA 3050B**					
Blank	**0690738-BLK1**									
Arsenic	6/23/99			ND	mg/kg dry	0.500				
Barium	"			ND	"	5.00				
Cadmium	"			ND	"	0.500				
Chromium	"			ND	"	0.500				
Selenium	"			ND	"	0.500				
Silver	"			ND	"	0.500				
LCS	**0690738-BS1**									
Arsenic	6/23/99	25.0		27.4	mg/kg dry	70.0-130	110			

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/30/99 09:27

Total Metals by EPA 6000/7000 Series Methods/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
LCS (continued)	**0690738-BS1**									
Barium	6/23/99	25.0		27.5	mg/kg dry	80.0-120	110			
Cadmium	"	25.0		26.6	"	70.0-130	106			
Chromium	"	25.0		27.7	"	80.0-120	111			
Selenium	"	25.0		27.5	"	70.0-130	110			
Silver	"	25.0		27.0	"	80.0-120	108			
Matrix Spike	**0690738-MS1**		**B906434-02**							
Arsenic	6/23/99	20.1	3.29	24.2	mg/kg dry	70.0-130	**104**			
Barium	"	20.1	13.3	34.3	"	70.0-130	**104**			
Cadmium	"	20.1	ND	19.8	"	70.0-130	**98.5**			
Chromium	"	20.1	5.83	25.2	"	70.0-130	**96.4**			
Selenium	"	20.1	ND	20.0	"	70.0-130	**99.5**			
Silver	"	20.1	ND	20.0	"	70.0-130	**99.5**			
Matrix Spike Dup	**0690738-MSD1**		**B906434-02**							
Arsenic	6/24/99	20.1	3.29	21.8	mg/kg dry	70.0-130	**92.1**	20.0	**12.1**	
Barium	"	20.1	13.3	36.2	"	70.0-130	**114**	20.0	**9.17**	
Cadmium	"	20.1	ND	21.4	"	70.0-130	**106**	20.0	**7.33**	
Chromium	"	20.1	5.83	31.0	"	70.0-130	**125**	20.0	**25.8**	2
Selenium	"	20.1	ND	20.8	"	70.0-130	**103**	20.0	**3.46**	
Silver	"	20.1	ND	21.0	"	70.0-130	**104**	20.0	**4.42**	
Batch: 0690817	**Date Prepared: 6/24/99**				**Extraction Method: EPA 7471A**					
Blank	**0690817-BLK1**									
Mercury	6/25/99			**ND**	mg/kg dry	**0.100**				
LCS	**0690817-BS1**									
Mercury	6/25/99	1.75		1.47	mg/kg dry	80.0-120	84.0			
Matrix Spike	**0690817-MS1**		**B906434-02**							
Mercury	6/25/99	0.611	ND	0.625	mg/kg dry	80.0-120	**102**			
Matrix Spike Dup	**0690817-MSD1**		**B906434-02**							
Mercury	6/25/99	0.636	ND	0.652	mg/kg dry	80.0-120	**103**	20.0	**0.976**	

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/30/99 09:27

Organochlorine Pesticides and PCBs by EPA Method 8081A and 8082/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0690668	**Date Prepared: 6/23/99**				**Extraction Method: EPA 3550B**					
Blank	**0690668-BLK2**									
Aldrin	6/24/99			ND	ug/kg dry	1.00				
alpha-BHC	"			ND	"	0.500				
beta-BHC	"			ND	"	0.900				
delta-BHC	"			ND	"	0.600				
gamma-BHC (Lindane)	"			ND	"	1.00				
Chlordane (tech)	"			ND	"	1.00				
alpha-Chlordane	"			ND	"	0.800				
gamma-Chlordane	"			ND	"	0.700				
4,4′-DDD	"			ND	"	1.00				
4,4′-DDE	"			ND	"	1.00				
4,4′-DDT	"			ND	"	1.00				
Dieldrin	"			ND	"	2.00				
Endosulfan I	"			ND	"	1.00				
Endosulfan II	"			ND	"	2.00				
Endosulfan sulfate	"			ND	"	1.00				
Endrin	"			ND	"	2.00				
Endrin aldehyde	"			ND	"	2.00				
Heptachlor	"			ND	"	1.00				
Heptachlor epoxide	"			ND	"	1.00				
Methoxychlor	"			ND	"	4.00				
Toxaphene	"			ND	"	50.0				
Aroclor 1016	6/25/99			ND	"	50.0				
Aroclor 1221	"			ND	"	50.0				
Aroclor 1232	"			ND	"	50.0				
Aroclor 1242	"			ND	"	50.0				
Aroclor 1248	"			ND	"	50.0				
Aroclor 1254	"			ND	"	50.0				
Aroclor 1260	"			ND	"	50.0				
Aroclor 1262	"			ND	"	50.0				
Aroclor 1268	"			ND	"	50.0				
Surrogate: TCX	*"*	*6.67*		*5.56*	*"*	*40.0-130*	*83.4*			
LCS	**0690668-BS2**									
Aldrin	6/24/99	8.33		9.03	ug/kg dry	35.0-138	108			
gamma-BHC (Lindane)	"	8.33		8.14	"	44.0-137	97.7			
Heptachlor	"	8.33		7.37	"	40.0-146	88.5			
Aroclor 1260	6/25/99	333		340	"	28.0-132	102			

Organochlorine Pesticides and PCBs by EPA Method 8081A and 8082/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
LCS (continued)	**0690668-BS2**									
Surrogate: TCX	*6/25/99*	*6.67*		*6.75*	*ug/kg dry*	*40.0-130*	*101*			
Matrix Spike	**0690668-MS2**		**B906500-05**							
Aldrin	6/24/99	8.68	ND	7.71	ug/kg dry	35.0-138	**88.8**			
gamma-BHC (Lindane)	"	8.68	ND	6.93	"	44.0-137	**79.8**			
Heptachlor	"	8.68	ND	7.01	"	40.0-146	**80.8**			
Aroclor 1260	6/25/99	347	ND	357	"	44.0-123	**103**			
Surrogate: TCX	*"*	*6.94*		*5.92*	*"*	*40.0-130*	*85.3*			
Matrix Spike Dup	**0690668-MSD2**		**B906500-05**							
Aldrin	6/24/99	8.68	ND	7.90	ug/kg dry	35.0-138	**91.0**	33.0	**2.45**	
gamma-BHC (Lindane)	"	8.68	ND	7.30	"	44.0-137	**84.1**	35.0	**5.25**	
Heptachlor	"	8.68	ND	7.24	"	40.0-146	**83.4**	32.0	**3.17**	
Aroclor 1260	6/25/99	347	ND	381	"	44.0-123	**110**	23.0	**6.57**	
Surrogate: TCX	*"*	*6.94*		*6.04*	*"*	*40.0-130*	*87.0*			

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/30/99 09:27

Volatile Organic Compounds by EPA Method 8260B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0690688	**Date Prepared: 6/21/99**				**Extraction Method: EPA 5030B [MeOH]**					
Blank	**0690688-BLK1**									
Acetone	6/21/99			ND	mg/kg dry	2.00				
Benzene	"			ND	"	0.100				
Bromobenzene	"			ND	"	0.100				
Bromochloromethane	"			ND	"	0.100				
Bromodichloromethane	"			ND	"	0.100				
Bromoform	"			ND	"	0.100				
Bromomethane	"			ND	"	0.100				
2-Butanone	"			ND	"	1.00				
n-Butylbenzene	"			ND	"	0.100				
sec-Butylbenzene	"			ND	"	0.100				
tert-Butylbenzene	"			ND	"	0.100				
Carbon disulfide	"			ND	"	0.100				
Carbon tetrachloride	"			ND	"	0.100				
Chlorobenzene	"			ND	"	0.100				
Chloroethane	"			ND	"	0.100				
Chloroform	"			ND	"	0.100				
Chloromethane	"			ND	"	0.500				
2-Chlorotoluene	"			ND	"	0.100				
4-Chlorotoluene	"			ND	"	0.100				
Dibromochloromethane	"			ND	"	0.100				
1,2-Dibromo-3-chloropropane	"			ND	"	0.500				
1,2-Dibromoethane	"			ND	"	0.100				
Dibromomethane	"			ND	"	0.100				
1,2-Dichlorobenzene	"			ND	"	0.100				
1,3-Dichlorobenzene	"			ND	"	0.100				
1,4-Dichlorobenzene	"			ND	"	0.100				
Dichlorodifluoromethane	"			ND	"	0.100				
1,1-Dichloroethane	"			ND	"	0.100				
1,2-Dichloroethane	"			ND	"	0.100				
1,1-Dichloroethene	"			ND	"	0.100				
cis-1,2-Dichloroethene	"			ND	"	0.100				
trans-1,2-Dichloroethene	"			ND	"	0.100				
1,2-Dichloropropane	"			ND	"	0.100				
1,3-Dichloropropane	"			ND	"	0.100				
2,2-Dichloropropane	"			ND	"	0.100				
1,1-Dichloropropene	"			ND	"	0.100				
cis-1,3-Dichloropropene	"			ND	"	0.100				

Refer to end of report for text of notes and definitions.

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/7/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/8/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/30/99 09:27

Volatile Organic Compounds by EPA Method 8260B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Blank (continued)	**0690688-BLK1**									
trans-1,3-Dichloropropene	6/21/99			ND	mg/kg dry	0.100				
Ethylbenzene	"			ND	"	0.100				
Hexachlorobutadiene	"			ND	"	0.100				
2-Hexanone	"			ND	"	1.00				
Isopropylbenzene	"			ND	"	0.100				
p-Isopropyltoluene	"			ND	"	0.100				
Methylene chloride	"			ND	"	1.00				
4-Methyl-2-pentanone	"			ND	"	1.00				
Naphthalene	"			ND	"	0.100				
n-Propylbenzene	"			ND	"	0.100				
Styrene	"			ND	"	0.100				
1,1,1,2-Tetrachloroethane	"			ND	"	0.100				
1,1,2,2-Tetrachloroethane	"			ND	"	0.100				
Tetrachloroethene	"			ND	"	0.100				
Toluene	"			ND	"	0.100				
1,2,3-Trichlorobenzene	"			ND	"	0.100				
1,2,4-Trichlorobenzene	"			ND	"	0.100				
1,1,1-Trichloroethane	"			ND	"	0.100				
1,1,2-Trichloroethane	"			ND	"	0.100				
Trichloroethene	"			ND	"	0.100				
Trichlorofluoromethane	"			ND	"	0.100				
1,2,3-Trichloropropane	"			ND	"	0.100				
1,2,4-Trimethylbenzene	"			ND	"	0.100				
1,3,5-Trimethylbenzene	"			ND	"	0.100				
Vinyl chloride	"			ND	"	0.100				
m,p-Xylene	"			ND	"	0.200				
o-Xylene	"			ND	"	0.100				
Surrogate: 2-Bromopropene	*"*	*2.00*		*2.14*	*"*	*70.0-130*	*107*			
Surrogate: 1,2-DCA-d4	*"*	*2.00*		*1.81*	*"*	*70.0-130*	*90.5*			
Surrogate: Toluene-d8	*"*	*2.00*		*2.01*	*"*	*70.0-130*	*100*			
Surrogate: 4-BFB	*"*	*2.00*		*1.83*	*"*	*70.0-130*	*91.5*			
LCS	**0690688-BS1**									
Benzene	6/21/99	1.00		0.987	mg/kg dry	70.0-130	98.7			
Chlorobenzene	"	1.00		1.00	"	70.0-130	100			
1,1-Dichloroethene	"	1.00		0.903	"	70.0-130	90.3			
Toluene	"	1.00		0.963	"	70.0-130	96.3			
Trichloroethene	"	1.00		1.09	"	70.0-130	109			

**Refer to end of report for text of notes and definitions.*

NORTH CREEK ANALYTICAL
Environmental Laboratory Services

18939 120th Avenue N.E., Suite 101, Bothell, WA 98011-9508 (425) 420-9200 FAX 420-9210
East 11115 Montgomery, Suite B, Spokane, WA 99206-4779 (509) 924-9200 FAX 924-9290
9405 S.W. Nimbus Avenue, Beaverton, OR 97008-7132 (503) 906-9200 FAX 906-9210

Request for additional Analyses on samples already in NCA possession

CHAIN OF CUSTODY REPORT

Work Order #

REPORT TO: Jerry Harris
ATTENTION:
ADDRESS: IT Corp. 5555 S. Renton Village Place Ste 700
Renton WA 98055
PHONE: 425 228 9645 FAX: 425 229 9793
PROJECT NAME: Time Oil Co Seattle Terminal
PROJECT NUMBER:
SAMPLED BY:

INVOICE TO: Time Oil Co ~~#~~
ATTENTION: Scott Sloan
ADDRESS: 2737 W Commodore Way
Seattle WA
P.O. NUMBER:
NCA QUOTE #:

TURNAROUND REQUEST in Business Days *

Organic & Inorganic Analyses: ☐ 10 (Standard) ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ Same Day

Fuels & Hydrocarbon Analyses: ☐ 5 (Standard) ☐ 3-4 ☐ 2 ☐ 1 ☐ Same Day

☐ OTHER Specify:

* Turnaround Requests less than standard may incur Rush Charges.

B906191 —

CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	NCA SAMPLE ID (Laboratory Use Only)	Total Lead (EPA 7421)	VOCs (EPA 8260)	Pest/PCBs (EPA 8080)	Total Metals - see	comments for TAL	EPH/GC MS SIM	& NWTPH-d ext with silica gel cleanup		MATRIX (W, S, A, O)	# OF CONTAINERS	COMMENTS
1. 01SB-09B	6/6/99 1048	-6191-11 6/21	X	} already logged in for 6020? Do not run again									
2. 01SB-08B	6/6/99 1156	-6191-31 ↓	X										
3. 02SB-08A	6/7/99 1150	B906234-03 6/15		X	X	X							
4. 03SB-07B	6/7/99 1010	B906235-08 6/15	X					X & run EPH MTCA per Jerry Harris 6/18					FAST APPROACHING HOLD TIME FOR VOCS
5. 03SB-09A	6/7/99 1029	B906235-07	X					X					
6. 03SB-07 H2O	6/7/99 1120	B906235-10							X		W		
7. 03SB-08 H2O	6/7/99 1040	B906235-09							X		W		
8. 03SB-09 H2O	6/7/99 1140	-11							X		W		
9.													
10.													

RELINQUISHED BY (Signature): DATE: 6/18/99
PRINT NAME: Gerald W. Harris FIRM: IT CORP TIME:
RECEIVED BY (Signature): DATE:
PRINT NAME: FIRM: TIME:
RELINQUISHED BY (Signature): DATE:
PRINT NAME: FIRM: TIME:
RECEIVED BY (Signature): DATE:
PRINT NAME: FIRM: TIME:

ADDITIONAL REMARKS: ① Invoice separately by prefix: 01SB-xx on one invoice; 02SB-xx on second; 03SB-xx on third.
② Total Metals target list is arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver

PAGE 1 OF 1

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/11/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/14/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 13:22

ANALYTICAL REPORT FOR SAMPLES:

Sample Description	Laboratory Sample Number	Sample Matrix	Date Sampled
02SB-09@6-6.5	B906371-01	Soil	6/11/99
02SB-09@20.5-21	B906371-02	Soil	6/11/99
02SB-09@15.5-16	B906371-03	Soil	6/11/99
02SB-09@10-10.5	B906371-04	Soil	6/11/99
02SB-09	B906371-05	Water	6/11/99

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Joy B Chang, Project Manager

IT Corporation - Renton 555 South Renton Village Place, Ste 700 Renton, WA 98055	Project: Time Oil #2750 Project Number: 783336 Project Manager: Jerry Harris	Sampled: 6/11/99 Received: 6/14/99 Reported: 6/25/99 13:22

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-09@6-6.5			**B906371-01**				**Soil**	
Gasoline Range Hydrocarbons	0690565	6/17/99	6/21/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*94.6*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*98.0*	"	
02SB-09@20.5-21			**B906371-02**				**Soil**	
Gasoline Range Hydrocarbons	0690565	6/17/99	6/24/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*84.2*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*86.5*	"	
02SB-09@15.5-16			**B906371-03**				**Soil**	
Gasoline Range Hydrocarbons	0690565	6/17/99	6/24/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*91.4*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*96.7*	"	
02SB-09@10-10.5			**B906371-04**				**Soil**	
Gasoline Range Hydrocarbons	0690565	6/17/99	6/24/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	**0.0699**	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*86.0*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*91.5*	"	
02SB-09			**B906371-05**				**Water**	
Gasoline Range Hydrocarbons	0690659	6/21/99	6/21/99		50.0	**1360**	ug/l	
Benzene	"	"	"		5.00	**639**	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	6/11/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	6/14/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	6/25/99 13:22

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-09 (continued)			B906371-05				Water	
Toluene	0690659	6/21/99	6/21/99		0.500	**1.89**	ug/l	
Ethylbenzene	"	"	"		0.500	**1.31**	"	
Xylenes (total)	"	"	"		1.00	**9.66**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*99.0*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*85.2*	"	

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	6/11/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	6/14/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	6/25/99 13:22

Semivolatile Petroleum Products by NWTPH-Dx (w/o Acid/Silica Gel Clean-up)
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02SB-09@6-6.5			**B906371-01**				**Soil**	
Diesel Range Hydrocarbons	0690555	6/17/99	6/19/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*59.8*	%	
02SB-09@20.5-21			**B906371-02**				**Soil**	
Diesel Range Hydrocarbons	0690555	6/17/99	6/19/99		10.0	**11.0**	mg/kg dry	1
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*61.7*	%	
02SB-09@15.5-16			**B906371-03**				**Soil**	
Diesel Range Hydrocarbons	0690555	6/17/99	6/19/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*53.0*	%	
02SB-09@10-10.5			**B906371-04**				**Soil**	
Diesel Range Hydrocarbons	0690555	6/17/99	6/19/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*71.8*	%	
02SB-09			**B906371-05**				**Water**	
Diesel Range Hydrocarbons	0690596	6/18/99	6/19/99		0.250	**0.617**	mg/l	2
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*71.0*	%	

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	6/11/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	6/14/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	6/25/99 13:22

Dry Weight Determination
North Creek Analytical - Bothell

Sample Name	Lab ID	Matrix	Result	Units
02SB-09@6-6.5	B906371-01	Soil	89.8	%
02SB-09@20.5-21	B906371-02	Soil	81.9	%
02SB-09@15.5-16	B906371-03	Soil	81.9	%
02SB-09@10-10.5	B906371-04	Soil	82.6	%

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/11/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/14/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 13:22

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0690565	**Date Prepared: 6/17/99**				**Extraction Method: EPA 5030B (MeOH)**					
Blank	**0690565-BLK1**									
Gasoline Range Hydrocarbons	6/23/99			ND	mg/kg dry	**5.00**				
Benzene	"			ND	"	**0.0500**				
Toluene	"			ND	"	**0.0500**				
Ethylbenzene	"			ND	"	**0.0500**				
Xylenes (total)	"			ND	"	**0.100**				
Surrogate: 4-BFB (FID)	*"*	*4.00*		*3.85*	*"*	*50.0-150*	*96.2*			
Surrogate: 4-BFB (PID)	*"*	*4.00*		*4.12*	*"*	*50.0-150*	*103*			
LCS	**0690565-BS1**									
Gasoline Range Hydrocarbons	6/21/99	25.0		20.5	mg/kg dry	70.0-130	82.0			
Surrogate: 4-BFB (FID)	*"*	*4.00*		*4.00*	*"*	*50.0-150*	*100*			
Duplicate	**0690565-DUP1**	**B906371-01**								
Gasoline Range Hydrocarbons	6/21/99		ND	ND	mg/kg dry			50.0		
Surrogate: 4-BFB (FID)	*"*	*4.45*		*4.03*	*"*	*50.0-150*	*90.6*			
Matrix Spike	**0690565-MS1**	**B906302-05**								
Benzene	6/21/99	0.568	ND	0.443	mg/kg dry	60.0-140	78.0			
Toluene	"	0.568	ND	0.471	"	60.0-140	82.9			
Ethylbenzene	"	0.568	0.0532	0.481	"	60.0-140	75.3			
Xylenes (total)	"	1.70	ND	1.43	"	60.0-140	84.1			
Surrogate: 4-BFB (PID)	*"*	*4.54*		*4.17*	*"*	*50.0-150*	*91.9*			
Matrix Spike Dup	**0690565-MSD1**	**B906302-05**								
Benzene	6/22/99	0.568	ND	0.451	mg/kg dry	60.0-140	79.4	20.0	1.78	
Toluene	"	0.568	ND	0.477	"	60.0-140	84.0	20.0	1.32	
Ethylbenzene	"	0.568	0.0532	0.477	"	60.0-140	74.6	20.0	0.934	
Xylenes (total)	"	1.70	ND	1.41	"	60.0-140	82.9	20.0	1.44	
Surrogate: 4-BFB (PID)	*"*	*4.54*		*4.08*	*"*	*50.0-150*	*89.9*			
Batch: 0690659	**Date Prepared: 6/21/99**				**Extraction Method: EPA 5030B (MeOH)**					
Blank	**0690659-BLK1**									
Methyl tert-butyl ether	6/21/99			ND	ug/l	**1.00**				
Gasoline Range Hydrocarbons	"			ND	"	**50.0**				
Benzene	"			ND	"	**0.500**				
Toluene	"			ND	"	**0.500**				
Ethylbenzene	"			ND	"	**0.500**				

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 6/7/99
Received: 6/8/99
Reported: 6/30/99 09:27

Volatile Organic Compounds by EPA Method 8260B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
LCS (continued)	**0690688-BS1**									
Surrogate: 2-Bromopropene	*6/21/99*	*2.00*		*2.13*	*mg/kg dry*	*70.0-130*	*107*			
Surrogate: 1,2-DCA-d4	*"*	*2.00*		*1.76*	*"*	*70.0-130*	*88.0*			
Surrogate: Toluene-d8	*"*	*2.00*		*1.93*	*"*	*70.0-130*	*96.5*			
Surrogate: 4-BFB	*"*	*2.00*		*1.80*	*"*	*70.0-130*	*90.0*			
Matrix Spike	**0690688-MS1**		**B906434-05**							
Benzene	6/21/99	1.06	ND	0.975	mg/kg dry	70.0-130	92.0			
Chlorobenzene	"	1.06	ND	1.05	"	70.0-130	99.1			
1,1-Dichloroethene	"	1.06	ND	0.805	"	70.0-130	75.9			
Toluene	"	1.06	ND	1.00	"	70.0-130	94.3			
Trichloroethene	"	1.06	ND	1.04	"	70.0-130	98.1			
Surrogate: 2-Bromopropene	*"*	*2.11*		*2.03*	*"*	*70.0-130*	*96.2*			
Surrogate: 1,2-DCA-d4	*"*	*2.11*		*1.77*	*"*	*70.0-130*	*83.9*			
Surrogate: Toluene-d8	*"*	*2.11*		*2.03*	*"*	*70.0-130*	*96.2*			
Surrogate: 4-BFB	*"*	*2.11*		*1.93*	*"*	*70.0-130*	*91.5*			
Matrix Spike Dup	**0690688-MSD1**		**B906434-05**							
Benzene	6/21/99	1.06	ND	0.977	mg/kg dry	70.0-130	92.2	15.0	0.217	
Chlorobenzene	"	1.06	ND	0.995	"	70.0-130	93.9	15.0	5.39	
1,1-Dichloroethene	"	1.06	ND	0.781	"	70.0-130	73.7	15.0	2.94	
Toluene	"	1.06	ND	0.972	"	70.0-130	91.7	15.0	2.80	
Trichloroethene	"	1.06	ND	1.02	"	70.0-130	96.2	15.0	1.96	
Surrogate: 2-Bromopropene	*"*	*2.11*		*1.93*	*"*	*70.0-130*	*91.5*			
Surrogate: 1,2-DCA-d4	*"*	*2.11*		*1.70*	*"*	*70.0-130*	*80.6*			
Surrogate: Toluene-d8	*"*	*2.11*		*2.01*	*"*	*70.0-130*	*95.3*			
Surrogate: 4-BFB	*"*	*2.11*		*1.94*	*"*	*70.0-130*	*91.9*			

**Refer to end of report for text of notes and definitions.*

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 6/7/99
Received: 6/8/99
Reported: 6/30/99 09:27

Notes and Definitions

#	Note
1	The spike recovery for this QC sample is outside of established control limits. Review of associated batch QC indicates the recovery for this analyte does not represent an out-of-control condition for the batch.
2	The RPD value for this QC sample is above the established control limit. Review of associated QC indicates the high RPD does not represent an out-of-control condition for the batch.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
Recov.	Recovery
RPD	Relative Percent Difference

North Creek Analytical - Bothell

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/11/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/14/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 13:22

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Blank (continued)	**0690659-BLK1**									
Xylenes (total)	6/21/99			**ND**	ug/l	**1.00**				
Surrogate: 4-BFB (FID)	*"*	*48.0*		*42.9*	*"*	*50.0-150*	*89.4*			
Surrogate: 4-BFB (PID)	*"*	*48.0*		*46.3*	*"*	*50.0-150*	*96.5*			
LCS	**0690659-BS1**									
Gasoline Range Hydrocarbons	6/21/99	500		502	ug/l	70.0-130	100			
Surrogate: 4-BFB (FID)	*"*	*48.0*		*45.3*	*"*	*50.0-150*	*94.4*			
Duplicate	**0690659-DUP1**		**B906347-01**							
Gasoline Range Hydrocarbons	6/22/99		ND	ND	ug/l			25.0		
Surrogate: 4-BFB (FID)	*"*	*48.0*		*43.5*	*"*	*50.0-150*	*90.6*			
Duplicate	**0690659-DUP2**		**B906373-05**							
Gasoline Range Hydrocarbons	6/22/99		ND	ND	ug/l			25.0		
Surrogate: 4-BFB (FID)	*"*	*48.0*		*43.3*	*"*	*50.0-150*	*90.2*			
Matrix Spike	**0690659-MS1**		**B906373-04**							
Methyl tert-butyl ether	6/22/99	10.0	ND	14.4	ug/l	70.0-130	**144**			3
Benzene	"	10.0	0.971	10.4	"	70.0-130	**94.3**			
Toluene	"	10.0	ND	9.58	"	70.0-130	**95.8**			
Ethylbenzene	"	10.0	ND	9.83	"	70.0-130	**98.3**			
Xylenes (total)	"	30.0	ND	29.2	"	70.0-130	**97.3**			
Surrogate: 4-BFB (PID)	*"*	*48.0*		*47.4*	*"*	*50.0-150*	*98.8*			
Matrix Spike Dup	**0690659-MSD1**		**B906373-04**							
Methyl tert-butyl ether	6/22/99	10.0	ND	16.0	ug/l	70.0-130	**160**	15.0	**10.5**	3
Benzene	"	10.0	0.971	11.1	"	70.0-130	**101**	15.0	**6.86**	
Toluene	"	10.0	ND	10.2	"	70.0-130	**102**	15.0	**6.27**	
Ethylbenzene	"	10.0	ND	10.5	"	70.0-130	**105**	15.0	**6.59**	
Xylenes (total)	"	30.0	ND	31.3	"	70.0-130	**104**	15.0	**6.66**	
Surrogate: 4-BFB (PID)	*"*	*48.0*		*48.2*	*"*	*50.0-150*	*100*			

**Refer to end of report for text of notes and definitions.*

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 6/11/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 6/14/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 6/25/99 13:22

Semivolatile Petroleum Products by NWTPH-Dx (w/o Acid/Silica Gel Clean-up)/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0690555	**Date Prepared: 6/17/99**				**Extraction Method: EPA 3550B**					
Blank	**0690555-BLK1**									
Diesel Range Hydrocarbons	6/18/99			**ND**	mg/kg dry	**10.0**				
Lube Oil Range Hydrocarbons	"			**ND**	"	**25.0**				
Surrogate: 2-FBP	*"*	*10.8*		*6.84*	*"*	*50.0-150*	*63.3*			
LCS	**0690555-BS1**									
Diesel Range Hydrocarbons	6/18/99	66.7		55.0	mg/kg dry	60.0-140	82.5			
Surrogate: 2-FBP	*"*	*10.8*		*9.21*	*"*	*50.0-150*	*85.3*			
Duplicate	**0690555-DUP1**		**B906373-01**							
Diesel Range Hydrocarbons	6/18/99		ND	ND	mg/kg dry			50.0		
Lube Oil Range Hydrocarbons	"		36.9	ND	"			50.0		
Surrogate: 2-FBP	*"*	*13.6*		*7.64*	*"*	*50.0-150*	*56.2*			
Batch: 0690596	**Date Prepared: 6/18/99**				**Extraction Method: EPA 3520C/600 Series**					
Blank	**0690596-BLK1**									
Diesel Range Hydrocarbons	6/19/99			**ND**	mg/l	**0.250**				
Lube Oil Range Hydrocarbons	"			**ND**	"	**0.500**				
Surrogate: 2-FBP	*"*	*0.325*		*0.241*	*"*	*50.0-150*	*74.2*			
LCS	**0690596-BS1**									
Diesel Range Hydrocarbons	6/19/99	2.00		1.73	mg/l	60.0-140	86.5			
Surrogate: 2-FBP	*"*	*0.325*		*0.240*	*"*	*50.0-150*	*73.8*			
LCS Dup	**0690596-BSD1**									
Diesel Range Hydrocarbons	6/19/99	2.00		1.78	mg/l	60.0-140	89.0	40.0	2.85	
Surrogate: 2-FBP	*"*	*0.325*		*0.240*	*"*	*50.0-150*	*73.8*			

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 6/11/99
Received: 6/14/99
Reported: 6/25/99 13:22

Notes and Definitions

#	Note
1	Results in the diesel organics range are primarily due to overlap from a heavy oil range product.
2	The sample chromatographic pattern does not resemble the fuel standard used for quantitation.
3	The spike recovery for this QC sample is outside of established control limits. Review of associated batch QC indicates the recovery for this analyte does not represent an out-of-control condition for the batch.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
Recov.	Recovery
RPD	Relative Percent Difference

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East 11115 Montgomery, Suite B, Spokane, WA 98206-4776 (509) 924-9200 FAX 924-9290
9405 S.W. Nimbus Avenue, Beaverton, OR 97008-7132 (503) 906-9200 FAX 906-9210
20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711 (541) 383-9310 FAX 382-7588

CHAIN OF CUSTODY REPORT

Work Order #: B906371

CLIENT: Time Oil Co
REPORT TO: Terry Harris
ADDRESS: 555 S. Renton Village Place Ste 700
Renton WA 98055
PHONE: 425-228-9649 FAX: 425 228 9793
PROJECT NAME: 2750
PROJECT NUMBER:
SAMPLED BY:

INVOICE TO: Time Oil Co Attn Scott Sloan
2737 W. Commodore Way
Seattle WA
P.O. NUMBER:

TURNAROUND REQUEST in Business Days*
Organic & Inorganic Analyses
☐ 10 ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1
STD.
Petroleum Hydrocarbon Analyses
☒ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1
STD.
☐ OTHER Please Specify

*Turnaround Requests less than standard may incur Rush Charges.

CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	REQUESTED ANALYSES NWTPH-G	NWTPH-D extended	BTEX		MATRIX (W, S, O)	# OF CONT.	COMMENTS	NCA WO ID
.02SB-09@6-6.5	6/11/99 8²⁸	X	X	X	B906371-01	S	1	Note date collected	
.02SB-09@20.5-21	8³⁵	X	X	X	-02	S	1		
.02SB-09@15.5-16	8⁰⁰	X	X	X	-03	S	1		
.02SB-09@10-10.5	8²⁵	X	X	X	-04	S	1		
02SB-09	12⁴⁵	X	X	X	-05	W	3		
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.									
0.									
1.									
2.									
3.								W/O 8.4°C	
4.									
5.									

RELINQUISHED BY: PRINT NAME: FIRM: IT DATE: 6/14/99 TIME:
RECEIVED BY: AAMaier #423 PRINT NAME: AA MAIER FIRM: CD&L DATE: 6/14/99 TIME: 1545
RELINQUISHED BY: PRINT NAME: ~~Gerald W. H~~ KBL 6/14 FIRM: ~~IT~~ GRL DATE: TIME:
RECEIVED BY: Tonty PRINT NAME: FRANY TONTY FIRM: NCA DATE: 6/14/99 TIME: 1646
ADDITIONAL REMARKS: Note collection date Samples in two coolers
TEMP:
PAGE OF

COC REV 3/99

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www.ncalabs.com

Seattle 18939 120th Avenue NE, Suite 101, Bothell, WA 98011-9508
425 420 9200 fax 425 420 9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
509.924 9200 fax 509 924 9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008 7132
503 906.9200 fax 503 906 9210
Bend 20332 Empire Avenue Suite F-1 Bend, OR 97701-5711
541 383 9310 fax 541 382 7588

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 9/13/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 9/14/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 9/22/99 10:45

ANALYTICAL REPORT FOR SAMPLES:

Sample Description	Laboratory Sample Number	Sample Matrix	Date Sampled
02MW-1A	B909253-01	Soil	9/13/99
02MW-1B	B909253-02	Soil	9/13/99
02MW-1C	B909253-03	Soil	9/13/99
02MW-1D	B909253-04	Soil	9/13/99
02MW-4A	B909253-05	Soil	9/13/99
02MW-4B	B909253-06	Soil	9/13/99
02MW-4C	B909253-07	Soil	9/13/99
02MW-4D	B909253-08	Soil	9/13/99
02MW-4E	B909253-09	Soil	9/13/99
02MW-5A	B909253-10	Soil	9/13/99
02MW-5B	B909253-11	Soil	9/13/99
02MW-5C	B909253-12	Soil	9/13/99
02MW-5D	B909253-13	Soil	9/13/99
02MW-5E	B909253-14	Soil	9/13/99
02MW-5F	B909253-15	Soil	9/13/99
02MW-5G	B909253-16	Soil	9/13/99

RECEIVED SEP 24 1999

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 9/13/99
Received: 9/14/99
Reported: 9/22/99 10:45

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02MW-1A			**B909253-01**				**Soil**	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*82.0*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*92.4*	"	
02MW-1B			**B909253-02**				**Soil**	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*67.6*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*80.5*	"	
02MW-1C			**B909253-03**				**Soil**	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/14/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*79.4*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*92.2*	"	
02MW-1D			**B909253-04**				**Soil**	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*80.1*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*91.8*	"	
02MW-4A			**B909253-05**				**Soil**	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 9/13/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 9/14/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 9/22/99 10:45

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02MW-4A (continued)			B909253-05				Soil	
Toluene	0990425	9/14/99	9/15/99		0.0500	ND	mg/kg dry	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*84.5*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*95.1*	"	
02MW-4B			B909253-06				Soil	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	6.88	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*82.6*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*104*	"	
02MW-4C			B909253-07				Soil	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*77.0*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*91.6*	"	
02MW-4D			B909253-08				Soil	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*78.2*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*87.8*	"	
02MW-4E			B909253-09				Soil	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 9/13/99
Received: 9/14/99
Reported: 9/22/99 10:45

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02MW-4E (continued)			**B909253-09**				**Soil**	
Xylenes (total)	0990425	9/14/99	9/15/99		0.100	ND	mg/kg dry	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*77.3*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*86.6*	"	
02MW-5A			**B909253-10**				**Soil**	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*81.2*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*93.1*	"	
02MW-5B			**B909253-11**				**Soil**	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*82.7*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*94.6*	"	
02MW-5C			**B909253-12**				**Soil**	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*81.1*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*94.0*	"	
02MW-5D			**B909253-13**				**Soil**	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/14/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*79.3*	*%*	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02MW-5D (continued)			**B909253-13**				**Soil**	
Surrogate: 4-BFB (PID)	*0990425*	*9/14/99*	*9/14/99*	*50.0-150*		*94.5*	*%*	
02MW-5E			**B909253-14**				**Soil**	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	0.222	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*82.6*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*90.3*	"	
02MW-5F			**B909253-15**				**Soil**	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*73.0*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*81.8*	"	
02MW-5G			**B909253-16**				**Soil**	
Gasoline Range Hydrocarbons	0990425	9/14/99	9/15/99		5.00	ND	mg/kg dry	
Benzene	"	"	"		0.0500	ND	"	
Toluene	"	"	"		0.0500	ND	"	
Ethylbenzene	"	"	"		0.0500	ND	"	
Xylenes (total)	"	"	"		0.100	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*78.4*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*88.2*	"	

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	9/13/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	9/14/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	9/22/99 10:45

Semivolatile Petroleum Products by NWTPH-Dx (w/o Acid/Silica Gel Clean-up)
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02MW-1A			**B909253-01**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*65.6*	*%*	
02MW-1B			**B909253-02**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*67.5*	*%*	
02MW-1C			**B909253-03**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	**10.5**	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	**27.7**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*62.5*	*%*	
02MW-1D			**B909253-04**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*61.8*	*%*	
02MW-4A			**B909253-05**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*71.3*	*%*	
02MW-4B			**B909253-06**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*76.5*	*%*	
02MW-4C			**B909253-07**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*61.4*	*%*	
02MW-4D			**B909253-08**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*72.3*	*%*	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled:	9/13/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received:	9/14/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported:	9/22/99 10:45

Semivolatile Petroleum Products by NWTPH-Dx (w/o Acid/Silica Gel Clean-up)
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02MW-4E			**B909253-09**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*66.8*	%	
02MW-5A			**B909253-10**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*80.5*	%	
02MW-5B			**B909253-11**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*66.2*	%	
02MW-5C			**B909253-12**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	**10.3**	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	**37.0**	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*60.2*	%	
02MW-5D			**B909253-13**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*80.3*	%	
02MW-5E			**B909253-14**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*70.6*	%	
02MW-5F			**B909253-15**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*65.7*	%	
02MW-5G			**B909253-16**				**Soil**	
Diesel Range Hydrocarbons	0990504	9/16/99	9/17/99		10.0	ND	mg/kg dry	
Lube Oil Range Hydrocarbons	"	"	"		25.0	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*66.2*	%	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 9/13/99
Received: 9/14/99
Reported: 9/22/99 10:45

Total Metals by EPA 6000/7000 Series Methods
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Specific Method	Reporting Limit	Result	Units	Notes*
02MW-1A			**B909253-01**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	3.86	mg/kg dry	
02MW-1B			**B909253-02**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	3.59	mg/kg dry	
02MW-1C			**B909253-03**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	1.81	mg/kg dry	
02MW-1D			**B909253-04**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	6.46	mg/kg dry	
02MW-4A			**B909253-05**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	5.04	mg/kg dry	
02MW-4B			**B909253-06**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	7.15	mg/kg dry	
02MW-4C			**B909253-07**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	2.47	mg/kg dry	
02MW-4D			**B909253-08**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	2.26	mg/kg dry	
02MW-4E			**B909253-09**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	6.77	mg/kg dry	
02MW-5A			**B909253-10**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	6.91	mg/kg dry	
02MW-5B			**B909253-11**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	2.82	mg/kg dry	
02MW-5C			**B909253-12**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	6.92	mg/kg dry	
02MW-5D			**B909253-13**				**Soil**	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	3.97	mg/kg dry	

**Refer to end of report for text of notes and definitions.*

Joy B Chang/ Project Manager

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 9/13/99
Received: 9/14/99
Reported: 9/22/99 10:45

Total Metals by EPA 6000/7000 Series Methods
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Specific Method	Reporting Limit	Result	Units	Notes*
02MW-5E			B909253-14				Soil	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	**1.69**	mg/kg dry	
02MW-5F			B909253-15				Soil	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	**3.37**	mg/kg dry	
02MW-5G			B909253-16				Soil	
Lead	0990509	9/16/99	9/21/99	EPA 6020	0.500	**3.46**	mg/kg dry	

IT Corporation - Renton 555 South Renton Village Place, Ste 700 Renton, WA 98055	Project: Time Oil #2750 Project Number: 783336 Project Manager: Jerry Harris	Sampled: 9/13/99 Received: 9/14/99 Reported: 9/22/99 10:45

Dry Weight Determination
North Creek Analytical - Bothell

Sample Name	Lab ID	Matrix	Result	Units
02MW-1A	B909253-01	Soil	85.0	%
02MW-1B	B909253-02	Soil	82.2	%
02MW-1C	B909253-03	Soil	84.7	%
02MW-1D	B909253-04	Soil	77.9	%
02MW-4A	B909253-05	Soil	82.5	%
02MW-4B	B909253-06	Soil	82.7	%
02MW-4C	B909253-07	Soil	82.3	%
02MW-4D	B909253-08	Soil	83.8	%
02MW-4E	B909253-09	Soil	77.7	%
02MW-5A	B909253-10	Soil	83.6	%
02MW-5B	B909253-11	Soil	79.6	%
02MW-5C	B909253-12	Soil	80.3	%
02MW-5D	B909253-13	Soil	81.2	%
02MW-5E	B909253-14	Soil	81.2	%
02MW-5F	B909253-15	Soil	72.0	%
02MW-5G	B909253-16	Soil	80.2	%

North Creek Analytical - Bothell

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 9/13/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 9/14/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 9/22/99 10:45

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0990425	**Date Prepared: 9/14/99**				**Extraction Method: EPA 5030B (MeOH)**					
Blank	**0990425-BLK1**									
Gasoline Range Hydrocarbons	9/14/99			ND	mg/kg dry	5.00				
Benzene	"			ND	"	0.0500				
Toluene	"			ND	"	0.0500				
Ethylbenzene	"			ND	"	0.0500				
Xylenes (total)	"			ND	"	0.100				
Surrogate: 4-BFB (FID)	*"*	*4.00*		*3.70*	*"*	*50.0-150*	*92.5*			
Surrogate: 4-BFB (PID)	*"*	*4.00*		*4.31*	*"*	*50.0-150*	*108*			
LCS	**0990425-BS1**									
Gasoline Range Hydrocarbons	9/14/99	25.0		22.7	mg/kg dry	70.0-130	90.8			
Surrogate: 4-BFB (FID)	*"*	*4.00*		*3.78*	*"*	*50.0-150*	*94.5*			
Duplicate	**0990425-DUP1**		**B909253-03**							
Gasoline Range Hydrocarbons	9/15/99		ND	ND	mg/kg dry			50.0		
Surrogate: 4-BFB (FID)	*"*	*4.72*		*3.57*	*"*	*50.0-150*	*75.6*			
Duplicate	**0990425-DUP2**		**B909253-13**							
Gasoline Range Hydrocarbons	9/15/99		ND	ND	mg/kg dry			50.0		
Surrogate: 4-BFB (FID)	*"*	*4.92*		*3.87*	*"*	*50.0-150*	*78.7*			
Matrix Spike	**0990425-MS1**		**B909253-15**							
Benzene	9/15/99	0.695	ND	0.545	mg/kg dry	60.0-140	78.4			
Toluene	"	0.695	ND	0.572	"	60.0-140	82.3			
Ethylbenzene	"	0.695	ND	0.599	"	60.0-140	86.2			
Xylenes (total)	"	2.08	ND	1.82	"	60.0-140	87.5			
Surrogate: 4-BFB (PID)	*"*	*5.56*		*4.85*	*"*	*50.0-150*	*87.2*			
Matrix Spike Dup	**0990425-MSD1**		**B909253-15**							
Benzene	9/15/99	0.695	ND	0.539	mg/kg dry	60.0-140	77.6	20.0	1.03	
Toluene	"	0.695	ND	0.573	"	60.0-140	82.4	20.0	0.121	
Ethylbenzene	"	0.695	ND	0.639	"	60.0-140	91.9	20.0	6.40	
Xylenes (total)	"	2.08	ND	1.80	"	60.0-140	86.5	20.0	1.15	
Surrogate: 4-BFB (PID)	*"*	*5.56*		*4.66*	*"*	*50.0-150*	*83.8*			

IT Corporation - Renton	Project: Time Oil #2750	Sampled:	9/13/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received:	9/14/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported:	9/22/99 10:45

Semivolatile Petroleum Products by NWTPH-Dx (w/o Acid/Silica Gel Clean-up)/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0990504	**Date Prepared: 9/16/99**				**Extraction Method: EPA 3550B**					
Blank	**0990504-BLK1**									
Diesel Range Hydrocarbons	9/17/99			**ND**	mg/kg dry	**10.0**				
Lube Oil Range Hydrocarbons	"			**ND**	"	**25.0**				
Surrogate: 2-FBP	*"*	*10.7*		*6.81*	*"*	*50.0-150*	*63.6*			
LCS	**0990504-BS1**									
Diesel Range Hydrocarbons	9/17/99	66.7		46.5	mg/kg dry	60.0-140	69.7			
Surrogate: 2-FBP	*"*	*10.7*		*6.91*	*"*	*50.0-150*	*64.6*			
Duplicate	**0990504-DUP1**		**B909296-02**							
Diesel Range Hydrocarbons	9/17/99		18.9	18.3	mg/kg dry			50.0	3.23	
Lube Oil Range Hydrocarbons	"		ND	ND	"			50.0		
Surrogate: 2-FBP	*"*	*11.4*		*8.07*	*"*	*50.0-150*	*70.8*			
Duplicate	**0990504-DUP2**		**B909253-07**							
Diesel Range Hydrocarbons	9/17/99		ND	ND	mg/kg dry			50.0		
Lube Oil Range Hydrocarbons	"		ND	ND	"			50.0		
Surrogate: 2-FBP	*"*	*13.0*		*9.26*	*"*	*50.0-150*	*71.2*			

Refer to end of report for text of notes and definitions.

Joy B Chang, Project Manager

IT Corporation - Renton 555 South Renton Village Place, Ste 700 Renton, WA 98055	Project: Time Oil #2750 Project Number: 783336 Project Manager: Jerry Harris	Sampled: 9/13/99 Received: 9/14/99 Reported: 9/22/99 10:45

Total Metals by EPA 6000/7000 Series Methods/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 0990509	**Date Prepared: 9/16/99**				**Extraction Method: EPA 3050B**					
Blank	**0990509-BLK1**									
Lead	9/21/99			ND	mg/kg dry	0.500				
LCS	**0990509-BS1**									
Lead	9/21/99	25.0		27.2	mg/kg dry	80.0-120	109			
Matrix Spike	**0990509-MS1**		**B909264-01**							
Lead	9/21/99	17.5	6.27	29.8	mg/kg dry	70.0-130	134			
Matrix Spike	**0990509-MS2**		**B909264-01**							
Lead	9/21/99	179	6.27	201	mg/kg dry	70.0-130	109			1
Matrix Spike Dup	**0990509-MSD1**		**B909264-01**							
Lead	9/21/99	17.7	6.27	22.4	mg/kg dry	70.0-130	91.1	20.0	38.1	2

**Refer to end of report for text of notes and definitions.*

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 9/13/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 9/14/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 9/22/99 10:45

Notes and Definitions

#	Note
1	Post-digestion Matrix Spike.
2	Visual examination indicates the RPD and/or matrix spike recovery is outside the control limit due to a non-homogeneous sample matrix.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
Recov.	Recovery
RPD	Relative Percent Difference

North Creek Analytical, Inc.
Environmental Laboratory Network
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20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711 (541) 383-9310 FAX 382-7588

CHAIN OF CUSTODY REPORT

Work Order #: B909253

CLIENT: IT Corp
REPORT TO: Jerry Harris
ADDRESS: 555 S. Renton Village Pl. #700
Renton, WA 98055
PHONE: 425-228-9645 FAX: 425-228-9793
PROJECT NAME: Time Oil 2750
PROJECT NUMBER: 783336
SAMPLED BY: CNS

INVOICE TO: Connie Hofman
" "
P.O. NUMBER:

TURNAROUND REQUEST in Business Days*
Organic & Inorganic Analyses
☐ 10 ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1
STD.
Petroleum Hydrocarbon Analyses
☒ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1
STD.
OTHER Please Specify
*Turnaround Requests less than standard may incur Rush Charges

REQUESTED ANALYSES

CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	TPH-G	TPH-Dext	BTEX	Lead	MATRIX (W, S, O)	# OF CONT.	COMMENTS	NCA WO ID
02MW-1A	9/13/99 7:46	X	X	X	X	Soil	1	B909253 -	01
02MW-1B	7:50							-	02
02MW-1C	7:54							-	03
02MW-1D	8:40							-	04
02MW-4A	8:23							-	05
02MW-4B	9:18							-	06
02MW-4C	9:24							-	07
02MW-4D	9:29							-	08
02MW-4E	9:34							-	09
02MW-5A	10:23							-	10
02MW-5B	10:26							-	11
02MW-5C	10:32							-	12
02MW-5D	10:38							-	13
02MW-5E	10:48							-	14
02MW-5F	10:53							-	15

RELINQUISHED BY: Chris N. Storey
PRINT NAME: Chris N. Storey FIRM: IT Corp DATE: 9/14/99 TIME: 9:41
RECEIVED BY: Bill Kun
PRINT NAME: BILL KUNIHOLM FIRM: NCA DATE: 9/14/99 TIME: 13:00

RELINQUISHED BY: Bill K
PRINT NAME: FIRM: NCA DATE: 9/14/99 TIME: 13:45
RECEIVED BY: S. Wideen
PRINT NAME: S. Wideen FIRM: NCA DATE: 9-14-99 TIME: 1345

ADDITIONAL REMARKS: w/o

TEMP: 13.5°C PAGE OF

CREV JAN

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20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711 (541) 383-9310 FAX 382-7588

CHAIN OF CUSTODY REPORT

Work Order #: B909253

LIENT: IT Corp
EPORT TO: Jerry Harris
DDRESS: 555 S. Renton Village PL #70
Renton, WA 98055
HONE: 425-228-9645 FAX: 425-228-9793
ROJECT NAME:
ROJECT NUMBER:
AMPLED BY:

INVOICE TO: Connie Hofman

P.O. NUMBER:

TURNAROUND REQUEST in Business Days*

Organic & Inorganic Analyses
10 7 5 4 3 2 1 <1
STD.

Petroleum Hydrocarbon Analyses
☒ 4 3 2 1 <1
STD.

OTHER Please Specify

*Turnaround Requests less than standard may incur Rush Charges.

REQUESTED ANALYSES

CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	TPH-G	TPH-Dext	BTEX	Lead										MATRIX (W, S, O)	# OF CONT.	COMMENTS	NCA WO ID
02MW-5G	9/13/99 16:57	X	X	X	X										Soil	1	B909253-	16

ELINQUISHED BY: Chris N. Storey
INT NAME: Chris N. Storey FIRM: IT Corp DATE: 9/14/99 TIME: 9:41
RECEIVED BY: Bill Kun
PRINT NAME: BILL KUNIHOLM FIRM: NCA DATE: 9/14/99 TIME: 13:00

ELINQUISHED BY: Bill Ku
INT NAME: FIRM: NCA DATE: 9/14/99 TIME: 3:45
RECEIVED BY:
PRINT NAME: FIRM: DATE: TIME:

DDITIONAL REMARKS: w/o

TEMP: 13.5°C

PAGE OF

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Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 9/28/99
Received: 9/29/99
Reported: 10/6/99 15:57

ANALYTICAL REPORT FOR SAMPLES:

Sample Description	Laboratory Sample Number	Sample Matrix	Date Sampled
02-MW-1	B909648-01	Water	9/28/99
02-MW-2	B909648-02	Water	9/28/99
02-MW-3	B909648-03	Water	9/28/99
02-MW-4	B909648-04	Water	9/28/99
02-MW-5	B909648-05	Water	9/28/99

RECEIVED OCT 8 1999

The results in this report apply to the samples analyzed in accordance with the chain of custody document.
This analytical report must be reproduced in its entirety.

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	9/28/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	9/29/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	10/6/99 15:57

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02-MW-1			**B909648-01**				**Water**	
Gasoline Range Hydrocarbons	1090003	10/1/99	10/1/99		50.0	**172**	ug/l	
Benzene	"	"	"		0.500	**72.9**	"	
Toluene	"	"	"		0.500	**0.811**	"	
Ethylbenzene	"	"	"		0.500	ND	"	
Xylenes (total)	"	"	"		1.00	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*91.7*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*83.8*	"	
02-MW-2			**B909648-02**				**Water**	
Gasoline Range Hydrocarbons	1090003	10/1/99	10/1/99		50.0	ND	ug/l	
Benzene	"	"	"		0.500	ND	"	
Toluene	"	"	"		0.500	ND	"	
Ethylbenzene	"	"	"		0.500	ND	"	
Xylenes (total)	"	"	"		1.00	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*82.9*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*85.8*	"	
02-MW-3			**B909648-03**				**Water**	
Gasoline Range Hydrocarbons	1090003	10/1/99	10/2/99		50.0	**160**	ug/l	
Benzene	"	"	"		0.500	**56.7**	"	
Toluene	"	"	"		0.500	**1.13**	"	
Ethylbenzene	"	"	"		0.500	ND	"	
Xylenes (total)	"	"	"		1.00	**1.14**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*91.2*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*81.7*	"	
02-MW-4			**B909648-04**				**Water**	
Gasoline Range Hydrocarbons	1090003	10/1/99	10/2/99		250	**3700**	ug/l	
Benzene	"	"	"		30.0	ND	"	1
Toluene	"	"	"		2.50	**185**	"	
Ethylbenzene	"	"	"		2.50	**226**	"	
Xylenes (total)	"	"	"		5.00	**473**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*99.6*	*%*	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*94.6*	"	
02-MW-5			**B909648-05**				**Water**	
Gasoline Range Hydrocarbons	1090003	10/1/99	10/2/99		50.0	ND	ug/l	
Benzene	"	"	"		0.500	**2.84**	"	

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton 555 South Renton Village Place, Ste 700 Renton, WA 98055	Project: Time Oil #2750 Project Number: 783336 Project Manager: Jerry Harris	Sampled: 9/28/99 Received: 9/29/99 Reported: 10/6/99 15:57

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02-MW-5 (continued)			B909648-05				Water	
Toluene	1090003	10/1/99	10/2/99		0.500	ND	ug/l	
Ethylbenzene	"	"	"		0.500	ND	"	
Xylenes (total)	"	"	"		1.00	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*100*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*90.8*	"	

*Refer to end of report for text of notes and definitions.

Joy B Chang, Project Manager

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	9/28/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	9/29/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	10/6/99 15:57

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02-MW-1			**B909648-01**				**Water**	
Diesel Range Hydrocarbons	1090047	10/2/99	10/4/99		0.250	ND	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*52.8*	*%*	
02-MW-2			**B909648-02**				**Water**	
Diesel Range Hydrocarbons	1090047	10/2/99	10/4/99		0.250	ND	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*51.8*	*%*	
02-MW-3			**B909648-03**				**Water**	
Diesel Range Hydrocarbons	1090047	10/2/99	10/4/99		0.250	ND	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*57.9*	*%*	
02-MW-4			**B909648-04**				**Water**	
Diesel Range Hydrocarbons	1090047	10/2/99	10/4/99		0.250	ND	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*53.9*	*%*	
02-MW-5			**B909648-05**				**Water**	
Diesel Range Hydrocarbons	1090047	10/2/99	10/4/99		0.250	ND	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*33.2*	*%*	*2*

IT Corporation - Renton	Project: Time Oil #2750	Sampled:	9/28/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received:	9/29/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported:	10/6/99 15:57

Total Metals by EPA 6000/7000 Series Methods
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Specific Method	Reporting Limit	Result	Units	Notes*
02-MW-1			B909648-01				Water	
Lead	1090064	10/3/99	10/4/99	EPA 6020	0.00100	**0.0360**	mg/l	
02-MW-2			B909648-02				Water	
Lead	1090064	10/3/99	10/4/99	EPA 6020	0.00100	**0.133**	mg/l	
02-MW-3			B909648-03				Water	
Lead	1090064	10/3/99	10/4/99	EPA 6020	0.00100	ND	mg/l	
02-MW-4			B909648-04				Water	
Lead	1090064	10/3/99	10/4/99	EPA 6020	0.00100	**0.0359**	mg/l	
02-MW-5			B909648-05				Water	
Lead	1090064	10/3/99	10/4/99	EPA 6020	0.00100	**0.0863**	mg/l	

IT Corporation - Renton 555 South Renton Village Place, Ste 700 Renton, WA 98055	Project: Time Oil #2750 Project Number: 783336 Project Manager: Jerry Harris	Sampled: 9/28/99 Received: 9/29/99 Reported: 10/6/99 15:57	

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 1090003	**Date Prepared: 10/1/99**				**Extraction Method: EPA 5030B (P/T)**					
Blank	**1090003-BLK1**									
Gasoline Range Hydrocarbons	10/1/99			ND	ug/l	50.0				
Benzene	"			ND	"	0.500				
Toluene	"			ND	"	0.500				
Ethylbenzene	"			ND	"	0.500				
Xylenes (total)	"			ND	"	1.00				
Surrogate: 4-BFB (FID)	"	*48.0*		*41.5*	"	*50.0-150*	*86.5*			
Surrogate: 4-BFB (PID)	"	*48.0*		*41.2*	"	*50.0-150*	*85.8*			
Blank	**1090003-BLK2**									
Gasoline Range Hydrocarbons	10/2/99			ND	ug/l	50.0				
Benzene	"			ND	"	0.500				
Toluene	"			ND	"	0.500				
Ethylbenzene	"			ND	"	0.500				
Xylenes (total)	"			ND	"	1.00				
Surrogate: 4-BFB (FID)	"	*48.0*		*43.8*	"	*50.0-150*	*91.2*			
Surrogate: 4-BFB (PID)	"	*48.0*		*41.2*	"	*50.0-150*	*85.8*			
LCS	**1090003-BS1**									
Gasoline Range Hydrocarbons	10/1/99	500		456	ug/l	70.0-130	91.2			
Surrogate: 4-BFB (FID)	"	*48.0*		*45.9*	"	*50.0-150*	*95.6*			
Duplicate	**1090003-DUP1**		**B909613-02**							
Gasoline Range Hydrocarbons	10/2/99		158000	160000	ug/l			25.0	1.26	
Surrogate: 4-BFB (FID)	"	*48.0*		*44.3*	"	*50.0-150*	*92.3*			
Duplicate	**1090003-DUP2**		**B909613-04**							
Gasoline Range Hydrocarbons	10/4/99		244000	242000	ug/l			25.0	0.823	
Surrogate: 4-BFB (FID)	"	*48.0*		*44.1*	"	*50.0-150*	*91.9*			
Matrix Spike	**1090003-MS1**		**B909613-07**							
Benzene	10/4/99	10.0	ND	8.84	ug/l	70.0-130	88.4			
Toluene	"	10.0	ND	9.09	"	70.0-130	90.9			
Ethylbenzene	"	10.0	ND	9.22	"	70.0-130	92.2			
Xylenes (total)	"	30.0	ND	27.8	"	70.0-130	92.7			
Surrogate: 4-BFB (PID)	"	*48.0*		*42.6*	"	*50.0-150*	*88.7*			

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled:	9/28/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received:	9/29/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported:	10/6/99 15:57

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Matrix Spike Dup	1090003-MSD1		B909613-07							
Benzene	10/4/99	10.0	ND	8.51	ug/l	70.0-130	**85.1**	15.0	**3.80**	
Toluene	"	10.0	ND	8.50	"	70.0-130	**85.0**	15.0	**6.71**	
Ethylbenzene	"	10.0	ND	8.60	"	70.0-130	**86.0**	15.0	**6.96**	
Xylenes (total)	"	30.0	ND	25.8	"	70.0-130	**86.0**	15.0	**7.50**	
Surrogate: 4-BFB (PID)	"	*48.0*		*41.6*	"	*50.0-150*	*86.7*			

*Refer to end of report for text of notes and definitions.

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled:	9/28/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received:	9/29/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported:	10/6/99 15:57

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 1090047	**Date Prepared: 10/2/99**				**Extraction Method: EPA 3520C/600 Series**					
Blank	**1090047-BLK1**									
Diesel Range Hydrocarbons	10/4/99			ND	mg/l	0.250				
Lube Oil Range Hydrocarbons	"			ND	"	0.500				
Surrogate: 2-FBP	*"*	*0.320*		*0.202*	*"*	*50.0-150*	*63.1*			
LCS	**1090047-BS1**									
Diesel Range Hydrocarbons	10/4/99	2.00		1.15	mg/l	50.0-150	57.5			
Surrogate: 2-FBP	*"*	*0.320*		*0.169*	*"*	*50.0-150*	*52.8*			
LCS Dup	**1090047-BSD1**									
Diesel Range Hydrocarbons	10/4/99	2.00		0.996	mg/l	50.0-150	49.8	50.0	14.4	3
Surrogate: 2-FBP	*"*	*0.320*		*0.176*	*"*	*50.0-150*	*55.0*			

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled:	9/28/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received:	9/29/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported:	10/6/99 15:57

Total Metals by EPA 6000/7000 Series Methods/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 1090064	**Date Prepared: 10/3/99**				**Extraction Method: EPA 3020A**					
Blank	**1090064-BLK1**									
Lead	10/4/99			ND	mg/l	**0.00100**				
Blank	**1090064-BLK2**									
Lead	10/4/99			ND	mg/l	**0.00100**				
LCS	**1090064-BS1**									
Lead	10/4/99	0.200		0.191	mg/l	80.0-120	95.5			
LCS	**1090064-BS2**									
Lead	10/4/99	0.200		0.209	mg/l	80.0-120	105			
Matrix Spike	**1090064-MS1**	**B909586-06**								
Lead	10/4/99	0.200	ND	0.211	mg/l	75.0-125	105			
Matrix Spike	**1090064-MS2**	**B909648-03**								
Lead	10/4/99	0.200	ND	0.213	mg/l	75.0-125	**106**			
Matrix Spike Dup	**1090064-MSD1**	**B909586-06**								
Lead	10/4/99	0.200	ND	0.213	mg/l	75.0-125	**106**	20.0	**0.948**	
Matrix Spike Dup	**1090064-MSD2**	**B909648-03**								
Lead	10/4/99	0.200	ND	0.209	mg/l	75.0-125	**105**	20.0	**0.948**	

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

Notes and Definitions

#	Note
1	The reporting limit for this analyte has been raised to account for interference from coeluting organic compounds present in the sample.
2	Surrogate recovery is below the established control limit, result may be biased low. There was no sample left to perform re-extraction and analysis for confirmation.
3	The spike recovery for this QC sample is outside of established control limits. Review of associated batch QC indicates the recovery for this analyte does not represent an out-of-control condition for the batch.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
Recov.	Recovery
RPD	Relative Percent Difference

Joy B Chang, Project Manager

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9405 S.W. Nimbus Avenue, Beaverton, OR 97008-7132 (503) 906-9200 FAX 906-9210
20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711 (541) 383-9310 FAX 382-7588

CHAIN OF CUSTODY REPORT

Work Order #: B909648

CLIENT: TIME OIL
REPORT TO: CHRIS STOREY (PM-JERRY HARRIS)
ADDRESS: 555 S. RENTON VILLAGE PL. STE. 700
RENTON, WA 98055-3295
PHONE: 425-228-9695 FAX: 425-228-9793
PROJECT NAME: TIME OIL SEATTLE TERMINAL
PROJECT NUMBER: 783336
SAMPLED BY: RYAN ROSS

INVOICE TO: IT CORPORATION
555 S. RENTON VILLAGE PL.
STE. 700
RENTON, WA 98055-3295
P.O. NUMBER: 783336

TURNAROUND REQUEST in Business Days*
Organic & Inorganic Analyses
▨ STD. ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1
Petroleum Hydrocarbon Analyses
☐ 5 STD. ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1
☐ OTHER Please Specify ____
*Turnaround Requests less than standard may incur Rush Charges.

CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	REQUESTED ANALYSES: TPH-G/BTEX 8020/8015		TPH-D (ext) NWTPH-Dx		TOTAL LEAD 7421									MATRIX (W, S, O)	# OF CONT.	COMMENTS	NCA WO ID
02-MN-1	9-28-99/ 1200	▨		▨		▨									W	4	B909648-	01
02-MN-2	9-28-99/ 1135	▨		▨		▨									W	4	-	2
02-MN-3	9-28-99/ 1215	▨		▨		▨									W	4	-	03
02-MN-4	9-28-99/ 1115	▨		▨		▨									W	4	-	04
02-MW-5	9-28-99/ 1050	▨		▨		▨									W	4	-	05
0.																		
1.																		
2.																		
3.																		
4.																		
5.																		

RELINQUISHED BY: DATE: 9-29-99
PRINT NAME: RYAN ROSS FIRM: EMCON/IT TIME:
RECEIVED BY: Cathy Nichols DATE: 9/29/99
PRINT NAME: Cathy Nichols FIRM: NCA TIME: 1:35

RELINQUISHED BY: DATE:
PRINT NAME: FIRM: TIME:
RECEIVED BY: DATE:
PRINT NAME: FIRM: TIME:

ADDITIONAL REMARKS: USE SILICA GEL CLEAN-UP FOR TPH-D EXTENDED

TEMP: 6

PAGE 1 OF 1

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509.924.9200 fax 509.924 9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906 9200 fax 503.906 9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541 383.9310 fax 541.382 7588

IT Corporation - Renton	Project:	Time Oil #2750	Sampled:	9/28/99
555 South Renton Village Place, Ste 700	Project Number:	783336	Received:	9/29/99
Renton, WA 98055	Project Manager:	Jerry Harris	Reported:	10/6/99 15:57

ANALYTICAL REPORT FOR SAMPLES:

Sample Description	Laboratory Sample Number	Sample Matrix	Date Sampled
02-MW-1	B909648-01	Water	9/28/99
02-MW-2	B909648-02	Water	9/28/99
02-MW-3	B909648-03	Water	9/28/99
02-MW-4	B909648-04	Water	9/28/99
02-MW-5	B909648-05	Water	9/28/99

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Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 9/28/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 9/29/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 10/6/99 15:57

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02-MW-1			B909648-01				Water	
Gasoline Range Hydrocarbons	1090003	10/1/99	10/1/99		50.0	**172**	ug/l	
Benzene	"	"	"		0.500	**72.9**	"	
Toluene	"	"	"		0.500	**0.811**	"	
Ethylbenzene	"	"	"		0.500	ND	"	
Xylenes (total)	"	"	"		1.00	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*91.7*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*83.8*	"	
02-MW-2			B909648-02				Water	
Gasoline Range Hydrocarbons	1090003	10/1/99	10/1/99		50.0	ND	ug/l	
Benzene	"	"	"		0.500	ND	"	
Toluene	"	"	"		0.500	ND	"	
Ethylbenzene	"	"	"		0.500	ND	"	
Xylenes (total)	"	"	"		1.00	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*82.9*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*85.8*	"	
02-MW-3			B909648-03				Water	
Gasoline Range Hydrocarbons	1090003	10/1/99	10/2/99		50.0	**160**	ug/l	
Benzene	"	"	"		0.500	**56.7**	"	
Toluene	"	"	"		0.500	**1.13**	"	
Ethylbenzene	"	"	"		0.500	ND	"	
Xylenes (total)	"	"	"		1.00	**1.14**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*91.2*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*81.7*	"	
02-MW-4			B909648-04				Water	
Gasoline Range Hydrocarbons	1090003	10/1/99	10/2/99		250	**3700**	ug/l	
Benzene	"	"	"		30.0	ND	"	I
Toluene	"	"	"		2.50	**185**	"	
Ethylbenzene	"	"	"		2.50	**226**	"	
Xylenes (total)	"	"	"		5.00	**473**	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*99.6*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*94.6*	"	
02-MW-5			B909648-05				Water	
Gasoline Range Hydrocarbons	1090003	10/1/99	10/2/99		50.0	ND	ug/l	
Benzene	"	"	"		0.500	**2.84**	"	

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled:	9/28/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received:	9/29/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported:	10/6/99 15:57

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02-MW-5 (continued)			B909648-05				Water	
Toluene	1090003	10/1/99	10/2/99		0.500	ND	ug/l	
Ethylbenzene	"	"	"		0.500	ND	"	
Xylenes (total)	"	"	"		1.00	ND	"	
Surrogate: 4-BFB (FID)	"	"	"	*50.0-150*		*100*	%	
Surrogate: 4-BFB (PID)	"	"	"	*50.0-150*		*90.8*	"	

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 9/28/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 9/29/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 10/6/99 15:57

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Surrogate Limits	Reporting Limit	Result	Units	Notes*
02-MW-1			**B909648-01**				**Water**	
Diesel Range Hydrocarbons	1090047	10/2/99	10/4/99		0.250	ND	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*52.8*	*%*	
02-MW-2			**B909648-02**				**Water**	
Diesel Range Hydrocarbons	1090047	10/2/99	10/4/99		0.250	ND	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*51.8*	*%*	
02-MW-3			**B909648-03**				**Water**	
Diesel Range Hydrocarbons	1090047	10/2/99	10/4/99		0.250	ND	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*57.9*	*%*	
02-MW-4			**B909648-04**				**Water**	
Diesel Range Hydrocarbons	1090047	10/2/99	10/4/99		0.250	ND	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*53.9*	*%*	
02-MW-5			**B909648-05**				**Water**	
Diesel Range Hydrocarbons	1090047	10/2/99	10/4/99		0.250	ND	mg/l	
Lube Oil Range Hydrocarbons	"	"	"		0.500	ND	"	
Surrogate: 2-FBP	"	"	"	*50.0-150*		*33.2*	*%*	*2*

***Refer to end of report for text of notes and definitions.**

Joy B Chang, Project Manager

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 9/28/99
Received: 9/29/99
Reported: 10/6/99 15:57

Total Metals by EPA 6000/7000 Series Methods
North Creek Analytical - Bothell

Analyte	Batch Number	Date Prepared	Date Analyzed	Specific Method	Reporting Limit	Result	Units	Notes*
02-MW-1			B909648-01				Water	
Lead	1090064	10/3/99	10/4/99	EPA 6020	0.00100	**0.0360**	mg/l	
02-MW-2			B909648-02				Water	
Lead	1090064	10/3/99	10/4/99	EPA 6020	0.00100	**0.133**	mg/l	
02-MW-3			B909648-03				Water	
Lead	1090064	10/3/99	10/4/99	EPA 6020	0.00100	ND	mg/l	
02-MW-4			B909648-04				Water	
Lead	1090064	10/3/99	10/4/99	EPA 6020	0.00100	**0.0359**	mg/l	
02-MW-5			B909648-05				Water	
Lead	1090064	10/3/99	10/4/99	EPA 6020	0.00100	**0.0863**	mg/l	

Refer to end of report for text of notes and definitions.

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled:	9/28/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received:	9/29/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported:	10/6/99 15:57

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 1090003	**Date Prepared: 10/1/99**				**Extraction Method: EPA 5030B (P/T)**					
Blank	**1090003-BLK1**									
Gasoline Range Hydrocarbons	10/1/99			ND	ug/l	50.0				
Benzene	"			ND	"	0.500				
Toluene	"			ND	"	0.500				
Ethylbenzene	"			ND	"	0.500				
Xylenes (total)	"			ND	"	1.00				
Surrogate: 4-BFB (FID)	"	*48.0*		*41.5*	"	*50.0-150*	*86.5*			
Surrogate: 4-BFB (PID)	"	*48.0*		*41.2*	"	*50.0-150*	*85.8*			
Blank	**1090003-BLK2**									
Gasoline Range Hydrocarbons	10/2/99			ND	ug/l	50.0				
Benzene	"			ND	"	0.500				
Toluene	"			ND	"	0.500				
Ethylbenzene	"			ND	"	0.500				
Xylenes (total)	"			ND	"	1.00				
Surrogate: 4-BFB (FID)	"	*48.0*		*43.8*	"	*50.0-150*	*91.2*			
Surrogate: 4-BFB (PID)	"	*48.0*		*41.2*	"	*50.0-150*	*85.8*			
LCS	**1090003-BS1**									
Gasoline Range Hydrocarbons	10/1/99	500		456	ug/l	70.0-130	91.2			
Surrogate: 4-BFB (FID)	"	*48.0*		*45.9*	"	*50.0-150*	*95.6*			
Duplicate	**1090003-DUP1**	**B909613-02**								
Gasoline Range Hydrocarbons	10/2/99		158000	160000	ug/l			25.0	1.26	
Surrogate: 4-BFB (FID)	"	*48.0*		*44.3*	"	*50.0-150*	*92.3*			
Duplicate	**1090003-DUP2**	**B909613-04**								
Gasoline Range Hydrocarbons	10/4/99		244000	242000	ug/l			25.0	0.823	
Surrogate: 4-BFB (FID)	"	*48.0*		*44.1*	"	*50.0-150*	*91.9*			
Matrix Spike	**1090003-MS1**	**B909613-07**								
Benzene	10/4/99	10.0	ND	8.84	ug/l	70.0-130	88.4			
Toluene	"	10.0	ND	9.09	"	70.0-130	90.9			
Ethylbenzene	"	10.0	ND	9.22	"	70.0-130	92.2			
Xylenes (total)	"	30.0	ND	27.8	"	70.0-130	92.7			
Surrogate: 4-BFB (PID)	"	*48.0*		*42.6*	"	*50.0-150*	*88.7*			

North Creek Analytical - Bothell

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton
555 South Renton Village Place, Ste 700
Renton, WA 98055

Project: Time Oil #2750
Project Number: 783336
Project Manager: Jerry Harris

Sampled: 9/28/99
Received: 9/29/99
Reported: 10/6/99 15:57

Volatile Petroleum Products and BTEX by NWTPH-Gx and EPA 8021B/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	**Reporting Limit** Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
<u>Matrix Spike Dup</u>	<u>1090003-MSD1</u>		<u>B909613-07</u>							
Benzene	10/4/99	10.0	ND	8.51	ug/l	70.0-130	85.1	15.0	3.80	
Toluene	"	10.0	ND	8.50	"	70.0-130	85.0	15.0	6.71	
Ethylbenzene	"	10.0	ND	8.60	"	70.0-130	86.0	15.0	6.96	
Xylenes (total)	"	30.0	ND	25.8	"	70.0-130	86.0	15.0	7.50	
Surrogate: 4-BFB (PID)	*"*	*48.0*		*41.6*	*"*	*50.0-150*	*86.7*			

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 9/28/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 9/29/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 10/6/99 15:57

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 1090047	**Date Prepared: 10/2/99**				**Extraction Method: EPA 3520C/600 Series**					
Blank	**1090047-BLK1**									
Diesel Range Hydrocarbons	10/4/99			ND	mg/l	0.250				
Lube Oil Range Hydrocarbons	"			ND	"	0.500				
Surrogate: 2-FBP	"	*0.320*		*0.202*	"	*50.0-150*	*63.1*			
LCS	**1090047-BS1**									
Diesel Range Hydrocarbons	10/4/99	2.00		1.15	mg/l	50.0-150	57.5			
Surrogate: 2-FBP	"	*0.320*		*0.169*	"	*50.0-150*	*52.8*			
LCS Dup	**1090047-BSD1**									
Diesel Range Hydrocarbons	10/4/99	2.00		0.996	mg/l	50.0-150	49.8	50.0	14.4	3
Surrogate: 2-FBP	"	*0.320*		*0.176*	"	*50.0-150*	*55.0*			

IT Corporation - Renton	Project: Time Oil #2750	Sampled: 9/28/99
555 South Renton Village Place, Ste 700	Project Number: 783336	Received: 9/29/99
Renton, WA 98055	Project Manager: Jerry Harris	Reported: 10/6/99 15:57

Total Metals by EPA 6000/7000 Series Methods/Quality Control
North Creek Analytical - Bothell

Analyte	Date Analyzed	Spike Level	Sample Result	QC Result	Units	Reporting Limit Recov. Limits	Recov. %	RPD Limit	RPD %	Notes*
Batch: 1090064	**Date Prepared: 10/3/99**				**Extraction Method: EPA 3020A**					
Blank	**1090064-BLK1**									
Lead	10/4/99			**ND**	mg/l	**0.00100**				
Blank	**1090064-BLK2**									
Lead	10/4/99			**ND**	mg/l	**0.00100**				
LCS	**1090064-BS1**									
Lead	10/4/99	0.200		0.191	mg/l	80.0-120	95.5			
LCS	**1090064-BS2**									
Lead	10/4/99	0.200		0.209	mg/l	80.0-120	105			
Matrix Spike	**1090064-MS1**		**B909586-06**							
Lead	10/4/99	0.200	ND	0.211	mg/l	75.0-125	**105**			
Matrix Spike	**1090064-MS2**		**B909648-03**							
Lead	10/4/99	0.200	ND	0.213	mg/l	75.0-125	**106**			
Matrix Spike Dup	**1090064-MSD1**		**B909586-06**							
Lead	10/4/99	0.200	ND	0.213	mg/l	75.0-125	**106**	20.0	**0.948**	
Matrix Spike Dup	**1090064-MSD2**		**B909648-03**							
Lead	10/4/99	0.200	ND	0.209	mg/l	75.0-125	**105**	20.0	**0.948**	

**Refer to end of report for text of notes and definitions.*

Joy B Chang, Project Manager

IT Corporation - Renton 555 South Renton Village Place, Ste 700 Renton, WA 98055	Project: Time Oil #2750 Project Number: 783336 Project Manager: Jerry Harris	Sampled: 9/28/99 Received: 9/29/99 Reported: 10/6/99 15:57

Notes and Definitions

#	Note
1	The reporting limit for this analyte has been raised to account for interference from coeluting organic compounds present in the sample.
2	Surrogate recovery is below the established control limit, result may be biased low. There was no sample left to perform re-extraction and analysis for confirmation.
3	The spike recovery for this QC sample is outside of established control limits. Review of associated batch QC indicates the recovery for this analyte does not represent an out-of-control condition for the batch.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
Recov.	Recovery
RPD	Relative Percent Difference

nca™
North Creek Analytical, Inc.
Environmental Laboratory Network
www.ncalabs.com

939 1 venue uite 1 thell, 011-9 (42 -9200 X 42
East 11115 Montgomery, Suite B, Spokane, WA 98206-4776 (509) 924-9200 FAX 924-9290
9405 S.W. Nimbus Avenue, Beaverton, OR 97008-7132 (503) 906-9200 FAX 906-9210
20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711 (541) 383-9310 FAX 382-7588

CHAIN OF CUSTODY REPORT

Work Order #: B909648

CLIENT: TIME OIL
REPORT TO: CHRIS STOREY (PM- JERRY HARRIS)
ADDRESS: 555 S. RENTON VILLAGE PL. STE. 700
RENTON, WA 98055-3295
PHONE: 425-228-9695 FAX: 425-228-9793
PROJECT NAME: TIME OIL SEATTLE TERMINAL
PROJECT NUMBER: 783336
SAMPLED BY: RYAN ROSS

INVOICE TO: IT CORPORATION
555 S. RENTON VILLAGE PL.
STE. 700
RENTON, WA 98055-3295
P.O. NUMBER: 783336

TURNAROUND REQUEST in Business Days*

Organic & Inorganic Analyses
☒ STD ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1

Petroleum Hydrocarbon Analyses
☐ 5 STD. ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1

☐ OTHER Please Specify ______

*Turnaround Requests less than standard may incur Rush Charges.

		REQUESTED ANALYSES																
CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	TPH-G / BTEX 8020/8015		TPH-D (ext) NWTPH-Dx		TOTAL LEAD 7421									MATRIX (W, S, O)	# OF CONT.	COMMENTS	NCA WO ID
02-MN-1	9-28-99/ 1200	■		■		■									W	4	B909648 –	01
02-MN-2	9-28-99/ 1135	■		■		■									W	4	–	2
02-MN-3	9-28-99/ 1215	■		■		■									W	4	–	03
02-MN-4	9-28-99/ 1115	■		■		■									W	4	–	04
02-MN-5	9-28-99/ 1050	■		■		■									W	4	–	05
0.																		
1.																		
2.																		
3.																		
4.																		
5.																		

RELINQUISHED BY: DATE: 9-29-99
PRINT NAME: RYAN ROSS FIRM: EMCON/IT TIME:
RECEIVED BY: Cathy Nichols DATE: 9/29/99
PRINT NAME: Cathy Nichols FIRM: NCA TIME: 1:35

RELINQUISHED BY: DATE:
PRINT NAME: FIRM: TIME:
RECEIVED BY: DATE:
PRINT NAME: FIRM: TIME:

ADDITIONAL REMARKS: USE SILICA GEL CLEAN-UP FOR TPH-D EXTENDED

TEMP: 6

PAGE 1 OF 1

ENVIRONMENTAL SITE ASSESSMENT: PHASE I

at

2750 West Commodore Way
Seattle, Washington

Prepared for

Time Oil Company

August 25, 2000

Prepared by

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

12100 NE 195th, Suite 200
Bothell, WA 98011

CONTENTS

FIGURES

TABLES

1. INTRODUCTION

Foster Wheeler Environmental Corporation (Foster Wheeler Environmental) has been retained by the Time Oil Company (TOC) to conduct Phase I Environmental Site Assessments (ESAs) at seven properties located on West Commodore Way. The properties are all owned by TOC and are located within a ¼-mile radius.

This report presents the results of the Phase I ESA of the property located at 2750 West Commodore Way, Seattle, Washington (the Property), shown on Figure 1. This report was prepared by Foster Wheeler Environmental for the sole use of TOC and with the express limitations detailed in Section 1.2. The format of this report is generally consistent with the recommended format in "Standard Practice for Environmental Site Assessment: Phase I," issued by the American Society for Testing Materials (ASTM) Standard E 1527-97.

1.1 PURPOSE

Pursuant to the scope of work, the purpose of this ESA was to identify recognized environmental conditions in connection with the property. As defined in the Standard E 1527-97, "recognized environmental conditions" means the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release, a past release, or a material threat of a release of any hazardous substances or petroleum products into structures on the property or into the ground, groundwater, or surface water of the property.

1.2 LIMITING CONDITIONS AND METHODOLOGY USED

The ESA was performed by Bryan S. Graham, RG, of Foster Wheeler Environmental. The scope of services for this project was limited to the following tasks:

- Task 1–Property Reconnaissance
- Task 2–Interview of Land Owner(s), current lessees, and Tenants
- Task 3–Regulatory Agency Database Search
- Task 4–Data Analysis and Report Preparation.

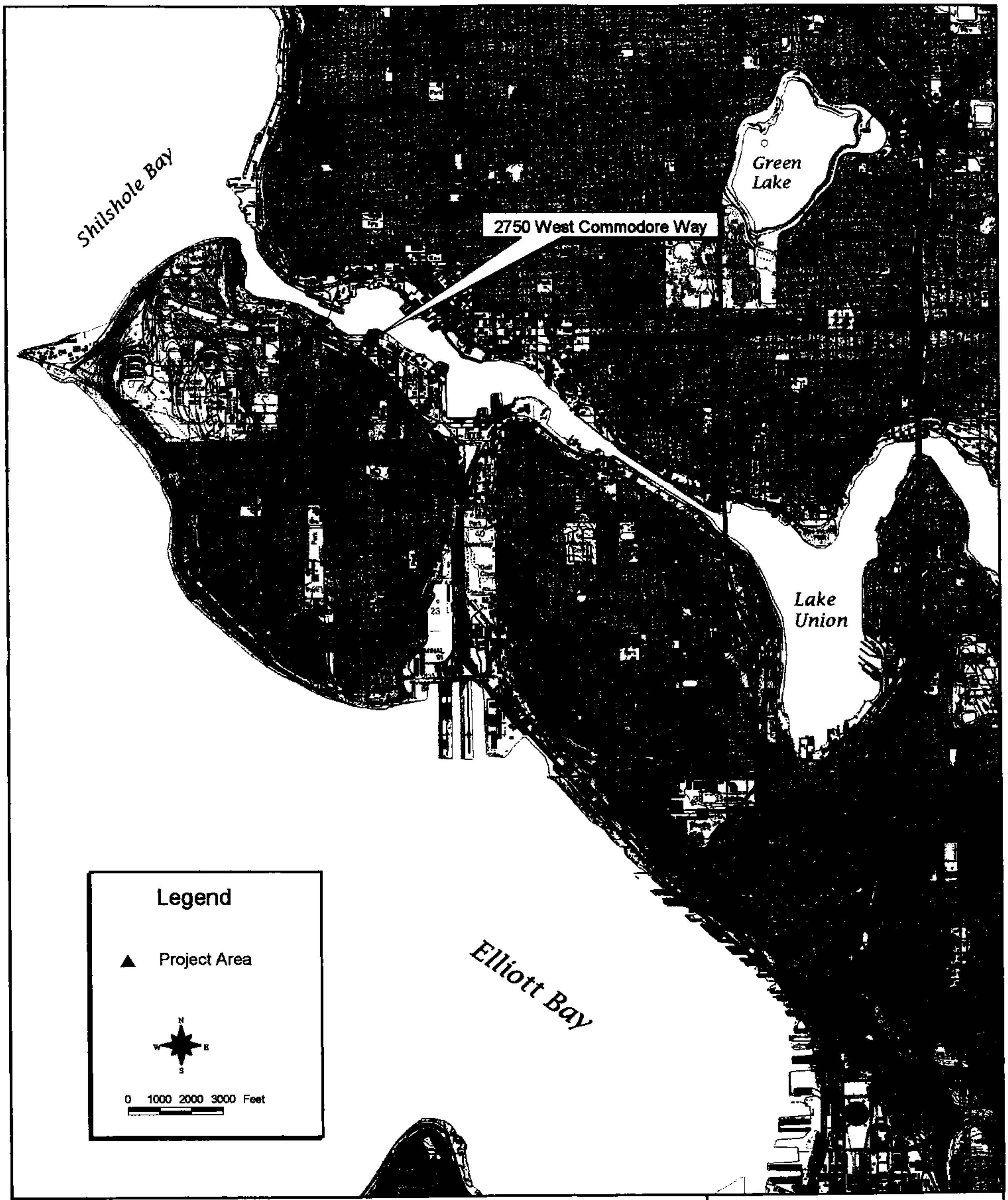


Figure 1

Location of
Target Property

Time Oil Company Phase 1
Environmental Site Assessment

c:\projects\time_oil\vic_map.apr June 2000

Historical photographs were purchased from Walker & Associates. Available records and files were reviewed from:

- Seattle Department of Design, Construction, and Land Use
- Washington State Department of Ecology (Ecology)
- King County Tax Assessors Office
- Puget Sound Regional Archives

The above tasks were accomplished in accordance with ASTM Standard E 1527-97. The ESA did not include wetlands evaluation; testing for or surveying of asbestos and radon, lead in tap water, or lead paint; or soil or groundwater sampling.

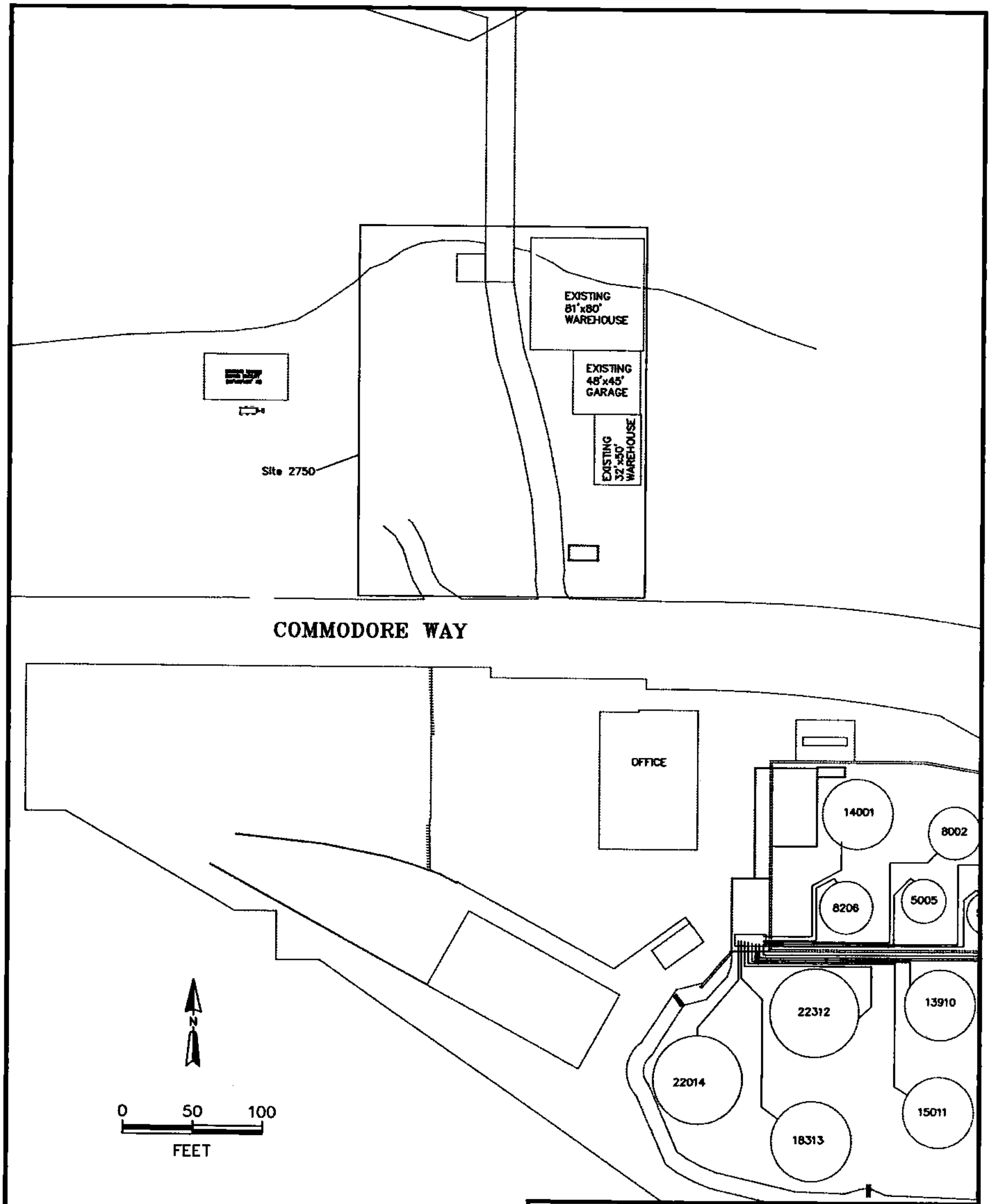
2. PROPERTY LOCATION AND DESCRIPTION

2.1 PROPERTY LOCATION AND LEGAL DESCRIPTION

TOC owns the Property located at 2750 West Commodore Way, Seattle, Washington. The Property is currently leased to George Broom's Sons, Inc. The Property is within section 11, township 25 north, range 3 east, Lawton Park, tax lots 5 through 9 and the eastern portion of tax lot 50.

2.2 PROPERTY DESCRIPTION

Figure 2 shows the layout of the Property. The Property is bounded on the south by West Commodore Way and to the north by the Lake Union Ship Canal. The Property includes a terminal dock area owned and operated by TOC. The Property slopes gently upward toward the south to West Commodore Way. Three structures are located on the Property. The main structure is a wood building (identified as "George Broom's Sons, Inc. Warehouse" on Figure 3) constructed between 1936 and 1946. The warehouse is used to construct marine supplies including tarps, lines, and spool cable. A dock, originally constructed in the late 1930s (Seattle Department of Design, Construction, and Land Use records), extends northward approximately 100 feet from the shoreline into the ship canal and angles westward approximately 150 feet. Immediately south of the Broom's Sons Warehouse is a covered area (identified as a "Garage" on Figure 2) used to store materials. The covered area connects the Broom's Sons Warehouse and a third structure, the TOC warehouse. Fuel lines which connect the dock facility with TOC above ground storage tank farm located south of West Commodore Way are exposed for a short distance as they extend from the



FOSTER WHEELER
ENVIRONMENTAL CORPORATION

Figure 2
Property Layout
2750 West Commodore Way
Seattle, Washington

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dock area. The fuel lines then run at an angle from the west side of the dock, under a wooden driveway, and are exposed on the surface until they pass under West Commodore Way. The western portion of the Property is a gravel parking lot and driveway that leads to West Commodore Way.

According to TOC personnel, a heating oil underground storage tank (UST) may be located near the southwest corner of the TOC warehouse. According to interviews with TOC personnel, the UST is no longer in service. Appendix A contains several photographs taken at the Property.

2.3 ADJOINING PROPERTIES

The area surrounding the Property generally consists of light industrial business, condominiums, and the ship canal. The Property is bounded on the west by the former Icicle Seafoods building (now used by ASKO); to the south by West Commodore Way; to the east by a U.S. Coast Guard facility; and to the north by the ship canal.

2.4 PROPERTY OPERATIONS

George Broom's Sons, Inc. makes canvas tarps and slings, and wire spools for commercial sailing vessels. According to an interview conducted with Mr. George Broom, he does not use any hazardous chemicals on the Property, nor is he familiar with any such products stored in any of the buildings on the Property.

2.5 PROPERTY HISTORY

Information about the history of the Property was derived from a review of available documents, historical photographs, and regulatory records. Former and current employees of TOC were also interviewed.

The Property was acquired by the Time Oil Company in early 1941. Historical photographs (Appendix B) demonstrate a number of changes have taken place at the Property since 1936. Prior to 1936 the Property was the location of a saw mill and kiln. The Rattan Furniture factory was located on the adjacent property to the east. By 1946 the Property had been acquired by TOC and several changes were made including:

- The saw mill and kiln were removed.
- A portion of the Rattan Furniture factory building (81 feet by 80 feet) was moved to the Property (presently occupied by George Broom's Sons). This information was

confirmed in the permit files at the King County Department of Design, Construction, and Land Use.

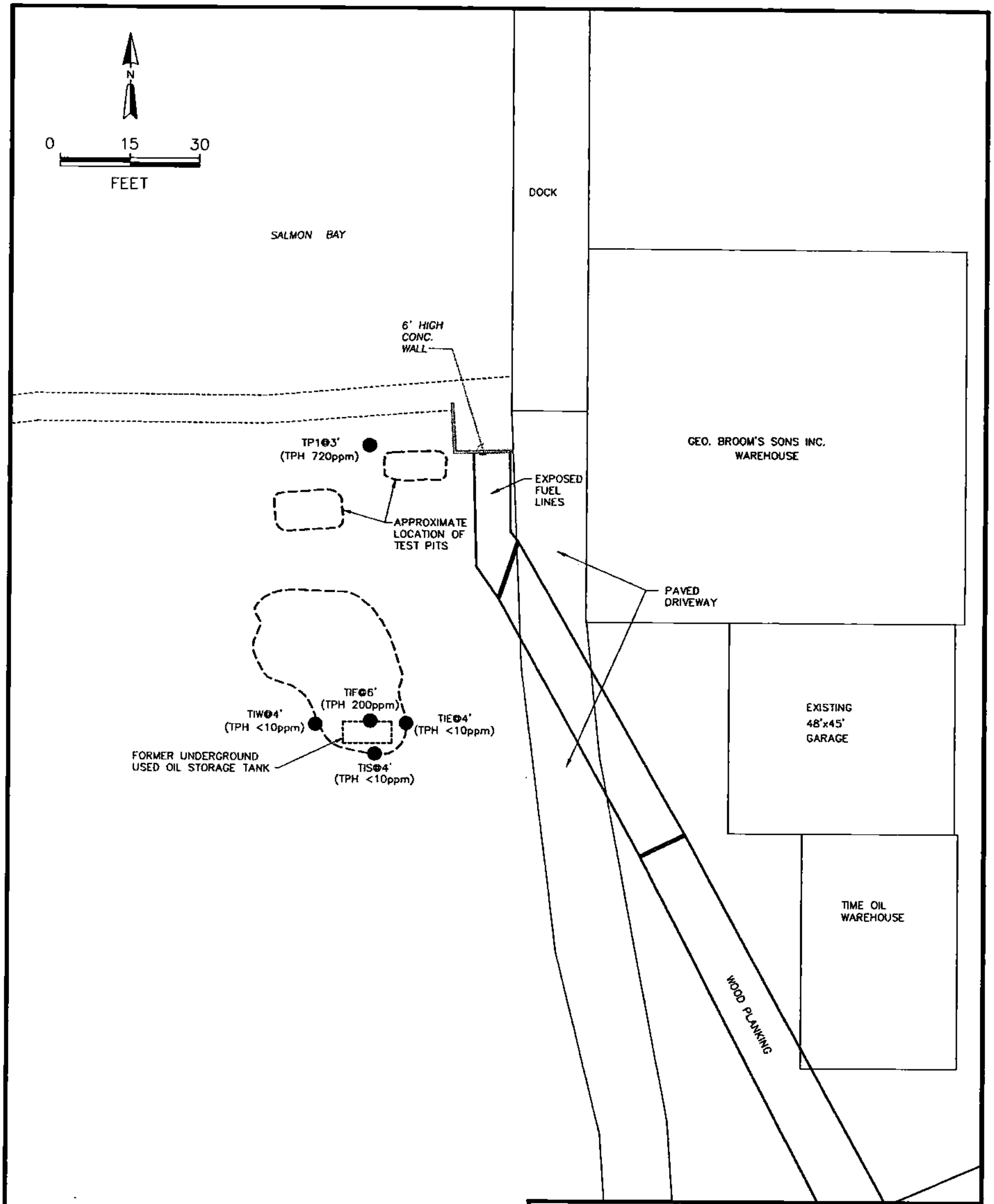
- A vehicle maintenance building was constructed (now a warehouse used by TOC).
- A barrel incline from the TOC facility across the street was added, extending to the end of the dock.
- A series of pipelines connecting the dock to the fuel storage tanks across West Commodore Way was constructed.

By 1960, the barrel incline had been removed and the area between the vehicle maintenance building and the new warehouse was covered. Interviews conducted with TOC personnel confirmed that the barrel incline ran under West Commodore Way and along the western edge of the Property. The photographs from 1974 and 1997 show no discernable change at the Property.

In 1991, a 300-gallon waste oil UST was removed from the Property (TOC, 1991). The installation date of the UST is not known. However, according to TOC interviewees, the UST was used to collect used oil during servicing of Time Oil vehicles. The UST was rusted, pitted, and showed evidence of corrosion. The depth to groundwater within the UST excavation varied from 2 feet to 6 feet below ground surface (bgs).

Hydrocarbon contamination was observed on the walls of the excavation and on the groundwater surface at the time of removal. A test pit was dug between the excavation and the shoreline to assess the lateral extent of contamination. The analytical results from the test pit showed concentrations of diesel and petroleum hydrocarbons at 310 ppm and 410 ppm, respectively. Figure 3 shows the locations of UST excavation and the test pit.

In 1992, a report was submitted to Ecology documenting additional excavation activities associated with the 1991 removal of a 300-gallon waste oil tank (TOC, 1992). As stated above, when the oil tank was originally removed, contaminated soil was observed in the excavation. Soils on the northern and eastern edges of the excavation contained concentrations of petroleum above the Model Toxics Control Act (MTCA) Cleanup Levels. Approximately 150 cubic yards of soil were removed before excavation activities were terminated. In 1992, additional soil excavation activities were implemented in the area of the former UST. The 1992 report concluded that soil containing elevated concentrations of petroleum hydrocarbon remain at the Property and that the groundwater may be impacted. Future assessment was planned at the former UST location. Figure 4 shows the 1992 sampling locations.



LEGEND

TIS@6' ● 1991 Sampling Location

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Figure 3
1991 Sampling Locations
2750 West Commodore Way
Seattle, Washington

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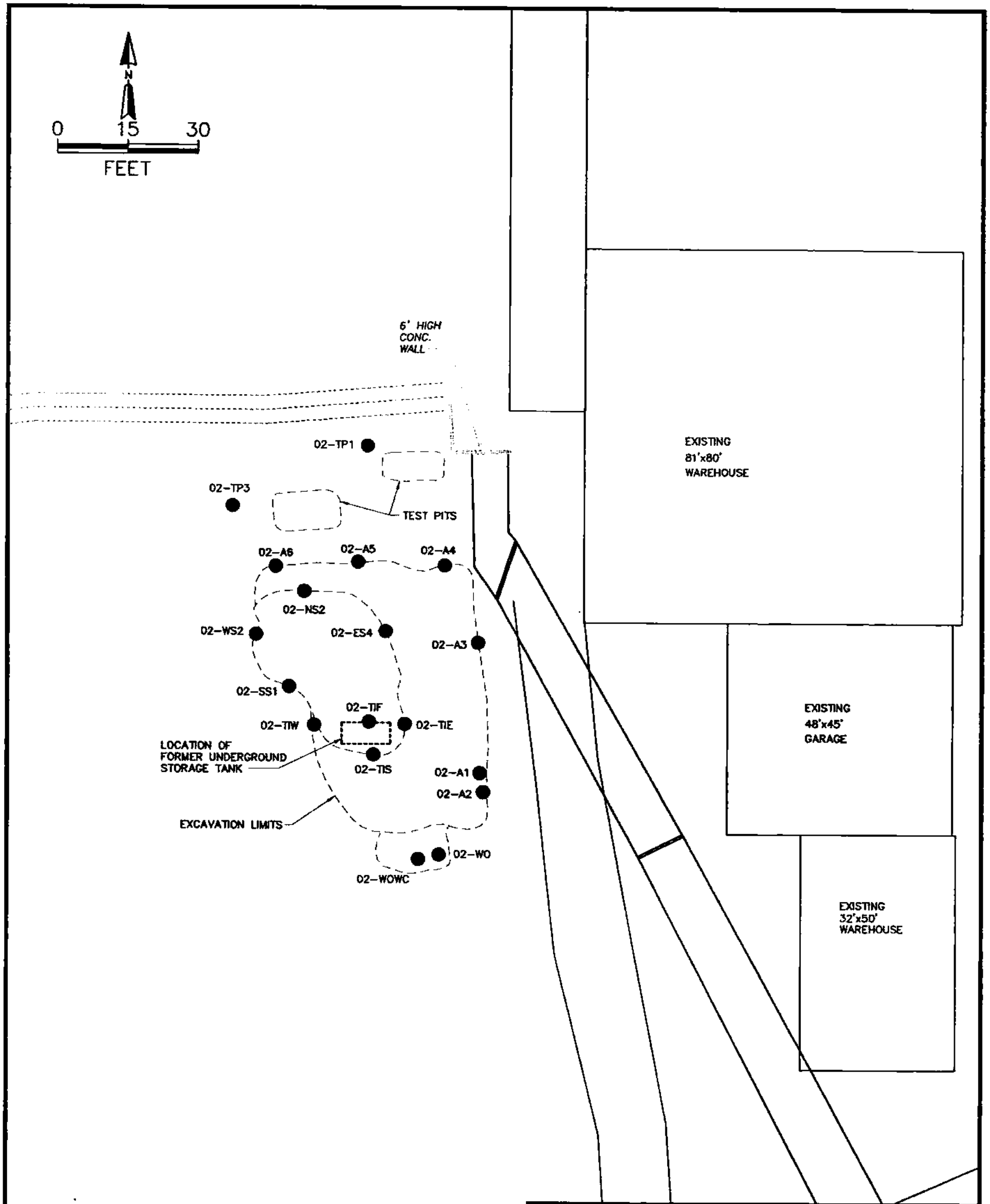

LEGEND

03-W● 1992 Sampling Location

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Figure 4
1992 Sampling Locations
2750 West Commodore Way
Seattle, Washington

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In 1999, additional site assessment activities were conducted at the former UST location including soil borings and groundwater monitoring well installation (IT, 2000). The locations of the 1999 soil borings and groundwater monitoring wells are shown in Figure 5. Soil boring logs included in the IT report indicate that soil in the area of the former UST from the surface to 15 feet bgs is composed of sand and silt layers with varying amounts of clay and gravel. Gravel is present to approximately 10 to 15 feet bgs. Very dense dry clay underlies the sand/silt unit and acts as an aquitard. Two soil samples (02SB-01 at a depth of 3.5 feet bgs and 02SB-01 at 6 feet bgs) contained diesel and heavy oil at concentrations above the MTCA Method A Cleanup Level. A third sample (02SB-08 at 3.5 feet bgs) contained heavy oil above the MTCA Method A Cleanup Level. One sample (02SB-08) down-gradient of the waste oil tank was analyzed for metals, pesticides, PCBs, and volatile organic compounds. No analytes were detected above the method reporting limit or their respective MTCA Method A or Method B guidelines. Groundwater was detected in eight of the nine borings at depths ranging from 6 to 18 feet bgs. Groundwater samples collected from Wells 02MW-01, 02MW-03, and 02MW-04 contained petroleum constituents above the MTCA Method A Cleanup Levels.

Table 1 contains the analytical results of the 1999 groundwater samples and boring water samples that exceeded the cleanup levels. The IT report concluded that the groundwater beneath the Property had been impacted by gasoline (including BTEX). The lateral extent of elevated concentrations of petroleum hydrocarbons has not been defined in the western and eastern directions. The groundwater monitoring well nearest the shoreline (02MW-02) did not contain concentrations of petroleum constituents above the MTCA Method A Cleanup Level.

Table 1. Results from 1999 Groundwater and Boring Water Samples Exceeding Cleanup Levels

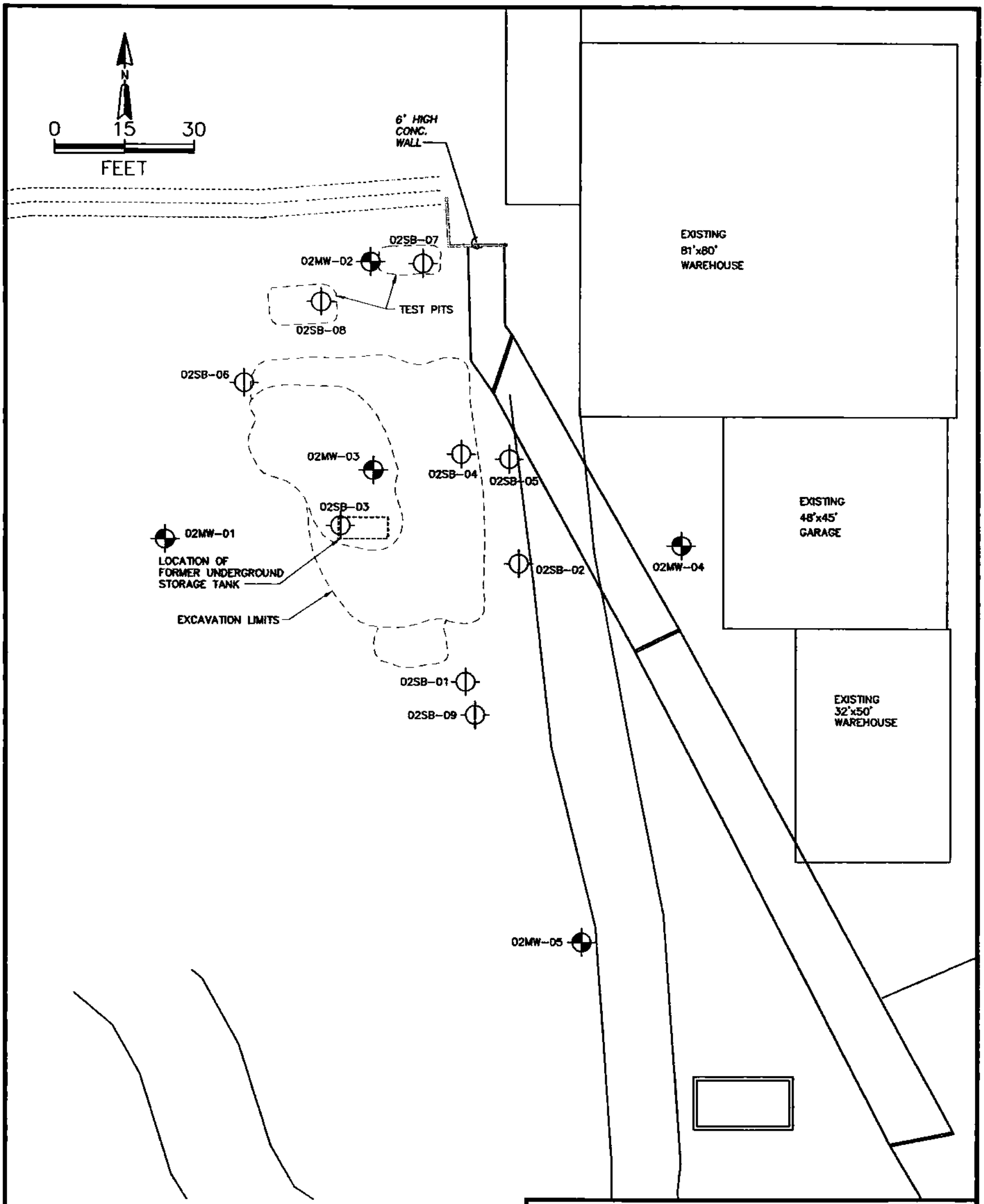
	Date	**Gasoline (mg/L)**	**Diesel (mg/L)**	**Oil (mg/L)**	**Benzene (µg/L)**	**Toluene (µg/L)**	**Ethyl benzene (µg/L)**	**Total Xylene (µg/L)**	**Total Lead (µg/L)**
MTCA[1]		1.0	1.0	1.0	5.0	40.0	30.0	20.0	5.0
02MW-01	9/28/99	0.172	ND (0.25)	ND (0.5)	**72.9**	0.811	ND (0.5)	ND (1.0)	**36**
02MW-02	9/28/99	ND (0.05)	ND (0.25)	ND (0.5)	ND (0.5)	ND (0.5)	ND (0.5)	ND (1.0)	**133**
02MW-03	9/28/99	0.16	ND (0.25)	ND (0.5)	**56.7**	1.13	ND (0.5)	1.14	ND (1.0)
02MW-04	9/28/99	**3.7**	ND (0.25)	ND (0.5)	ND (30.0)	**185**	**226**	**473**	**35.9**
02MW-05	9/28/99	ND (0.05)	ND (0.25)	ND (0.5)	2.84	ND (0.5)	ND (0.5)	ND (1.0)	**86.3**
02SB-02	6/7/99	**8.26**	**3.12**	ND (0.5)	**214**	**155**	**459**	**1110**	--
02SB-03	6/7/99	ND (0.05)	**1.07**	ND (0.5)	**6.64**	1.36	0.617	1.93	--
02SB-04	6/7/99	0.0556	0.867	0.503	**59.8**	2.28	1.62	8.18	--
02SB-05	6/7/99	0.685	0.865	ND (0.5)	**19.9**	4.18	19.9	**20.2**	--
02SB-07	6/7/99	ND (0.05)	**1.07**	0.626	ND (0.5)	ND (0.5)	ND (0.5)	ND (1.0)	--
02SB-09	6/11/99	**1.36**	0.617	ND (0.5)	**639**	1.89	1.31	9.66	--

[1/] MTCA Cleanup Levels in 1999

Results exceeding cleanup levels are bolded

ND – not detected above method reporting limit (reporting limit in parentheses)

-- no analysis conducted



LEGEND

03SB-09 ⌽ Soil Boring

02MW-01 ⊕ Monitoring Well

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Figure 5
1999 Sampling Locations
2750 West Commodore Way
Seattle, Washington

In May 2000, TOC submitted a letter (TOC, 2000) to Mr. Joe Hickey of Ecology's UST division summarizing previous field activities. In the letter, TOC also indicated that future assessment of the extent of contamination beneath the Property would be conducted.

3. RESULTS OF INVESTIGATION AND RECORDS REVIEW

3.1 PROPERTY INSPECTION OBSERVATIONS

On June 6, 2000, Foster Wheeler Environmental conducted a reconnaissance of the Property. The purpose of the visit was to obtain information relating to recognized environmental conditions, if any, associated with the Property.

In general, the facility was well kept. The inside of the buildings were clean, and no chemicals or potential contaminants of concern were observed. As noted above, Mr. George Broom stated that there are no chemicals and/or solvents used in the building he leases from TOC. The area surrounding the buildings was clear of debris and also well kept. Wire, spools, and hose are stored under the George Broom's Sons warehouse on the ground surface.

3.2 RECORDS REVIEW

Because all of the properties for which Phase I ESAs were conducted are within close proximity to one another, one central point (the TOC property at 2737 West Commodore Way) was used for the database search. The Phase I database search was performed by EDR, Inc. EDR searched readily available state, federal, regional, and local agency database listings. The results of the database search are presented in the following subsections. The entire EDR report is presented in the ESA for 2737 West Commodore Way (Foster Wheeler Environmental, 2000). As specified in ASTM Standard E 1527-97, the following government records were reviewed:

- EPA National Priorities List (NPL) within 1.0 mile
- EPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) within ½ mile
- EPA Resource Conservation and Recovery Act (RCRA) Corrective Action Reports (CORRACTS) within 1.0 mile
- EPA RCRA non-CORRACTS Treatment, Storage, and Dispoal Facilities within ½ mile
- EPA RCRA generators list on the Property and adjoining properties

- Federal Emergency Response Notification System (ERNS) list on the Property
- State Hazardous Waste Site List within 1.0 mile
- Leaking Underground Storage Tanks (LUST) list within ½ mile
- State Registered UST list on the Property and adjoining properties
- Solid Waste/Landfills within ½ mile.

3.2.1 EPA National Priorities List (NPL)

The NPL identifies federal Superfund Sites with the highest priority for cleanup. ASTM Standards require the identification of NPL sites within 1 mile of the subject property. There were no NPL sites identified within a 1-mile radius of the Property.

3.2.2 EPA Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS)

The CERCLIS list identifies sites that the EPA has investigated or is in the process of investigating for potential hazardous substance contamination. A CERCLIS site may or may not become an NPL site. ASTM Standards require the identification of CERCLIS sites within ½ mile of the subject property. The EDR report did not identify any CERCLIS sites within a ½ mile radius of the Property.

3.2.3 EPA Resource Conservation and Recovery Act (RCRA) Corrective Action Reports (CORRACTS)

RCRA tracks the status and filing of any corrective actions that have taken place at a facility. The ASTM Standards require the identification of RCRA CORRACTS facilities within 1 mile of the subject property. The EDR report did not identify any such facilities within a 1-mile radius of the Property.

3.2.4 EPA RCRA non-CORRACTS Treatment, Storage, and Disposal Facilities

RCRA non-CORRACTS Treatment, Storage, and Disposal (TSD) Facilities are those facilities on which treatment, storage, and/or disposal of hazardous wastes takes place and at which corrective remedial action has not been required by EPA, as defined and regulated by RCRA. The ASTM Standards require the identification of RCRA non-CORRACTS TSD Facilities within ½ mile of the subject property. This information is listed in the EDR report under the heading of Resource Conservation and Recovery Information System (RCRIS)

TSD Facilities, which are substantively the same. The EDR report did not identify any such facilities within ½ mile of the Property.

3.2.5 EPA RCRA Generators List

The ASTM Standards require the identification of RCRA generators on or adjacent to the subject property. RCRIS includes information on facilities that generate, transport, store, treat and/or dispose of hazardous wastes as defined and regulated by RCRA, and as listed in the EDR report. The EDR report showed 11 RCRIS small quantity generators (SQGs) within ¼ mile of the site. The SQGs include:

• Aickinstrut Incorporated	2901 West Commodore Way
• ASKO Hydraulic Repair	2805 West Commodore Way
• Icicle Seafoods, Inc. (no longer in operation)	2752 West Commodore Way (also listed as 2770 West Commodore Way)
• Northwest Awning Fabric, Inc.	2600 West Commodore Way
• Tosco Corp. Seattle Terminal	2740 West Commodore Way
• Seattle Port Maritime Industries	2700 West Commodore Way
• U.S. DOT CG Support Center	2700 West Commodore Way
• Sea Coast Towing, Inc.	2700 West Commodore Way
• Rapp Hydema U.S., Inc.	4433 27th Avenue West
• Abella Woodworking, Inc.	2600 West Commodore Way
• Gilman Pl Waste Pain	4439 Gilman PL W

3.2.6 Federal Emergency Response Notification System (ERNS) List

The ERNS list records and stores information on reported releases of oil and hazardous substances. The ASTM Standards require the identification of ERNS on the subject property. The EDR report did not identify the Property as appearing on the ERNS List.

3.2.7 State Hazardous Waste List

The State of Washington lists potential or confirmed hazardous substance release properties on Ecology's Confirmed and Suspected Contaminated Sites List (CSCSL) Database. The ASTM Standard requires the identification of these sites within 1 mile of the subject property. There were 20 sites on the CSCSL identified within 1 mile of the Property. The sites listed on the EDR report are:

• Springer Dave	4459 26th Avenue West
• Washington Marine Engine Co.	4403 24th Avenue West (listed twice on database)

• U.S. Army Corps of Engineers	3015 NW 54th Street
• Dyno Battery Co.	4248 23rd Avenue West
• NW Market Street Site	2801 NW Market Street
• Salmon Bay Center	5301-5309 Shilshole Avenue
• Weiman Property	5332 Ballard Avenue NW
• Thordarson Property	2200 West Emerson Place
• Chevron 60090968	2021 NW Market Street
• Ballard Auto Wrecking	1515 NW Leary Way
• Ballard Recycling	1509 NW 49th Street
• Interbay Prints	1809 West Emerson
• Discovery Park Old Maint Yd.	Discovery Park 40th West
• The Tux Shop	5409 15th Avenue NW
• Mamco MFG Bldg.	1415/1427 NW 49th Street (listed twice on database)
• General Disposal Corp.	1415 NW Ballard Way
• Bardahl	1400 NW 52nd Street
• Anderson Marine Repair	2360 West Commodore Way

3.2.8 EPA Leaking Underground Storage Tank (LUST) Sites

The LUST list shows the sites containing one or more underground storage tanks that have been identified as having leaked or as potentially leaking their contents into the ground or groundwater. The ASTM Standards require the identification of LUST sites within ½ mile of the subject property. There are eight LUST Sites within ½ mile of the Property. The sites listed in the EDR report are:

• Time Oil Co.	2754 West Commodore Way
• Time Oil Co.	2750 West Commodore Way
• USCG Support Center	2700 West Commodore Way
• Time Oil Co.	3031 West Commodore Way
• Ric's Automotive and Texaco	3317 West Government Way
• Hiram Chittenden Locks	3015 Northwest 54th Street
• Northwest Market Street	2801 NW Market Street
• Sabroe Refrigeration, Inc.	4401 23rd Avenue West

The UST shown at 2754 West Commodore Way is the same UST as the UST at 2752 West Commodore Way (the Property). An administrative error has listed the UST with two addresses. This LUST site and the 2750 Property will continue to appear on this list until Ecology reviews the Property and closes the case.

3.2.9 EPA Underground Storage Tank (UST) Sites

The UST list shows the sites containing one or more underground storage tanks that have been identified as being located on the subject property. The ASTM Standards require the identification of USTs on the subject property and adjoining properties. There are five USTs within ¼ mile of the Property. The sites listed in the EDR report are:

• Time Oil Co.	2754 West Commodore Way
• Time Oil Co.	2752 West Commodore Way
• USCG Support Center	2700 West Commodore Way
• Time Oil Co.	3031 West Commodore Way
• Northwest Instrument Co.	2525 West Commodore Way

The UST shown at 2754 West Commodore Way is the same UST as the former UST at 2752 West Commodore Way (the Property). An administrative error has listed the UST with two addresses. The UST will continue to appear on this list until Ecology reviews the Property and closes the case.

3.2.10 Solid Waste/Landfill Facilities

Solid waste/landfill facilities are those sites that currently accept, or have accepted in the past, waste of any kind for disposal on site. The ASTM Standards require the identification of solid waste/landfill sites within ½ mile of the subject property. The EDR report did not list any such sites within ½ mile of the Property.

4. CONCLUSIONS AND RECOMMENDATIONS

Foster Wheeler Environmental conducted a Phase I ESA of the Property at 2750 West Commodore Way, Seattle, Washington. The purpose of this Phase I ESA was to identify, to the extent feasible pursuant to the processes described herein, recognized environmental conditions, if any, associated with the Property. Our findings are summarized below.

According to the current tenant and TOC, the Property has been used for light industrial activities (canvas tarp and sling preparation) since 1974. Remedial actions were conducted in 1991 (UST removal), 1992 (soil excavation), and 1999 (additional site characterization).

The results of these investigations indicate that petroleum-impacted soil and groundwater are present beneath the Property and that additional site assessment activities may be necessary to determine the full lateral and vertical extent of elevated concentrations of petroleum hydrocarbons is soil and groundwater.

Foster Wheeler Environmental recommends that additional site investigation activities be conducted in the vicinity of the former waste oil UST. Based on the previous reports, the eastern and western extent of petroleum impacted soil and groundwater has not been fully defined. Foster Wheeler Environmental recommends the following activities be conducted:

Groundwater Sampling of Existing Groundwater Monitoring Wells

- Obtain groundwater samples from each of the five existing groundwater monitoring wells
- Submit groundwater samples for laboratory analysis for the following parameters:
    - Total petroleum hydrocarbons—gasoline
    - Total petroleum hydrocarbons—diesel and residual range organics (heavy oils)
    - Volatile organic compounds
    - Total dissolved lead

Based on the results of this sampling, the need for additional groundwater monitoring well installation should be evaluated.

4.1 LIMITATIONS

This report is prepared for the sole use of TOC, pursuant to their contract with Foster Wheeler Environmental. The scope of work and the findings should not be considered suitable for other potential users, and any use by other parties shall be at their sole risk.

This report is based on the review of limited data, as described herein, in accordance with generally accepted professional practices, applicable to work of similar nature and complexity in similar localities, at the time the services were performed. No warranty, expressed or implied, is made. The scope of this report is limited in nature and intended to provide a preliminary evaluation of the current conspicuous environmental conditions at the Property at the time of the report. It does not constitute definitive or in-depth review of all the potential environmental impairments and situations. Foster Wheeler Environmental assumes no responsibility for conditions of which it is unaware and/or as to which there was no opportunity or request for review.

It is important to recognize that even the most comprehensive scope of services may not detect all the environmental liabilities at a particular Property. Therefore, nothing herein shall be construed as a representation or certification that the Property is either fully characterized or is free of environmental impairments and/or contamination.

In order to conduct the investigation for this report, Foster Wheeler Environmental relied upon readily available information, as discussed in the report and, unless explicitly included in our scope, included no verification of the accuracy or completeness of documentation or data or possible withholding of information by the interviewees, agencies, or other parties. [Please also refer to the EDR Disclaimer.]

5. REFERENCES

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TOC. 2000. Transmittal of Site Assessment Report, Time Oil Co. Property No. 01-425; Former Used Motor Oil UST, 2750 West Commodore Way; Seattle, Washington. May 30, 2000.

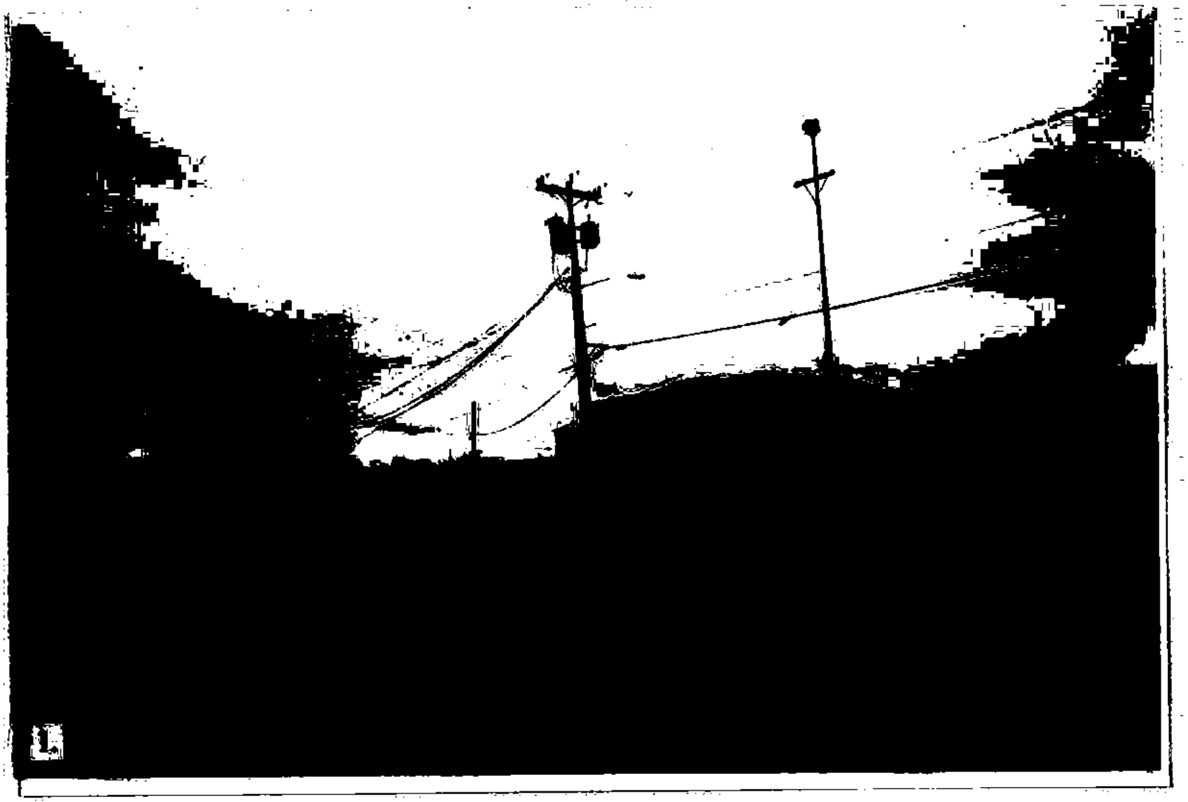
Washington State Department of Ecology Web Site. Downloaded on May 12, 2000. Facility/Site Identification System. www.wa.gov/ecology/iss/fsweb/fshelp.html.

APPENDIX A

PROPERTY PHOTOGRAPHS

Property Photographs: 2750 West Commodore Way

1. Looking southeast at former TOC laboratory, tank farm, and office building.
2. Looking east at roof of former vehicle maintenance facility. Coast Guard building in background.
3. Looking northeast, covered area between buildings.
4. Looking north at George Broom's Sons building.
5. Looking north at TOC pipeline leading onto TOC dock.
6. Looking southeast at TOC pipeline on 2750 West Commodore Way.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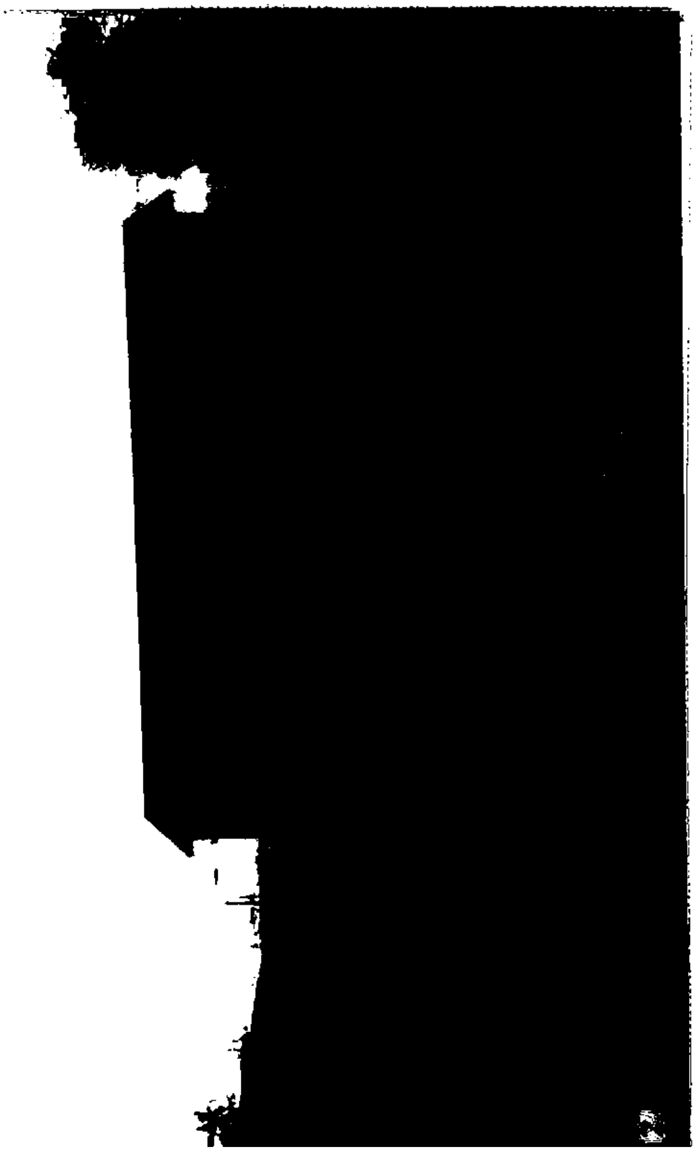
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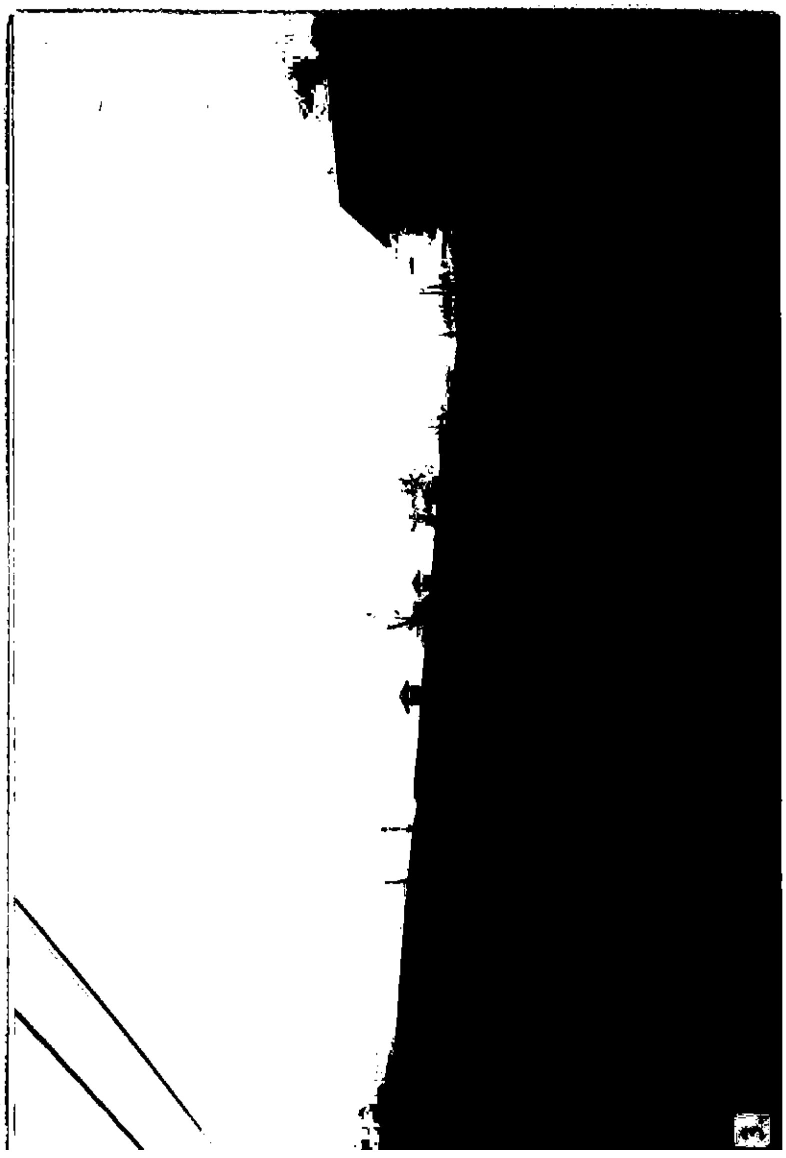
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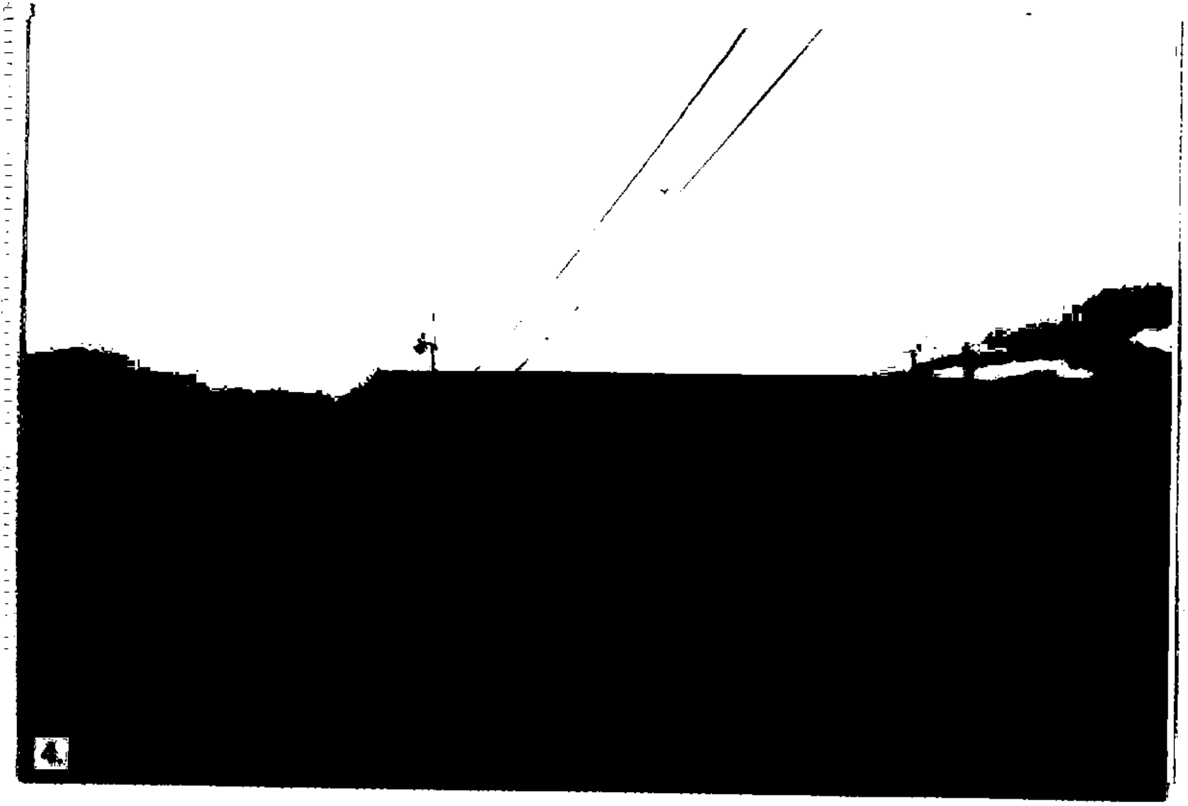

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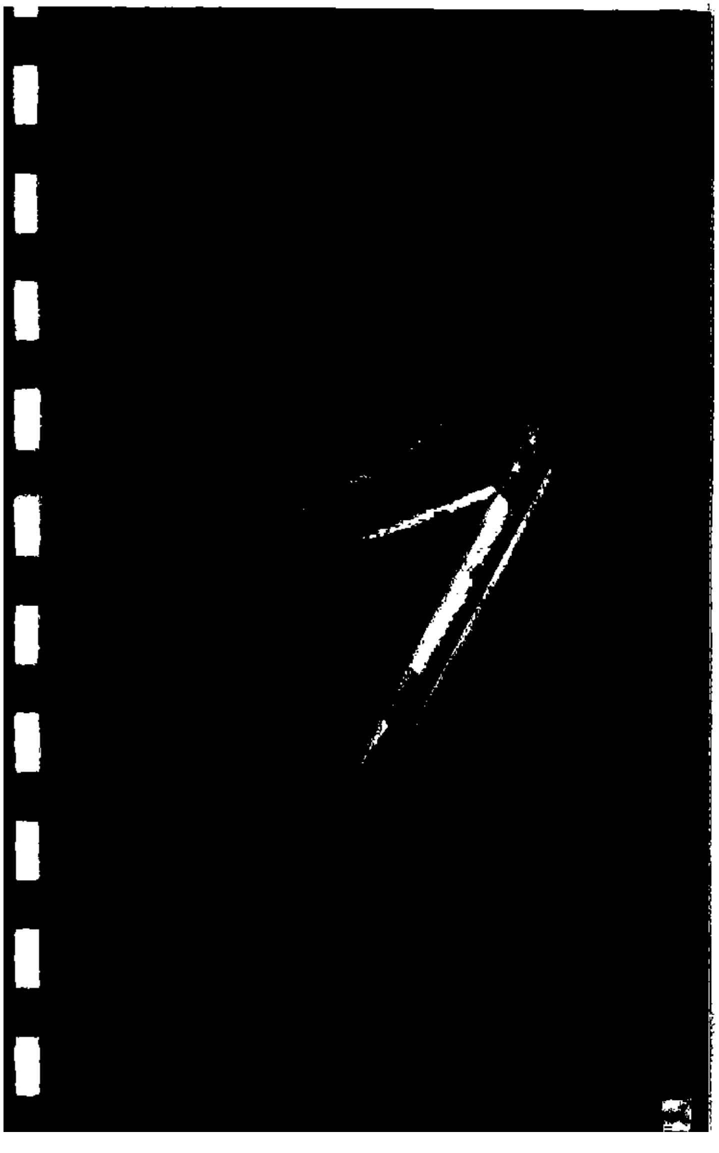

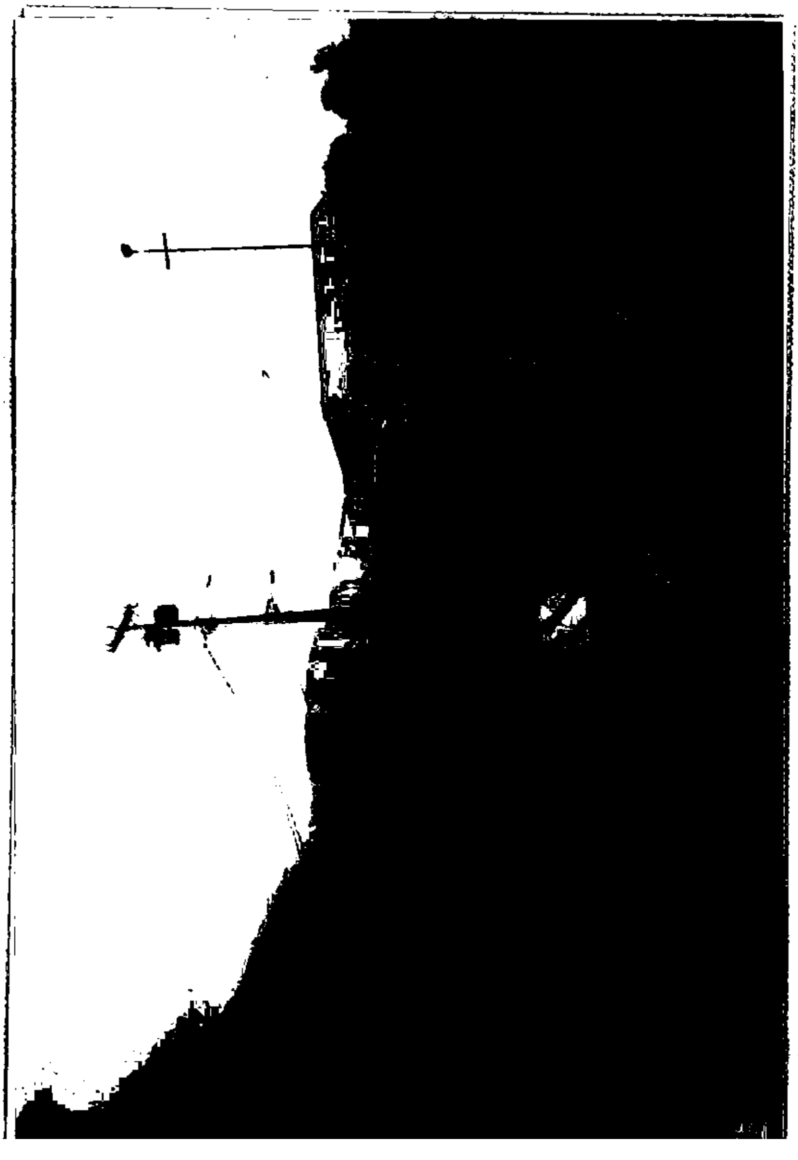

APPENDIX B

HISTORICAL PHOTOGRAPHS

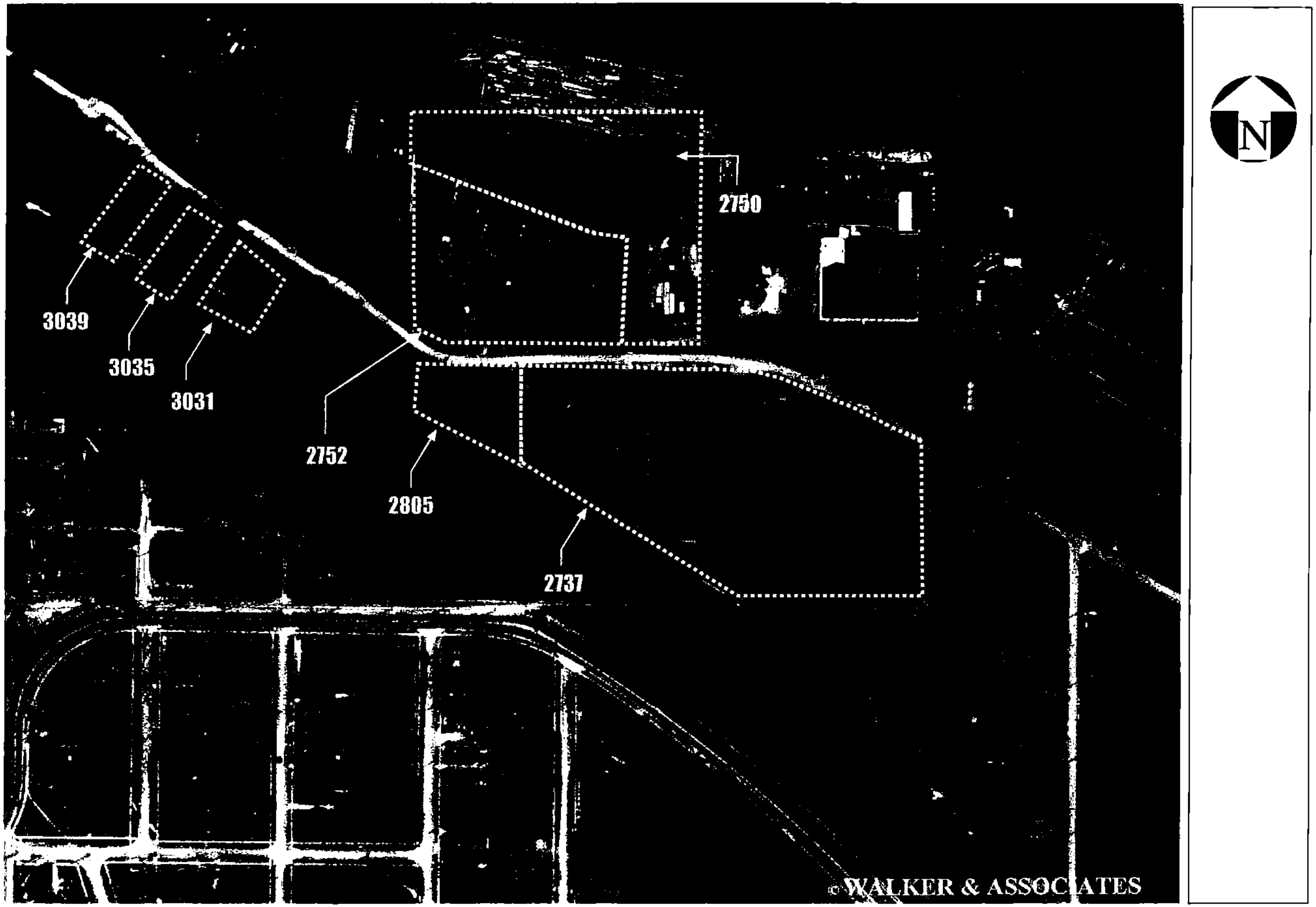

Figure B-1 Aerial Photo of West Commodore Way (1936)

Figure B-2 Aerial Photo of West Commodore Way (1946)

Figure B-3 Aerial Photo of West Commodore Way (1960)

Figure B-4 Aerial Photo of West Commodore Way (1974)

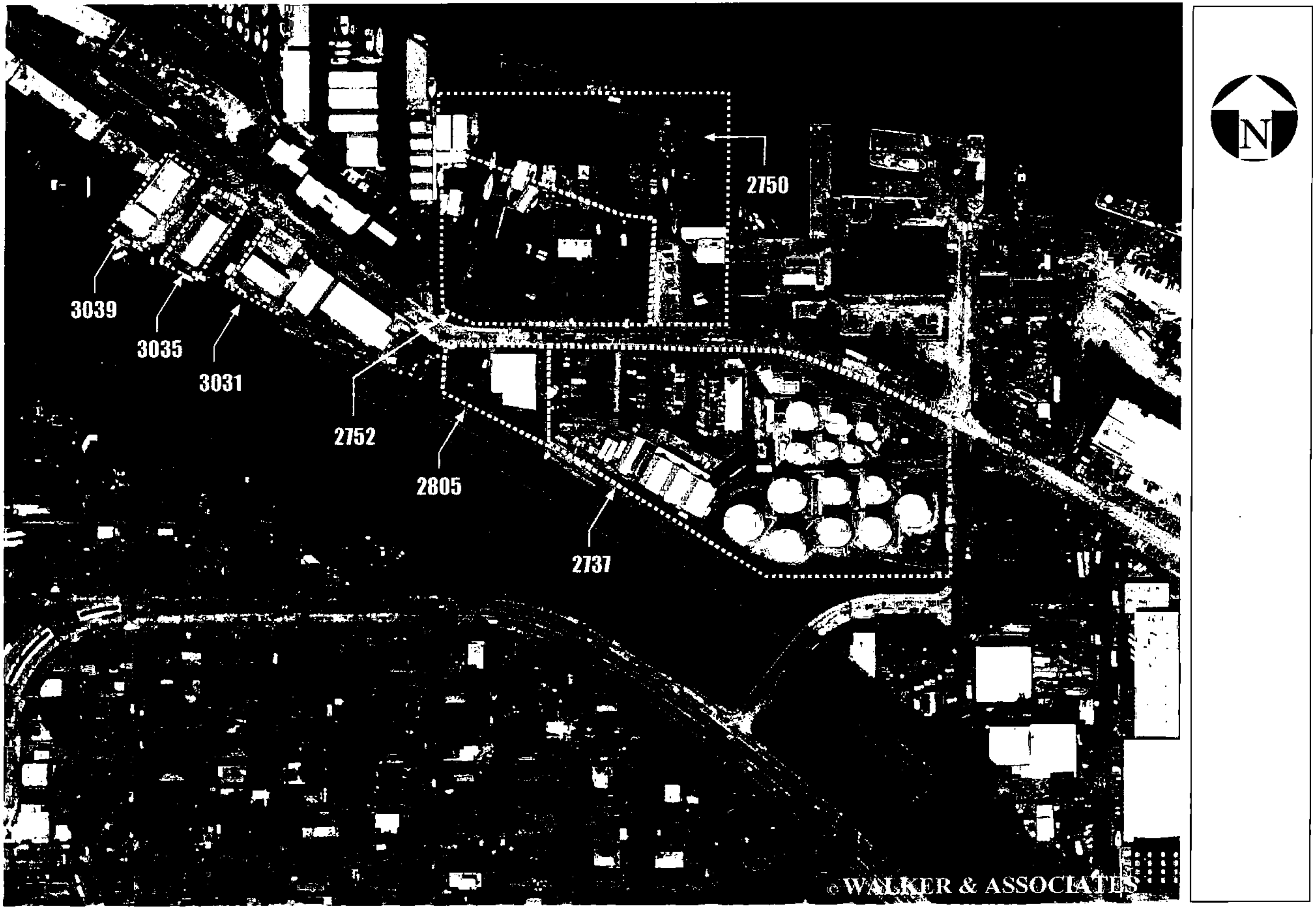

Figure B-5 Aerial Photo of West Commodore Way (1997)

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

Concentrations of Chemical Contaminants and Bioassay Response to Sediments in Salmon Bay, Seattle

Results of Phase III Sampling

December 2000

Publication No. 00-03-053
printed on recycled paper

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Concentrations of Chemical Contaminants and Bioassay Response to Sediments in Salmon Bay, Seattle

Results of Phase III Sampling

by
Dave Serdar, James Cubbage, and Dave Rogowski

Environmental Assessment Program
Olympia, Washington 98504-7710

December 2000

Waterbody No. WA-08-9340

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Table of Contents

List of Figures and Tables

Abstract

Ecology's Environmental Assessment Program has conducted a multi-phase study of Salmon Bay sediments to facilitate cleanup efforts by Ecology's Toxics Cleanup Program. Phase I and Phase II examined physical characteristics and toxic contaminants of Salmon Bay sediments on a broad geographical scale. Objectives of this Phase III study were to assess toxicity of sediments, delineate boundaries of highly contaminated areas, and confirm sediment contamination found during the Phase II study.

Bottom sediments were collected from 27 locations throughout Salmon Bay and two reference locations in Lake Washington. Samples were analyzed for conventional parameters, metals, semivolatile organics, and butyltins. Polychlorinated biphenyls (PCBs) were sampled in areas of known contamination. Toxicity was assessed through *Hyalella azteca* survival, *Chironomus tentans* growth and survival, and Microtox®. Potential toxicity of the sediments was assessed by comparing chemistry to Freshwater Sediment Quality Values (FSQVs) and the Puget Sound Dredge Disposal Analysis screening level (SL) for tributyltin (TBT).

Results confirmed widespread chemical contamination in Salmon Bay found during the Phase II study. TBT, mercury, bis(2-ethylhexyl)phthalate, indeno(1,2,3-cd)pyrene, and carbazole appear to be the most pervasive problem chemicals based on comparisons to the SL and FSQVs. Zinc, copper, arsenic, lead, chromium, and polycyclic aromatic hydrocarbons also exceeded FSQVs. At least one chemical was detected above FSQVs in 23 of the 27 samples. TBT concentrations were above the SL in 26 of the 27 Salmon Bay sediments.

Ninety percent of the Salmon Bay samples were toxic to at least one bioassay organism. The *Chironomus* growth test was the most sensitive bioassay, followed by Microtox®, *Hyalella* survival, and *Chironomus* survival. Results suggest that the number of organic chemicals exceeding FSQVs was more closely related to toxicity than to the degree of metals contamination.

The distribution of contaminants in Salmon Bay could be characterized by "hot-spots" generally occurring near shore, with cleaner sediments toward the channel center. In most cases, hot-spots detected during Phase II were verified by this survey. However, the sample coverage was too thin to delineate hot-spot boundaries. Therefore, it is recommended that future sampling be designed to delineate hot-spots by focusing on the most contaminated Phase III stations individually.

Acknowledgements

The authors would like to thank the following people for their contributions to this study:

- ◊ Rick Huey and Joanne Polayse-Wien for help with field sampling.
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- ◊ Dale Norton and Nigel Blakely for reviewing the report.
- ◊ Joan LeTourneau for final report formatting and editing.

Introduction

Background

Salmon Bay and the Lake Washington Ship Canal comprise a narrow body of water in Seattle, Washington, connecting Lake Union to the east with Puget Sound to the west through the Hiram Chittenden Locks (Figure 1). Salmon Bay was originally a saltwater bay, but was inundated with freshwater in 1914 when the locks were constructed to the west of Salmon Bay and connected the bay to Lake Union through the Lake Union Ship Canal. The Ship Canal is a narrow channel with some shallow embayments on the southern shoreline near the west end of the canal.

Numerous industries have been located along the shores of Salmon Bay and the Ship Canal, including shipyards, marinas, bulk fuel plants, fish processing, wood treating, lumber mills and plywood plants, bulk materials handling facilities, a large steel manufacturing plant, and an asphalt plant. In addition, stormwater from urban areas, the Ballard and Fremont bridges, and combined sewer overflows (CSOs) discharge into the Ship Canal and Salmon Bay. These various sources have contributed to sediment contamination in Salmon Bay and the west end of the Ship Canal, but the nature, extent, and sources of contamination are not well defined. This lack of information has hampered attempts at source control and sediment cleanup in this area.

Recently, contamination of Salmon Bay sediments has been addressed in a three-phase study conducted by Ecology's Environmental Assessment Program (formerly Environmental Investigations and Laboratory Services Program).

1. Phase I reconnaissance sampling was completed during 1995 and consisted of visual examination of sediments from 81 stations evenly distributed throughout Salmon Bay and the Ship Canal (Michelsen, 1995). Samples were inspected for grain size (e.g., sand, silt, clay), evidence of contamination (oil, wood debris, paint chips), and biological organisms. Results were used to differentiate areas with probable contamination and those unlikely to contain high levels of contaminants.

2. Phase II, also conducted during 1995, included chemical analyses from 29 stations distributed throughout Salmon Bay based on Phase I results (Serdar and Cubbage, 1996). Chemicals analyzed included metals, semivolatile organics, PCBs, and butyltins. Most of the 29 stations sampled during the Phase II study had at least one chemical above criteria recommended for the protection of aquatic life, with several stations exceeding criteria for multiple chemicals. Problem chemicals included copper, mercury, lead, arsenic, zinc, chromium, benzyl alcohol, 4-methylphenol, bis(2-ethylhexyl)phthalate, PAHs, and PCB-1260. Tributyltin (TBT) was judged to be a significant concern at many stations due to its exceedence of the Puget Sound Dredge Disposal Analysis screening level.

   Although a number of stations showed significant sediment contamination during the Phase II study, cleanup decisions remain difficult because Ecology has not yet formally adopted chemical standards for freshwater sediment. In the absence of chemical standards, biological toxicity testing may be used to determine the need for cleanup and/or source control.

3. Phase III study of Salmon Bay was conducted to assess the toxicity of sediments and delineate potential contaminated areas using sediment bioassays and chemical analyses in order to facilitate cleanup and source control efforts. Results of the Phase III study are the focus of this report.

Objectives of the Phase III Study

The primary objectives of the present study are as follows:

- Confirm and delineate areas of clean and contaminated sediment in Salmon Bay and nearshore areas of the Ship Canal found during the Phase II study.
- Evaluate the toxicity of these problem areas with sediment bioassays and assess the potential for sediments to be toxic, by comparison to chemical criteria recommended to protect aquatic life.
- To the extent possible, identify the contaminants contributing to sediment toxicity in the problem areas, including an evaluation of butyltins to determine whether this class of contaminants should be included in routine (e.g., National Pollutant Discharge Elimination System, NPDES) sediment analyses for Lake Union and the Ship Canal.
- To the extent possible, identify likely historical and current sources of contaminants to these problem areas.

The Salmon Bay study benefits cleanup and source control programs by:

- Identifying areas that require remediation, with recommendations and some indication of their relative priority. In addition, the data may provide adequate evidence to allow cleanup of some offshore areas within existing Model Toxics Control Act (MTCA) and Resource Conservation and Recovery Act (RCRA) actions at related upland facilities.
- Streamlining dredging, construction, and NPDES permit processing for areas that are identified as “clean”. The results may also provide justification for discharge and baseline sediment monitoring as part of the NPDES permitting program for areas that are identified as contaminated.
- Beginning to identify areas that require additional stormwater or CSO control to prevent recontamination of areas targeted for dredging or cleanup.
- Contributing synoptic chemistry and bioassay data to help evaluate the toxicity of butyltin compounds, with the eventual goal of establishing apparent effects thresholds (AETs) for these compounds.

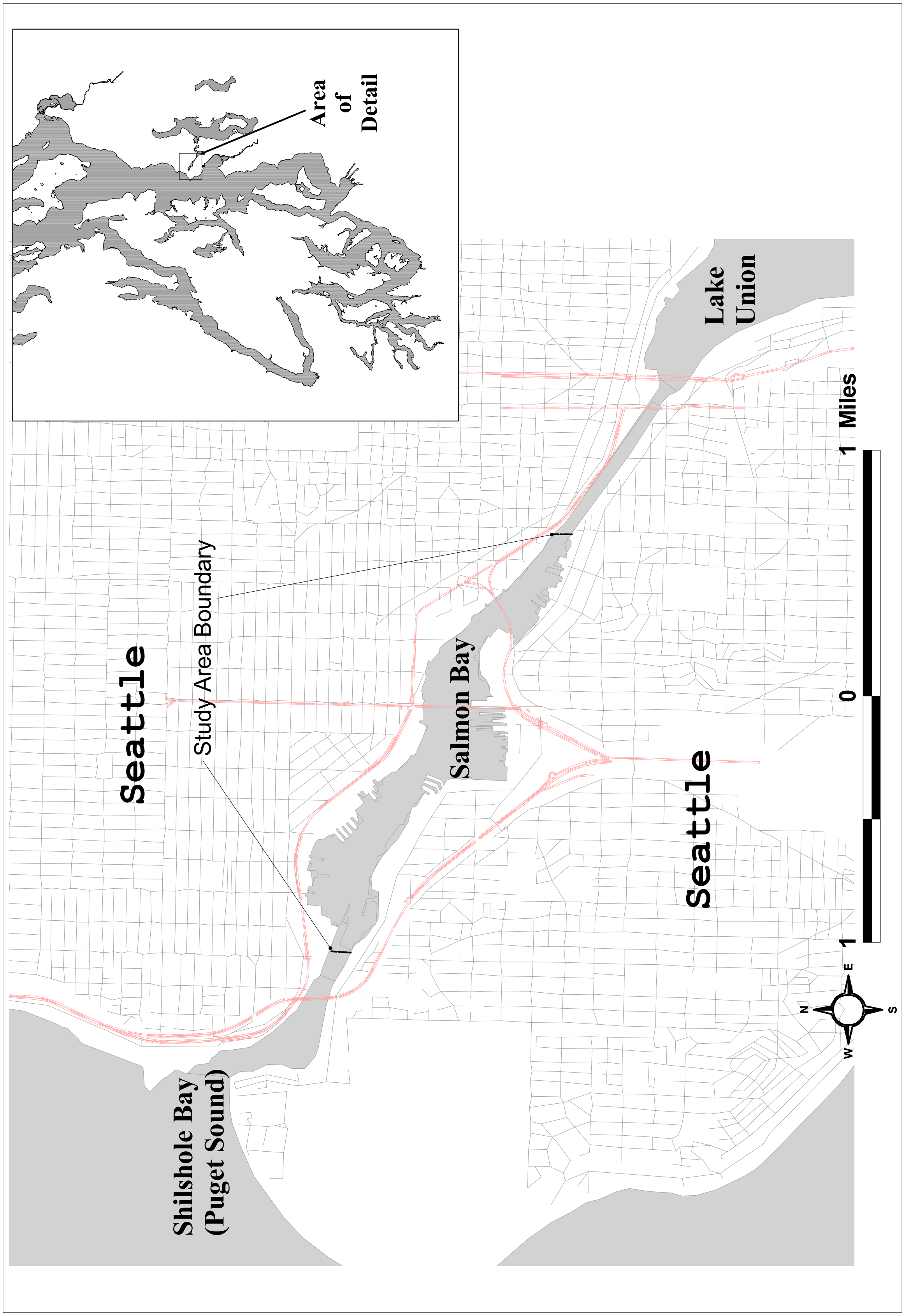

Figure 1. Salmon Bay and Vicinity.

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Methods

Sampling Strategy

Chemical analyses was performed on bottom sediments from 27 locations throughout Salmon Bay and two reference locations in Lake Washington; bioassays were performed on a subset of 20 Salmon Bay sediments and the reference samples. The study area extends from the locks (on the west) to the western end of the Ship Canal (on the east).

Results of the reconnaissance (Phase I) study indicated that most sediments in the vicinity of the eastern Ship Canal are coarse-grained which suggests little deposition of fine material. Little visible oil or other evidence of contamination was seen in this area as well. Based on these observations, this area was excluded from further investigation during Phases II and III.

Phase II revealed several highly contaminated areas in Salmon Bay. Because the Sediment Management Standards (SMS; Ecology, 1991) require at least three stations for any regulatory decisions, three or more stations were grouped in each major area of concern or natural geographical feature for Phase III (Figure 2). These zones were chosen to represent groups of industries and CSOs or areas that may have similar contaminant levels (e.g., the central channel). A description of each sampling station is in Appendix A.

Sampling Methods

Sampling methods were consistent with the Puget Sound Estuary Program (PSEP) protocols (EPA, 1986a) as modified by the SMS and sampling methods used during Phase II and previous Lake Union and Lake Washington studies conducted by Ecology. However, to support evaluation of historical contamination and the cleanup program, the top 10 cm of sediment was sampled. This layer includes most of the biologically active zone in freshwater.

Samples were collected from Ecology's 20-foot skiff equipped with a 0.1 m^2 stainless steel Van Veen grab sampler. Stations were recorded using a Magellan® GPS (Global Positioning System) receiver with differential correction as well as from sightings on nearby landmarks. Datasheets were used at grab stations to log samples (number of grabs, observations, samples collected) and at the helm to log position with reference to landmarks. A grab was considered adequate if it was filled with sediment and both the grab and access doors on top of the grab were closed tightly (see PSEP protocols for full description). For each grab, the overlying water was siphoned off and the top 10 cm of sediment not touching the walls of the grab was scooped out of the top doors and placed in a stainless steel beaker.

To prevent contamination from boat engine exhaust, the boat was maneuvered so the stern was downwind of sampling gear. To prevent sample cross-contamination, sites were sampled in a gradient from lowest suspected concentration of contaminants to highest.

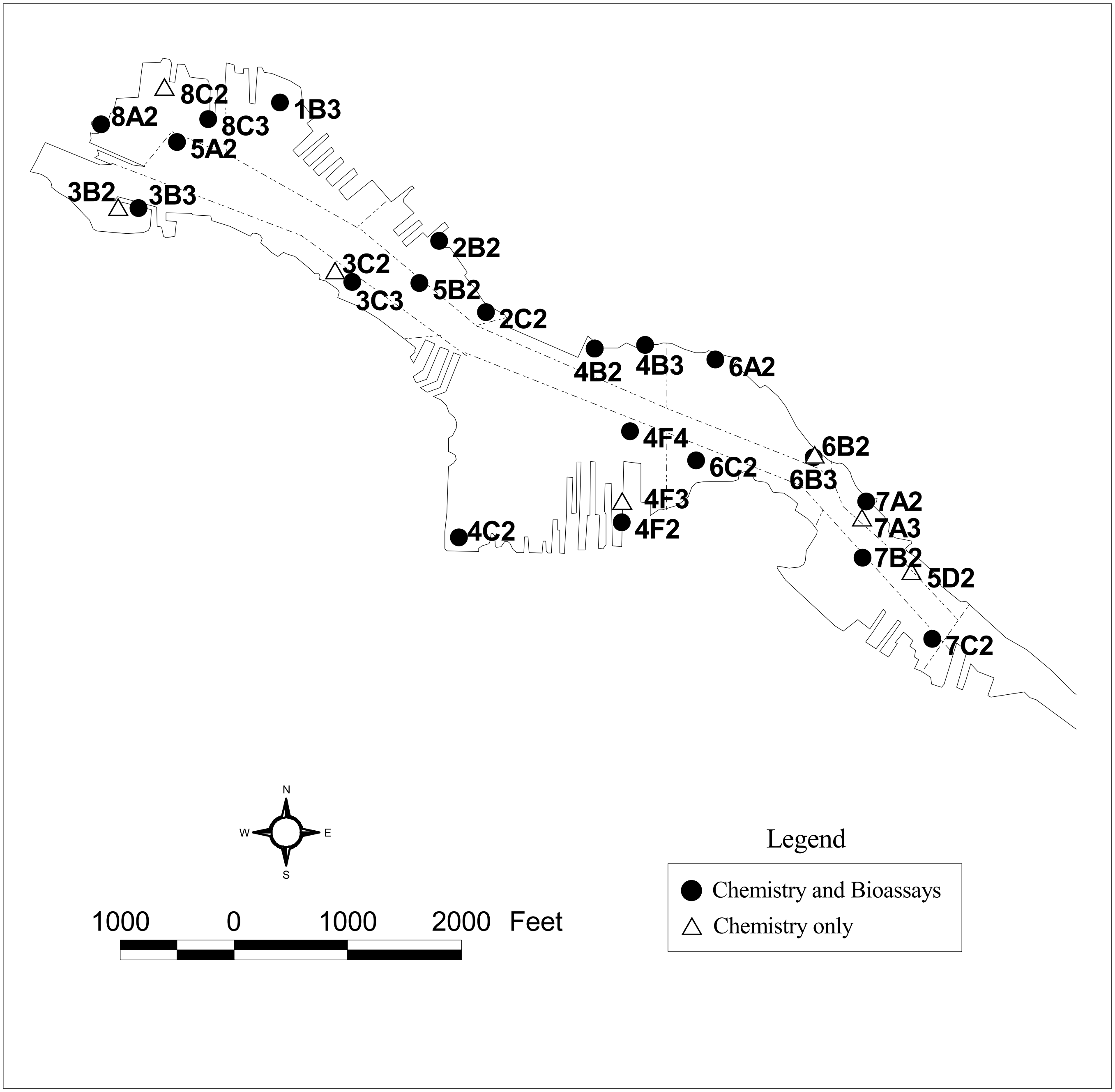

Figure 2. Station Locations and Sample Zones for Salmon Bay Phase III Sampling. Zone 5 Occupies the Channel Center and Zones 4,6, and 7 are on Both Sides of the Channel.

Prior to sampling, all stainless steel tools (grab, beakers, spoons) were decontaminated with the following procedure:

- wash in hot water and Liquinox® detergent
- rinse in tap water
- rinse in 10% nitric acid
- rinse with deionized water
- rinse with pesticide analysis grade acetone
- air dry
- wrap in aluminum foil

The beaker contents were homogenized, and subsamples for metals and organics analysis were dispensed into separate 8-oz priority pollutant-clean jars capped with teflon lid liners. Samples for organic carbon analysis were placed in 4-oz jars. Grain size samples were placed in Whirl-Pak® bags. If oil was visible in the sample, the sampler was washed with detergent and the sample was disposed into a drum onboard. Between samples, the grab sampler was thoroughly brushed and rinsed with on-site water. Samples for bioassays were placed into 1-gal jars.

Quality assurance samples collected in the field included homogenized sediments from two stations sent to the lab under different labels to represent blind field splits. Split samples are primarily used to measure laboratory precision, but results may also be influenced by homogenization and packaging in the field. Sampling was also replicated at one station to measure overall (environmental + sampling + laboratory) precision.

Chemical Analysis and Data Quality

All samples were analyzed for the chemical parameters in Table 1, except PCBs which were analyzed at six sites only. Grain size analysis was done by Rosa Environmental & Geotechnical Laboratory, Seattle, WA. All other analyses were performed at the Ecology/EPA Manchester Environmental Laboratory in Manchester, WA.

Data quality was assessed through analysis of field splits, field replicates, laboratory replicates, matrix spikes, laboratory control samples (metals only), and surrogate spikes (organics only). Holding times and adherence to EPA CLP quality control limits was assessed. Procedural blanks were analyzed to assess laboratory contamination. Quality assurance results are in Appendix B.

Quality of the conventional sediment data (solids, grain size, TOC) was excellent at all levels. Results of field splits, field replicates, and laboratory replicate suggest that environmental or sampling variability accounted for roughly equal loss of precision compared to the laboratory analyses. Some of the percent solids analyses were performed one day past holding times and are flagged (H).

Table 1. Methods for Analysis of Sediments.

Analysis	Method	Reference	Target Detection Limit
Total organic carbon (TOC)	PSEP Method	EPA, 1986a	0.1%, dw
Grain size	PSEP Method	EPA, 1986a	--
% Solids	Gravimetric - EPA Method 160.3	EPA, 1986b	0.1%
Arsenic	ICP - EPA Method 200.7 or ICP/MS - EPA Method 200.8	EPA, 1986b	1 ug/g, dw
Cadmium	ICP - EPA Method 200.7	EPA, 1986b	1 ug/g, dw
Chromium	ICP - EPA Method 200.7	EPA, 1986b	1 ug/g, dw
Copper	ICP - EPA Method 200.7	EPA, 1986b	1 ug/g, dw
Mercury	CVAA - EPA Method 245.5	EPA, 1986b	0.1 ug/g, dw
Lead	ICP - EPA Method 200.7	EPA, 1986b	1 ug/g, dw
Nickel	ICP - EPA Method 200.7	EPA, 1986b	1 ug/g, dw
Zinc	ICP - EPA Method 200.7	EPA, 1986b	1 ug/g, dw
Semivolatile organics	GC/MS - modified EPA Method 8270	EPA, 1986b	100 ug/Kg, dw
PCBs	GC/ECD - EPA Method 8080	EPA, 1986b	50 ug/Kg, dw
Butyltins	SIM mode GC/MS - PSEP/NOAA Methods	EPA, 1986a Krone et al., 1989	20 ug/Kg, dw

Precision and accuracy of the metals data were good. Arsenic analysis was hampered by high iron, >50,000 ug/g in some samples, requiring qualification (J). Samples with lower arsenic concentrations (<100 ug/g) were analyzed using ICP/MS EPA Method 200.8 due to the iron interference. The only other qualification (J) for the metals data was the cadmium result for the sample from 6B2 due to a relatively high standard deviation of results.

Quality of the semivolatile organics analysis was mixed. Practical quantitation limits were generally much higher than anticipated due in part to the high water content of the samples. In many cases, however, analytes were detected at concentrations much lower than the quantitation limits and are qualified as estimates (J). Matrix spike and surrogate recoveries were low for most analytes, possibly indicating the data were systematically biased low. Poor precision of the matrix spike duplicates suggests that laboratory analysis accounted for much of the data variability. Analysis of a certified reference material (National Research Council of Canada HS-6 - PAHs in Nova Scotia marine harbor sediments) yielded 75% of results within certified values, no evident systematic bias, and high precision. These results support the conclusion that data quality problems with the semivolatile analyses were due primarily to matrix effects.

Overall quality of the butyltin data was poor, also probably due in large part to matrix effects. Environmental variability of samples also appeared to result in poor precision, thought to be due to the presence of hull paint particles which contain highly concentrated tributyltin (see Case Narrative in Appendix B). Similar problems were encountered in the Salmon Bay Phase II study (Serdar and Cubbage, 1996). Accuracy of the data was difficult to assess due to degradation of the PACS-1 reference material (National Research Council of Canada PACS-1 – British Columbia marine harbor sediments). Analysis of a newer reference material, PACS-2, produced better data but results remained outside certified ranges.

The PCB data should be used with caution due to a number of factors making their accuracy questionable. Calibration curves for Aroclors 1242 and 1260 were outside control limits. In some cases surrogate recoveries were poor, although matrix spike recoveries were generally good and results from matrix spike duplicates were precise. Analysis of the reference material HS-2 (National Research Council of Canada HS-2 – PCBs in Nova Scotia marine harbor sediments) yielded results slightly below certified values for Aroclor 1254.

Bioassay Procedures

Bioassay tests included 10-day *Hyalella azteca* survival, 10-day *Chironomus tentans* growth and survival, and 15-minute *Vibrio fischeri* luminescence (i.e., Microtox®). *Hyalella* and *Chironomus* tests were performed by EVS Environment Consultants (North Vancouver, B.C.) through SAIC (Poulsbo, WA). Microtox testing was done by CH2M Hill in Corvallis, OR. A discussion of the highlights and data for each test replicate are in Appendix D.

There were few problems associated with testing the bioassay organisms. Negative control survival rates for *Hyalella* and *Chironomus* were 96% and 100%, respectively.

Data Analysis

Chemical data were compared to Ecology recommended freshwater sediment quality values (FSQVs; Table 2) (Cubbage et al., 1997). FSQVs were derived by analyzing freshwater bioassay and chemistry data sets collected in Washington, and by reviewing freshwater and marine sediment criteria developed in Canada and the U.S., including Washington standards for marine waters. The authors concluded that, when applied to freshwater, the existing Sediment Management Standards (SMS; Ch. 173-204 WAC) for marine waters provided the best mix of sensitivity and efficiency in predicting effects to the bioassay organism *Hyalella azteca* and miscellaneous effects related to metals. Numerical criteria promulgated in the SMS are essentially minimum chemical concentrations expected to cause adverse effects on biological resources. For organics, FSQVs are based on Microtox® probable apparent effects thresholds derived from a variety of bioassay and chemistry data sets from freshwater sediments in Washington. Like FSQVs for metals, the FSQVs for organics are not codified standards. However, creators of the FSQVs conclude they predict biological effects better than other sets of values, including sediment quality criteria and guidelines developed by other regulatory agencies.

Table 2. Freshwater Sediment Quality Values (FSQVs)*
for Metals and Organics in Washington State.

Chemical	FSQV
Metals (ug/g, dw)	
Arsenic	57
Cadmium	5.1
Chromium	260
Copper	390
Nickel	na
Lead	450
Zinc	410
Mercury	0.41
PAHs(ug/kg, dw)	
Naphthalene	37,000
Acenaphthylene	1,900
Acenaphthene	3,500
Fluorene	3,600
Phenanthrene	5,700
Anthracene	2,100
LPAH[a]	27,000
Fluoranthene	11,000
Pyrene	9,600
Benzo(a)anthracene	5,000
Chrysene	7,400
Total Benzofluoranthenes	11,000
Benzo(a)pyrene	7,000
Indeno(1,2,3-cd)pyrene	730
Dibenzo(a,h)anthracene	230
Benzo(ghi)perylene	1,200
HPAH[b]	36,000
Total PAH[c]	60,000
Other Semivolatile Organics(ug/kg, dw)	
Bis(2-Ethylhexyl)phthalate	640
Carbazole	140
Chlorinated Organics(ug/kg, dw)	
PCB-1248	21
PCB-1254	7.3
Total PCB	21

* FSQVs derived by Cubbage et al. (1997).

[a] Represents the sum of Anthracene, Acenaphylene, Acenaphthene, Phenanthrene, Fluorene, and Naphthalene. The LPAH criterion is not the sum of the criterion values for individual LPAH as listed above.

[b] Represents the sum of Pyrene, Benzo(g,h,i)perylene, Indeno(1,2,3-c,d)pyrene, Benzofluoranthene(s), Fluoranthene, Chrysene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, and Benzo(a)anthracene. The HPAH criterion is not the sum of the criterion values for individual HPAH as listed above.

[C] Total PAH = LPAH + HPAH

na= not available

Results

Field Observations

Sediments were observed for characteristics of color, odor, grain composition, oil sheen, and content. Complete results of field observations are in Appendix A.

Most of the sediments were brown or dark brown in color and appeared in the field to be composed mainly of silt or sand, with some "muck" or clay. Approximately two-thirds of the sediments had an oil sheen, with the heaviest sheen in sediment from Station 6B2. Sediments from some stations had a petroleum odor, although this did not always correspond to an observable oil sheen (e.g., Stations 3B2 and 8A2). Only one station (5B2) appeared to have noticeably anoxic sediments based on its rotten egg odor.

Contents of the sediments varied from station to station. Samples from Stations 1B3, 2B2, 3B3, 4B3, 6A2, 7A2, and 7A3 contained partially decomposed organic debris. Paint particles were observed in sediments from Stations 4F2, 5D2, 6A2, 7A2, 7A3, and 8C3. Clams from the Lake Washington reference stations (10A2 and 10B2) were the only recorded observations of macroinvertebrates in sediments.

Conventional Characteristics of Sediments

Conventional parameters measured in Salmon Bay sediments (solids, grain size, TOC) are presented in Table 3. TOC70 is determined at 70°C whereas TOC104 is determined at 104°C. On average, TOC104 results were 4% higher than TOC70. TOC, which has been known to correlate well with non-polar organic compounds, ranged from 0.8% at Station 7C2 to 21.3% at 7B2. Sediment from Station 7B2 was described by the grain size analyst as fibrous and mostly peat (see Case Narrative in Appendix B).

Grain size analysis showed that sediments from all stations were made up of mostly sand or silt, generally followed by clay and gravel. Sediments from 5D2, 7C2, and 4C2 had sand and gravel making up 70% or more of the sample dry weight, as did sediment from reference station 10B2. The characterization of sediment from 7B2 as mostly sand and gravel is not entirely accurate since, as mentioned previously, this sample was mostly peat.

Samples from Stations 3C3, 3C2, 6C2, 4B2, and 8C3 were composed of 80% or more fine material (i.e., ≤ 62 um) by weight, mostly silt for all sediments except 7A3 which contained 41% clay. Contaminant concentrations in sediments are often positively correlated with percent fines since more surface area is available for binding.

Table 3. Organic Carbon, Solids, and Grain Size Composition of Salmon Bay Phase III Sediments and Lake Washington Reference Sediments.

				Grain Size Composition (%)			
Station	**TOC70 (%)**	**TOC104 (%)**	**Solids (%)**	**Gravel (>2,000 um)**	**Sand (62-2,000 um)**	**Silt (3.9-62 um)**	**Clay (<3.9 um)**
1B3	6.5	6.8	26.1	0	34	54	12
2B2	11.5	12.2	23.2	4	51	37	8
2C2	7.7	7.9	25.9	6	37	44	13
3B2	5.1	5.1	28.5	0	24	56	20
3B3	4.5	4.6	34.2	0	45	39	16
3C2	5.9	6.1	24.3	0	16	76	8
3C3	6.0	6.3	24.4	0	15	77	8
4B2	6.2	6.4	26.9	0	18	68	14
4B3	10.5	10.6	26.0	1	38	54	7
4C2	4.7	5.0	38.2 H	1	69	22	8
4F2	14.9	15.8	16.3 H	13	48	32	7
4F3	7.4	7.8	26.4 H	0	25	56	19
4F4	11.7	12.1	27.3	3	45	43	9
5A2	4.8	5.2	25.3	0	26	57	17
5B2	5.0	4.9	26.3	0	27	55	18
5D2	3.2	3.0	55.9 H	14	66	13	7
6A2	9.2	9.7	33.4	2	43	44	11
6B2	2.4	2.5	42.7	0	51	44	5
6B3	3.3	3.4	36.3	0	26	64	10
6C2	5.4	5.7	45.8	2	15	51	32
7A2	2.6	2.8	42.8	2	62	28	8
7A3	1.6	1.6	54.1 H	2	26	31	41
7B2	18.7	21.3	15.3 H	14	56	18	12
7C2	0.78	0.82	66.1 H	0	73	21	6
8A2	2.8	3.0	48.9	2	63	29	6
8C2	4.3	4.5	43.4	0	60	32	9
8C3	5.5	5.6	38.8	2	17	56	24
10A2 (ref.)	3.4	3.6	38.2 H	0	26	62	11
10B2 (ref.)	1.2	1.2	58.9 H	1	75	20	4

TOC70= Total organic carbon determination at 70°C

TOC104= Total organic carbon determination at 104°C

H= Exceeds sample holding time

*Results may be biased due to the fibrous nature of this sample. See Case Narrative in Appendix B for more detail.

Chemical Concentrations in Sediments

Metals

Concentrations of metals in sediments are shown in Table 4. Extremely high levels were found at some stations. The range of dry weight concentrations (ug/g, parts per million) for individual metals were as follows: arsenic 5 - 210, mercury 0.1 - 43, cadmium 0.3 - 5, chromium 24 - 620, copper 48 - 10,800, lead 12 - 1,300, nickel 30 - 640, and zinc 84 - 4,200. Station 4F2 had the highest concentrations of mercury, cadmium, copper, lead, and zinc. Arsenic was found at the highest concentration at 1B3. Chromium and nickel concentrations were highest in sediments from 6B2. Metals in reference sediments were at concentrations near the low end of the Salmon Bay range.

Higher metals concentrations were positively correlated with sites that had higher proportions of fine sediments (Appendix C). Conversely, sites with more sand tended to have lower metals concentrations. All metals were positively correlated except nickel-arsenic and nickel-lead. The strongest links were cadmium-chromium, cadmium-copper, chromium-copper, chromium-nickel, and mercury-zinc.

Table 5 ranks the stations according to concentrations of each metal. Stations 1B3, 4F2, and 3B3 had the highest overall rank. The Lake Washington reference stations (10A2 and 10B2) and Salmon Bay stations 7C2, 6C2, and 7B2 tended to have the least metals, the latter showing little or no metals enrichment above reference conditions.

Concentrations of all metals except cadmium exceed freshwater sediment quality values (FSQVs) at two or more stations. Fully three-quarters of the stations exceed the FSQV for mercury, including one of the Lake Washington reference stations (10B2). Nearly half the stations exceed FSQVs for copper or zinc, five exceed the arsenic FSQV, and two stations each exceed chromium and lead FSQVs. The cadmium FSQV was not exceeded by any samples. No FSQV has been derived for nickel.

Stations 1B3 and 4F2 each exceed FSQVs for five metals; 3B3 and 7A2 each exceed FSQVs for four metals. Only six stations – 5D2, 6C2, 10A2, 7A3, 7B2, and 7C2 – did not surpass the FSQVs for any of the metals analyzed.

Table 4. Concentrations of Metals in Salmon Bay Phase III Sediments and Lake Washington Reference Sediments (ug/g, dw).

Station	Arsenic	Mercury	Cadmium	Chromium	Copper	Lead	Nickel	Zinc
1B3	209 *	3.7	3.6	102	2,010	525	62	2,010
2B2	16	0.66	2.7	62	651	431	44	754
2C2	17	0.84	1.4	100	508	177	77	407
3B2	25	2.1	1.8	66	314	311	53	497
3B3	175 *	2.7	3.0	81	651	436	48	1,770
3C2	28	1.0	1.3	64	856	199	48	490
3C3	31	0.99	1.4	67	627	194	49	567
4B2	13	1.0	2.0	121	536	187	102	453
4B3	13	0.66	1.3	77	327	150	64	368
4C2	20	0.44	1.1	45	142	99	39	391
4F2	152 J*	43	5.0	96	10,800	1,310	58	4,150
4F3	23	1.6	1.7	77	632	305	61	614
4F4	13	0.62	1.0	56	210	114	54	269
5A2	31	2.0	1.6	80	571	249	62	550
5B2	22	0.80	1.2	57	363	152	45	377
5D2	25	0.36	0.61	44	145	408	34	246
6A2	13	0.75	1.6	81	315	150	71	354
6B2	17 J	0.27	3.5 J	621	2,220	74	644	259
6B3	20 J	0.56	2.9	348	1,460	133	355	406
6C2	6	0.16	(0.3) U	54	48	12	60	86
7A2	123 *	3.0	1.3	63	829	230	49	1,080
7A3	16	0.10	0.65	53	73	321	54	165
7B2	31	0.10	(0.3) U	24	50	27	46	84
7C2	5	0.10	0.31	25	74	27	30	98
8A2	14	1.2	1.0	45	158	258	38	423
8C2	12	1.2	1.3	45	206	194	39	419
8C3	111 *	2.2	2.0	68	371	299	53	675
10A2 (ref.)	7	0.14	0.45	43	28	59	39	90
10B2 (ref.)	4	0.54	0.69	27	24	90	26	131

*Analyzed using EPA 200.7. All other Arsenic results using EPA 200.8.

J= Estimated concentration

U= Undetected at concentration in parentheses

Table 5. Salmon Bay Phase III and Lake Washington Reference Stations Ranked According to Metals Concentrations (lower rank = higher concentration).

Rank	Arsenic	Mercury	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	Overall Rank
1	1B3	4F2	4F2	6B2	4F2	4F2	6B2	4F2	1B3
2	3B3	1B3	1B3	6B3	6B2	1B3	6B3	1B3	4F2
3	4F2	7A2	6B2	4B2	1B3	3B3	4B2	3B3	3B3
4	7A2	3B3	3B3	1B3	6B3	2B2	2C2	7A2	8C3
5	8C3	8C3	6B3	2C2	3C2	5D2	6A2	2B2	4F3
6	7B2	3B2	2B2	4F2	7A2	7A3	4B3	8C3	5A2
7	3C3	5A2	4B2	3B3	2B2	3B2	1B3	4F3	7A2
8	5A2	4F3	8C3	6A2	3B3	4F3	5A2	3C3	6B3
9	3C2	8A2	3B2	5A2	4F3	8C3	4F3	5A2	4B2
10	5D2	8C2	4F3	4F3	3C3	8A2	6C2	3B2	3B2
11	3B2	3C2	5A2	4B3	5A2	5A2	4F2	3C2	3C3
12	4F3	3C3	6A2	8C3	4B2	7A2	7A3	4B2	6B2
13	5B2	4B2	2C2	3C3	2C2	3C2	4F4	8A2	2C2
14	4C2	2C2	3C3	3B2	8C3	3C3	3B2	8C2	2B2
15	6B3	5B2	3C2	3C2	5B2	8C2	8C3	2C2	3C2
16	2C2	6A2	4B3	7A2	4B3	4B2	3C3	6B3	6A2
17	6B2	4B3	7A2	2B2	6A2	2C2	7A2	4C2	4B3
18	2B2	2B2	8C2	5B2	3B2	5B2	3B3	5B2	5B2
19	7A3	4F4	5B2	4F4	4F4	4B3	3C2	4B3	8A2
20	8A2	6B3	4C2	6C2	8C2	6A2	7B2	6A2	8C2
21	4B2	10B2	4F4	7A3	8A2	6B3	5B2	4F4	7A3
22	6A2	4C2	8A2	8A2	5D2	4F4	2B2	6B2	4F4
23	4B3	5D2	10B2	4C2	4C2	4C2	4C2	5D2	5D2
24	4F4	6B2	7A3	8C2	7C2	10B2	10A2	7A3	4C2
25	8C2	6C2	5D2	5D2	7A3	6B2	8C2	10B2	7B2
26	10A2	10A2	10A2	10A2	7B2	10A2	8A2	7C2	6C2
27	6C2	7A3	7C2	10B2	6C2	7C2	5D2	10A2	10B2
28	7C2	7B2	6C2	7C2	10A2	7B2	7C2	6C2	10A2
29	10B2	7C2	7B2	7B2	10B2	6C2	10B2	7B2	7C2

☐ Exceeds Freshwater Sediment Quality Values (Cubbage et al., 1997). No FSQV has been derived for Nickel.

Semivolatile Organics

Table 6 summarizes the median and concentration range of each semivolatile organic compound detected in sediments. Complete results of semivolatile organic analyses are in Appendix C.

Slightly more than half (39 of 75) of the semivolatiles analyzed were detected, with "priority pollutant" PAHs the most frequently detected group (Figure 3). Total PAH concentrations ranged from 1,100 ug/kg at Station 7B2 to over 300,000 ug/kg at 4F2, which translates to 0.03% of the dry sample weight. High levels of total PAHs were also found at 2C2 (96,000 ug/kg), 8A2 (79,000 ug/kg), and 2B2 (64,000 ug/kg). Concentrations at most stations were between 10,000 and 50,000 ug/kg, with a median of 18,000 ug/kg. Total PAHs at Stations 10A2 and 10B2 were low: 700 ug/kg and 3,000 ug/kg, respectively.

Eighteen of the 27 Salmon Bay sediment samples had one or more PAH at concentrations above FSQVs. Station 4F2 had 13 individual PAHs as well as total PAH concentrations above FSQVs. Stations 2B2, 2C2, and 8A2 also had total PAHs as well as several individual PAHs above FSQVs.

Phenol and alkyl-substituted phenols were detected in more than half the samples, with the highest concentration in sediment from Station 4B3. Pentachlorophenol was detected at several sites at concentrations from 300 - 700 ug/kg, but was highest at 7A2 (1,240 ug/kg). Other semivolatile organics, when detected, were generally in the 100 - 1,000 ug/kg range, and like phenols have no associated FSQV. Bis(2-ethylhexyl)phthalate was an exception with concentrations both high and in exceedence of the FSQV in about three-quarters of the samples. Carbazole was above the FSQV in more than half the samples, although concentrations were not particularly high.

Total PAH showed a moderately strong positive correlation with TOC (Appendix C). Other semivolatile compounds such as bis(2-ethylhexyl)phthalate, 4-methylphenol, and carbazole were even more strongly correlated with TOC. There appears to be no relationship between stations with visible oil or petroleum odor in samples and high levels of PAH. For instance, an oil sheen was visible in sediment from 4F2 but was not observed at 2C2 where total PAH was 100,000 ug/kg. Conversely, some sites with oily sediments had relatively low PAH (e.g., 6B2, 6C2, 7A3, 1B3).

Table 6. Median, Minimum, and Maximum Detected Concentrations of Semivolatile Organic Compounds in Salmon Bay Phase III Sediments (ug/kg, dw).

Chemical	Median	Min.	Station	Max.	Station
Priority Pollutant PAHS					
Naphthalene	640	37	7C2	5,600	4F2
Acenaphthylene	260	12	7C2	1,300	4B3
Acenaphthene	350	33	7C2	7,400	4F2
Fluorene	480	39	7C2	7,000	4F2
Phenanthrene	2,000	71	7B2	41,000	4F2
Anthracene	590	67	7C2	16,000	4F2
Total LPAH	4,400	71	7B2	78,000	4F2
Fluoranthene	3,400	120	7B2	46,000	4F2
Pyrene	3,500	120	7B2	56,000	4F2
Benzo(a)anthracene	1,200	150	6C2	26,000	4F2
Chrysene	1,500	59	7B2	28,000	4F2
Benzo(b+k)fluoranthenes	2,300	67	7B2	42,000	4F2
Benzo(a)pyrene	1,400	180	7B2	24,000	4F2
Indeno(1,2,3-cd)pyrene	990	91	7A3	14,000	4F2
Dibenzo(a,h)anthracene	250	34	7C2	3,100	4F2
Benzo(ghi)perylene	1,000	87	7B2	12,000	4F2
Total HPAH	15,000	1,000	7B2	250,000	4F2
Total PAH	18,000	1,100	7B2	329,000	4F2
Phenols and non-Priority Pollutant PAHs					
Phenol	120	36	5D2	770	4B3
2-Methylphenol	90	72	8C2	300	4B3
4-Methylphenol	510	52	5D2	6,300	4B3
2,4-Dimethylphenol	140	140	4B3	140	4B3
Pentachlorophenol	470	290	4C2	1,200	7A2
Retene	1,100	94	7C2	76,000	4F4
2-Methylnaphthalene	220	28	7C2	3,500	4F2
1-Methylnaphthalene	110	14	7C2	1,800	4F2
Phthalates					
Dimethylphthalate	150	15	7C2	580	6A2
Diethylphthalate	90	32	4F3	180	3C3
Di-N-Butylphthalate	420	69	4F3	1,700	3C3
Butylbenzylphthalate	190	28	7C2	1,500	2B2
Bis(2-Ethylhexyl)phthalate	2,800	280	6C2	23,000	4F3
Di-N-Octyl Phthalate	300	200	4C2	400	4B3
Miscellaneous Semivolatiles					
1,4-Dichlorobenzene	50	27	4B2	94	8C2
1,2-Dichlorobenzene	110	73	4F2	120	2B2
Benzyl Alcohol	80	14	7C2	330	2B2
Isophorone	51	51	4B3	51	4B3
Benzoic Acid	2,500	1,000	6B2	4,200	4B3
Dibenzofuran	240	24	7C2	3,800	4F2
Caffeine	34	34	6C2	34	6C2
Carbazole	180	24	7C2	2,900	4F2
3β-Coprostanol	2,100	1,400	4C2	32,000	4B2

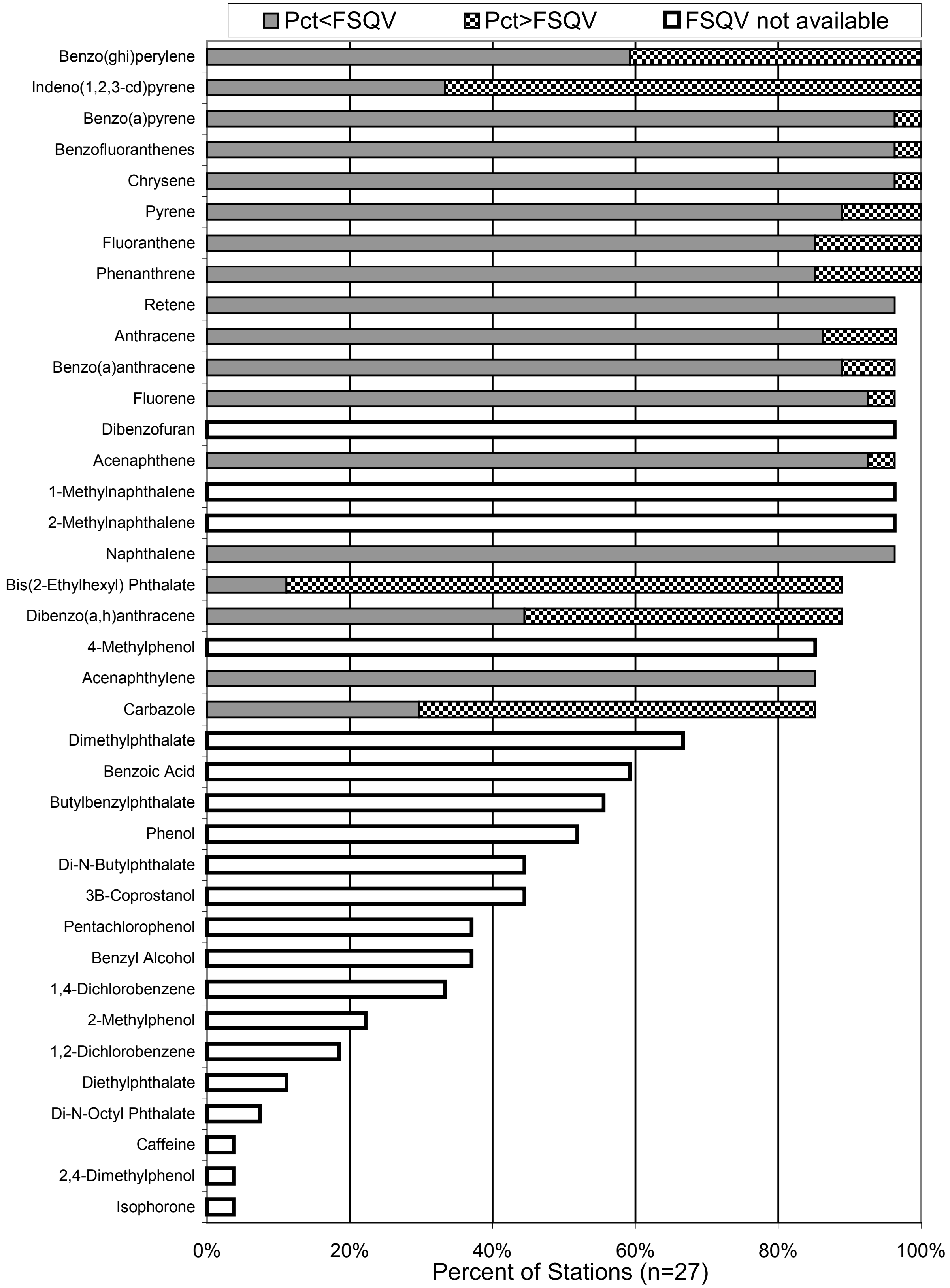

Figure 3. Frequency of Detection and Exceedence of Freshwater Sediment Quality Values (FSQVs) for Semivolatile Organics in Salmon Bay Phase III Sediments.

Butyltins

Butyltin concentrations are shown in Table 7. Tributyl-chlorotin (TBTCl) was detected in all samples, with concentrations ranging from 45 to 72,000 ug/kg. Ion-equivalent tributyltin (TBT^+) concentrations ranged from 40 ug/kg to 64,000 ug/kg. Monobutyl-chlorotin (MBTCl), dibutyl chlorotin (DBTCl), and tetrabutyltin (TeBT) were detected in most samples.

TBT is an organometallic compound with biocidal properties. Its presence in the aquatic environment is mainly due to its use in anti-fouling paint for vessel hulls, although in 1988 its use in the U.S. was severely restricted for most applications. MBT and DBT are metabolites formed during the progressive debutylation of TBT. Substituted-MBTs and -DBTs are also used as PVC stabilizers, and as catalysts in the manufacture of polyurethane foam and silicone elastomers (EPA, 1996). TeBT may be an impurity produced during TBT manufacturing or possibly formed photolytically or microbially from lesser butylated congeners.

On average, TBTCl made up 70% of the butyltin concentrations in the Phase III samples. Concentrations of all butyltins were extremely high in the sample from 4F2, with total butyltin concentrations making up 0.01% of the dry sample weight. It should be noted that the accuracy of these data is suspect due to the poor precision encountered during analysis, probably as a result of matrix effects such as the presence of paint particles.

Red paint chips were observed in the sample from 4F2 which most likely contributed to the high level of TBT, and probably copper as well as zinc, in this sample. However, visual observations are probably a poor indicator of contaminant levels among sites since most samples with high TBT, copper, and zinc concentrations had no observable paint chips. Of the four additional stations where paint chips were observed (5D2, 6A2, 7A2, 8C3), only 7A2 had concentrations of TBT^+, copper, and zinc above median values. Nevertheless, there is evidence that hull paint is associated with high copper and zinc concentrations in sediments. Rank order data for copper and zinc is highly correlated to TBT (Spearman correlation coefficients of 0.76 and 0.72, respectively; Appendix C), signifying that sites with high TBT tend to have high copper and zinc. Conversely, sites with low TBT concentrations tended toward lower copper and zinc concentrations.

The presence of paint particles adds to the complexity of determining the bioavailability and toxicity of TBT in sediment. Other factors include organic carbon, pH, salinity, clay content, and the presence of inorganic constituents such as iron oxides (EPA, 1996). Due to its complex behavior in the aquatic environment, no sediment quality criteria have been adopted for TBT in marine sediments. In 1988, the PSDDA agencies developed an interim screening level (73 ug TBT^+/kg) for use in marine areas, based on best available knowledge of the chemical and its properties. There is currently much uncertainty surrounding the use of a bulk sediment screening level for TBT due to unresolved questions about environmental partitioning, bioavailability, and methods to determine toxicity (Michelsen et al., 1996). Although site-specific screening levels for TBT have been recommended at Superfund Sites in Puget Sound (EPA, 1996), numerical criteria have not been established to replace the 1988 PSDDA screening level concentrations for bulk sediments. There are also no available sediment quality criteria for TBT in freshwater.

Table 7. Concentrations of Butyltins in Salmon Bay Phase III Sediments and Lake Washington Reference Sediments (ug/kg, dw).

Station	**Monobutyl-trichlorotin**	**Dibutyl-dichlorotin**	**Tributyl-chlorotin**	**Tetrabutyltin**	**TBT$^+$ (ion equiv.)**
1B3	4,110 J	2,515 J	17,600	451	15,664
2B2	736	182	1,920	35 J	1,709
2C2	636	202	2,470	30 J	2,198
3B2	307	262	973	60	866
3B3	267	139	782	70	696
3C2	840	393	4,030	59 J	3,587
3C3	608	663	7,460	68	6,639
4B2	534 J	260	1,214	20 J	1,080
4B3	428	171	1,050	(36) U	935
4C2	340	376	811	7 J	722
4F2	7,785 J	22,150 J	72,450	771	64,481
4F3	537	1,980	3,180	96 J	2,830
4F4	95	91	671	(28) U	597
5A2	737	862	2,840	51 J	2,528
5B2	610 J	642 J	1,580	45 J	1,406
5D2	60	24	142	(18) U	126
6A2	355 J	69 J	909	24 J	809
6B2	186 J	246	1,360	51	1,210
6B3	312 J	419	1,360	(23) U	1,210
6C2	38 J	(24) U	70	(24) U	62
7A2	248 J	346	2,490	36	2,216
7A3	32 J	37	150	(15) U	134
7B2	61 J	(62) U	127	(61) U	113
7C2	87	100	222	(14) U	198
8A2	500	304	2,800	112 J	2,492
8C2	389 J	288	1,155	16 J	1,028
8C3	65 J	(30) U	925	148	823
10A2 (ref.)	41 J	22 J	87	(28) U	77
10B2 (ref.)	36 J	16 J	45	(17) U	40

U= Undetected at associated concentration
J= Estimated concentration
▨ Exceeds PSDDA Screening Level

Concentrations of TBT in Phase III sediment samples generally exceeded the PSDDA screening level (SL) by an order of magnitude. Samples from 1B3 and 3C3 had TBT levels two orders of magnitude above the SL, and TBT was 900 times the SL in sediment from Station 4F2. Several stations had TBT near or below the SL, including the reference stations.

PCBs

PCBs were analyzed at six stations in the vicinities of stations where substantial concentrations (~1,000 ug/kg or greater) were detected during Phase II sampling. Five of the six stations analyzed had detectable PCB concentrations (Table 8). Total PCBs were highest at 4F2 (2,100 ug/kg) and 1B3 (1,500 ug/kg). The lowest concentrations were at 7A2 (140 ug/kg) and at 7A3 which had no detectable PCBs at quantitation limits of 66 ug/kg.

Table 8. PCB Concentrations in Selected Salmon Bay Phase III Sediments (ug/kg, dw).

Station	**PCB - 1016**	**PCB - 1221**	**PCB - 1232**	**PCB - 1242**	**PCB - 1248**	**PCB - 1254**	**PCB - 1260**	**Total PCBs**
1B3	140 HUJ	140 HUJ	140 HUJ	140 HUJ	140 HUJ	**960** H	**500** H	**1,460** H
4C2	79 UJ	79 UJ	79 UJ	79 UJ	79 UJ	**230** J	**74** J	**304** J
4F2	180 HUJ	180 HUJ	180 HUJ	**570** H	180 HUJ	**1,060** H	**460** H	**2,090** H
4F3	130 HUJ	130 HUJ	130 HUJ	130 HUJ	130 HUJ	**570** H	**210** H	**780** H
7A2	82 U	82 U	82 U	82 U	82 U	**140**	82 U	**140**
7A3	66 U	66 U	66 U	66 U	66 U	66 U	66 U	66 U

Detected compounds in **bold**
U= Undetected at associated concentration
UJ= Undetected at associated estimated concentration
J= Estimated concentration
H= Exceeded holding time

In general, it appeared that concentrations were similar to those detected in nearby sites from Phase II. The exceptions were at Stations 7A2 and 7A3 whose "root" station (7A from Phase II) had the highest total PCB concentrations in sediments (7,600 ug/kg).

Sediment Bioassays

Bioassay results for *Hyalella* survival, *Chironomus* growth and survival, and Microtox® response are summarized in Table 9. Complete test results are in Appendix D.

Each station was compared to one reference site using a one-sided upper tail student's T-test. Alpha was set at 0.05 except for the *Chironomus* growth bioassay where alpha was 0.10 as recommended by SMS/PSDDA, since larval bioassays tend to have large variance (Michelsen and Shaw, 1996).

Reference station 10A2 was used for all comparisons except *Chironomus* survival, since grain size and TOC content of reference station 10A2 were closer to those of test stations than reference station 10B2. Average survival in the *Chironomus* survival bioassay was 50% in reference sediment 10A2. This is below the SMS performance standard of greater than 70% survival for reference sediments (WAC 173-204-315); as a result, station 10B2 was used for *Chironomus* survival comparisons.

Table 9. Summary of Bioassay Test Results on Selected Salmon Bay Phase III Sediments.

	***Hyalella* Survival** (%)		***Chironomus* Survival** (%)		***Chironomus* Growth** (mg, dw)		**Microtox** (% light red. from control)	
Station	mean	*p*	mean	*p*	mean	*p*	mean	*p*
1B3	90	0.055	66	0.24	1.40	**<0.00025**	12	**<0.00025**
2B2	90	0.16	54	**0.013**	2.08	**<0.00025**	8.7	**0.0005**
2C2	82	**0.002**	80	1.0	1.68	**<0.00025**	48	**<0.00025**
3B3	78	**0.001**	74	0.15	1.50	**<0.00025**	11	**<0.00025**
3C3	98	0.19	88	0.005*	2.91	**0.014**	-1.5	#
4B2	92	0.19	96	0.001*	2.56	**0.008**	44	**<0.00025**
4B3	70	**0.002**	68	**0.006**	3.08	**0.011**	57	**<0.00025**
4C2	98	0.19	76	0.24	2.71	**0.0005**	59	**<0.00025**
4F2	86	**0.049**	60	**0.011**	1.40	**<0.00025**	37	**<0.00025**
4F4	62	**0.0005**	82	0.40	3.22	**0.040**	19	**<0.00025**
5A2	88	0.17	86	0.15	2.32	**0.0005**	18	**<0.00025**
5B2	84	0.13	78	0.31	2.93	**0.0005**	-6.1	#
6A2	80	**0.028**	82	0.35	3.09	**0.021**	45	**<0.00025**
6B3	92	0.19	72	**0.05**	1.51	**<0.00025**	7.8	0.099
6C2	94	0.23	82	0.37	3.22	0.21	-13	#
7A2	70	0.093	82	0.40	3.54	0.43	-8.9	#
7B2	64	**0.007**	72	0.17	2.93	**0.010**	1.6	0.004**
7C2	80	**0.039**	64	**0.098**	3.09	**0.014**	19	**<0.00025**
8A2	68	**0.008**	54	**0.083**	1.31	**0.0005**	19	**<0.00025**
8C3	78	**0.004**	28	**<.00025**	0.40	**<0.00025**	8.4	**<0.00025**
10A2 (ref.)	98	**--**	50	**--**	3.60	**--**	4.2	**--**
10B2 (ref.)	96	**--**	80	**--**	3.46	**--**	17	**--**

P values of a one tailed T-test of sample (n = 4-5 replicates) against one reference site (n=5). Station 10A2 used as reference site for *Hyalella* survival, *Chironomus* growth, and Microtox. Station 10B2 used as reference site for *Chironomus* survival.

All percentile results were arcsin-square root transformed prior to data analysis (*Hyalella*, *Chironomus* survival, and Microtox).

"Hits" are in **bold**. A hit is p<0.05 for all but *Chironomus* survival (p<0.1, per SMS/PSDDA guidance).

*Survival in sample was significantly *higher* than in reference

**Light reduction in sample was significantly *lower* than in reference

= no difference: there was no reduction in the light emission compared to the laboratory controls. As a result, these replicate samples had a negative decreased illumination. The arcsin transformation will not work on negative values.

All stations except 6C2 and 7A2 had significant bioassay responses for one or more tests. Stations 4B3, 4F2, 7C2, 8A2, and 8C3 showed hits in all four bioassays; five other stations had hits in three tests (2B2, 2C2, 3B3, 4F4, and 6A2). *Chironomus* growth was the most sensitive (i.e., significant difference from reference site) of the bioassay tests, followed by the Microtox test. In contrast, only seven stations had hits for *Chironomus* survival due mainly to low survival rates at the reference station 10A2. Results of the *Chironomus* growth bioassays were correlated with *Chironomus* survival ($r = 0.328$, $p = 0.020$), and Microtox ($r = 0.301$, $p = 0.045$).

Discussion

Confirmation of Phase II Results

The distribution of contaminants in Salmon Bay could be characterized by "hot-spots" interspersed among a field of sediments with more moderate concentrations. These areas of high contamination tend to be closer to shore, with decreasing concentrations toward the channel center. This is consistent with findings of the Phase II study, and generally indicates shoreside point sources of contamination, although these sources may extend outward from shore in the case of piers and moored vessels. A more detailed discussion of contaminants related to possible sources in Salmon Bay is discussed in the Phase II report (Serdar and Cubbage, 1996). Shoreside businesses or activities located near each station are included in the table of station descriptions (Appendix A)

One of the objectives of the Phase III study was to confirm and delineate areas of clean and contaminated sediment found during Phase II. For the most part, this survey was successful in confirming areas of highly contaminated sediments. Table 10 lists instances where chemical concentrations at Phase III stations agreed well with either high or low degrees of contamination at their associated Phase II stations. Figure 4 shows locations of both Phase II and Phase III stations.

Table 10. Instances Where Phase III Samples Confirmed Phase II Results*.

Phase II Station	**Associated Phase III Station**	**Similarities Between Phase II and Phase III**
1B	1B3	High As, Hg, Pb, Cd, Cu, Zn, PCB, and TBT Low HPAH
3B	3B2, 3B3	High Hg
3C	3C2, 3C3	High TBT
4B	4B2	High TBT
4F	4F2, 4F3	High Pb, Cd, Cu, Zn, HPAH, LPAH, PCB, and TBT
6A	6A2	High Cd
6B	6B2, 6B3	High Ni, Cd, Cr, and Cu Low Hg
7A	7A2	High Cu and Zn
7C	7C2	Low As, Hg, Pb, Cd, Cu, Zn, HPAH, LPAH, and TBT
8A	8A2	High TBT
8B	8C2	High Hg Low HPAH
8C	8C3	High Hg, Pb, and Cd Low HPAH

*Serdar and Cubbage, 1996

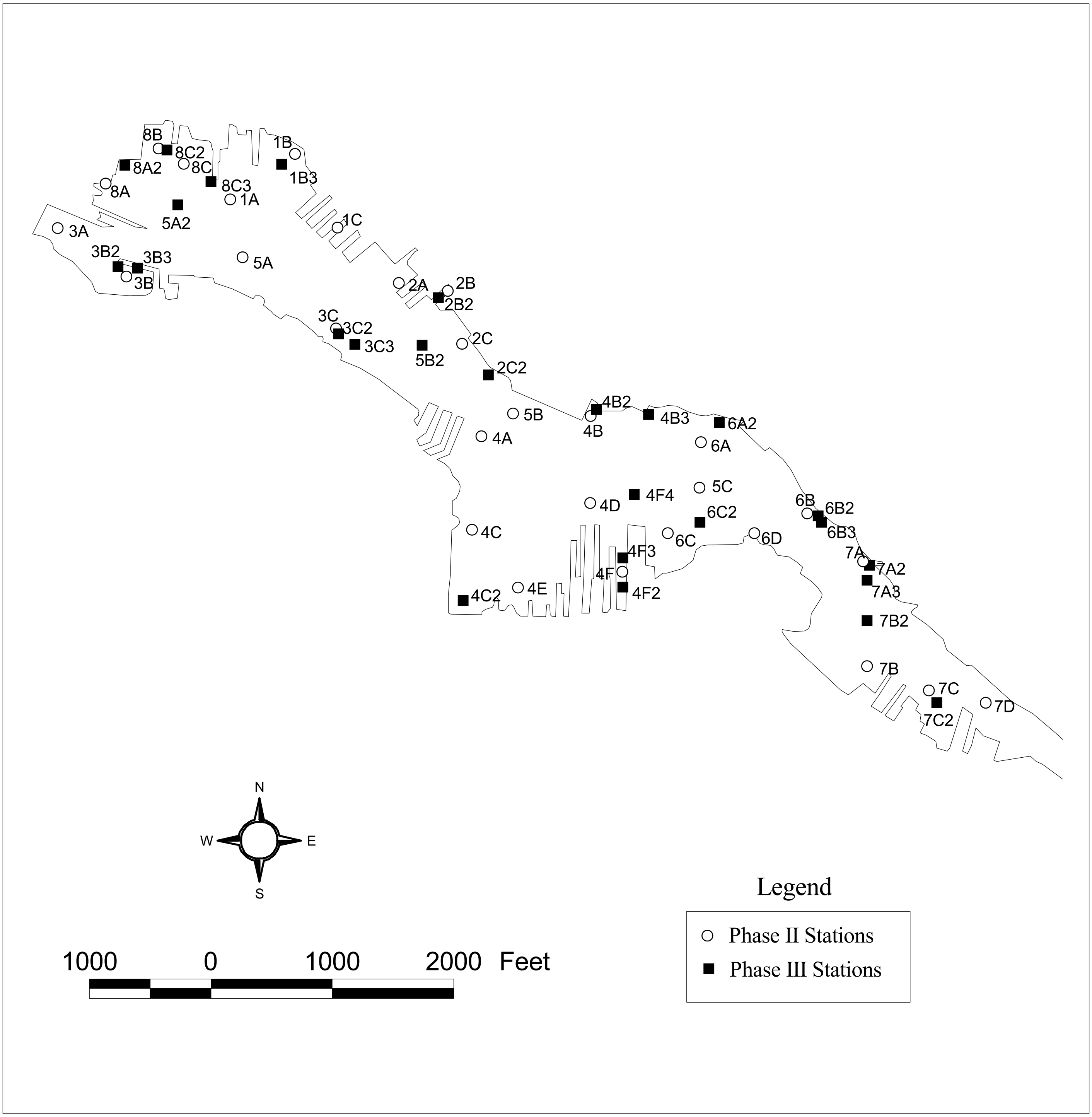

Figure 4. Salmon Bay Station Locations for Phase II and Phase III.

Moderate contaminant levels were generally confirmed during Phase III sampling, although these comparisons are subject to the extreme range of concentrations for many chemicals. There were few confirmations of "clean" areas, due mainly to the lack of Phase III samples designed for this purpose. For instance, further sampling of the relatively clean and sandy central channel region was not considered warranted for Phase III.

Due to the variability of sample results, the sampling coverage used for this project was unable to delineate hot-spots. Delineation and resolution of hot-spots will require more intensive sampling in a small area together with extremely accurate determinations of sampling locations. However, in some cases Phase III samples failed to confirm high contaminant levels found at associated Phase II stations, thereby yielding clues about the directional boundaries of these hot-spots. For instance, Station 7A2 had concentrations of copper and zinc almost identical to Phase II Station 7A, yet copper and zinc concentrations decreased by an order of magnitude 150 feet offshore at Station 7A3. The 7A/7A2 hot-spot southern boundary therefore extends no farther than Station 7A3. It is noteworthy that PCB concentrations at these stations did not follow the same pattern as copper and zinc. Total PCBs were high at 7A2 (7,600 ug/kg), one-fiftieth of that concentration at 7A2, and undetectable at Station 7A3.

The southeast portion of the Fisherman's Terminal embayment represents another hot-spot area. The extreme southeast corner appears to have the most overall contaminated sediments from both phases of sampling (Stations 4F and 4F2). Other samples in Fisherman's Terminal southwest corner (4C2) and to the north (4F3 and 4F4) indicate that: 1) contaminant concentrations are inversely related to distance from 4F2, and 2) the western and northern portions of Fisherman's Terminal have low-to-moderate contamination.

Phase III sampling may have revealed a new hot-spot in the case of Station 2B2. This station was sampled to confirm clean sediments 170 feet from Phase II Station 2B. However, Station 2B2 had much higher contaminant levels than 2B, especially copper and TBT. Although differences between Stations 2B and 2B2 are probably related to sediment grain size (90% sand vs. 51% sand, respectively), this example suggests that other hot-spots may have been missed with the existing sample coverage.

Toxicity of Sediments

Samples analyzed during Phase III represent some of the most contaminated freshwater sediments Ecology has found in Washington. For instance, the highest copper concentration found during the present survey (11,000 mg/kg) surpassed all 332 detectable results listed in the SEDQUAL database. Maximum Phase III concentrations of mercury and nickel also exceeded all SEDQUAL results for these metals (265 and 234 results, respectively). Given the number of highly concentrated chemicals in many samples, a high degree of toxicity seems likely. Of the 80 bioassay tests performed on 20 samples, 49 showed significant toxicity compared to controls. However, none of the samples appeared to be extremely toxic to test organisms. Median survival for *Hyalella* and *Chironomus* were 83% and 75%, respectively (compared to an average *Chironomus* survival of 65% in reference sediments). Only one sample (8C3) had survival less than 50%. *Chironomus* growth was the most sensitive test in terms of response relative to reference sediments.

The number of chemicals in sediments, the limited sampling coverage for bioassays, and the varying degrees of contamination and bioassay response make it difficult to assess the toxic effects of individual chemicals. Likewise, the predictive and protective powers of the FSQVs are impossible to determine without more rigorous analysis of the results and are beyond the scope of this report. More general observations about sediment toxicity related to chemical concentrations suggest that sediments having the most chemicals above FSQVs also demonstrated the most toxicity to test organisms (Table 11). Sixty-one percent of the bioassay hits occurred at the ten most contaminated stations. About one-half of the bioassay hits and one-half of the total FSQV exceedences occurred at the seven most contaminated stations. Therefore, it appears there is a positive correlation between the number of contaminants above FSQVs and toxicity in a sample. Exceptions to this are samples from Stations 7A2, with seven chemicals above FSQVs and no toxic response, and 7C2 where only TBT exceeded (the PSDDA SL), yet there was significant toxicity in all four bioassays. Station 6C2 did not have chemicals above FSQVs or bioassay hits. Like the "hot-spots" of chemical concentrations in Salmon Bay, toxicity appeared to be distributed irregularly throughout Salmon Bay. Figure 5 summarizes bioassay hits for the four tests performed on the 20 Salmon Bay sediments.

Most chemicals exceeding FSQVs are organic compounds. When stations were sorted according to the number of organics above FSQVs, the pattern of bioassay hits remains the same (61% of hits occurred at the ten most contaminated stations). The ten sediments most contaminated with PAH (LPAH, HPAH, or total PAH) had 65% of the bioassay hits, the most of any chemical or group of chemicals analyzed. Carbazole appeared to be the second most toxic constituent, followed by chromium and bis(2-ethylhexyl)phthalate.

Stations sorted according to their overall metals concentrations (as in Table 5) had only 47% of the bioassay hits in the ten highest ranked samples. The least toxic metals among the ten most contaminated stations appeared to be arsenic (47% of hits), followed by nickel and lead (51% each). Even fewer hits (45%) were associated with samples having the top ten TBT concentrations. Using this approach, TBT appears to have relatively low toxicity.

Table 11. Summary of Chemicals Exceeding Freshwater Sediment Quality Values and Bioassay Hits in Salmon Bay Phase III Sediments.

	Stations																												
	4F2	8A2	2C2	2B2	4B2	4B3	8C3	3B3	5A2	3C3	3B2	6A2	3C2	7A2	1B3	4F3	6B3	4F4	8C2	5B2	6B2	4C2	5D2	7C2	7B2	7A3	10A2	10B2	6C2
CHEMICALS																													
Tributyltin*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Mercury	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X		X	X					X	
Bis(2-ethylhexyl)phthalate	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
Indeno(1,2,3-cd)pyrene	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X		X			X						
Carbazole	X	X	X	X	X	X	X		X	X	X	X		X		X		X	X										
Zinc	X	X		X	X		X	X	X	X	X		X	X	X	X			X										
Copper	X		X	X	X			X	X	X			X	X	X	X	X				X								
Dibenzo(a,h)anthracene	X	X	X	X	X	X	X		X	X	X	X	X																
Benzo(ghi)perylene	X	X	X	X	X	X	X	X	X		X	X																	
Arsenic	X						X	X						X	X														
Phenanthrene	X	X	X			X																							
Fluoranthene	X	X	X	X																									
HPAH	X	X	X	X																									
TotPAH	X	X	X	X																									
Anthracene	X	X	X																										
Pyrene	X	X	X																										
Lead	X														X														
LPAH	X		X																										
Chromium																	X				X								
Benzo(a)anthracene	X	X																											
Chrysene	X																												
Benzo(b+k)fluoranthenes	X																												
Benzo(a)pyrene	X																												
Acenaphthene	X																												
Fluorene	X																												
Number > FSQVs	24	15	15	12	9	8	8	8	8	8	8	7	7	7	7	7	6	5	5	4	3	3	3	1	1	1	1	1	0
BIOASSAYS																													
Chironomus Growth	X	X	X	X	X	X	X	X	X	X	na	X	na		X	na	X	X	na	X	na	X	na	X	X	na	--	--	
MICROTOX	X	X	X	X	X	X	X	X	X		na	X	na		X	na		X	na		na	X	na	X		na	--	--	
Hyalella Survival	X	X	X			X	X	X			na	X	na			na		X	na		na		na	X	X	na	--	--	
Chironomus Survival	X	X		X		X	X				na		na			na	X		na		na		na	X		na	--	--	
Number of Hits	4	4	3	3	2	4	4	3	2	1	--	3	--	0	2	--	2	3	--	1	--	2	--	4	2	--	--	--	0

*PSDDA Screening Level (No FSQV developed for tributyltin)
na=not analyzed

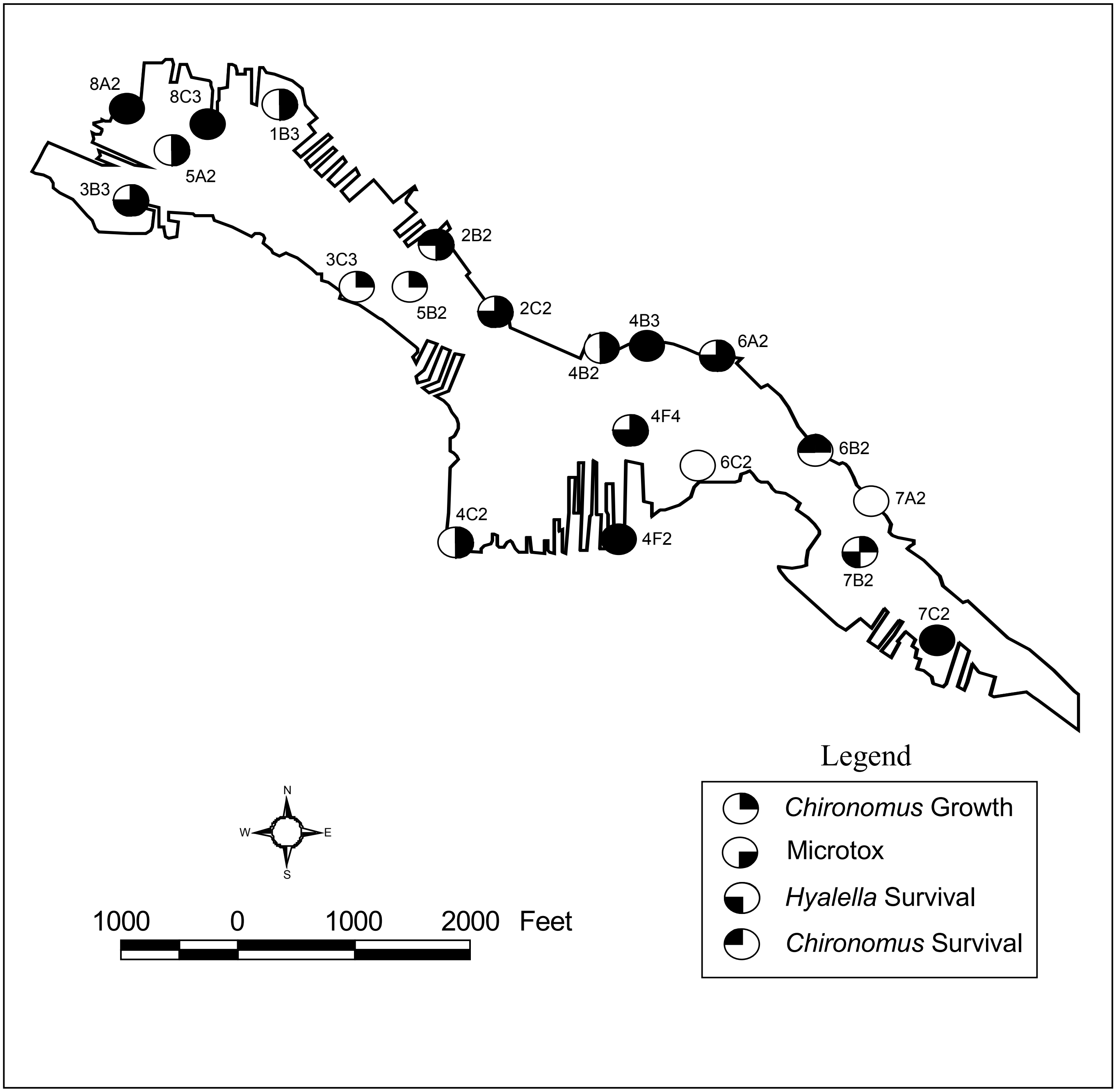

Figure 5. Summary of Bioassay Hits in Salmon Bay Phase III Sediments.

Summary and Conclusions

There is widespread chemical contamination in Salmon Bay, based on results of 27 Phase III sediment samples analyzed for metals and organics. Table 12 summarizes concentrations of the major chemical contaminants in Salmon Bay sediments. Tributyltin, mercury, bis(2-ethylhexyl)-phthalate, indeno(1,2,3-cd)pyrene, and carbazole were found at elevated concentrations in most stations. These appear to be the most pervasive problem chemicals, based on comparisons to FSQVs and the PSDDA SL.

Table 12. Summary of Major Contaminant Concentrations in Salmon Bay Phase III Sediments.

Chemical	Maximum	Minimum	Median
Metals (ug/g, dw)			
Arsenic	210	5	20
Mercury	43	0.1	0.8
Cadmium	5	<0.3	1.4
Chromium	620	24	66
Copper	11,000	48	370
Lead	1,300	12	190
Nickel	640	30	53
Zinc	4,200	84	420
Organics (ug/kg, dw)			
Low Molecular Weight PAHs (LPAH)	78,000	70	4,400
High Molecular Weight PAHs (HPAH)	250,000	1,200	15,000
Total PAH	330,000	1,300	18,000
Bis(2-ethylhexyl)phthalate	23,000	<140	2,500
Carbazole	2,900	24	170
Tributyltin (ion equivalent)	64,000	62	1,100

In some cases, chemicals were found at extremely high concentrations. The tributyltin (TBT) concentration at Station 4F2, located in the furthest southeast corner of Fisherman's Terminal, was 64,000 ug/kg TBT. This station also had extremely high concentrations of mercury (43 ug/g), copper (11,000 ug/g), lead (1,300 ug/g), zinc (4,200 ug/g), PAHs (total = 330,000 ug/kg), bis(2-ethylhexyl)phthalate (23,000 ug/kg), and carbazole (2,900 ug/kg). Other chemicals in 4F2 sediment were also found in high concentrations, making it by far the most contaminated of any station examined.

The distribution of contaminants in Salmon Bay could be characterized by "hot-spots" interspersed among a field of more moderate concentrations. These hot-spots generally occur near shore; cleaner sediments tend to be found toward the channel center. In most cases, hot-spots detected during Phase II sampling were verified by the Phase III survey. Some areas of cleaner sediments were also verified. Although Phase III sampling generally succeeded in verifying hot-spots, sample coverage was too thin to delineate the hot-spot boundaries. The thin coverage, along with the failure to verify all of the “clean” Phase II stations, suggests that additional hot-spots may have gone undetected by the two rounds of sampling conducted to date.

Most of the sediments analyzed in Phase III probably have an adverse effect on benthic organisms. This conclusion is based on: 1) comparisons to Freshwater Sediment Quality Values (FSQVs) which attempt to strike a balance between protecting aquatic organisms and predicting minimum adverse biological effects, and 2) four bioassay toxicity tests conducted on 20 of the 27 Salmon Bay sediment samples.

At least one chemical was detected above FSQVs in 23 of the 27 samples. Tributyltin concentrations were above the SL in 26 of the 27 Salmon Bay sediments. One of the reference samples (10B2) had mercury above the FSQV, and the other reference sample (10A2) had TBT above the SL. Most samples had multiple chemicals above FSQVs/SL, with seven as the median number of exceedences at each station. Only one station (6C2, located east of Fisherman's Terminal) had no chemicals above FSQVs or the SL.

Eighteen of the 20 Salmon Bay sediments were toxic to at least one bioassay organism. One-half of the samples showed a toxic response in three or more toxicity tests. The *Chironomus* growth test was the most sensitive bioassay, followed by Microtox, *Hyalella* survival, and *Chironomus* survival. Toxicity of sediments appeared to be positively correlated to the number of chemicals above FSQVs/SL, although this pattern is somewhat inconsistent. It appears that the number of organic chemicals exceeding FSQVs is more closely related to toxicity than to the degree of metals contamination in samples. A coarse analysis of the relationship between individual chemicals or chemical groups suggests that PAHs (LPAH, HPAH, or total PAH) are the most toxic, followed by carbazole, chromium, and bis(2-ethylhexyl)phthalate. Arsenic appeared to have the least toxicity among metals. TBT appeared to be the least toxic chemical analyzed in terms of relationships between relative concentration and toxic response. Like the "hot-spots" of chemical concentrations, toxicity exhibited an irregular distribution in Salmon Bay.

Recommendations

Focus sampling around highly contaminated areas (hot-spots) to better resolve and define the boundaries of contamination. Sampling should be designed to:

1. Determine concentration gradients with confidence.

2. Delineate a boundary with statistically significant differences in chemical concentration across the boundary.

The best candidates for focused sampling appear to be the areas around Stations 4F2, 8A2, and 2C2.

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Appendices

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Appendix A

Station Descriptions

Field Observations

Table A-1. Salmon Bay Phase III Station Descriptions.

Station	Sample No.	Date and Time	Depth (ft)	Lat (deg)	Lat (min)	Lat (sec)	Long (deg)	Long (min)	Long (sec)	Location Description
1B3	8281	5/21/97 12:30	15	47	40	00.06	122	23	15.30	Off Pacific Fishermen, Inc.
2B2	8282	5/20/97 16:12	30	47	39	49.38	122	22	54.48	Off 20th Ave NW
2C2	8283	5/20/97 13:23	20	47	39	42.30	122	22	48.24	Off Ballard Mill Properties
3B2	8284	5/20/97 19:23	18	47	39	50.64	122	22	35.76	Off Time Oil inside pier near end
3B3	8285	5/20/97 18:50	17	47	39	50.82	122	23	32.94	Off Time Oil inside pier east of 3B2
3C2	8286	5/20/97 17:10	36	47	39	45.60	122	23	07.74	Off float on west side of Marco Shipyard
3C3	8287	5/20/97 16:46	36	47	39	44.64	122	23	05.46	Off NW corner of Marco Shipyard drydock
4B2	(8288/8308)/8312	5/20/97 12:25	15	47	39	39.36	122	22	34.14	Off Lake Union Boat Center
4B3	8289	5/20/97 12:00	5	47	39	39.78	122	22	27.72	Off Seattle Maritime Education
4C2	8290	5/19/97 18:41	11	47	39	22.68	122	22	51.00	West End of Fishermen's Terminal
4F2	8291	5/19/97 19:55	7	47	39	24.36	122	22	30.18	East End of Fishermen's Terminal
4F3	8292	5/19/97 19:30	19	47	39	25.80	122	22	28.86	Under 15th Ave. bridge
4F4	8293	5/20/97 9:05	15	47	39	32.28	122	22	29.40	Off Bakketun & Thomas Boat Refitters
5A2	8294	5/21/97 8:44	27	47	39	56.40	122	23	28.44	North of breakwater for locks
5B2	8295	5/20/97 15:49	37	47	39	44.70	122	22	56.88	Mid-channel off 20th Ave. NW
5D2	8296	5/19/97 15:19	35	47	39	20.70	122	21	52.86	Mid-channel off Foss dock
6A2	8297	5/20/97 8:41	16	47	39	38.64	122	22	18.66	Off Commercial Marine Center by 14th Ave.
6B2	8298	5/20/97 15:06	12	47	39	30.60	122	22	05.64	Off Seattle Steel
6B3	8299	5/20/97 15:29	17	47	39	30.36	122	22	05.70	Off small cove by Seattle Steel
6C2	8300	5/20/97 9:41	16	47	39	29.88	122	22	20.82	Off unknown property
7A2	8301	5/20/97 17:42	13	47	39	26.64	122	21	58.86	By docks at Union Bay Shipbuilding
7A3	8302	5/19/97 16:59	22	47	39	25.26	122	21	59.34	Off Union Bay Shipbuilding
7B2	8303	5/19/97 16:25	21	47	39	21.78	122	21	59.16	Off west side of Foss
7C2	8304	5/19/97 15:51	18	47	39	14.88	122	21	49.98	Off Always Ready Bldg.
8A2	8305	5/21/97 9:17	15	47	39	59.04	122	23	38.70	By Army Corps Bldg. At locks
8C2	8306/8309	5/21/97 10:13	8	47	40	01.14	122	23	30.18	Off Seaborn Marine Terminal
8C3	8307	5/21/97 10:42	21	47	39	59.46	122	23	24.48	Off end of pier at Seattle Shop Bldg.
10A2	8310	5/19/97 11:30	22	47	44	49.26	122	16	25.86	Reference - Sheridan Beach in Lake Washington
10B2a	8311	5/19/97 13:30	26	47	39	48.60	122	15	50.46	Reference - Wolf Beach in Lake Washington
10B2b	8311	5/19/97 13:55	26	47	39	48.48	122	15	49.68	Reference - Wolf Beach in Lake Washington
10B2c	8311	5/19/97 14:15	26	47	39	49.68	122	15	51.06	Reference - Wolf Beach in Lake Washington

Table A-2. Field Observations Made During Phase III Sampling.

Station	Color	Odor	Oil Sheen?	Composition	Comments
1B3	dark brown	slight petroleum	slight	silt	Had terrible time obtaining sample. Moved station after 10-12 attempts. Much large debris. This is the station where they had run the boat prop with boat against dock?
2B2	dark brown	oil	yes	silty, mucky	Leaves & twigs
2C2	dark brown	none	no	silty	Chunks of organic debris
3B2	medium brown	slight petroleum	no	silty and fine	
3B3	brown	petroleum	yes	sand & silt	Chunks of debris and clay
3C2	dark brown	muddy	spots	silty muck	
3C3	dark brown	muddy	spots	muck	Tarps over dry dock opening doing poor job of containment.
4B2	very dark brown	slight muddy	slight	silty	
4B3	dark brown	sedimenty	slight	silt	A little organic debris
4C2	black/brown	none	yes	fine mucky silt	Composite of 2 grabs
4F2	brownish black		yes		Red paint chips
4F3	brownish		yes	silty sand	
4F4	greyish brown	oily, muddy	slight	silty	Large organic debris
5A2	medium brown	none	no	silt	
5B2	dark brown	rotten eggs	no	very silty, mucky	
5D2	grey		slight	sandy	2 grabs, broken glass, rusty metal, paint chips
6A2	dark brown	none	slight	silty	A few red paint chips, a little organic debris
6B2	dark brownish grey	oily, muddy	yes	silty, mucky	Large oil sheen came up with sample
6B3	dark brown	none	slight	mucky, silty	
6C2	grey		light	clay	Moved from original site which had a lot of wood debris.
7A2	medium brown		yes	silty, clay clumps	Composite of 2 grabs, large chunks of organic debris, red paint chips
7A3	grey		spots	silt & sand, chunks of clay	Wood debris, one blue paint chip
7B2	brown	none	no	sand & chunks	
7C2	grey/brown			silt & sand, chunks of clay	
8A2	brown	mild oil		silt	Composite of 3 grabs
8C2	dark brown	none	spots	lumpy silt with sand	
8C3	dark brown	none	no	silt/clay	Composite of 2 grabs. Boats were anchored at planned station. Bits of rusted metal debris, some red paint chips
10A2	chocolate	none	no	fines & silt	Big clam in grab
10B2					
10B2a	grey	none	no	silts sand	First of 3 grabs, clams.
10B2b	grey	none	no	silts sand	Second of 3 grabs, clams.
10B2c	grey	none	no	silts sand	Third of 3 grabs, clams.

Appendix B

Quality Assurance Data

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State of Washington Department of Ecology
Manchester Environmental Laboratory
7411 Beach Dr. East Port Orchard WA. 98366

July 15; 1997

Project: Salmon Bay Sediments

Samples: 21-8281-8312

Laboratory: Rosa Environmental

By: Pam Covey

Case Summary

These samples required thirty-two (32) Grain Size analyses on sediment using Puget Sound EstuaryProtocol (PSEP) method.

The samples were received at the Manchester Environmental Laboratory on May 22, 1997 and transported to Rosa Entironmental on May 29, 1997 for Grain Size analyses.

The analyses were reviewed for qualitative and quantitative accuracy, validity and usefulness.

The results are acceptable for use as reported.

ROSA ENVIRONMENTAL & GEOTECHNICAL LABORATORY, LLC.

Washington State Department of Ecology
Manchester Laboratory
Salmon Bay Project
Narrative

The following notes were taken during the analyses.

1. The samples were analyzed for grain size distribution following the Puget Sound Estuary Protocol. The samples were not treated for organics, and are thus reported as "apparent" grain size distributions. There were not any significant deviations from the procedure, nor were there any significant anomalies in the sediment samples, except as noted below.

2. Sample 21-8291 did not contain enough fines to get the required 5 grams for the pipette portion of the analysis. This small sample size may have biased the data.

3. Sample 21-8296 had a large rock, which was excluded from the analysis (it was approximately 1.5" x 1").

4. Samples 21-8298 and 21-8299 had an oily sheen during the washing and pipetteing portions of the analysis.

5. Sample 21-8303 was mostly peat, with some coarse sand. After washing the minus #230 material, the sample was oven dried at 90° C. During the oven drying, the peat formed a thick mass that resisted breaking up for the sieve portion of the analysis. Every effort was made to separate the fibers without compromising the grain size, but the chunks of peat would not break up into individual particles. The sieve data reported indicates a sample that is much more coarse that it actually was, and the data should be evaluated carefully. Also, because the sample was mostly organic and water (472% water on a dry weight basis), there was not enough fines (3.68 g.) to meet the required 5 gram minimum.

6. The triplicate run on sample 21-8307 needs to be evaluated carefully. The second sample in the triplicate had a large piece of rusted iron retained on both the #4 and #10 sieves. There were no pieces of iron visible in the other samples of the set. The presence of metal fragments may have skewed the entire analysis, if the finer fractions also contained significant amounts of metal, as the specific gravity of the sediment in the pipette portion of the analysis would be higher than accounted for by the procedure.

7. Sample 21-8309 had what appeared to be a green sequin retained on the #10 sieve.

8. Sample 21-8312 had an oily sheen on it during washing and pipetteing.

Washington State Department of Ecology
Manchester Laboratory

July 11, 1997

TO: Jim Cubbage

FROM: Aileen Richmond, Technician

THROUGH: Becky Bogaczyk, Chemist

SUBJECT: General Chemistry Quality Assurance memo: Salmon Bay, week 21.

SUMMARY

The data generated by the analysis of these samples is acceptable for use. Some samples have a holding time issue.

SAMPLE INFORMATION

These samples were received by Manchester Laboratory on 5/22/97 in good condition.

HOLDING TIMES

The samples were analyzed within the EPA holding times for total organic carbon and total solids with the exception of those samples collected on 5/19/97. Total solids (percent solids) samples # 97-218290, 91, 92, 96, and 97-218302, 3, 4, 10, and 11 were analyzed one day past the holding due to several things. The memorial day weekend, transit time, and the visit of Dan Silver to the lab were the main interferences with timely analysis.

ANALYSIS PERFORMANCE

Instrument Calibration

Where applicable, instrument calibration was performed before each analytical run and checked by initial calibration verification standards and blanks. All initial and continuing calibration verification standards were within the relevant USEPA (CLP) control limit. A correlation coefficient of 0.995 or greater was met as stated in CLP calibration requirements. The turbidimeter is standardized quarterly and calibrated with known check standards before each analytical run. All balances are calibrated yearly with calibration verification occurring monthly. Oven temperatures are recorded before and after analyses to ensure control.

Laboratory Control Sample

The laboratory controls were within acceptance windows.

Precision Data

Results from duplicate analysis were used to evaluate precision. All were within the acceptance window of ± 20 % Relative Percent Difference(RPD).

Procedural Blanks

Procedural blanks associated with these samples showed no analytically significant levels of analytes.

Other Quality Assurance Measures and Issues

The percent solid results for samples # 97-218290, 91, 92, 96, and 97-218302, 3, 4, 10, and 11 are qualified as estimates because they were analyzed one day past the holding time.

Total organic carbon samples # 97-218292, 95, and 97-218308 do not have replicate results for the 104°C analysis because the analyst running the 104°C determination did not duplicate the same samples as the analyst running the total organic carbon and 70°C percent solids determination.

Please call Aileen Richmond at 360-871-8823, or Becky Bogaczyk if you have any questions.

cc: Bill Kammin
Project file

Table B-1. Precision of Field Sampling and Laboratory Analysis for Grain Size Composition.

Sample No.	Station	QA type		<4750 um	2000-4750 um	1000-2000 um	500-1000 um	200-500 um	125-200 um	62-125 um	31-62 um	15.6-31 um	7.8-15.6 um	3.9-7.8 um	2-3.9 um	1-2 um	<1 um
97218288	4B2	split	%	0	0	0	1	3	7	10	15	20	17	10	7	5	5
97218308	9A2	split	%	0	0	1	0	2	5	10	15	21	18	12	7	8	1
			mean=	0	0	1	1	2	6	10	15	20	18	11	7	6	3
			RPD=			200%	200%	50%	33%	0%	0%	5%	6%	18%	0%	50%	133%
97218288/97218308	4B2/9A2	fld rep	%	0	0	1	1	2	6	10	15	20	18	11	7	6	3
97218312	9C2	fld rep	%	0	0	0	1	1	3	12	20	16	18	18	8	0	3
			mean=	0	0	0	1	2	4	11	18	18	18	14	8	3	3
			RPD=			200%	67%	57%	75%	18%	29%	22%	3%	50%	13%	185%	0%
97218306	8C2	split	%	0	0	1	3	13	31	15	10	9	6	5	2	3	2
97218309	9B2	split	%	0	0	1	3	11	28	14	10	8	8	8	5	4	0
			mean=	0	0	1	3	12	30	14	10	8	7	6	4	4	1
			RPD=			0%	0%	17%	10%	7%	0%	13%	29%	50%	75%	25%	200%
97218307	8C3	lab rep	%	0	1	4	4	3	3	4	6	17	19	14	8	9	8
97218307	8C3	lab rep	%	3	2	2	4	4	3	4	5	17	19	14	9	7	7
97218307	8C3	lab rep	%	0	0	4	4	3	3	4	8	16	20	14	10	7	7
			mean=	1	1	3	4	3	3	4	6	17	19	14	9	8	7
			RSD=	173%	100%	38%	0%	19%	0%	0%	25%	3%	3%	0%	11%	14%	8%
97218310	10A2	lab rep	%	0	0	0	0	1	8	19	12	22	14	13	7	3	1
97218310	10A2	lab rep	%	0	0	0	0	1	7	17	13	21	15	14	9	2	1
97218310	10A2	lab rep	%	0	0	0	0	2	7	17	15	18	17	13	8	2	1
			mean=	0	0	0	0	1	7	18	13	20	15	13	8	2	1
			RSD=					58%	8%	6%	12%	10%	10%	4%	13%	29%	0%

Table B-2. Precision of Field Sampling and Laboratory Analysis for Organic Carbon and Solids Composition.

Sample No.	Station	QA type		TOC70	TOC104	Solids	
97218288	4B2	split	%	6.5	6.4	26.6	
97218308	9A2	split	%	6.0	6.2	26.5	
			mean=	6.2	6.3	26.6	
			RPD=	8.1%	3.2%	0.4%	
97218288/9721	4B2/9A2	fld rep	%	6.2	6.3	26.6	
97218312	9C2	fld rep	%	5.9	6.5	27.2	
			mean=	6.2	6.4	26.9	
			RPD=	4.8%	3.1%	2.4%	
97218306	8C2	split	%	4.2	4.4	44.2	
97218309	9B2	split	%	4.4	4.6	42.7	
			mean=	4.3	4.5	43.4	
			RPD=	4.7%	4.4%	3.5%	
97218292	4F3	lab rep	%	7.6			
97218292	4F3	lab rep	%	7.4			
97218292	4F3	lab rep	%	7.1			
			mean =	7.4			
			RSD=	3.4%			
97218295	5B2	lab rep	%	4.9			
97218295	5B2	lab rep	%	5.2			
			mean =	5.0			
			RPD=	6.0%			
97218308	9A2	lab rep	%	6.0			
97218308	9A2	lab rep	%	5.9			
97218308	9A2	lab rep	%	6.1			
			mean =	6.0			
			RSD=	1.7%			
97218290	4C2	lab rep	%			38.1	H
97218290	4C2	lab rep	%			38.2	H
			mean=			38.2	
			RPD=			0.3%	
97218300	6C2	lab rep	%			45.6	
97218300	6C2	lab rep	%			45.9	
			mean =			45.8	
			RPD=			0.7%	
97218310	10A2	lab rep	%			38.2	H
97218310	10A2	lab rep	%			38.3	H
			mean =			38.2	
			RPD=			0.3%	
97218312	9C2	lab rep	%			27.0	
97218312	9C2	lab rep	%			27.4	
			mean =			27.2	
			RPD=			1.5%	

H=Exceeds recommended holding time

July 3, 1997

To: Jim Cubbage RJK

From: Randy Knox, Metals Chemist

Subject: Salmon Bay Project Sediment

QUALITY ASSURANCE SUMMARY

Data quality for this project is generally good. High iron levels in some samples interfered with arsenic. Samples 97218298 and 97218299 had extremely high iron levels. Cadmium on 97218298 showed poor replicate precision. No other significant quality assurance issues are noted with the data.

SAMPLE INFORMATION

The samples from the Salmon Bay Project were received by the Manchester Laboratory on 5/22/97 in good condition.

HOLDING TIMES

All analyses were performed within the USEPA Contract Laboratory Program (CLP) holding times for metals analysis (28 days for mercury, 180 days for all other metals).

INSTRUMENT CALIBRATION

Instrument calibration was performed before each analytical run and checked by initial calibration verification standards and blanks. Continuing calibration standards and blanks were analyzed at a frequency of 10% during the run and again at the end of the analytical run. All initial and continuing calibration verification standards were within the relevant USEPA (CLP) control limits. AA calibration gave a correlation coefficient (r) of 0.995 or greater, also meeting CLP calibration requirements. Internal standard used for ICP-MS analysis of arsenic was outside allowed limits for the high iron sample, 97218298 and 97218299. Arsenic data for these samples is qualified J, as estimated.

PROCEDURAL BLANKS

The procedural blanks associated with these samples show no analytically significant levels of analyte.

SPIKED SAMPLES ANALYSIS

Spiked and duplicate spiked sample analysis were performed on this data set. All spike recoveries are within the CLP acceptance limits of +/- 25%.

PRECISION DATA

The results of the spiked and duplicate spiked samples are used to evaluate precision on this sample set. The relative percent difference (RPD) for all analytes is within the 20% CLP acceptance window for duplicate analysis. One spiked sample pair in the mercury analysis showed a relative percent difference of 21. Since we also ran a duplicate of this sample with the RPD within the allowed 20%, data was not qualified based on this result. ICP data showed a high relative standard deviation of results for cadmium on sample 97218298. Cadmium data, for this sample only, is qualified J as estimated.

SERIAL DILUTION

A five times serially diluted portion of several samples was analyzed by ICP and the analytical results, corrected for dilution were compared to the original sample analyses as a test for interference. The RPD (relative % difference) for all analytes at levels greater than 50 times the detection level was within the allowed 10%. Arsenic levels less than 200 mg/Kg , determined by ICP, on samples with iron greater than 50000 mg/Kg are qualified J. Interference was noted to be significant for lower level arsenic samples for this iron level.

LABORATORY CONTROL SAMPLE (LCS) ANALYSIS

LCS analyses are within the windows established for each parameter.

Please call Randy Knox at SCAN 360-871-8811 or Jim Ross at SCAN 360-871-8808 to further discuss this project.

RLK:rlk

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
MANCHESTER ENVIRONMENTAL LABORATORY
7411 Beach Drive East • Port Orchard, Washington 98366-8204 • (360) 871-8860 • FAX (360) 871-8850

August 14, 1997

TO: Jim Cubbage
EILS

THROUGH: Bill Kammin
Laboratory Director

FROM: Susan Davis
Mercury Analyst

SUBJECT: Replacement of Mercury Analysis Report

Please replace your current Mercury Analysis Report for Salmon Bay with this version. This new report has been corrected to an actual Dry Weight unit value. It was the policy of the Manchester Laboratory, prior to August 1 of this year, to report Mercury in sediment on a wet-weight, or as-received, basis. At the request of our clients we will discontinue this practice. All future sediments analyzed for Mercury will reflect a Dry Weight value.

Thank you for your patience with this cross-over, and please let us know if you have other suggestions or questions where we might be of help to you.

SD

Attachment

Table B-3. Precision and Accuracy of Metals Data.

Sample No.	QA Type	Field ID	As EPA 200.8	As EPA 200.7	Hg	Cd	Cr	Cu	Pb	Ni	Zn
8288	Field Splits (ug/g, dry)	4B2	14.3	na	0.8	2.1	133	619	204	113	527
8308		9A2	13.5	na	0.972	1.8	107	484	177	94.7	418
		mean=	13.9		0.9	2.0	120	552	191	104	473
		RPD=	6%		19%	15%	22%	24%	14%	18%	23%
8306	Field Splits (ug/g, dry)	8C2	12.1	na	1.1	1.2	44.7	207	196	40.4	416
8309		9B2	11.6	na	1.3	1.4	44.9	204	192	37	422
		mean=	11.9		1.2	1.3	44.8	205.5	194	39	419
		RPD=	4%		17%	15%	0.4%	1%	2%	9%	1%
8288/8308	Field Replicates (ug/g, dry)	4B2/9A2	13.9	na	0.9	2.0	120	552	191	104	473
8312		9C2	13	na	1.03	1.5 U	122	520	184	101	433
		mean=	13		1.0		121	536	187	102	453
		RPD=	7%		15%		2%	6%	3%	3%	9%
8285	Lab Duplicates (ug/g, dry)	3B3	na	na	2.48	na	na	na	na	na	na
8285		3B3	na	na	3	na	na	na	na	na	na
		mean=			2.7						
		RPD=			19%						
8303	Lab Duplicates (ug/g, dry)	7B2	na	na	0.075	na	na	na	na	na	na
8303		7B2	na	na	0.119	na	na	na	na	na	na
		mean=			0.097						
		RPD=			45%						
8281	Matrix Spikes (% recov.)	1B3	100	95	na	90	88	NC	82	84	NC
8281		1B3	100	89	na	94	82	NC	82	85	NC
		mean=	100	92		92	85		82	85	
		RPD=	0%	7%		4%	7%		0%	1%	
8312	Matrix Spikes (% recov.)	9C2	86	91	na	104	80	NC	112	84	104
8312		9C2	79	89	na	108	103	NC	106	95	103
		mean=	83	90		106	92		109	90	104
		RPD=	8%	2%		4%	25%		6%	12%	1%
8303	Matrix Spikes (% recov.)	7B2	na	na	107	na	na	na	na	na	na
8303		7B2	na	na	107	na	na	na	na	na	na
		mean=			107						
		RPD=			0%						
LCS71269	Lab Control Samples (% recov.)	M7155SL1	94	94	na	98	96	98	107	100	94
LCS71270		M7155SL2	90	88	na	93	90	91	102	93	88
		mean=	92	91		96	93	95	105	97	91
		RPD=	4%	7%		5%	6%	7%	5%	7%	7%
27071264	Lab Control Samples (% recov.)	M7154SG	na	na	99	na	na	na	na	na	na
BLN71267	Lab Blanks (ug/g, dry)	M7155SB1	3 U	0.3 U	na	0.3 U	0.5 U	1 U	2 U	1 U	2 U
BLN71268		M7155SB2	3 U	0.3 U	na	0.3 U	0.5 U	1 U	2 U	1 U	2 U
BLN71263		M7154SH	na	na	0.005 U	na	na	na	na	na	na

U=Undetected at concentration shown

na=not analyzed

NC=Not Calculated

MANCHESTER ENVIRONMENTAL LABORATORY

7411 Beach Drive E , Port Orchard Washington 98366

CASE NARRATIVE

September 19, 1997

Subject: Salmon Bay

Samples: 97218281 to 97218312

Case No. 1259-97

Officer: Jim Cubbage

By: **Dickey D. Huntamer**
Organics Analysis Unit

SEMIVOLATILE ORGANICS

ANALYTICAL METHODS:

The semivolatile soil samples were extracted with acetone following the Manchester modification of the EPA CLP and SW 846 8270 procedure with capillary GC/MS analysis of the sample extracts. Normal QA/QC procedures were performed with the analyses. Most of the samples had a high water content and low percent, solids. Consequently a solvent back extraction of the water layer remaining after the Soxhlet extraction was used in addition to sodium sulfate to dry the extracts.

HOLDING TIMES:

All sample and extraction holding times were within the recommended limits.

BLANKS:

Low levels of some target compounds were detected in the laboratory blanks. The EPA five times rule was applied to all target compounds which were found in the blank. Compounds that were found in the sample and in the blank were considered real and not the result of contamination if the levels in the sample are greater than or equal to five times the amount of compounds in the associated method blank.

SURROGATES:

The normal Manchester Laboratory surrogates were added to the sample prior to extraction. Generally surrogate recoveries were within acceptable limits except for sample 97218281 which had 4% to 13% recoveries of all analytes. The data, for 97218281 was "J" qualified. A few other samples 97-218299, 97218298, 972182886, 972182887, 972182895 and 97218309 had one surrogate below the recommended guidelines but all other surrogates were acceptable and no qualifiers were added to the data.

Sample 97218289 had six of eight surrogates which were higher than the guidelines which was probably due to the low internal standard areas. Those compound results in sample 97218289 affected by the internal standard areas were "J" qualified.

MATRIX SPIKE AND MATRIX SPIKE DUPLICATE:'

Matrix spike recoveries were low (<40%) for pyridine, aniline, 2,2'oxybis(1-chloropropane), hexchloroethane, nitrobenzene, hexachlorocylcopentadiene, 3 and 4-nitroanilines, and 4-chloroaniline. High native concentrations caused low calculated recoveries for pyrene, chrysene, bis-(2-ethylhexyl)phthalate and benzo(b)fluoranthene. The "J" qualifier was added to the results for these compounds in the matrix source sample 97218294. Hexachlorocyclopentadiene was not recovered and the data in the source sample was flagged as rejected "REJ".

ANALYTICAL COMMENTS:

No special analytical problems were encountered in the semivolatile analyses other one sample with low surrogates and another with low internal standard area counts. One other analytical problem was the high water content which in some samples exceeded 70%. This resulted in higher quantitation limits for some samples.

Quantitation limits were reported not detection limits. Detection limits were generally three or four times lower than the quantitation limits. An example is sample 97218311 where the quantitation limit for naphthalene and the methylnaphthalenes is 63U but the analytes were detected at 18J, 16J and 8J respectively. The data is acceptable for use as qualified.

DATA QUALIFIER CODES:

U - The analyte was not detected at or above the reported value.

J - The analyte was positively identified. The associated numerical value is an estimate.

UJ - The analyte was not detected at or above the reported estimated result.

REJ - The data are unusable for all purposes.

EXP - The result is equal to the number before EXP times 10 to the power of the number after EXP. As an example 3EXP6 equals 3 X 10^6.

NAF - Not analyzed for.

N - For organic analytes there is evidence the analyte is present in this sample.

NJ - There is evidence that the analyte is present. The associated numerical result is an estimate.

E - This qualifier is used when the concentration of the associated value exceeds the known calibration range.

bold - The analyte was present in the sample. (Visual Aid to locate detected compound on report sheet.)

Table B-4. Precision and Accuracy of Semivolatile Organics Data.

Sample No.	Station	QA type	Units	N-Nitrosodimethylamine	Pyridine	Aniline	Phenol	Bis(2-Chloroethyl)Ether	2-Chlorophenol	1,3-Dichlorobenzene	1,4-Dichlorobenzene	1,2-Dichlorobenzene	Benzyl Alcohol	2-Methylphenol
97218294	5A2	LMX1	%	47	NAF	3	66	49	64	46	47	50	75	67
97218294	5A2	LMX2	%	40	NAF	4	52	40	51	42	45	46	58	51
		RPD=		16%		29%	24%	20%	23%	9%	4%	8%	26%	27%
97218288	4B2	split	ug/Kg	659 U	659 UJ	659 U	172	132 U	132 U	132 U	264 U	264 U	130 J	93 J
97218308	9A2	split	ug/Kg	616 U	616 UJ	616 U	171	123 U	123 U	123 U	246 U	246 U	211	246 U
		mean	ug/Kg	616 U	616 UJ	616 U	172	123 U	123 U	123 U	246 U	246 U	170 J	93 JFSU
		RPD=					1%						48%	
97218288/97218308	4B2/9A2	fld rep	ug/Kg	616 U	616 UJ	616 U	172	123 U	123 U	123 U	246 U	246 U	170 J	93 JFSU
97218312	9C2	fld rep	ug/Kg	635 U	254 UJ	635 U	181	127 U	127 U	127 U	27 J	254 U	127 U	96 J
		mean	ug/Kg	616 U	254 UJ	616 U	176	123 U	123 U	123 U	27 JFRU	246 U	170 JFRU	93 J
		RPD=					5%							3%
97218306	8C2	split	ug/Kg	360 U	360 UJ	360 U	63 J	72 U	72 U	72 U	111 J	144 U	72 U	144 U
97218309	9B2	split	ug/Kg	441 U	441 UJ	441 U	102	88 U	88 U	88 U	76 J	176 U	31 J	72 J
		mean	ug/Kg	360 U	360 UJ	360 U	82 J	72 U	72 U	72 U	94 J	144 U	31 JFSU	72 JFSU
		RPD=					48%				37%			
BLN72138	OBS7148B1	BLNK	ug/Kg	267 U	267 U	267 U	133 U	267 U	267 U	267 U	267 U	267 U	267 U	133 U
BLN72139	OBS7148B2	BLNK	ug/Kg	267 U	267 U	267 U	133 U	267 U	267 U	267 U	267 U	267 U	267 U	133 U
BLN72140	OBS7153A	BLNK	ug/Kg	267 U	**1850**	267 U	133 U	267 U	267 U	267 U	267 U	267 U	267 U	133 U

U= Undetected at concentration shown
J= Estimated concentration
NAF= Not analyzed for
FSU= Field split undetected
FRU= Field rep undetected

Table B-4. Precision and Accuracy of Semivolatile Organics Data.

Sample No.	Station	QA type	Units	2,2'-Oxybis[1-chloropropane]	N-Nitroso-Di-N-Propylamine	4-Methylphenol	Hexachloroethane	Nitrobenzene	Isophorone	2-Nitrophenol	2,4-Dimethylphenol	Bis(2-Chloroethoxy)Methane	Benzoic Acid	2,4-Dichlorophenol	1,2,4-Trichlorobenzene
97218294	5A2	LMX1	%	NAF	58	71	6	52	66	56	67	73	124	86	68
97218294	5A2	LMX2	%	NAF	46	50	5	36	51	41	52	56	100	66	56
		RPD=			23%	35%	18%	36%	26%	31%	25%	26%	21%	26%	19%
97218288	4B2	split	ug/Kg	264 U	264 U	476	264 U	659 U	132 U	659 U	132 U	132 U	2910 J	132 U	132 U
97218308	9A2	split	ug/Kg	246 U	246 U	497	246 U	616 U	526 U	616 U	123 U	123 U	2950 J	123 U	123 U
		mean	ug/Kg	246 U	246 U	486	246 U	616 U	526 U	616 U	123 U	123 U	2930 J	123 U	123 U
		RPD=				4%							1%		
97218288/97218308	4B2/9A2	fld rep	ug/Kg	246 U	246 U	486	246 U	616 U	526 U	616 U	123 U	123 U	2930 J	123 U	123 U
97218312	9C2	fld rep	ug/Kg	254 U	254 U	538	254 U	635 U	127 U	635 U	127 U	127 U	2540 UJ	127 U	127 U
		mean	ug/Kg	246 U	246 U	512	246 U	616 U	127 U	616 U	123 U	123 U	2930 JFRU	123 U	123 U
		RPD=				10%									
97218306	8C2	split	ug/Kg	144 U	144 U	591	144 U	360 U	72 U	360 U	72 U	72 U	1650 J	72 U	72 U
97218309	9B2	split	ug/Kg	176 U	176 U	631	176 U	441 U	88 U	441 U	88 U	88 U	1830 J	88 U	88 U
		mean	ug/Kg	144 U	144 U	611	144 U	360 U	72 U	360 U	72 U	72 U	1740 J	72 U	72 U
		RPD=				7%							10%		
BLN72138	OBS7148B1	BLNK	ug/Kg	133 U	267 U	133 U	267 U	133 U	133 U	267 U	133 U	133 U	2670 UJ	133 U	133 U
BLN72139	OBS7148B2	BLNK	ug/Kg	133 U	267 U	133 U	267 U	133 U	133 U	267 U	133 U	133 U	2670 UJ	133 U	133 U
BLN72140	OBS7153A	BLNK	ug/Kg	133 U	267 U	133 U	267 U	133 U	133 U	267 U	133 U	133 U	2670 UJ	133 U	133 U

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FRU= Field rep undetected

Table B-4. Precision and Accuracy of Semivolatile Organics Data.

Sample No.	Station	QA type	Units	Naphthalene	4-Chloroaniline	Hexachlorobutadiene	4-Chloro-3-Methylphenol	2-Methylnaphthalene	1-Methylnaphthalene	Hexachlorocyclopentadiene	2,4,6-Trichlorophenol	2,4,5-Trichlorophenol	2-Chloronaphthalene	2-Nitroaniline	Dimethylphthalate
97218294	5A2	LMX1	%	65	2	61	76	79	NAF	REJ	86	89	74	75	75
97218294	5A2	LMX2	%	46	3	54	55	61	NAF	REJ	67	65	56	53	55
		RPD=		34%	40%	12%	32%	26%			25%	31%	28%	34%	31%
97218288	4B2	split	ug/Kg	3220	659 U	132 U	264 U	555	192	659 UJ	264 U	264 U	132 U	659 U	311
97218308	9A2	split	ug/Kg	1420	616 U	123 U	246 U	598	303	616 UJ	246 U	246 U	123 U	616 U	302
		mean	ug/Kg	2320	616 UJ	246 U	246 U	576	248	616 UJ	246 U	246 U	123 U	616 U	306
		RPD=		78%				7%	45%						3%
97218288/97218308	4B2/9A2	fld rep	ug/Kg	2320	616 UJ	246 U	246 U	576	248	616 UJ	246 U	246 U	123 U	616 U	306
97218312	9C2	fld rep	ug/Kg	1080	635 U	127 U	254 U	471	240	635 UJ	254 U	254 U	127 U	635 U	253
		mean	ug/Kg	1700	616 UJ	127 U	246 U	471	244	616 UJ	246 U	246 U	123 U	616 U	280
		RPD=		73%				22%	3%						19%
97218306	8C2	split	ug/Kg	472	360 U	72 U	144 U	227	102	360 UJ	144 U	144 U	72 U	360 U	52 J
97218309	9B2	split	ug/Kg	421	441 U	88 U	176 U	213	99	441 UJ	176 U	176 U	88 U	441 U	43 J
		mean	ug/Kg	446	360 U	72 U	144 U	220	100	360 UJ	144 U	144 U	72 U	360 U	48 J
		RPD=		11%				6%	3%						19%
BLN72138	OBS7148B1	BLNK	ug/Kg	133 U	133 U	133 U	133 U	133 U	133 U	1330 UJ	267 U	267 U	133 U	667 U	267 U
BLN72139	OBS7148B2	BLNK	ug/Kg	133 U	133 U	133 U	133 U	133 U	133 U	1330 UJ	267 U	267 U	133 U	667 U	267 U
BLN72140	OBS7153A	BLNK	ug/Kg	133 U	133 U	133 U	133 U	**5.5** J	**3.3** J	1330 UJ	267 U	267 U	133 U	667 U	267 U

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FSU= Field split undetected
FRU= Field rep undetected

Table B-4. Precision and Accuracy of Semivolatile Organics Data.

Sample No.	Station	QA type	Units	2,6-Dinitrotoluene	Acenaphthylene	3-Nitroaniline	Acenaphthene	2,4-Dinitrophenol	4-Nitrophenol	Dibenzofuran	2,4-Dinitrotoluene	Diethylphthalate	Fluorene	4-Chlorophenyl-Phenylether
97218294	5A2	LMX1	%	62	71	14	68	73	67	73	62	75	70	77
97218294	5A2	LMX2	%	45	53	12	51	60	48	59	47	56	54	58
		RPD=		32%	29%	15%	29%	20%	33%	21%	28%	29%	26%	28%
97218288	4B2	split	ug/Kg	659 U	314	659 U	316	1320 UJ	659 U	443	1320 U	132 U	507	132 U
97218308	9A2	split	ug/Kg	616 U	394	616 U	407	1230 UJ	616 U	384	1230 U	123 UJ	609	123 U
		mean	ug/Kg	616 U	354	616 U	362	1230 UJ	616 U	414	1230 U	123 UJ	558	123 U
		RPD=			23%		25%			14%			18%	
97218288/97218308	4B2/9A2	fld rep	ug/Kg	616 U	354	616 U	362	1230 UJ	616 U	414	1230 U	123 UJ	558	123 U
97218312	9C2	fld rep	ug/Kg	635 U	331	635 U	378	1270 UJ	635 U	359	1270 U	127 U	557	127 U
		mean	ug/Kg	616 U	342	616 U	370	1230 UJ	616 U	386	1230 U	123 UJ	558	123 U
		RPD=			7%		4%			14%			0%	
97218306	8C2	split	ug/Kg	360 U	112	360 U	216	720 U	360 U	205	720 U	72 U	328	72 U
97218309	9B2	split	ug/Kg	441 U	112	441 U	272	883 UJ	441 U	228	883 U	88 J	322	88 U
		mean	ug/Kg	360 U	112	360 U	244	720 U	360 U	216	720 U	88 JFSU	325	72 U
		RPD=			0%		23%			11%			2%	
BLN72138	OBS7148B1	BLNK	ug/Kg	267 U	133 U	267 U	133 U	2670 UJ	667 U	133 U	667 U	**26** J	133 U	133 U
BLN72139	OBS7148B2	BLNK	ug/Kg	267 U	**6.7** J	267 U	133 U	2670 UJ	667 U	133 U	667 U	**22** J	133 U	133 U
BLN72140	OBS7153A	BLNK	ug/Kg	267 U	**6.6** J	267 U	**16** J	2670 UJ	667 U	**8.1** J	667 U	**16** J	**13** J	133 U

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Table B-4. Precision and Accuracy of Semivolatile Organics Data.

Sample No.	Station	QA type	Units	4-Nitroaniline	4,6-Dinitro-2-Methylphenol	N-Nitrosodiphenylamine	1,2-Diphenylhydrazine	4-Bromophenyl-Phenylether	Hexachlorobenzene	Pentachlorophenol	Phenanthrene	Anthracene	Caffeine	Carbazole
97218294	5A2	LMX1	%	32	62	55	60	84	81	61	60	73	NAF	NAF
97218294	5A2	LMX2	%	15	47	44	45	64	61	46	47	55	NAF	NAF
		RPD=		72%	28%	22%	29%	27%	28%	28%	24%	28%		
97218288	4B2	split	ug/Kg	264 U	1320 U	132 U	132 U	132 U	132 U	706	2080	660	132 U	124 J
97218308	9A2	split	ug/Kg	246 U	1230 U	123 U	123 U	123 U	123 U	836	2670	880	123 U	236
		mean	ug/Kg	246 U	1230 U	123 U	123 U	123 U	123 U	771	2375	770	123 U	180 J
		RPD=								17%	25%	29%		62%
97218288/97218308	4B2/9A2	fld rep	ug/Kg	246 U	1230 U	123 U	123 U	123 U	123 U	771	2375	770	123 U	180 J
97218312	9C2	fld rep	ug/Kg	254 U	1270 U	127 U	127 U	127 U	127 U	652	2370	744	127 U	178
		mean	ug/Kg	246 U	1230 U	123 U	123 U	123 U	123 U	712	2372	757	123 U	179 J
		RPD=								17%	0%	3%		1%
97218306	8C2	split	ug/Kg	144 U	720 U	72 U	72 U	72 U	72 U	269 J	1600	358	72 U	139
97218309	9B2	split	ug/Kg	176 U	883 U	88 U	88 U	88 U	88 U	329 J	1830	360	88 U	182
		mean	ug/Kg	144 U	720 U	72 U	72 U	72 U	72 U	299 J	1715	359	72 U	160
		RPD=								20%	13%	1%		27%
BLN72138	OBS7148B1	BLNK	ug/Kg	1330 U	1330 U	133 U	133 U	133 U	133 U	1330 U	133 U	133 U	133 U	133 U
BLN72139	OBS7148B2	BLNK	ug/Kg	1330 U	1330 U	133 U	133 U	133 U	133 U	1330 U	133 U	133 U	133 U	133 U
BLN72140	OBS7153A	BLNK	ug/Kg	1330 U	1330 U	133 U	133 U	133 U	133 U	1330 U	**76** J	**22** J	133 U	**12** J

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Table B-4. Precision and Accuracy of Semivolatile Organics Data.

Sample No.	Station	QA type	Units	Di-N-Butylphthalate	Fluoranthene	Benzidine	Pyrene	Retene	Butylbenzylphthalate	Benzo(a)anthracene	3,3'-Dichlorobenzidine	Chrysene	Bis(2-Ethylhexyl) Phthalate
97218294	5A2	LMX1	%	73	71	NAF	44	NAF	74	68	NAF	65	36
97218294	5A2	LMX2	%	59	56	NAF	22	NAF	56	48	NAF	39	36
		RPD=		21%	24%		67%		28%	34%		50%	0%
97218288	4B2	split	ug/Kg	805	3370	264 U	3540	5400	274	1180	264 U	1710	4330
97218308	9A2	split	ug/Kg	597	4050	246 U	3600	3290	246 U	1550	246 U	2110	4170
		mean	ug/Kg	701	3710	246 U	3570	4345	274 FSU	1365	246 U	1910	4250
		RPD=		30%	18%		2%	49%		27%		21%	4%
97218288/97218308	4B2/9A2	fld rep	ug/Kg	701	3710	246 U	3570	4345	274 FSU	1365	246 U	1910	4250
97218312	9C2	fld rep	ug/Kg	261	3720	254 U	3760	3160	286	1390	254 U	1970	4240
		mean	ug/Kg	481	3715	246 U	3665	3752	280	1378	246 U	1940	4245
		RPD=		91%	0%		5%	32%	4%	2%		3%	0%
97218306	8C2	split	ug/Kg	132 J	2530	144 U	2070	1080	223	722	144 U	973	3090
97218309	9B2	split	ug/Kg	175 J	2800	176 U	2300	1030	159 J	881	176 U	1180	2780
		mean	ug/Kg	154 J	2665	144 U	2185	1055	191 J	802	144 U	1076	2935
		RPD=		28%	10%		11%	5%	34%	20%		19%	11%
BLN72138	OBS7148B1	BLNK	ug/Kg	**48** J	133 U	267 U	133 U	133 U	133 U	133 U	2670 U	133 U	**34** J
BLN72139	OBS7148B2	BLNK	ug/Kg	**123** J	133 U	267 U	133 U	133 U	133 U	133 U	2670 U	133 U	**36** J
BLN72140	OBS7153A	BLNK	ug/Kg	**47** J	**49** J	267 U	**52** J	133 U	133 U	133 U	2670 U	**20** J	**26** J

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Table B-4. Precision and Accuracy of Semivolatile Organics Data.

Sample No.	Station	QA type	Units	Di-N-Octyl Phthalate	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Benzo(a)pyrene	3B-Coprostanol	Indeno(1,2,3-cd)pyrene	Dibenzo(a,h)anthracene	Benzo(ghi)perylene
97218294	5A2	LMX1	%	60	59	75	67	NAF	76	79	72
97218294	5A2	LMX2	%	49	36	57	44	NAF	53	57	46
		RPD=		20%	48%	27%	41%		36%	32%	44%
97218288	4B2	split	ug/Kg	659 U	2080	751	1620	2820	1350	294	1520
97218308	9A2	split	ug/Kg	616 U	2540	880	1870	2770	1510	329	1620
		mean	ug/Kg	616 U	2310	816	1745	2795	1430	312	1570
		RPD=			20%	16%	14%	2%	11%	11%	6%
97218288/97218308	4B2/9A2	fld rep	ug/Kg	616 U	2310	816	1745	2795	1430	312	1570
97218312	9C2	fld rep	ug/Kg	635 U	2510	806	1800	3590	1460	332	1620
		mean	ug/Kg	616 U	2410	811	1772	31922	1445	322	1595
		RPD=			8%	1%	3%	2%	2%	6%	3%
97218306	8C2	split	ug/Kg	360 U	1130	406	689	4780	586	159	544
97218309	9B2	split	ug/Kg	441 U	1280	492	822	3890	657	184	592
		mean	ug/Kg	360 U	1205	449	756	4335	622	172	568
		RPD=			12%	19%	18%	21%	11%	15%	8%
BLN72138	OBS7148B1	BLNK	ug/Kg	1330 U	133 U	133 U	133 U	1330 U	267 U	133 U	133 U
BLN72139	OBS7148B2	BLNK	ug/Kg	1330 U	133 U	133 U	133 U	1330 U	267 U	133 U	133 U
BLN72140	OBS7153A	BLNK	ug/Kg	1330 U	**10** J	**5.9** J	**8.9** J	1330 U	267 U	133 U	133 U

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Table B-5. Results of PAH Standard Reference Material Analysis (NRCC HS-6; µg/Kg, dry).

	HS672141	HS672142	RPD	NRCC HS-6 Certified Values
Anthracene	965	956	1%	1100 ± 400
Pyrene	2470	2610	6%	3000 ± 600
Benzo(ghi)perylene	1570	1630	4%	1780 ± 720
Indeno(1,2,3-cd)pyrene	1910	1970	3%	1950 ± 580
Benzo(b)fluoranthene	3370	$\boxed{3710}$	10%	2800 ± 600
Fluoranthene	3400	3500	3%	3540 ± 650
Benzo(k)fluoranthene	1450	1440	1%	1430 ± 150
Acenaphthylene	$\boxed{450}$	$\boxed{470}$	4%	190 ± 50
Chrysene	2110	2180	3%	2000 ± 300
Benzo(a)pyrene	$\boxed{1640}$	$\boxed{1600}$	2%	2200 ± 400
Dibenzo(a,h)anthracene	503	503	0%	490 ± 160
Benzo(a)anthracene	$\boxed{1390}$	1520	9%	1800 ± 300
Acenaphthene	162 J	$\boxed{148}$ J	9%	230 ± 70
Phenanthrene	3000	3050	2%	3000 ± 600
Fluorene	402	413	3%	470 ± 120
Naphthalene	3790	3540	7%	4100 ± 1100

J = estimated concentration

$\boxed{}$ = outside range of certified values

MANCHESTER ENVIRONMENTAL LABORATORY

7411 Beach Drive E , Port Orchard Washington 98366

CASE NARRATIVE

September 19, 1997

Subject: Salmon Bay

Samples: 97218281 to 97218312

Case No. 1259-97

Officer: Jim Cubbage

By: Dickey D. Huntamer
Organics Analysis Unit

TRIBUTYL TINS

ANALYTICAL METHODS:

The samples were extracted following the methods given in Puget Sound Estuary Program (PSEP) "Recommended Guidelines for Measuring Organic Compounds in Puget Sound Sediment and Tissue Samples" Recommended Methods for Organotin Compounds. The samples were extracted by tumbling with sodium sulfate and methylene chloride/10% methanol and 0.1% by weight tropolone. After extraction the samples were solvent exchanged to hexane. The organotin compounds were hexylated using the Grignard reaction given in Krone et al (1989) including the silica gel/alumina cleanup. Analysis was done by capillary Gas Chromatography using Single Ion Monitoring (SIM) mode GC/MS. All samples are reported on a dry weight basis.

HOLDING TIMES:

The samples were stored frozen following PSEP Guidelines until extraction. After extraction all samples were analyzed within the recommended 40 day extract time.

BLANKS:

No target analytes were detected in the laboratory blanks.

SURROGATES:

Recovery of the surrogate spike, Tripropyltin, ranged from 6% to 115%. Recoveries of the tripentyl tin ranged from 18% to 141%. No surrogate recovery QC limits have been established for this method. Although several samples had one surrogate with less than 20% recovery none of the samples had <20% recovery for both surrogates. Consequently no data qualifiers were added to the results based on surrogate recoveries.

MATRIX SPIKE AND MATRIX SPIKE DUPLICATE:

No spike recovery or RPD QC limits have been established for organotins at this time. Two and one-half pairs of matrix spikes were analyzed with the samples. Source samples were 91218297 and -218302 and 97218310. Sample 97218297 had significant levels of organotin compounds native to the sample. These may have affected the recoveries which ranged from 2% to 204%. Tetrabutyltin which was not detected in the sample had 63% and 64% recovery. Matrix spike recoveries for 97218302 which was a high clay content sample ranged from 50% to 85%. Recoveries for 97218310 ranged from 10% to 73%.

The relative percent differences ranged from 1.4% to 193% for 97218297 and from 0.7% to 63% for 97218310.

ANALYTICAL COMMENTS:

Two additional samples were analyzed with the sediment samples. These were Sequim Bay Reference Sediments which presumably was spiked with 100 ng/gm (100 ug/Kg) wet weight of tributyltin. No value for tributyltin has been established for the Sequim Bay Reference Sediment so the accuracy of the analysis cannot be determined. These samples are identified as -SBR72041 (SRMl) and SBR72042 (SRM2).

SRMl	70.6	ug/Kg (wet weight)	Tributyltin
SRM2	75.6	ug/Kg (wet weight)	Tributyltin

Note that the data sheets report these values as dry weight. The percent solids is 56% for these samples.

Two reference materials, PACS-1 (PAC72043 and PAC72044) and PACS-2 (PAC72045) was also analyzed with the samples. PACS-2 is a new material and has not been certified as to it's value for organotins. PACS-1 provided anomalous results with lower concentrations of the tributyltin and higher concentrations relative to tributyltin for the dibutyl- and monobutyltins. Results for tributyltin were roughly one-third the certified value. Since the concentrations of the less substituted tin species increased it may be that the sample is deteriorating over time. A phone conversation with Eric Crecilius at Battelle Sequim laboratory confirmed that PACS-1 was not stable and the concentrations had been changing over time. Consequently data reported for PACS-1 should not be used and previous data reported for PACS-1 may be compromised.

Table B-6. Precision and Accuracy of Butyltin Data.

Sample No.	Field ID	QA Type	Monobutyltin Chloride	Dibutyltin Chloride	Tributyltin Chloride	Tetrabutyltin Chloride
8297	6A2	Matrix Spikes (% recov.)	29	2	144	63
8297	6A2		64	86	205	64
	mean=		47	44	175	64
	RPD=		75%	191%	35%	2%
8302	7A3	Matrix Spikes (% recov.)	57	30	85	62
8310	10A2	Matrix Spikes (% recov.)	14	73	10	43
8310	10A2		14	38	12	30
	mean=		14	56	11	37
	RPD=		0%	63%	18%	36%
8288	4B2	Field splits (ug/kg, dry)	816	434	2090	32 J
8308	9A2		906	355	1830	25 J
	mean=		861	395	1960	28 J
	RPD=		10%	20%	13%	23%
8288/8308	4B2/9A2	Field reps. (ug/kg, dry)	861	395	1960	28 J
8312	9C2		206 J	126	468	11 J
	mean=		534 J	260	1214	20 J
	RPD=		123%	103%	123%	88%
97218306	8C2	Field splits (ug/kg, dry)	386 J	209	1190	17 J
97218309	9B2		391	368	1120	14 J
	mean=		389 J	288	1155	16 J
	RPD=		1%	55%	6%	19%
BLN72033	OBS7153A3	Lab Blanks (ug/kg, dry)	33 J	21 U	44	20 U
BLN72034	OBS7153A4		24 J	21 U	36 J	20 U
BLN72035	OBS7154A2		12 J	23 U	31 J	22 U
BLN72040	OBS7154A3		22 J	23 U	20 J	22 U
PAC72043	OCS7154A3	Certified Reference Material NRCC PACS-1, ug/kg as Sn, dry	$\boxed{1120}$ J	$\boxed{188}$ J	$\boxed{380}$ J	500 U
PAC72044	OCS7154A4		$\boxed{920}$ J	$\boxed{100}$ J	$\boxed{292}$ J	440 U
	mean=		$\boxed{1020}$ J	$\boxed{144}$ J	$\boxed{336}$ J	
	RPD=		20%	61%	26%	
PACS-1certified values			280 +/-170	1160 +/-180	1270+/-220	
PAC72045	OCS7154A5		$\boxed{640}$ J	$\boxed{400}$ J	$\boxed{820}$ J	620 U
PACS-2 certified values			450+/-50	1090 +/-150	980+/ -130	

U=Undetected at concentration shown

J=estimated concentration

☐ = outside certified range of values

State of Washington Department of Ecology
Manchester Environmental Laboratory
7411 Beach Dr. East Port Orchard WA. 98366

PCB Data Review
September 19, 1997

Project: **Salmon Bay**

Samples: 218281 218291 218292 218301 218302

By: Stuart Magoon SM

Case Summary for Polychlorinated Biphenyl's
(PCB)

Data from these analyses were reviewed for qualitative and quantitative accuracy, validity, and usefulness. These samples were prepared and analyzed according to EPA method SW-846 8080.

The results are reported in micrograms per kilogram (ug/Kg); parts per billion dry weight.

PCB Analysis

Holding times:

Sample no.	Collect date	Extraction date	Analysis date
218281	5/21/97	6/2/97	7/1/97
218281 re-extract	5/21/97	7/21/97	7/30/97
218291	5/19/97	5/28/97	7/1/97
218292	5/19/97	5/28/97	7/1/97
218301	5/20/97	6/2/97	7/1/97
218302	5/19/97	5/28/97	7/1/97

* data from this sample has been rejected, and was not included in the final report.

All samples were extracted within fourteen (14) days of collection, with one exception. The re-extract of sample 218281 occurred sixty one (61) days after the sample was collected. It is unlikely given the environmentally persistent nature of PCB's that exceeding the recommended holding time by 47 days has had a measurable effect on the results. However, positive results 1254 and 1260 for sample 218281 have been qualified as estimates ("J"), and all the non-detects have been qualified with "UJ".

All sample extracts were analyzed within forty (40) days of extraction.

Method Blank:

No target analytes were detected in any of the method blanks.

Calibration:

The calibration standards were within 20% relative standard deviations (RSD) for all the PCB aroclors except 1242 and 1260 on July 1, 1997. As a consequence aroclors 1242 and 1260 detected in samples 218291 and 218292 have been reported as estimated values ("J" qualified).

Surrogate Recoveries:

Sample 218281 was re-extracted due to poor surrogate recoveries. Surrogate recoveries for the re-extraction of 218281 and the other samples, blanks, and reference material demonstrate the extraction and analysis are within control. The surrogate recoveries for one of the blanks (BLN71686) were extremely poor. This blank was evaporated to dryness during the final concentration procedure; the results have been rejected (“REJ”) due to the poor surrogate recoveries. Since the second blank (BLN71687) extracted and analyzed along with this data set displayed acceptable recoveries, no qualification of the sample data was warranted.

Certified Reference Material HS2:

The certified sediment reference material (SRM) from NRCC, HS2, was analyzed in duplicate along with this sample set. HS2 is certified for aroclor 1254 at 111.8 ug/Kg +/-2.5. There is also some 1260 aroclor present in this SRM sample, but the values are not certified. Aroclor 1254 was reported at 98 and 106 ug/Kg which corresponds to 87.7% and 94.8% of the certified value with an RPD of 7.8%.

Matrix Spikes:

Sample 218290 was used for the matrix spikes. PCB analysis was not requested for sample 218290, however, due to a mistake during the extraction process (BNA's were extracted along with the PCB's) this sample was chosen. There were no pesticide surrogates added to the unspiked aliquot of sample 218290, however the extract was also analyzed for BNA compounds and the surrogate recoveries for the BNA analysis were well within control limits. Sample 218290 was re-extracted with PCB surrogates added. Results from the re-extraction were quite different from the original:

	218290	218290 re-ext
Aroclor 1254	230 ug/Kg	2500 ug/kg
Aroclor 1260	74 ug/Kg	460 ug/Kg

Since there were no PCB surrogate recoveries on the original extract, but the BNA recoveries were within control, it is not clear why there is such are large discrepancy for the two analyses. Some of the analyte may have been lost during the florisil treatment, or the sample may not have been homogenous.

Inconsistent native determinations for sample 218290 combined with the poor calibration curve for aroclors 1242 and 1260 render the matrix spike data unreliable. Matrix spike recoveries for aroclor 1260 have been rejected (“REJ”) and aroclor 1242 recoveries should be considered estimates. This matrix spike data should not be used to assess overall recovery, precision or accuracy for this project.

Summary:

The original analysis of sample 218281 has not been included because surrogate recoveries for all three surrogates were less than 15%, and the PCB results were rejected. The results from the re-extraction of this sample have been reportd. I recommend that samples 218291 and 218292 be re-extracted and re-analyzed in order to quantitate the PCB aroclors 1242 and 1260 with a valid calibration curve.

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Manchester Environmental Laboratory

7411 Beach Dr E
Port Orchard Washington 98366
December 10, 1997

Project:	**Salmon Bay**
Parameter:	PCB re-extracts
Samples:	97218281, 97218291, 97218292
By:	Karin Feddersen KF

These samples were analyzed by EPA Method 8080 for PCB's, employing the dual column confirmation technique.

Holding Times:

These samples were extracted and analyzed after the method-specified holding times. PCB's are normally very persistent in the environment. Exceeding the holding time probably has had little significant effect on the results. However, the results for these samples have been qualified as estimates; positive results with "J", and non-detects with "UJ".

Method Blanks:

No analytes of interest were detected in the method blanks.

Surrogates:

All recoveries were within the recommended range of between 50% and 150%.

Matrix Spikes

Sample 97218281 was chosen for matrix spike/spike duplicate analysis. These samples can be used to assess accuracy and precision. Instead of spiking the sample with one of the PCB aroclors, it was spiked with 18 different PCB congeners. PCB aroclors are a complex mixture of the 209 PCB congeners. PCB aroclors are identified by pattern recognition and quantitated on 4-8 distinct peaks which represent one or more congeners. The percent recovery of an aroclor is actually the average percent recovery of the peaks used for quantitation. The average recovery of the 18 congeners for each of the spikes are 79% and 83%, and the relative percent difference (RPD) is 4%.

Sample Results:

This data is acceptable for use with the qualifications mentioned.

Table B-7. Precision and Accuracy of PCB Data.

Sample No.	Field ID	QA Type	Decachlorobiphenyl	PCB congener 8	PCB congener 18	PCB congener 28	PCB congener 44	PCB congener 52	PCB congener 66	PCB congener 101	PCB congener 105	PCB congener 118	PCB congener 128	PCB congener 138
8281	1B3	Matrix Spikes	102	106	98	99	88	74	75	48	66	49	83	44
8281	1B3	(% recov.)	103	117	101	102	93	77	79	53	68	56	80	49
	mean=		103	112	100	101	91	76	77	51	67	53	82	47
	RPD=		1%	10%	3%	3%	6%	4%	5%	10%	3%	13%	4%	11%

Sample No.	Field ID	QA Type	PCB congener 153	PCB congener 170	PCB congener 180	PCB congener 187	PCB congener 195	PCB congener 206
8281	1B3	Matrix Spikes	58	86	77	80	98	99
8281	1B3	(% recov.)	63	87	77	88	96	96
	mean=		61	87	77	84	97	98
	RPD=		8%	1%	0%	10%	2%	3%

Sample No.	Field ID	QA Type	PCB - 1260	PCB - 1254	PCB - 1221	PCB - 1232	PCB - 1248	PCB - 1016	PCB - 1242
8290	4C2	Matrix Spikes	REJ	NAF	NAF	NAF	NAF	NAF	110
8290	4C2	(% recov.)	REJ	NAF	NAF	NAF	NAF	NAF	86
	mean=								98
	RPD=								24%

Sample No.	Field ID	QA Type	PCB - 1260	PCB - 1254	PCB - 1221	PCB - 1232	PCB - 1248	PCB - 1016	PCB - 1242
BLN71686	OBS7148B1		REJ	REJ	REJ	REJ	REJ	REJ	REJ
BLN71687	OBS7148B2	Lab Blanks	20 U	20 U	20 U	20 U	20 U	20 U	20 U
BLN71704	OBS7153A1	(ug/kg, dry)	20 U	20 U	20 U	20 U	20 U	20 U	20 U
BLN71705	OBS7153A2		20 U	20 U	20 U	20 U	20 U	20 U	20 U
BLN73455	OBS7302A1		130 U	130 U	130 U	130 U	130 U	130 U	130 U
BLN73456	OBS7302A2		130 U	130 U	130 U	130 U	130 U	130 U	130 U

Sample No.	Field ID	QA Type	PCB - 1260	PCB - 1254	PCB - 1221	PCB - 1232	PCB - 1248	PCB - 1016	PCB - 1242
HS272467	OCS7148A1	Reference	50	98	20 U	20 U	20 U	20 U	20 U
HS272468	OCS7148A2	Material NRCC	76	106	20 U	20 U	20 U	20 U	20 U
	mean=	HS-2, ug/kg,	63	102					
	RPD=	dry)	41%	8%					

U=Undetected at Concentration Shown

REJ=Sample result rejected, data are unusable

NAF=Not Analyzed For

☐ = Outside of certified range of values. HS-2 is certified for PCB-1254 at 111.8 +/- 2.5 ug/kg, dry. It is not certified for other PCBs.

Appendix C

Complete Results of Semivolatile Organics Analyses

Spearman Correlation Matrix for Chemistry Data

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Table C-1. Priority Pollutant Low Molecular Weight PAHs (LPAH) Detected in Salmon Bay Phase III Sediments (µg/kg, dw).

Station	Naphthalene	Acenaphthylene	Acenaphthene	Fluorene	Phenanthrene	Anthracene	Total LPAH
1B3	110 J	(276) UJ	162 J	167 J	1,130 J	233 J	1,800
2B2	650	265	523	666	5,470	1,230	8,800
2C2	4,890	642	2,460	3.400	$\boxed{14,200}$	$\boxed{2,920}$	$\boxed{28,500}$
3B2	751	294	434	539	2,130	799	4,900
3B3	627	209	177	274	1,070	406	2,800
3C2	427	174	172	230	1,100	465	2,600
3C3	424	171	252	270	1,480	552	3,100
4B2	1,700	342	370	558	2,372	757	6,100
4B3	4,870 J	1,260 J	1,250 J	1,720 J	$\boxed{6,190}$ J	1,580 J	16,900
4C2	471	136	310	465	1,200	465	3,000
4F2	5,630	1,020	$\boxed{7,420}$	$\boxed{6.970}$	$\boxed{41,100}$	$\boxed{16,200}$	$\boxed{78,300}$
4F3	3,060	323	938	1.020	4,020	1,070	10,400
4F4	4,970	697	1,320	1.540	4,440	1,110	14,100
5A2	913	279	332	498	1,990	717	4,700
5B2	501	148	156	185	778	320	2,100
5D2	304	95	1,680	542	2,640	528	5,800
6A2	2,280	594	792	932	3,620	915	9,100
6B2	366	(77) U	196	262	1,040 J	294 J	2,200
6B3	466	110	203	251	1,300	373	2,700
6C2	1,030	265	130	126	569	124	2,200
7A2	291	42 J	360	400	2,660	630	4,400
7A3	73 J	(132) UJ	74 J	95 J	384	95 J	720
7B2	(201) U	(201) U	(201) U	(201) U	71 J	(201) U	70
7C2	37 J	12 J	33 J	39 J	234	67	420
8A2	1,360	362	2,460	3,240	$\boxed{8,420}$	$\boxed{2,860}$	18,700
8C2	446	112	244	325	1,715	359	3,200
8C3	1,310	640	1,060	1,070	3,990	1,130	9,200
10A2	(100) U	(100) U	(100) U	(100) U	39 J	14 J	50
10B2	18 J	(63) UJ	18 J	25 J	244	53 J	360

U=Undetected at concentration in parentheses

UJ=Undetected at estimated concentration in parentheses

J=Estimated concentration

Exceeds Freshwater Sediment Quality Values (Cubbage *et al*,1997).

Table C-2. Priority Pollutant High Molecular Weight PAHs (HPAH) Detected in Salmon Bay Phase III Sediments (µg/kg, dw).

Station	**Fluoranthene**	**Pyrene**	**Benzo(a)anthracene**	**Chrysene**	**Benzo(b+k)fluoranthenes**	**Benzo(a)pyrene**	**Indeno(1,2,3-cd)pyrene**	**Dibenzo(a,h)anthracene**	**Benzo(ghi)perylene**	**Total HPAH**
1B3	1,690 J	1,630 J	600 J	816 J	1,151 J	615 J	363 J	82 J	424	7,400
2B2	11,100	8,790	4,260	5,940	10,990	4,810	4,120	839	4,020	54,900
2C2	29,200	15,900	3,750	5,880	6,590	2,750	1,750	437	1,720	68,000
3B2	5,350	6,880	2,430	2,780	4,560	3,000	1,880	412	2,140	29,400
3B3	2,340	2,530	958	1,300	2,315	1,530	1,180	217	1,330	13,700
3C2	2,690	2,250	1,030	1,340	2,095	1,180	993	287	944	12,800
3C3	3,140	2,710	1,220	1,540	2,451	1,420	1,160	292	1,150	15,100
4B2	3,715	3,665	1,378	1,940	3,221	1,772	1,445	322	1,595	19,100
4B3	7,730 J	7,540	2,380	3,430	4,440	2,220	1,450	327	1,660	31,200
4C2	3,450	2,960	1,060	1,440	2,022	890	643	214	613	13,300
4F2	46,100	55,600	25,600	28,100	41,800	24,300	13,900	3,070	12,100	250,000
4F3	3,480	4,610	1,240	1,780	2,444	1,430	917	212	1,020	17,100
4F4	4,700	4,700	1,100	1,130	2,002	1,070	740	200 J	827	16,500
5A2	3,210	4,410 J	1,580	2,170 J	3,620	1,890	1,340	332	1,410	20,000
5B2	1,640	1,590	523	755	1,376	783	773	216 J	791	8,400
5D2	3,800	5,190	1,430	1,890	3,139	1,850	1,170	205	1,180	19,900
6A2	4,780	5,120	1,720	2,210	3,396	1,840	1,220	342	1,350	22,000
6B2	1,380 J	2,000 J	631 J	893 J	1,234 J	715 J	431 J	(77) UJ	438 J	7,700
6B3	1,780	2,340	917	1,260	1,955	1,080	763	116	821	11,000
6C2	646	679	148	193	283 J	206	180	157 U	187	2,500
7A2	3,360	3,460	1,270	1,560	1,778	915	518	132 J	497	13,500
7A3	478	536	192	240	307 J	176	91 J	(130) U	110 J	2,100
7B2	123 J	118 J	(201) U	59 J	67 J	176 J	198 J	176 J	87 J	1,200
7C2	359	488	181	263	421	226	133	34 J	146	2,300
8A2	21,100	14,500	5,430	5,730	7,110	2,960	1,500	424	1,350	60,100
8C2	2,665	2,185	802	1,076	1,654	756	622	172	568	10,500
8C3	7,710	7,150	2,620	3,700	5,530	3,340	2,340	490	2,510	35,400
10A2	97 J	150	(100) U	91 J	127 J	37 J	59 J	(100) U	68 J	630
10B2	428	523	199	320	496	248	199	(63) U	216	2,600

U=Undetected at concentration in parentheses
UJ=Undetected at estimated concentration in parentheses
J=Estimated concentration

Exceeds Freshwater Sediment Quality Values (Cubbage *et al*,1997).

Table C-3. Total Priority Pollutant PAHs Detected in Salmon Bay Phase III Sediments (µg/kg, dw).

Station	Total LPAH	Total HPAH	Total PAH
1B3	1,800	7,400	9,200
2B2	8,800	54,900	63,700
2C2	28,500	68,000	96,500
3B2	4,900	29,400	34,300
3B3	2,800	13,700	16,500
3C2	2,600	12,800	15,400
3C3	3,100	15,100	18,200
4B2	6,100	19,100	25,200
4B3	16,900	31,200	48,100
4C2	3,000	13,300	16,300
4F2	78,300	250,000	328,300
4F3	10,400	17,100	27,500
4F4	14,100	16,500	30,600
5A2	4,700	20,000	24,700
5B2	2,100	8,400	10,500
5D2	5,800	19,900	25,700
6A2	9,100	22,000	31,100
6B2	2,200	7,700	9,900
6B3	2,700	11,000	13,700
6C2	2,200	2,500	4,700
7A2	4,400	13,500	17,900
7A3	720	2,100	2,820
7B2	70	1,200	1,270
7C2	420	2,300	2,720
8A2	18,700	60,100	78,800
8C2	3,200	10,500	13,700
8C3	9,200	35,400	44,600
10A2	50	630	680
10B2	360	2,600	2,960

Exceeds Freshwater Sediment Quality Values (Cubbage *et al*,1997).

Table C-4. Phenols and Non-Priority Pollutant PAHs Detected in Salmon Bay Phase III Sediments (µg/kg, dw).

Station	**Phenol**	**2-Methylphenol**	**4-Methylphenol**	**2,4-Dimethylphenol**	**Pentachlorophenol**	**Retene**	**2-Methylnaphthalene**	**1-Methylnaphthalene**
1B3	276 UJ	276 UJ	276 UJ	276 UJ	2,760 UJ	**352**	**62** J	**58** J
2B2	**247**	238 U	**1,210**	119 U	**524** J	**2,170**	**469**	**232**
2C2	**187**	257 U	**699**	129 U	**472** J	**4,230**	**2,310**	**1,220**
3B2	112 U	112 U	**192**	112 U	1,120 U	**542**	**239**	**124**
3B3	**58** J	187 U	**215**	94 U	468 U	**202**	**188**	**94** J
3C2	**66** J	**83** J	**189** J	134 U	**457** J	**726**	**172**	**81** J
3C3	**121** J	**93** J	**239** J	138 U	692 U	**782**	**170**	**96** J
4B2	**176**	**93** J	**512**	123 U	**712**	**3,752**	**471**	**244**
4B3	**767** J	**295** J	**6,310** J	**140** J	1,230 UJ	**19,200**	**1,770** J	**1,050** J
4C2	79 U	158 U	**159**	79 U	**288** J	**289**	**214**	**102**
4F2	371 U	371 U	**2,360**	371 U	3,710 U	**54,500**	**3,470**	**1,810**
4F3	119 U	119 U	**581**	119 U	1,190 U	**35,600**	**1,060**	**523**
4F4	115 U	230 U	**2,030**	115 U	576 U	**73,600**	**1,720**	**922**
5A2	135 U	135 U	**512**	135 U	1,350 U	**1,170**	**353**	**171**
5B2	**50** J	**88** J	**188** J	142 U	**626** J	**564**	**180**	**93** J
5D2	**36** J	70 U	**52** J	70 U	704 U	**291**	**90**	**65** J
6A2	**193**	191 U	**1,730**	96 U	**459** J	**11,200**	**982**	**629**
6B2	77 U	77 U	**195**	77 U	773 UJ	**908**	**162**	**101**
6B3	86 U	86 U	**150**	86 U	863 U	**1,470**	**180**	**93**
6C2	**52** J	157 U	**551**	79 U	393 U	**6,020**	**160**	**109**
7A2	**212**	164 U	**77** J	164 U	**1,240** J	**553**	**141** J	**103** J
7A3	132 U	132 U	132 U	132 U	1,320 U	**132**	**53** J	**35** J
7B2	201 U	401 U	401 U	201 U	1,000 U	401	201 U	201 U
7C2	50 U	50 U	50 U	50 U	500 U	**94**	**28** J	**14** J
8A2	**72** J	150 U	**382**	75 U	375 U	**1,050**	**877**	**438**
8C2	**82** J	**72** JFSU	**611**	72 U	**299** J	**1,055**	**220**	**100**
8C3	**235**	200 U	**1,560**	100 U	500 U	**1,900**	**443**	**265**
10A2	100 U	100 U	100 U	100 U	1,000 U	**201**	100 U	100 U
10B2	63 U	63 U	**16** J	63 U	**484** J	**75**	**16** J	**8** J

detected compounds in **bold**

U=Undetected at associated concentration

UJ=Undetected at associated estimated concentration

J=Estimated concentration

FSU=field split undetected

Exceeds Freshwater Sediment Quality Values (Cubbage *et al*,1997).

Table C-5. Phthalates Detected in Salmon Bay Phase III Sediments (µg/kg, dw).

Station	Dimethylphthalate	Diethylphthalate	Di-N-Butylphthalate	Butylbenzylphthalate	Bis(2-Ethylhexyl) Phthalate	Di-N-Octyl Phthalate
1B3	**54** J	276 UJ	276 UJ	**131** J	**3,010** J	2,760 UJ
2B2	**436**	119 U	**690**	**1,520**	**2,800**	594 U
2C2	**362**	129 U	257 U	**198** J	**2,800**	644 U
3B2	225 U	112 U	225 U	112 U	**2,500**	1,120 U
3B3	94 U	94 U	187 U	187 U	**727**	468 U
3C2	**105** J	134 U	269 UJ	**193** J	**1,970**	672 U
3C3	**172**	**179**	**1,740**	**222** J	**2,520**	692 U
4B2	**280**	123 UJ	**481**	**280**	**4,245**	616 U
4B3	**270** J	123 UJ	**350** J	**366**	**6,360**	**399** J
4C2	**158**	79 U	158 U	158 U	**6,380**	**201** J
4F2	**314** J	371 UJ	742 U	371 U	**10,500**	3,710 U
4F3	**82** J	**32** J	**69** J	119 U	**22,600**	1,190 U
4F4	115 U	115 UJ	**254**	230 U	**5,120**	576 U
5A2	**147** J	135 U	270 U	**165**	**4,970** J	1,350 U
5B2	**108** J	142 U	**306**	**182** J	**1,970**	711 U
5D2	141 U	70 U	141 UJ	70 U	141 UJ	704 U
6A2	**576**	96 U	**893**	**258**	**3,970**	478 U
6B2	**131** J	77 U	77 UJ	77 UJ	**2,220** J	773 UJ
6B3	**156** J	86 U	**1,180**	**53** J	**2,140**	863 U
6C2	79 U	79 UJ	**158**	**163**	**275**	393 U
7A2	**31** J	164 UJ	164 UJ	164 U	**1,090**	1,640 U
7A3	263 U	132 UJ	263 UJ	130 U	658 UJ	1,320 U
7B2	201 U	201 U	201 UJ	401 U	401 UJ	1,000 U
7C2	**15** J	50 UJ	**481**	**28** J	**520**	500 U
8A2	75 U	75 U	150 U	150 U	**3,420**	375 U
8C2	**48** J	**88** JFSU	**154** J	**191** J	**2,935**	360 U
8C3	100 U	100 U	200 U	200 U	**501**	500 U
10A2	200 U	100 UJ	100 UJ	100 U	500 UJ	1,000 U
10B2	126 U	63 UJ	**841**	**48** J	**444**	629 U

detected compounds in **bold**

U=Undetected at associated concentration

UJ=Undetected at associated estimated concentration

J=Estimated concentration

FSU=field split undetected

Exceeds Freshwater Sediment Quality Values (Cubbage *et al*,1997).

Table C-6. Miscellaneous Semivolatile Organics Detected in Salmon Bay Phase III Sediments (µg/kg, dw).

Station	1,4-Dichlorobenzene	1,2-Dichlorobenzene	Benzyl Alcohol	Isophorone	Benzoic Acid	Dibenzofuran	Caffeine	Carbazole	3β-Coprostanol
1B3	552 UJ	552 UJ	552 UJ	276 UJ	5,520 UJ	**116** J	276 UJ	276 UJ	**2,010** J
2B2	**94** J	**119** J	**329**	119 U	**3,790** J	**384**	119 U	**923**	**6,730**
2C2	**91** J	129 U	129 U	129 U	**2,840** J	**2,260**	129 U	**825**	1,290 U
3B2	**31** J	225 U	225 U	112 U	2,250 U	**282**	112 U	**176**	1,120 U
3B3	**34** J	**106** J	94 U	94 U	**2,020** J	**166**	94 U	**85** J	935 U
3C2	269 U	269 U	**70** J	134 U	**2,790** J	**168**	134 U	**128** J	**1,640**
3C3	277 U	277 U	**86** J	138 U	2,770 UJ	**180**	138 U	**172**	**2,310**
4B2	**27** JFRU	246 U	**170** JFRU	127 U	**2,930** JFRU	**386**	123 U	**179** J	**31,922**
4B3	**53** J	**116** J	**184** J	**51** J	**4,200** J	**928** J	123 UJ	**389** J	**3,890**
4C2	79 U	158 U	79 U	79 U	**1,650** J	**244**	79 U	**117**	**1,450**
4F2	742 U	**73** J	742 U	371 U	7,420 U	**3,810**	371 U	**2,920**	3,710 U
4F3	239 U	239 U	239 U	119 U	2,390 UJ	**743**	119 U	**196**	1,190 U
4F4	**36** J	230 U	115 U	115 U	**2,640** J	**1,010**	115 U	**238**	**1,930**
5A2	270 U	270 U	270 U	135 U	2,700 UJ	**372**	135 U	**194**	**2,180**
5B2	284 U	284 U	**53** J	142 U	**2,830** J	**138** J	142 U	**71** J	**1,680**
5D2	141 U	141 U	141 U	70 U	1,410 UJ	**119**	70 U	**91**	704 U
6A2	**57** J	**106** J	**95** J	96 U	**2,170**	**460**	96 U	**274**	**2,100**
6B2	155 U	155 U	155 U	77 U	**1,020** J	**167**	77 UJ	**116** J	773 UJ
6B3	173 U	173 U	173 U	86 U	1,730 UJ	**168**	86 U	**94**	863 U
6C2	157 U	157 U	79 U	79 U	1,570 UJ	**90**	**34** J	79 UJ	786 U
7A2	329 U	329 U	**53** J	164 U	**2,070** J	**234**	164 U	**229**	1,640 U
7A3	263 U	263 U	263 U	132 U	2,630 UJ	**51** J	132 U	132 U	1,320 U
7B2	401 U	401 U	201 U	201 U	**4,110** J	201 U	201 U	201 U	2,010 U
7C2	100 U	100 U	**14** J	50 U	1,000 UJ	**24** J	50 U	**24** J	500 U
8A2	**48** J	75 U	75 U	75 U	**1,540** J	**1,750**	75 U	**437**	750 U
8C2	**94** J	144 U	**31** JFSU	72 U	**1,740** J	**216**	72 U	**160**	**4,335**
8C3	100 UJ	200 U	100 U	100 U	**2,430** J	**399**	100 U	**234**	1,000 U
10A2	200 U	200 U	200 U	100 U	2,000 UJ	100 U	100 U	100 U	1,000 U
10B2	126 U	126 U	126 U	63 U	**813** J	**14** J	63 U	63 U	629 U

detected compounds in **bold**
U=Undetected at associated concentration
UJ=Undetected at associated estimated concentration
J=Estimated concentration
FSU=field split undetected
FRU=field rep undetected

Exceeds Freshwater Sediment Quality Values (Cubbage *et al*,1997).

Table C-7. Semivolatile Organic Compounds Below Detectable Concentrations in Salmon Bay Phase III Sediments (Practical Quantitation Limits in ug/kg, dw).

Station	N-Nitrosodimethylamine	Pyridine	Aniline	Bis(2-Chloroethyl)Ether	2-Chlorophenol	1,3-Dichlorobenzene	2,2'-Oxybis[1-chloropropane]	N-Nitroso-Di-N-Propylamine	Hexachloroethane	Nitrobenzene	2-Nitrophenol	Bis(2-Chloroethoxy)Methane	2,4-Dichlorophenol	1,2,4-Trichlorobenzene	4-Chloroaniline	Hexachlorobutadiene	4-Chloro-3-Methylphenol	Hexachlorocyclopentadiene	2,4,6-Trichlorophenol	2,4,5-Trichlorophenol	2-Chloronaphthalene	2-Nitroaniline	2,6-Dinitrotoluene	3-Nitroaniline	2,4-Dinitrophenol	4-Nitrophenol	2,4-Dinitrotoluene	4-Chlorophenyl-Phenylether	4-Nitroaniline	4,6-Dinitro-2-Methylphenol	N-Nitrosodiphenylamine	1,2-Diphenylhydrazine	4-Bromophenyl-Phenylether	Hexachlorobenzene	Benzidine	3,3'-Dichlorobenzidine
1B3	552	552	552	552	552	552	276	552	552	276	552	276	276	276	276	276	276	2760	552	552	276	1380	552	552	5520	1380	1380	276	2760	2760	276	276	276	276	552	5520
2B2	594	594	594	119	119	119	238	238	238	594	594	119	119	119	594	119	238	594	238	238	119	594	594	594	1190	594	1190	119	238	1190	119	119	119	119	238	238
2C2	644	644	644	129	129	129	257	257	257	644	644	129	129	129	644	129	257	644	257	257	129	644	644	644	1290	644	1290	129	257	1290	129	129	129	129	257	257
3B2	225	262	225	225	225	225	112	225	225	112	225	112	112	112	112	112	112	1120	225	225	112	562	225	225	2250	562	562	112	1120	1120	112	112	112	112	225	2250
3B3	468	468	468	94	94	94	187	187	187	468	468	94	94	94	468	94	187	468	187	187	94	468	468	468	935	468	935	94	187	935	94	94	94	94	187	187
3C2	672	672	672	134	134	134	269	269	269	672	672	134	134	134	672	134	269	672	269	269	134	672	672	672	1340	672	1340	134	269	1340	134	134	134	134	269	269
3C3	692	692	692	138	138	138	277	277	277	692	692	138	138	138	692	138	277	692	277	277	138	692	692	692	1380	692	1380	138	277	1380	138	138	138	138	277	277
4B2	616	254	616	123	123	123	246	246	246	616	616	123	123	123	616	127	246	616	246	246	123	616	616	616	1230	616	1230	123	246	1230	123	123	123	123	246	246
4B3	616	616	616	123	123	123	246	246	246	616	616	123	123	123	616	123	246	616	246	246	123	616	616	616	1230	616	1230	123	246	1230	123	123	123	123	246	246
4C2	395	395	395	79	79	79	158	158	158	395	395	79	79	79	395	79	158	395	158	158	79	395	395	395	790	395	790	79	158	790	79	79	79	79	158	158
4F2	742	742	742	742	742	742	371	742	742	371	742	371	371	371	371	371	371	3710	742	742	371	1850	742	742	7420	1850	1850	371	3710	3710	371	371	371	371	742	7420
4F3	239	239	239	239	239	239	119	239	239	119	239	119	119	119	119	119	119	1190	239	239	119	597	239	239	2390	597	597	119	1190	1190	119	119	119	119	239	2390
4F4	576	576	576	115	115	115	230	230	230	576	576	115	115	115	576	115	230	576	230	230	115	576	576	576	1150	576	1150	115	230	1150	115	115	115	115	230	230
5A2	270	270	270	270	270	270	135	270	270	135	270	135	135	135	135	135	135		270	270	135	676	270	270	2700	676	676	135	1350	1350	135	135	135	135	270	2700
5B2	711	711	711	142	142	142	284	284	284	711	711	142	142	142	711	142	284	711	284	284	142	711	711	711	1420	711	1420	142	284	1420	142	142	142	142	284	284
5D2	141	141	141	141	141	141	70	141	141	70	141	70	70	70	70	70	70	704	141	141	70	352	141	141	1410	352	352	70	704	704	70	70	70	70	141	1410
6A2	478	478	478	96	96	96	191	191	191	478	478	96	96	96	478	96	191	478	191	191	96	478	478	478	956	478	956	96	191	956	96	96	96	96	191	191
6B2	155	155	155	155	155	155	77	155	155	77	155	77	77	77	77	77	77	773	155	155	77	386	155	155	1550	386	386	77	773	773	77	77	77	77	155	1550
6B3	173	173	173	173	173	173	86	173	173	86	173	86	86	86	86	86	86	863	173	173	86	432	173	173	1730	432	432	86	863	863	86	86	86	86	173	1730
6C2	393	393	393	79	79	79	157	157	157	393	393	79	79	79	393	79	157	393	157	157	79	393	393	393	786	393	786	79	157	786	79	79	79	79	157	157
7A2	329	329	329	329	329	329	164	329	329	164	329	164	164	164	164	164	164	1640	329	329	164	823	329	329	3290	823	823	164	1640	1640	164	164	164	164	329	3290
7A3	263	263	263	263	263	263	132	263	263	132	263	132	132	132	132	132	132	1320	263	263	132	658	263	263	2630	658	658	132	1320	1320	132	132	132	132	263	2630
7B2	1000	1000	1000	201	201	201	401	401	401	1000	1000	201	201	201	1000	201	401	1000	401	401	201	1000	1000	1000	2010	1000	2010	201	401	2010	201	201	201	201	401	401
7C2	100	100	100	100	100	100	50	100	100	50	100	50	50	50	50	50	50	500	100	100	50	250	100	100	1000	250	250	50	500	500	50	50	50	50	100	1000
8A2	375	379	375	75	75	75	150	150	150	375	375	75	75	75	375	75	150	375	150	150	75	375	375	375	750	375	750	75	150	750	75	75	75	75	150	150
8C2	360	360	360	72	72	72	144	144	144	360	360	72	72	72	360	72	144	360	144	144	72	360	360	360	720	360	720	72	144	720	72	72	72	72	144	144
8C3	500	200	500	100	100	100	200	200	200	500	500	100	100	100	500	100	200	500	200	200	100	500	500	500	1000	500	1000	100	200	1000	100	100	100	100	200	200
10A2	200	200	200	200	200	200	100	200	200	100	200	100	100	100	100	100	100	1000	200	200	100	501	200	200	2000	501	501	100	1000	1000	100	100	100	100	200	2000
10B2	126	126	126	126	126	126	63	126	126	63	126	63	63	63	63	63	63	629	126	126	63	314	126	126	1260	314	314	63	629	629	63	63	63	63	126	1260

Table C-8. Spearman Rank-Order Correlation Coefficients for Salmon Bay Phase III Conventional, Metals, and Selected Organics Data.

	TOC	Gravel	Sand	Silt	Clay	Fines	Arsenic	Mercury	Cadmium	Chromium	Copper	Lead	Nickel	Zinc	LPAH	HPAH	TotalPAH	Bis(2-EH)Phthal.	4-MePhenol	Carbazole
Gravel	0.36																			
Sand	-0.24	0.35																		
Silt	0.23	-0.59	-0.87																	
Clay	0.11	-0.13	-0.64	0.38																
Fines	0.18	-0.48	-0.98	0.92	0.60															
Arsenic	0.11	-0.01	-0.13	0.12	0.13	0.08														
Mercury	0.16	-0.22	-0.22	0.33	0.15	0.24	0.60													
Cadmium	0.20	-0.33	-0.24	0.46	0.04	0.28	0.43	0.60												
Chromium	0.22	-0.33	-0.43	0.62	0.11	0.45	0.27	0.43	0.85											
Copper	0.15	-0.32	-0.21	0.46	-0.18	0.25	0.53	0.58	0.85	0.78										
Lead	0.02	0.04	-0.08	0.03	0.13	0.06	0.56	0.67	0.48	0.19	0.41									
Nickel	0.28	-0.16	-0.50	0.55	0.27	0.49	-0.02	0.10	0.52	0.84	0.44	-0.12								
Zinc	0.20	-0.22	-0.20	0.33	0.06	0.23	0.63	0.90	0.72	0.47	0.72	0.73	0.06							
LPAH	0.42	0.37	0.02	0.09	-0.15	-0.03	-0.07	0.42	0.26	0.26	0.16	0.30	0.18	0.36						
HPAH	0.39	0.32	-0.03	0.15	-0.14	0.02	0.09	0.48	0.37	0.30	0.24	0.43	0.12	0.47	0.93					
Total PAH	0.43	0.36	-0.02	0.12	-0.15	0.01	0.05	0.46	0.34	0.28	0.23	0.40	0.12	0.45	0.96	0.99				
Bis(2-EH)Phthal.	0.45	-0.14	0.02	0.23	-0.18	0.03	-0.13	0.36	0.37	0.37	0.29	0.09	0.32	0.36	0.60	0.49	0.52			
4-MePhenol	0.70	0.28	-0.20	0.23	0.06	0.17	-0.21	0.24	0.25	0.27	0.10	0.00	0.32	0.19	0.72	0.62	0.66	0.54		
Carbazole	0.58	0.36	0.03	0.11	-0.20	-0.04	0.05	0.49	0.37	0.32	0.33	0.30	0.23	0.49	0.87	0.84	0.88	0.65	0.73	
TBT	0.20	-0.30	-0.22	0.46	-0.20	0.27	0.42	0.66	0.56	0.51	0.76	0.42	0.22	0.72	0.30	0.36	0.34	0.51	0.14	0.50

Appendix D

Bioassay Results

ENVIRONMENT
CONSULTANTS

Our File #: 9/771-01
Work Order #: 9700432, 9700433

June 13, 1997

Dave Goodwin
SAIC
18960 State Highway 305 NE
Suite 200
Poulsbo, WA 98370-7400

Dear Mr. Goodwin:

Re: Results of Sediment Toxicity Testing using *Hyalella azteca, Chironomus tentans and Vibrio fischeri*

EVS Environment Consultants performed toxicity testing on 22 freshwater sediment samples using *Hyalella azteca, Chironomus tentans* and V*ibrio fischeri.* Testing of *H. azteca* and *C. tentans* involved exposures for 10 days and followed procedures outlined in ASTM (1994). Testing of *V. fischeri* involved the Saline Extract Microtox test method as outlined by Microbics Corporation, EPA (1991). Microtox testing was performed by the CH2M Hill Laboratory in Corvallis, OR. All tests were performed following procedures described in PESP (1995) as applicable.

Copies of all raw bench sheets and calculations of means (± SD) are attached. Below are some points that we have highlighted for your convenience.

General Notes:

- Chain-of-Custody (C-O-C) forms were not received with the samples, they were faxed later. Please refer to the EVS C-O-C for sample receipt and integrity information.

10-d *H. azteca* Survival Test:

- Low dissolved oxygen levels were reported in some of the vessels designated for water quality measurements due to a stoppage in aeration overnight, aeration was reinitiated. Aeration was checked in additional replicates and confirmed to within appropriate levels. This appeared not to affected the results.

- Due to a buildup of food on the sediment surface on Day 6, tetramin slurry was not fed on this day (only algae was fed). The feeding schedule was resumed after this.

- Negative control survival (96%) met the required criterion (80%).

- Sample 7A2 (EVS 4805) had one replicate (D) which may have been missed in seeding, when compared to the other replicate results. Mean (± SD) survival calculations have been provided including this replicate (5 replicates total), removing it as an outlier would result in a mean (± SD) of 87.5 ± 12.6% (4 replicates).

- Reference toxicant value is within the established range.

10-d *C tentans* Survival and Growth Test:

- Low dissolved oxygen levels were reported in some of the vessels designated for water quality measurements due to a stoppage in aeration overnight, aeration was reinitiated. Aeration was checked in additional replicates and confirmed to within appropriate levels. This appeared not to affected the results.

- Sample 1B3 (EVS 4840) had one replicate (C) which may have been missed in seeding; when compared to the other replicate results. Mean (± SD) survival calculations have been provided including this replicate (5 replicates total), removing it as an outlier would result in a mean (± SD) of 82.5 ± 17.1% (4 replicates).

- Sample 8A2 (EVS 4829) had one replicate (E) which may have been missed in seeding, when compared to the other replicate results. Mean (± SD) survival calculations have been provided including this replicate (5 replicates total), removing it as an outlier would result in a mean (± SD) of 67.5 ±18.9% (4 replicates).

- Negative control survival (100%) met the required criterion (70%).

- Reference toxicant value is within the established range.

Saline Extract Microtox Test:

- Data enclosed is a faxed version, when the official final report has been received we will forward it to you.

- The highest dilution tested was 54 - 56%, approximately 58%

If you have any questions or need further information, please do not hesitate to call me at (604) 986-4331.

Yours truly,

EVS ENVIRONMENT CONSULTANTS

Jennifer Stewart

Jennifer V. Stewart, B.Sc.
Supervisor, Toxicology Testing

JVS/js

Table D-1. Test Results for Each Bioassay Replicate.

Sample No.	Station	Rep	*Hyalella* Survival	*Chironomus* Survival	*Chironomus* Growth (mg)	Microtox Light Reduction
8310	10A2	1	10	3	4.40	5.00
8310	10A2	2	9	5	3.16	6.00
8310	10A2	3	10	6	4.17	3.60
8310	10A2	4	10	4	3.05	3.90
8310	10A2	5	10	7	3.20	2.50
8311	10B2	1	10	9	2.48	16.70
8311	10B2	2	10	8	3.14	15.60
8311	10B2	3	9	7	3.16	19.40
8311	10B2	4	10	9	4.92	16.10
8311	10B2	5	9	7	3.59	18.40
8281	1B3	1	8	10	1.32	13.40
8281	1B3	2	10	6	1.33	12.70
8281	1B3	3	9	0	.	11.30
8281	1B3	4	9	8	1.59	10.60
8281	1B3	5	9	9	1.38	11.90
8282	2B2	1	9	5	1.98	9.20
8282	2B2	2	8	7	1.84	8.70
8282	2B2	3	8	7	2.29	7.50
8282	2B2	4	10	5	1.84	7.50
8282	2B2	5	10	3	2.47	10.40
8283	2C2	1	8	4	1.18	46.80
8283	2C2	2	9	9	2.08	48.70
8283	2C2	3	7	9	1.84	48.00
8283	2C2	4	8	9	1.60	48.60
8283	2C2	5	9	9	1.72	47.40
8285	3B3	1	7	8	1.69	9.50
8285	3B3	2	8	6	1.30	11.20
8285	3B3	3	9	7	1.90	9.50
8285	3B3	4	8	7	1.06	11.80
8285	3B3	5	7	9	1.54	10.40
8287	3C3	1	9	8	3.35	-1.90
8287	3C3	2	10	10	2.64	-0.60
8287	3C3	3	10	9	2.31	-0.90
8287	3C3	4	10	8	3.38	-0.90
8287	3C3	5	10	9	2.86	-3.10
8288	4B2	1	9	9	2.57	41.90
8288	4B2	2	8	10	1.98	46.00
8288	4B2	3	10	10	3.50	42.70
8288	4B2	4	10	9	2.22	43.80
8288	4B2	5	9	10	2.54	44.20

Table D-1. Test Results for Each Bioassay Replicate.

Sample No.	Station	Rep	*Hyalella* Survival	*Chironomus* Survival	*Chironomus* Growth (mg)	Microtox Light Reduction
8289	4B3	1	8	5	3.48	57.40
8289	4B3	2	6	6	3.08	53.40
8289	4B3	3	6	7	3.27	57.90
8289	4B3	4	9	8	2.65	57.10
8289	4B3	5	6	8	2.93	58.40
8290	4C2	1	10	7	2.41	59.90
8290	4C2	2	9	6	2.65	57.80
8290	4C2	3	10	8	2.59	61.00
8290	4C2	4	10	8	2.88	55.90
8290	4C2	5	10	9	3.04	58.40
8291	4F2	1	9	4	0.93	37.50
8291	4F2	2	8	6	1.48	36.20
8291	4F2	3	10	7	1.61	35.90
8291	4F2	4	9	6	1.65	38.50
8291	4F2	5	7	7	1.33	37.20
8293	4F4	1	7	9	3.07	17.60
8293	4F4	2	5	7	3.37	18.60
8293	4F4	3	5	6	3.75	20.40
8293	4F4	4	6	9	2.79	19.50
8293	4F4	5	8	10	3.14	17.10
8294	5A2	1	10	7	2.40	18.00
8294	5A2	2	9	9	2.00	17.60
8294	5A2	3	6	8	1.91	17.90
8294	5A2	4	9	9	2.74	18.00
8294	5A2	5	10	10	2.54	20.70
8295	5B2	1	6	7	3.06	-5.40
8295	5B2	2	9	8	2.66	-5.30
8295	5B2	3	10	8	2.84	-7.80
8295	5B2	4	7	9	3.06	-6.70
8295	5B2	5	10	7	3.04	-5.40
8297	6A2	1	8	8	2.51	46.60
8297	6A2	2	10	8	3.56	43.10
8297	6A2	3	8	8	3.00	45.20
8297	6A2	4	7	7	3.26	44.50
8297	6A2	5	7	10	3.12	45.10
8299	6B3	1	10	7	1.01	10.30
8299	6B3	2	9	7	1.23	8.50
8299	6B3	3	9	8	1.36	0.98
8299	6B3	4	8	8	2.03	9.10
8299	6B3	5	10	6	1.93	10.20

Table D-1. Test Results for Each Bioassay Replicate.

Sample No.	Station	Rep	*Hyalella* Survival	*Chironomus* Survival	*Chironomus* Growth (mg)	Microtox Light Reduction
8300	6C2	1	9	9	4.41	-9.00
8300	6C2	2	9	9	1.80	-12.80
8300	6C2	3	10	9	2.98	-15.10
8300	6C2	4	10	8	3.50	-12.60
8300	6C2	5	9	6	3.42	-13.00
8301	7A2	1	7	10	3.34	-9.00
8301	7A2	2	9	7	3.54	-7.80
8301	7A2	3	10	9	2.68	-9.00
8301	7A2	4	0	9	3.52	-10.40
8301	7A2	5	9	6	4.63	-8.40
8303	7B2	1	7	8	3.13	3.10
8303	7B2	2	2	5	3.50	1.90
8303	7B2	3	8	6	2.47	0.90
8303	7B2	4	8	8	2.86	0.80
8303	7B2	5	7	9	2.71	1.30
8304	7C2	1	8	8	2.36	21.10
8304	7C2	2	10	4	4.40	19.50
8304	7C2	3	7	9	2.22	18.70
8304	7C2	4	9	7	3.57	19.90
8304	7C2	5	6	4	2.88	16.40
8305	8A2	1	8	8	1.68	19.50
8305	8A2	2	3	8	1.24	17.00
8305	8A2	3	9	4	1.38	18.60
8305	8A2	4	7	7	0.97	20.30
8305	8A2	5	7	0	.	18.60
8307	8C3	1	9	3	0.33	7.60
8307	8C3	2	8	4	1.03	9.00
8307	8C3	3	9	3	0.13	8.20
8307	8C3	4	6	1	0.30	8.50
8307	8C3	5	7	3	0.20	8.50
1111	Control	1	10	10	3.48	
1111	Control	2	10	10	2.18	
1111	Control	3	10	10	2.11	
1111	Control	4	10	10	2.47	
1111	Control	5	8	10	2.27	

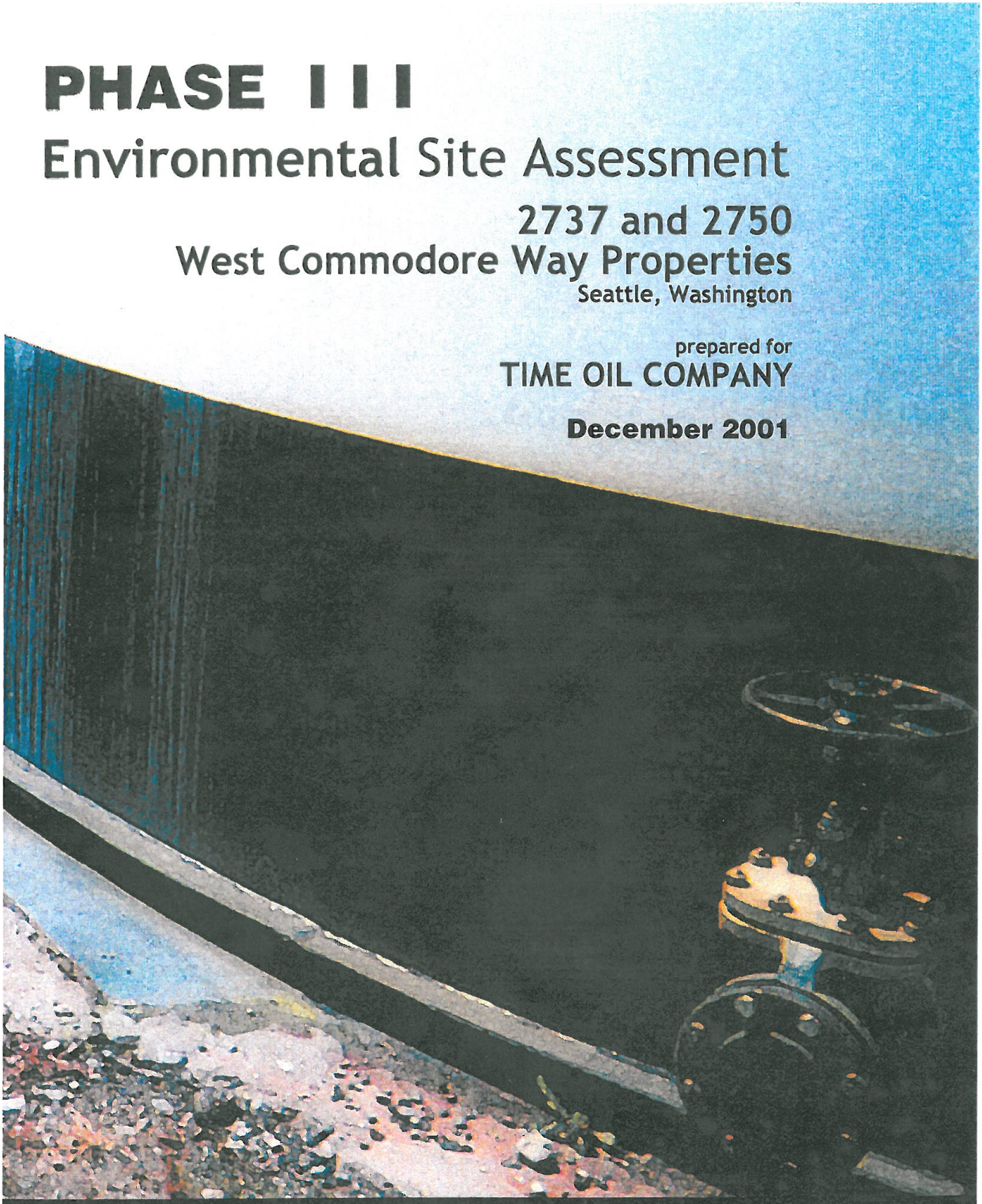
PHASE III

Environmental Site Assessment

2737 and 2750
West Commodore Way Properties
Seattle, Washington

prepared for
TIME OIL COMPANY

December 2001



prepared by:

FOSTER WHEELER ENVIRONMENTAL CORPORATION

CONTENTS

CONTENTS

CONTENTS

FIGURES

TABLES

CONTENTS

ACRONYMS AND ABBREVIATIONS

μg/L	micrograms per liter
AST	above-ground storage tank
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
cPAH	carcinogenic polyaromatic hydrocarbon
DPE	dual-phase extraction
EC	equivalent carbon
EPA	U.S. Environmental Protection Agency
ESA	Environmental Site Assessment
Foster Wheeler Environmental	Foster Wheeler Environmental Corporation
HDPE	high-density polyethylene
ID	inner diameter
IT	IT Corporation
LUST	leaking underground storage tank
MCL	maximum contaminant level
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MNA	monitored natural attenuation
mS/cm	millisiemens per centimeter
MTCA	Model Toxics Control Act
NAD	North America Datum
NAVD	National America Vertical Datum
NOAA	National Oceanic Atmospheric Administration
NTU	nephelometric turbidity unit
NWTPH-D_x	Northwest total petroleum hydrocarbon-diesel extended
NWTPH-G_x	Northwest total petroleum hydrocarbon-gasoline
OSWER	Office of Solid Waste and Emergency Response
PAH	polyaromatic hydrocarbons
PCP	pentachlorophenol
PID	photoionization detector
ppb	parts per billion

ACRONYMS AND ABBREVIATIONS

ppm	parts per million
Property	2737 West Commodore Way
PVC	polyvinyl chloride
RBCA	Risk Based Corrective Action
SQuiRT	Screening Quick Reference Table
TOC	Time Oil Company
TPH	total petroleum hydrocarbon
UST	underground storage tank

1. INTRODUCTION

In August 2000, Foster Wheeler Environmental Corporation (Foster Wheeler Environmental) completed Phase I Environmental Site Assessments (ESAs) at seven properties owned by the Time Oil Company (TOC) that are located along West Commodore Way in Seattle, Washington. The results of the Phase I ESA activity were documented in Phase I ESA reports prepared for each of the seven properties (Foster Wheeler Environmental 2000).

The Phase I ESA report prepared for the property located at 2737 West Commodore Way (Property) concluded that additional investigation was required to better understand subsurface conditions. Phase II ESA activities were subsequently conducted at the Property in November and December 2000, and results are documented in Phase II's Final ESA (Foster Wheeler Environmental 2001a). The Phase II report recommended additional subsurface sampling at 2737 West Commodore Way and quarterly groundwater sampling at 2737 and 2750 West Commodore Way; consequently, investigation activities and quarterly sampling were conducted in July 2001.

Figure 1-1 depicts the general location of the project area. Figure 1-2 illustrates the locations of 2737 and 2750 West Commodore Way.

1.1 PURPOSE AND ORGANIZATION

The purpose of Phase III field activities was to evaluate subsurface conditions at 2737 West Commodore Way in specific areas identified during the Phase II ESA. This report includes the results from the subsurface investigation and from quarterly groundwater sampling at 2737 and 2750 West Commodore Way.

This report is organized into six sections and three appendices:

- Section 1 – Introduction
- Section 2 – Property History and Previous Investigations
- Section 3 – Field Activities
- Section 4 – Analytical Results
- Section 5 – Conclusions and Recommendations

- Section 6 – References
- Appendix A – Soil Boring Logs
- Appendix B – Surveyor's Report
- Appendix C – Laboratory Data Packages

1.2 PROJECT OBJECTIVES

The results of the Phase II ESA conducted at 2737 West Commodore Way suggested that additional investigation activities be conducted at five areas to further evaluate subsurface conditions and to conduct quarterly groundwater sampling at both properties (i.e., 2737 and 2750 West Commodore Way). A layout of the property at 2737 West Commodore Way and the areas investigated is provided in Figure 1-3. The areas and the justification for additional investigation are as follows:

1. Upper Rail Line Spur Area – Historical photographs show stained soil along the former rail line spur on the south side of the Upper Tank Yard Area. Previous investigations did not show extensive petroleum-impacted soil. Petroleum-impacted groundwater was detected beneath the tank yards north of the Upper Rail Line Spur Area. A monitoring well was planned in the area to evaluate up-gradient (background) groundwater conditions.
2. Former PCP/Diesel Mixing Area – The Former PCP/Diesel Mixing Area is a sub-area of the Lower Tank Yard Area. An above-ground storage tank (AST) was used in the Lower Tank Yard Area to mix pentachlorophenol (PCP) and diesel during a short period of time in the late 1960s. Soil borings, near subsurface sampling, and a monitoring well were planned to evaluate the potential for petroleum-impacted and PCP-impacted soil and groundwater.
3. Former Barrel Shed Area – The Former Barrel Shed Area was between the warehouse and the office building. The pipeline from the PCP/diesel mixing tank also ran underground in this area. During the Phase II activities (December 2000), several borings and a monitoring well were installed in this area. Soil samples were not analyzed for PCP but the groundwater sample from the monitoring well (01MW-06) did contain low levels of PCP. A soil boring was planned near 01MW-06 to evaluate the potential for petroleum-impacted and PCP-impacted soil from the former structure.
4. New Barrel Shed Area – The New Barrel Shed Area is west of the warehouse. The area was used for a short time during the late 1960s to fill 55-gallon barrels with the

PCP/diesel mixture through an overhead distribution system. The pipeline ran from the Former PCP/Diesel Mixing Area, beneath the Former Barrel Shed Area, and into the New Barrel Shed Area. A soil boring was drilled on the north end of the New Barrel Shed Area near the pipeline, and a well was installed. Samples were analyzed for petroleum products, lead, and PCP.

5. West Commodore Way Perimeter Area – Historical releases from a leaking underground storage tank (LUST) used to store petroleum products have affected the subsurface soil and groundwater in this area. A soil boring and monitoring well were planned to evaluate the extent of petroleum-impacted soil and groundwater in the area.

2. PROPERTY HISTORY AND PREVIOUS INVESTIGATIONS

The following sections describe the history of the Property and summarize previously conducted investigations.

2.1 PROPERTY DESCRIPTION

The Property runs from West Commodore Way south to the Burlington Northern rail line. Except for the area of the former rail lines behind the warehouse, and the Upper and Lower Tank Yard Areas on the east side of the Property, the Property has been paved. A two-story office building is located in the center of the Property toward West Commodore Way. A three-section warehouse is located behind the office building, and a former boiler room is connected to the east side of the warehouse via a covered loading dock. An open-air barrel shed is located to the northwest of the warehouse. The Tank Yard is divided into two sections, the Lower Tank Yard Area and the Upper Tank Yard Area, each constructed at a different time. The Lower Tank Yard Area contains six ASTs. The Upper Tank Yard Area contains eight ASTs that are larger in volume than those in the Lower Tank Yard Area. The south side of the Upper Tank Yard Area, banks steeply upward to the fence line and former rail line spur. The surface of the Tank Yards is unpaved gravel with patches of grass. Immediately to the west of the Tank Yards are a pump shed and foamite shed (used for fire suppression).

According to available regulatory records and interviews with TOC personnel, there are several underground storage tanks (USTs) on the Property. Two USTs are located on the north side of the office building: an unused heating oil tank is located on the east side of the office building adjacent to the former furnace room, and a gasoline vapor knock-out tank is located along the north side of the Lower Tank Yard Area. The knock-out tank is associated with the overhead fuel loading racks located just north of the Lower Tank Yard Area of the tank farm. There are no known drinking water wells on the Property, but several monitoring wells from previous site investigations are installed within the shallow water-bearing zone beneath the Property.

2.2 PROPERTY OPERATION

The Property is used by TOC for a variety of purposes: it is the site of the TOC administrative offices; it previously served as a tank farm for petroleum products; and portions are used to store equipment and supplies for service stations, such as fuel dispensers, fascia, signs, and miscellaneous supplies (most of these materials are kept near the New Barrel Shed Area or in part of the warehouse). The ASTs range in size from approximately 5,225 barrels to 23,000 barrels. Fuel distribution lines connect the ASTs to an extensive manifold system that is connected to the truck loading rack and a waterfront dock located in the ship canal across West Commodore Way. When the tank farm was operating, fuel was off-loaded from barges and tankers in the ship canal and transferred to the ASTs. From there, the fuel was transferred to tanker trucks via the overhead loading rack outside of, and just north of, the Lower Tank Yard Area.

Operation of the TOC Seattle Terminal as a petroleum storage and transfer facility was discontinued in October 2001. The ASTs and pipelines have been purged of petroleum products, appropriately cleaned, and are currently empty. Although the terminal improvements remain in place, there are currently no plans to use the facility for petroleum storage and/or transfer again; thus, the potential for additional hydrocarbon releases is believed to be very low.

2.3 PROPERTY HISTORY

Information about the history of the Property was derived from a review of available documents, historical photographs, and regulatory records. Former and current employees of TOC were also interviewed.

The Property was acquired by TOC around 1941. Before 1936, the Property appears to have been used for agricultural purposes. Historical aerial photographs and fire insurance maps presented in the Phase I reports (Foster Wheeler Environmental 2000) show the Rattan Furniture factory, a sawmill, dry kiln, and a U.S. Coast Guard facility located across West Commodore Way.

A 1946 photograph shows the original office building, the Lower and Upper Tank Yard Areas of the tank farm, the pump shed and foamite building, a former barrel shed located immediately west of the office building, and overhead fuel loading racks. The unpaved surface of the Lower Tank Yard Area is noticeably dark, and it is unclear whether this darkness is an artifact of the photograph or is indicative of site operations. Numerous rows of empty 55-gallon drums are located to the west of the Property, which, according to interviews with TOC employees, were filled with petroleum products in the Former Barrel Shed Area, rolled under West Commodore Way via a barrel incline and tunnel to the TOC dock in the ship canal, and loaded onto ships. This operation was conducted primarily to support World War II efforts. According to the interviewees, laborers were hired to fill the barrels and load them onto ships. The filling apparatus was controlled by pulling a line to dispense fuel into a drum. One pull of the line would automatically dispense 50 gallons of fuel into the 55-gallon drums via an overhead nozzle at a very high rate and if the line was pulled twice, then twice as much fuel would be dispensed (and so on). The interviewees stated they had heard of many times when drums were overfilled and fuel spilled on the ground.

In 1946, a large volume of fuel arrived at the Property via rail cars. There were four rail spurs off the main Burlington Northern line leading onto the TOC property: one spur ran behind the Former Barrel Shed Area and the other lines led toward the southwest end of the tank farm's Upper Tank Yard Area. One of these lines ran all the way behind the Upper Tank Yard Area toward 27th Avenue West. Fuel was transferred from tanker cars via hoses to a subsurface line, from which it was pumped into the ASTs. Careful examination of the historical photograph from 1946 shows what appear to be equally spaced dark patches of soil on the rail spur on the south side of the tank farm's Upper Tank Yard Area. According to the interviewees, the tank cars were off-loaded with hoses; therefore, these dark patches may be related to petroleum leaks and spills that occurred during off-loading operations. After the lines were disconnected, it was not uncommon for residual fuel to drain from the lines and onto the ground.

The historical photograph from 1960 depicts the Property largely as it is today. A warehouse building, built in the late 1940s according to information in the Puget Sound Regional Archives, is located south of the office building parallel to the rail spurs (several of the rail spurs were deactivated by the time of this photograph). A new barrel shed, built in 1952 according to the Puget Sound Regional Archive files, is located just northwest of the warehouse; the boiler house was added in 1950 (Puget Sound Regional Archive files). The barrel shed seen in the 1946 photograph is no longer on the Property in the 1960 photograph.

According to interviewees, TOC operated a fleet of fuel delivery service trucks that were serviced across the street at the vehicle maintenance facility at 2750 West Commodore Way. Historical photographs show three ASTs located north of the New Barrel Shed Area. According to TOC employees, these ASTs were used to store used motor oil. The immediate area surrounding the ASTs was unpaved, but an outer area was paved. The interviewees also indicated that this area had been affected by several small spills and leaks related to used motor oil transfer and storage activities.

By 1974 a new vehicle maintenance facility was added on the adjacent property (2800 block) immediately west of the Property. After TOC terminated its fuel truck distribution service, this building was leased to Precision Engineering Specialists (a marine and engine repair facility) in 1976.

According to TOC employees, pentachlorophenol (PCP) was mixed in a small AST near the west wall of the tank farm's Lower Tank Yard Area. The PCP was transferred via underground lines to the new barrel shed where 55-gallon drums and 5-gallon drums were filled, rolled onto a loading dock between the warehouse and the barrel shed, and loaded onto rail cars. This operation reportedly ran for 3 to 4 months during 1967 as part of a military contract. A few of the interviewees also stated that the parking lot on the Property had subsided in the vicinity where the former barrel incline ducked under West Commodore Way; the area was leveled and patched with new asphalt. The 1997 photograph shows the Property as it exists today.

Several of the interviewees mentioned that TOC had wanted to demolish the existing office building to construct a new office building; however, there was concern about excavating to the west of the existing office building because of the potential presence of petroleum-impacted soil. A couple of the interviewees also mentioned that many of the ASTs had small weeps or leaks near the bases. While there were no reports of large releases, numerous small leaks could have had a cumulative impact. Some of the interviewees also indicated that the fuel line between the rail spurs was an area where there had been releases in the past. Other statements by the interviewees noted a release of gasoline near the northern (outer) overhead fuel-loading rack. During one incident, the driver of a tanker truck is reported to have struck a portion of the loading facilities, resulting in a spill of over 1,000 gallons of gasoline; most of the fuel was reportedly recovered. The overhead loading racks initially had a center island surrounded by sand with only the driveways paved. The southern (inside) rack was replaced in the mid-1980s, and the entire area surrounding both loading racks was paved. Interviewees identified the pipeline leading to the dock across the street as an area where petroleum releases may have occurred. The pipeline consists of several pipes encased in an outer conduit. The speculation was that the older 8-inch pipes had failed and newer 6-inch pipes were placed within the older pipes.

2.4 PREVIOUS INVESTIGATIONS

In September 1991 (TOC 1991), three USTs were removed from the Property, including a 4,000-gallon unleaded gasoline tank, a 2,500-gallon diesel fuel tank, and a 1,500-gallon regular leaded gasoline tank. Figure 2-1 shows the locations of the former USTs and soil sampling locations.

The diesel fuel and leaded gasoline tanks were part of a baffled system (one 4,000-gallon tank) that was installed in 1980. Following removal of the USTs, a new 4,000-gallon UST was installed at the same location. This new tank is baffled to provide two compartments (one 3,000-gallon compartment and one 1,000-gallon compartment) and is therefore registered with Washington State Department of Ecology (Ecology) as two tanks. Two new fuel dispensers were also installed. The TOC report from 1991 indicated that the soil in the excavation appeared discolored and a hydrocarbon odor was evident. In addition, water with a hydrocarbon sheen was encountered at a depth of 18 feet below ground surface (bgs).

Efforts to excavate the petroleum-impacted soil were impeded by the proximity of the TOC building to the excavation and the presence of groundwater in the excavation space. Water samples were not collected, but soil samples indicated that the highest concentration (12,000 parts per million [ppm]) of hydrocarbons was present in surficial soils beneath the former fuel dispensers (east side of the building).

Additional site assessment activities were conducted in 1999, including the installation of nine soil borings and five groundwater monitoring wells (IT Corporation [IT] 2000). The locations of the 1999 borings are shown in Figure 2-2. Soil boring logs included in the IT report indicate that soil composition beneath the Property from the surface to approximately 20 to 25 feet bgs consists of sands and silts, with varying amounts of clay and gravel. Very dense dry clay underlies this sand/silt unit and acts as an aquitard. Several soil samples contained diesel and gasoline at concentrations above the historic Model Toxics Control Act (MTCA) Method A level. The concentrations ranged from 381 ppm to 755,000 ppm. One soil sample (01SB-09 at 2.5 feet bgs) contained heavy oil above the historic MTCA Method A level and, although the analytical results for heavy oil on several other samples were below limits of detection, the detection limits exceed the historic MTCA cleanup level. Benzene was reported above the soil cleanup level in samples collected from borings 01SB-08, 01SB-09, and 01MW-05.

Table 2-1 presents the analytical results for soil samples with petroleum concentrations above the cleanup levels. Concentrations of benzene in soil samples ranged from 2.12 ppm to 5,590 ppm. Several soil samples also exceeded the cleanup level for toluene, ethylbenzene, and xylene.

Groundwater was encountered in eight of the nine borings and all of the monitoring wells. Depth to groundwater ranged from 14 to 17 feet bgs. The wells were sampled in September 1999; only one well (01MW-01) did not contain detectable concentrations of hydrocarbons.

Table 2-2 lists the analytical results from the groundwater monitoring well and boring water samples collected in 1999. Well 01MW-05 contained floating product with an apparent thickness of 0.78 feet; consequently, this well was not sampled. The concentrations of gasoline in wells 01MW-01 through 01MW-04 ranged from 12.2 milligrams per liter (mg/L) to 27.2 mg/L, and concentrations of diesel ranged from 0.7 mg/L to 1.32 mg/L. Heavy oil was not detected in any of the wells. Benzene ranged from 3,880 mg/L to 11,300 mg/L. Wells 01MW-02 through 01MW-04 contained concentrations of toluene, ethylbenzene, and xylene above the MTCA Method A level. Total lead exceeded the cleanup level in every well except 01MW-01, with the highest concentration (130 parts per billion [ppb]) detected in 01MW-04. Most of the elevated concentrations appear to be located near the northeast corner of the office building. The IT report recommended additional site characterization.

In May 2000, TOC submitted a letter (TOC 2000) to Mr. Joe Hickey of the UST division of Ecology that summarizes previous field activities. In the letter, TOC indicated that the extent of contamination beneath the Property would be assessed.

During November and December 2000, Foster Wheeler Environmental conducted additional investigation activities at 2805, 2750, and 2737 West Commodore Way. The findings of these investigations are documented in the Environmental Site Assessment (Foster Wheeler Environmental 2001a). The report concluded that additional subsurface investigations were not necessary at 2805 or 2750 West Commodore Way. Groundwater monitoring was recommended for 2737 and 2750 West Commodore Way.

The investigation at 2737 West Commodore Way focused on several distinct areas and recommended additional work in five areas:

- Upper Rail Line Spur Area
- Former PCP/Diesel Mixing Area

- Former Barrel Shed Area
- New Barrel Shed Area
- West Commodore Way Perimeter Area

3. FIELD ACTIVITIES

Field activities at 2737 West Commodore Way included soil borings, near subsurface soil sampling, well installation, soil sampling, quarterly groundwater sampling, fuel characterization, and surveying. The following sections describe the methodology used to complete the field activities.

3.1 SOIL BORINGS

3.1.1 Soil Boring Locations

Nine soil borings were drilled at 2737 West Commodore Way, as shown on Figure 3-1. The total depth of each soil boring and the depth groundwater encountered at each location is described below:

<u>Upper Rail Line Spur Area</u>:

- SB-61 was located between SB-21 and SB-22 and advanced to a depth of 32 feet. Groundwater was encountered at a depth of approximately 22 feet bgs during drilling. Monitoring well 01MW-17 was installed at this location as an up-gradient well.

<u>Former PCP/Diesel Mixing Area (Lower Tank Yard Area)</u>:

- SB-52 was located south of the Former PCP/Diesel Mixing Area (near SB-01). The boring was advanced to a depth of 14 feet. Groundwater was encountered at a depth of approximately 11 feet bgs.
- SB-53 was located east of the Former PCP/Diesel Mixing Area (near SB-02). The boring was advanced to a depth of 12 feet. Groundwater was encountered at a depth of approximately 11 feet bgs.
- SB-54 was located west of the Former PCP/Diesel Mixing Area (near SB-04). The boring was advanced to a depth of 12 feet. Groundwater was encountered at a depth of approximately 10.5 feet bgs.

- SB-55 was located northeast of the Former PCP/Diesel Mixing Area. The boring was advanced to a depth of 12 feet. Groundwater was encountered at a depth of approximately 11.5 feet bgs.
- SB-56 was located north of the Former PCP/Diesel Mixing Area. The boring was advanced to a depth of 15 feet. Groundwater was encountered at a depth of approximately 8 feet bgs. Monitoring well 01MW-14 was completed in this location.
- SB-57 was located southeast of the Former PCP/Diesel Mixing Area. This sampling location was not a soil boring, because of restricted access and the presence of utilities. A near sub-surface sample was collected by removing the upper 18 inches of overburden with a clean shovel. A decontaminated stainless steel spoon was then used to collect a soil sample.

Former Barrel Shed Area:

- SB-59 was located on the west end of the Former Barrel Shed Area near 01MW-06. The boring was advanced to a depth of 20 feet. Groundwater was not encountered during drilling.

New Barrel Shed Area:

- SB-58 was located in the parking lot near the subsurface pipes as they enter the foundation of the New Barrel Shed Area. The boring was advanced to a depth of 30 feet. Groundwater was encountered at a depth of 22 feet bgs during drilling. Monitoring well 01MW-15 was completed at this location.

West Commodore Way Perimeter Area:

- SB-60 was located east of the LUST area, between 01MW-02 and 01MW-10. The boring was advanced to a depth of 22.5 feet. Groundwater was encountered at a depth of approximately 18 feet bgs. Monitoring well 01MW-16 was installed at this location.

3.1.2 Soil Boring Methods

Soil borings in the Former PCP/Diesel Mixing Area were drilled with an Acker Soil Mechanic operated by BoreTec. The Acker Soil Mechanic is a portable drilling machine that can be broken down into smaller pieces to allow for access into restricted areas. The machine uses 2-inch inner diameter (ID) hollow-stem augers. Split-spoon samples were driven every 5 feet. The spoons were 12 inches long, 1 inch ID, and driven with a 140-pound hammer.

The remaining borings were drilled with a CME 75 High Torque drill rig operated by Cascade Drilling. The augers used on the drill rig were 4.25-ID hollow stem. Split-spoon samples were driven every 5 feet to describe lithologies and collect soil samples. In most borings, an extra split-spoon sample was driven at the 2-foot-depth interval. Split-spoon samples were 12 inches long (not including the shoe), 2-inch ID, and driven by a 300-pound down-hole jar hammer. Appendix A contains the soil boring logs for the Property.

3.1.3 Soil Sampling Methods

Soil samples were collected directly from the split spoon and placed in the appropriate laboratory-supplied sample container. The analyses requested for each sample depended on the location. In general, the samples were analyzed for:

- Gasoline using Ecology's Northwest total petroleum hydrocarbon-gasoline (NWTPH-Gx) method
- Benzene, toluene, ethylbenzene, and xylene (BTEX) using U.S. Environmental Protection Agency (EPA) 8021B
- Diesel and oil using Ecology's Northwest total petroleum hydrocarbon-diesel extended (NWTPH-Dx) method
- PCP using EPA Method 8270-sim (selected ion monitoring)
- Carcinogenic polyaromatic hydrocarbons (cPAHs) using EPA Method 8270-sim
- Total lead using EPA 6000/7000 series

The gasoline/BTEX samples were collected first out of each spoon. The sample containers were placed in sealed baggies and placed directly into a chilled cooler for transport to the laboratory. Soil samples were labeled according to their soil boring location and depth collected (i.e., SB-52-2 = soil boring 52, sample depth 2 feet). North Creek Analytical (Bothell, Washington) received the samples at the end of each day in the field.

The split spoons were decontaminated by thoroughly washing them in soapy water, rinsing with water, rinsing with methanol, and finally rinsing with deionized water supplied by the analytical laboratory.

3.1.4 Product Sampling

Product samples were collected from three wells: 01MW-05, 01MW-10, and 01MW-14. The samples were collected using capillary tubes and submitted to Friedman & Bruya, Inc. for characterization of product and PCP analysis.

3.2 MONITORING WELL INSTALLATION

Four new monitoring wells were installed and developed during the Phase III investigation activities. The locations of the new monitoring wells as well as the existing wells are shown on Figure 3-2. Table 3-1 presents the available well construction information for wells at 2737 West Commodore Way.

3.2.1 Monitoring Well Locations

Each of the wells installed was designed and located with a specific purpose in mind. The rationale behind each well location is as follows:

- 01MW-14 (SB-56) was located south of the Former PCP/Diesel Mixing Area. The well is screened within the shallow water-bearing zone. The purpose of this well is to evaluate the potential impacts of fuel and PCP from the Former PCP/Diesel Mixing Area.
- 01MW-15 (SB-58) was located downgradient and north of the New Barrel Shed Area to evaluate potential groundwater impacts. The well is screened within the shallow water-bearing zone with the bottom of the well above a dry, impermeable clay/silt layer.
- 01MW-16 (SB-60) was located just east of the office building near the Former LUST Area, between 01MW-02 and 01MW-10, to evaluate the extent of petroleum-impacted groundwater. The well is screened within the shallow water-bearing zone with the bottom of the well above a dry, impermeable clay/silt layer.
- 01MW-17 (SB-61) was located upgradient of the Upper Tank Yard Area to evaluate background groundwater conditions. The well is screened within the shallow water-bearing zone with the bottom of the well above a dry, impermeable clay/silt layer.

3.2.2 Well Installation Methods

The monitoring wells were drilled as described in Section 3.1.2.

3.2.3 Installation Materials

Most of wells were installed with flush-threaded, 2-inch ID polyvinyl chloride (PVC) casing with variable screen lengths of 0.010-inch slots. The sand pack consists of a 20-40 Colorado silica sand around the screen to 2 feet (typically) above the top of the screen. The sand pack is overlain by a bentonite seal of at least 1 foot (typically). Concrete and flush-mount monuments were used to complete the wells. Heavy-duty well monuments were used for wells in areas with high levels of vehicular traffic.

Monitoring well 01MW-14 was installed with the Acker Soil Mechanic. Because of the smaller boring diameter, this well features a 1-inch ID casing. The annular materials are identical to those of the 2-inch ID wells.

3.2.4 Well Development

The wells were developed following installation. For development, the wells were surged frequently with a double-stage purge pump. At least three well volumes of water were pumped from the wells using the double-stage purge pump. Before a different well was pumped, the tubing was changed on the pump, and the pump was decontaminated by washing it with soapy (Liquinox) water, pumping soapy water through it, and rinsing it with deionized water supplied by the analytical laboratory.

Visual observations and measurement of physical parameters provided monitoring of development progress. Measurements during development and well sampling were made for pH, temperature, conductivity, and turbidity using a Hydrolab Data Sonde. The meter was calibrated before each use using standards supplied by the instrument provider. Table 3-2 provides the final parameters measured during the sampling and development of the wells.

3.3 SURVEYING

The soil boring locations were surveyed by Inca Engineering, Inc. Horizontal control was specified to 0.1 foot, based on Washington State Plane Coordinate System, North America Datum (NAD) 83/91 City of Seattle. Vertical control was specified to 0.01 foot, based on the National America Vertical Datum (NAVD) 88 City of Seattle. A summary of the survey results is presented in Table 3-1, and the complete data are provided in Appendix B.

3.4 WATER LEVEL MEASUREMENTS

Water level measurements were made from all available wells. Depth to groundwater measurements were subtracted from surveyed measuring point elevations to determine the water level elevations (potentiometric head), as shown in Table 3-3. The potentiometric surface maps for 2737 and 2750 West Commodore Way are shown in Figures 3-3 and 3-4, respectively.

3.5 GROUNDWATER SAMPLING AND ANALYSIS

Groundwater samples were collected from July 25 through July 27, 2001. Water samples were collected in laboratory-supplied glassware and delivered to the laboratory each evening after sampling.

Samples were collected using a peristaltic pump, disposable high-density polyethylene (HDPE) tubing, and silicone tubing. At each well the HDPE tubing was inserted into the water at approximately the center of the well screen. A piece of disposable silicon tubing was connected to the HDPE tubing and run through the pump. Both pieces of tubing were discarded after each use, and new tubing was used for the next well.

The analyses performed on each groundwater sample depended on the location. In general, the water samples were analyzed for the following potential contaminants:

- Gasoline, using Ecology's NWTPH-Gx Method
- BTEX, using EPA Method 8021B
- Diesel and oil, using Ecology's NWTPH-Dx Method
- cPAHs, using EPA Method 8270-sim
- PCP, using EPA Method 8270-sim
- Total lead, using EPA 6000/7000 series

3.6 INVESTIGATION DERIVED WASTE

Soil cuttings from the Property were transferred to the stock piles on the Property for disposal by TOC. Decontamination water was collected by the drilling company in 55-gallon type 1A drums, transferred to TOC.

4. ANALYTICAL RESULTS

Soil samples and groundwater were analyzed by North Creek Analytical Labs in Bothell, Washington. Product characterization samples were analyzed by Friedman & Bruya, Inc., in Seattle, Washington. Where applicable, results were compared to Ecology's new Method A soil levels for unrestricted land use. Ecology's new rule does not differentiate between industrial property and unrestricted land use. The new soil levels for diesel and oil are higher than the previous MTCA Method A levels, with the new soil levels for gasoline divided into two categories: gasoline without benzene and less than 20 percent aromatics between equivalent carbon (EC) 8 and EC16 (proposed soil cleanup level of 100 milligrams per kilogram [mg/kg]); and all other gasoline mixtures (proposed soil cleanup level of 30 mg/kg). The new BTEX levels for soil are lower than previous levels. For PCP, the soil results were compared to the MTCA Method B carcinogenic levels for residential soils. Groundwater concentrations were compared to the National Oceanic Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRT) values. The SQuiRT values provide screening levels for acute and chronic exposures to both freshwater and saltwater. Because the groundwater beneath the site is not used for drinking water and the ultimate point of exposure is the Ship Canal (a fishwater body), it is appropriate to compare the groundwater concentrations to the NOAA SQuiRT values for fishwater. Groundwater concentrations were compared to the MTCA Method A levels for groundwater for analytes that did not have applicable NOAA SQuiRT values. The analytical results are presented in Tables 4-1 through 4-5. The footnotes at the bottom of each table identify the applicable action levels.

Appendix C contains the laboratory data packages for the samples collected at the Property. The data packages are presented in their entirety to allow the reader to evaluate the data relative to the quality control data associated with the environmental samples.

The following sections present the analytical results. The results for Phase III soil samples and the new monitoring wells are presented in Section 4.1. Quarterly groundwater results are presented in Section 4.2.

4.1 PHASE III ACTIVITIES

4.1.1 Upper Rail Line Spur Area

Soil

One soil boring (SB-61) was located near the Upper Rail Line Spur Area on the south side of the Upper Tank Yard Area. Four soil samples were collected from the boring and analyzed for gasoline, diesel, and oil. Diesel and oil were detected at low concentrations in the sample collected from a depth of 2 feet bgs. None of the soil samples showed concentrations of petroleum analytes above the reporting limit.

Groundwater

The groundwater sample collected from 01MW-17 contained concentrations of diesel (0.884 mg/L) above the MTCA Method A level (0.500 mg/L). None of the other petroleum analytes were detected above the reporting limits.

4.1.2 Former PCP/Diesel Mixing Area

Soil

Five soil borings (SB-52 through SB-56) were installed in the Former PCP/Diesel Mixing Area. Gasoline (1,410 mg/kg) and diesel (4,180 mg/kg) were detected above the MTCA Method A level for unrestricted soil in SB-52 at a depth of 2.5 feet bgs. None of the samples collected from the 6-foot or 10-foot depth showed concentrations above the MTCA Method A level for unrestricted soil.

None of the soil samples from SB-53 or SB-54 showed concentrations above the MTCA Method A levels for unrestricted soil. Gasoline, diesel, and oil were detected in SB-54 at a depth of 2 feet bgs.

Gasoline (185 mg/kg) was detected above the MTCA Method A level in SB-55 at a depth of 6 feet bgs. None of the petroleum analytes were detected above the reporting limit in SB-55. None of the petroleum analytes exceeded the MTCA Method A levels for unrestricted soil in the sample collected from the 10-foot depth in SB-55. PCP was not detected above the MTCA cleanup level.

Gasoline, benzene, ethylbenzene, xylene, and diesel were detected above the MTCA Method A level for unrestricted soil in SB-56 at depths of 2.5 feet bgs and 5 feet bgs. PCP was detected (8.88 mg/kg) above the MTCA Method B level (8.33 mg/kg) for soil. None of the analytes exceeded the MTCA Method A levels for unrestricted soil in the sample collected from the 10-foot depth. The concentration of cPAHs (2.6240 mg/kg) exceeded the MTCA Method A level of 1.0 mg/kg in SB-56 at a depth of 2.5 feet bgs.

A near subsurface sample was collected at SB-57 from a depth of 1.5 feet. Gasoline (2,590 mg/kg), ethylbenzene (18.2 mg/kg), and diesel (3,970 mg/kg) were detected above the MTCA Method A level for unrestricted soil. PCP was not detected above the laboratory reporting limit.

Groundwater

A monitoring well (01MW-14) was installed in SB-55. The well contained approximately 6.7 feet of product with no discernable groundwater present. A product sample was collected for fuel characterization and PCP analysis. The lab concluded that the majority of the material present in the sample is indicative of a middle distillate such as diesel fuel #2 or heating oil. The report also concluded that low-level degraded gasoline may have impacted the sample. PCP was detected in the sample at a concentration of 140 μg/g (ppm).

4.1.3 Former Barrel Shed Area

Soil

One soil boring (SB-59) was installed near the Former Barrel Shed Area. Gasoline (799 mg/kg) and diesel (4,950 mg/kg) were detected above the MTCA Method A levels for unrestricted soil at a depth of 5 feet. Samples from the 15-foot and 20-foot-depth interval in SB-27 did not contain concentrations of petroleum-impacted soil above the method reporting limit.

Lead, PCP, and cPAHs were not detected above the MTCA Method A levels in SB-59.

4.1.4 New Barrel Shed Area

Soil

One boring (SB-58) was installed just north of the loading dock directly north of the New Barrel Shed Area. None of the samples had concentrations of analytes above the MTCA Method A level for unrestricted soil.

Groundwater

A monitoring well (01MW-15) was installed in boring SB-58. None of the analytes exceeded the MTCA Method A levels or the NOAA SQuiRT values.

4.1.5 West Commodore Way Perimeter Area

Soil

One boring (SB-60) was located along West Commodore Way and north of the Lower Tank Yard Area. Gasoline (1,240 mg/kg), benzene (1.68 mg/kg), xylenes (10.2 mg/kg), and diesel (11,400 mg/kg) were detected above the MTCA Method A level for unrestricted soil at a depth of 15 feet. The sample from the 20-foot depth did not show concentrations of analytes above the reporting limits.

Lead was not detected above the MTCA Method A levels.

Groundwater

A monitoring well (01MW-16) was installed in boring SB-60. Gasoline (11,000 μg/L) and diesel (11.1 mg/L) were detected at concentrations above the MTCA levels.

4.2 QUARTERLY GROUNDWATER SAMPLING

Groundwater samples are collected on a quarterly basis (January, April, July, and October) at 2737 and 2750 West Commodore Way. The first quarterly sampling event occurred during the third quarter of the 2001 calendar year. The specific analyses depend on the sample location. The following sections present the results for each property.

4.2.1 Quarterly Groundwater Sampling at 2737 West Commodore Way

Diesel exceeded the MTCA Method A level in every groundwater sample except the sample from well 01MW-15. Gasoline exceeded the MTCA Method A level in 01MW-02, 01MW-03, 01MW-04, 01MW-09, 01MW-12, and 01MW-16. Benzene exceeded the NOAA SQuiRT value in 01MW-02, and 01MW-03. Total xylene exceeded the cleanup level in 01MW-02 and 01MW-04. PCP did not exceed the NOAA SQuiRT values in any of the samples.

4.2.2 Quarterly Groundwater Sampling at 2750 West Commodore Way

Diesel exceeded the MTCA Method A level in every well except 02MW-07. Gasoline (4,270 μg/L) exceeded the MTCA Method A level in 02MW-04. None of the other analytes were detected above the applicable regulatory levels.

5. CONCLUSIONS AND RECOMMENDATIONS

The following sections describe the nature and extent of contamination as well as recommendations for future actions.

5.1 NATURE AND EXTENT OF CONTAMINATION

The following subsections describe the nature and extent of contamination within each area. A summary table (Table 5-1) shows the soil samples exceeding the MTCA Method A levels for unrestricted soil. Tables 5-2 and 5-3 show the groundwater samples exceeding action levels at 2737 and 2750 West Commodore Way, respectively.

5.1.1 Upper Rail Line Spur Area

None of the samples collected from the new boring (SB 61) exceeded the MTCA levels for unrestricted soil. The groundwater sample from 01MW-17 showed concentrations of diesel (0.884 mg/L) above the MTCA cleanup level (0.500 mg/L). The potentiometric surface for the site also showed that 01MW-17 is downgradient from the site, possibly owing to a localized recharge area beneath the Tank Yards. Figure 5-1 shows the extent of diesel-impacted groundwater beneath the site.

5.1.2 Former PCP/Diesel Mixing Area

Diesel- and gasoline-impacted soil appears to be present near the Former PCP/Diesel Mixing Area in SB-52, SB-55, and SB-56 at depths ranging from 2.5 feet to 6 feet. The samples collected from the 10-foot depth in each boring did not show concentrations of petroleum contaminants above the MTCA level for unrestricted soil. PCP was detected (8.88 mg/kg) at a level just above the cleanup level (8.33 mg/kg) in SB-56 at a depth of 5 feet. A well (01MW-14) was installed in boring SB-56. The well was found to contain more than 6 feet of product, with no measurable groundwater present. When the product was sampled, PCP was detected at a concentration of 140 μg/g. Carcinogenic PAHs exceeded the cleanup level (1 mg/kg) in SB-56 at a depth of 2.5 feet. Based on the recent findings and previous investigations, it appears that petroleum-impacted soil is generally limited to the upper 5 feet.

5.1.3 Former Barrel Shed Area

Petroleum-impacted soil was evident in SB-59 at a depth of 5 feet. This result is consistent with the findings from previous investigations. PCP was not detected in soil above the MTCA levels. Analytes were not detected above applicable regulatory levels in groundwater. PCP was detected at low levels and may be a result of historic operations or related to wood preservatives used on former buildings or railroad ties.

5.1.4 New Barrel Shed Area

None of the soil samples from SB-58, located north of the New Barrel Shed Area, exceeded the MTCA Method A levels.

The groundwater samples from 01MW-15 did not show concentrations above the regulatory levels. PCP was detected at low levels and may be a result of historic operations or related to wood preservatives used on former buildings or railroad ties.

5.1.5 West Commodore Way Perimeter Area

Petroleum-impacted soil was found in SB-60 at a depth of 15 feet. The soil contamination was found near the water table and may be the result of groundwater influence rather than contaminated soil. A well (01MW-16) was installed in this location. The groundwater sample showed concentrations of gas and diesel above the MTCA levels. It is not clear whether groundwater contamination is due solely to activities at the Former PCP/Diesel Mixing Area to the south, the loading rack immediately to the south, the Former LUST Area to the west, or a combination of these areas. Figures 5-2 and 5-3 show the extent of gasoline- and benzene-impacted groundwater beneath the site, respectively.

5.2 QUARTERLY GROUNDWATER MONITORING

5.2.1 2737 West Commodore Way

Figures 5-1 through 5-3 show the extent of impacted groundwater beneath 2737 West Commodore Way. In general, groundwater concentrations are consistent with those measured in December 2000.

There appear to be two distinct sources of petroleum hydrocarbon-impacted groundwater beneath the site. One source of hydrocarbon-impacted groundwater may be near the Former

LUST Area where gasoline and benzene concentrations are the highest. Another distinct source of hydrocarbon-impacted groundwater appears to originate in the Tank Yards and extend to the north through the tank farm valve manifold to the truck loading rack area. Although the groundwater impact originating in the Tank Yards consists primarily of petroleum hydrocarbon compounds, a low concentration of PCP was detected in a free product sample collected immediately adjacent to the Former PCP/Diesel Mixing Area.

Although results of the Phase III assessment indicate that groundwater that is impacted with PCP is likely present near the Former PCP/Diesel Mixing Area, the source of low-level PCP impacts in other areas of the site is undetermined. It is possible that the low-level PCP groundwater impacts in areas distant from the Former PCP/Diesel Mixing Area could be related to historical PCP handling at the site. It is also possible that the low-level PCP impacts could be the result of wood treatment chemicals used on former site structures or railroad ties. Additional groundwater sampling and analysis for PCP is necessary to more accurately evaluate potential sources of the low-level PCP impacts to groundwater. None of the PCP concentrations detected in the groundwater samples exceeded the corresponding NOAA SquiRT value.

5.2.2 2750 West Commodore Way

Table 5-3 shows the detections of analytes above the MTCA levels for groundwater. Gasoline and diesel were the only analytes detected above the applicable regulatory levels. The petroleum-impacted groundwater appears to be centered around 02MW-04 near the former garage area. Elevated concentrations in up-gradient well 02MW-05 indicate that it is possible that the petroleum-impacted groundwater is entering the property from the LUST area at 2737 West Commodore Way. Table 5-5 shows the cumulative results of groundwater samples collected at the site.

5.3 RECOMMENDATIONS FOR FUTURE ACTIONS

Based on the conclusions above, Foster Wheeler Environmental recommends future actions for the Property, as described in the sections below. The suggestions below include source removal, installation of a dual-phase extraction (DPE) system, and groundwater monitoring.

In addition to typical fuel-related analytes in groundwater, other parameters may be analyzed to evaluate the natural attenuation process at the site. These parameters include iron, nitrate, sulfate, and dissolved oxygen. Monitored natural attenuation (MNA) is a useful tool to demonstrate compliance with regulatory cleanup levels.

According to a directive from EPA's Office of Solid Waste and Emergency Response titled Use of Monitored Natural Attenuation at Superfund RCRA Correction and UST Sites (April 1999), MNA is most appropriate when used in conjunction with other remedial actions or as a follow-up remediation measure. At this particular site, source removal activities have been conducted and additional activities are recommended depending on the area. Bioremediation and MNA, in conjunction with the quarterly monitoring of groundwater movement and petroleum and BTEX concentrations, will provide useful information to evaluate groundwater movement and monitor the effectiveness of the source removal and bioremediation activities, coupled with the natural attenuation of contaminants as they undergo degradation. Risk Based Corrective Action (RBCA) evaluations are currently being conducted to ensure that soil and groundwater impacts proposed to be addressed by MNA do not present unacceptable threats to the environment or to the current or future inhabitants of the property.

5.3.1 Upper Rail Line Spur Area

The purpose of installing 01MW-17 was to establish an up-gradient (background) well for the site. Based on the potentiometric surface for July 24, 2001, it appears that the groundwater is mounded beneath the Tank Yards; consequently, groundwater flows in a southwesterly direction from the site toward 01MW-17. The groundwater flow direction to the south from the Tank Yards may provide an explanation for the elevated diesel concentration in the groundwater sample collected from 01MW-17. Continued groundwater monitoring will be useful in evaluating the extent of impacted groundwater.

In order to address the need for a background well, Foster Wheeler Environmental recommends that two additional wells be installed at the site. Possible locations and the rationale for the wells are as follows:

- 01MW-21 (new well) – to be located on the east side of the 2737 West Commodore Way property. The well would be screened in the shallow aquifer and is intended to determine the extent of groundwater mounding beneath the Tank Yards and to provide a potential background well.

- 01MW-22 (new well) – to be located south of the warehouse. The area south of the warehouse was identified as the Former Lower Rail Line Spur Area in the Phase I ESA. Sampling activities conducted during Phase II did not indicate any contaminated soil in this area. Consequently, this area may be a good location to install a background well and further define the potentiometric surface at the site.

5.3.2 Former PCP/Diesel Mixing Area

Petroleum- and PCP-impacted soil has been identified in the upper 2 feet to 5 feet in many of the soil borings in the Former PCP/Diesel Mixing Area. The samples showing the elevated concentrations are from locations surrounding the former PCP/diesel mixing tank. One sample from the 5 foot depth showed elevated concentrations of PCP and cPAHs. Product was detected in the monitoring well (01MW-14) installed north of the former PCP/diesel mixing tank. The thickness of the fuel was estimated to be more than 6 feet. Foster Wheeler Environmental recommends several additional activities in the Former PCP/Diesel Mixing Area, including well installation, groundwater monitoring, surface soil removal, and fuel recovery.

Additional wells, screened in the shallow aquifer, are recommended within the Lower Tank Yard Area near the Former PCP/Diesel Mixing Area, to delineate the lateral extent of the floating product phase. In order to install the new monitoring wells, some surface piping may need to be removed to allow a drill rig to maneuver. If surface piping cannot be removed, a limited access drill rig may be lifted via a crane and lowered into selected areas. Four-inch diameter wells are recommended so they can be used for fuel recovery, should that become necessary.

It is recommended that quarterly groundwater monitoring continue in order to evaluate groundwater concentrations. In addition, water levels will be measured quarterly to develop potentiometric surface maps. Quarterly samples will be analyzed for fuel-related compounds (gasoline, diesel, oil, BTEX) and PCP.

The removal of affected surface soil is also recommended. PCP pellets are visible on the surface due to historical practices of mixing PCP and diesel fuel. Removal of the surface soil, with possible excavation to a depth of 2 feet to 5 feet, may remove source material that could be contributing to the groundwater impacts.

The pipelines that were formerly used to transfer wood-treating solutions from the Former PCP/Diesel Mixing Area to the New Barrel Shed Area have been purged, cleaned, and either decommissioned or converted to stormwater conveyance lines. Because PCP was not detected in soil samples collected from a boring immediately adjacent to the former conveyance lines, and the conveyance lines are no longer used to transfer hydrocarbons or wood treating solutions, it is unlikely that these lines or the soils surrounding them could serve as an ongoing source of hydrocarbon or PCP impacts.

5.3.3 Former Barrel Shed Area

Soil boring SB-59 was installed in the Former Barrel Shed Area to determine whether the operation of the PCP/diesel pipeline had resulted in PCP-impacted soil. The soil samples collected from the boring did not indicate the presence of PCP-impacted soil; however, groundwater beneath the area did show elevated concentrations of PCP. Continued groundwater monitoring is recommended in the area to evaluate PCP-impacted groundwater trends.

5.3.4 New Barrel Shed Area

Soil boring SB-58 was installed in the New Barrel Shed Area to determine whether the operation of the PCP/diesel pipeline and New Barrel Shed Area resulted in PCP-impacted soil. The soil samples collected from the boring did not indicate the presence of PCP-impacted soil; however, groundwater beneath the area did show detectable concentrations of PCP below the regulatory level. Continued groundwater monitoring is recommended in the area to evaluate PCP-impacted groundwater trends.

5.3.5 West Commodore Way Perimeter Area

Petroleum-impacted soil was detected in soil boring SB-60 at a depth of 15 feet below ground surface. Monitoring well 01MW-16 was installed in this location. Groundwater at this location was found to be affected by diesel, gasoline, benzene, and PCP. Because groundwater was found at a depth of approximately 18 feet during drilling, it is possible that the elevated petroleum contamination in soil is a result of groundwater impacts and not due to historic operations affecting the soil directly. During the July quarterly sampling event, product was discovered in nearby well 01MW-10, which was dry during the last sampling episode (December 2000). With the elevated concentrations in 01MW-16, the proximity of the Former LUST Area, and the newly detected product in 01MW-10, it is recommended that an additional well be installed, groundwater monitoring continue, and pilot-testing activities (Foster Wheeler Environmental 2001c) be conducted.

An additional well located to the south near the truck-loading rack would be useful for many reasons. It is important to determine the extent of product discovered in the Former PCP/Diesel Mixing Area and whether it is related to the product discovered in 01MW-01. In addition, the loading rack may be a potential source area.

Continued quarterly groundwater monitoring is recommended, as mentioned in the previous subsections. Groundwater samples should be analyzed for petroleum products and PCP.

The document *Proposed Product Pilot Testing Activities*, published in October 2001 (Foster Wheeler Environmental 2001c), outlined several steps necessary to design a fuel-recovery system for the Former LUST Area. Implementation of this plan and the ensuing fuel recovery system will aid in the removal of a portion of the contaminant source that appears to be affecting the groundwater beneath the site.

5.3.6 Quarterly Groundwater Sampling

Groundwater samples are collected on a quarterly basis at 2737 and 2750 West Commodore Way. In the past, analyses for PCP have been limited to a few wells. It is recommended that PCP be added to the analyses for wells at both properties. This information will be useful in evaluating the extent of PCP-impacted groundwater, as well as understanding whether the different service areas are mixing or extending across the street from 2737 West Commodore Way to 2750 West Commodore Way. In addition, silica gel cleanup of groundwater samples collected may remove naturally occurring compounds that could be yielding false positive detection of diesel.

6. REFERENCES

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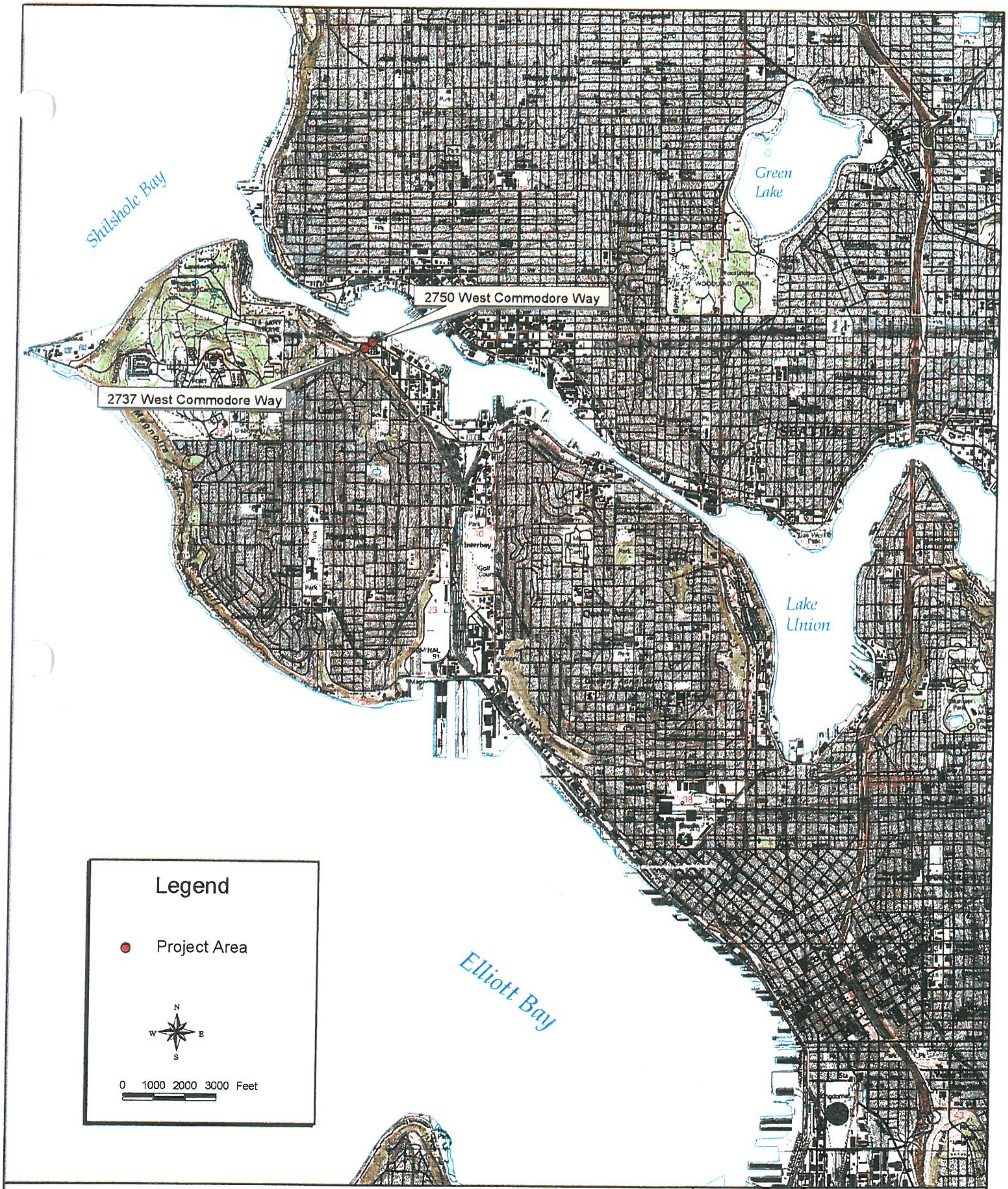


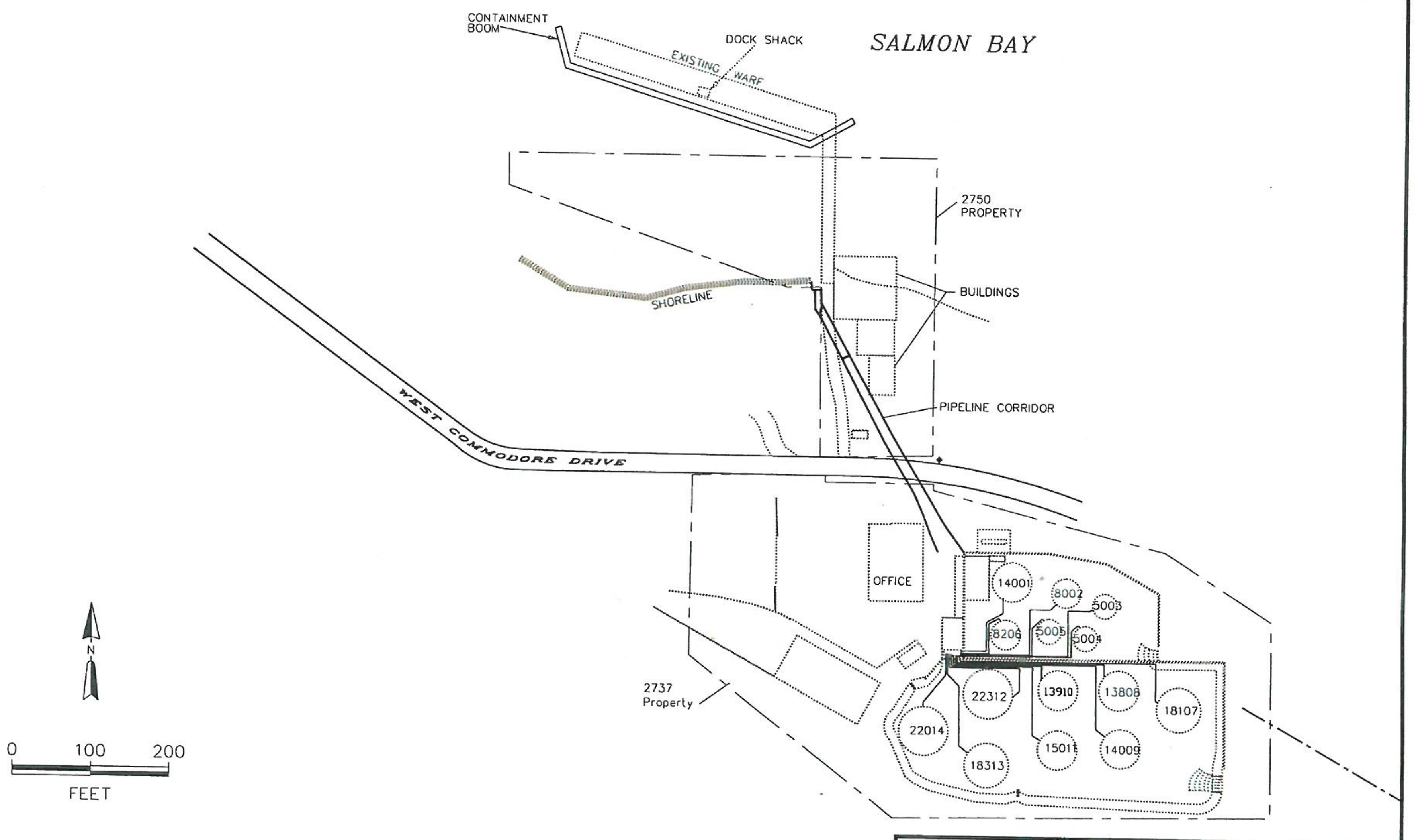
Time Oil Company
Phase III Environmental Site Assessment
and Quarterly Groundwater Sampling

Figure 1-1

Locations of 2737 and 2750
West Commodore Way

c:\projects\time_oil\vic_map_2001.apr December 2001

I:\Projects\23063312\dwg\ETIOFG07.dwg 11/05/01 09:58:26 AM PST



FOSTER WHEELER
ENVIRONMENTAL CORPORATION

Figure 1–2

Location of 2737 and 2750 West Commodore Way

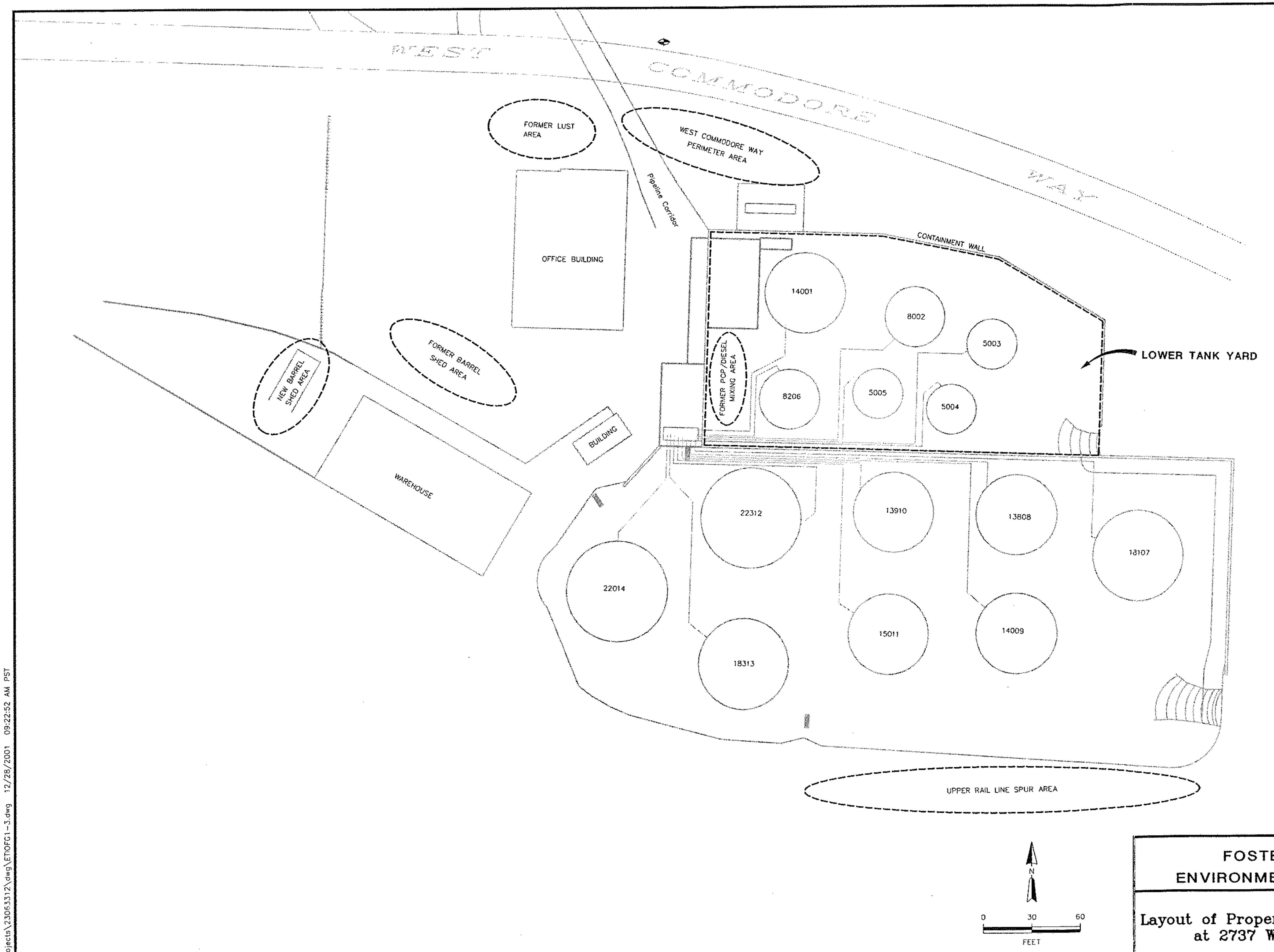


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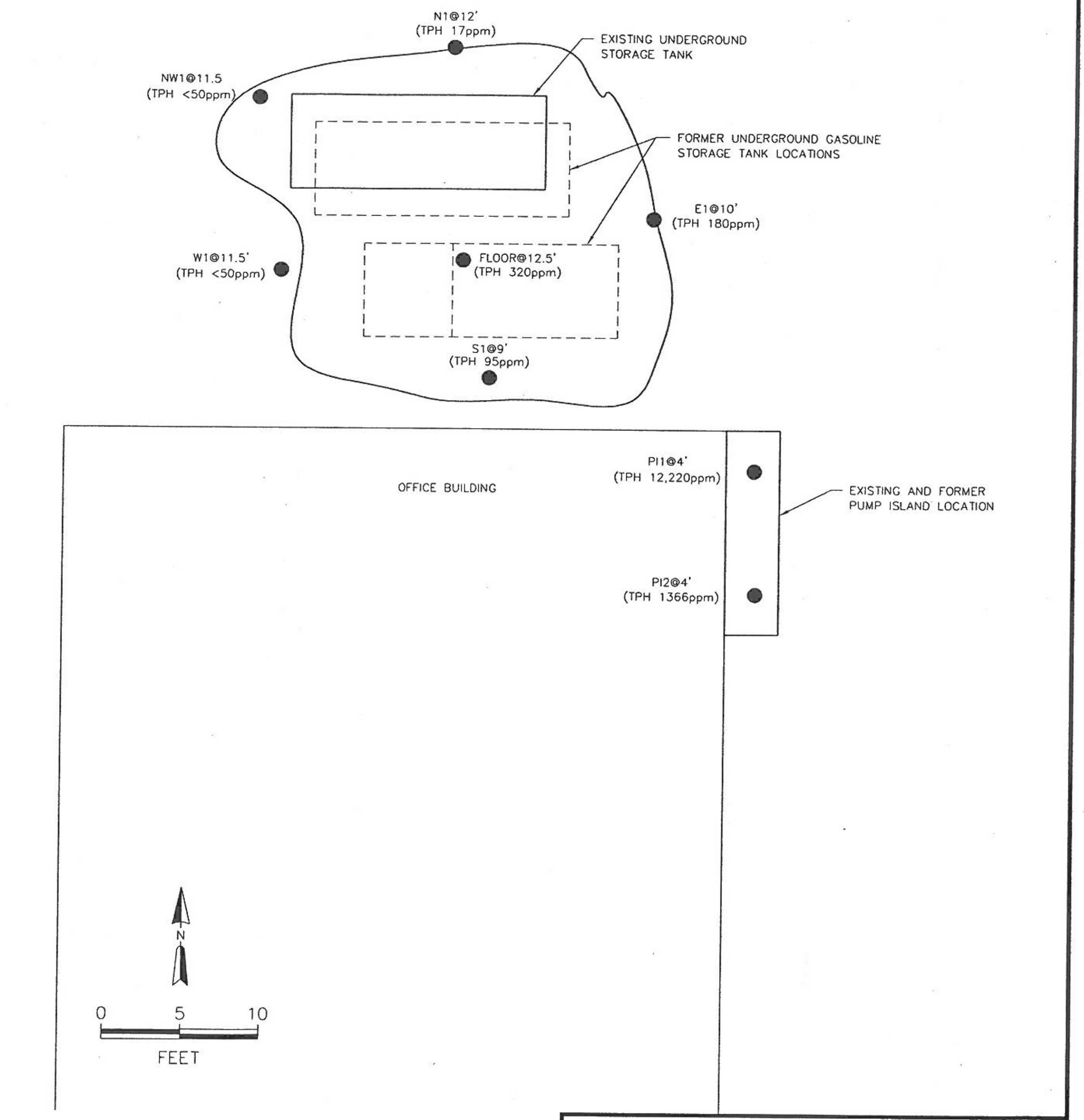
Figure 1-3
Layout of Property and Investigation Areas
at 2737 West Commodore Way

I:\Projects\23063312\dwg\ETIOFG1-3.dwg 12/28/2001 09:22:52 AM PST



LEGEND

N1@12' (TPH 17 ppm)	●	APPROXIMATE SAMPLING LOCATION WITH RESPECTIVE DEPTH AND TPH CONCENTRATION

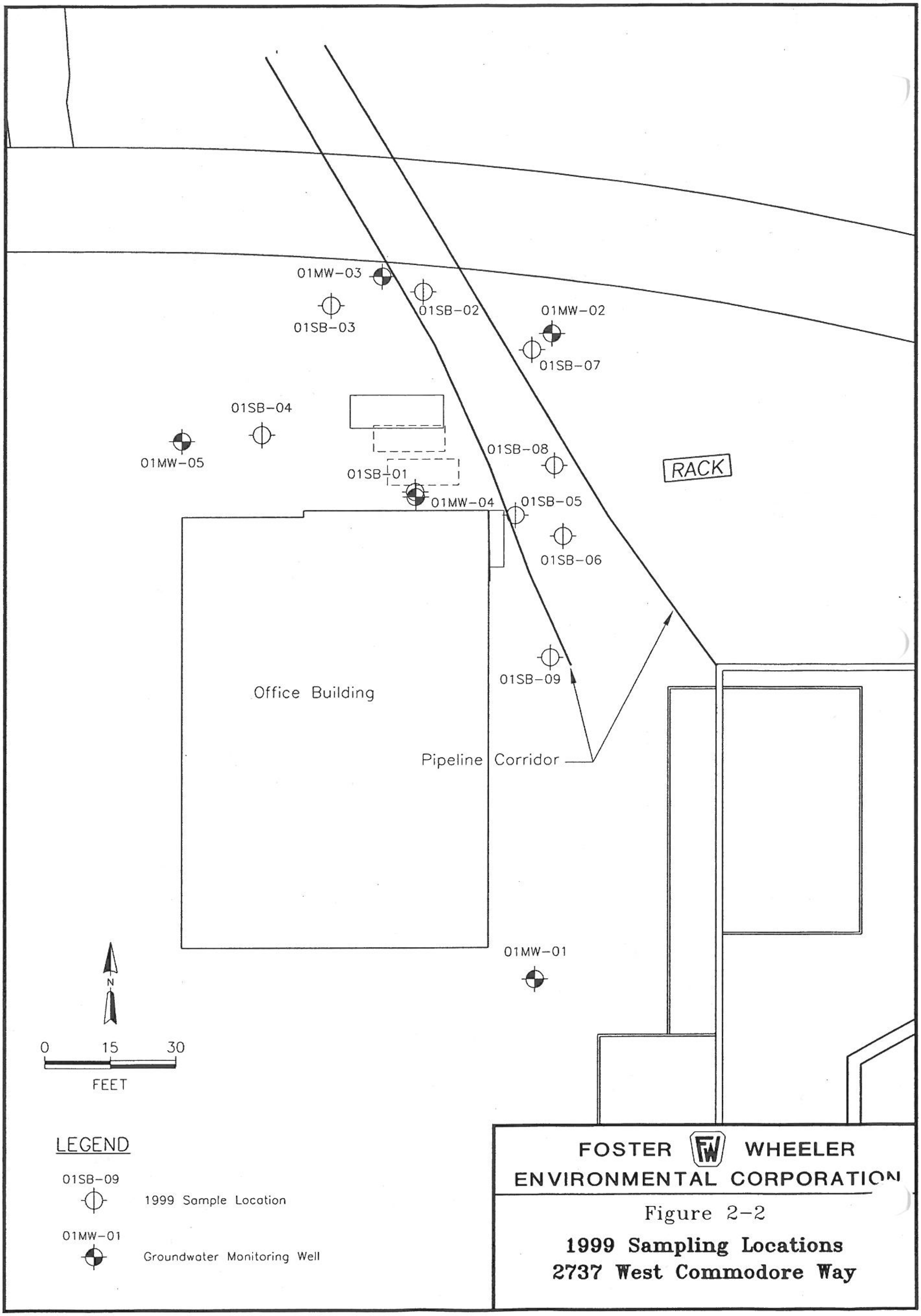
FOSTER WHEELER
ENVIRONMENTAL CORPORATION

Figure 2–1

1991 Sampling Locations

2737 West Commodore Way

I:\Projects\23063312\dwg\ETIOFG11.dwg 12/28/2001 09:19:35 AM PST

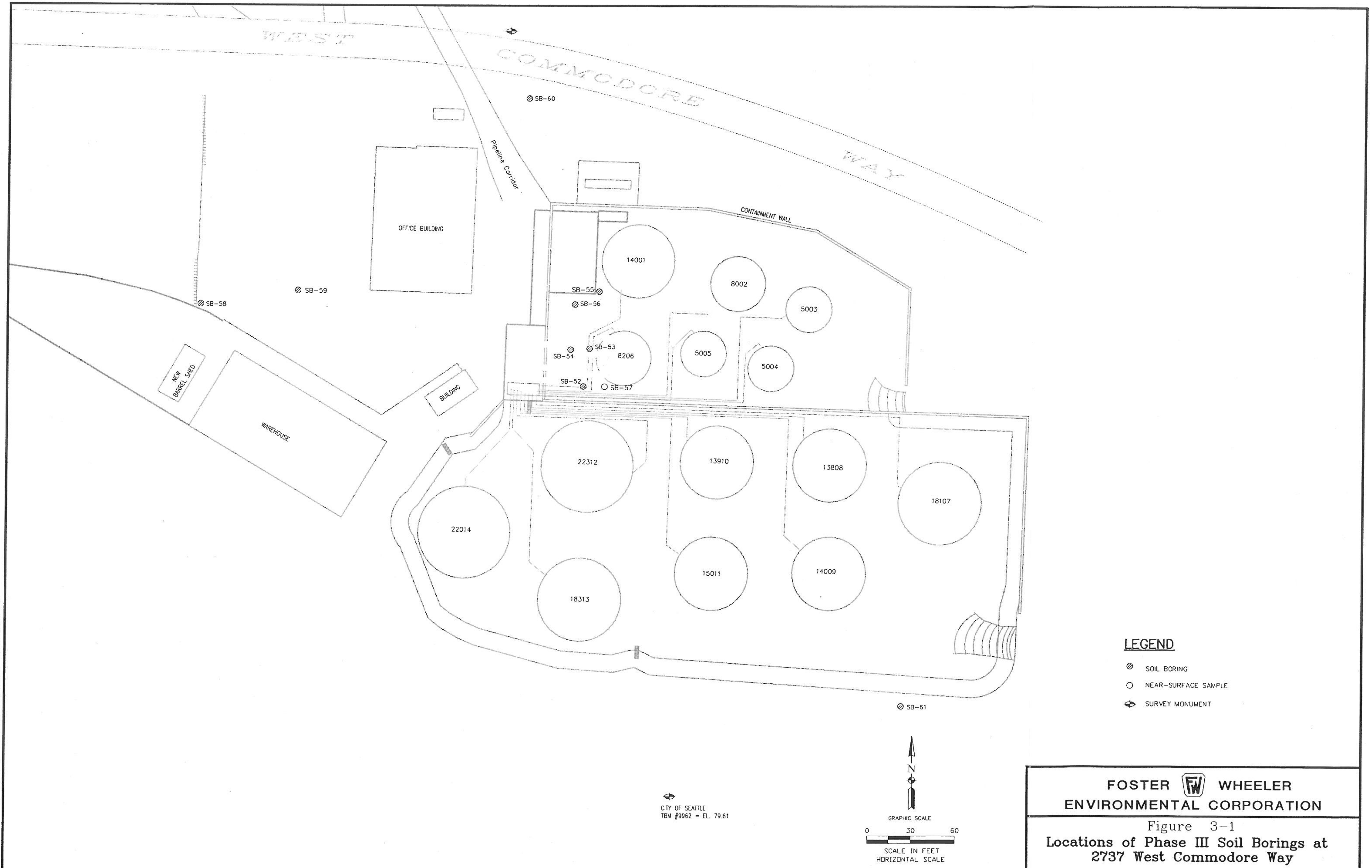


FOSTER WHEELER
ENVIRONMENTAL CORPORATIO

Figure 2-2

1999 Sampling Locations
2737 West Commodore Way

I:\PROJECTS\2306312\DWG\ETIOFG10.DWG
PLOT/UPDATE: DEC 28 2001 09:17:37

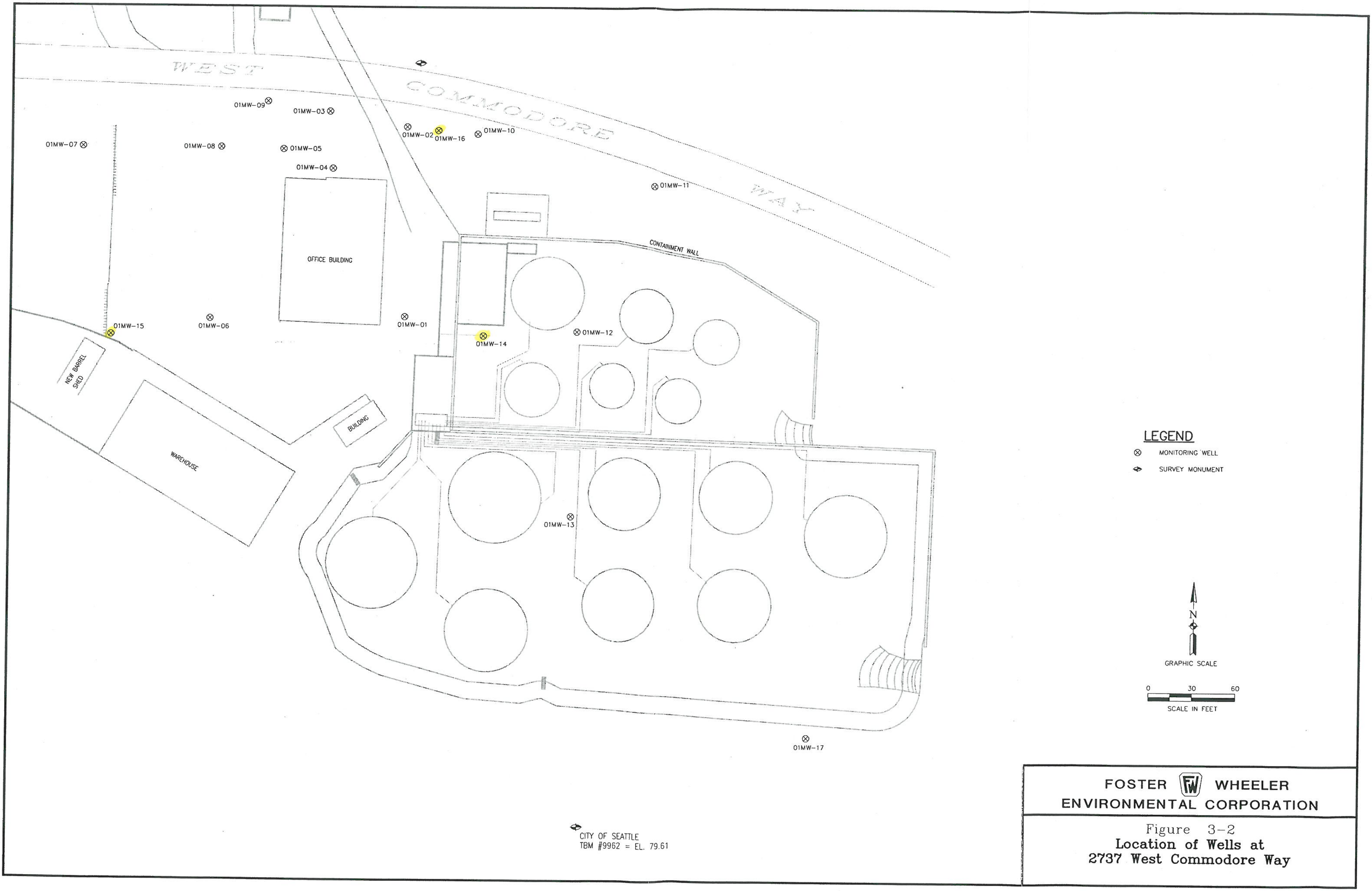


FOSTER WHEELER
ENVIRONMENTAL CORPORATION

Figure 3–1

Locations of Phase III Soil Borings at 2737 West Commodore Way

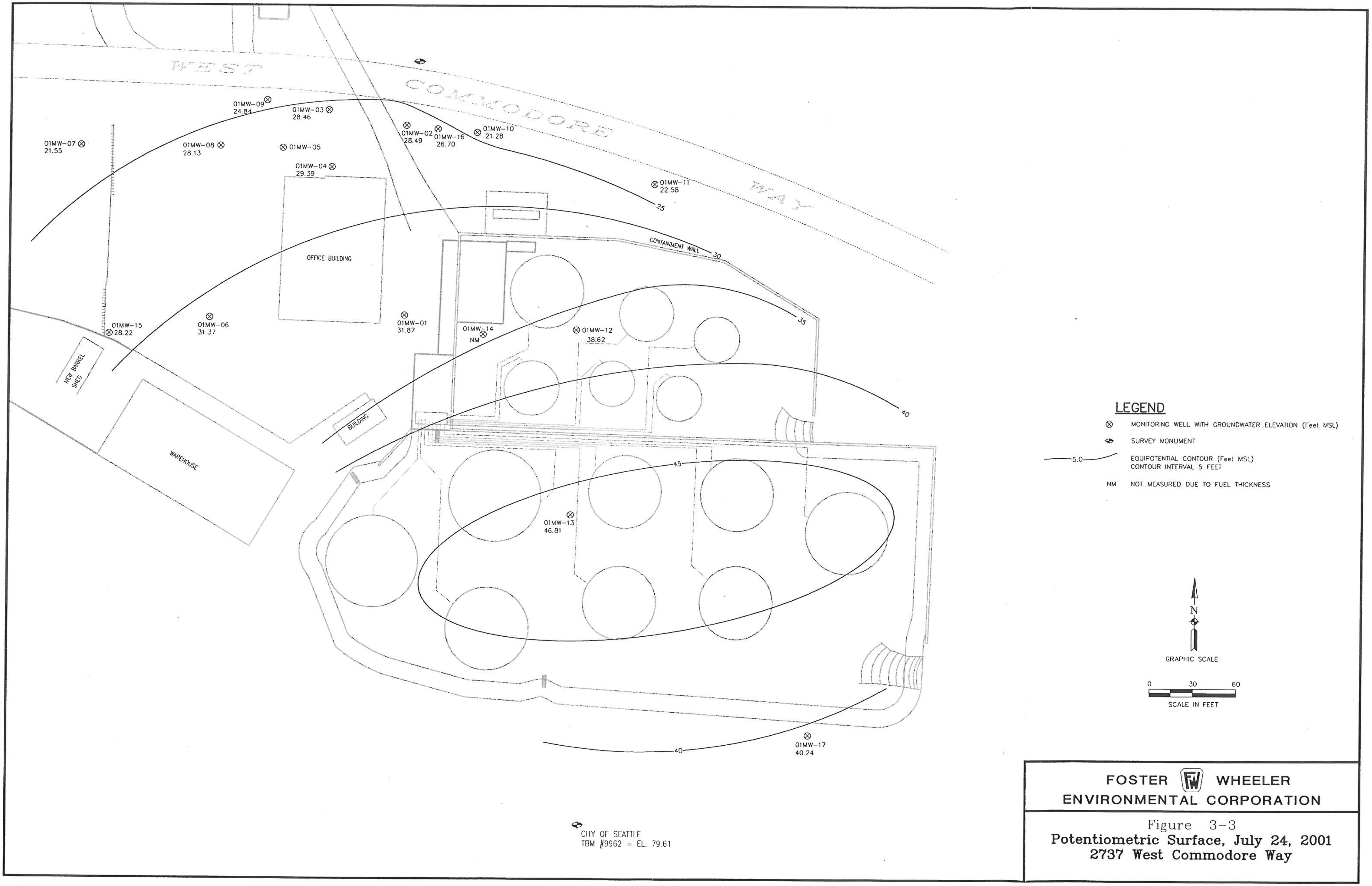
I:\Projects\23063312\dwg\ETIOFG3-1_PH3.dwg 12/28/2001 09:15:23 AM PST



FOSTER WHEELER
ENVIRONMENTAL CORPORATION

Figure 3-2
Location of Wells at
2737 West Commodore Way

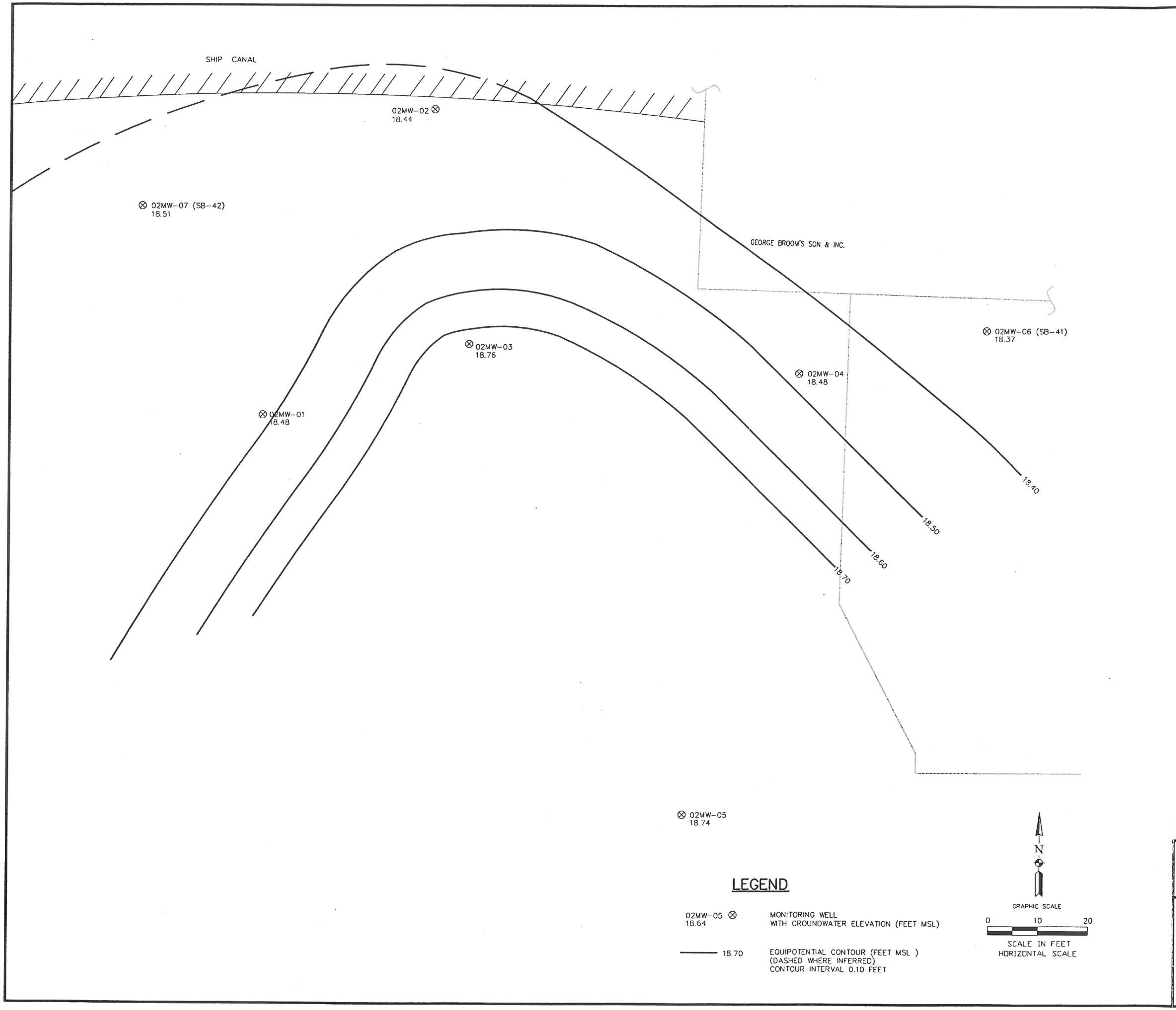
I:\PROJECTS\23063312\DWG\ETIOFG2-2.DWG
PLOT/UPDATE: DEC 28 2001 09:12:45



I:\PROJECTS\23063312\DWG\ET10FG3-3.DWG
PLOT/UPDATE: DEC 28 2001 09:11:27

FOSTER WHEELER
ENVIRONMENTAL CORPORATION

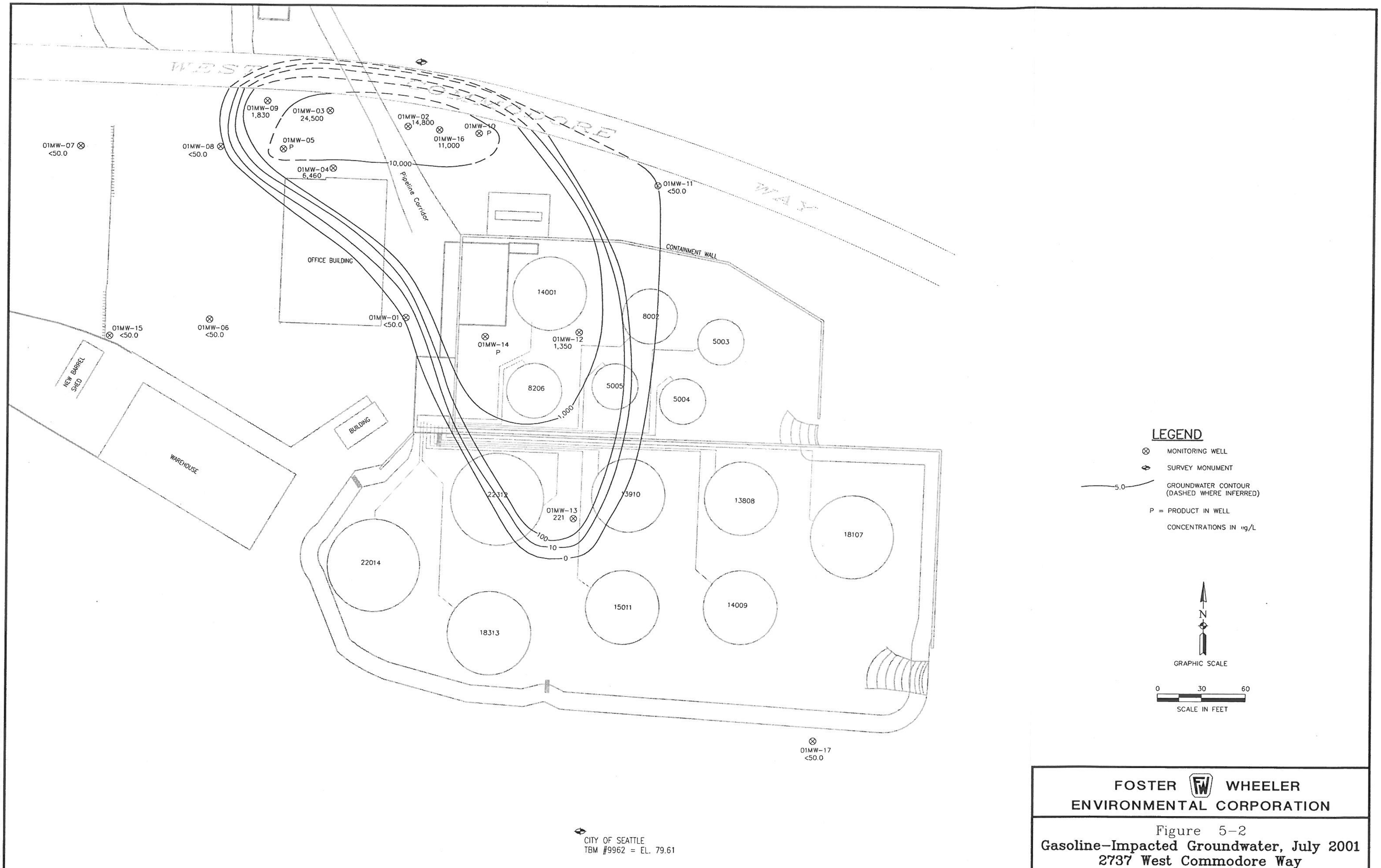
Figure 3-3
Potentiometric Surface, July 24, 2001
2737 West Commodore Way



FOSTER WHEELER
ENVIRONMENTAL CORPORATION

Figure 3-4
Location of Monitoring Wells and Potentiometric Surface, Measured July 24, 2001
2750 West Commodore Way

I:\PROJECTS\23063312\DWG\ETIOFG26.DWG
PLOT/UPDATE: NOV 05 2001 10:19:35



FOSTER WHEELER
ENVIRONMENTAL CORPORATION

Figure 5-2
Gasoline-Impacted Groundwater, July 2001
2737 West Commodore Way

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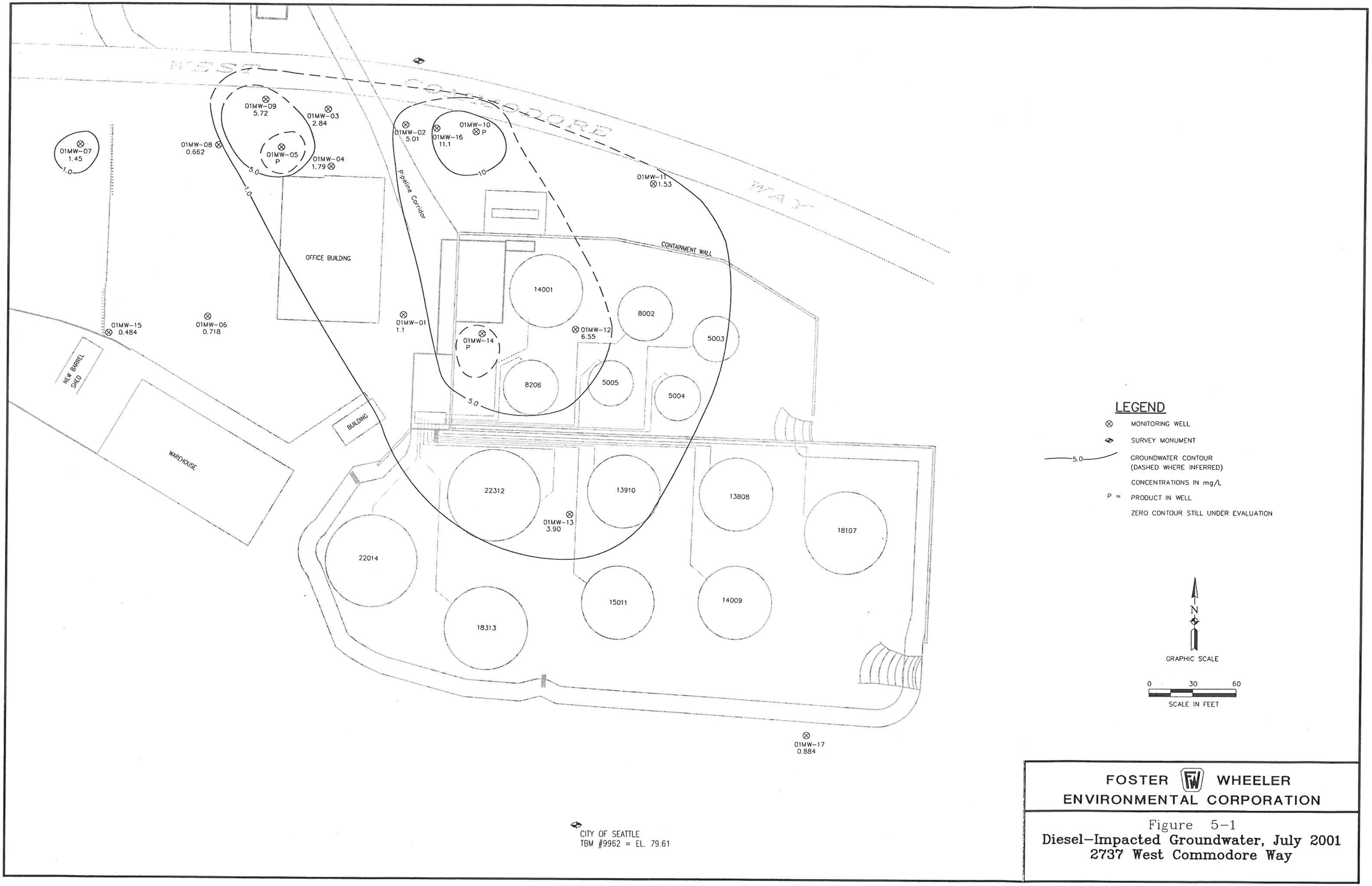
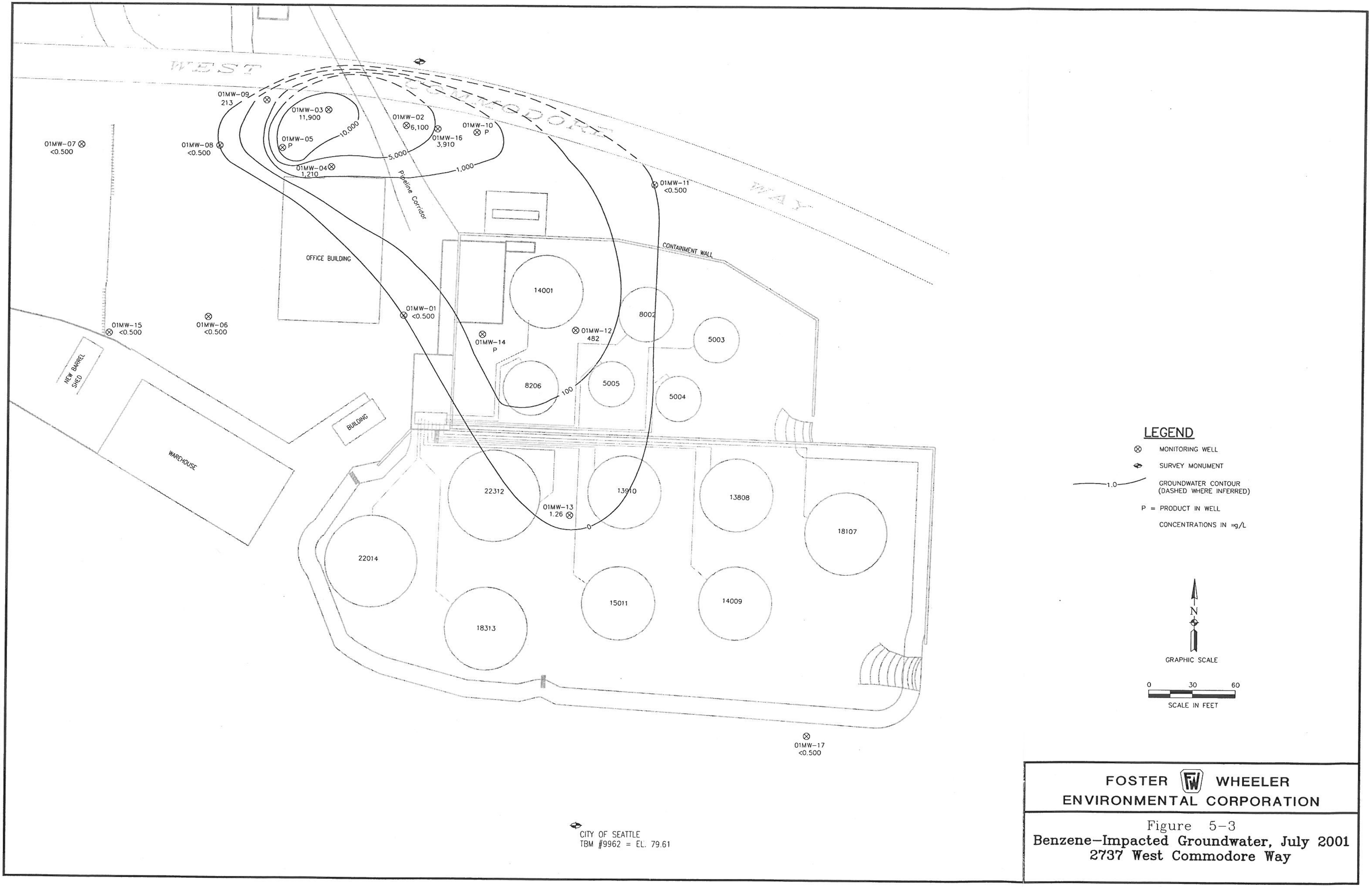
PLOT/UPDATE: DEC 28 2001 09:08:33



I:\PROJECTS\23063312\DWG\ETIOFG5-3.DWG
PLOT/UPDATE: DEC 28 2001 09:09:32

FOSTER WHEELER
ENVIRONMENTAL CORPORATION

Figure 5-1
Diesel-Impacted Groundwater, July 2001
2737 West Commodore Way



FOSTER WHEELER
ENVIRONMENTAL CORPORATION

Figure 5-3
Benzene-Impacted Groundwater, July 2001
2737 West Commodore Way

I:\PROJECTS\23063312\DWG\ETIOFG5-1.DWG
PLOT/UPDATE: DEC 28 2001 09:07:34

Table 2-1. Analytical Results from 1999 Soil Samples above Cleanup Levels (mg/kg)

	Depth (Feet)	**Gasoline**	**Diesel**	**Oil**	**Benzene**	**Toluene**	**Ethyl benzene**	**Total xylene**
MTCA		**100**	**200**	**200**	**0.5**	**40**	**20**	**20**
01SB-05	10	***2,360***	***2,450***	<126	<2.5	33.5	***31***	***190***
01SB-08	12.5	***3,650***	***33,900***	<1,030	***9.96***	<5.0	***20.9***	***73.4***
01SB-09	2.5	***381***	***1,780***	***514***	***2.12***	<0.2	<1.4	**<1.2**
01SB-09	7.0	***2,360***	***24,800***	<525	***3.45***	8.11	11.9	***32.1***
01SB-09	12.5	***755,000***	***15,000***	<525	***5,590***	***26,200***	***9,500***	***55,800***
01SB-09	18	***3,970***	***5,870***	<525	***5.26***	10.5	13.7	***61.5***

Notes: Detections above historic MTCA Method A levels are shown in ***bold italic*** type.

Source: IT Corporation 2000

Table 2-2. Analytical Results from 1999 Groundwater and Boring Water Samples

	Date	Total lead (µg/L)	Gasoline (mg/L)	Diesel (mg/L)	Oil (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethyl benzene (µg/L)	Total xylene (µg/L)
MTCA		**5.0**	**1.0**	**1.0**	**1.0**	**5.0**	**40.0**	**30.0**	**20.0**
01MW-01	9/28/99	4.15	<0.0500	<0.0500	<1.0	<0.500	<0.500	<0.500	<1.00
01MW-02	9/28/99	***84.9***	***12.2***	0.714	<0.5	***3,880***	***525***	***230***	***1,100***
01MW-03	9/28/99	***87***	***27.2***	0.944	<0.5	***11,300***	***405***	***398***	***1,590***
01MW-04	9/28/99	***130***	***18.9***	***1.32***	<0.5	***4,370***	***1,150***	***606***	***2,780***
01SB-01	6/6/99	--	***9***	***7.56***	<0.5	***2,280***	***579***	***106***	***483***
01SB-02	6/6/99	--	***1.12***	0.965	<0.5	***25.1***	13.5	19.8	***43.6***
01SB-03	6/6/99	--	0.881	<0.25	<0.5	***147***	5.58	24.6	***68***
01SB-04	6/6/99	--	***11***	***7.12***	<0.5	***547***	***847***	***358***	***1,630***
01SB-05	6/6/99	--	***42.9***	***8.71***	***1.01***	***9,580***	***6,600***	***657***	***3,050***
01SB-07	6/6/99	--	***5.36***	***4.18***	0.577	***1,360***	***270***	***139***	***586***
01SB-08	6/6/99	--	***3.41***	***9.55***	<2.5	***1,160***	***93.3***	***60.5***	***218***
01SB-09	6/6/99	--	***54.8***	***12.8***	***1.06***	***11,000***	***7,510***	***840***	***4,570***

Notes: Detections above historic MTCA Method A levels are shown in ***bold italic*** type.
-- = No data.
µg/L = micrograms per liter
mg/L = milligrams per liter

Source: IT Corporation 2000

Table 3-1. Well Construction Details

Well	Coordinates (WA State Plane)		Top of Casing Elevation (Feet msl)	Ground Elevation (Feet msl)	Total Depth of Boring (Feet bgs)	Total Depth of Well (Feet bgs)	Depth of Screen Interval (Feet bgs)	Elevation of Screen Interval (Feet msl)
	Northing (Feet)	Easting (Feet)						
2737 West Commodore Way								
01MW-01	245454.603	1256198.248	46.48	46.76	25.00	25.25	10 - 25	36.76 - 21.76
01MW-02	245585.027	1256198.518	44.78	45.15	25.00	24.91	10 - 25	35.15 - 20.15
01MW-03	245597.585	1256160.493	44.35	44.75	25.20	25.15	10 - 25	34.75 - 19.75
01MW-04	245563.117	1256163.148	45.08	45.56	25.00	24.90	10 - 25	35.56 - 20.56
01MW-05	245569.311	1256114.025	45.40	45.77	25.00	24.88	10 - 25	35.77 - 20.77
01MW-06	245452.677	1256064.638	47.74	48.23	25	25.10	10 - 25	38.23 -23.23
01MW-07	245570.711	1255975.885	45.17	45.53	30	28.17	15 - 30	30.53 - 15.53
01MW-08	245570.471	1256070.985	45.21	45.63	25	24.93	10 - 25	35.63 - 20.63
01MW-09	245602.062	1256103.039	43.91	44.37	25	24.70	10 - 25	34.37 - 19.37
01MW-10	245580.377	1256246.968	45.02	45.35	25	24.90	10 - 25	35.35 - 20.35
01MW-11	245545.081	1256368.92	46.10	46.45	30	29.90	15 - 30	31.45 - 16.45
01MW-12	245444.877	1256316.069	45.84	46.29	20	20.00	5 - 20	40.84 - 25.84
01MW-13	245317.347	1256313.287	46.36	46.81	20	19.88	15 - 20	31.81 - 26.81
01MW-14	245441.662	1256252.373	46.15	46.15	15	15.00	5 - 15	41.15 - 31.15
01MW-15	245441.314	1255996.388	50.89	50.89	30.12	30.00	10 - 30	40.89 - 20.89
01MW-16	245582.687	1256220.015	44.95	44.95	22.5	20.00	10 - 20	34.95 - 24.95
01MW-17	245166.941	1256477.520	59.42	59.42	30	30.00	15 - 30	44.42 - 29.42
2750 West Commodore Way								
02MW-01	245789.704	1255985.066	24.19	24.72	20	19.60	20 - 10	15.22 - 5.22
02MW-02	245848.029	1256019.016	20.06	20.57	10	9.90	10 - 5	16.07 - 11.07
02MW-03	245801.020	1256026.193	27.86	28.41	20	19.75	20 - 10	18.91 - 8.91
02MW-04	245795.225	1256092.088	27.17	27.59	20	20.05	20 - 10	18.09 - 8.09
02MW-05	245706.854	1256069.207	36.59	37.05	35	33.85	35 - 20	17.55 - 2.55
02MW-06	245803.277	1256129.549	26.54	27.00	20	19.97	20 - 10	17.50 - 7.50
02MW-07	245828.584	1255960.724	20.85	21.39	12	12.20	12 - 2	19.89 - 9.89

Notes: bgs = below ground surface
msl = mean sea level

Table 3-2. Well Development and Sampling Parameters, July 2001

Well	Date	Gallons Purged	pH	Temperature (Celsius)	Dissolved O_2 (mg/L)	Conductivity (mS/cm)	Turbidity (NTU)	Notes
2737 West Commodore Way								
01MW-01	7/24/01	48	7.14	13.98	0.31	0.733	25.8	None
01MW-02	7/26/01	30	6.9	15.1	2.1	1.159	96	Purges dry, recharges in ~5 minutes
01MW-03	7/26/01	28	6.76	14.6	2.6	0.682	62.1	Fuel odor, purges dry after 10 gallons
01MW-04	7/26/01	38	6.89	15.02	2.59	0.754	35.2	None
01MW-06	7/24/01	24	7.25	14.01	0.42	0.961	58.4	None
01MW-07	7/24/01	24	6.86	17.61	0.49	1.052	20.3	None
01MW-08	7/24/01	24	6.97	14.70	0.26	1.152	57.6	None
01MW-09	7/24/01	36	6.96	15.87	0.14	0.849	12.3	None
01MW-10	*Not developed due to product in well*							
01MW-11	7/24/01	25	7.14	14.38	0.28	0.844	2.9	None
01MW-12	7/26/01	24	6.76	12.29	2.46	1.199	104.2	None
01MW-13	7/26/01	45	6.75	12.02	0.38	1.030	52.7	None
01MW-14	*Not developed due to product in well*							
01MW-15	7/26/01	47	7.31	12.65	1.32	1.046	67.9	Slight H_2S odor
01MW-16	*Insufficient water to sample*							
01MW-17	7/26/01	30	7.26	12.56	0.39	0.801	44.2	None
2750 West Commodore Way								
02MW-01	7/23/01	*Instrument failure*						
02MW-02	7/26/01	70	6.67	14.06	2.64	0.775	10.9	None
02MW-03	7/26/01	85	6.58	12.36	0.19	1.219	560	None
02MW-04	7/26/01	25	6.81	12.83	1.24	0.971	120.5	None
02MW-05	7/24/01	20	6.70	13.50	2.61	1.040	>1,000	None
02MW-06	7/26/01	20	6.81	11.60	0.36	0.846	30.2	None

Notes: mg/L = milligrams per liter
mS/cm = millisiemens per centimeter
NTU = nephelometric turbidity unit
H_2S = hydrogen sulfide

Table 4-1. Analytical Results for TPH, Lead, and PCP in Soil at 2737 West Commodore Way, July 2001

Page 2 of 2

Sample	PCP (mg/kg)	Diesel (mg/kg)	Oil (mg/kg)	Gas (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)	Lead (mg/kg)
MTCA[1/]	**8.33[2/]**	**2,000**	**2,000**	**30[3/] 100[4/]**	**0.03**	**7**	**6**	**9**	**250**
				New Barrel Shed Area					
SB-58-2	<0.500	116	180	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	4.49
SB-58-5	<0.0500	21.4	29.6	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	5.12
SB-58-10	<0.0500	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	2.49
SB-58-15	0.159	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	3.98
SB-58-25	<0.0500	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	2.27
				Former Barrel Shed Area					
SB-59-2	<0.0500	528	470	65.6	<0.0500	<0.0500	0.0733	0.126	5.24
SB-59-5	<0.500	***4,950***	1,170	***799***	<1.00	<1.00	1.94	<2.00	8.14
SB-59-10	<0.0500	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	5.10
SB-59-15	<0.0500	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	2.67
SB-59-20	0.148	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	2.00
				West Commodore Way Perimeter Area					
SB-60-2	Na	58.7	79.8	22.8	<0.0500	<0.0500	<0.0500	< 0.100	4.53
SB-60-5	Na	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	8.64
SB-60-10	Na	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	8.20
SB-60-15	Na	***11,400***	<2,520	***1,240***	***1.68***	<1.00	4.04	***10.2***	2.29
SB-60-20	Na	<10.0	<25.0	<5.00	0.0500	<0.0500	<0.500	< 0.100	2.09

Notes: 1/ Results above MTCA Method A level for unrestricted land uses are in ***bold italic*** type.

2/ Results above MTCA Method B carcinogenic level are in ***bold italic*** type.

3/ All other gasoline mixtures.

4/ Without benzene and <20% aromatic hydrocarbons between EC8 and EC16.

< symbol indicates that result is less than reporting limit.

na = No analysis requested.

TPH = total petroleum hydrocarbon

PCP = pentachlorophenol

mg/kg = milligrams per kilogram

MTCA = Model Toxics Control Act

Table 4-2. Analytical Results for PAHs in Soil at 2737 West Commodore Way, July 2001

Page 1 of 2

Sampl	**Benzo(a)anthracene**	**Benzo(a)pyrene**	**Benzo(b)fluoranthene**	**Benzo(k)fluoranthene**	**Chrysene**	**Dibenz(a,h)anthracene**	**Indeno(1,2,3-cd)pyrene**	**Total cPAHs**
				Former PCP/Diesel Mixing Area (Lower Tank Yard Area)				
SB-52-2.5	0.0252	0.0187	0.0138	<0.0100	0.0301	<0.0100	0.0309	0.1187
SB-52-6	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-52-10	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-53-2	<0.0100	0.0109	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0109
SB-53-5	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-53-10	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-54-2	0.159	0.111	<0.0200	<0.0200	0.204	<0.0200	0.0896	0.5636
SB-54-5	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-54-10	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-55-2.5	<0.0100	0.0133	<0.0100	<0.0100	<0.0100	<0.0100	0.0289	0.0422
SB-55-6	<0.0100	0.0143	<0.0100	<0.0100	0.0143	<0.0100	0.0286	0.0572
SB-55-10	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-56-2.5	0.717	0.757	<0.500	<0.500	1.15	<0.500	<0.500	***2.6240***
SB-56-5	<0.500	0.736	<0.500	<0.500	<0.500	<0.500	<0.500	0.7360
SB-56-10	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0112	0.0279	0.0391
SB-57-1.5	<0.100	<0.100	<0.100	<0.100	0.189	<0.100	<0.100	0.189
				Former Barrel Shed Area				
SB-59-2	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-59-5	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	0.000
SB-59-10	<0.0100	0.111	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.1110
SB-59-15	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-59-20	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000

Table 4-2. Analytical Results for PAHs in Soil at 2737 West Commodore Way, July 2001

Page 2 of 2

Sample	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Indeno(1,2,3-cd)pyrene	Total cPAHs
New Barrel Shed Area								
SB-58-2	0.221	<0.100	<0.100	<0.100	0.122	<0.100	<0.100	0.343
SB-58-5	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-58-10	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-58-15	<0.0100	0.102	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.1020
SB-58-20	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-58-25	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
West Commodore Way Perimeter Area								
SB-60-2	<0.0100	<0.0100	<0.0100	<0.0100	0.0209	<0.0100	<0.0100	0.0209
SB-60-5	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-60-10	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-60-15	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-60-20	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
Upper Rail Line Spur Area								
SB-61-2	<0.0100	0.0327	0.0295	<0.0100	<0.0100	<0.0100	0.0463	0.1085
SB-61-5	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-61-10	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000
SB-61-15	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	<0.0100	0.0000

Notes: Total cPAHs include sum of detections. Half of reporting limit used for non-detects.
All values in milligrams per kilogram (mg/kg).
Total cPAHs that exceed MTCA Method A level of 1 mg/kg are in ***bold italic*** type.
cPAHs = carcinogenic polyaromatic hydrocarbons

Table 4-3. Analytical Results for Groundwater Samples from 2737 West Commodore Way, July 2001

Sample	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylenes (µg/L)	Lead (µg/L)
MTCA[1/]	**15[2/]**	**0.5**	**0.5**	**800[3/]** **1,000[4/]**	**5,300[5/]**	**17,500[5/]**	**32,000[5/]**	**1,000**	**15**
Former LUST Area									
01MW-01	3.94	***1.11***	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00
01MW-02	na	***5.01***	<1.50	***14,800***	***6,900***	162	262	***1,110***	< 1.00
01MW-03	na	***2.84***	<1.50	***24,500***	***11,900***	238	414	515	< 1.00
01MW-04	na	***1.79***	<1.50	***6,460***	1,210	204	134	***1,470***	< 1.00
01MW-07	na	***1.45***	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00
01MW-08	na	***0.662***	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00
01MW-09	na	***5.72***	< 0.500	***1,830***	213	114	48.1	230	< 1.00
West Commodore Way Perimeter Area									
01MW-10	na	na	na	na	na	na	na	na	na
01MW-11	na	***1.53***	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00
01MW-16A	2.54	***11.1***	< 2.50	***11,000***	3,910	123	261	891	< 1.00
01MW-16B	2.09	***9.62***	< 2.50	***9,390***	3,700	122	209	745	< 1.00
Relative Percent Difference	*19%*	*14%*	*nc*	*16%*	*6%*	*1%*	*22%*	*18%*	*nc*
Lower Tank Yard Area									
01MW-12	na	***6.55***	< 1.50	***1,350***	482	8.84	14.0	26.4	< 1.00
Upper Tank Yard Area									
01MW-13	na	***3.90***	< 1.50	221	1.26	< 0.500	< 0.500	2.31	< 1.00
Former PCP/Diesel Mixing Area (Lower Tank Yard Area)									
01MW-14	na	na	na	na	na	na	na	na	na
Former Barrel Shed Area									
01MW-06	2.17	***0.718***	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00
New Barrel Shed Area									
01MW-15	1.66	0.484	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00
Upper Rail Line Spur Area									
01MW-17	< 0.500	***0.884***	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00

Notes: 1/ Results above MTCA Method A level are in ***bold italic*** type.
2/ NOAA SQuiRT value for freshwater continuous concentration.
3/ Gasoline range with benzene present.
4/ Gasoline range without benzene present.
5/ NOAA SQuiRT value for freshwater maximum concentration.
na = No analysis requested.
nc = Not able to calculate.
µg/L = micrograms per liter
mg/L = milligrams per liter
< symbol indicates that result is less than reporting limit.

Table 3-3. Water Levels Measured at 2737 and 2750 West Commodore Way, July 24, 2001

Well	Top of Casing Elevation (Feet msl)	Ground Elevation (Feet msl)	Total Depth of Well (Feet bgs)	Depth of Fuel (Feet bgs)	Depth of Water (Feet bgs)	Fuel Thickness (Feet)	Water Elevation (Feet msl)
2737 West Commodore Way							
01MW-01	46.48	46.76	25.25	0.00	14.61	0.00	31.87
01MW-02	44.78	45.15	24.91	0.00	16.29	0.00	28.49
01MW-03	44.35	44.75	25.15	0.00	15.89	0.00	28.46
01MW-04	45.08	45.56	24.90	0.00	15.69	0.00	29.39
01MW-05	45.40	45.77	24.88	15.82	21.77	5.95	28.39
01MW-06	47.74	48.23	25.10	0.00	16.37	0.00	31.37
01MW-07	45.17	45.53	28.17	0.00	23.62	0.00	21.55
01MW-08	45.21	45.63	24.93	0.00	17.08	0.00	28.13
01MW-09	43.91	44.37	24.70	0.00	19.07	0.00	24.84
01MW-10	45.02	45.35	24.90	23.74	24.47	0.73	21.28
01MW-11	46.10	46.45	29.90	0.00	23.52	0.00	22.58
01MW-12	45.84	46.29	20.00	0.00	7.22	0.00	38.62
01MW-13	46.36	46.81	19.88	0.00	6.47	0.00	46.81
01MW-14	46.15	46.15	15.00	8.30	na	6.70	na
01MW-15	50.89	50.89	30.00	0.00	22.67	0.00	28.22
01MW-16	44.95	44.95	20.00	0.00	18.25	0.00	26.70
01MW-17	59.42	59.42	30.00	0.00	19.18	0.00	40.24
2750 West Commodore Way							
02MW-01	24.19	24.72	19.60	0.00	5.71	0.00	18.48
02MW-02	20.06	20.57	9.90	0.00	1.62	0.00	18.44
02MW-03	27.86	28.41	19.75	0.00	9.10	0.00	18.76
02MW-04	27.17	27.59	20.05	0.00	8.69	0.00	18.48
02MW-05	36.59	37.05	33.85	0.00	17.85	0.00	18.74
02MW-06	26.54	27.00	19.97	0.00	8.17	0.00	18.37
02MW-07	20.85	21.39	12.20	0.00	2.34	0.00	18.51

Notes: na = Water level was not determined because product was present.
msl = mean sea level
bgs = below ground surface

Table 4-1. Analytical Results for TPH, Lead, and PCP in Soil at 2737 West Commodore Way, July 2001

Page 1 of 2

Sample	PCP (mg/kg)	Diesel (mg/kg)	Oil (mg/kg)	Gas (mg/kg)	Benzene (mg/kg)	Toluene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)	Lead (mg/kg)
MTCA[1/]	**8.33[2/]**	**2,000**	**2,000**	**30[3/]** **100[4/]**	**0.03**	**7**	**6**	**9**	**250**
Upper Rail Line Spur Area									
SB-61-2	na	20.1	88.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	5.14
SB-61-5	na	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	7.43
SB-61-10	na	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	2.86
SB-61-15	na	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	4.17
Former PCP/Diesel Mixing Area (Lower Tank Yard Area)									
SB-52-2.5	<0.0500	***4,180***	<1,020	***1,410***	<1.00	<1.00	1.42	2.18	5.02
SB-52-6	<0.0500	34.4	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	7.45
SB-52-10	0.129	10.3	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	2.39
SB-53-2	0.0916	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	2.67
SB-53-5	<0.0500	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	5.83
SB-53-10	<0.0500	15.7	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	2.54
SB-54-2	0.181	1,500	1,230	86.2	<0.100	<0.100	<0.100	< 0.200	3.24
SB-54-5	<0.0500	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	4.08
SB-54-10	0.0780	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	2.37
SB-55-2.5	<0.0500	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	4.98
SB-55-6	0.174	370	<75.0	***185***	<0.200	<0.200	0.811	3.06	7.56
SB-55-10	0.0770	13.4	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	2.58
SB-56-2.5	<0.500	***28,300***	<5,020	***5,100***	***10.2***	6.24	***29.3***	***75.6***	10.9
SB-56-5	***8.88***	***2,040***	<525	***4,060***	***9.36***	<1.00	***22.3***	***60.5***	6.85
SB-56-10	0.0765	<10.0	<25.0	<5.00	<0.0500	<0.0500	<0.0500	< 0.100	2.59
SB-57-1.5	<0.0500	***3,970***	881	***2,590***	***0.387***	1.94	***18.2***	8.85	13.2

Table 4-4. Analytical Results for PAHs in Groundwater at 2737 West Commodore Way, July 2001

Sample	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Indeno(1,2,3-cd)pyrene	Total cPAHs
Former Barrel Shed Area								
01MW-06	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
New Barrel Shed Area								
01MW-15	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
West Commodore Way Perimeter Area								
01MW-16A	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
01MW-16B	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100
Relative Percent Difference	nc	nc	nc	nc	nc	nc	nc	nc
Upper Rail Line Spur Area								
01MW-17	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100	<0.100

Notes: Total cPAHs include sum of detections. Half of reporting limit used for non-detects.
All values in micrograms per liter (µg/L).
nc = Not able to calculate.
cPAHs = carcinogenic polyaromatic hydrocarbons

Table 4-5. Analytical Results for Groundwater at 2750 West Commodore Way, July 2001

Sample	Gas (µg/L)	Diesel (mg/L)	Oil (mg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylenes (µg/L)	Lead (µg/L)
MTCA	**800**[1/] **1,000**[2/]	**0.5**	**0.5**	**5,300**[3/]	**1,000**	**32,000**[3/]	**1,000**	**15**
02MW-01	119	***0.500***	< 0.500	44.4	0.662	< 0.500	1.15	< 1.00
02MW-02	< 50.0	***0.679***	< 0.500	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00
02MW-03	90.4	***0.619***	< 0.500	38.6	0.664	< 0.500	< 1.00	< 1.00
02MW-04	***4,270***	***1.41***	< 0.500	23.9	231	165	484	4.68
02MW-05	51.8	***0.997***	< 0.500	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00
02MW06A	< 50.0	***0.923***	< 0.500	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00
02MW06B	< 50.0	***0.897***	< 0.500	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00
Relative Percent Difference	*nc*	*3%*	*nc*	*nc*	*nc*	*nc*	*nc*	*nc*
02MW-07	244	0.417	< 0.500	< 0.500	< 0.500	< 0.500	2.79	< 1.00

Notes: Detections above MTCA Method A are in ***bold italic*** type.

1/ Gasoline range with benzene present.

2/ Gasoline range without benzene present.

3/ NOAA SQuiRT values for freshwater continuous concentration.

na = Not applicable.

nc = Not able to calculate.

µg/L = micrograms per liter

mg/L = milligrams per liter

Table 5-1. Phase III Soil Sample Results Exceeding MTCA Method A Levels for Unrestricted Soil at 2737 West Commodore Way

Sample	PCP (mg/kg)	Diesel (mg/kg)	Gas (mg/kg)		Benzene (mg/kg)	Ethylbenzene (mg/kg)	Xylenes (mg/kg)	cPAHs (mg/kg)
MTCA[1/]	**8.33[2/]**	**2,000**	**30[3/]**	**100[4/]**	**0.03**	**6**	**9**	**1.0**
Former PCP/Diesel Mixing Area (Lower Tank Yard Area)								
SB-52-2.5	<0.0500	***4,180***	***1,410***		<1.00	1.42	2.18	0.1187
SB-55-6	0.174	370	***185***		<0.200	0.811	3.06	0.0572
SB-56-2.5	<0.500	***28,300***	***5,100***		***10.2***	***29.3***	***75.6***	***2.624***
SB-56-5	***8.88***	***2,040***	***4,060***		***9.36***	***22.3***	***60.5***	0.736
SB-57-1.5	<0.0500	***3,970***	***2,590***		***0.387***	***18.2***	8.85	0.189
Former Barrel Shed Area								
SB-59-5	<0.500	***4,950***	***799***		<1.00	1.94	<2.00	na
West Commodore Way Perimeter Area								
SB-60-15	na	***11,400***	***1,240***		***1.68***	4.04	***10.2***	0.0000

Notes:
1/ Results above MTCA Method A level for unrestricted land uses are in ***bold italic*** type.
2/ Results above MTCA Method B carcinogenic level are in ***bold italic*** type.
3/ All other gasoline mixtures
4/ Without benzene and <20% aromatic hydrocarbons between EC8 and EC16
< symbol indicates that result is less than reporting limit.
na = No analysis requested.
MTCA = Model Toxics Control Act
PCP = pentachlorophenol
cPAHs = carcinogenic polyaromatic hydrocarbons
mg/kg = milligrams per kilogram

Table 5-2. Groundwater Samples Exceeding Cleanup Levels at 2737 West Commodore Way, July 2001

Sample	PCP (µg/L)	Diesel (mg/L)	Gas (µg/L)		Benzene (µg/L)	Xylenes (µg/L)
MTCA[1/]	**15[2/]**	**0.5**	**800[3/]**	**1,000[4/]**	**5,300[5/]**	**1,000**
			Former LUST Area			
01MW-01	3.94	***1.11***	< 50.0		< 0.500	< 1.00
01MW-02	na	***5.01***	***14,800***		***6,900***	***1,110***
01MW-03	na	***2.84***	***24,500***		***11,900***	515
01MW-04	na	***1.79***	***6,460***		1,210	***1,470***
01MW-07	na	***1.45***	< 50.0		< 0.500	< 1.00
01MW-08	na	***0.662***	< 50.0		< 0.500	< 1.00
01MW-09	na	***5.72***	***1,830***		213	230
			West Commodore Way Perimeter Area			
01MW-11	na	***1.53***	< 50.0		< 0.500	< 1.00
01MW-16A	2.54	***11.1***	***11,000***		*3,910*	891
01MW-16B	2.09	***9.62***	***9,390***		3,700	745
			Lower Tank Yard Area			
01MW-12	na	***6.55***	***1,350***		482	26.4
			Upper Tank Yard Area			
01MW-13	na	***3.90***	221		1.26	2.31
			Former Barrel Shed Area			
01MW-06	2.17	***0.718***	< 50.0		< 0.500	< 1.00
			New Barrel Shed Area			
01MW-15	1.66	0.484	<50.0		<0.500	<1.00
			Upper Rail Line Spur Area			
01MW-17	<0.500	***0.884***	<50.0		<0.500	<1.00

Notes: 1/ Results above MTCA Method A level are in ***bold italic*** type.
2/ NOAA SQuiRT value for freshwater continuous concentrations.
3/ Gasoline range with benzene present.
4/ Gasoline range without benzene present.
5/ NOAA SQuiRT value for freshwater maximum concentration.
na = No analysis requested.
µg/L = micrograms per liter
mg/L = milligrams per liter
< symbol indicates that result is less than reporting limit.

Table 5-3. Groundwater Samples Exceeding Cleanup Levels at 2750 West Commodore Way, July 2001

Sample	**Diesel (mg/L)**	**Gas (µg/L)**	
MTCA	**0.5**	**800**[1/]	**1,000**[2/]
02MW-01	***0.500***	119	
02MW-02	***0.679***	< 50.0	
02MW-03	***0.619***	90.4	
02MW-04	***1.41***	***4,270***	
02MW-05	***0.997***	51.8	
02MW-06A	***0.923***	< 50.0	
02MW-06B	***0.897***	< 50.0	
02MW-07	0.417	244	

Notes: Detections above MTCA Method A are in ***bold italic*** type.

1/ Gasoline range with benzene present.

2/ Gasoline range without benzene present.

mg/L = milligrams per liter

µg/L = micrograms per liter

Table 5-4. Cumulative Groundwater Samples, 2737 West Commodore Way

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)		Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylenes (µg/L)
MTCA[1/]		**15[2/]**	**0.5**	**0.5**	**800[3/]**	**1,000[4/]**	**5,300[5/]**	**17,500[5/]**	**32,000[5/]**	**1,000**
Former LUST Area										
01MW-01	Sep-99	na	< 50.0	< 1.0	< 50.0		< 0.500	< 0.500	< 0.500	1.93
01MW-01	Dec-00	na	***1.65***	< 0.500	75.2		0.924	1.46	< 0.500	1.93
01MW-01	Jul-01	3.94	***1.11***	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
01MW-02	Sep-99	na	***0.714***	< 0.500	***12,200***		3,880	525	230	***1,100***
01MW-02	Dec-00	na	***5.00***	< 0.500	***12,700***		3,300	1010	331	***1,510***
01MW-02	Jul-01	na	***5.01***	<1.50	***14,800***		***6,900***	162	262	***1,110***
01MW-03	Sep-99	na	***0.944***	< 0.500	***27,200***		***11,300***	405	398	***1,590***
01MW-03	Dec-00	na	***1.65***	< 0.500	***3,620***		1,020	26.9	63.6	210
01MW-03	Jul-01	na	***2.84***	<1.50	***24,500***		***11,900***	238	414	515
01MW-04	Sep-99	na	***1.32***	< 0.500	***18,900***		4,370	1,150	606	***2,780***
01MW-04	Dec-00	na	***1.86***	< 0.500	***7,930***		71.2	402	570	***2,840***
01MW-04	Jul-01	na	***1.79***	<1.50	***6,460***		1,210	204	134	***1,470***
01MW-07	Dec-00	na	< 0.250	< 0.500	< 50.0		< 1.08	< 0.500	< 0.500	< 1.00
01MW-07	Jul-01	na	***1.45***	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
01MW-08	Dec-00	na	0.404	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
01MW-08	Jul-01	na	***0.662***	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
01MW-09	Dec-00	na	***1.07***	< 0.500	***2,210***		302	143	65.2	333
01MW-09	Jul-01	na	***5.72***	< 0.500	***1,830***		213	114	48.1	230
West Commodore Way Perimeter Area										
01MW-10	Jul-01	na	na	na	na		na	na	na	na
01MW-11	Dec-00	na	***0.504***	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
01MW-11	Jul-01	na	***1.53***	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
01MW-16A	Jul-01	2.54	***11.1***	<2.50	***11,000***		3,910	123	261	891
01MW-16B	Jul-01	2.09	***9.62***	<2.50	***9,390***		3,700	122	209	745
Upper Tank Yard Area										
01MW-13	Dec-00	na	***3.94***	0.513	254		< 0.500	0.694	< 0.817	< 1.23
01MW-13	Jul-01	na	***3.90***	<1.50	221		1.26	< 0.500	< 0.500	2.31
Lower Tank Yard Area										
01MW-12	Dec-00	na	***1.07***	< 0.500	***802***		98.4	11.0	17.4	24.6
01MW-12	Jul-01	na	***6.55***	<1.50	***1,350***		482	8.84	14.0	26.4
Former PCP/Diesel Mixing Area										
01MW-14	Jul-01	na	na	na	na		na	na	na	na
Former Barrel Shed Area										
01MW-06	Dec-00	1.80	< 0.250	< 0.500	87.4		< 0.500	< 0.500	< 0.500	< 1.00
01MW-06	Jul-01	2.17	***0.718***	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
New Barrel Shed Area										
01MW-15	Jul-01	1.66	0.484	<0.500	< 50.0		<0.500	<0.500	<0.500	<1.00
Upper Rail Line Spur Area										
01MW-17	Jul-01	<0.500	***0.884***	<0.500	< 50.0		<0.500	<0.500	<0.500	<1.00

Notes: 1/ Results above MTCA Method A cleanup level are in ***bold italic*** type.
2/ NOAA SQuiRT value for freshwater continuous concentrations.
3/ Gasoline range with benzene present.
4/ Gasoline range without benzene present.
5/ NOAA SQuiRT value for freshwater maximum concentration.
PCP = pentachlorophenol
na = No analysis requested.
µg/L = micrograms per liter
mg/L = milligrams per liter
< symbol indicates that result is less than method reporting limit.

Table 5-5. Cumulative Groundwater Results, 2750 West Commodore Way

Sample	Date	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylenes (µg/L)	Lead (µg/L)
MTCA		**0.500**	**0.500**	**800[1/] 1,000[2/]**	**5,300[3/]**	**17,500[3/]**	**32,000[3/]**	**1,000**	**15**
02MW-01	9/28/99	< 250	< 500	172	72.9	0.811	< 0.5	< 1.0	**36**
02MW-01	11/16/00	0.488	< 0.500	79.0	19.6	1.04	< 0.500	2.35	< 1.00
02MW-01	7/25/01	**0.500**	< 0.500	119.0	44.4	0.662	< 0.500	1.15	< 1.00
02MW-02	9/28/99	< 250	< 500	< 50	< 0.5	< 0.5	< 0.5	< 1.0	**133**
02MW-02	11/16/00	***0.666***	< 0.500	55.0	< 0.580	1.63	0.598	3.28	< 1.00
02MW-02	7/25/01	***0.679***	< 0.500	< 50	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00
02MW-03	9/28/99	< 250	< 500	160	56.7	1.13	< 0.5	1.14	< 1.00
02MW-03	11/16/00	***0.534***	< 0.500	241	118	2.05	< 1.25	< 2.50	< 1.00
02MW-03	7/25/01	***0.619***	< 0.500	90.4	38.6	0.664	< 0.500	< 1.00	< 1.00
02MW-04	9/28/99	< 250	< 500	***3700***	< 30.0	185	226	473	< 1.00
02MW-04	11/16/00	***1.07***	< 0.500	***9020***	< 12.5	972	617	1,840	4.66
02MW-04A	11/16/00	***1.23***	< 0.500	***9650***	< 25.0	996	627	1,850	5.12
02MW-04	7/25/01	***1.41***	< 0.500	***4270***	23.9	231	165	484	4.68
02MW-05	9/28/99	< 250	< 500	< 50	2.84	< 0.5	< 0.5	< 1.0	**86.3**
02MW-05	11/16/00	***0.536***	< 0.500	64.0	< 0.500	< 0.500	< 0.500	1.17	< 0.00100
02MW-05	7/25/01	***0.997***	< 0.500	51.8	< 0.500	< 0.500	< 0.500	< 1.00	< 0.00100
02MW-06	11/30/00	***1.00***	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 0.00100
02MW-06A	7/25/01	***0.923***	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 0.00100
02MW-06B	7/25/01	***0.897***	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 0.00100
02MW-07	12/1/00	0.299	< 0.500	356	< 0.500	< 0.820	< 3.55	< 9.83	< 0.00100
02MW-07	7/25/01	***0.417***	< 0.500	244	< 0.500	< 0.500	< 0.500	2.79	< 0.00100
Trip Blank (11/30)	12/1/00	na	na	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na

Notes: Detections are in ***bold italic*** type.

1/ Gasoline range with benzene present.

2/ Gasoline range without benzene present.

3/ NOAA SQuiRT value for freshwater maximum concentration.

µg/L = micrograms per liter

mg/L = milligrams per liter

na = No analysis requested.

APPENDIX A

SOIL BORING LOGS

FOSTER WHEELER ENVIRONMENTAL CORP.

PROJECT NAME: Phase III Site Assessment

BORING NUMBER: SB-52

LOCATION: 2737 West Commodore Way

AREA: Former PCP/Diesel Mixing Area

CLIENT: Time Oil Company

SITE MANAGER: Scott Sloan

DRILLING METHOD: 2-inch Acker Soil Mechanic

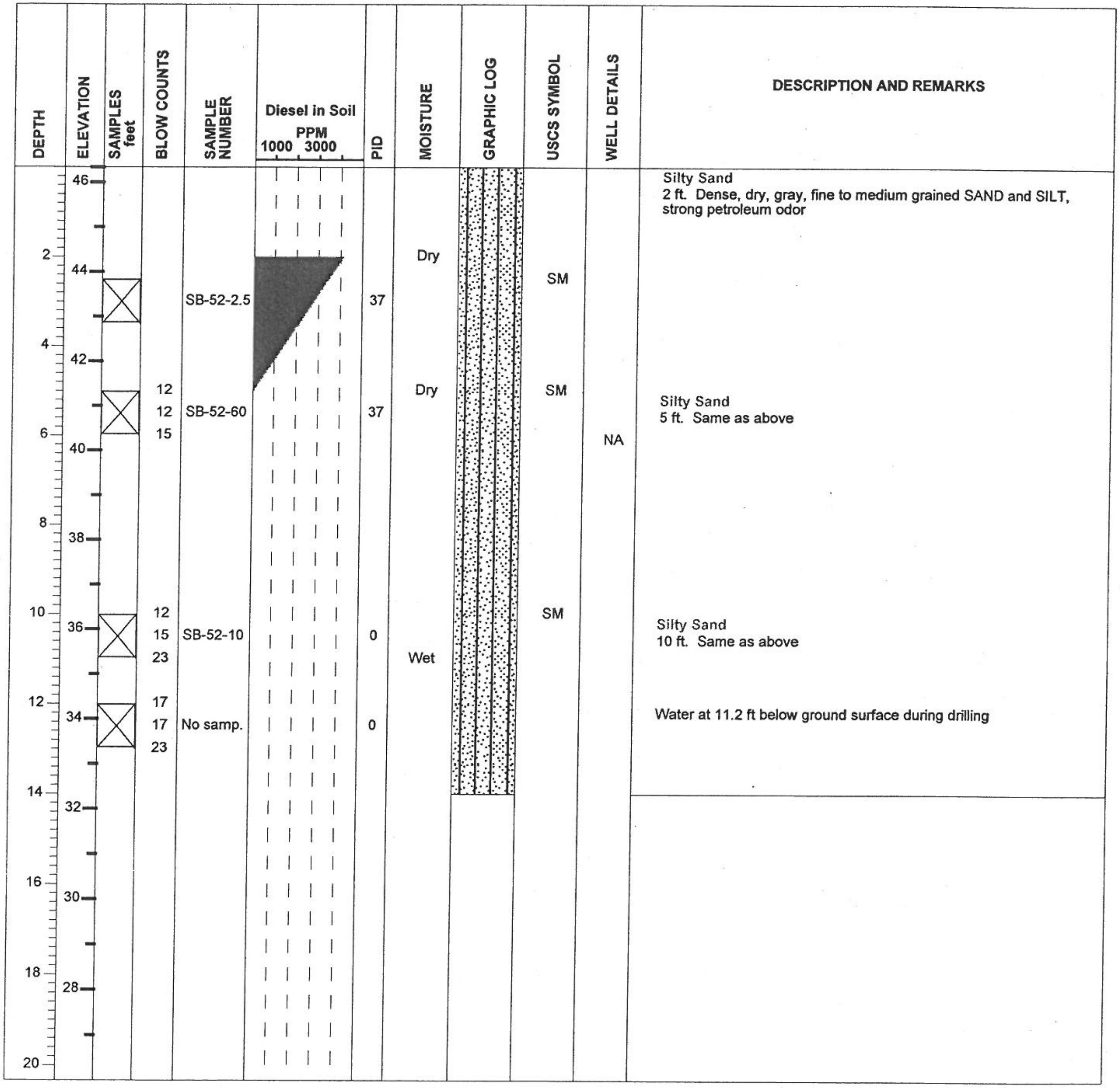
DRILLING CONTRACTOR: BoreTec

DATE/TIME STARTED: 7/16/01 0830

DATE/TIME COMPLETED: 7/16/01 0930

TOTAL DEPTH: 14 feet

WATER DEPTH: 11 feet



DEPTH	ELEVATION	SAMPLES feet	BLOW COUNTS	SAMPLE NUMBER	Diesel in Soil PPM 1000 3000	PID	MOISTURE	GRAPHIC LOG	USCS SYMBOL	WELL DETAILS	DESCRIPTION AND REMARKS
	46										Silty Sand 2 ft. Dense, dry, gray, fine to medium grained SAND and SILT, strong petroleum odor
2	44	☒		SB-52-2.5		37	Dry		SM		
4	42	☒	12 12 15	SB-52-60		37	Dry		SM	NA	Silty Sand 5 ft. Same as above
10	36	☒	12 15 23	SB-52-10		0	Wet		SM		Silty Sand 10 ft. Same as above
12	34	☒	17 17 23	No samp.		0					Water at 11.2 ft below ground surface during drilling

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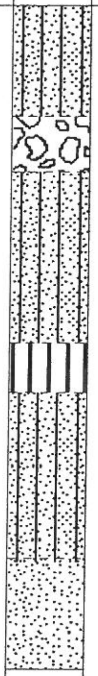
FOSTER WHEELER ENVIRONMENTAL CORP.

PROJECT NAME: Phase III Site Assessment
BORING NUMBER: SB-53
LOCATION: 2737 West Commodore Way
AREA: Former PCP/Diesel Mixing Area
CLIENT: Time Oil Company
SITE MANAGER: Scott Sloan

DRILLING METHOD: 2-inch Acker Soil Mechanic
DRILLING CONTRACTOR: BoreTec
DATE/TIME STARTED: 7/16/01 1030
DATE/TIME COMPLETED: 7/16/01 1130
TOTAL DEPTH: 12 feet
WATER DEPTH: 11 feet

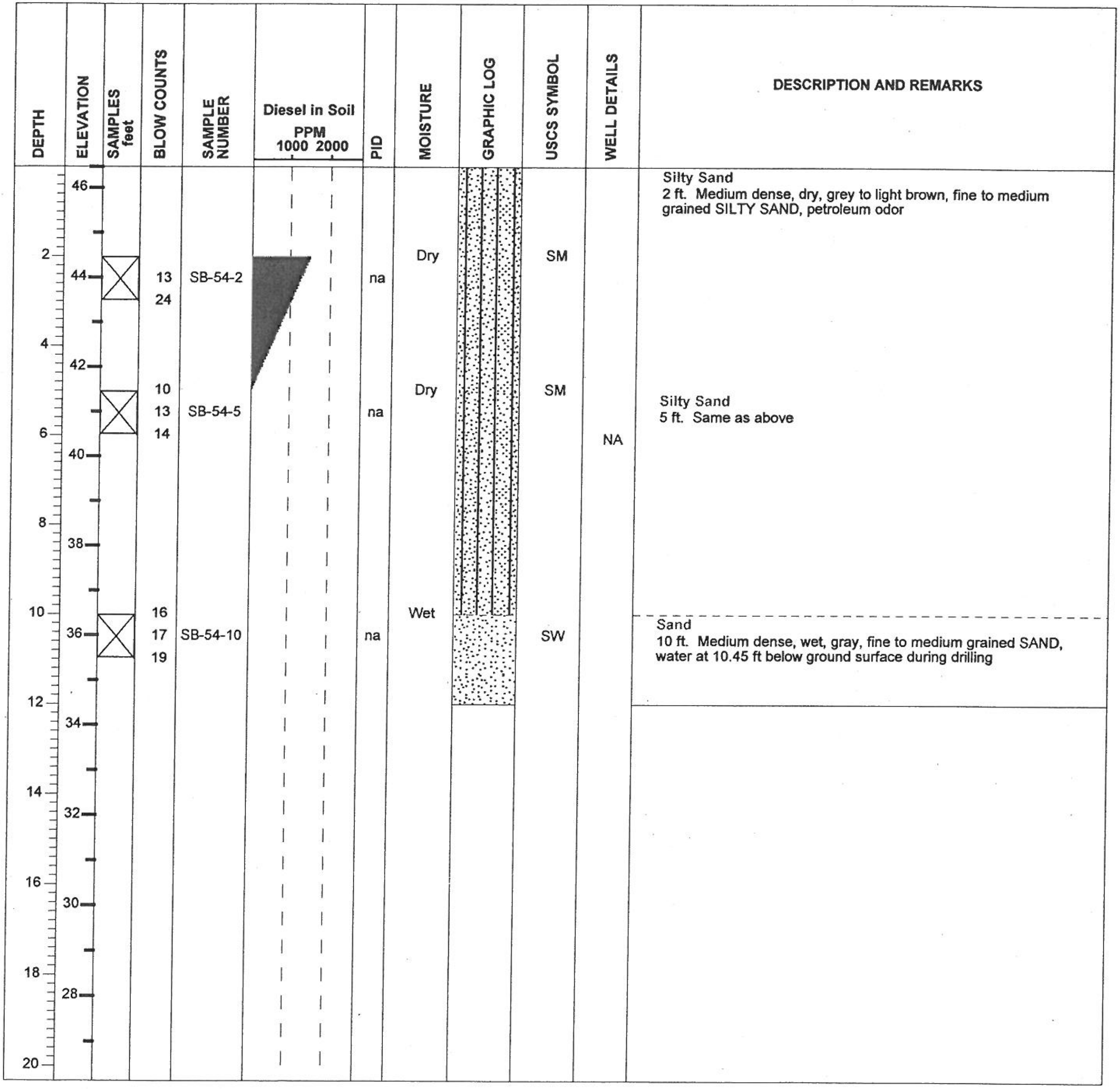


DEPTH	ELEVATION	SAMPLES feet	BLOW COUNTS	SAMPLE NUMBER	Diesel in Soil PPM 20 30 40	PID	MOISTURE	GRAPHIC LOG	USCS SYMBOL	WELL DETAILS	DESCRIPTION AND REMARKS
	46								SM		Silty Sand 0 to 2 ft. Medium dense, dry, gray, fine to medium grained SILTY SAND, petroleum odor, some oxidized layers in upper 2 feet
2	44	☒	12 16	SB-53-2		7.3	Dry		GP		Gravel 2 ft. Dense, dry, gray to brown, GRAVEL
											Silty Sand 3 ft. medium dense, dry, gray, fine to medium grained SILTY SAND, petroleum odor
4	42	☒	17 13 14	SB-53-5		5.1	Dry		SM		
6	40								ML	NA	Silt 6 ft. Silt lenses
									SM		Silty Sand 7 ft. Silty Sand as above
8	38										
10	36	☒	12 13 15	SB-53-10		0	Wet		SW		Sand 10 ft. Medium dense, wet, gray, fine to medium grained SAND, no odor
12	34										
14	32										
16	30										
18	28										
20											

FOSTER WHEELER ENVIRONMENTAL CORP.

PROJECT NAME: Phase III Site Assessment
BORING NUMBER: SB-54
LOCATION: 2737 West Commodore Way
AREA: Former PCP/Diesel Mixing Area
CLIENT: Time Oil Company
SITE MANAGER: Scott Sloan

DRILLING METHOD: 2-inch Acker Soil Mechanic
DRILLING CONTRACTOR: Foster Wheeler
DATE/TIME STARTED: 7/16/01 1245
DATE/TIME COMPLETED: 7/16/01 1320
TOTAL DEPTH: 12 feet
WATER DEPTH: 10.5 ft



DEPTH	ELEVATION	SAMPLES feet	BLOW COUNTS	SAMPLE NUMBER	Diesel in Soil PPM 1000 2000	PID	MOISTURE	GRAPHIC LOG	USCS SYMBOL	WELL DETAILS	DESCRIPTION AND REMARKS
											Silty Sand 2 ft. Medium dense, dry, grey to light brown, fine to medium grained SILTY SAND, petroleum odor
		☒	13 24	SB-54-2		na	Dry		SM		
		☒	10 13 14	SB-54-5		na	Dry		SM	NA	Silty Sand 5 ft. Same as above
		☒	16 17 19	SB-54-10		na	Wet		SW		Sand 10 ft. Medium dense, wet, gray, fine to medium grained SAND, water at 10.45 ft below ground surface during drilling

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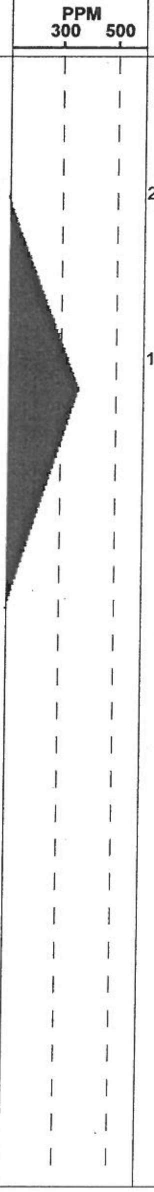
FOSTER WHEELER ENVIRONMENTAL CORP.

PROJECT NAME: Phase III Site Assessment
BORING NUMBER: SB-55
LOCATION: 2737 West Commodore Way
AREA: Former PCP/Diesel Mixing Area
CLIENT: Time Oil Company
SITE MANAGER: Scott Sloan

DRILLING METHOD: 2-inch Acker Soil Mechanic
DRILLING CONTRACTOR: Cascade
DATE/TIME STARTED: 7/16/01 1410
DATE/TIME COMPLETED: 7/16/01 1500
TOTAL DEPTH: 12 feet
WATER DEPTH: 10.5 ft

DEPTH	ELEVATION	SAMPLES feet	BLOW COUNTS	SAMPLE NUMBER	Diesel in Soil PPM 300 500	PID	MOISTURE	GRAPHIC LOG	USCS SYMBOL	WELL DETAILS	DESCRIPTION AND REMARKS
											Silty Sand 2 ft. Medium dense, dry, gray to brown, fine to medium SILTY SAND, petroleum odor
2	44	☒	11 13 18	SB-55-2		28.4	Dry		SM		
4	42										
		☒	10 18	SB-55-5		12.1	Dry		SM		Silty Sand 5 ft. Same as above
6	40									NA	
8	38										
10	36	☒	20 21 28	SB-55-10		0	Wet		SM		Silty Sand 10 ft. Same as above, slight sheen on sample
12	34										
14	32										
16	30										
18	28										
20	26										



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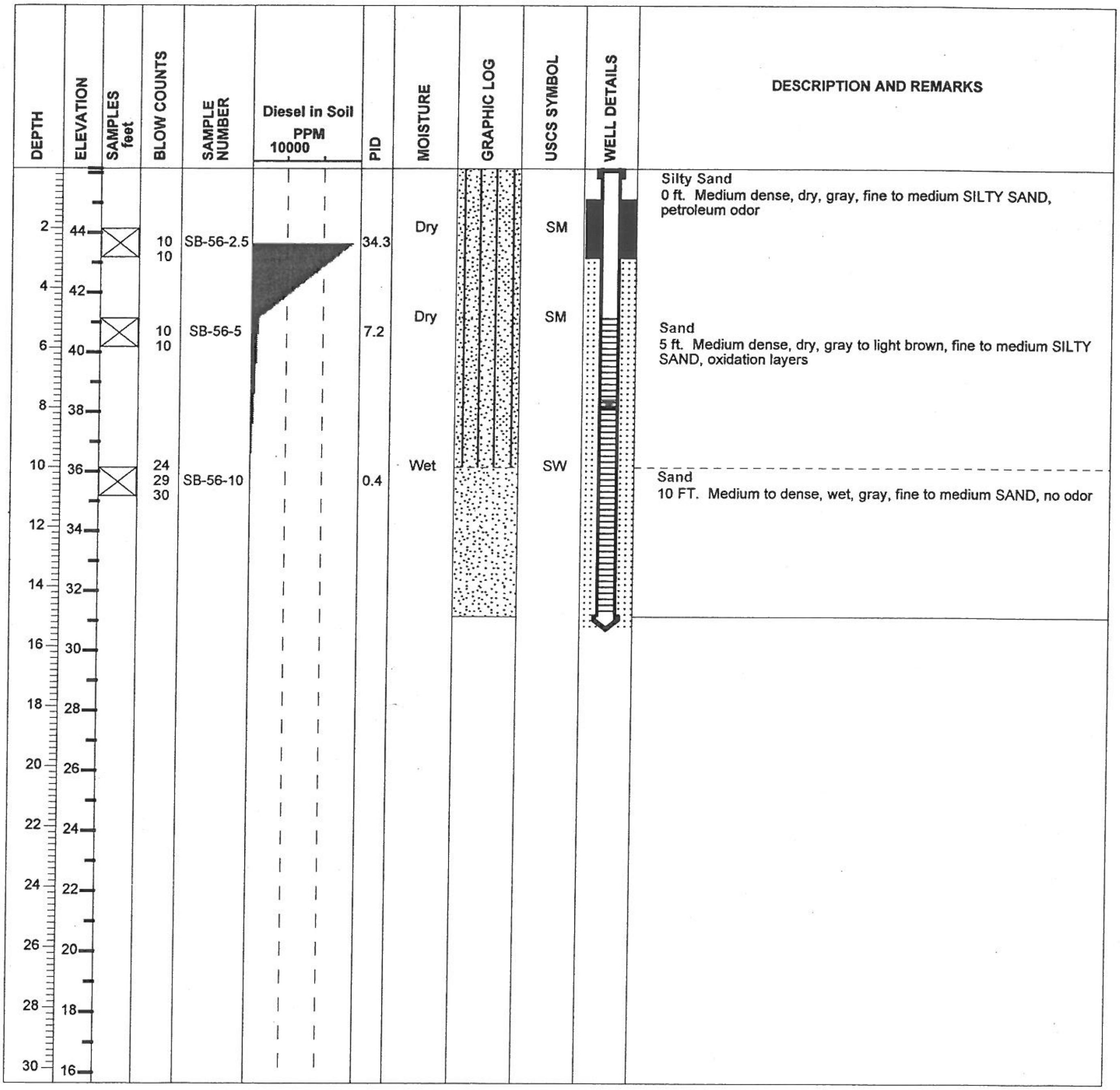
FOSTER WHEELER ENVIRONMENTAL CORP.

PROJECT NAME: Phase III Site Assessment
BORING NUMBER: SB-56 (01MW-14)
LOCATION: 2737 West Commodore Way
AREA: Former PCP/Diesel Mixing Area
CLIENT: Time Oil Company
SITE MANAGER: Scott Sloan

DRILLING METHOD: 2-inch Acker Soil Mechanic
DRILLING CONTRACTOR: BoreTec
DATE/TIME STARTED: 7/17/01 0715
DATE/TIME COMPLETED: 7/17/01 1047
TOTAL DEPTH: 15 ft
WATER DEPTH: 8 ft

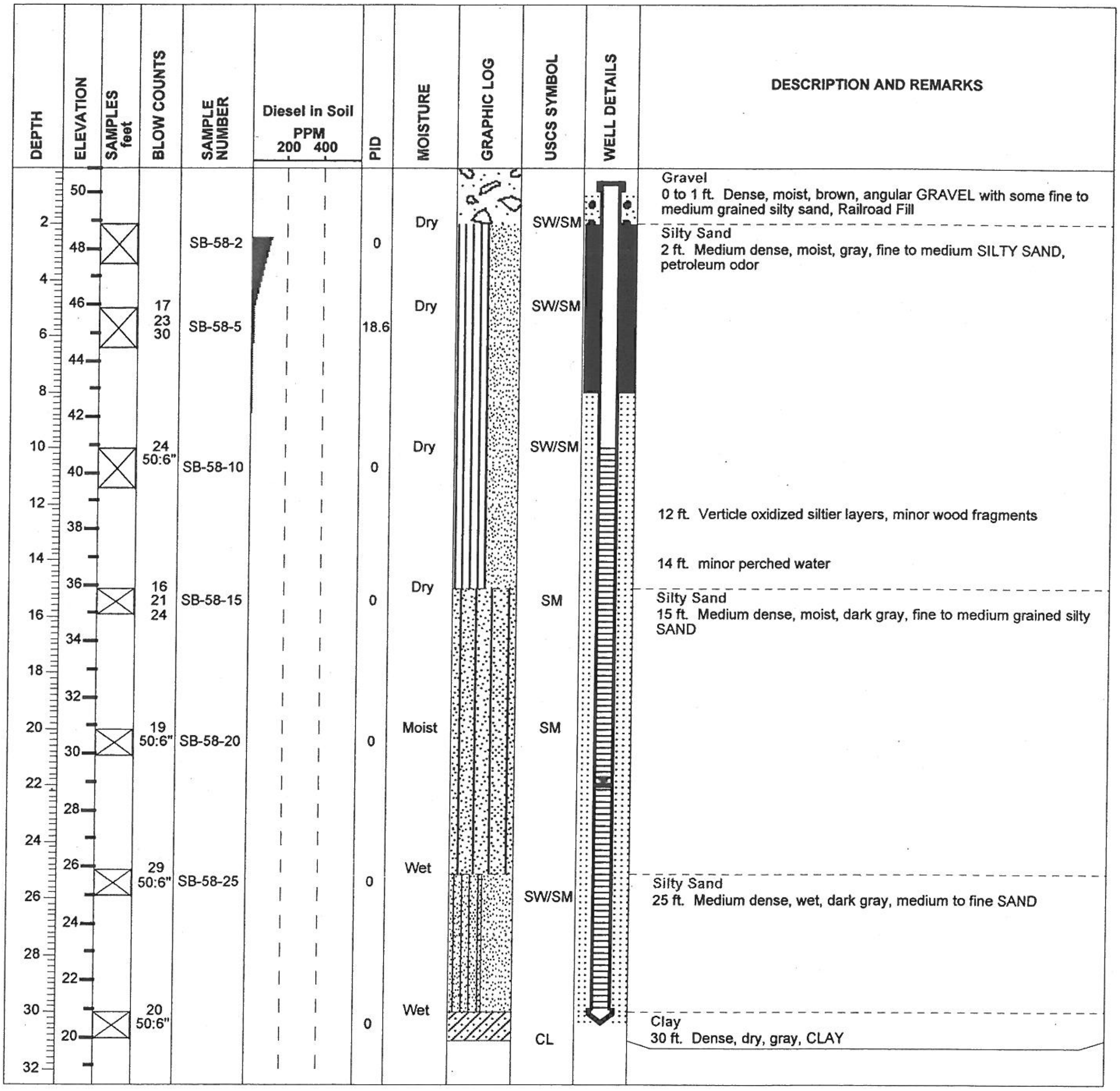


DEPTH	ELEVATION	BLOW COUNTS	SAMPLE NUMBER	PID	MOISTURE	USCS SYMBOL	DESCRIPTION AND REMARKS
0							Silty Sand 0 ft. Medium dense, dry, gray, fine to medium SILTY SAND, petroleum odor
2.5		10 10	SB-56-2.5	34.3	Dry	SM	
5		10 10	SB-56-5	7.2	Dry	SM	Sand 5 ft. Medium dense, dry, gray to light brown, fine to medium SILTY SAND, oxidation layers
10		24 29 30	SB-56-10	0.4	Wet	SW	Sand 10 FT. Medium to dense, wet, gray, fine to medium SAND, no odor

FOSTER WHEELER ENVIRONMENTAL CORP.

PROJECT NAME: Phase III Site Assessment
BORING NUMBER: SB-58 (01MW-15)
LOCATION: 2737 West Commodore Way
AREA: New Barrel Shed
CLIENT: Time Oil Company
SITE MANAGER: Scott Sloan

DRILLING METHOD: 4-inch HSA
DRILLING CONTRACTOR: Cascade
DATE/TIME STARTED: 7/19/01 0750
DATE/TIME COMPLETED: 7/19/01 1015
TOTAL DEPTH: 30 ft
WATER DEPTH: 22 ft



DEPTH	SAMPLES feet	BLOW COUNTS	SAMPLE NUMBER	PID	MOISTURE	USCS SYMBOL	DESCRIPTION AND REMARKS
0							Gravel 0 to 1 ft. Dense, moist, brown, angular GRAVEL with some fine to medium grained silty sand, Railroad Fill
2	☒		SB-58-2	0	Dry	SW/SM	Silty Sand 2 ft. Medium dense, moist, gray, fine to medium SILTY SAND, petroleum odor
5	☒	17 23 30	SB-58-5	18.6	Dry	SW/SM	
10	☒	24 50:6"	SB-58-10	0	Dry	SW/SM	
12							12 ft. Verticle oxidized siltier layers, minor wood fragments
14							14 ft. minor perched water
15	☒	16 21 24	SB-58-15	0	Dry	SM	Silty Sand 15 ft. Medium dense, moist, dark gray, fine to medium grained silty SAND
20	☒	19 50:6"	SB-58-20	0	Moist	SM	
25	☒	29 50:6"	SB-58-25	0	Wet	SW/SM	Silty Sand 25 ft. Medium dense, wet, dark gray, medium to fine SAND
30	☒	20 50:6"		0	Wet	CL	Clay 30 ft. Dense, dry, gray, CLAY

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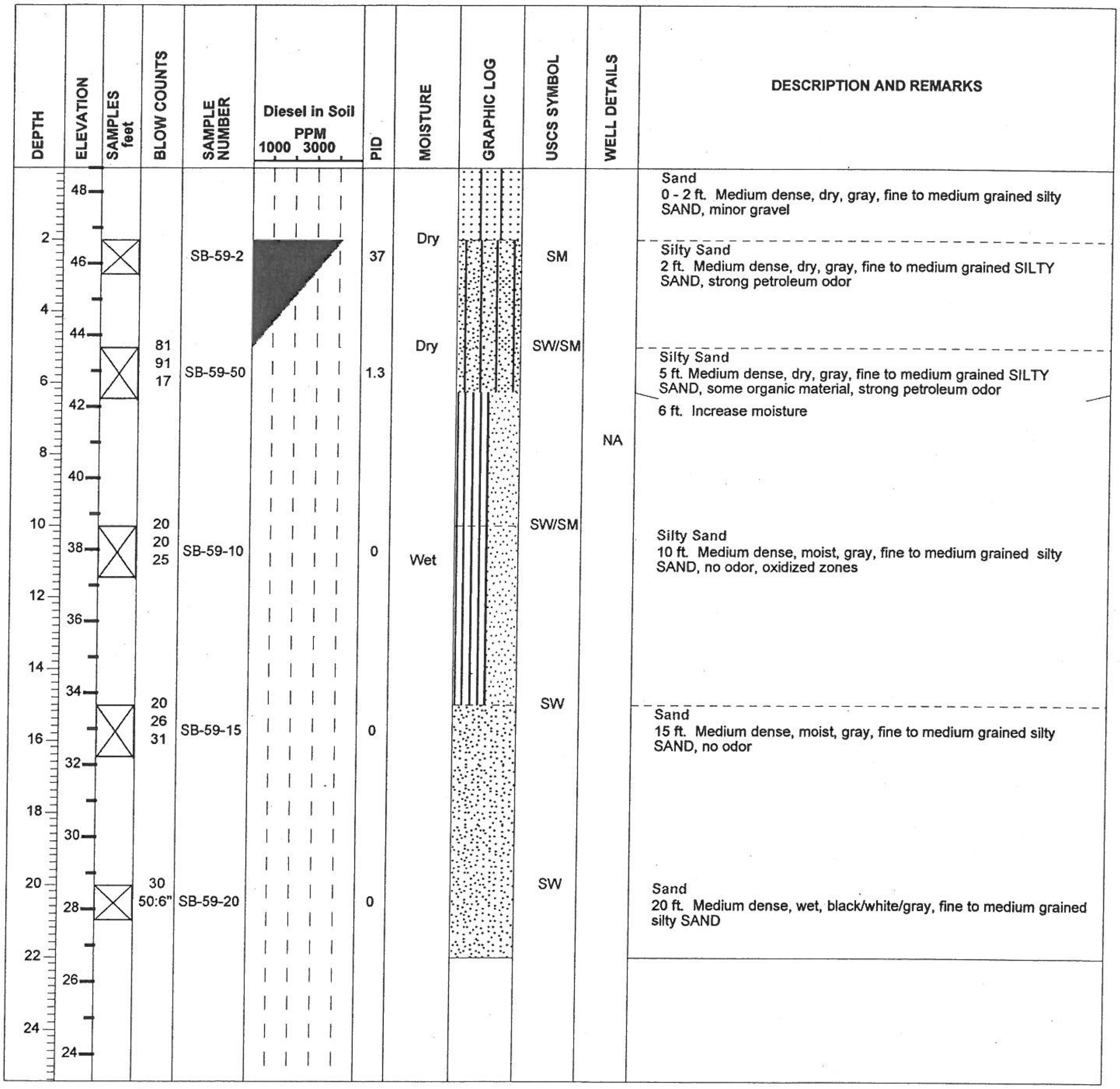
FOSTER WHEELER ENVIRONMENTAL CORP.

PROJECT NAME: Phase III Site Assessment
BORING NUMBER: SB-59
LOCATION: 2737 West Commodore Way
AREA: Old Barrel Shed
CLIENT: Time Oil Company
SITE MANAGER: Scott Sloan

DRILLING METHOD: 4-inch HSA
DRILLING CONTRACTOR: Cascade
DATE/TIME STARTED: 7/19/01 1030
DATE/TIME COMPLETED: 7/19/01 1125
TOTAL DEPTH: 20 feet
WATER DEPTH: na



DEPTH	ELEVATION	BLOW COUNTS	SAMPLE NUMBER	PID	MOISTURE	USCS SYMBOL	WELL DETAILS	DESCRIPTION AND REMARKS
0 - 2	48							Sand 0 - 2 ft. Medium dense, dry, gray, fine to medium grained silty SAND, minor gravel
2	46		SB-59-2	37	Dry	SM		Silty Sand 2 ft. Medium dense, dry, gray, fine to medium grained SILTY SAND, strong petroleum odor
5	43	81 91 17	SB-59-50	1.3	Dry	SW/SM		Silty Sand 5 ft. Medium dense, dry, gray, fine to medium grained SILTY SAND, some organic material, strong petroleum odor
6	42							6 ft. Increase moisture
8	40						NA	
10	38	20 20 25	SB-59-10	0	Wet	SW/SM		Silty Sand 10 ft. Medium dense, moist, gray, fine to medium grained silty SAND, no odor, oxidized zones
15	33	20 26 31	SB-59-15	0		SW		Sand 15 ft. Medium dense, moist, gray, fine to medium grained silty SAND, no odor
20	28	30 50:6"	SB-59-20	0		SW		Sand 20 ft. Medium dense, wet, black/white/gray, fine to medium grained silty SAND

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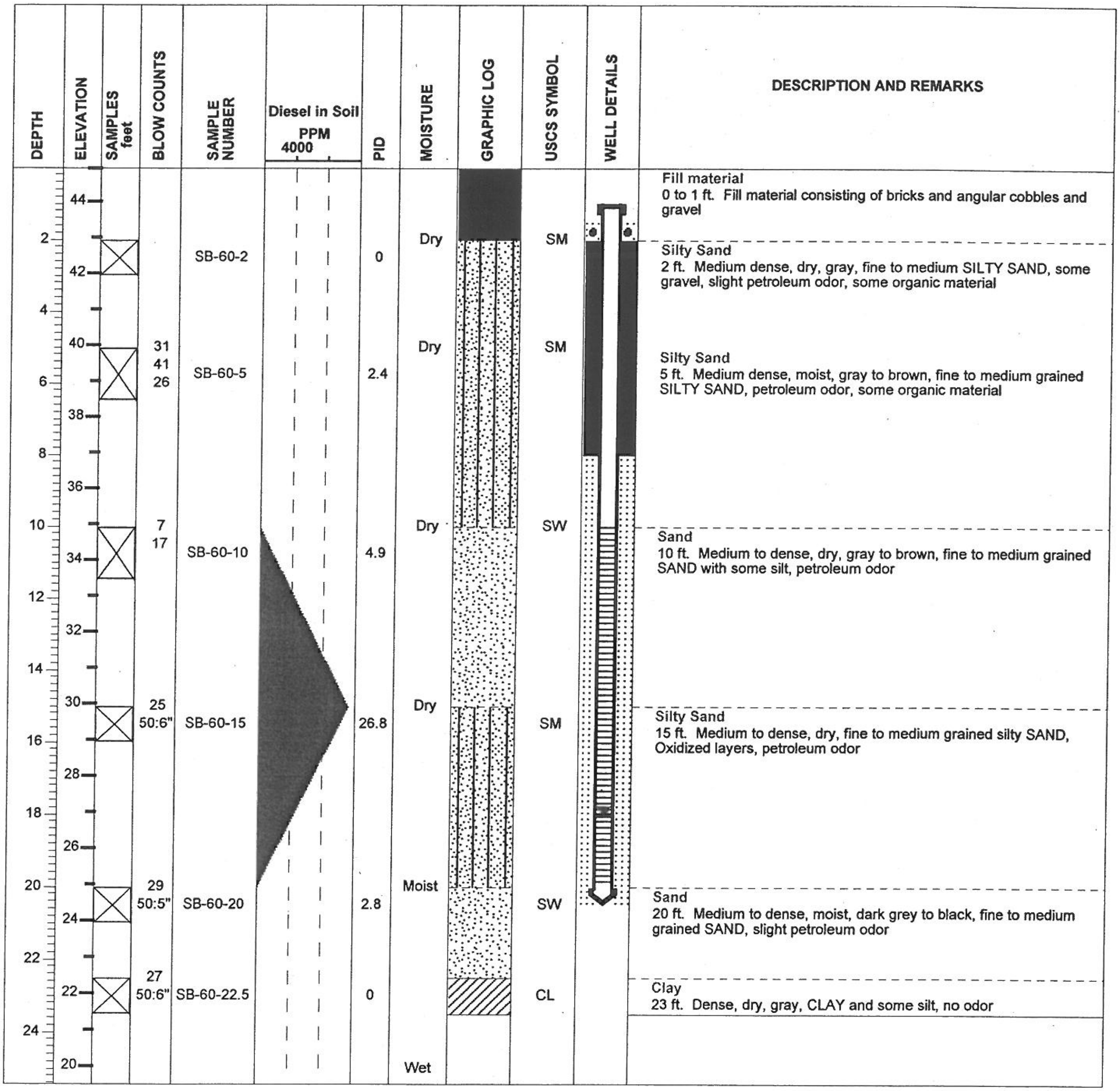
FOSTER WHEELER ENVIRONMENTAL CORP.

PROJECT NAME: Phase III Site Assessment
BORING NUMBER: SB-60 (01MW-16)
LOCATION: 2737 West Commodore Way
AREA: West Commodore Way Perimeter
CLIENT: Time Oil Company
SITE MANAGER: Scott Sloan

DRILLING METHOD: 4-inch HSA
DRILLING CONTRACTOR: Cascade
DATE/TIME STARTED: 7/19/01 1255
DATE/TIME COMPLETED: 7/19/01 1415
TOTAL DEPTH: 22.5 ft
WATER DEPTH: 18 ft



BLOW COUNTS	SAMPLE NUMBER	PID	MOISTURE	USCS SYMBOL	DESCRIPTION AND REMARKS
					Fill material 0 to 1 ft. Fill material consisting of bricks and angular cobbles and gravel
	SB-60-2	0	Dry	SM	Silty Sand 2 ft. Medium dense, dry, gray, fine to medium SILTY SAND, some gravel, slight petroleum odor, some organic material
31 41 26	SB-60-5	2.4	Dry	SM	Silty Sand 5 ft. Medium dense, moist, gray to brown, fine to medium grained SILTY SAND, petroleum odor, some organic material
7 17	SB-60-10	4.9	Dry	SW	Sand 10 ft. Medium to dense, dry, gray to brown, fine to medium grained SAND with some silt, petroleum odor
25 50:6"	SB-60-15	26.8	Dry	SM	Silty Sand 15 ft. Medium to dense, dry, fine to medium grained silty SAND, Oxidized layers, petroleum odor
29 50:5"	SB-60-20	2.8	Moist	SW	Sand 20 ft. Medium to dense, moist, dark grey to black, fine to medium grained SAND, slight petroleum odor
27 50:6"	SB-60-22.5	0		CL	Clay 23 ft. Dense, dry, gray, CLAY and some silt, no odor
			Wet		

FOSTER WHEELER ENVIRONMENTAL CORP.

PROJECT NAME: Phase III Site Assessment

BORING NUMBER: SB-61 (01MW-17)

LOCATION: 2737 West Commodore Way

AREA: Upper Railroad Spur

CLIENT: Time Oil Company

SITE MANAGER: Scott Sloan

DRILLING METHOD: 4-inch HSA

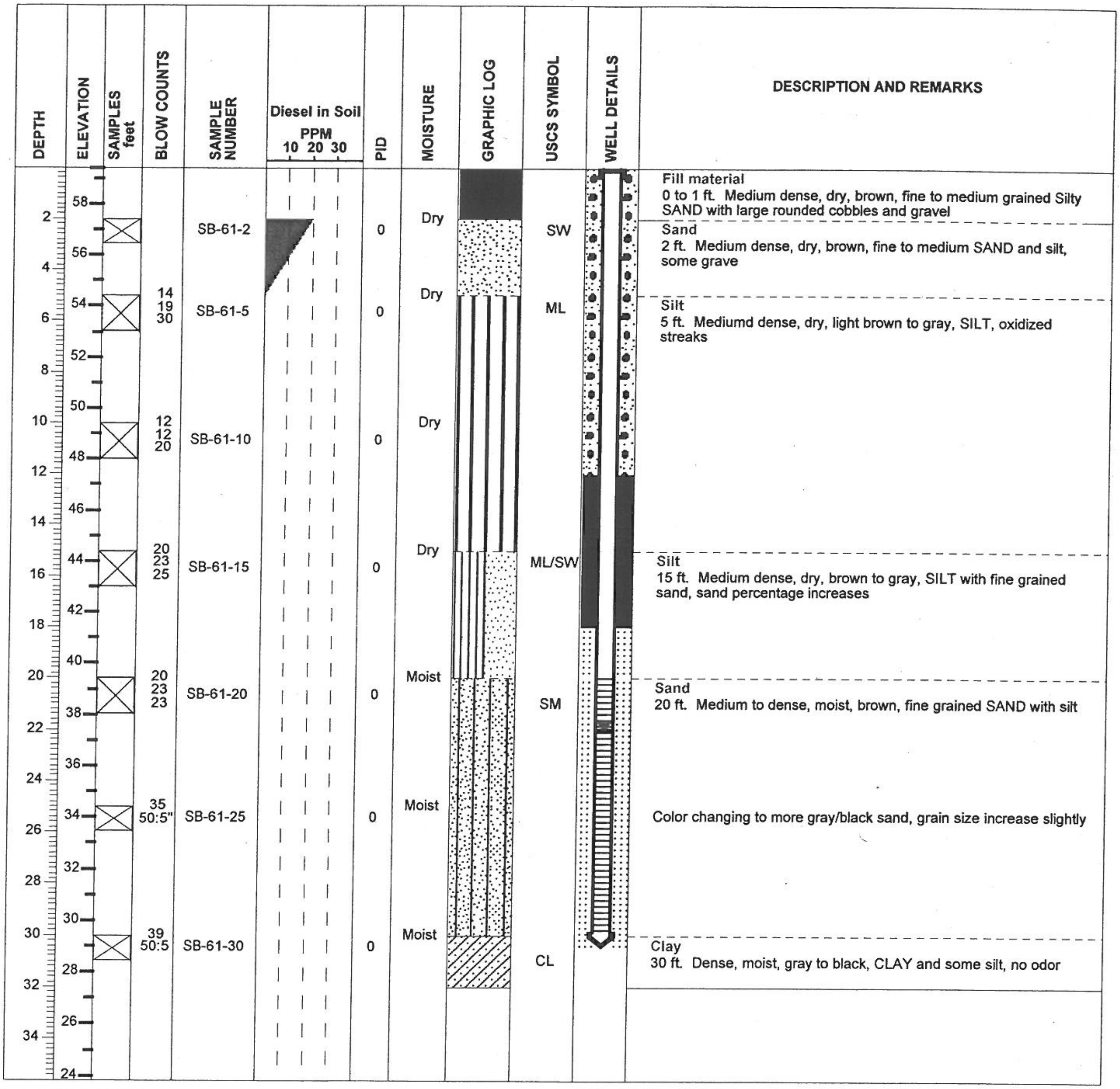
DRILLING CONTRACTOR: Cascade

DATE/TIME STARTED: 7/19/01 1438

DATE/TIME COMPLETED: 7/19/01 1745

TOTAL DEPTH: 32 ft

WATER DEPTH: 22 ft



BLOW COUNTS	SAMPLE NUMBER	PID	MOISTURE	USCS SYMBOL
	SB-61-2	0	Dry	SW
14 19 30	SB-61-5	0	Dry	ML
12 12 20	SB-61-10	0	Dry	
20 23 25	SB-61-15	0	Dry	ML/SW
20 23 23	SB-61-20	0	Moist	SM
35 50:5"	SB-61-25	0	Moist	
39 50:5	SB-61-30	0	Moist	CL

DESCRIPTION AND REMARKS

Fill material
0 to 1 ft. Medium dense, dry, brown, fine to medium grained Silty SAND with large rounded cobbles and gravel

Sand
2 ft. Medium dense, dry, brown, fine to medium SAND and silt, some grave

Silt
5 ft. Mediumd dense, dry, light brown to gray, SILT, oxidized streaks

Silt
15 ft. Medium dense, dry, brown to gray, SILT with fine grained sand, sand percentage increases

Sand
20 ft. Medium to dense, moist, brown, fine grained SAND with silt

Color changing to more gray/black sand, grain size increase slightly

Clay
30 ft. Dense, moist, gray to black, CLAY and some silt, no odor

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DEVELOPMENT OF FRESHWATER SEDIMENT QUALITY VALUES FOR USE IN WASHINGTON STATE

Phase II Report:
Development and Recommendation of SQVs for Freshwater Sediments in Washington State

September, 2003

Publication Number 03-09-088

Prepared for

Washington Department of Ecology
Toxics Cleanup Program
Sediment Management Unit

By

Teresa Michelsen, Ph.D
Avocet Consulting
Kenmore, WA

under contract to

Science Applications International Corporation
Bothell, WA

DEVELOPMENT OF FRESHWATER SEDIMENT QUALITY VALUES FOR USE IN WASHINGTON STATE

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Avocet Consulting

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

2LAET – second lowest Apparent Effects Threshold
AET – Apparent Effects Threshold
ASTM – American Society for Testing and Materials
C – control
CF – control final
CI – control initial
CSL – Cleanup Screening Level
DDD – dichlorodiphenyldichloroethane
DDE – dichlorodiphenyldichloroethylene
DDT – dichlorodiphenyltrichloroethane
DMEF – Dredged Material Evaluation Framework
DMMP – Dredged Material Management Programs
EPA – Environmental Protection Agency
ERL – Effects Range Low
HPAH – high molecular weight polynuclear aromatic hydrocarbon
LAET – lowest Apparent Effects Threshold
LPAH – low molecular weight polynuclear aromatic hydrocarbon
MCUL – Minimum Cleanup Level
ML – Maximum Level
NOAA – National Oceanic and Atmospheric Administration
PAET – Probable Apparent Effects Threshold
PAH – polynuclear aromatic hydrocarbon
PCB – polychlorinated biphenyl
PSDDA – Puget Sound Dredged Disposal Analysis
PSEP – Puget Sound Estuary Program
QA – quality assurance
QA/QC – quality assurance/quality control
R – reference
RF – reference final
SAIC – Science Applications International Corporation
SEDQUAL – Sediment Quality Information System
SQS – Sediment Quality Standard
SQV – sediment quality value
T – test
TBT – tributyltin
TEL – Threshold Effects Level
TEQ – toxic equivalent
TOC – total organic carbon

EXECUTIVE SUMMARY

In early 2002, the Washington State Department of Ecology (Ecology) embarked on a project to identify, update, and ultimately select freshwater sediment quality values (SQVs) for use in Ecology's sediment management programs. The first phase of this effort was completed in December 2002 (SAIC and Avocet, 2002), and included compilation of existing freshwater SQVs in North America, and an assessment of their reliability in predicting effects in Washington State. The results of this work indicated that additional Phase II work was needed to update existing freshwater Apparent Effects Thresholds (AETs) and calculate more reliable SQVs for Washington State, as none of the existing guidelines were adequately predictive of toxicity in the Washington State data set.

The goals of the Phase II work described in this report are:

- Update Ecology's freshwater AETs (Ecology 1997), including additional tests and endpoints if possible
- Investigate additional methods of calculating SQVs, including the optimal percentile and floating percentile approaches described in Section 2.0
- Conduct reliability testing to identify which SQVs are most predictive of toxicity in the Washington State data set, and make recommendations regarding their use in accordance with the Sediment Management Standards.

As part of the process of deriving SQVs, additional development work was completed that will be beneficial to Ecology's programs:

- The freshwater sediment database was substantially updated and both the chemistry and bioassay data were subjected to detailed review to ensure accuracy and quality
- Interpretation guidelines for freshwater biological tests were developed
- The SEDQUAL freshwater bioassay interpretation tool, including statistical analysis and comparison of bioassay data to interpretation guidelines, was completed and thoroughly tested

Results of the Phase II SQV development work include the following:

- The freshwater data set is considerably stronger than it was in 1997, and has been improved from a quality assurance standpoint. The current database allows for the calculation of two additional AETs, for a total of four acute and subchronic endpoints. The 2003 AETs are more consistent with one another, and encompass a broader range of analytes than the 1997 AETs. Unfortunately, no benthic or chronic freshwater tests have enough data to allow calculation of AETs.

- There is still a lack of data for a variety of pesticides, herbicides and biocides, among other chemicals. These chemicals may be important in areas of the state that have not been widely sampled, particularly in central and eastern Washington. At sites or locations in which these chemicals are likely to be present, the AETs and other SQVs derived in this report may not provide adequate protectiveness, and bioassay testing should be undertaken on a site-specific basis. In addition, it is possible that lack of these analytes in the existing data set reduced the sensitivity of the AETs as well as the other SQVs calculated, if they contributed to observed toxicity in the bioassays.

- The freshwater AETs are not as sensitive as the marine AETs are in Puget Sound, most likely due to variations in metals bioavailability from one area to the next. The two mortality bioassays exhibit the lowest sensitivity and reliability. Because these AETs are less protective than the marine AETs, they may not meet the narrative goals of the SQS and the CSL in the Sediment Management Standards.

- Use of lower percentiles of the no-hit distribution improves sensitivity, and shows a reasonable balance between protectiveness and efficiency - in the 75-80% sensitivity range, with a corresponding efficiency of 60-80%. This approach is similar to the Probable Apparent Effects Threshold proposed in Ecology (1997), but has been modified to allow any optimal percentile to be chosen, rather than only the 95th percentile.

- Use of the floating percentile method (described in Section 2.0) further improves the sensitivity and efficiency, resulting in SQVs with a sensitivity of 85% and efficiency of 75%, and an overall reliability of better than 80%. Other choices of sensitivity and efficiency are possible, and a range of potential guideline values was calculated to illustrate the trade-offs involved.

- Metals, certain phthalates, PCBs, and PAHs acting in an additive manner are most closely associated with toxicity in the data set. There is a significant degree of covariance among many of the metals and among the PAHs, which complicates calculation of the SQVs.

The following recommendations to Ecology are provided, based on the conclusions above and supporting analyses:

- AETs, calculated in the standard way, are not recommended for setting freshwater SQS and CSL values at this time, because of their relatively low sensitivity. The freshwater AETs are nevertheless useful for other purposes within the sediment management programs, because they are highly efficient. Above these levels, it is nearly certain that adverse effects will be observed. Therefore, they would be appropriate as MLs in the dredging programs, and as hotspot and early action levels in the cleanup programs.

- As an alternative to AETs, the Floating Percentile method is recommended over the optimal percentile approach, because it is more reliable and provides SQVs that better predict toxicity in the Washington State data set. Using this method, it is possible to develop an optimized SQV set for any choice of false negative rate and any definition of adverse effects determined to be appropriate to a given program. The method is also capable of providing customized SQVs for a given region of the state, should it be considered appropriate to stratify the freshwater data set into ecoregions, watersheds, or political boundaries.

- Within the range of adverse effects levels evaluated in this report, it is recommended that Ecology retain use of the biological SQS and CSL levels, as defined in the Phase I report (subject to agency and peer review), rather than using a statistical significance only comparison. The SQS and CSL biological effects levels are more consistent with the existing rules and marine programs.

- Based on the evaluations conducted for the Phase I report, it is recommended that Ecology use a comparison to control rather than a comparison to reference for calculating SQVs. Once freshwater reference areas have been identified and their performance validated over time, the decision of whether to use reference or control comparisons can be made on a programmatic basis. However, the Phase I reliability analysis indicated that if a decision is made to use reference comparisons, they must be used consistently on all projects and not mixed with comparisons to control, or the reliability of the decision process will substantially decline.

- It is recommended that PCB criteria be set only for total PCBs, rather than individual Aroclors, based on the sensitivity analysis. The manner in which total PCBs should be calculated when congener data are available was outside the scope of this study (since congener data were not present in the data set); however, this will be important to address in the future.

- It is also recommended that LPAH and HPAH measures not be used, based on the sensitivity analysis. For PAHs, two alternative approaches could be used, which seem to provide roughly the same sensitivity and reliability. A single SQV can be set using a molar sum of PAHs, consistent with narcosis theory. Alternatively, SQVs for individual PAHs can be set using the freshwater AETs.

- It is recommended that areas of the state susceptible to contamination by pesticides, herbicides, and other chemicals not well-represented in the existing data set be further sampled, using synoptic chemistry and bioassay testing. This will allow additional SQVs to be calculated that will provide greater protection in these areas.

1.0 INTRODUCTION

In 1997, the Washington State Department of Ecology (Ecology) released its first set of freshwater AETs for Washington State (Ecology 1997), based on data that had been collected through 1994. At that time, there were enough data to calculate AETs for two endpoints – the 10-day *Hyalella azteca* mortality bioassay, and the Microtox® luminescence bioassay. A relatively small database existed, and some of the data were collected prior to standardization of freshwater bioassay protocols. Because of these factors, these AETs were not intended for regulatory use. Since then, quite a bit of additional data have been collected, new tests have been introduced, protocols have been standardized, and interest in having updated regional freshwater sediment quality values (SQVs) has grown. Recent data are now available from the Duwamish River, the Spokane River, the Columbia River, the Willamette River, and various large lakes on both the east and west side of the Cascades.

Consequently, in early 2002, Ecology embarked on a project to identify, update, and recalculate freshwater SQVs for use in Washington State sediment management programs. Ideally, two levels of SQVs would be developed, to correspond to the narrative Sediment Quality Standard (SQS) and Cleanup Screening Level/Minimum Cleanup Level (CSL/MCUL). Phase I of the project was completed in December 2002 (SAIC and Avocet 2002), and included:

- A compilation of existing freshwater SQV sets in North America
- An evaluation of the appropriateness of these guidelines for Ecology's programs, using narrative criteria, resulting in the selection of eight SQV sets for further evaluation
- An update of the regional freshwater sediment database, including gathering additional synoptic data sets, and conducting quality assurance reviews of both new and old data sets
- Adding new freshwater bioassay evaluation tools to the SEDQUAL information system, allowing the development of custom bioassay hit/no-hit definitions and comparison of bioassay data to these definitions to identify stations with hits
- A reliability analysis of the eight chosen SQV sets against the newly updated freshwater data set, to evaluate their ability to correctly predict biological hits and no-hits
- An evaluation of the use of marine AETs as freshwater dredged material disposal guidelines, and recommended updates to the Columbia River DMEF manual (DMEF 1998).

The results of these analyses indicated that the existing freshwater SQV sets were not able to correctly predict both hits and no-hits with an acceptable degree of reliability, and further work was therefore needed in Phase II to update the 1997 freshwater AETs and/or calculate new freshwater guidelines.

This report provides the results of Phase II, and includes the following:

- Calculation of updated freshwater AETs for four bioassay endpoints
- Calculation of alternative freshwater SQVs, including use of a lower no-hit percentile for the AETs and entirely new SQVs based on iterative error rate minimization techniques

- A reliability analysis of the AETs and alternative SQVs based on the updated regional freshwater data set
- Recommendations for how these values could be used in Ecology's programs.

Section 2 of this report describes the methods used to finalize the data set, calculate the SQVs, and conduct the reliability assessment. Section 3 presents the updated freshwater AETs and alternative SQVs and the associated reliability analyses, and Section 4 provides additional discussion of technical and policy issues. Section 5 summarizes conclusions and recommendations, and Section 6 provides the references for the report.

It should be emphasized that this report provides initial recommendations to Ecology, which will make the final decision on how any SQVs presented in this report, or any modifications to the SQVs presented here, will actually be used in Ecology's sediment management programs. Among the results presented here are a wide variety of options for setting final SQS and CSL-equivalent values. Additionally, the SQVs presented in this report were guided and based on initial policy and technical decisions made by Ecology, described in Section 2. Any potential future modifications to these underlying choices and conditions could significantly change the associated values.

2.0 METHODS

2.1 Data Preparation

Data Collection. Most of the data collection and data entry was conducted under Phase I; the Phase I report provides details of the data sets obtained and the process that was used to screen them. One additional data set for Lake Sammamish was added which came in at the very end of Phase I. The final Phase II data file used for the development of SQVs (a subset of the publicly available SEDQUAL data set) is available from Ecology by request.

Data Screening. Two early data sets for McCormick & Baxter Creosoting Company (MBCREOS1 and MBCREOS2) were deleted when it was determined that the logistic regression models using the *Hyalella azteca* results for these data sets were significantly different from the rest of the *H. azteca* data sets. These studies were conducted in the 1990-1991 timeframe, and unlike more recent studies, the *H. azteca* organisms were collected locally and may have had a different sensitivity to contaminants. Although for some time there has been a general sense that the early McCormick & Baxter results were unusual, this was recently confirmed in a more rigorous manner by both NOAA (Field et al. 2003) and the Oregon Department of Environmental Quality (Brunelle et al., 2003).

In addition, some surveys and individual stations were screened out because of a low number of replicates in bioassays, below what is considered a minimum standard in modern freshwater protocols (ASTM 2000). Surveys or stations with less than five replicates were screened out, including:

- **LAKROO92 (all 18 stations) –** 7-day Hyalella, 3 replicates.
- **LSAMM99 (all 16 stations)** – Microtox®, 2 replicates
- **MARCO90 (1 station) –** 10-day Hyalella, 3 replicates.
- **QUEBAX2 (all 4 stations) –** 14-day Hyalella, 4 replicates.
- **SIMILK00 (all 4 stations) –** 10-day Hyalella, 4 replicates.
- **TRISTAR (all 3 stations)** – Microtox®, 3 replicates.
- **UNIMAR2 (all 9 stations)** – 14-day Hyalella, 3 replicates.

Although conducting a power analysis was discussed, it was decided against at this time. The purpose of a power analysis is to determine the minimum difference between two samples that can be detected with a given confidence (alpha level), or conversely whether or not there is sufficient power to detect a specified minimum detectable difference. Conducting a power analysis requires identification of a minimum detectable difference and/or a confidence level that is considered appropriate, and these variables have not been defined or selected by Ecology. The Phase II analysis uses statistical difference from control only, rather than a specified threshold that could serve as a target for a minimum detectable difference.

The freshwater ASTM protocols recommend 8 replicates and require a minimum of 4 replicates in order to provide appropriate power under most circumstances. The minimum of 4 is mainly considered appropriate for less rigorous applications, such as trend analysis between years, and is fewer than the PSDDA marine bioassay standard of 5 replicates. The data sets remaining in the database after the above screening meet or exceed both of these minimum guidelines.

Surveys and stations were also screened out if they had an insufficient analyte list. Although it would be ideal for all stations to have the same analyte list when developing SQVs, that is not possible when using historical data sets. A minimum of PAHs and metals was selected as a general guideline for including a survey or station, consistent with other national criteria development efforts. Metals and PAHs both contribute significantly to toxicity in most contaminated sediment data sets, and if these minimum analytes were not available, toxicity would frequently occur in samples without adequate chemistry to explain it. This would lead to an unrealistically high number of false negatives in the reliability analysis, based solely on the analyte list and not on the accuracy of the SQVs.

For some surveys, different stations had varying analyte lists. In these surveys, only those stations with adequate analyte lists were retained. The surveys and stations deleted included:

- **COLALU94 (all 6 stations) –** Only conventionals.
- **LKROOS92 (2, 8, 10, 11, 15, 17, 19, 61, 71)** – 6 metals and TOC.
- **LKROOS01 (all 10 stations) –** 6 metals plus conventionals.
- **SIMILK00 (all 4 stations) –** metals and conventionals, no organics.
- **STEILLK2 (all 4 stations) –** metals and conventionals, no organics.
- **QUEBAX2 (all 4 stations) –** PAHs and conventionals, no metals.

Finally, individual chemical data were screened out based on qualifiers assigned during the quality assurance process by the original authors. Data qualified as H, N, Q, X, or R (defined in Table 2-1 below) were not included in the analysis. Undetected data were also not included, as these data do not provide useful information for the purposes of developing SQVs.

Table 2-1. Qualifier Definitions for Screened-Out Data

Qualifier	Definition
H	Holding time exceeded (conventionals)
N	Estimate based on presumptive evidence analyte is present in sample
Q	Questionable value
X	Less than 10% recovery
R	Rejected – failure to meet QA guidelines

For AET recalculations only, outliers were also removed using the 3x rule (if the highest no-hit value is more than three times the next-highest value, the highest value is considered an outlier). Statistical outlier approaches such as Rosner’s test and Dixon’s test are also available; however, there is some evidence that these statistical approaches do not work well with distributions that are patchy in their upper ranges, such as the freshwater data set (Gilbert 1987, Sokal and Rohlf 1981). They are also not consistent with the approach approved by the EPA Science Advisory Board. Therefore, the standard 3x rule was used for Phase II update of freshwater AETs.

Selection of Bioassay Tests and Endpoints. In Phase I it was determined that there is currently insufficient data to calculate SQVs for the chronic tests. Four tests have sufficient data to calculate SQVs: *Hyalella azteca* 10-day mortality, *Chironomus* 10-day mortality, *Chironomus* 10-day growth, and Microtox® 15-minute luminescence bioassays. These endpoints were used for Phase II update of the AETs and development of alternative SQVs.

The Microtox® protocol has recently undergone revision and finalization. In particular, the handling of "overluminescence," or values greater than 100% of the initial control luminescence, was finalized during this project. Phase II interpretation guidelines were revised in accordance with the final 2003 protocol, as follows:

- A certain amount of luminescence greater than 100% is considered normal variation and within the acceptable range. A 10% threshold was set, to be consistent with the level below which mortality and reduction in luminescence is not considered significant. Therefore, mean values of the normalized control, reference, or test sample between 100% and 110% are considered normal. Mean values greater than 110% will be considered a QA failure in the case of a control or reference sample, and uninterpretable in the case of a test sample.

- Similarly, values of Test/Reference (T/R) or Test/Control (T/C) between 100% and 110% will be treated as a no-hit result. Values of T/R or T/C greater than 110% will be considered uninterpretable. Enhancement in luminescence greater than 110% could theoretically be considered a hit or adverse effect, but no consensus has yet been reached on this issue.

The revisions to the Microtox® interpretation and quality assurance guidelines had not yet been programmed into the SEDQUAL bioassay statistical analysis tool at the time Phase II was being conducted, so these interpretations were performed by inspecting the results for each sample and making necessary corrections to the hit/no-hit interpretations in an Excel spreadsheet.

Comparison to Control vs. Reference. Based on the results of Phase I, there appears to be no reliability advantage to using a comparison to reference rather than a comparison to control, for this freshwater data set. Freshwater reference areas have not yet been standardized, and the variability of reference stations in the historical data set appears to overwhelm any theoretical advantage they may provide. In addition, many test stations do not have valid reference stations and would have to be excluded from the analysis if comparison to reference were used. Consequently, a comparison to control provides a much larger and more consistent data set to work with in calculating SQVs. Finally, all of the other national SQV sets that have been developed for freshwater have used a comparison to control. Therefore, it was decided to use comparison to control for Phase II derivation of SQVs.

This decision does not limit how individual regulatory programs may choose to interpret and use their bioassay data. It is expected that freshwater reference areas may be developed over time and standardized, and once this process is completed it may be possible to use a comparison to reference for future updates of the SQVs. However, it is likely that the process may be more difficult than in the marine environment because of the more heterogeneous nature of freshwater environments, and that there may not be valid reference areas for all freshwater sites.

Selection of Hit/No-Hit Criteria. For development of AETs, a sample was considered to be a hit if it was statistically different from the control. One minor exception to this interpretation guideline was introduced for mortality and luminescence bioassays, because many of these bioassays have become relatively well-controlled and show only minor variance in the control replicates. Thus, even very small differences can be statistically significant. For these bioassays, an observed effect was required to be both statistically significant and at least a 10% different from the control to be considered a hit. "Statistically significant" means a statistical difference from a control sample at an alpha level of 0.05. Data transformations, selection of null hypotheses, and statistical testing procedures are identical to those currently in use by Ecology and DMMP programs for marine sediment data (Michelsen and Shaw 1996, Fox et al. 1998).

The alternative approaches for calculating SQVs (optimal percentiles and floating percentiles) used the same three levels of effects evaluated in Phase I – statistical significance only (including the above modification), a level equivalent to the SQS, and a level equivalent to the CSL. For a detailed discussion of the derivation of these hit/no-hit interpretation guidelines, please see the Phase I report (SAIC and Avocet, 2002). Changes were made to the Microtox QA/QC interpretation guidelines, as described above and shown in Table 2-2 below. As noted above, when using the SEDQUAL Bioassay Statistical Analysis tool, the reference for all stations was set to the control.

Table 2-2. SQS and CSL Endpoints for Biological Tests

Test	QA Control	QA Reference	SQS	CSL
Hyalella azteca 10-day mortality	C ≤ 20%	R ≤ 25%	T – R > 10%	T – R > 25%
Chironomus tentans 10-day mortality	C ≤ 30%	R ≤ 30%	T – R > 10%	T – R > 25%
Chironomus tentans 10-day growth	CF ≥ 0.48 mg/ind	RF/CF ≥ 0.8	T/R < 0.8	T/R < 0.7
Microtox® decrease in luminescence	CF/CI ≥ 0.72, CF/CI ≤ 1.1	RF/CF ≥ 0.8, RF/CF ≤ 1.1	T/R < 0.85	T/R < 0.75

C = Control, CI = Control Initial, CF = Control Final
R = Reference, RF = Reference Final
T = Test Sample

AETs are developed for individual bioassays, and the lowest and second-lowest AETs can be used to set lower and upper regulatory levels. The alternative approaches work in a somewhat different manner, starting directly with the biological definitions of these various regulatory levels. This requires all bioassays at a station to be assessed in a combined, or "pooled," approach at each of the effects levels for which SQVs need to be derived. The SQS and CSL effects levels defined in Phase I were applied to the individual bioassay results for a station, and if any one bioassay at a station showed an observed effect, the station as a whole was considered to be a hit.

Selection of Final Analyte List. In Phase I, any detected chemical that was on one of the SQV lists was included in the reliability analysis. However, for development of SQVs, a minimum number of data points is required. To be as inclusive as possible, a minimum of 30 detected values was chosen as the lower limit for inclusion on the analyte list. For AETs, the list of chemicals with 30 detected values varies, because some test endpoints have more data than others. For calculation of alternative endpoints, chemicals were included if there was enough data for at least three of the four bioassays.

Analytes were also screened out for other reasons. Some analytes, such as iron, aluminum, and magnesium, were screened out because they are crustal elements and are naturally present in high concentrations. Certain conventional analytes, such as grain size parameters and acid-volatile sulfides, were screened out because they likewise are not considered contaminants. Others were derived quantities, such as dioxin TEQs. Finally, several chemicals and conventional parameters were screened out because the hit and no-hit distributions were statistically indistinguishable and the highest no-hit value was higher than the highest hit value (known as a "greater than" value in AET terminology). These included TOC, ammonia, sulfides, and phosphorus, as well as some chemicals that had not enough data for some bioassays and "greater than" values for others, such as beryllium, mono- and dibutyltin, DDE and DDD, di-n-butyl phthalate, benzoic acid, and carbazole.

Chemicals with not enough detected data to calculate SQVs include DDT and derivatives, along with essentially all other pesticides, herbicides, and biocides except TBT, PCB Aroclors other than 1254 and 1260, PCB congeners, dioxins/furans, and chlorinated phenols and benzenes. The lack of data for these chemicals is likely a combination of factors, including the possibility that many of these chemicals are simply not widespread in the areas surveyed so far, the lack of surveys in agricultural areas of the state, and a limited list of analytes in many older surveys. For areas of the state where these chemicals are important, their absence in this data set could result in a lack of sensitivity of the derived AETs and alternative SQVs, and site-specific bioassay testing is recommended.

The final list of chemicals for which a full set of SQVs were derived includes:

- **Metals:** Antimony, arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, and tributyltin

- **PAHs:** 2-Methylnaphthalene, acenaphthene, acenaphthylene, anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(ghi)perylene, chrysene, dibenz(ah)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene, pyrene, total benzofluoranthenes, LPAHs, HPAHs, and the molar sum of PAHs

- **Other Organic Chemicals:** Aroclor 1254, Aroclor 1260, total PCBs, bis(2-ethylhexyl) phthalate, butylbenzyl phthalate, dimethyl phthalate, di-n-octyl phthalate, and dibenzofuran

AETs were calculated for additional chemicals for some bioassay endpoints with sufficient data, including DDT and derivatives, 4-methylphenol, benzoic acid, beryllium, carbazole, monobutyltin, dibutyltin, di-n-butyl phthalate, phosphorus, retene, TOC, and sulfides. These chemicals were not retained for other SQVs because there were only enough data for some bioassays, and because some of these chemicals had "greater than" AETs and did not appear to be associated with toxicity in the data set.

Normalization and Summing. To date, evaluations of the reliability of dry weight-normalized SQVs vs. organic carbon-normalized SQVs has shown that the dry weight values have equal or better reliability than the organic carbon-normalized values (PSEP 1988, Ecology 1997). In addition, organic carbon normalization has created some confusion and difficulty in implementation that would be eliminated if dry weight SQVs were used. Therefore, it was decided to calculate Phase II SQVs on a dry weight normalized basis.

In the past, marine AETs have been available both for individual PAHs and for summed dry weight values such as LPAHs and HPAHs. In recent years, there has been a trend toward using summed values of PAHs in the development of SQVs, as this may better reflect their mode of action and additive toxicity (Swartz et al., 1995; EPA 2000). However, dry weight sums are not necessarily appropriate, as narcosis-based toxicity is additive on a molar basis. Dividing the dry weight concentrations by the molecular weight provides molar concentrations that can be summed to predict narcosis-based toxicity (Hermens et al., 1984; Hermens et al., 1985a,b; Deneer et al., 1988). Based on the potential for this approach to better reflect PAH toxicity, it was decided to calculated two sets of SQVs for each method, one using the existing approach of individual PAHs plus dry weight sums, and one using only the molar sum of PAHs. In the SQV set that used the molar sum of PAHs, the individual Aroclors were also summed into a single Total PCBs value.

2.2 Sediment Quality Value Calculations

Apparent Effects Thresholds. The derivation of AETs is described in detail in PSEP (1988), and the same general steps were followed in Phase II for each of the four bioassay endpoints, as described below and shown in Figure 2-1.

1. **Data Query.** The project database was queried to retrieve all the chemistry and bioassay data for stations at which that bioassay was conducted.

2. **Bioassay Statistical Analysis.** Using SEDQUAL's bioassay statistical analysis tool, the bioassay results for each station were compared to the quality assurance and hit/no-hit criteria listed above, and each station was designated as a hit, no-hit, or failed quality assurance. Those stations that failed quality assurance criteria were removed from the data set. In the case of the Microtox® bioassay, some quality assurance evaluations were conducted by hand subsequent to the BSA analysis, as discussed above.

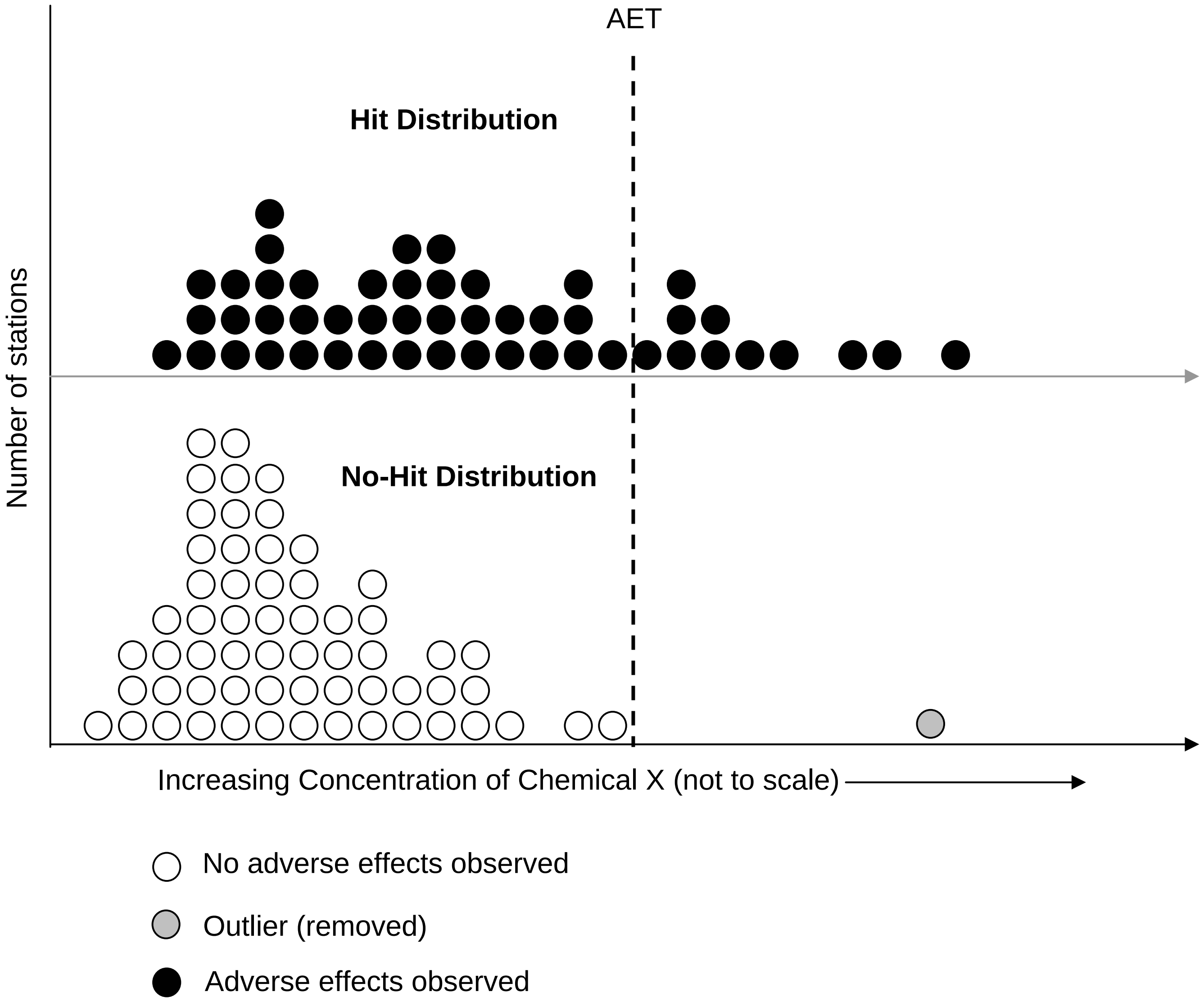
3. **Chemical Screening.** Analytes with less than 30 data points were screened out.

4. **Creation of Hit and No-Hit Distributions.** The chemistry data for each remaining analyte were then divided into hit and no-hit distributions, and ranked in order of increasing concentration for each of the distributions.

5. **Removal of Outliers.** The highest no-hit concentration was compared with the second highest no-hit concentration, and if it was more than three times higher, it was designated as an outlier and removed from the no-hit distribution. This could be done more than once; however, only in a few cases were two data points removed through this process, and never more than two.

6. **Identification of AET.** The highest remaining no-hit concentration was designated as the AET. If the highest remaining no-hit concentration for an analyte was higher than the highest hit concentration, then a greater than sign (>) was placed before the AET value to indicate that the actual AET may be higher than that value, or an AET may not exist for that chemical.

Figure 2-1. Calculation of Apparent Effects Thresholds (AETs)



Optimal Percentiles. In Ecology (1997), an alternative AET called the Probable Apparent Effects Threshold (PAET) was proposed, which was the 95th percentile of the no-hit distribution, without outliers removed. This approach was suggested as a possible alternative to removal of outliers. As part of Phase II, this idea was further explored by evaluating all possible percentiles of the hit and no-hit distribution, to see which ones provided the best reliability with this data set. The procedure used was as follows:

- **Creation of Hit and No-Hit Distributions.** Hit and no-hit distributions were created for each analyte following the same procedures outlined above. Outliers were not removed from the distributions.

- **Calculation of Percentiles.** Percentiles of the hit and the no-hit distributions were calculated for each analyte in an Excel spreadsheet, ranging from one to one hundred, in increments of one. The results were arranged with analytes in columns and percentiles in rows. This resulted in 200 possible percentiles and associated chemical concentrations that could be selected as candidate SQV sets.

- **Reliability Analysis.** Each percentile row was then treated as if it were a set of SQVs, and all six reliability parameters were calculated for each row, as described in Section 2.3.

- **Identification of Optimal Percentiles.** An Excel macro was used to search the reliability results for the best-performing percentiles, corresponding to various false negative rates that the agency might choose. Target false negative rates were chosen from 5% to 25%, in increments of 5%. For each target false negative rate, the macro searched the percentile rows for the one that had a false negative rate closest to the target and the lowest false positive rate, giving the greatest overall reliability. Using this method, Ecology can select any target false negative rate, and find the percentile choice that provides the most efficient set of SQVs that meet that target. Selecting multiple false negative rates and comparing the results allows examination of the trade-offs in efficiency and overall reliability that occur as the false negative rate is varied.

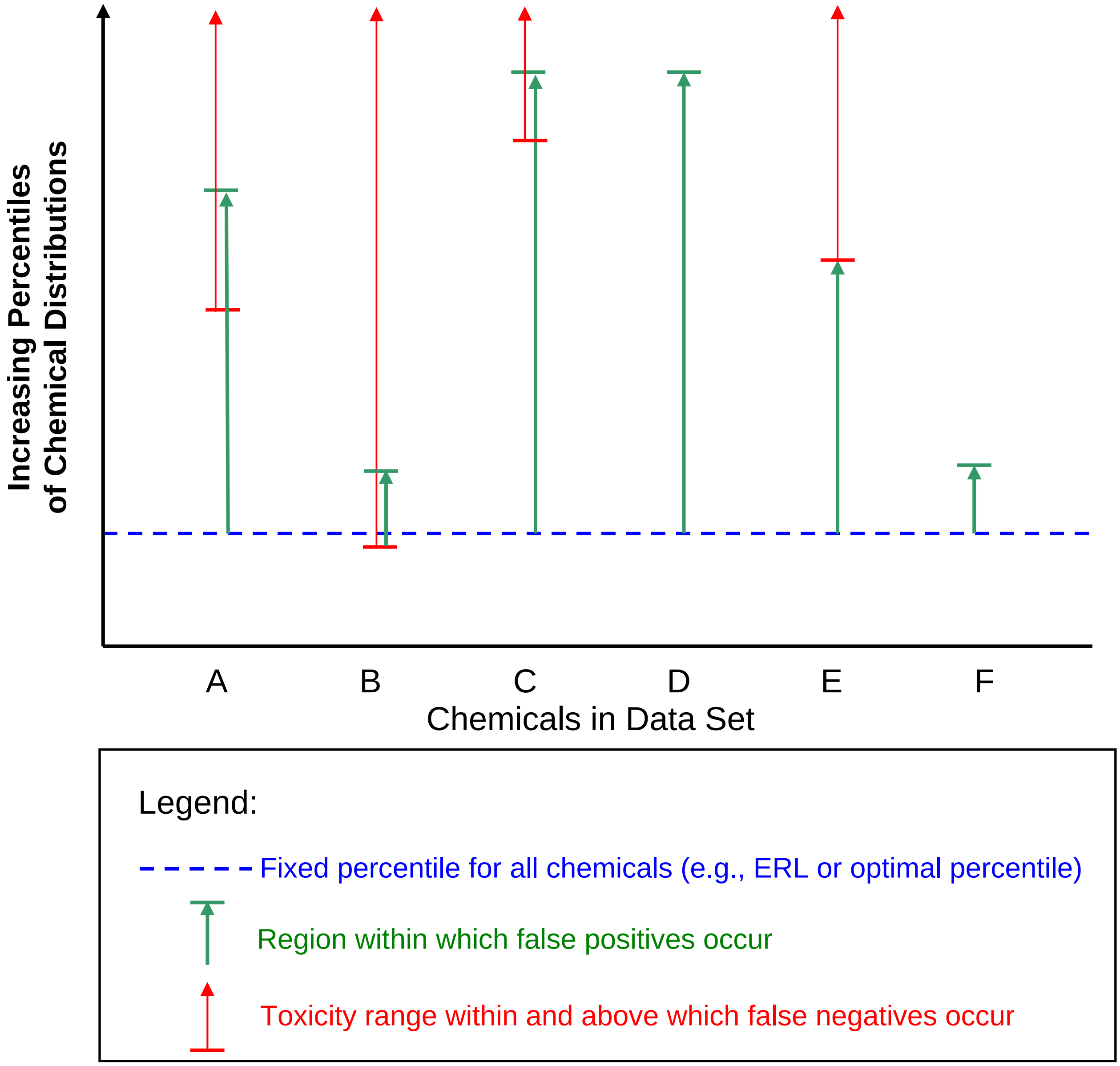
This approach allows for the possibility that percentiles of either the hit or the no-hit distribution may have the best combination of error rates, and does not distinguish between the two on theoretical grounds. However, for this data set, percentiles of the no-hit distribution were as good or better than the hit distribution (within a percentage or two). Use of the no-hit distribution is more consistent with how AETs have been developed, as well as previous alternatives to AETs suggested by Ecology (1997), such as PAETs. Therefore, only the no-hit distribution was used in the final analysis.

Error Rate Minimization Techniques. A significant percentage of the error in the methods described above and in currently available SQV sets is related to the use of a single percentile of the distribution to set the criterion for all chemicals (Michelsen 1999). Because all chemicals do not contribute equally to toxicity in a data set, this oversimplification results in substantial mathematical error.

To improve on these approaches, a new method of calculating SQVs was developed that does not require the SQVs to be based on the same percentile of the hit or no-hit distribution for all chemicals. This method, known as the Floating Percentile method, substantially improves false negative and false positive error rates for the freshwater data set over existing approaches, and results in guidelines that are reasonably protective without being over-conservative.

The basic concept behind the Floating Percentile method (Figure 2-2) is to select an optimal percentile of the data set that provides a low false negative rate (as described above), then adjust individual chemical concentrations upward until false positive rates are decreased to their lowest possible level while retaining the same false negative rate. The Y axis in Figure 2-2 is the percentile of each chemical's overall distribution and is not linearly related to toxicity. The green bar shows the concentration range within which toxicity does not occur, and the red bar shows the range within which toxicity occurs. These ranges may overlap due to site-specific or sample-specific variations in bioavailability or toxicity.

Figure 2-2. Floating Percentile Method



First, a constant percentile of the distribution that results in a low false negative rate (similar to an ERL) is initially selected for all chemicals, represented by the blue dashed line. The difference between this constant percentile and the lower end of the toxicity range for each chemical is the area between the blue line and the red bar, and this is the source of most of the false positive errors.

The second step is to determine which chemicals are associated with false positive errors in the data set and adjust those SQVs upward until the lower end of their toxicity ranges are reached (red bar). Above this point, false negatives will begin to increase. Above the red bar, both false negatives and false positives may occur, as is shown for Chemicals A, B, and C. This region is the range of concentrations over which site-specific bioavailability plays an important role in toxicity, and therefore hit and no-hit samples are mixed together, causing both types of errors.

In Figure 2-2, Chemical B’s concentration cannot be raised at all, because it is already within its toxic concentration range. In any data set, a few chemicals will already be at a toxic level, giving rise to the low percentage of false negatives that the blue line represents. Some chemicals may show a sharper toxicity threshold, such as Chemical E. Others may not appear to be related to toxicity in the data set at all, as shown by Chemicals D and F. These chemical concentrations can be raised to their maximum percentile without any observed increase in toxicity. However, it may be safer in practice to raise them only to the point where false positives no longer occur (represented by the green bar) or to a similar endpoint such as AETs.

Once each chemical has been individually adjusted upward to the lower end of its toxicity range, the false positives will have been significantly reduced while retaining the same low false negative rate. Most chemicals should be at or near their actual toxicity range, rather than a level arbitrarily assigned by a fixed percentile. In this manner, optimized criteria sets can be developed for a number of different target false negative rates, allowing the trade-offs between false negatives and false positive to be evaluated and a final set of SQVs to be selected.

In summary, the steps required to calculate SQVs using this approach include:

- Select toxicity tests and endpoints
- Compile synoptic chemistry/bioassay data
- Assign hit/no-hit status
- Screen data and develop chemical distributions
- Select a range of target false negative rates and identify associated optimal percentile values
- Adjust percentiles for individual chemicals upward to reduce false positives

Optimization of chemical concentrations occurs in two steps, an iterative automated step using Excel macros, and a hand-optimization step to address covariance and other issues that cannot be satisfactorily resolved by the macros alone. The Excel macro uses the following approach to conduct the initial optimization:

1. An appropriate incremental increase for testing is calculated for each analyte based on that analyte's complete concentration range (e.g., 1/10 of the difference between the highest and lowest concentration).

2. The number of false positives contributed by each individual analyte is calculated, and the chemical contributing the most false positives is selected to begin the optimization procedure.

3. The concentration for that analyte is increased by the chosen increment.

4. After each incremental increase, false negative and false positive rates are recalculated for the entire SQV set.

5. If the false negative rate increases, the chemical concentration is adjusted back down to its previous level and that chemical is "locked in" at that level.

6. If the false positive rate is reduced to zero, the chemical concentration is locked in at that level.

7. If either of the above two conditions is met, that chemical is completed and the macro moves on to the chemical with the next highest number of false positives. If neither criterion is met, the macro raises the concentration by another increment and repeats steps 4-7.

8. Incremental increases and recalculations continue until every chemical has reached its toxicity threshold or a level at which it has no more false positives.

Through this process, it is possible to identify those analytes having the greatest influence on toxicity in the data set (those whose concentrations cannot be increased without increasing false negatives), and those chemicals having little or no influence on toxicity in the data set (those that can be increased to their highest concentrations with no effect on error rates).

Inspection of the results of the automated process, particularly when various starting percentiles are chosen, also indicates analytes (often metals) with a high covariance in the data set. It may also become apparent that other chemicals, such as PAHs, have relatively little effect individually, but may act in an additive manner to cause toxicity. Because the automated process treats each chemical as acting independently in the data set, this can cause variation in the results depending on the starting values that are chosen, if covariance or additive effects are pronounced in the data set, as was true for this freshwater data set. This effect must be addressed through a final optimization step, requiring judgment on the part of the SQV developer to select the most appropriate values.

The spreadsheets used to develop the SQVs provide a test area, where candidate SQV sets may be adjusted and finalized, and the results of each change tested with respect to all the reliability parameters (this area also allows the operator to enter any criteria set of their choice and test its reliability against the regional data set). The following guidelines were followed in finalizing the criteria sets:

- The resulting SQV sets should be internally consistent within the same hit/no-hit definition. Specifically, chemical concentrations should increase or stay the same as the false negative rate increases and the false positive rate decreases. Developing candidate SQV sets for multiple increasing false negative rates (e.g., 5-25%, in increments of 5%) allows this criterion to be used most effectively.

- The resulting SQV sets should be consistent across different hit/no-hit definitions. Specifically, chemical concentrations should increase as the adverse effects level increases. Using more than two hit/no-hit definitions allows this criterion to be used most effectively.

- The resulting SQV sets should be consistent with toxicological information. For example, metals concentrations should be within the range shown to be toxic in national literature. PAH values should be consistent with narcosis theory. Relative concentrations within chemical classes should be similar to those observed in other data sets and in toxicological literature. Concentrations should not be below regional background concentrations.

- The resulting SQV sets should have equal or better reliability than those produced by the automated macros and all other available methods.

Following each of these guidelines ensures that any anomalies produced by covariance or other interactions between chemicals in the data set are removed and addressed in a scientifically defensible manner.

2.3 Reliability Analysis

Reliability analysis was conducted following the derivation of the AETs, to evaluate their predictive accuracy when used with the regional data set. In addition, reliability analysis was used to select optimal percentiles that could be used as an alternative to AETs, and is an integral part of the iterative process used to calculate the Floating Percentile SQVs. In all three cases, the same measures of reliability were used, listed below. These same measures were used in Phase I to evaluate the reliability of existing SQV sets in North America (SAIC and Avocet, 2002).

- **False Negatives:** hits predicted as no-hits/total number of hits
- **False Positives:** no-hits predicted as hits/total number of no-hits
- **Sensitivity:** hits correctly predicted/total number of hits (100% - % false negatives)
- **2002 Efficiency:** no-hits correctly predicted/total number of no-hits (100% - % false positives)
- **1988 Efficiency:** correctly predicted hits/total predicted hits
- **Reliability:** correct predictions/total stations

False positives and false negatives are the primary measure of predictive errors in the reliability assessment. Each of the other reliability values is related to them in some way. Most of these values can be compared across data sets and SQV types. However, because the denominator of the 1988 efficiency measure varies by SQV set and is not constant with respect to the data set, this measure cannot be compared across SQV sets, or against the results of 1997 freshwater AETs.

2.4 Sensitivity Analysis

The processes described above, especially the automated and hand-optimized iterative processes, provide a great deal of insight into the sensitivity of the results to variations in approaches, initial assumptions and starting conditions, and relationships between analytes in the data set. Additional sensitivity analysis was conducted by comparing side-by-side spreadsheets for individual PAHs and Aroclors vs. summed PAHs and Aroclors, to evaluate the effect of summing certain chemical classes on reliability. In addition, the relative importance of each individual analyte was assessed by dropping out that analyte and noting any changes to reliability of the SQV set. This allows an evaluation of which analytes are critical to include in the SQV set, which are of lesser importance, and which may not be needed at all.

3.0 RESULTS

3.1 Final Data Set

The number and types of bioassay endpoints in the final data set is shown in Table 3-1, comprising 901 distinct sample/test combinations. Tables 3-1 and 3-2 do not include samples that failed quality assurance requirements.

Table 3-1. Bioassays and Endpoints in Final Data Set

Test	No. of Samples
Hyalella azteca 10-day mortality	381
Chironomus tentans 10-day mortality	238
Chironomus tentans 10-day growth	179
Microtox® decrease in luminescence	103

These samples are associated with 319 stations having various combinations of bioassays at each station. Table 3-2 shows the number and percentage of stations associated with biological hits for each effects level.

Table 3-2. Biological Hits at Each Effects Level

Effects Level	Biological Hits Number (Percent)
Statistical significance Comparison to control	204 (64%)
SQS[a] Comparison to control	192 (60%)
CSL[a] Comparison to control	129 (40%)

[a]See Table 2-2 for SQS and CSL definitions

From Table 3-2, it can be seen that there is not a great deal of difference between the statistical significance-only and the SQS comparison. This may be because the SQS levels were chosen based on power analyses reported in ASTM (2000), and are close to the minimum detectable differences that would be expected in these bioassays. Also, there is a good balance between hits and no-hits, so that the data set and reliability measures are not skewed or dominated by one or the other. When developing SQVs, it is helpful to have a balanced data set between toxic and non-toxic samples, so that the distributions are more likely to contain the actual toxicity thresholds and the thresholds are less likely to be located within the tails of the distributions.

3.2 2003 Apparent Effects Thresholds

2003 Apparent Effects Thresholds for four bioassay endpoints are listed in Table 3-3, along with a comparison to the 1997 AETs. Lowest AETs (LAETs) and second-lowest AETs (2LAETs) are also shown, since in the marine program, these have been used as the SQS and CSL standards, respectively. The chemical distributions used in calculating the 2003 AETs are provided in Appendix B.

Table 3-3. 2003 Apparent Effects Thresholds

Analyte	Hyalella Mortality	Chironomus Growth	Chironomus Mortality	Microtox® Lumin.	2003 LAET	2003 2LAET	1997 AET Microtox®	1997 AET Hyalella
Antimony	**4.4**	0.6	1.9	> 5.1	0.6	1.9	3	64
Arsenic	200	**31.4**	**50.9**	**123**	31.4	50.9	40	150
Beryllium	> 2	--	0.46	--	0.46	--	--	--
Cadmium	9.1	> 5.6	**2.39**	**2.9**	2.39	2.9	7.6	12
Chromium	> 348	133	133	**95**	95	133	--	280
Copper	2010	**829**	**619**	1460	619	829	--	840
Lead	> 1310	1160	**335**	**431**	335	431	260	720
Mercury	3.74	3.04	**0.8**	3.04	0.8	3.04	0.56	2.7
Nickel	113	113	113	**53.1**	53.1	113	46	--
Silver	3.5	> 3.3	> 3.3	**0.545**	0.545	3.5	--	4.5
Zinc	> 4150	**1080**	**683**	**1130**	683	1080	520	3200
Monobutyltin	> 4850	--	**98**	**459**	98	459	--	--
Dibutyltin	> 1930	--	**96**	--	96	--	--	--
Tributyltin	> 15700	6650	**260**	--	260	6650	--	--
2-Methylnaphthalene	**710**	1770	**555**	**469**	469	555	--	--
Acenaphthene	**7420**	**1320**	**6290**	**1060**	1060	1320	4100	100000
Acenaphthylene	**1020**	1260	**470**	**640**	470	640	2200	2600
Anthracene	**16200**	**1580**	**1900**	**1230**	1230	1580	2800	41000
Benz(a)anthracene	**44000**	**11000**	**5800**	**4260**	4260	5800	7700	33000
Benzo(a)pyrene	**55000**	**14000**	**3300**	4810	3300	4810	11000	25000
Benzo(bk)fluoranthenes	**79000**	**19900**	**13800**	11000	11000	13800	16000	34000
Benzo(ghi)perylene	**12100**	**11000**	**5200**	4020	4020	5200	1400	21000
Chrysene	**46000**	**11000**	**6400**	5940	5940	6400	11000	39000
Dibenz(ah)anthracene	**3070**	2600	**800**	839	800	839	230	3500
Fluoranthene	**46100**	**15000**	**16700**	**11100**	11100	15000	21000	130000
Fluorene	**6970**	**3850**	**3890**	**1070**	1070	3850	4200	96000
Indeno(123-cd)pyrene	**18000**	**18000**	**5300**	4120	4120	5300	760	15000
Naphthalene	**5630**	4970	**529**	**1310**	529	1310	46000	140000
Phenanthrene	**41100**	**7570**	**8950**	**6100**	6100	7570	15000	210000
Pyrene	**68000**	**16000**	**18000**	**8790**	8790	16000	23000	85000
LPAHs	**78300**	41970	**6590**	**9200**	6590	9200	74000	440000
HPAHs	**471000**	**120500**	**31640**	**54800**	31640	54800	91000	310000
4-Methylphenol	2360	--	**760**	--	760	2360	--	--
Benzoic Acid	3790	--	**2910**	--	2910	3790	--	--
Bis(2-ethylhexyl)phthalate	22300	**6380**	**7590**	**2520**	2520	6380	750	--

Analyte	**Hyalella Mortality**	**Chironomus Growth**	**Chironomus Mortality**	**Microtox® Lumin.**	**2003 LAET**	**2003 2LAET**	**1997 AET Microtox®**	**1997 AET Hyalella**
Butylbenzyl phthalate	> 1520	366	980	**260**	260	366	--	--
Dimethyl phthalate	436	> 576	**311**	436	311	436	--	--
Di-n-butyl phthalate	> 1740	> 1740	**103**	> 1740	103	--	--	43
Di-n-octyl phthalate	**201**	399	256	11	11	201	--	--
Carbazole	**923**	--	--	--	923	--	140	1800
Dibenzofuran	**660**	**1010**	**443**	**399**	399	443	--	32000
Retene	**6020**	--	--	--	6020	--	--	--
4,4-DDD	96	--	> 96	--	96	--	--	--
4,4-DDE	21	--	> 20	--	21	--	--	--
4,4-DDT	**19**	--	--	--	19	--	--	--
Aroclor 1254	> 1060	294	340	**230**	230	294	7.3	350
Aroclor 1260	500	**138**	**184**	140	138	140	--	--
Total PCBs	2090	394	**354**	62	62	354	21	820
Phosphorus	> 3290	--	> 3290	--	--	--	--	--
Sulfides	941	--	702	--	702	941	130	920
Total Organic Carbon	> 25	> 21.3	**9.82**	> 21.3	9.82	--	14	25

Units: Metals and nutrients in mg/kg, organics in µg/kg, butyltins in µg/kg ion, TOC in percent
Bold: High-confidence AETs
Non-Bold: Lower-confidence AETs

One thing to note is that not all AETs have the same degree of confidence. An AET was considered a lower-confidence AET if any of the conditions below apply:

- The AET is a "greater than" value
- The AET has only one or two hit values above it
- The AET was developed from a no-hit distribution of less than three values

In the table above, PAHs have an average of three high-confidence AETs, the highest percentage of any chemical class. Metals averaged two high-confidence AETs and two lower-confidence AETs. Organic chemicals other than PAHs tended to have fewer AETs overall and closer to 75% low-confidence AETs. The number of AETs is an indication of how often that chemical was analyzed for and/or detected in the surveys, while the percentage of high-confidence AETs tends to be a measure of natural variability in the data with respect to bioavailability, as well as the possible lack of toxicity thresholds for some chemicals within their concentration distributions.

The 2003 AETs as a whole are a clear improvement over the 1997 AETs in several ways. First, two additional endpoints have been added for *Chironomus.* These AETs are generally between the *Hyalella* and Microtox® AETs in sensitivity, providing a more complete distribution of bioassay sensitivities. Also, the *Hyalella* and Microtox® AETs have been strengthened by removal of the anomalous MBCREOS1 and MBCREOS2 surveys, as well as a number of other older data sets with very few replicates and out-of-date protocols. The addition of many newer surveys to these biological data sets has allowed calculation of more robust AET values. It is interesting to note that the result in most cases is to decrease many of the *Hyalella* AETs and increase some of the Microtox® AETs, which together with the *Chironomus* AETs, creates a more consistent set of AETs for each chemical.

The reliability of the 2003 AETs is shown in Table 3-4. The reliability of each of the bioassay-specific AETs was assessed only against that bioassay's data set, while the reliability of the LAET was assessed against the pooled data set at the SQS effects level, and the reliability of the 2LAET was assessed against the pooled data set at the CSL effects level. In each case, the reliability of the AETs was assessed as a complete set of AETs, rather than by individual chemical.

Table 3-4. Reliability of 2003 Apparent Effects Thresholds

Measure of Reliability (%)	**Hyalella Mortality**	**Chironomus Growth**	**Chironomus Mortality**	**Microtox® Lumin.**	**2003 LAET**	**2003 2LAET**
False Negatives	78	33	60	19	35	57
False Positives	2	4	2	14	11	6
Sensitivity	22	67	40	81	65	43
2003 Efficiency	98	96	98	86	89	94
1988 Efficiency	88	83	93	94	93	87
Overall Reliability	67	91	75	83	73	69

The first four columns represent the reliability of each set of AETs in representing the bioassay data from which they were derived. In other words, how well do the chemical criteria actually do in predicting hits within their own data set? Here it can be seen that the AETs for the two mortality tests are the least accurate at predicting hits and the least sensitive, while the error rates for the subchronic endpoints are lower and more sensitive. The Microtox® AETs are the best at predicting hits in the data set from which they were derived, and have both low false negative and low false positive rates. This could be because variations in bioavailability are relatively well controlled in the Microtox® test – the pH, oxygenation, alkalinity, and salinity of the water in which the test is conducted is carefully controlled. This could tend to buffer natural variations in bioavailability, especially in metals, much as is the case in marine water and sediments. As can be seen from a close inspection of the Microtox® data, the variability among replicates for this test is far lower than for any of the other bioassays.

The relatively poor performance of the AETs for mortality endpoints is difficult to explain, unless it is related to the fact that these are older tests, and the existing historical database may contain surveys run under varying conditions, with organisms from varying sources. The variation among replicates in these tests is typically not very high, especially compared to a growth test, and there are typically no significant quality assurance problems with these tests. Therefore, the relative inability of the highest no-hit value to accurately predict hits within the mortality data sets must be related either to greater susceptibility of this endpoint to natural variations in bioavailability, or to laboratory variations within the historical data set.

The LAET has a reasonably low error rate compared to the individual bioassay AETs or the 2LAET. AETs are meant to be used in a pooled manner, with the LAET as a regulatory threshold, so these reliability values are more relevant than those for the individual bioassays. However, SQS is narratively defined as a level below which adverse effects are not observed, and the false negative error rates associated with the LAET (35%) may not meet that narrative goal. In addition, the errors tend to be weighted toward more false negatives than false positives, which may not be appropriate for a lower screening level.

Similarly, the 2LAET may have more false negatives than would be desirable at that level. The CSL is intended as a level below which only minor adverse effects would occur, and above which more significant adverse effects are expected. Keeping in mind that the reliability calculations for the 2LAET were conducted against a biological CSL definition, the 2LAET failed to identify 57% of the hit stations even at this higher level of adverse effects. On the other hand, the 2LAET has very high efficiency, and above this level, one could be nearly certain that adverse effects would occur and there would be little value in conducting biological testing. Therefore, it could be useful as an ML in the dredging program, or a hot spot or early action level in the cleanup program.

The sensitivities of the LAET and the 2LAET are surprisingly low, considering the proven success and protectiveness of these levels when used as the SQS and CSL in marine sediment programs. This is very likely due to the greater heterogeneity of freshwater environments, and the variation in bioavailability of metals (in particular) in these environments. In marine systems, water and sediments are fairly well buffered, and one would expect metals toxicity thresholds to be roughly the same in most areas. However, toxicity thresholds for metals may vary greatly in freshwater, resulting in some no-hit values that are higher than toxicity thresholds for the same metal in other areas. It is possible that this approach would have more success if the freshwater data set were stratified by ecoregion or geochemical environment, and AETs calculated for each region.

For state-wide SQVs, the highest no-hit value may not be protective of all areas of the state, whereas the same would not be expected in the marine environment. This conclusion is supported by the Floating Percentile calculations (see Section 3.4), which indicate that the AETs for PAHs are appropriate, but the AETs for many metals are too high. Lowering certain metals' SQVs improves the sensitivity without a loss of efficiency.

3.3 Optimal Percentiles

As an alternative to AETs, the hit and no-hit distributions were evaluated to identify percentiles with a higher sensitivity, with efficiency also as high as possible. False negative rates of 5, 10, 15, 20, and 25% (sensitivity of 75-95%) were chosen as the target levels. Tables 3-5, 3-6, and 3-7 show the optimal percentiles and their associated reliability for each of these target levels, and for each of the adverse effects definitions being evaluated (statistical significance only, SQS, and CSL).

Although percentiles of the hit distribution were evaluated, in each case they were equal to or less reliable than percentiles of the no-hit distribution, within ± one percent. Therefore, in each case, the optimal percentile is that percentile of the no-hit distribution that comes closest to (without exceeding) the target false negative rate, and has the lowest false positive rate of the percentiles that meet the target false negative rate. Appendix C provides tables of the chemical concentrations associated with the 15 sets of optimal percentiles.

In the tables below, the first number in each pair is from the spreadsheets in which individual PAHs and Aroclors were retained, and the second number is from the spreadsheets in which individual PAHs and Aroclors were summed.

Table 3-5. Optimal Percentiles for Statistical Significance Only Effects Level

Measure of Reliability (%)	**95% Sensitivity**	**90% Sensitivity**	**85% Sensitivity**	**80% Sensitivity**	**75% Sensitivity**
Optimal Percentile	51st / 51st	66th / 66th	77th / 71st	83rd / 81st	90th / 88th
False Negatives	5 / 5	10 / 10	15 / 14	19 / 19	25 / 25
False Positives	70 / 68	54 / 50	42 / 43	37 / 34	26 / 22
Sensitivity	95 / 95	90 / 90	85 / 86	81 / 81	75 / 75
2003 Efficiency	30 / 32	46 / 50	58 / 57	63 / 66	74 / 78
1988 Efficiency	78 / 79	82 / 83	84 / 84	85 / 86	89 / 90
Overall Reliability	77 / 78	78 / 79	78 / 78	76 / 77	75 / 76

Table 3-6. Optimal Percentiles for the SQS Effects Level

Measure of Reliability (%)	**95% Sensitivity**	**90% Sensitivity**	**85% Sensitivity**	**80% Sensitivity**	**75% Sensitivity**
Optimal Percentile	52nd / 52nd	67th / 66th	78th / 71st	83rd / 81st	91st / 88th
False Negatives	5 / 5	10 / 10	15 / 15	20 / 20	24 / 25
False Positives	69 / 68	51 / 51	42 / 44	35 / 32	24 / 24
Sensitivity	95 / 95	90 / 90	85 / 85	80 / 80	76 / 75
2003 Efficiency	31 / 32	49 / 49	58 / 56	65 / 68	76 / 76
1988 Efficiency	76 / 76	80 / 80	82 / 82	84 / 85	88 / 88
Overall Reliability	76 / 76	78 / 78	77 / 77	76 / 76	76 / 75

Table 3-7. Optimal Percentiles for the CSL Effects Level

Measure of Reliability (%)	**95% Sensitivity**	**90% Sensitivity**	**85% Sensitivity**	**80% Sensitivity**	**75% Sensitivity**
Optimal Percentile	63rd / 63rd	65th / 65th	72nd /72nd	77th / 76th	82nd / 80th
False Negatives	5 / 5	9 / 10	13 / 15	20 / 19	25 / 25
False Positives	59 / 57	57 / 54	50 / 48	43 / 43	37 / 38
Sensitivity	95 / 95	91 / 90	87 / 85	80 / 81	75 / 25
2003 Efficiency	41 / 43	43 / 46	50 / 52	57 / 57	63 / 62
1988 Efficiency	62 / 62	62 / 62	63 / 64	65 / 65	67 / 66
Overall Reliability	68 / 69	67 / 68	68 / 69	68 / 69	69 / 69

It is important to keep in mind when reviewing these numbers that the hit and no-hit distributions are not the same for each effects level. Each hit and no-hit distribution is created by applying a different level of biological effects to the overall data set. Nevertheless, the results for the statistical significance only and the SQS adverse effects levels are quite similar, as are the distributions created by these two biological effects definitions, for the reasons discussed in Section 3.2.

From these tables, it can be seen that the optimal percentiles for reasonably sensitive SQVs would be somewhere in the range of the 50th to the 90th percentile of the no-hit distribution, or for the CSL level, a somewhat smaller range of the 60th to the 80th percentile. The individual and summed versions perform almost identically, suggesting that the summed distributions are reasonably representative and could be used in place of the individual distributions for PAHs and PCBs.

False positive error rates are still quite high until the 80% and 75% sensitivity levels are reached, at which point there begins to be more balance. Ideally, a set of SQVs could be developed in the higher sensitivity ranges with lower false positive rates. To develop such SQVs, these optimal percentiles were used as starting points for the Floating Percentile optimization process, discussed in Section 3.4 below.

3.4 Floating Percentile SQVs

Using the process described in Section 2.2, SQV sets were derived with optimized sensitivity and efficiency, shown in Tables 3-8 through 3-10 below. As in the previous section, these tables show results for five different choices of false negative rates, at three different effects levels – statistical difference from control, an effects level equivalent to the SQS, and an effects level equivalent to the CSL (see Table 2-2 for details of these biological effects levels).

In the tables below, the first number of each pair provides results for the SQV sets with individual PAHs and Aroclors, and the second number shows results for the SQV sets with summed PAHs and Aroclors.

Table 3-8. Floating Percentile Results for Statistical Significance Only Effects Level

Measure of Reliability (%)	**95% Sensitivity**	**90% Sensitivity**	**85% Sensitivity**	**80% Sensitivity**	**75% Sensitivity**
False Negatives	4 / 5	10 / 10	15 / 15	20 / 20	25 / 25
False Positives	55 / 57	39 / 42	26 / 33	20 / 28	16 / 24
Sensitivity	96 / 95	90 / 90	85 / 85	80 / 80	75 / 75
2003 Efficiency	45 / 43	61 / 58	74 / 67	80 / 72	84 / 76
1988 Efficiency	82 / 82	86 / 85	89 / 85	92 / 89	93 / 89
Overall Reliability	82 / 81	82 / 81	82 / 81	81 / 78	78 / 75

Table 3-9. Floating Percentile Results for the SQS Effects Level

Measure of Reliability (%)	**95% Sensitivity**	**90% Sensitivity**	**85% Sensitivity**	**80% Sensitivity**	**75% Sensitivity**
False Negatives	5 / 5	10 / 10	15 / 15	20 / 20	25 / 25
False Positives	57 / 55	44 / 45	26 / 33	20 / 26	15 / 23
Sensitivity	95 / 95	90 / 90	85 / 85	80 / 80	75 / 75
2003 Efficiency	43 / 45	56 / 55	74 / 67	80 / 74	85 / 77
1988 Efficiency	79 / 80	82 / 82	88 / 85	90 / 87	92 / 88
Overall Reliability	80 / 80	80 / 80	82 / 80	80 / 78	78 / 76

Table 3-10. Floating Percentile Results for the CSL Effects Level

Measure of Reliability (%)	95% Sensitivity	90% Sensitivity	85% Sensitivity	80% Sensitivity	75% Sensitivity
False Negatives	5 / 5	10 / 10	15 / 15	20 / 20	25 / 25
False Positives	50 / 50	37 / 44	26 / 24	23 / 17	21 / 16
Sensitivity	95 / 95	90 / 90	85 / 85	80 / 80	75 / 75
2003 Efficiency	50 / 50	63 / 56	74 / 76	77 / 83	79 / 84
1988 Efficiency	66 / 65	71 / 67	76 / 78	77 / 82	78 / 83
Overall Reliability	73 / 72	77 / 73	80 / 81	79 / 82	78 / 80

This process results in an overall lowering of the false positive rates associated with each level of sensitivity, which in turn allows selection of SQVs with higher sensitivity, in the 90-80% range (for example). Comparison of the unsummed values with the summed values indicates that summing the PAHs and Aroclors gives mixed results. At lower effects levels, this approach tends to result in slightly less reliable SQVs, while at higher effects levels the balance shifts toward slightly greater reliability in the 85% to 75% sensitivity range.

This approach provides a range of options for Ecology to choose among in setting SQS and CSL-equivalent levels for use in Ecology's sediment management programs, depending on the level of protectiveness desired, the level of errors that are considered acceptable, and whether or not a summing approach is utilized. Tables showing chemical concentrations associated with each of the 30 options explored above are included in Appendix D. One example of a set of SQS and CSL guidelines that could be selected is shown in Table 3-11 below, using SQS and CSL effects levels, the mid-point of the sensitivity options above (85%), and individual PAHs. This example is associated with 15% false negatives, approximately 25% false positives, and better than 80% overall accuracy. ***This example is provided for discussion purposes only – final SQVs will be selected by Ecology and may differ from the values shown.***

Table 3-11. Example SQS and CLS Values Based on Floating Percentile Approach

Analyte	SQS	CSL
Antimony	0.4	0.6
Arsenic	20	51
Cadmium	0.6	1.0
Chromium	95	100
Copper	80	830
Lead	335	430
Mercury	0.50	0.75
Nickel	60	70
Silver	2.0	2.5
Zinc	140	160
Tributyltin	75	75
2-Methylnaphthalene	470	560
Acenaphthene	1060	1320
Acenaphthylene	470	640

Analyte	**SQS**	**CSL**
Anthracene	1200	1580
Benz(a)anthracene	4260	5800
Benzo(a)pyrene	3300	4810
Benzo(bk)fluoranthenes	11000	14000
Benzo(ghi)perylene	4020	5200
Chrysene	5940	6400
Dibenz(ah)anthracene	800	840
Fluoranthene	11000	15000
Fluorene	1000	3000
Indeno(123-cd)pyrene	4120	5300
Naphthalene	500	1310
Phenanthrene	6100	7600
Pyrene	8800	16000
LPAHs	6600	9200
HPAHs	31000	54800
Bis(2-ethylhexyl)phthalate	230	320
Butylbenzyl phthalate	260	370
Dimethyl phthalate	46	440
Di-n-octyl phthalate	26	45
Dibenzofuran	400	440
Total PCBs	60	120

Units: Metals in mg/kg, organics in µg/kg, butyltins in µg/kg ion

One immediately apparent attribute of this set of SQVs is that the metals are relatively low, while the PAHs are relatively high. Some of the metals concentrations fall as low as those of other North American SQV sets, such as TELs, while most of the PAH concentrations are much higher, similar to AETs in concentration. For the most part, the metals values shown here could not be raised at all without increases (in some cases dramatic) in the false negative rates, indicating that metals are toxic at these low levels in freshwater environments, at least in some forms and environments where they are more bioavailable. There may also be sites where metals are not toxic at these levels, indicating natural variability in substrate and environment, as well as variability in the form of the metal (e.g., grit particles vs. more soluble forms).

The individual PAH values did not affect toxicity in this data set to any great degree, and each one could be raised to its highest concentration (or eliminated from the data set altogether) without any impact on any of the reliability measures. This is a result of the PAHs all covarying to a strong degree. In order to address this issue and provide a measure of safety, PAH and other organic chemicals' SQVs were not allowed to rise above the LAET for SQS values or the 2LAET for CSL values.

3.5 Sensitivity Analysis

Once all of the above steps had been completed, individual chemicals (and groups of chemicals) were dropped out of the spreadsheets to identify those that had a strong influence on toxicity and error rates in the data set, and those that do not appear to affect the predictiveness of the SQVs. Chemicals were classified as follows:

- **Strong Influence:** In every version of the SQVs, these chemicals affected the reliability of the SQVs if removed from the data set: Antimony, zinc, bis(2-ethylhexyl) phthalate, total PCBs, individual PAHs (when removed as a group), and the molar sum of PAHs.

- **Lesser Influence:** In some SQV sets but not others, removal of these chemicals affected the reliability of the SQVs: Arsenic, cadmium, copper, mercury, tributyltin, and di-n-octyl phthalate.

- **Little or No Influence:** In no case did removal of these chemicals or chemical groups affect the reliability of the SQVs: Chromium, lead, nickel, silver, individual PAHs (removed one at a time), LPAH, HPAH, dibenzofuran, individual Aroclors (removed singly or as a group), butyl benzyl phthalate, and dimethyl phthalate.

These results may reflect one or both of the following phenomena. First, the list may indicate decreasing contributions to toxicity in the data set from the top to the bottom categories. Second, covariance may play a strong role for some chemicals. Chemicals in the “Strong Influence” list are almost certainly associated with adverse effects and act largely independently of other chemicals – or act as a good surrogate for other chemicals that are important to toxicity. Chemicals in the “Lesser Influence” list also have some toxicity, and most likely have strong covariances with other chemicals on the list, so that at times their influence is obscured. Chemicals in the “Little or No Influence” list either are not very toxic at the concentrations in the data set, or covary so strongly with other chemicals that their individual influence cannot be observed. Some, such as the metals, may be somewhat toxic on their own, but nearly always occur with more toxic or higher-concentration metals.

Other chemical groups, such as the PAHs and PCBs, may exert their toxicity primarily in an additive manner. The results of the sensitivity analysis showed that the LPAH and HPAH measures are not particularly useful as additive measures of PAH toxicity. When the individual PAHs were removed, these two measures by themselves were not able to produce good reliability. Use of either SQVs for individual PAHs capped at the AETs (without LPAH and HPAH) or a summed molar PAH concentration was more reliable. The sensitivity analysis also showed that only the total PCB measure affected the reliability of the SQVs; it is not necessary to have additional guidelines for individual Aroclors.

It should be noted that these SQVs are optimized to this data set and were derived from it. Future data sets may have different combinations of chemicals that could vary the results above somewhat. While it is not likely that “strong influence” chemicals would become “no influence” chemicals or vice versa, it may not be appropriate to immediately drop all chemicals in the “no influence” list from the SQVs. A more protective approach would be to set the SQVs for these chemicals at their AET or the level above which no false positives occur, to ensure that there are some minimal criteria for these chemicals in case they are unusually important at certain sites.

4.0 CONCLUSIONS AND RECOMMENDATIONS

In summary, the following observations and conclusions can be drawn:

- The freshwater data set is considerably stronger than it was in 1994, and has been improved from a quality assurance standpoint. The current database allows for the calculation of two additional AETs, for a total of four acute and subchronic endpoints. Unfortunately, no benthic or chronic freshwater tests have enough data to allow calculation of AETs.

- There is still a lack of data for a variety of pesticides, herbicides and biocides, among other chemicals. These chemicals may be important in areas of the state that have not been widely sampled, particularly in central and eastern Washington. At sites or locations in which these chemicals are likely to be present, the AETs and other SQVs derived in this report may not provide adequate protectiveness, and bioassay testing should be undertaken on a site-specific basis. In addition, it is possible that lack of these analytes in the existing data set reduced the sensitivity of the AETs as well as the other SQVs calculated, if they contributed to observed toxicity in the bioassays.

- The 2003 AETs are more consistent with one another, and encompass a broader range of analytes. Due to the removal of older data not meeting current protocols, the four AETs fall within a narrower range for most chemicals than did the two previously calculated 1997 AETs. In general, the *Hyalella azteca* AETs were the least sensitive, the two *Chironomus* AETs were in the middle, and the Microtox® AET was the most sensitive.

- The freshwater AETs are not as sensitive as the marine AETs are in Puget Sound, most likely due to variations in metals bioavailability from one area to the next. Pooled sensitivity ranges from 45-65%, while efficiency is much higher, ranging from 87-93%. Overall reliability is about 70%. The two mortality bioassays exhibit the lowest sensitivity and reliability.

- Use of optimal percentiles of the no-hit distribution improves sensitivity, and shows a reasonable balance - in the 75-80% sensitivity range, with a corresponding efficiency of 60-80%.

- Use of the floating percentile method further improves the sensitivity and efficiency, resulting in SQVs with a sensitivity of 85% and efficiency of 75%, and an overall reliability of better than 80%. Other choices of sensitivity and efficiency are possible, and a range of potential guideline values was calculated to illustrate the trade-offs involved.

- Metals, certain phthalates, PCBs, and PAHs acting in an additive manner are most closely associated with toxicity in the data set. There is a significant degree of covariance among many of the metals and among the PAHs, which complicates calculation of the SQVs.

The following recommendations are provided, based on the conclusions above and supporting analyses:

- Standard AETs are not recommended for setting freshwater SQS and CSL values at this time, because of their relatively low sensitivity. The freshwater AETs are nevertheless useful for other purposes within the sediment management programs, because they are highly efficient. Above these levels, it is nearly certain that adverse effects will be observed. Therefore, they would be appropriate as MLs in the dredging programs, and as hotspot and early action levels in the cleanup programs. In addition, for those chemicals that covary sufficiently that individual toxicity thresholds cannot be identified using iterative methods, the AETs serve as an appropriate method for setting SQVs, providing an upper limit and a measure of safety against future data sets that may not covary in the same ways.

- As an alternative to AETs, the Floating Percentile method is recommended over the optimal percentile approach, because it allows SQVs to be developed that improve both sensitivity and efficiency over fixed-percentile methods. Using this method, it is possible to develop an optimized SQV set for any choice of false negative rate and any definition of adverse effects determined to be appropriate to a given program. The method is also capable of providing customized SQVs for a given region, should it be considered appropriate to stratify the freshwater data set into ecoregions, watersheds, or political boundaries.

- Within the range of adverse effects levels evaluated in this report, it is recommended that Ecology retain use of the biological SQS and CSL levels, as defined in the Phase I report (subject to agency and peer review), rather than using a statistical significance only comparison. The SQS and CSL biological effects levels are more consistent with the existing rules and marine programs. The results of this analysis indicate that the statistical significance only level is not very different from the SQS level in any case, most likely because the SQS thresholds were selected based on minimum detectable differences observed in recent round robin studies.

- Based on the evaluations conducted for the Phase I report, it is recommended that Ecology use a comparison to control rather than a comparison to reference for calculating SQVs. Once freshwater reference areas have been identified and their performance validated over time, the decision of whether to use reference or control comparisons can be made on a programmatic basis. However, the Phase I reliability analysis indicated that if a decision is made to use reference comparisons, they must be used consistently on all projects and not mixed with comparisons to control, or the reliability of the decision process will substantially decline.

- Within the range of false negative rates for which example SQV sets were developed (5-25%), it is recommended that a level be chosen that balances false negative and false positive rates, but with more weight given to reducing false negative errors. For both the SQS and CSL effects definitions, this level is around 15% false negatives, corresponding to 25% false positives and an overall 80+% reliability. However, other choices may also be appropriate depending on programmatic needs.

It is important to keep in mind when considering this factor that the error rate is not the same as the degree of protectiveness, although there is a relationship. In other words, a 5% false negative rate is not equivalent to protecting 95% of the species, or a 5% effects level. The adverse effects level and hence the protectiveness of the SQVs is set by the hit/no-hit definition; the error rate shows how accurately the chemical SQVs predict the chosen biological effects level for the existing data set.

- It is recommended that PCB criteria be set only for total PCBs, rather than individual Aroclors, based on the sensitivity analysis. The manner in which total PCBs should be calculated when congener data are available was outside the scope of this study (since congener data were not present in the data set); however, this will be important to address in the future.

- It is also recommended that LPAH and HPAH measures not be used, based on the sensitivity analysis. For PAHs, two alternative approaches could be used, which seem to provide roughly the same sensitivity and reliability. A single SQV can be set using a molar sum of PAHs, consistent with narcosis theory. Alternatively, SQVs for individual PAHs can be set using the freshwater AETs.

- It is recommended that areas of the state susceptible to contamination by pesticides, herbicides, and other chemicals not well-represented in the existing data set be further sampled, using synoptic chemistry and bioassay testing. This will allow additional SQVs to be calculated that will provide greater protection in these areas.

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Appendix A

APPENDIX A. LIST OF SURVEYS

Survey	***Chironomus***	***Hyalella***	**Microtox®**	**Description**
BOISECAS	0	4	0	Class II Inspection of the Boise Cascade Pulp and Paper Mill Wallula Washington, WA Dept. of Ecology EILS, 1993
CARGIL01	3	3	0	Cargill Irving Elevator Terminal, Cargill Irving, 2001
CBSLOUGH	0	20	0	Columbia Slough Sediment Analyses and Remediation Project, Phase 1 Report, Dames & Moore for City of Portland, 1991
CEDARIV	0	5	5	Sediment Sampling and Analysis Report Cedar River Delta Sediments, Golder Assts. for City of Renton, 1992
LCBWRS93	0	15	0	Lower Columbia River Backwater Reconnaissance Survey, TetraTech for Lower Columbia River Bi-State Program, 1994
LKUNDRDK	0	4	0	Sediment Monitoring Program Results Lake Union Drydock Company, Hart Crowser, 1992
LKUNION	0	9	0	Survey of Contaminants in Lake Union and Adjoining Waters, WA Dept. of Ecology EILS, 1989
LKWA00	28	28	27	Lake Washington Baseline Sediment Study, King County, 2000
LSAMM99	16	16	0	Lake Sammamish Baseline Sediment Study, King County, 1999
LUUCSO00	6	6	6	Lake Union University Regulator CSO Post Separation Study, King County, 2000
MBCREOS3	43	43	0	McCormick & Baxter RD Phase I Sediment Survey, Oregon DEQ, 2002
MBCREOS4	18	18	0	McCormick & Baxter RD Phase II Sediment Survey, Oregon DEQ, 2002
PPTLDT24	4	4	0	Sediment Characterization Study, Marine Terminal 2 Berths 203-206 and Marine Terminal 4 Berth 416, Hart Crowser for Port of Portland, 1999
PSYD&M97	0	3	0	Portland Shipyard Environmental Audit, Dames & Moore for Cascade General, 1998
PSYSEA98	55	55	55	Portland Shipyard Sediment Investigation Data Report, Striplin Env. Assts. for Port of Portland, 1998
QUEBAX1	0	4	0	Distribution and Significance of Polycyclic Aromatic Hydrocarbons in Lake Washington Sediments Adjacent to Quendall Terminals, WA Dept. of Ecology EILS, 1991
QUEBAX3	0	3	0	Results of Sediment Sampling in the JH Baxter Cove Lake Washington, WA Dept. of Ecology EILS, 1992
ROSSIS99	11	11	0	Ross Island Facility Site Investigation, Hart Crowser for Port of Portland, 2000
SALIII97	22	22	22	Salmon Bay Results of Phase III Sampling, WA Dept of Ecology EAP, 2000
SEACOM94	0	3	3	Sediment Sampling Report Seattle Commons Parcel C Seattle, Washington, 1994
SPOK2000	0	0	8	Chemical Analysis and Toxicity Testing of Spokane River Sediments Collected in October 2000, WA Dept. of Ecology EAP, 2001
SPOKNR94	0	3	3	Spokane River PCB Study, WA Dept of Ecology EILS, 1994
TOSCO99	2	2	0	TOSCO Portland Terminal, 1999 Sediment Sampling Results, Portland District Corps of Engineers, 1999
TRI-STAR	0	3	0	Tri-Star Marine NPDES Sediment Monitoring, Beak Consultants, 1997
VALCOA93	0	4	0	Aluminum Company of America; Vancouver Works Baseline Sediment Characterization, ENSR for WA Dept. of Ecology, 1994
WEYLONG	0	3	0	Class II Inspection of Weyerhaeuser Longview Pulp and Paper Mill, WA Dept. of Ecology EILS, 1991
WILREF02	3	3	0	Willamette Reference Survey, Hart Crowser for the Portland District Corps of Engineers, 2002
WLRPT498	18	18	0	Terminal 4 Slip 3 Sediment Investigation, Hart Crowser for Port of Portland, 1998
WRD&M98	0	2	0	Portland Shipyard Environmental Audit, Dames & Moore for Cascade General, 1998
TOTAL	**229**	**314**	**129**	

Notes:
1. *Chironomus* column includes both mortality and growth endpoints
2. Totals may not match text, as some samples failed quality assurance review during the analysis

Appendix B

APPENDIX B. 2003 APPARENT EFFECTS THRESHOLDS CHEMICAL DISTRIBUTIONS

Chemical distributions for the AETs reported in Section 3 are presented in this appendix. Each chemical has a no-hit (no adverse effects observed) distribution and a hit (adverse effects observed) distribution. Prior to identifying AETs, outliers are removed from the no-hit distribution, and any such outliers that have been removed are shaded in yellow. The AET is set at the highest remaining no-hit concentration. AETs are shaded dark blue if they are high confidence and light blue if they are lower confidence. The next highest concentration in the hit distribution above the AET is shaded green. The concentration gap between the blue AET and the green next highest concentration shows the magnitude of the uncertainty in the AET.

HYALELLA MORTALITY									
2-Methylnaphthalene	**2-Methylnaphthalene**	**4,4'-DDD**	**4,4'-DDD**	**4,4'-DDE**	**4,4'-DDE**	**4,4'-DDT**	**4,4'-DDT**	**4-Methylphenol**	**4-Methylphenol**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
0.7	0.95	0.6	0.8	0.5	0.8	0.73	2	7.3	36
0.76	1.5	0.7	5	0.76	2	1.4	3	11	41
1.1	1.9	0.7	7	0.8	4	3	3	16	48
1.2	2.2	0.77	8	0.8	5	3	5	16	50
1.3	11	0.9	8	0.9	5	5	6.1	24	63
1.6	12	0.99	8.9	1.2	6	5.2	7	24	117
1.7	13	1	11	2	6.5	10	7.9	50	198
2.2	13	1.3	14	2	6.7	13	10	77	215
2.7	13	1.6	20	2	6.8	13	10	130	382
3.2	14	2	22	3	8	19	12	150	699
4.2	15	3	27	3	8	100	19	150	710
5.1	15	3	30	3	8		23	159	760
10	16	3.4	49	3.2	8.6		24	180	1560
11.7	18	4.7	59	3.8	11		26	188	1730
12	20	5.6	310	4.6	11		39	239	2030
15	24	6.5		6.9	20		140	476	3590
16	28	7		7.3	22		140	512	6310
18	28	7.5		7.4	44			551	
35	30	8.3		7.8				599	
62	35	9.2		8.3				1210	
141	36	12		8.9				2360	
160	52	16		9					
170	54	22		9.6					
180	56	24		11					
180	64	33		14		🟦	AET - low confidence		
214	65	45		18		🟦	AET - high confidence		
353	87	50		19		🟩	next highest hit value		
469	94	52		20		🟨	outlier		
555	120	70		20					
710	143	96		21					
3470	188								
	189								
	443								
	877								
	982								
	1720								
	1770								
	2300								
	2310								
	4700								
	40000								
	42000								
	110000								
	460000								
	1600000								

HYALELLA MORTALITY											
Acenaphthene	**Acenaphthene**		**Acenaphthylene**	**Acenaphthylene**	**Anthracene**	**Anthracene**		**Antimony**	**Antimony**	**Aroclor 1254**	**Aroclor 1254**
No-Hit	**Hit**	**Hit (Cont.)**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**Hit (Cont.)**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
0.72	1.3	2940	1	1.7	1.2	1.9	1130	0.05	0.1	7.3	11
1.2	2.2	5700	1.1	2.2	1.2	2.7	1400	0.06	0.1	11	16
1.3	3	6290	1.2	9.93	1.9	3.2	1520	0.1	0.1	12	18
1.6	11	7390	1.3	11	2.1	4.9	1580	0.1	0.2	17	24
1.7	11	20000	2.5	12	2.3	10	1700	0.13	0.2	25	37
1.7	12	20800	2.5	12	2.6	11	1900	0.14	0.2	35	47
1.8	12	25000	3.2	12	3.1	11.7	1900	0.2	0.2	57	51
2.7	14	26000	3.3	13	4.9	12	2860	0.2	0.2	70	52
3.4	14	29600	3.5	14	5	14	2920	0.3	0.2	71	54
4.1	14.2	31000	4.5	14	5.6	18	3640	0.47	0.2	74	54
6.1	15	86200	5.4	15	12	20	5700	0.6	0.2	81	54
10	17	980000	8.5	17	12	21.5	6140	2.7	0.3	90	54
10	17.3	3900000	11	18.8	12	22	6600	2.9	0.3	95	57
11	18		13	20	12	22	6900	3.5	0.3	110	58
12	18		13	25	13	23	7900	4.4	0.4	120	62
14	20		14	34	13	25	13000	64	0.4	120	70
18	23		15.7	34	14	26	16600		0.4	140	70
18	23		16	62	15	27	35000		0.41	140	78
19	25.3		19	72	16	28	36000		0.45	150	78
20	32		20.8	88	16	28	680000		0.5	160	81
23	33		23	96	17	29	890000		0.5	180	97
23	37		23	110	20.5	32			0.5	200	100
24	37		30	120	22	37			0.5	230	140
36	37		35.8	140	23	40.9			0.54	350	156
39	45		36.8	200	25	41			0.6	960	160
43	52		42	209	27	42			0.61	1060	163
51	53		44	233	29	48.1			0.61	> 1060	168
56	59		71	296	38.6	52			0.62		170
73	60		94	362	40	53			0.66		170
82	65		110	460	40.1	57			0.72		170
88	72		136	470	46	63			0.8		189
91.9	75		140	480	46	65			1		202
99	77		148	594	53	67			1.1		209
107	90		171	640	72.5	70			1.6		227
120	92		200	642	75.1	74			1.8		230
130	100		265	697	95	85			1.9		256
148	110		265	730	101	99			4		290
156	112		279	840	124	110			31.3		294
162	130		314	1260	126	115			62.3		297
170	134		990	3500	155	150			311		340
170	177		1020	3600	220	170					520
203	210			6100	233	177					770
209	220			11000	250	177					870
230	260			11000	280	210					
240	272				320	220					
252	280				320	220					
260	310				343	260					
310	400				350	355					
316	410				353	356					
332	470				370	362					
360	560				373	370					
520	560				465	380					
523	630				510	406					
920	792				552	410					
940	830				600	420					
990	1060				630	429					
2350	1100				660	510					
2700	1250				717	560					
2790	1320				1190	580					
6100	2460				1230	690					
7420	2460				1500	774					
					1700	814					
					1700	915					
					2000	965					
					5900	980					
					16200	1110					

HYALELLA MORTALITY									
Aroclor 1260	**Aroclor 1260**	**Arsenic**		**Arsenic**		**Benzo(a)anthracene**		**Benzo(a)anthracene**	
No-Hit	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**
18	15	0.48	5	1.7	8	4.8	167	5.6	3190
24	15	0.58	5	2.1	8	5.3	170	10	3200
26	20	1.23	5	2.4	8	8.1	186	12	3300
27	24	1.4	5.02	2.5	8	8.7	190	13	3340
38	29	1.8	5.1	2.6	8.18	9	190	16	3500
40	37	1.9	5.22	2.6	8.7	9.1	199	17	3750
43	37	2	5.3	2.7	9	11	235	18.7	4000
57	38	2	5.43	2.8	9	11	240	19	5430
74	40	2.1	5.57	3	9	11	259	20	5800
130	42	2.1	5.6	3	9.14	13	271	20	7930
130	42	2.3	5.7	3.1	9.32	13	280	22	8600
460	46	2.7	5.7	3.5	9.7	14	280	24	9000
460	46	2.7	5.81	3.5	10.7	14	310	29	13000
500	48	2.9	5.9	3.68	11.1	15	350	30	19000
	53	3	6	3.8	11.7	15	354	30	37000
	57	3	6	3.9	12.2	16	470	32	43000
	57	3	6.1	3.9	12.7	16.9	523	32	49000
	62	3	6.16	3.97	12.8	17	598	37	58000
	64	3	6.2	4	13	17	600	38	63000
	64	3	6.26	4	13	18	700	41	77000
	69	3.2	6.58	4	13.1	18	724	41	280000
	70.1	3.3	6.75	4	13.7	18	740	41.4	890000
	77	3.3	6.92	4	14.7	19	917	43	
	83	3.3	7	4	15	19	1060	49	
	85	3.3	7	4	15	20	1180	67	
	98	3.4	7	4.2	17	20	1200	78	
	98	3.5	7.08	4.2	17	20	1220	79	
	116	3.55	7.08	4.3	17.2	20	1270	89	
	122	3.6	7.11	4.36	18	22	1330	93	
	138	3.6	7.38	4.4	26.6	23	1470	93	
	140	3.7	7.7	4.4	31.4	24.4	1500	93	
	150	3.7	7.8	4.5	32	25	1580	94	
	180	3.75	8	4.54	38.7	26	1800	102	
	184	3.8	8.03	4.6	49	27	2300	103	
	280	3.9	8.1	4.7	61	27	2700	105	
	310	3.9	8.6	4.7	63	28	4260	105	
	310	3.94	8.62	4.8	71.1	29	6200	106	
	330	4	8.64	4.9	103	29	10000	112	
	340	4	8.88	5	111	29	11000	112	
	2500	4	8.89	5	147	30	11000	113	
		4	9	5	175	31	12000	115	
		4	9	5	639	32	25600	130	
		4	9.46	5	1150	32	44000	136	
		4	9.7	5		33		150	
		4	10.6	5		35		154	
		4	11	5		35		168	
		4	11	5		36		170	
		4	11.7	5		37		179	
		4	13	5		37		181	
		4	13.1	5.17		38		188	
		4	13.6	5.23		39		220	
		4	14.3	5.36		40		240	
		4.09	15	5.59		50		268	
		4.1	16.5	5.6		51		288	
		4.2	17.8	5.8		52		321	
		4.24	19	6		52.7		342	
		4.3	19	6		55		350	
		4.3	19	6		56		353	
		4.3	20	6		59		373	
		4.3	20	6		62		411	
		4.3	21.7	6		64		441	
		4.3	23	6		68		470	
		4.33	23.9	6		70		516	
		4.4	26.8	6		71		530	
		4.5	28	6		71		539	
		4.5	30.6	6		73		561	
		4.6	31.3	6		73		570	
		4.6	44.9	6.1		75		590	
		4.7	49.3	6.24		77.8		740	
		4.7	50.7	6.43		78		750	
		4.7	50.9	7		79		760	
		4.7	122	7		82		870	
		4.74	123	7		95		958	
		4.85	149	7		97		1080	
		4.9	152	7.18		99		1100	
		5	200	7.69		100		1100	
		5				109		1100	
		5				110		1100	
		5				116		1300	
						120		1300	
						130		1480	
						140		1600	
						140		1700	
						148		1720	
						150		2380	
						162		2620	
						163		2640	

HYALELLA MORTALITY						
Benzo(a)pyrene		**Benzo(a)pyrene**		**Benzo(g,h,i)perylene**		**Benzo(g,h,i)perylene**
No-Hit	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**No-Hit (Cont.)**	**Hit**
4.2	298	8.8	2960	8.4	490	11
4.8	310	12	3100	9.6	497	14
8.6	310	14	3340	11	510	14
8.8	360	15	4000	11	580	16
8.8	360	16	4600	11	613	17
9.3	430	19	4900	11	680	18
10	454	19	9600	12	791	18
11	490	21	11000	13	821	18
11	570	21	11000	13	965	18.6
12	615	23.1	13000	13.5	1150	19
12	690	26	15000	14	1200	22
13	750	26	39000	14	1410	22
13	783	29	51000	15	1520	22
13	880	32	62000	15	1900	29
14	890	34	63000	16	2500	30
15	910	35	86000	16.8	2500	31
16	915	36	100000	17	4020	32
16	990	38	140000	17	5400	33
16	1080	38	250000	17	8900	35
16	1420	40		17	9400	36
18	1620	43		18	11000	46
18	1650	44.4		18	12000	56
18.6	1800	48		19	12100	56
19	1890	60		19	38000	65
19	2700	68		19		69
19	2800	73		20		70
20	3300	85		20		70
21	4810	87		20.9		77
23	6700	92.8		21		77.2
24	12000	93		21		78
25	13000	114		22		82
25	13000	116		22		87
25	14000	117		22		94
27	24300	120		23		99
27	55000	120		23		99
27.4		120		23.2		103
28		124		29		104
28		131		30		108
29		133		30		110
31		135		30		114
32		160		32		127
32		176		32		133
33		176		36		134
34		176		40		146
35.9		189		41		149
36		195		42		155
37		195		43		164
40		213		44		170
40		216		45		181
43		223		48		186
45		226		50		216
49		240		51		219
51		256		51		220
56		270		57		221
58		280		65		223
61		333		67		231
66		334		68		240
67		343		71		270
76		351		73.3		280
80		358		73.4		308
81		382		77		320
85		387		77		330
88		390		84		400
91		451		85		430
92		660		90		570
100		710		100		670
102		720		102		700
128		740		110		827
128		820		115		840
130		840		121		840
131		1000		140		854
145		1070		150		1100
150		1100		150		1200
153		1100		175		1330
153		1110		187		1350
170		1180		190		1350
171		1400		200		1500
180		1500		200		1500
195		1530		210		1660
206		1630		210		1700
210		1840		216		1720
210		2100		220		2510
230		2100		246		2800
231		2210		280		3300
248		2220		310		5200
256		2500		350		7100
280		2750		424		7600
						11000
						22000
						27000
						48000
						49000
						55000
						93000
						170000
						310000

HYALELLA MORTALITY							
Benzoic acid	**Benzoic acid**	**Beryllium**	**Beryllium**	**Bis(2-ethylhexyl) phthalate**	**Bis(2-ethylhexyl) phthalate**	**Butyl benzyl phthalate**	**Butyl benzyl phthalate**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
35	140	0.071	0.147	18	17	10	11
50	170	0.0883	0.16	18	18	21	18
64	250	0.102	0.162	18	23	24	18
73	270	0.135	0.19	25	23	25	18.8
82	300	0.147	0.42	30	24	25	23.1
110	300	0.151	0.427	32	26	31	24
110	330	0.153	0.477	32	30	32	24
250	800	0.154	0.62	40	78	34	25
250	1300	0.162	0.82	49	140	36	28
360	1500	0.188	0.9	50	220	37	32
650	1540	0.2	0.91	50	230	41	35
660	2020	0.202	2	51	250	42	40
720	2170	0.214	2	55	307	48	43
740	2430	0.249	2	62	310	50	47
813	2640	0.252		62	370	52	47
880	2840	0.256		70	370	53	50
900	4110	0.261		100	370	55	53
1650	4200	0.262		110	418	56	55
2070		0.286		110	420	56	57
2380		0.308		110	440	63	57
2910		0.317		120	452	110	62
3790		0.325		120	460	131	64
		0.327		120	460	160	64
		0.348		160	470	163	66
		0.358		160	490	165	66.4
		0.361		170	501	182	69.6
		0.385		170	510	222	70
		0.387		170	519	274	73
		0.417		170	520	470	86
		0.444		180	546	870	90
		0.463		190	547	1100	105
		0.49		200	575	1520	119
		0.5		220	713	> 1520	121
		0.5		230	727		122
		0.64		240	772		138
		0.66		260	774		140
		0.68		275	779		145
		0.7		285	867		170
		0.76		290	900		180
		0.8		300	913		184
		0.8		320	1020		198
		0.8		322	1050		230
		0.84		330	1110		258
		0.87		330	1370		260
		0.96		337	1380		280
		1.1		350	1390		366
		1.2		350	1400		407
		2		350	1440		409
		> 2		360	1600		430
				360	1600		540
				390	1680		763
				420	1740		980
				420	1800		
				444	1800		
				450	1810		
				480	1900		
				500	1900		
				540	1900		
				550	1920		
				577	1930		
				580	2000		
				660	2000		
				660	2140		
				720	2200		
				778	2220		
				800	2400		
				940	2400		
				1000	2400		
				1090	2800		
				1100	2800		
				1200	3000		
				1400	3100		
				1700	3400		
				1970	3420		
				2000	3510		
				2140	3970		
				2520	4100		
				2900	5120		
				3010	5700		
				4330	6360		
				4970	7590		
				6380	33300		
				10000			
				10500			
				18000			
				22300			

HYALELLA MORTALITY												
Cadmium		**Cadmium**		**Carbazole**	**Carbazole**	**Chromium**		**Chromium**	**Chrysene**		**Chrysene**	
No-Hit	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**
0.052	1.2	0.04	1.6	62.27758007	24	7	44.9	9.4	5.1	161	9.1	3430
0.053	1.23	0.04	1.8	67	85	9.58	45.4	10.5	6.5	170	17	3620
0.07	1.3	0.04	1.9	71	130	10.1	46.2	12	8.1	170	19	3700
0.074	1.3	0.05	1.9	94	230	10.1	46.3	13	9.5	179	22	3800
0.093	1.3	0.07	2	117	234	10.8	46.5	13.6	11	180	24	3800
0.1	1.3	0.07	2.2	124	238	11.1	47	14.8	12	187	24	4800
0.1	1.3	0.1	2.3	130	240	12	48.5	15	13	193	25	5730
0.1	1.39	0.1	2.3	172	274	12.2	49.6	17	13	210	27	5880
0.1	1.4	0.1	2.5	194	389	14.3	50.2	17.4	13	221	28	6400
0.11	1.4	0.1	2.6	229	420	15.1	50.7	18.6	13	230	28.6	7240
0.12	1.44	0.12	2.6	374	437	15.2	50.9	21.5	14	249	29	7800
0.13	1.6	0.2	3.01	923	460	15.7	52.1	22	15	260	30	8900
0.13	1.69	0.2	3.2	2920	825	16.5	52.3	23	15	281	32	11000
0.14	1.7	0.2	3.2		850	16.7	52.8	23.1	15	290	34	18000
0.159	1.7	0.2	39.6		1000	16.8	53.9	23.1	17	314	36	38000
0.16	1.8	0.2			450000	17.6	54.6	23.6	17	320	48	49000
0.161	1.9	0.2			480000	18.3	55.6	23.8	17.9	320	50	60000
0.17	1.9	0.2				18.4	57.3	24	19	340	51	75000
0.17	2	0.2				18.5	58	24	19	390	51	96000
0.173	2	0.2				18.6	58.2	24.1	21	393	51	110000
0.18	2.07	0.2				18.9	60.8	24.6	22	400	55	300000
0.18	2.1	0.22				19.1	61	25	23	430	59	950000
0.186	2.15	0.27				19.3	62	25.4	23	490	60.8	
0.187	2.39	0.3				20	63.1	26	24	498	61	
0.19	2.5	0.3				20.1	63.4	26	24	570	70	
0.2	2.7	0.3				20.1	66.7	26	24.6	601	73	
0.2	2.9	0.3				20.2	79	26	25	657	104	
0.2	3.67	0.3				20.3	80.1	26.2	25	690	110	
0.2	3.91	0.3				20.5	89	26.2	26	730	110	
0.2	5	0.31				20.6	95	27	26	755	117	
0.2	5.6	0.4				20.8	96.2	27	27	816	126	
0.2	9.07	0.4				21.1	102	28.4	28	819	128	
0.2		0.4				21.5	133	28.7	28	930	129	
0.2		0.4				21.8	348	28.9	28.1	1260	140	
0.2		0.4				22	> 348	29	30	1440	144	
0.2		0.472				22.1		29.2	31	1500	157	
0.2		0.5				23		29.3	32	1500	160	
0.2		0.5				23.3		29.4	33	1540	161	
0.2		0.5				24		29.8	33	1560	172	
0.2		0.5				25		30	34	1670	177	
0.21		0.5				25.1		31	35	1710	180	
0.24		0.55				25.4		31	35	2170	190	
0.26		0.6				25.8		31	35.9	2200	202	
0.267		0.6				26		31	36	2320	209	
0.29		0.6				26		31.5	36	3000	211	
0.292		0.6				26.1		31.8	36.6	3700	220	
0.3		0.61				26.2		32	38	5940	263	
0.3		0.651				26.4		32	39	7000	266	
0.3		0.7				27		32	39	10000	280	
0.3		0.7				27		32.1	40	11000	318	
0.3		0.7				27.3		33	43	11000	385	
0.357		0.7				28		34	43	11000	390	
0.361		0.75				28		35	45	28100	412	
0.377		0.75				29		36	46	46000	425	
0.391		0.78				29		36	47		430	
0.4		0.8				29		36.3	50		482	
0.45		0.8				29		36.5	50		489	
0.49		0.875				29		36.7	52		507	
0.506		0.9				29.4		37	55		508	
0.52		0.963				29.8		37	57		510	
0.6		0.968				31		37.7	57.3		541	
0.6		0.98				31		38	58		562	
0.607		1				31.1		38.2	59		620	
0.63		1				31.2		39	61		670	
0.69		1				31.9		39	70		707	
0.7		1				31.9		39.7	70.4		850	
0.791		1				32		40	71		1000	
0.8		1.08				33.4		40	73		1100	
0.811		1.1				33.7		40.5	76		1130	
0.82		1.1				34		41	78		1140	
0.834		1.15				34.2		42	91		1200	
0.9		1.16				34.9		42.1	93		1200	
0.913		1.17				36.4		43	95		1300	
0.973		1.2				36.5		43	95		1300	
1		1.26				37.8		43.9	98		1300	
1		1.3				38.2		45	100		1400	
1		1.3				38.8		45.3	100		1500	
1		1.3				39		45.5	105		1600	
1.1		1.3				39		46	110		1800	
1.1		1.3				40		48	110		1800	
1.1		1.36				40.5		53.9	111		2100	
1.1		1.4				40.5		55.9	126		2140	
1.1		1.5				41		61.3	130		2210	
1.13		1.51				42.8		67	130		2460	
1.2		1.53				43.3		68.3	140		3000	
1.2		1.55				43.5		69.2	147		3200	
1.2		1.58				44.3		75.6	152		3370	
								76				
								77.1				
								79.9				
								80.7				
								80.7				
								81.9				
								84.4				
								99.5				
								112				
								208				

HYALELLA MORTALITY									
Copper		**Copper**		**Dibenz(a,h)anthracene**	**Dibenz(a,h)anthracene**	**Dibenzofuran**	**Dibenzofuran**	**Dibutyltin**	**Dibutyltin**
No-Hit	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
3.8	45.6	7.4	213	1.5	2.5	0.81	1.1	3.5	43
4.69	48.1	11	229	2.8	4.9	0.86	1.5	5.5	53
5.15	49.9	11	267	3.7	10	1.3	1.9	6.9	70
8.5	50.9	14.8	314	3.7	10.9	1.5	10	7.6	77
8.5	50.9	16	315	4.8	12	1.7	10	9.2	79.2
9.5	51.4	16	327	7.9	12	3.7	12	9.2	92
9.7	54.5	16	338	8.5	13	4.3	12	12	96
10.7	57.6	17	371	13	14	4.9	13	12	107
10.7	59.3	17	382	14	14	9.2	13	16	131
10.9	61	17	397	14	14	9.4	14	17	155
11	61.8	18	399	17	16	12	14	19	233
15.2	62	18.3	461	18	16	14	15	20	259
15.4	62.9	18.4	461	19.3	18	16	16	25	277
15.6	64	19	508	21	18	30	18	26	
16	65	20.3	622	26	18	31	19	85	
16.5	65.2	20.4	635	34.1	22	52	24	130	
16.7	66	23.4	651	50	24	90	26	140	
16.8	66.9	23.6	655	55.9	28	98	26	265	
17.2	70.4	24.7	2090	58	28.5	116	33	288	
18	71.2	24.8		82	29	138	38	321	
18.1	84.5	25.9		97	30	160	41	333	
19.3	94.4	28.6		116	31	168	46	492	
20	101	30.1		120	34	170	62	509	
20.2	113	31.7		132	36	180	64	661	
20.2	136	32		214	37	200	68	1930	
20.4	142	32.4		216	37.3	234	75	17000	
20.7	146	32.9		251	38	244	83	> 1930	
20.9	187	33.8		280	43	372	94		
21.1	363	35		292	45	384	110		
21.4	420	35.9		294	45.3	443	140		
21.7	526	36		320	49	660	160		
22.5	571	36.2		332	56	3810	160		
22.6	619	38.5		350	66		166		
22.9	627	41		540	72		170		
23.6	651	41.4		780	91		194		
24.2	829	43.1		839	99		204		
24.3	1460	43.4		1200	125		310		
24.4	2010	44		1700	176		399		
24.4	10800	44.1		2200	200		460		
25.3		44.6		2600	217		928		
25.5		46		3070	230		1010		
26		46.9		11000	240		1750		
26		47.7			260		2260		
26.5		48.6			300		7800		
26.6		50			327		7900		
26.7		50.4			342		8300		
26.8		52.2			390		10000		
27.9		53.2			424		19000		
28		53.4			437		580000		
28.2		54			490		2200000		
28.3		57.3			630				
28.7		62			720				
29.5		62.7			730				
30		63.8			800				
30		68			800				
30.7		69.4			1200				
30.9		71.1			1700				
31		71.1			3000				
31.2		74.5			4700				
31.6		76.7			33000				
32.2		77			39000				
32.5		77.9			710000				
33		81.2							
33.8		82.3							
34		86							
34		90.1							
34.1		90.9							
34.2		94.3							
35		96.6							
35		96.7							
35.4		100							
35.5		106							
36.5		109							
36.5		119							
36.8		119							
38		122							
38.3		125							
39.1		130							
40.1		140							
40.6		146							
40.7		154							
41		158							
41.9		163							
42.7		188							
42.9		209							
43.7		210							
43.8		212							

HYALELLA MORTALITY					
Dimethyl phthalate	**Dimethyl phthalate**	**Di-n-butyl phthalate**	**Di-n-butyl phthalate**	**Di-n-octyl phthalate**	**Di-n-octyl phthalate**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
5.4	11	6.5	11	12	10
31	11	8.1	11	13	11
46	12	9	14	17	12
54	13	10	15	25	13
108	13	11	15	32	13
147	14	12	16	34	15
156	15	12	17	46	17
158	16	13	17	47	18
172	16	15	19	48	21
311	19	17	20	49	21
314	21	19	22	52	22
436	37	21	24	54	23
	42	21	26	55	26
	54	23	26	58	26
	58	24	26.3	66	27
	71	30	27	100	30
	93	37	31	201	30
	110	158	34		34
	112	306	37		34
	160	690	40		37
	171	805	41		39
	190	841	41		40
	270	1180	41		44
	362	1740	41.7		45
	576	> 1740	44		54
			47		67
			61		74
			67		90
			68		110
			71		115
			90		256
			99.9		399
			101		413
			103		1420
			108		1520
			116		3400
			136		4290
			254		
			350		
			350		
			481		
			893		

HYALELLA MORTALITY							
Fluoranthene		**Fluoranthene**		**Fluorene**	**Fluorene**	**High Molecular Weight PAH**	**High Molecular Weight PAH**
No-Hit	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
5.6	160	13	4950	0.85	0.78	47.3	75
8.1	170	18	6100	0.86	1.8	54	100
8.5	190	28	7400	1.5	2.5	55	118
14	192	30	7710	1.5	2.7	56	144
15	200	32	7730	2.2	12	86.9	270
15	210	36	7900	2.2	13	88.1	300
16	210	38.6	15000	3	14	89	337
16	230	39	15000	4.7	15	96.6	510
16	230	41	16100	5.9	15.3	99	799
16	240	43	16700	6	17	107.1	1004
17	240	47	18000	9.2	17	116	1600
18	240	54	19200	11	18	131.2	2080
19	268	58	20100	12	18.3	134	2251
19	270	67.6	24200	13	19	136	3290
21	276	68	26000	13	19	157	3600
22	310	70	35000	18	23	193.7	4850
23	319	80	37000	19	23	223.6	6740
23	320	81.5	43000	22	24	255.8	6800
23	363	96	47700	22.3	28.2	290	10270
23.5	380	97	86000	25	30	309	13690
24	383	116	100000	29	33	412.4	15600
26.9	428	120	120000	30	37	441	16460
27	452	123	120000	33	39	470	18000
27.2	455	124	1600000	36	43	524.5	19800
28	460	130	5200000	36.2	44	612	21970
34	460	130		38.1	47	629	27820
35	500	143		42	50	711	31170
36	520	157		49	60	1376	35390
36	580	158		57	73	2068	38030
38	646	206		62	79	2522	44500
39	690	206		67.4	88	2629	57000
39	710	280		75	104	3370	62900
40	731	280		85	107	3457	95330
40.9	770	288		91	120	4280	111800
41	940	291		100	124	4660	134300
43	1100	291		120	140	6270	161500
44	1220	300		124	160	7370	427700
44	1260	301		126	171	8440	511000
44.7	1400	324		140	174	9000	627000
45	1500	334		160	180	10410	765000
46	1620	342		167	190	11020	852500
53	1640	344		181	200	13290	3556000
54	1690	356		185	201	13480	12858000
55	1780	359		220	230	15080	
58	2000	380		251	250	16780	
61	2000	390		270	274	17410	
63	2300	410		390	285	19960	
64	2660	419		400	310	25180	
65	3100	437		420	330	28550	
65	3140	445		465	465	31640	
66	3210	450		498	470	54800	
67	3360	453		590	490	72000	
69	3370	455		666	570	120500	
70	3450	502		730	620	120900	
70.2	4040	540		2080	660	121500	
70.7	5000	674		2350	670	122700	
71	6500	695		2500	932	250500	
71	6600	699		6970	1070	471000	
71.5	9340	720			1200		
72	9800	740			1540		
75	11100	766			1720		
76	15000	798			1900		
76	15000	833			3240		
77	21000	939			3400		
77	46100	950			3850		
79	180000	1100			3890		
87		1300			6740		
91		1300			14000		
91		1400			14000		
93		1500			15800		
93		1600			17000		
97		1900			18300		
110		2000			34000		
110		2140			56400		
110		2340			930000		
112		2450			3200000		
116		2600					
129		2600					
130		2800					
130		3190					
130		3200					
138		3300					
144		3600					
150		4200					
153		4500					
160		4700					
160		4780					

HYALELLA MORTALITY								
Indeno(1,2,3-c,d)pyrene		**Indeno(1,2,3-c,d)pyrene**	**Lead**		**Lead**		**Low Molecular Weight PAH**	**Low Molecular Weight PAH**
No-Hit	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**Hit**
8	643	9	0.62	56.2	5.6	154	8.9	9.5
8.1	763	10	0.77	58.7	6.19	177	10	18
8.2	770	13	2.28	58.8	6.3	180	10	18
10	773	14	3.02	64	6.8	185	10.4	24
11	800	16	4.27	65	7	203	10.8	25
11	1150	16	4.7	68.4	7.6	210	17.1	29.4
12	1160	17	5.01	73.5	7.8	223	18	31
12	1340	17.8	5.24	79.7	9.9	232	21.1	59
12	1350	18	5.99	79.9	10.7	234	23.3	71
13	1700	21	6.69	80.7	11	246	24.7	160
14	2300	22	7.1	81	11.8	258	28.6	247
14	3400	23	7.17	82.9	11.9	272	32.2	247
14	4120	24	7.24	89.6	12.2	283	40	422
15	4600	27	7.3	91	12.5	284	51	553
15	10000	28	7.3	95.2	12.7	294	52	651
16	11000	30	9.21	99.4	13.3	295	53	850
16	13900	30	10.2	102	13.4	299	71.1	1000
17	14000	30	10.5	105	13.8	323	95	1310
17.7	17000	33	11.1	115	14	436	103.8	1470
18	18000	35	11.1	122	14.8	470	147	2010
19	60000	36	11.2	133	15.1	495	181	2108
20		36	11.4	152	15.2	542	233	2760
20		44	11.6	171	15.2	678	351	2890
20		44	11.8	172	15.7	719	358	3000
22		59	12	184	15.9	739	363	3110
22		61	12	189	16	1180	420	4672
22		64.2	12.2	194	16.1		750	8130
22.8		73	12.6	204	16.2		1225	8980
24		76	12.7	210	16.9		1763	9130
24		80	12.7	211	17.6		1800	9200
25		81	12.7	230	17.9		1900	10270
27		83	12.7	249	18.1		2088	14070
27		88	12.9	293	19.8		2186	16870
28		88	13.1	322	20.2		2240	18700
29		93.9	13.2	335	20.8		2498	28500
29		97	13.2	357	21		2700	29010
30		100	13.3	371	21.1		3040	49000
31		100	13.4	431	25.6		3140	128580
34		106	13.5	461	25.9		3200	154100
40		120	13.7	510	26		4380	171000
41		124	14.4	525	26.6		4720	175180
43		130	14.4	715	27.3		6259	3453500
43		130	14.6	1160	27.4		6590	19801000
43		133	14.7	1310	27.4		8255	
45		134	14.7	> 1310	27.5		8800	
45		144	14.9		29		9380	
52		155	15		30.2		9520	
53		170	15.2		31		12990	
53		178	15.3		33.6		41971	
59		198	15.5		36		78300	
60		207	15.6		36.2			
65.6		208	15.7		38			
67		210	15.9		38.9			
68		222	15.9		39			
68		244	16.4		41.5			
69		255	16.5		41.9			
70		260	16.6		44.8			
74		260	17.3		47.6			
81		269	17.3		48.8			
82		294	17.4		49.9			
90		330	17.9		50			
95		330	18.6		50.2			
97.2		330	18.8		52.2			
101		342	18.9		53.5			
110		450	21		54.4			
110		460	22.4		56			
116		580	23.5		60.8			
120		720	23.6		62.5			
134		730	23.6		64.3			
141		740	26.1		68.1			
150		810	26.3		78.5			
160		889	30.1		79.1			
160		920	31		80.8			
180		960	32.4		87.6			
199		1180	35		89			
200		1200	36		93			
210		1220	37.8		94.6			
220		1450	39		96.6			
270		1500	39.2		111			
280		1600	42.3		114			
283		1600	45.9		118			
310		1750	47.7		124			
340		1800	48.2		125			
363		2000	48.3		125			
370		2340	51.1		131			
470		5100	51.7		150			
518		5300	54		150			
		6000						
		6500						
		10000						
		13000						
		19000						
		29000						
		41000						
		43000						
		43000						
		46000						
		84000						
		88000						
		110000						

HYALELLA MORTALITY													
Mercury		**Mercury**	**Monobutyltin**	**Monobutyltin**	**Naphthalene**	**Naphthalene**	**Nickel**		**Nickel**	**Phenanthrene**		**Phenanthrene**	
No-Hit	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**
0.006	0.433	0.01	1	3.2	1	1.3	5.3	35.7	9.1	4.3	384	5.6	1100
0.0083	0.435	0.01	1.3	4.19	1.3	2.2	7.79	36	12.7	6.6	388	14	1200
0.01	0.445	0.01	1.7	11.3	1.5	3.6	8	38.9	13	6.7	420	14	1300
0.013	0.461	0.024	3.97	12.4	1.9	3.9	8.4	39	14	6.8	569	14	1340
0.02	0.478	0.033	4.2	21.5	2.2	6.81	8.7	39.4	14.7	8.8	587	16	1500
0.03	0.48	0.033	4.3	26.9	2.5	6.83	10	39.9	15.3	10	617	18	1700
0.038	0.53	0.036	4.4	37	2.8	11	10	40.7	16	10	719	18	1720
0.039	0.54	0.04	4.8	38	3.1	12.1	10.9	41	16	11	730	19	1800
0.04	0.545	0.044	5	40	3.3	13	11.2	41.4	16	11	750	19	1900
0.04	0.552	0.05	5.2	50	4.9	13	11.6	43.5	16.5	12	778	21	2600
0.04	0.558	0.05	5.3	54	6.1	14	12.9	43.7	17	13	1000	22	2900
0.04	0.659	0.05	6.4	56	7.8	14.4	14.5	44.2	17.4	14	1130	22	3620
0.04	0.796	0.053	6.91	59	8.1	15	14.6	45	18	14	1200	24	3990
0.042	0.8	0.056	7.1	64	9.7	15	14.6	45	18.4	14	1200	25	4370
0.05	0.9	0.06	7.13	76	9.8	15	14.7	45.2	20.8	16	1300	26	4440
0.05	0.993	0.06	9.3	97.7	10	16	14.7	45.6	21	17	1400	33	4700
0.05	2.01	0.06	9.5	166	10	19	15	46.8	21	17	1480	33	4700
0.05	2.07	0.06	10	221	10	19	15.4	47	21	17	1500	38	4900
0.05	3.04	0.06	11	267	13	19	15.5	47.3	22	19	1600	41	6100
0.05	3.74	0.07	11	312	18	22	15.8	48.1	22	19	1730	42.9	6190
0.05	43	0.07	11.2	396	18	24	15.8	48.7	22	19	1730	44	6400
0.052		0.07	12.1		20	27	16	48.9	22	19	1900	49	7570
0.057		0.08	13.6		20	27	16	49.4	22.6	19.3	1990	54	8420
0.0583		0.08	15		20	27	17	51	22.7	20	2080	59	8950
0.06		0.08	17		22.2	30	17.4	53.9	23	21	2660	60	14200
0.06		0.08	18.8		23.4	31	17.6	54.9	23	22	4230	71	15000
0.06		0.08	19		24	32	17.9	55.3	23	23	4700	80	21700
0.06		0.0853	20.3		26.6	33	18.2	57.6	23	23	5300	86	36200
0.06		0.0885	21		30	33.6	18.3	58.2	23	25	5470	86	39200
0.06		0.09	22		30	34	18.5	59.6	23	26	5700	96	44000
0.06		0.09	22		31.5	37	18.5	60	23.6	26	5700	102	49000
0.06		0.09	24		33	48	18.8	61.5	23.9	26	6100	109	50000
0.06		0.09	24.9		35.6	55	19.2	62.4	24	28	8240	110	52000
0.06		0.09	26		40	61	19.3	63.9	24	29	26000	128	67000
0.07		0.096	26		42	64	19.4	113	25	31.2	41100	129	100000
0.07		0.1	26		49	65	19.7	355	25	32		133	120000
0.07		0.1	27		54	100	19.9		25	33		136	260000
0.07		0.1	29		58	100	20.1		25	34		142	9500000
0.0776		0.1	30		64	110	20.3		25	35		143	
0.08		0.12	38		70	120	20.3		25.7	35		160	
0.08		0.13	38		86	126	20.8		26	36		160	
0.08		0.13	40		92	148	21		26	36		161	
0.08		0.13	41		100	161	21		27	37		180	
0.08		0.13	43		100	165	21		27	39		186	
0.08		0.13	46		110	225	21.2		27	43		190	
0.08		0.13	60		160	235	22		27	45		196	
0.0838		0.131	98		250	350	22		27	52		234	
0.0844		0.14	154		291	380	22		27.8	53		234	
0.0877		0.14	194		424	400	22		28	54		240	
0.088		0.15	212		466	440	22		28	55		282	
0.0998		0.15	379		471	450	22		28	56.7		290	
0.1		0.16	380		501	510	22		28	60		333	
0.1		0.16	459		650	529	22		28	60		354	
0.104		0.16	459		913	540	23		28	62		384	
0.11		0.17	508		1030	627	23		28	63		393	
0.11		0.18	2560		1300	1270	23		28.9	65		394	
0.11		0.18	4850		1400	1310	23		29	65		440	
0.114		0.186	>4850		1600	1360	23.7		29	65		469	
0.119		0.2			3220	2200	24		29.5	71		472	
0.12		0.2			5630	2280	24		29.6	73		566	
0.13		0.21				3630	24		29.7	80		570	
0.13		0.21				4870	24.1		29.8	81		620	
0.13		0.215				4890	24.8		30	87		629	
0.14		0.23				4970	26		30	93		680	
0.14		0.25				12000	26		30	93		848	
0.141		0.251				21000	26		30.6	93		880	
0.149		0.253				40600	26		30.6	93		1000	
0.15		0.259				67000	26.8		30.8	93.1		1000	
0.157		0.26				92000	27		31	95		1000	
0.16		0.27				600000	27		31	95		1040	
0.16		0.27				2300000	27		31	97		1070	
0.165		0.286					27.2		32	110			
0.17		0.343					27.3		33.7	120			
0.18		0.36					28		36	130			
0.19		0.46					28.2		37	150			
0.206		0.52					28.7		37.9	150			
0.21		0.546					28.8		38.8	160			
0.21		0.56					29		39.1	180			
0.232		0.604					29.1		39.2	190			
0.28		0.62					29.3		39.3	190			
0.284		0.662					30.4		39.6	210			
0.284		0.673					31		43.4	231			
0.297		0.69					32.9		45.1	240			
0.335		0.711					33.6		46	244			
0.359		0.749					34.2		48.4	260			
0.37		0.8					34.3		52.3	278			
0.389		0.844					34.4		53.1	332			
		1.25							54				
		1.3							56				
		1.41							56.8				
		1.5							58.4				
		1.72							61.9				
		2							63				
		2.22							64				
		2.7							70.6				
		2.7							77.4				
		2.9							88				
		2.93							105				
		3.3							133				
		9.5							594				

HYALELLA MORTALITY									
Phosphorus	**Phosphorus**	**Pyrene**		**Pyrene**		**Retene**	**Retene**	**Silver**	**Silver**
No-Hit	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
128	459	7	160	14	4400	75	94	0.06	0.094
282	475	8.7	160	20	4700	77.1	202	0.08	0.094
306	563	10	162	24	5120	128	1050	0.094	0.098
349	625	13	200	29	5300	201	1900	0.1	0.1
352	657	14	210	30	7000	289	4230	0.1	0.1
393	1310	14	210	34	7150	352	6020	0.1	0.1
402	2770	17	240	36	7500	553	8700	0.1	0.1
410		17	240	37	7540	564	11200	0.1	0.11
425		17	250	45.5	8100	782	16000	0.1	0.12
428		17	250	46	9130	1170	19200	0.1	0.14
486		18	254	47	11200	1300	27000	0.1	0.16
503		18	261	53	13300	1470	35000	0.1	0.199
507		19	270	54	13600	2170	66400	0.1	0.2
516		19	280	66	15900	5400	360000	0.1	0.2
531		20	280	71	18000	6020		0.11	0.2
538		21	289	71.2	20000	54500		0.11	0.2
590		21.1	319	74	21000	810000		0.12	0.2
615		22	350	82	25000			0.14	0.2
624		24	361	85.7	32200			0.14	0.2
691		25	375	88.1	40000			0.144	0.2
694		27	379	92	65000			0.15	0.217
710		27	380	96	68000			0.16	0.23
725		30	387	97	98000			0.17	0.3
741		31	430	110	100000			0.19	0.3
824		32.2	450	110	110000			0.2	0.3
880		33	523	118	130000			0.2	0.3
908		33	560	120	1100000			0.2	0.3
1040		37	560	124	3900000			0.2	0.3
1150		37	580	130				0.2	0.3
1160		38	581	133				0.2	0.3
1180		39	626	144				0.2	0.322
1540		39	679	175				0.2	0.36
1590		41	830	183				0.2	0.39
2060		42	927	260				0.2	0.4
2660		43	950	300				0.2	0.4
2790		45	970	304				0.2	0.4
3290		46	987	308				0.2	0.4
> 3290		48	1100	320				0.2	0.444
		48.5	1250	320				0.2	0.5
		50	1320	332				0.2	0.5
		51.6	1350	332				0.219	0.5
		54	1500	333				0.22	0.5
		55	1590	352				0.23	0.5
		55	1630	356				0.25	0.53
		56	1900	359				0.26	0.545
		57	2000	370				0.26	0.58
		63	2100	380				0.27	0.6
		64	2340	404				0.28	0.6
		65.6	2700	410				0.3	0.6
		66	2710	429				0.3	0.63
		67	2870	431				0.3	0.7
		67	2960	452				0.3	0.72
		67	3460	455				0.3	0.8
		68	3500	465				0.3	0.8
		68	3540	477				0.35	0.8
		70	4410	488				0.359	0.8
		72.4	5000	510				0.38	0.86
		73	5700	536				0.4	1
		74	6800	626				0.4	1.1
		74	8790	634				0.4	1.1
		75	10000	685				0.43	1.2
		77	16000	700				0.43	1.32
		80	21000	715				0.45	2.8
		82	22000	730				0.45	2.9
		83	26000	750				0.53	3.3
		89	55600	770				0.7	4.5
		90	68000	829				0.77	
		91		1200				0.8	
		92		1320				0.9	
		92		1400				1.1	
		93		1500				1.4	
		99		1600				1.6	
		100		1710				1.8	
		107		1820				1.9	
		108		2190				1.9	
		110		2200				2	
		117		2300				2.2	
		120		2300				3.1	
		120		2500				3.5	
		121		2530					
		130		3000					
		140		3200					
		140		3650					
		140		4100					
		150		4200					
		150		4280					
		158		4300					

HYALELLA MORTALITY			
Total benzofluoranthenes (b+k (+j))		**Total benzofluoranthenes (b+k (+j))**	
No-Hit	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**
11.7	350	16	5400
12	414	16	5530
13	480	23	5600
15	496	27	6590
15	501	29	7000
15.1	560	29	7110
15.4	600	41	8900
17	630	41	13500
19.2	630	42	13800
20	630	44	14600
20	770	48	22100
21	799	49	25000
21	890	50	47000
22	906	54	85000
25	1040	62	101000
25	1100	67	144000
26	1151	70	163000
26	1280	76	200000
26	1340	77	280000
27	1370	82	560000
32	1380	83	
36	1780	91	
36.9	1923	91	
38	1960	102	
39	2020	103	
39	2100	117	
41	2450	119	
41	2800	120	
43	2830	143	
43	3170	148	
44	3400	175	
44	3620	178	
45	4800	198	
46.4	5300	234	
50	11000	245	
50	12000	290	
50	17900	293	
52	18400	300	
53	19900	311	
53	20100	312	
54	41800	313	
55	79000	316	
57		320	
59		335	
59		348	
60		363	
63		379	
66.9		412	
68		421	
69		445	
72		541	
76		552	
76.6		579	
79		617	
83		643	
87		657	
93		680	
102		686	
110		774	
110		823	
116		853	
118		855	
120		881	
124		890	
127		1028	
140		1200	
141		1390	
142		1410	
149		1410	
150		1600	
176		1700	
180		1850	
186		1860	
187		2000	
188		2100	
190		2270	
191		2320	
220		2620	
248		2750	
248		3200	
255		3200	
283		3400	
297		3700	
310		3810	
338		4300	
339		4440	
339		5180	

HYALELLA MORTALITY					
Total organic carbon		**Total organic carbon**		**Total Polychlorinated Biphenyls**	**Total Polychlorinated Biphenyls**
No-Hit	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**Hit**
0.05	2.51	0.05	3.8	11	11
0.08	2.52	0.1	3.95	12	16
0.13	2.54	0.22	4.13	17	29
0.14	2.57	0.25	4.19	43	40
0.14	2.6	0.25	4.25	43	53
0.21	2.61	0.4	4.49	48	57
0.22	2.69	0.4	4.56	73	62
0.23	2.71	0.4	4.6	108	69
0.23	2.74	0.56	4.9	130	70.1
0.26	2.8	0.6	5.1	217	82
0.35	2.87	0.67	5.6	304	88
0.38	3.1	0.76	5.7	460	108
0.38	3.12	0.8	5.81	1460	112
0.4	3.3	0.82	5.9	2090	116
0.42	3.31	0.83	6.27		116
0.6	3.4	0.89	7.07		116
0.61	3.42	0.9	7.35		116
0.65	3.48	0.91	7.4		129
0.67	3.6	0.95	7.7		130
0.69	3.6	0.97	7.9		168
0.72	3.61	1.01	8.3		209
0.72	3.71	1.1	8.9		251
0.74	3.89	1.12	9		253
0.78	4.01	1.19	9.7		257
0.81	4.01	1.2	9.82		284
0.88	4.05	1.3	10		300
0.9	4.14	1.45	10.6		310
0.94	4.31	1.46	12		310
0.97	4.65	1.46	12.1		330
0.996	4.74	1.48	13		340
1.03	4.74	1.52	18		354
1.16	4.9	1.56	19		379
1.2	4.92	1.61	21.3		388
1.24	5	1.62			394
1.26	5.02	1.65			1050
1.27	5.13	1.67			1050
1.28	5.2	1.73			2500
1.28	5.7	1.75			
1.3	6.3	1.77			
1.3	6.4	1.8			
1.3	6.4	1.83			
1.3	6.8	1.83			
1.32	7.35	1.89			
1.37	12	1.9			
1.39	12	1.96			
1.4	12.2	1.97			
1.42	15.8	1.97			
1.44	25	1.98			
1.44	> 25	2.01			
1.5		2.03			
1.5		2.1			
1.5		2.11			
1.52		2.11			
1.57		2.13			
1.59		2.14			
1.6		2.15			
1.68		2.16			
1.72		2.18			
1.77		2.21			
1.8		2.25			
1.8		2.25			
1.82		2.26			
1.83		2.27			
1.85		2.3			
1.87		2.34			
1.87		2.35			
1.91		2.41			
1.93		2.44			
1.96		2.46			
1.98		2.47			
2.06		2.5			
2.07		2.61			
2.09		2.66			
2.1		2.7			
2.13		2.74			
2.15		2.74			
2.16		3			
2.17		3			
2.18		3.03			
2.21		3.13			
2.27		3.48			
2.3		3.52			
2.31		3.58			
2.35		3.6			
2.42		3.68			
2.45		3.69			
2.48		3.7			

HYALELLA MORTALITY						
Total Sulfides	**Total Sulfides**	**Tributyltin**	**Tributyltin**	**Zinc**		**Zinc**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**
0.17	0.21	0.503	1.28	13.6	152	40
0.9	0.21	0.87	1.95	14.8	158	45
2.3	0.31	1	2	17.2	161	45.4
2.69	1.8	1.16	2.27	17.7	167	49
2.9	2.9	2	52	18.6	173	54
3.3	6	2.4	60	24.4	188	55
3.4	6.6	2.51	110	30.7	193	55
3.8	9.9	2.88	113	34.8	203	58
5.8	17.4	3.6	160	47.5	211	60
6.2	17.5	4.3	198	48	215	60.6
6.2	20	4.3	250	49.7	243	61.5
7	20.8	4.4	260	51.3	249	62.2
7.8	21	4.7	370	55	377	68.3
9	21	5.7	590	55.9	391	73.7
9.2	21.7	6.4	598	58.1	397	75
10	22	7.6	697	58.2	399	77
10.8	23	8.5	810	61.3	406	79.8
11.4	24	9	824	65	435	84.3
12.6	31	9.3	936	65.6	520	85
13.4	42.4	9.5	965.2	65.6	527	86
15.8	44.2	11	1700	66	550	87
16	44.6	12	1700	69.9	567	90
18.4	48	13	1959	70.3	623	93.2
18.4	48.1	13	2200	70.8	684	96
19.3	62	18	2490	70.8	754	97.6
22.6	65.8	19	2750	71.1	849	98.8
24.7	80.1	22		71.6	904	101
34	96.3	25		72.7	1020	101
35.6	130	27		72.7	1080	110
47.4	133.9	30		73	1180	111
60.6	149	32		73.5	2010	115
64	150	35		74	4150	120
65.5	161	37		76	> 4150	120
74.1	181	40		76.4		122
83.8	202	62		76.8		130
87	223	78		76.9		130
92.4	230	100		77.3		133
97.3	249	200		79.3		136
110	341	210		79.3		137
146	450	220		81.5		144
231	590	247		82		145
247	703	300		83		155
321	920	723		83		164
360	2330	1210		84		169
493	7700	1410		84		190
514		1710		84		193
702		1860		84.4		210
900		2220		85		210
941		2530		85.3		212
		6650		85.7		220
		15700		85.9		225
		64600		86		227
		> 15700		87		238
				87		242
				89.3		254
				89.4		262
				89.6		264
				90		269
				90.5		270
				91.8		271
				94.4		279
				95.9		281
				96.8		284
				97.3		286
				98		296
				101		306
				104		314
				106		333
				106		337
				107		354
				113		359
				114		368
				117		369
				119		370
				119		374
				122		375
				124		377
				124		385
				126		397
				128		407
				131		423
				136		435
				139		443
				142		450
				145		457
				148		470
						494
						562
						582
						593
						661
						673
						675
						683
						689
						1070
						1090
						1770
						2980
						4050

CHIRONOMUS GROWTH							
2-Methylnaphthalene	**2-Methylnaphthalene**	**Acenaphthene**	**Acenaphthene**	**Acenaphthylene**	**Acenaphthylene**	**Anthracene**	**Anthracene**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
11	13	10	20	3.2	4.5	5	13
12	13	10	23	3.5	12	10	52
13	52	11	59	11	13	11	53
14	54	11	60	11	17	12	74
15	62	11	88	12	23	12	110
15	64	12	92	12	35.8	12	126
15	180	12	162	13	44	12	155
16	188	12	177	14	94	13	170
16	189	14	203	14	110	14	233
20	443	14	260	14	110	14	370
24	877	15	272	15	200	15	373
28	2310	17	310	15.7	209	16	406
28	3470	18	410	19	362	16	560
30		18	560	20.8	460	17	774
36		18	630	23	480	18	814
141		18	940	25	640	20	1130
160		19	990	30	642	22	1190
170		23	1060	34	1020	22	1400
180		23	1100	36.8	3600	23	1520
214		24	2350	42		25	1700
353		32	2460	71		25	1700
469		33	2460	88		27	1700
555		36	2790	120		27	1900
982		37	2940	136		28	2860
1720		37	5700	140		28	2920
1770		39	7420	148		29	5700
		43	20800	171		29	6140
🟦	AET - low confidence	45	29600	265		32	6600
🟦	AET - high confidence	52		265		37	16200
🟩	next highest hit value	72		279		38.6	
🟨	outlier	73		314		40	
		75		594		40.1	
		82		697		41	
		90		1260		42	
		91.9				46	
		99				53	
		107				65	
		112				67	
		120				70	
		130				72.5	
		148				85	
		156				95	
		209				99	
		240				101	
		252				115	
		260				124	
		310				177	
		316				220	
		332				320	
		360				343	
		520				350	
		523				356	
		792				429	
		920				465	
		1250				510	
		1320				552	
		6100				600	
		6290				630	
						660	
						717	
						915	
						965	
						1110	
						1230	
						1500	
						1580	
						5900	

CHIRONOMUS GROWTH											
Antimony	**Antimony**	**Aroclor 1254**	**Aroclor 1254**	**Aroclor 1260**	**Aroclor 1260**	**Arsenic**		**Arsenic**	**Benzo(a)anthracene**		**Benzo(a)anthracene**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**
0.05	0.06	11	52	15	42	1.4	5.17	3.5	4.8	99	8.1
0.1	0.1	11	70	15	53	1.9	5.3	3.9	11	103	28
0.1	0.1	12	156	18	57	2	5.6	4	11	105	162
0.1	0.2	16	170	20	57	2	5.6	4.3	13	105	179
0.13	0.2	17	227	24	77	2.7	5.7	4.3	13	106	220
0.14	0.3	18	960	26	184	2.9	5.7	4.4	14	109	235
0.2	0.3	24	1060	27	460	3	5.81	4.7	14	110	240
0.2	0.4	25		29	500	3	5.9	5	15	112	288
0.2	0.4	37		37		3	6	5	15	112	373
0.2	0.5	47		38		3	6	5	16	113	411
0.2	0.6	51		40		3	6	5	16.9	115	516
0.2	0.8	54		42		3	6	6	17	130	600
0.2	1.1	54		43		3	6	6	17	140	724
0.2		58		46		3.2	6	6	18	148	917
0.3		62		46		3.3	6	6	18	150	958
0.3		70		48		3.3	6	6	18	154	1080
0.47		78		62		3.4	6.1	7	19	163	1330
0.5		81		64		3.5	6.92	7.7	19	167	2620
0.6		140		74		3.5	7	7.8	19	170	2640
4.4		189		85		3.7	7	8	20	181	2700
		202		98		3.9	7	9	20	186	3340
		209		116		4	7	13.7	20	188	3750
		230		138		4	7	15	22	199	4000
		256		2500		4	8	17	22	259	5430
		294				4	8	17.2	24	271	8600
						4	8	20	24.4	321	9000
						4	8.1	111	25	342	11000
						4	9	152	26	353	12000
						4	9	175	29	441	13000
						4	9	200	29	523	25600
						4	9		29	539	37000
						4	11		30	561	77000
						4	11		30	598	
						4	11.7		31	1060	
						4	12.7		32	1100	
						4	12.8		32	1180	
						4	13		32	1220	
						4	13.1		32	1270	
						4	14.3		33	1480	
						4	16.5		35	1500	
						4	17		35	1580	
						4.09	20		35	1720	
						4.1	21.7		36	2300	
						4.2	30.6		37	2380	
						4.3	31.3		38	3200	
						4.3	31.4		41	4260	
						4.6	123		41	6200	
						4.6			43	11000	
						4.7			49	44000	
						4.7			51		
						4.7			52		
						4.8			56		
						4.9			62		
						5			64		
						5			67		
						5			70		
						5			71		
						5			73		
						5			73		
						5			77.8		
						5			79		
						5			79		
						5			82		
						5			89		
						5			93		
						5			93		
						5			94		

CHIRONOMUS GROWTH							
Benzo(a)pyrene		**Benzo(a)pyrene**	**Benzo(g,h,i)perylene**		**Benzo(g,h,i)perylene**	**Bis(2-ethylhexyl) phthalate**	**Bis(2-ethylhexyl) phthalate**
No-Hit	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**Hit**
10	102	8.8	11	73.3	9.6	50	120
12	114	11	11	73.4	18	62	300
12	116	20	11	77	84	62	310
13	117	153	11	77	99	110	370
13	120	160	12	78	102	110	420
13	120	176	13	82	104	120	450
14	120	195	13.5	87	121	140	460
14	124	213	14	94	127	160	501
15	128	216	14	99	134	180	540
15	128	223	14	108	164	200	727
16	133	298	15	110	170	240	1930
16	135	334	16	114	231	250	2140
16	145	358	16	115	308	260	2140
18	150	387	16.8	133	424	275	2800
18	170	570	17	146	821	290	3010
18.6	171	615	17	149	1330	307	3420
19	176	1080	17	150	1350	320	3510
19	176	1110	17	175	1720	330	7590
19	180	1530	17	186	2500	330	10500
21	189	2750	18	187	2510	337	33300
21	195	2960	18	216	3300	350	
21	206	3300	18	220	7100	350	
23	226	3340	19	221	7600	350	
24	231	4900	19	223	8900	360	
25	248	9600	19	270	9400	360	
25	256	11000	19	497	11000	370	
26	256	13000	20	613	12100	370	
27	270	13000	20	791	27000	390	
27	333	15000	20.9	827	55000	418	
27.4	351	24300	21	854		420	
28	382	39000	22	1150		420	
28	451	86000	22	1200		440	
29	783		22	1350		444	
31	890		22	1410		452	
32	915		22	1520		460	
32	1070		23	1660		470	
32	1420		29	1900		480	
33	1620		29	2800		500	
34	1630		30	4020		510	
34	1800		30	5400		519	
36	1840		30	11000		520	
36	1890		31	38000		546	
37	2220		32			547	
38	2700		32			550	
40	4000		33			575	
40	4810		35			660	
43	6700		36			774	
43	14000		41			778	
43	55000		42			800	
45			43			867	
48			44			913	
49			45			1000	
51			46			1020	
56			48			1050	
58			50			1090	
60			51			1110	
67			51			1370	
68			56			1380	
73			56			1390	
76			57			1400	
85			57			1440	
85			65			1740	
87			68			1800	
88			69			1920	
91			70			1970	
93			70			2220	
100			71			2520	
						3970	
						4330	
						4970	
						5120	
						6360	
						6380	
						22300	

CHIRONOMUS GROWTH													
Butyl benzyl phthalate	**Butyl benzyl phthalate**	**Cadmium**		**Cadmium**	**Chromium**		**Chromium**	**Chrysene**		**Chrysene**	**Copper**		**Copper**
No-Hit	**Hit**	**No-Hit**		**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**No-Hit (Cont)**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**
10	24	0.07	1.1	0.18	7	42	21.1	5.1	110	9.5	8.5	106	35.4
11	36	0.1	1.2	0.3	10.1	42.8	23	12	110	11	10.7	119	41.4
18	47	0.1	1.3	0.6	12	44.9	23.1	13	117	13	15.4	130	42.9
18	53	0.1	1.3	0.6	12	46	23.6	14	126	61	15.6	136	44.1
21	55	0.1	1.4	0.7	13	53.9	29.2	15	126	161	17.2	140	44.6
24	86	0.1	1.6	1	14.3	55.9	29.4	15	128	280	18.3	142	46
24	131	0.1	1.6	1	15	57.3	31	17	130	318	20.3	146	50.9
25	145	0.1	2.1	1.1	15.2	62	31.2	17	140	393	20.4	154	52.2
25	198	0.1	2.5	1.2	15.7	63.4	31.9	17.9	144	412	20.9	163	57.3
25	407	0.11	2.7	1.3	16.7	66.7	36	19	147	430	21.7	187	62
28	763	0.13	5.6	1.4	16.8	77.1	39	21	157	507	22.5	209	64
31		0.14	> 5.6	1.5	17	80.1	40.5	22	160	541	22.9	210	70.4
32		0.17		1.9	18.3	80.7	41	23	161	562	23.6	267	71.1
32		0.2		2	19.1	133	43	23	170	816	23.6	314	82.3
34		0.2		2	22		43	24	172	819	24.2	315	119
35		0.2		2.2	22		45.3	24	177	1140	24.3	327	158
37		0.2		2.3	23		68.3	24	179	1260	26	363	188
40		0.2		2.6	23.3		80.7	24.6	180	1300	26.6	397	371
41		0.2		2.9	24		96.2	25	187	2320	26.8	571	508
42		0.2		3.01	24		99.5	25	190	2460	27.9	619	651
43		0.2		3.67	24		102	25	193	3000	28.6	627	655
47		0.2		5	24.1		348	26	202	3370	30	651	1460
48		0.2			24.6			27	211	3700	30.7	829	2010
50		0.2			25			27	221	3800	31.2		10800
52		0.2			25			28	249	5730	31.6		
53		0.2			25.4			28	263	5880	32		
56		0.2			25.4			28.1	281	7800	32.4		
56		0.2			26			30	314	8900	32.9		
57		0.2			26			31	320	10000	33		
57		0.2			26			32	390	11000	34.1		
62		0.2			26			32	425	11000	35		
64		0.2			26			33	482	28100	35		
64		0.2			26			33	489	38000	35.5		
66		0.2			26.4			34	508	75000	35.9		
70		0.2			27			34	601		36.2		
73		0.2			27			35	657		36.5		
90		0.2			27			35	707		36.8		
119		0.3			27			35	755		36.8		
121		0.3			27.3			36	1130		38		
160		0.3			28			38	1400		38.3		
163		0.3			28			39	1440		38.5		
165		0.3			28.4			43	1500		40.6		
170		0.3			29			45	1540		40.7		
182		0.3			29			46	1560		41.9		
184		0.3			29			47	1710		43.4		
222		0.31			29			48	2140		44		
258		0.4			29			51	2170		45.6		
274		0.4			29			51	2200		46.9		
280		0.4			29.4			51	2210		48.1		
366		0.4			31			52	3200		50		
1520		0.4			31			55	3430		50.4		
		0.4			31			57	5940		53.2		
		0.45			31			58	7000		61		
		0.5			31			59	11000		61.8		
		0.5			32			61	46000		62.9		
		0.5			32			70			71.1		
		0.6			32			70			74.5		
		0.6			33			70.4			76.7		
		0.6			34			73			81.2		
		0.69			34			91			84.5		
		0.7			35			93			86		
		0.8			36			95			90.9		
		0.9			37			95			94.3		
		0.9			37			98			94.4		
		0.9			38			100			96.6		
		1			40			104			96.7		
		1			41			105			100		

CHIRONOMUS GROWTH					
Dibenz(a,h)anthracene	**Dibenz(a,h)anthracene**	**Dibenzofuran**	**Dibenzofuran**	**Dimethyl phthalate**	**Dimethyl phthalate**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
10	17	10	14	11	11
12	22	10	15	12	16
12	24	12	33	13	37
13	30	12	38	13	42
13	31	13	46	14	54
14	43	13	52	15	58
14	55.9	14	75	16	156
14	58	14	116	19	314
14	72	16	160	21	362
16	82	16	166	31	
16	116	18	168	108	
18	217	19	170	147	
18	424	24	200	158	
18	437	26	204	171	
18	490	26	399	172	
19.3	540	30	1750	270	
21	730	31	2260	311	
26	800	41	3810	436	
28	1200	62		576	
29	1200	64		> 576	
34	1700	90			
34.1	2200	138			
36	3070	160			
37	4700	170			
38		180			
49		234			
50		244			
56		372			
66		384			
125		443			
132		460			
176		660			
200		928			
214		1010			
216					
280					
292					
294					
327					
332					
342					
350					
630					
839					
1700					
2600					
11000					

CHIRONOMUS GROWTH						
Di-n-butyl phthalate	**Di-n-butyl phthalate**	**Di-n-octyl phthalate**	**Di-n-octyl phthalate**	**Fluoranthene**		**Fluoranthene**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**
6.5	9	10	54	5.6	190	14
10	44	11	115	16	192	15
11	61	12	256	16	206	18
11	71	12	413	19	210	44
11	108	13		19	210	276
12	350	13		21	240	453
12	1180	13		22	240	455
13		15		23	268	540
14		17		23	270	674
15		17		23.5	280	695
15		18		26.9	280	939
15		21		27	288	1400
16		21		28	291	1690
17		22		32	301	1780
17		23		34	320	2340
17		25		35	324	2450
19		26		36	334	2660
19		26		39	342	4950
20		27		40	356	6500
21		30		41	359	6600
21		30		41	363	7400
22		32		44	380	7710
23		34		44.7	383	9340
24		34		45	390	15000
24		34		53	428	15000
26		37		54	437	16700
26		39		54	445	18000
27		40		58	450	19200
30		44		58	452	20100
31		45		61	455	24200
34		46		63	500	26000
37		47		63	502	46100
37		48		65	646	100000
40		49		65	699	120000
41		52		67	731	
41		54		68	740	
67		55		69	798	
68		58		70	833	
90		66		71	1260	
103		67		72	1400	
116		74		75	1620	
158		90		76	1640	
254		100		77	2140	
306		110		79	2300	
350		201		80	3140	
481		399		91	3190	
690				91	3210	
805				93	3360	
841				93	3370	
893				96	3450	
1740				97	3600	
> 1740				97	4700	
				110	4780	
				110	5000	
				112	6100	
				116	7730	
				116	9800	
				123	11100	
				124	15000	
				130	180000	
				138		
				143		
				144		
				153		
				157		
				158		
				160		

CHIRONOMUS GROWTH									
Fluorene	**Fluorene**	**High Molecular Weight PAH**	**High Molecular Weight PAH**	**Indeno(1,2,3-c,d)pyrene**		**Indeno(1,2,3-c,d)pyrene**	**Lead**		**Lead**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**
11	30	54	56	8	88	8.2	4.7	44.8	12.6
12	33	107.1	96.6	10	88	18	5.24	47.6	13.5
12	42	116	7370	10	95	68	7.1	48.8	16.5
13	88	131.2	11020	11	97	100	7.3	52.2	29
13	160	134	13690	11	97.2	116	9.21	56	41.5
13	160	136	31640	12	100	130	10.2	58.7	50.2
14	167	470	35390	12	106	134	10.5	62.5	54.4
15	201	629	44500	12	110	134	11.1	68.4	68.1
17	230	711	57000	13	110	155	11.2	79.1	80.7
17	251	799	62900	14	120	170	11.6	87.6	94.6
18	274	1004	95330	14	124	207	12	89.6	118
19	285	1376	111800	14	133	208	12.2	96.6	125
19	570	2068	121500	15	141	342	12.5	99.4	133
19	590	2080	122700	16	144	363	12.7	114	177
22	620	2251	134300	16	160	763	12.7	150	210
22.3	670	2522	250500	16	178	1180	12.7	150	258
23	730	2629	427700	16	180	1500	12.7	152	272
23	1070	8440	765000	17	198	1750	12.9	194	294
24	1200	13290		17.7	199	2340	13.1	204	299
25	1900	13480		18	222	4600	13.2	230	322
33	2080	15080		19	255	6000	13.2	249	357
36	2350	16460		20	260	10000	13.3	431	436
36.2	3240	16780		20	269	13000	13.3	1160	525
37	3400	17410		21	340	13900	13.4		1310
38.1	3890	19960		22	518	14000	13.7		
39	6970	21970		22	643	17000	13.8		
44	15800	28550		22	740	19000	14.4		
47	18300	31170		23	773	41000	14.4		
49		38030		24	889	110000	14.7		
50		54800		24	1160		14.8		
57		72000		25	1220		14.9		
60		120500		27	1340		15.1		
62		471000		27	1350		15.2		
73				28	1450		15.2		
75				29	2300		15.2		
79				30	3400		15.3		
85				30	4120		15.7		
91				30	5100		15.9		
100				30	10000		16.2		
107				31	18000		17.3		
124				34	60000		17.9		
126				36			17.9		
171				36			18.1		
181				40			18.6		
185				43			18.8		
200				43			20.8		
270				44			21		
390				44			21.1		
400				45			22.4		
420				45			23.5		
465				52			23.5		
498				53			23.6		
666				53			25.6		
932				59			25.9		
1540				59			26.1		
1720				61			26.6		
2500				65.6			27.3		
3850				67			27.4		
				68			27.5		
				69			30.1		
				73			30.2		
				74			33.6		
				76			36		
				80			36.2		
				81			38.9		
				81			39		
				83			41.9		

CHIRONOMUS GROWTH											
Low Molecular Weight PAH	**Low Molecular Weight PAH**	**Mercury**	**Mercury**	**Naphthalene**	**Naphthalene**	**Nickel**		**Nickel**	**Phenanthrene**		**Phenanthrene**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**
10.8	23.3	0.02	0.05	3.3	7.8	8	27.2	18.5	4.3	133	11
28.6	1800	0.04	0.06	6.1	27	10	28	21	11	136	13
53	2498	0.04	0.08	10	27	12.9	28	22	14	142	231
71	2700	0.05	0.08	10	30	13	28	22	14	150	234
95	2760	0.05	0.09	11	30	14.7	28	22	14	160	282
160	3110	0.05	0.1	13	35.6	15.5	28	23	14	160	566
233	8130	0.05	0.13	13	48	15.8	29.5	24.1	16	160	570
358	8980	0.05	0.13	13	64	16	29.7	25	17	161	617
422	9200	0.05	0.14	14	65	16	30	25	17	180	629
1225	9380	0.05	0.15	15	86	16	31	27	19	186	848
1763	9520	0.05	0.16	15	110	16	31	27	19	190	1070
2088	10270	0.05	0.17	15	126	16	39	27	19	234	1130
2240	18700	0.06	0.21	16	148	17	39.4	28	19	240	1300
2890	28500	0.06	0.25	18	161	17	43.5	28	19	244	1600
3040	29010	0.06	0.558	18	250	17.6	45.2	35.7	19.3	278	1900
3140	49000	0.06	0.844	19	400	18	46	36	20	332	3990
4380	78300	0.06	1.25	19	440	18.5	48.9	37.9	21	333	4230
4720		0.06	2.22	19	450	18.8	49.4	48.4	21	384	4370
6259		0.06	2.7	20	466	19.2	54	53.1	22	384	4700
6590		0.06	3.74	20	529	20.1	59.6	58.2	23	388	4900
8255		0.06	43	22	627	20.3	61.5	62.4	23	393	5700
8800		0.06		22.2	1310	21	64	77.4	24	469	6100
9130		0.07		23.4	1360	21	70.6	355	25	472	6400
14070		0.07		24	2200	21	113	594	25	569	8240
16870		0.07		24	4890	21			26	587	8420
41970		0.07		27	5630	21			26	730	8950
		0.07		30	40600	21			26	778	14200
		0.08		31		21.2			28	1000	15000
		0.08		31.5		22			29	1040	36200
		0.08		32		22			31.2	1200	39200
		0.09		33		22			32	1480	41100
		0.09		33		22			33	1700	49000
		0.096		34		22			33	1720	
		0.1		37		22			35	1730	
		0.1		40		22			35	1990	
		0.1		42		22			36	2080	
		0.1		49		22.7			36	2660	
		0.11		54		23			37	3620	
		0.11		55		23			38	4440	
		0.12		58		23			39	4700	
		0.12		61		23			41	5300	
		0.12		92		23			44	5470	
		0.13		100		23			49	6190	
		0.13		100		23			54	7570	
		0.13		225		23			54	26000	
		0.13		291		23			60		
		0.14		424		23.7			60		
		0.141		471		23.9			60		
		0.15		501		24			62		
		0.157		650		24			71		
		0.16		913		24			71		
		0.16		1030		24			80		
		0.16		1400		25			80		
		0.2		2280		25			81		
		0.23		3220		25			86		
		0.435		4870		26			86		
		0.54		4970		26			87		
		0.545				26			93		
		0.62				26			93		
		0.659				26			93		
		0.662				26			93.1		
		0.749				27			95		
		0.796				27			96		
		0.8				27			102		
		0.8				27			109		
		0.993				27			128		
		2.01									
		3.04									

CHIRONOMUS GROWTH							
Pyrene		**Pyrene**	**Silver**	**Silver**	**Total benzofluoranthenes (b+k (+j))**		**Total benzofluoranthenes (b+k (+j))**
No-Hit	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**
10	150	14	0.1	0.1	11.7	143	15.4
14	158	17	0.1	0.2	15	148	20
17	160	19	0.1	0.2	15	149	41
17	175	37	0.1	0.22	15.1	175	93
19	210	56	0.1	0.3	17	176	188
21	240	375	0.1	0.3	19.2	178	300
21.1	254	455	0.1	0.3	23	186	339
22	260	510	0.1	0.3	25	191	541
24	261	536	0.1	0.3	25	234	552
27	270	626	0.1	0.5	26	245	579
30	280	700	0.1	0.6	26	248	617
30	289	829	0.1	0.7	27	248	855
31	300	1320	0.14	0.8	36	255	881
32.2	304	1350	0.14	0.8	36.9	283	906
33	308	1630	0.15	0.8	39	290	1028
36	319	1820	0.2	0.8	39	293	1151
37	320	2340	0.2		41	297	1200
37	332	2530	0.2		41	311	1923
38	333	3650	0.2		41	312	1960
39	352	5000	0.2		42	316	2310
41	356	5700	0.2		43	335	2320
42	361	7150	0.2		43	338	2620
45	370	7500	0.2		44	339	4800
48	379	11200	0.2		44	348	5530
48.5	380	13300	0.2		45	363	6590
53	380	13600	0.2		46.4	379	7000
54	387	15900	0.2		48	414	7110
54	404	20000	0.2		50	421	13500
55	429	21000	0.2		50	445	14600
57	431	21000	0.2		50	496	18400
63	452	22000	0.2		53	501	20100
64	477	25000	0.2		54	630	22100
66	488	55600	0.2		54	657	41800
67	523	98000	0.2		55	686	47000
67	581	110000	0.2		57	774	144000
68	626		0.2		59	823	
68	634		0.26		59	853	
68	679		0.26		59	1380	
70	715		0.28		60	1410	
71	770		0.3		62	1780	
73	927		0.3		63	2000	
74	1250		0.3		66.9	2020	
74	1320		0.3		67	2270	
75	1590		0.3		68	2450	
77	1710		0.3		69	2800	
82	2190		0.3		70	2830	
82	2700		0.38		72	3400	
89	2710		0.4		76	3400	
91	2960		0.4		76	3620	
92	3460		0.4		77	4440	
96	3540		0.4		82	5600	
97	4280		0.4		83	11000	
100	4410		0.4		87	12000	
107	4700		0.5		91	19900	
108	5120		0.5		102	79000	
110	6800		0.5		103		
117	7000		0.5		110		
118	7540		0.6		117		
120	8790		0.6		118		
120	10000		0.7		119		
121	16000		0.8		120		
124	68000		1		124		
130			1.1		127		
133			1.9		140		
140			3.3		141		
144			> 3.3		142		

CHIRONOMUS GROWTH							
Total organic carbon		**Total organic carbon**	**Total Polychlorinated Biphenyls**	**Total Polychlorinated Biphenyls**	**Zinc**		**Zinc**
No-Hit	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**
0.21	2.35	1.28	11	112	49.7	238	70.3
0.23	2.41	1.3	11	129	51.3	254	89.3
0.38	2.42	1.44	12	209	55	262	96.8
0.42	2.44	1.46	16	284	55.9	264	164
0.56	2.45	1.67	17	354	58.1	269	167
0.61	2.48	1.77	29	1460	62.2	271	225
0.67	2.51	1.89	40	2090	65	281	279
0.69	2.52	2.03	43		65.6	296	306
0.72	2.57	2.16	43		65.6	314	333
0.74	2.61	2.5	53		66	354	337
0.78	2.8	2.61	57		71.1	359	385
0.82	3.03	2.66	62		72.7	368	397
0.88	3.6	2.71	69		73	374	399
0.89	4.9	2.74	82		74	375	406
0.95	5	2.74	88		75	377	407
0.97	5.2	3	108		76	391	423
1.03	5.7	3	108		76.4	435	435
1.19	6.3	3.4	116		76.9	443	450
1.2	6.4	3.52	116		77	527	593
1.24	9.7	3.69	116		82	550	675
1.26	10.6	4.6	116		83	567	683
1.28	12.1	5.6	130		83	754	1770
1.3	12.2	6.8	253		84	1020	2010
1.3	21.3	7.9	257		84.3	1080	4150
1.37	> 21.3	15.8	300		85		
1.39			304		85		
1.44			379		85.7		
1.45			394		85.9		
1.46			2500		86		
1.56					86		
1.59					87		
1.61					87		
1.65					87		
1.68					89.6		
1.72					90		
1.73					90		
1.77					96		
1.83					97.6		
1.87					98		
1.87					101		
1.91					101		
1.93					104		
1.96					106		
1.96					111		
1.97					113		
1.98					122		
1.98					122		
2.01					124		
2.06					130		
2.07					130		
2.11					131		
2.11					133		
2.13					137		
2.15					142		
2.16					142		
2.18					144		
2.21					145		
2.21					145		
2.25					158		
2.25					161		
2.26					173		
2.27					190		
2.3					203		
2.3					212		
2.3					220		
2.34					227		

CHIRONOMUS MORTALITY							
2-Methylnaphthalene	**2-Methylnaphthalene**	**4,4'-DDD**	**4,4'-DDD**	**4,4'-DDE**	**4,4'-DDE**	**4-Methylphenol**	**4-Methylphenol**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
11	5.1	0.77	1	0.76	2	7.3	16
12	10	0.99	3	0.8	2	11	24
12	13	3	7	2	3	16	48
13	15	3.4	8	2	3.2	117	50
13	16	4.7	8	3	3.8	476	63
14	16	5	8.3	3	5	760	77
15	28	5.6	11	4	5		130
15	28	7.5	12	4.6	6		150
20	30	8.9	16	6.7	6.8		159
24	52	9.2	20	7.8	8		180
36	54	14	22	8.3	8		188
189	62	22	27	8.9	8		215
555	64	24	45	11	8.6		239
	141	30		11	11		382
	160	33		18			512
	170	49		19			551
	180	50		20			699
	180	52		20			710
	188	59		20			1210
	214	70		> 20			1560
	353	96					1730
	443	> 96					2030
	469						2360
	877						6310
	982						
	1720						
	1770						
	2310						
	3470						
🟦	AET - low confidence						
🟦	AET - high confidence						
🟩	next highest hit value						
🟨	outlier						

CHIRONOMUS MORTALITY								
Acenaphthene	**Acenaphthene**	**Acenaphthylene**	**Acenaphthylene**	**Anthracene**		**Anthracene**	**Antimony**	**Antimony**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**No-Hit**	**Hit**
6.1	10	3.2	2.5	5	115	12	0.05	0.1
10	11	3.5	8.5	10	126	14	0.06	0.1
11	12	4.5	11	11	150	16	0.1	0.13
11	14	11	12	12	155	20	0.1	0.14
12	14	12	12	12	177	22	0.1	0.2
12	18	13	14	12	210	23	0.2	0.2
14	18	13	17	13	220	28	0.2	0.2
15	19	13	23	13	220	28	0.2	0.2
17	20	14	25	14	343	32	0.2	0.2
18	24	14	30	15	353	37	0.2	0.3
18	33	15	42	16	370	40	0.4	0.3
20	37	15.7	71	17	380	46	0.47	0.3
23	59	19	110	18	429	53	0.5	0.3
23	60	20.8	110	22	510	67	0.6	0.4
23	73	23	120	22	660	110	0.66	0.4
32	90	34	136	23	774	124	1	0.5
36	92	35.8	140	25	965	170	1.6	0.54
37	120	36.8	148	25	1190	220	1.8	0.6
39	130	44	171	27	1520	233	1.9	0.8
43	156	88	200	27	1900	280		1.1
45	162	94	209	29	5700	320		4.4
51	177	314	265	29		350		
52	203	470	265	38.6		356		
56	252		279	40.1		373		
72	260		362	41		406		
75	280		460	42		420		
77	310		480	46		465		
82	310		594	48.1		510		
88	332		640	52		552		
91.9	360		642	53		560		
99	410		697	65		600		
100	520		1020	70		630		
107	523		1260	72.5		717		
110	560		3600	74		814		
112	560			75.1		915		
130	630			85		980		
148	792			95		1110		
170	920			99		1130		
209	940			101		1230		
240	990					1400		
260	1060					1500		
272	1100					1580		
316	1250					1700		
830	1320					1700		
2350	2460					1700		
2790	2460					1900		
2940	6100					2860		
5700	7420					2920		
6290	20800					5900		
29600	86200					6140		
						6600		
						16200		
						16600		

CHIRONOMUS MORTALITY							
Aroclor 1254	**Aroclor 1254**	**Aroclor 1260**	**Aroclor 1260**	**Arsenic**		**Arsenic**	
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**
12	11	15	15	1.8	5.6	1.4	7
17	11	18	24	2	5.6	1.9	7
24	16	20	26	2.7	5.7	2	7.08
25	18	24	27	2.7	5.7	2.1	7.08
37	35	29	38	2.9	5.9	2.3	7.38
51	47	37	40	3	6	3	8
52	62	38	42	3	6	3	8.64
54	70	40	42	3	6	3	8.7
54	70	46	43	3.1	6	3	8.89
57	81	48	46	3.2	6	4	9
58	140	53	57	3.3	6	4	9
70	160	62	57	3.3	6	4	9
78	170	64	74	3.3	6.1	4	9
97	227	64	85	3.4	6.16	4	9
100	230	69	116	3.5	6.58	4	9.14
120	256	77	138	3.5	7	4	11
120	294	98	460	3.5	7	4	11
140	960	130	500	3.55	7	4	12.7
150	1060	130	2500	3.6	7	4	12.8
156		140		3.7	7.7	4	13.1
170		150		3.75	7.8	4.09	13.1
170		184		3.8	8	4.1	13.7
180				3.9	8	4.5	16.5
189				3.9	8	4.7	17
200				3.94	8.03	5	17.2
202				4	8.1	5	20
209				4	8.18	5	20
230				4	8.62	5	21.7
340				4	9.32	5	23
				4	9.46	5	23.9
				4	9.7	5	30.6
				4	10.6	5	31.3
				4	11.7	5	31.4
				4	11.7	5	32
				4	12.2	5	111
				4.2	13	5	123
				4.2	14.3	5	152
				4.3	14.7	5.17	175
				4.3	15	5.81	200
				4.3	15	6	
				4.3	15	6	
				4.3	17	6	
				4.36	17.8	6	
				4.4	19	6	
				4.6	26.6	6	
				4.6	26.8	6	
				4.7	28	6.1	
				4.7	44.9	6.92	
				4.7	49.3		
				4.7	50.7		
				4.74	50.9		
				4.8			
				4.9			
				5			
				5			
				5			
				5			
				5			
				5.1			
				5.3			

CHIRONOMUS MORTALITY							
Benzo(a)anthracene		**Benzo(a)anthracene**		**Benzo(a)pyrene**		**Benzo(a)pyrene**	
No-Hit	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**
4.8	103	11	561	8.8	128	12	358
8.1	105	13	600	10	131	14	430
11	109	14	917	11	133	15	451
13	112	16	958	12	135	16	615
14	112	19	1060	13	145	19	783
15	113	19	1100	13	150	19	890
15	115	22	1220	13	153	21	915
16.9	116	24	1270	14	171	21	1070
17	130	25	1500	15	176	24	1080
17	140	26	1580	16	176	25	1110
18	140	29	1700	16	180	26	1420
18	150	30	1720	18	189	31	1530
18	154	30	2300	18	195	32	1800
19	162	32	2380	18.6	195	34	1840
20	163	33	2620	19	210	36	1890
20	167	35	3200	20	210	36	2210
20	170	35	3340	21	213	37	2220
22	170	36	3500	23	216	38	2500
24.4	179	38	3750	25	223	43	2700
27	186	41	4000	27	231	43	2750
28	188	50	4260	27	240	48	2960
29	190	51	5430	27.4	256	51	3340
29	235	56	6200	28	256	56	4000
29	240	70	7930	28	280	66	4600
31	240	73	8600	29	298	67	4810
32	259	75	9000	32	310	73	4900
32	268	79	11000	32	333	81	6700
32	271	79	11000	33	343	85	9600
35	280	93	12000	34	351	87	11000
37	288	93	13000	40	360	91	13000
37	321	94	25600	40	360	100	13000
38	342	95	37000	40	382	116	14000
39	353	97	44000	43	387	117	15000
41	354	99	77000	45	454	120	24300
43	441	105		49	570	120	39000
49	470	106		58	710	130	55000
52	516	110		60	720	153	86000
55	539	120		68	750	160	
59	590	130		76	820	170	
62	598	148		80	1000	176	
64	724	150		85	1400	206	
67	740	181		88	1620	226	
68	750	190		92	1630	230	
71	760	199		93	1650	248	
71	1080	220		102	3300	270	
73	1180	310		114	11000	334	
77.8	1300	373		120			
78	1330	411		124			
82	1470	523		128			
89	1480						
93	2640						
100	2700						
	5800						

CHIRONOMUS MORTALITY							
Benzo(g,h,i)perylene		**Benzo(g,h,i)perylene**		**Benzoic acid**	**Benzoic acid**	**Beryllium**	**Beryllium**
No-Hit	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
9.6	73.3	11	613	35	82	0.071	0.135
11	73.4	11	791	64	110	0.0883	0.147
11	78	14	821	73	110	0.102	0.153
12	84	15	827	250	250	0.147	0.188
13	85	17	840	300	270	0.151	0.249
13.5	90	17	1150	300	813	0.154	0.256
14	94	18	1200	360	880	0.16	0.317
14	99	18	1330	650	900	0.162	0.385
16	102	19	1350	660	1540	0.162	0.444
16	104	19	1350	720	1650	0.19	0.477
16.8	108	22	1410	740	2020	0.202	0.5
17	110	22	1500	800	2070	0.214	
17	114	23	1660	1300	2170	0.252	
17	115	29	1720	1500	2380	0.261	
18	121	30	1900	2910	2430	0.262	
18	127	32	2510		2640	0.286	
19	133	32	2800		2840	0.308	
19	134	36	3300		3790	0.325	
20	149	42	4020		4110	0.327	
20	164	50	5400		4200	0.348	
20.9	175	51	7100			0.358	
21	186	56	7600			0.361	
22	190	56	8900			0.387	
22	200	57	9400			0.417	
22	210	57	11000			0.427	
29	210	65	11000			0.463	
30	216	68	12100				
30	220	70	27000				
31	220	70	38000				
33	221	77	55000				
35	240	77					
36	246	77					
41	280	82					
43	280	87					
44	310	99					
45	400	100					
46	430	110					
48	490	140					
51	570	146					
65	854	150					
67	965	150					
69	1520	170					
71	2500	181					
	5200	187					
		216					
		223					
		231					
		270					
		308					
		350					
		424					
		497					

CHIRONOMUS MORTALITY				
Bis(2-ethylhexyl) phthalate	**Bis(2-ethylhexyl) phthalate**		**Butyl benzyl phthalate**	**Butyl benzyl phthalate**
No-Hit	**Hit**	**Hit (Cont.)**	**No-Hit**	**Hit**
30	55	1090	10	18
32	62	1370	11	24
32	62	1400	18	24
50	110	1920	21	24
62	120	1970	25	25
70	120	2140	31	25
100	140	2140	47	28
110	160	2220	50	32
110	200	2520	50	32
120	220	2800	52	34
160	240	3010	55	35
170	250	3420	56	36
170	260	3970	57	37
170	275	4970	62	40
170	290	5120	63	41
180	310	6360	64	42
190	320	6380	64	43
220	330	10500	66	47
230	350	22300	70	48
285	350	33300	110	53
300	360		119	53
307	370		121	55
322	370		140	56
330	370		145	57
337	390		180	73
350	420		184	86
360	420		230	90
418	444		274	131
420	450		407	160
440	452		409	163
470	460		430	165
480	460		470	170
519	500		540	182
577	501		980	198
713	510			222
772	520			258
774	540			260
778	546			280
913	547			366
1000	550			763
1020	575			1520
1050	580			
1110	660			
1200	727			
1380	800			
1390	867			
1400				
1440				
1600				
1740				
1800				
1800				
1930				
2000				
2800				
3400				
3510				
4330				
7590				

CHIRONOMUS MORTALITY											
Cadmium		**Cadmium**		**Chromium**		**Chromium**		**Chrysene**		**Chrysene**	
No-Hit	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**
0.07	0.7	0.074	0.9	10.8	40	7	32	5.1	147	15	1540
0.093	0.8	0.1	0.9	12	40.5	10.1	33	9.5	152	19	1560
0.1	0.834	0.1	0.968	12.2	40.5	12	33.4	11	160	21	2170
0.1	0.875	0.1	0.973	15	41	13	34	12	161	23	2200
0.1	0.913	0.1	1	15.1	43	14.3	35	13	170	24	2210
0.11	0.963	0.1	1	15.2	43.9	15.7	36	13	172	25	3000
0.12	1.13	0.12	1	16.5	45.4	16.7	38	14	179	27	3200
0.13	1.17	0.13	1	16.8	45.5	18.3	38.8	15	180	28	3370
0.159	1.2	0.14	1.1	17	46.3	18.5	39	17	180	31	3430
0.16	1.39	0.17	1.1	17.4	46.5	19.1	39	17	187	32	3700
0.161	1.44	0.2	1.2	17.6	48.5	20.2	41	17.9	202	34	3800
0.17	1.55	0.2	1.23	18.4	49.6	21.5	42	22	211	34	4800
0.173	1.58	0.2	1.3	20.3	50.2	22	42.1	23	220	35	5730
0.18	1.69	0.2	1.3	20.5	50.9	23	42.8	24	221	35	5880
0.18	2.07	0.2	1.3	20.6	52.1	23.1	43	24	230	35	5940
0.187	2.1	0.2	1.3	21.1	52.3	23.3	43.3	24.6	249	39	7000
0.19	2.15	0.2	1.4	22	52.8	23.6	43.5	25	260	43	7240
0.2	2.3	0.2	1.4	23	53.9	24	44.9	25	281	43	7800
0.2	2.39	0.2	1.5	24	58.2	24	45.3	26	290	48	8900
0.2		0.2	1.6	25	60.8	24.1	46	26	314	51	10000
0.2		0.2	1.6	25	61	24.6	53.9	27	318	52	11000
0.2		0.2	1.9	26	133	25.1	55.9	28	340	58	11000
0.2		0.2	2	26		25.4	57.3	28.1	385	59	11000
0.2		0.2	2	26.2		25.4	58	30	390	61	28100
0.2		0.2	2.2	28.9		26	62	32	390	71	38000
0.2		0.21	2.5	29		26	63.4	33	393	91	46000
0.22		0.26	2.6	29		26	66.7	33	412	95	75000
0.24		0.267	2.7	29		26	68.3	35.9	425	95	
0.27		0.292	2.9	29		26.2	77.1	36	430	98	
0.3		0.3	3.01	29.4		26.4	80.1	36.6	482	100	
0.3		0.3	3.67	31		27	80.7	38	489	100	
0.3		0.3	5	31		27	80.7	45	490	104	
0.3		0.3	5.6	31		27	96.2	46	498	110	
0.357		0.3		31		27	99.5	47	507	111	
0.361		0.31		31.8		27.3	102	50	508	130	
0.377		0.4		31.9		28	348	50	601	140	
0.391		0.4		32		28		51	657	140	
0.4		0.45		32		28.4		51	690	157	
0.4		0.52		32.1		28.7		55	707	161	
0.4		0.6		34		29		57	819	170	
0.4		0.6		34.2		29		59	1000	177	
0.472		0.607		36		29.2		61	1100	190	
0.5		0.69		36.5		29.4		70	1140	193	
0.5		0.7		37		29.8		70	1200	210	
0.5		0.75		37		31		70.4	1300	263	
0.506		0.791		37.7		31		73	1670	280	
0.6		0.8		38.2		31.2		76	1710	320	
0.6		0.811		38.2		31.9		78	1800	320	
0.6		0.9		39		32		93	2140	400	
0.651								105	2320	541	
								110	2460	562	
								110	3000	755	
								110	6400	816	
								117		1130	
								126		1260	
								126		1300	
								128		1400	
								130		1440	
								144		1500	

CHIRONOMUS MORTALITY									
Copper		**Copper**		**Dibenz(a,h)anthracene**	**Dibenz(a,h)anthracene**	**Dibenzofuran**	**Dibenzofuran**	**Dibutyltin**	**Dibutyltin**
No-Hit	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
3.8	71.2	8.5	76.7	7.9	12	9.4	9.2	6.9	7.6
4.69	77.9	10.7	81.2	10	14	10	12	16	9.2
5.15	82.3	17.2	84.5	12	14	10	12	20	12
11	90.9	18.1	86	13	14	13	12	26	12
15.2	94.3	20.2	96.7	13	14	14	13	85	17
15.4	94.4	20.2	140	14	18	14	14	96	19
15.6	96.6	20.3	142	16	18	15	16	333	43
16.5	100	21.4	146	16	30	16	24		53
16.7	106	21.7	154	17	34	18	30		70
16.8	119	22.5	158	18	43	19	31		77
18	119	22.9	187	18	66	26	33		92
18.3	125	23.6	210	19.3	72	26	38		107
18.4	130	23.6	267	21	82	41	46		131
20.4	136	24.4	315	22	97	52	62		140
20.9	163	26	327	24	116	204	64		155
22.6	188	26.6	363	26	132	443	75		233
24.2	209	26.7	371	28	176		90		265
24.3	212	27.9	397	29	200		116		288
24.4	229	28.6	508	31	214		138		321
25.9	314	28.7	571	34.1	216		140		492
26.5	619	32.9	627	36	217		160		509
26.8		33	651	37	240		160		661
28.2		34	651	38	280		166		1930
28.3		34.2	655	49	292		168		17000
29.5		35	829	50	327		170		
30		35.5	1460	55.9	332		170		
30.7		35.9	2010	56	342		180		
30.9		36.8	10800	58	350		200		
31.2		36.8		125	390		234		
31.6		38		251	424		244		
32		40.6		294	437		310		
32.4		40.7		540	490		372		
34.1		41.4		800	630		384		
35		41.9			730		399		
35.4		42.7			800		460		
36.2		43.4			839		660		
36.5		44			1200		928		
36.5		44.1			1200		1010		
38.3		44.6			1700		1750		
38.5		45.6			1700		2260		
39.1		46			2200		3810		
42.9		46.9			2600				
43.1		47.7			3070				
43.7		48.1			4700				
43.8		50			11000				
48.6		50.4							
50.9		51.4							
50.9		52.2							
54		53.2							
57.6		53.4							
59.3		54.5							
61		57.3							
62		61.8							
65		62.7							
65.2		62.9							
66		64							
66.9		70.4							
69.4		71.1							
71.1		74.5							

CHIRONOMUS MORTALITY									
Dimethyl phthalate	**Dimethyl phthalate**	**Di-n-butyl phthalate**	**Di-n-butyl phthalate**	**Di-n-octyl phthalate**	**Di-n-octyl phthalate**	**Fluoranthene**		**Fluoranthene**	
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**
12	5.4	6.5	11	10	11	5.6	157	19	3140
13	11	8.1	11	12	12	14	160	23	3210
14	11	9	12	13	13	15	190	27	3360
16	13	10	13	15	13	16	192	28	3450
21	15	11	15	17	17	16	200	32	4500
37	16	12	15	26	18	18	206	46	4700
42	19	14	15	26	21	19	230	54	4780
46	31	17	16	27	21	21	230	58	5000
54	54	17	17	30	22	22	268	58	6100
58	108	19	19	32	23	23	270	63	6600
71	147	22	20	34	25	23.5	276	63	7400
110	156	23	21	34	30	26.9	288	65	7710
160	158	24	21	37	34	34	291	68	7730
171	172	26	24	45	39	35	300	70	7900
190	270	26	27	48	40	36	324	76	9800
311	314	34	30	54	44	36	342	79	11100
	362	37	31	54	46	39	356	87	15000
	436	37	40	55	47	39	363	91	15000
	576	41	67	66	49	40	380	93	15000
		41	90	74	52	40.9	383	96	18000
		44	108	110	58	41	437	97	19200
		61	116	115	67	41	445	97	20100
		68	158	256	90	44	452	110	24200
		71	254		100	44	453	123	26000
		103	306		201	44.7	455	129	46100
		805	350		399	45	460	130	47700
			350		413	53	500	143	100000
			481			54	502	158	120000
			690			61	520	160	180000
			841			64	674	160	
			893			65	695	170	
			1180			67	699	210	
			1740			67.6	710	210	
						69	731	240	
						70	740	240	
						70.2	766	240	
						70.7	798	280	
						71	833	280	
						71	1220	301	
						72	1260	310	
						75	1300	320	
						77	1300	334	
						77	1400	359	
						80	1620	380	
						91	1900	390	
						93	2000	428	
						110	2000	450	
						110	2450	455	
						112	2660	540	
						116	3190	580	
						116	3200	646	
						124	3370	939	
						130	3600	1400	
						130	4040	1640	
						130	4950	1690	
						138	6500	1780	
						144	9340	2140	
						150	15000	2300	
						153	16700	2340	

CHIRONOMUS MORTALITY							
Fluorene	**Fluorene**	**High Molecular Weight PAH**	**High Molecular Weight PAH**	**Indeno(1,2,3-c,d)pyrene**		**Indeno(1,2,3-c,d)pyrene**	
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**
9.2	12	54	116	8	97.2	10	363
11	12	56	470	8.2	100	10	370
13	17	96.6	612	11	100	16	518
13	18	107.1	629	11	101	18	643
13	19	131.2	1004	12	106	20	740
14	23	134	1376	12	116	22	763
15	23	136	2080	12	124	22	773
17	25	441	2251	13	130	23	960
18	29	711	2522	14	134	24	1160
19	33	799	2629	14	134	25	1180
19	39	2068	3457	14	141	27	1220
22	50	17410	7370	15	144	27	1340
22.3	85	31640	8440	16	155	28	1450
24	88		11020	16	160	30	1500
30	100		13290	16	178	34	1600
33	126		13480	17	200	36	1750
36	160		13690	17.7	210	43	2300
36.2	167		15080	18	210	43	2340
37	171		16460	19	220	45	3400
38.1	185		16780	20	222	52	4120
42	200		19960	21	244	59	5100
44	201		21970	22	255	59	6000
47	230		28550	24	260	60	10000
49	251		31170	29	270	67	10000
57	270		35390	29	280	70	13000
60	274		38030	30	283	73	13900
62	310		44500	30	330	80	14000
67.4	390		54800	30	330	81	17000
73	400		57000	31	340	81	18000
75	420		62900	36	460	88	19000
79	465		72000	40	470	90	41000
91	498		95330	44	720	95	60000
107	570		111800	44	889	110	110000
120	590		120500	45	1150	110	
120	620		121500	53	1350	110	
124	660		122700	53	4600	120	
124	666		134300	61	5300	120	
140	670		250500	65.6		133	
160	730		427700	68		150	
180	932		471000	68		160	
181	1070		765000	69		170	
190	1200			74		180	
285	1540			76		198	
470	1720			82		199	
1900	2500			83		207	
2080	3240			88		208	
2350	3400			97		260	
3850	6970					269	
3890	15800					342	
18300	56400						

CHIRONOMUS MORTALITY								
Lead		**Lead**		**Low Molecular Weight PAH**	**Low Molecular Weight PAH**	**Mercury**	**Mercury**	
No-Hit	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**Hit (Cont.)**
3.02	41.5	4.7	68.1	10.8	53	0.02	0.03	0.343
4.27	41.9	5.01	68.4	23.3	71	0.038	0.04	0.359
5.24	44.8	5.99	73.5	28.6	95	0.039	0.04	0.435
6.19	45.9	7.3	79.1	147	160	0.04	0.05	0.545
6.69	47.6	11.1	79.7	233	181	0.04	0.05	0.558
7.1	47.7	11.6	79.9	2498	351	0.042	0.05	0.62
7.17	48.2	12	80.8	6590	358	0.05	0.05	0.659
7.24	48.8	12.2	87.6		422	0.05	0.05	0.662
9.21	50	12.5	89.6		1225	0.05	0.05	0.749
10.2	50.2	12.7	94.6		1763	0.052	0.05	0.796
10.5	51.1	12.7	99.4		1800	0.057	0.06	0.8
11.2	52.2	13.2	102		2088	0.0583	0.06	0.844
11.4	54.4	13.2	105		2240	0.06	0.06	0.993
11.8	64	13.3	114		2700	0.06	0.06	1.25
12.6	80.7	13.3	118		2760	0.06	0.06	2.01
12.7	95.2	13.7	125		2890	0.06	0.06	2.22
12.7	96.6	14.4	133		3040	0.06	0.06	2.7
12.9	111	14.7	150		3110	0.07	0.07	3.04
13.1	122	14.8	150		3140	0.0844	0.07	3.74
13.4	125	14.9	152		4380	0.0853	0.07	43
13.5	171	15	154		4720	0.0877	0.07	
13.8	172	15.1	177		6259	0.09	0.0776	
14.4	184	15.2	194		8130	0.0998	0.08	
14.7	185	15.3	210		8255	0.1	0.08	
15.2	189	15.7	230		8800	0.1	0.08	
15.2	204	15.7	234		8980	0.11	0.08	
15.5	210	15.9	249		9130	0.114	0.08	
15.9	283	16.6	258		9200	0.119	0.0838	
16	284	17.3	272		9380	0.13	0.088	
16.2	295	17.9	294		9520	0.13	0.09	
16.5	335	18.1	299		10270	0.13	0.09	
16.9		20.8	322		14070	0.14	0.096	
17.3		21	357		16870	0.149	0.1	
17.9		23.5	431		18700	0.15	0.1	
18.6		23.5	436		28500	0.15	0.1	
18.8		23.6	525		29010	0.16	0.104	
18.9		25.9	1160		41971	0.16	0.11	
21		26.1	1310		49000	0.165	0.12	
21.1		27.3			78300	0.17	0.12	
22.4		27.4				0.186	0.12	
25.6		29				0.23	0.13	
26.6		30.1				0.232	0.13	
27.5		30.2				0.284	0.13	
33.6		32.4				0.286	0.14	
35		36				0.297	0.141	
36.2		39				0.389	0.157	
37.8		56				0.433	0.16	
38.9		58.7				0.445	0.16	
39.2		62.5				0.461	0.2	
						0.478	0.206	
						0.54	0.21	
						0.546	0.21	
						0.552	0.25	
						0.604	0.253	
						0.673	0.259	
						0.711	0.284	
						0.8	0.335	

CHIRONOMUS MORTALITY											
Monobutyltin	**Monobutyltin**	**Naphthalene**	**Naphthalene**	**Nickel**		**Nickel**		**Phenanthrene**		**Phenanthrene**	
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**
1.7	1	3.3	8.1	7.79	34.4	8	30.4	4.3	180	14	1990
3.97	1.3	6.1	10	8.4	35.7	10	31	11	180	14	2600
4.19	9.5	7.8	13	8.7	37	12.9	31	11	190	14	2660
4.3	11	10	16	11.6	38.8	13	33.6	13	190	17	3620
4.4	11.2	10	18	15.8	38.9	14.7	36	14	231	19	3990
4.8	15	11	19	16	39.1	15.5	37.9	16	234	19	4440
5.2	19	13	22	16	39.3	15.8	39	17	278	22	4700
6.4	21	13	24	16	39.6	16	39.4	19	282	23	4700
6.91	22	14	24	17	40.7	16	39.9	19	332	24	4900
7.1	24	15	30	17.6	44.2	17	41.4	19	333	25	5300
7.13	24.9	15	37	18	45.1	19.9	43.4	19.3	354	25	5470
10	26	15	40	18.5	45.6	20.8	43.5	20	384	26	5700
11	26	18	48	18.5	46.8	21	43.7	21	384	26	6100
11.3	26	19	49	18.8	47.3	21	45	21	388	33	6100
12.1	26.9	19	65	19.2	48.1	21	45.2	23	393	36	6190
12.4	38	20	92	19.3	48.7	21	46	26	469	37	6400
13.6	40	20	100	19.7	53.9	21	48.4	28	472	38	8420
17	54	20	100	20.1	54.9	22	48.9	29	566	39	14200
18.8	59	22.2	110	20.3	55.3	22	49.4	31.2	587	49	15000
20.3	64	23.4	110	20.3	57.6	22	53.1	32	617	54	26000
22	76	27	161	21	58.4	22	54	33	680	63	39200
27	154	27	250	21	60	22	58.2	35	719	65	41100
29	166	27	291	21.2	113	22	59.6	35	880	71	49000
30	194	30	400	22		22	61.5	36	1000	73	120000
38	212	30	424	22		22	62.4	41	1000	93	
38	221	31	440	22		22	64	43	1500	93	
40	267	31.5	450	23		22.7	70.6	44	1600	93	
41	312	32	466	23		23	77.4	45	1720	93	
43	379	33	471	23		23	355	53	1730	95	
46	380	33	501	23		23	594	54	1730	96	
56	396	34	627	23		23		55	1800	97	
98	459	35.6	650	23.6		23		60	2080	128	
508	459	42	913	23.7		23.9		60	4230	136	
	2560	54	1030	24		24		60	4370	160	
	4850	55	1310	24		24		62	4700	160	
		58	1360	24.1		25		65	7570	160	
		61	1400	25		25		65	8240	186	
		64	2200	25		25.7		71	8950	234	
		86	2280	25		26		80	36200	240	
		126	3630	26		26		80		240	
		148	4870	27		26		81		244	
		225	4890	27		26		86		260	
		510	4970	27		26		86		569	
		529	5630	27.2		27		87		570	
		3220		27.3		27		93.1		629	
		40600		28		27		95		730	
				28		27		102		778	
				28		27		109		848	
				28		28		110		1000	
				28		28		110		1040	
				28.7		28.2		120		1070	
				29.3		28.8		130		1130	
				30.6		28.9		133		1200	
				30.8		29.1		142		1300	
				32.9		29.5		150		1480	
				34.2		29.7		150		1700	
				34.3		30		161		1900	

CHIRONOMUS MORTALITY									
Phosphorus	**Phosphorus**	**Pyrene**			**Pyrene**		**Silver**		**Silver**
No-Hit	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**No-Hit (Cont.)**	**Hit**
128	410	10	130	477	19	2340	0.094	0.8	0.1
282	486	14	140	536	27	2530	0.1	0.8	0.1
306	507	14	140	560	30	2700	0.1	1	0.1
349	538	17	158	580	31	2710	0.1	1.1	0.1
352	590	17	160	581	36	2960	0.1	1.32	0.1
393	625	17	160	626	39	3460	0.1	1.4	0.1
402	710	19	175	626	53	4200	0.1	1.6	0.1
425	725	21	200	634	54	4410	0.11	1.8	0.1
428	824	21.1	240	685	57	4700	0.12	1.9	0.1
459	1160	22	250	700	66	5120	0.12	2	0.11
475	1310	24	250	715	67	6800	0.144	2.2	0.14
503	1590	30	254	770	68	7000	0.15	3.3	0.14
516	2770	32.2	260	927	68	7150	0.17	> 3.3	0.16
531		33	289	987	70	7500	0.19		0.2
563		33	304	1250	71	7540	0.199		0.2
615		37	319	1320	74	8100	0.2		0.2
624		37	320	1350	82	8790	0.2		0.2
657		37	332	1400	83	10000	0.2		0.2
691		38	333	1500	88.1	13300	0.2		0.2
694		39	356	1600	91	13600	0.2		0.2
741		41	361	1820	92	15900	0.2		0.2
880		42	375	2100	96	16000	0.2		0.2
908		45	379	2190	100	20000	0.2		0.2
1040		46	380	2300	118	21000	0.2		0.2
1150		48	380	2500	120	21000	0.217		0.2
1180		48.5	387	2870	130	22000	0.22		0.2
1540		50	430	3540	133	25000	0.23		0.2
2060		51.6	431	3650	140	32200	0.23		0.2
2660		54	452	4280	144	55600	0.25		0.2
2790		55	455	5000	150	68000	0.26		0.219
3290		56		5700	150	98000	0.26		0.3
> 3290		63		11200	162	110000	0.27		0.3
		64		18000	210		0.28		0.3
		65.6			210		0.3		0.3
		66			240		0.3		0.3
		67			261		0.3		0.3
		68			270		0.3		0.3
		71.2			280		0.3		0.3
		73			280		0.322		0.3
		74			300		0.38		0.35
		75			308		0.4		0.359
		77			320		0.4		0.36
		80			350		0.4		0.39
		82			352		0.4		0.4
		89			370		0.4		0.43
		92			404		0.4		0.45
		97			429		0.43		0.5
		99			450		0.444		0.5
		107			488		0.45		0.5
		108			510		0.5		0.53
		110			523		0.5		0.7
		110			679		0.545		0.7
		117			829		0.6		0.8
		120			1320		0.6		0.8
		120			1590		0.6		0.8
		121			1630		0.63		1.1
		124			1710		0.77		1.9

CHIRONOMUS MORTALITY							
Total benzofluoranthenes (b+k (+j))		**Total benzofluoranthenes (b+k (+j))**		**Total organic carbon**		**Total organic carbon**	
No-Hit	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**
11.7	311	15	2450	0.22	3.12	0.21	2.8
15	320	23	2620	0.23	3.42	0.35	2.87
15.1	335	36	2800	0.23	3.48	0.38	3
15.4	338	39	3400	0.26	3.52	0.56	3
17	339	41	3400	0.42	3.58	0.6	3.03
19.2	339	41	3620	0.61	3.61	0.67	3.31
20	348	44	4300	0.69	3.71	0.67	3.4
25	350	48	4440	0.72	3.89	0.74	3.48
25	363	50	5180	0.72	3.95	0.78	3.6
26	379	54	5530	0.88	4.01	0.82	3.69
26	414	55	5600	0.95	4.01	0.89	3.8
27	445	59	6590	0.97	4.56	1.19	4.05
36.9	501	59	7000	1.03	4.65	1.2	4.14
39	541	62	7110	1.26	4.74	1.24	4.6
41	552	67	8900	1.27	4.92	1.28	4.74
41	579	69	11000	1.28	5.02	1.3	4.9
42	600	72	12000	1.3	5.81	1.37	4.9
43	617	76	13500	1.3	6.4	1.39	5
43	630	77	14600	1.32	7.07	1.46	5.13
44	630	83	18400	1.4	7.35	1.46	5.2
45	630	91	19900	1.42	7.35	1.57	5.6
46.4	643	102	20100	1.44	8.9	1.59	5.7
50	657	116	22100	1.44	9.82	1.67	6.3
50	686	117	41800	1.45		1.72	6.8
53	774	120	47000	1.52		1.77	7.9
54	799	120	79000	1.56		1.82	9.7
57	823	127	144000	1.61		1.83	10.6
59	853	140		1.65		1.87	12.1
60	890	141		1.68		1.89	12.2
63	906	142		1.73		1.93	15.8
66.9	1028	175		1.77		1.96	21.3
68	1040	176		1.83		1.97	
70	1200	180		1.87		1.98	
76	1390	186		1.91		2.06	
79	1410	190		1.96		2.07	
82	1850	220		1.98		2.11	
87	1860	245		2.01		2.16	
93	1923	283		2.03		2.16	
103	2270	290		2.11		2.18	
110	2750	293		2.13		2.21	
118	2830	300		2.14		2.21	
119	3170	312		2.15		2.25	
124	4800	316		2.15		2.27	
143	13800	421		2.17		2.3	
148		480		2.25		2.3	
149		496		2.26		2.3	
150		770		2.31		2.35	
178		855		2.34		2.42	
187		881		2.35		2.44	
188		1151		2.41		2.5	
191		1380		2.45		2.52	
234		1410		2.48		2.57	
248		1780		2.51		2.61	
248		1960		2.54		2.69	
255		2000		2.61		2.71	
297		2020		2.66		2.74	
310		2320		3.1		2.74	

CHIRONOMUS MORTALITY									
Total Polychlorinated Biphenyls	**Total Polychlorinated Biphenyls**	**Total Sulfides**	**Total Sulfides**	**Tributyltin**	**Tributyltin**	**Zinc**		**Zinc**	
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**No-Hit (Cont.)**	**Hit**	**Hit (Cont.)**
12	11	2.9	0.9	0.503	1.16	13.6	211	47.5	354
17	11	12.6	2.3	0.87	2	17.2	212	48	368
40	16	13.4	2.9	1	2.27	18.6	215	55	374
43	29	35.6	3.3	1.28	4.4	30.7	249	55.9	377
53	43	44.2	3.8	1.95	7.6	34.8	254	58.1	385
57	48	47.4	3.8	2.4	9.5	45.4	262	65	391
69	62	48.1	6.2	2.51	13	49.7	264	70.8	397
82	73	60.6	6.6	2.88	18	51.3	270	71.6	399
88	108	62	7	4.7	40	58.2	271	72.7	406
116	108	74.1	7.8	8.5	60	61.3	281	73	407
116	112	80.1	9	9	62	62.2	296	75	423
116	116	83.8	9.2	9.3	78	65.6	333	77	435
129	284	87	9.9	11	113	65.6	337	81.5	435
130	304	110	10	13	160	66	359	84	443
130	379	146	10.8	19	198	69.9	370	84.3	450
209	394	149	17.5	22	200	70.3	375	85	550
253	1460	150	65.5	25	210	70.8	527	85.7	567
257	2090	161	65.8	27	598	71.1	683	85.9	593
300	2500	202	92.4	32	697	72.7		86	675
354		231	96.3	35	723	73.5		86	754
		247	97.3	37	810	73.7		87	1020
		321	181	100	824	74		87	1080
		341	223	220	936	76		89.6	1770
		360	249	260	1210	76.4		90	2010
		514	493	1860	1410	76.8		96	4150
		702	590		1710	76.9		97.6	
			941		2200	79.3		101	
			2330		2220	79.3		101	
					2490	82		104	
					2530	83		106	
					6650	83		106	
					15700	85		110	
					64600	85.3		113	
						87		114	
						89.3		122	
						90		122	
						90.5		124	
						96.8		124	
						98		130	
						107		131	
						111		137	
						115		142	
						120		142	
						120		144	
						126		145	
						130		158	
						133		161	
						139		164	
						145		203	
						152		220	
						167		225	
						173		227	
						188		238	
						190		269	
						193		279	
						210		306	
						210		314	

MICROTOX					
2-Methylnaphthalene	**2-Methylnaphthalene**	**Acenaphthene**	**Acenaphthene**	**Acenaphthylene**	**Acenaphthylene**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
2.2	11	77	10	42	11
8.8	12	156	10	110	11
141	13	203	11	148	12
170	13	252	11	171	12
180	13	280	11	265	12
180	14	360	12	640	13
443	15	523	12		15
469	15	560	14		17
	15	1060	15		88
	16		18		136
	16		18		140
	20		18		209
	24		19		279
	28		20		314
	36		23		362
	52		23		470
	54		32		594
	62		33		642
	120		45		697
	188		52		1020
	189		59		1260
	214		60		
	353		72		
	555		75		
	877		100		
	982		110		
	1720		130		
	1770		162		
	2310		170		
	3470		177		
			210		
			272		
			310		
			316		
			332		
			792		
			830		
			1250		
			1320		
			2460		
			2460		
			7420		

MICROTOX									
Anthracene	**Anthracene**	**Antimony**	**Antimony**	**Aroclor 1254**	**Aroclor 1254**	**Aroclor 1260**	**Aroclor 1260**	**Arsenic**	**Arsenic**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
4.8	11	0.54	0.1	7.3	11	15	15	2.1	2
14	12	0.61	0.1	47	16	140	18	2.5	2.8
82	12	0.61	0.1	100	18		20	2.6	3
210	12	0.62	0.1	140	24		24	3.55	3
280	14	0.72	0.2	160	25		27	3.9	3
320	15	1.9	0.2	170	37		29	3.94	3
373	16	2.7	0.2	230	51		37	4	4
420	20	2.9	0.2		52		38	4.2	4
552	22	5.1	0.2		54		40	4.74	4
630	22	> 5.1	0.2		54		42	4.8	4
980	23		0.3		57		43	6.92	4
1130	25		0.3		58		46	7.08	4
1230	27		0.41		62		46	7.08	4
	28		0.45		70		48	7.38	4
	28		0.5		70		53	8.5	4
	29		0.5		78		57	8.7	4
	32		0.6		78		62	8.89	4
	40		0.66		81		64	9.14	4
	41		1		95		64	11.7	4.09
	52		1.1		97		69	14.7	4.36
	53		1.6		150		74	16.5	5
	53		1.8		156		77	19	5
	67		3.5		170		98	19	5
	70		4		170		138	20	5
	74				189		150	21.7	5
	85				202		184	31.3	5
	99				209		460	31.4	5
	115				227		500	111	5
	170				230		2500	123	5
	220				256				5
	220				960				5
	233				1060				5
	320								5.17
	380								5.8
	406								6
	429								6
	465								6
	580								6
	660								6
	717								6
	814								6
	915								6
	1110								7
	1580								7
	1900								7
	2860								7
	2920								8
	16200								8
									8
									8
									8.18
									9
									9
									11
									12.2
									12.7
									12.8
									13
									13
									13
									13.1
									13.7
									14.3
									15
									15
									17
									17
									17.2
									20
									23.9
									26.6
									30.6
									152
									175
									200

MICROTOX					
Benzo(a)anthracene	**Benzo(a)anthracene**	**Benzo(a)pyrene**	**Benzo(a)pyrene**	**Benzo(g,h,i)perylene**	**Benzo(g,h,i)perylene**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
8.6	14	11	13	15	11
13	14	14	15	30	11
17	15	16	16	68	11
27	17	25	18	77	11
59	18	37	19	87	14
75	19	81	19	100	15
120	19	153	21	140	16
170	22	176	21	220	17
190	24	230	24	400	17
523	25	240	25	497	18
750	26	783	26	791	18
917	29	915	27	821	19
1220	29	1000	28	840	19
1270	29	1080	31	1150	19
1700	30	1420	32	1500	20
2620	30	2500	34	2510	21
3500	30	3340	34	4020	22
4260	32	4600	36		22
	32	4810	36		22
	33		38		29
	35		40		30
	36		43		30
	38		48		31
	41		51		32
	41		58		33
	49		67		36
	56		76		42
	64		85		43
	67		87		44
	70		91		51
	71		93		56
	79		114		65
	93		116		69
	99		117		70
	103		120		70
	105		120		77
	105		124		82
	106		133		99
	112		135		108
	113		176		110
	115		189		114
	130		195		127
	154		213		133
	179		223		134
	181		226		146
	188		248		149
	199		333		164
	240		334		170
	280		351		186
	288		358		216
	321		360		221
	342		382		231
	353		615		240
	373		720		280
	411		820		280
	600		890		424
	740		910		570
	740		1070		613
	760		1400		680
	958		1530		827
	1060		1620		854
	1100		1630		1330
	1180		1840		1350
	1300		1890		1350
	1480		2100		1410
	1580		2220		1500
	1600		2750		1520
	1720		2960		1660
	2380		11000		1720
	3750		24300		5200
	5430				12100
	5800				
	25600				

MICROTOX					
Bis(2-ethylhexyl) phthalate	**Bis(2-ethylhexyl) phthalate**	**Butyl benzyl phthalate**	**Butyl benzyl phthalate**	**Cadmium**	**Cadmium**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
23	18	25	10	0.04	0.07
23	30	53	11	0.04	0.07
32	160	55	18	0.04	0.1
55	160	140	18	0.05	0.1
78	180	182	21	0.1	0.1
220	200	222	24	0.159	0.1
433	250	260	24	0.161	0.1
501	307	1520	25	0.2	0.1
580	320		25	0.267	0.1
1090	330		25	0.292	0.2
1600	330		28	0.3	0.2
1970	337		31	0.391	0.2
2140	350		32	0.45	0.2
2520	360		32	0.5	0.2
22300	370		34	0.52	0.2
	390		35	0.607	0.2
	418		40	0.963	0.2
	420		42	0.968	0.2
	440		43	1.17	0.2
	444		47	1.2	0.2
	452		48	1.3	0.2
	460		50	1.3	0.2
	470		52	1.4	0.2
	480		53	2	0.2
	510		55	2.7	0.2
	519		56	2.9	0.2
	520		56	11	0.2
	546		57		0.2
	547		57		0.2
	550		62		0.2
	575		64		0.3
	660		64		0.3
	727		66		0.3
	774		70		0.3
	778		73		0.3
	800		86		0.31
	867		119		0.4
	913		121		0.4
	1000		131		0.4
	1020		145		0.4
	1050		160		0.4
	1110		165		0.472
	1370		170		0.5
	1380		180		0.5
	1390		184		0.5
	1400		198		0.6
	1440		230		0.6
	1740		258		0.6
	1800		274		0.651
	1800		280		0.69
	1930		366		0.7
	2000		407		0.7
	2140		430		0.8
	2220		763		0.811
	2800		980		0.875
	2800				1
	3010				1
	3400				1
	3420				1.1
	3510				1.1
	3970				1.2
	4330				1.3
	4970				1.4
	5120				1.44
	6360				1.55
	6380				1.6
	7590				1.6
	10500				2.1
	33300				2.3
					3.01
					3.67
					5

MICROTOX									
Chromium	**Chromium**	**Chrysene**	**Chrysene**	**Copper**	**Copper**	**Dibenz(a,h)anthracene**	**Dibenz(a,h)anthracene**	**Dibenzofuran**	**Dibenzofuran**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
4.4	12	17	17	4.69	15.6	116	12	15	10
7	13	24	17	7	17	132	13	138	10
12	15	25	21	7.2	19	176	14	140	12
14	17	36	23	8.5	20.3	216	14	168	12
15.1	17.4	43	24	11	23.6	240	14	180	13
20.3	22	59	27	16	26.6	292	16	234	14
23	22	76	27	16	30	390	18	310	14
24.1	23	91	28	16.7	31.2	490	18	384	14
25.1	24	100	30	17	32	839	18	399	15
26.2	24	210	31	17	32.4		22		16
26.2	24	220	32	18.1	32.9		24		16
28.7	24.6	320	33	21.4	33		28		18
29.8	25	755	34	23	35		29		19
38.8	25	1200	34	24.4	35		31		24
39	26	1260	35	27.9	35.9		34		26
40.5	26	1540	36	28.6	36.2		36		26
42.8	26	1560	36	34	36.5		38		33
45.5	26	3000	38	40.1	38.3		43		38
57.3	26	3700	39	41	38.5		49		41
62	27	4800	43	47.7	40.6		56		110
63.4	27	5940	48	50	41.9		72		116
66.7	27		51	54	43.4		82		166
68.3	27		51	62.7	45.6		120		204
89	28		51	125	46.9		125		244
95	28		58	363	48.6		200		372
348	29		61	371	51.4		214		443
	29		70	627	53.2		217		460
	29		70	651	61		230		928
	29		93	829	61.8		294		1010
	29		95	1460	65.2		327		1750
	29		98		71.1		332		2260
	31		104		71.1		342		3810
	31		126		74.5		424		
	31		128		76.7		437		
	31		140		77.9		800		
	31		157		81.2		3070		
	32		160		82.3				
	32		161		84.5				
	32.1		172		86				
	33		177		90.1				
	34		180		90.9				
	34		202		94.3				
	35		211		94.4				
	36		263		96.6				
	36		318		96.7				
	37		320		100				
	37		390		101				
	38		412		106				
	38.2		425		119				
	39		430		119				
	39		482		130				
	40		489		136				
	41		490		140				
	41		541		142				
	42		562		146				
	43		816		154				
	43		930		158				
	44.9		1000		163				
	45.3		1100		187				
	46		1130		188				
	48.5		1300		209				
	53.9		1440		210				
	55.9		1710		212				
	76		1800		229				
	77.1		2100		314				
	79		2140		315				
	80.1		2170		327				
	80.7		2210		397				
	80.7		3430		508				
	96.2		5730		571				
	99.5		5880		619				
	102		6400		651				
	133		28100		655				
					2010				
					10800				

MICROTOX					
Dimethyl phthalate	**Dimethyl phthalate**	**Di-n-butyl phthalate**	**Di-n-butyl phthalate**	**Di-n-octyl phthalate**	**Di-n-octyl phthalate**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
31	11	15	10	11	10
71	11	134	11		12
108	12	306	11		12
156	13	690	11		13
172	13	1180	12		13
436	14	1710	12		13
	15	1740	13		15
	16	> 1740	14		17
	16		15		17
	19		15		18
	21		16		21
	37		17		21
	42		17		22
	54		17		23
	54		19		25
	58		19		26
	110		20		26
	147		21		27
	158		21		30
	160		22		30
	171		23		32
	190		24		34
	270		24		34
	311		26		37
	314		26		39
	362		27		40
	576		30		44
			31		45
			34		46
			37		47
			37		48
			40		49
			41		52
			41		54
			41		54
			44		55
			61		58
			67		66
			68		74
			71		90
			103		110
			108		115
			116		201
			254		256
			350		399
			350		413
			481		
			805		
			841		
			893		

MICROTOX					
Fluoranthene	**Fluoranthene**	**Fluorene**	**Fluorene**	**High Molecular Weight PAH**	**High Molecular Weight PAH**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
5.9	27	24	12	29	300
15	34	120	12	90	2251
28	36	185	13	118	2629
39	45	251	13	254	7370
41	54	270	14	309	9000
43	54	310	15	629	13290
46	58	400	17	1004	13690
55	58	660	19	8440	16460
97	65	666	19	11020	17410
110	65	1070	23	13480	18000
123	68		23	15080	19960
170	70		24	35390	21970
300	72		25	54800	31170
310	76		30		57000
580	77		33		62900
1300	79		33		250500
1640	91		37		
1780	91		39		
3140	96		44		
3360	97		47		
4500	110		73		
7710	116		79		
7900	120		88		
11100	130		124		
	130		140		
	143		140		
	158		167		
	160		180		
	190		190		
	206		201		
	240		250		
	270		274		
	288		285		
	301		465		
	320		470		
	324		498		
	334		932		
	342		1540		
	356		1720		
	359		3240		
	380		3400		
	390		6970		
	428				
	437				
	445				
	450				
	453				
	455				
	502				
	674				
	695				
	699				
	710				
	740				
	833				
	939				
	1400				
	1690				
	1900				
	2000				
	2000				
	2340				
	2800				
	3200				
	3210				
	3370				
	3450				
	3600				
	4700				
	4780				
	7730				
	15000				
	19200				
	24200				
	46100				

MICROTOX							
Indeno(1,2,3-c,d)pyrene	**Indeno(1,2,3-c,d)pyrene**	**Lead**	**Lead**	**Low Molecular Weight PAH**	**Low Molecular Weight PAH**	**Mercury**	**Mercury**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
10	10	4.7	7.8	17	18	0.014	0.024
28	12	6.3	10.2	18	59	0.03	0.044
59	13	6.8	10.5	24	358	0.033	0.05
70	15	7	11	52	422	0.033	0.05
110	16	7.24	11.1	53	1800	0.036	0.05
120	18	7.6	12.2	71	1900	0.042	0.05
198	19	14.8	12.5	98	2760	0.053	0.05
210	20	15.9	12.7	109	3000	0.0583	0.05
460	21	16.6	12.7	2088	3040	0.06	0.05
518	22	17.3	12.7	2700	4720	0.0776	0.06
763	22	27.3	12.9	3140	6590	0.0838	0.06
773	23	32.4	13.1	4380	9130	0.087	0.06
960	24	48.2	13.2	8800	14070	0.104	0.06
1160	24	58.7	13.3	9200	16870	0.114	0.06
1600	25	79.9	13.3		18700	0.141	0.06
2340	27	84	13.4		28500	0.21	0.07
4120	27	125	13.7		78300	0.253	0.07
	28	133	14.4			0.286	0.07
	29	152	14.7			0.343	0.08
	30	154	14.9			0.558	0.0853
	30	185	15.2			0.604	0.09
	30	194	15.2			0.659	0.09
	34	230	15.3			0.796	0.096
	36	234	15.7			0.993	0.1
	36	299	16.2			2.22	0.1
	44	431	17.9			3.04	0.1
	45		18.1				0.1
	45		18.6				0.11
	52		20.8				0.11
	59		21.1				0.12
	61		22.4				0.13
	68		23.6				0.13
	73		25.6				0.13
	76		25.9				0.14
	80		26.1				0.14
	81		26.6				0.15
	81		27.4				0.15
	97		27.5				0.16
	100		30.2				0.16
	106		33.6				0.16
	120		36.2				0.17
	124		38.9				0.186
	130		41.5				0.19
	133		41.9				0.21
	134		44.8				0.23
	144		47.6				0.284
	155		48.8				0.435
	178		50				0.54
	199		50.2				0.545
	207		52.2				0.552
	208		54.4				0.62
	222		56				0.662
	255		62.5				0.673
	260		68.1				0.69
	270		79.7				0.711
	330		89.6				0.749
	363		94.6				0.8
	643		96.6				0.844
	720		99.4				1.25
	740		111				2.01
	770		114				2.7
	889		150				3.74
	1180		150				43
	1220		177				
	1340		184				
	1350		204				
	1450		249				
	1500		258				
	1750		284				
	1800		295				
	5300		436				
	13900		525				
			1310				

MICROTOX									
MonobutyItin	**MonobutyItin**	**Naphthalene**	**Naphthalene**	**Nickel**	**Nickel**	**Phenanthrene**	**Phenanthrene**	**Pyrene**	**Pyrene**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
4.8	22	3	10	6.5	13	5.3	14	11	29
5.2	26	29	11	7.79	16	14	17	14	31
9.5	50	110	13	8	16	18	18	34	37
10	54	291	14	8.1	18	27	19	36	42
11	59	424	15	14	21	30	19	39	48
15	60	466	15	16	21	33	19	46	53
19	98	501	15	25.7	21	39	20	55	54
26	166	650	16	27.3	22	52	21	78	57
38	212	1310	18	28	22	53	22	92	64
40	221		19	28.2	22	65	23	118	66
64	267		19	28.9	22	71	23	130	67
76	312		19	29	22	93	24	150	70
154	396		24	29	22.7	110	25	280	71
194	459		24	29.1	23	260	25	320	74
379	508		27	29.3	23	680	26	450	74
380	2560		27	30	23	778	26	1400	77
459	4850		27	30.4	23	1300	29	1590	82
			31	33.6	23	1480	32	2340	82
			32	39	23	2600	33	2710	91
			33	39.6	23	2660	36	3460	92
			34	43.5	23	3990	37	4200	92
			37	45	23	5470	38	7150	96
			48	45.1	23.6	6100	41	8100	110
			65	45.2	23.7		49	8790	120
			110	46	23.9		54		124
			148	47	24		54		133
			160	48.9	24		59		140
			350	49.4	24		60		144
			471	53.1	24		60		160
			510	355	25		86		175
			627		25		87		240
			913		25		93		254
			1360		26		96		261
			2280		26		102		304
			3220		26		109		308
			4870		26		128		320
			4890		26		133		332
			4970		26		136		333
			5630		27		142		352
					27		160		356
					27		160		380
					27		161		404
					28		180		429
					28		180		431
					28		186		452
					28		234		455
					28		234		477
					28		244		488
					28		282		523
					29.5		384		536
					29.7		393		580
					30		469		634
					31		472		700
					31		566		715
					31		629		770
					31		848		829
					37		1000		1320
					37.9		1000		1500
					38.8		1070		1600
					39.4		1130		1630
					40.7		1200		1900
					41.4		1200		2500
					48.4		1500		2530
					51		1720		2960
					54		1800		3000
					56		1990		3540
					58.2		2080		4280
					58.4		3620		4410
					61.5		4440		4700
					62.4		4700		5120
					64		6190		7540
					70.6		8420		13300
					77.4		14200		15900
					113		41100		18000
					594				55600

MICROTOX					
Silver	**Silver**	**Total benzofluoranthenes (b+k (+j))**	**Total benzofluoranthenes (b+k (+j))**	**Total organic carbon**	**Total organic carbon**
No-Hit	**Hit**	**No-Hit**	**Hit**	**No-Hit**	**Hit**
0.06	0.094	14	25	0.21	0.23
0.08	0.098	16	27	0.22	0.25
0.094	0.1	41	27	0.23	0.67
0.1	0.1	53	36	0.3	0.82
0.11	0.1	67	39	0.56	0.95
0.14	0.1	120	41	0.76	0.97
0.16	0.1	127	41	0.996	1.16
0.16	0.1	135	43	1.32	1.19
0.2	0.1	220	44	1.42	1.2
0.2	0.1	320	48	1.57	1.28
0.3	0.1	480	50	1.82	1.39
0.39	0.199	1380	54	2.3	1.44
0.43	0.2	1780	55	2.7	1.45
0.444	0.2	1860	57	2.8	1.46
0.53	0.2	1960	59	3.4	1.46
0.545	0.2	2450	60	3.6	1.56
2.5	0.2	4300	62	3.8	1.65
	0.2	5530	69	3.8	1.72
	0.2	8900	72	4.05	1.73
	0.2	11000	76	4.9	1.8
	0.2		76	4.9	1.83
	0.2		77	5.13	1.87
	0.2		82	5.6	1.91
	0.2		91	6.3	1.96
	0.2		102	7.35	1.96
	0.2		103	8.9	1.97
	0.2		117	12.2	1.98
	0.2		124	21.3	1.98
	0.217		141	> 21.3	2.01
	0.3		148		2.03
	0.3		175		2.06
	0.3		186		2.07
	0.3		191		2.11
	0.3		234		2.11
	0.3		245		2.13
	0.322		293		2.15
	0.35		311		2.16
	0.4		312		2.18
	0.4		316		2.21
	0.4		335		2.25
	0.4		348		2.25
	0.4		363		2.26
	0.4		421		2.27
	0.5		445		2.3
	0.5		496		2.34
	0.5		552		2.41
	0.5		579		2.42
	0.5		617		2.44
	0.53		686		2.45
	0.6		774		2.48
	0.6		823		2.51
	0.6		853		2.52
	0.7		855		2.57
	0.8		881		2.61
	0.8		890		2.66
	1		1151		2.74
	1.1		1280		3
	1.1		1390		3.03
	1.32		1850		3.52
	1.4		2000		3.58
	3.3		2020		4.14
			2270		4.6
			2320		5
			2750		5.2
			2830		5.81
			3200		6.4
			3400		6.8
			3620		7.07
			4440		7.35
			6590		7.9
			7110		9.7
			13800		9.82
			41800		10.6
					12.1
					15.8

MICROTOX			
Total Polychlorinated Biphenyls	**Total Polychlorinated Biphenyls**	**Zinc**	**Zinc**
No-Hit	**Hit**	**No-Hit**	**Hit**
62	11	30.7	58
	16	47	60
	29	49	66
	40	54	73
	43	55	74
	43	55	76
	53	55	77
	57	56	83
	69	70.8	83
	82	81.5	85
	88	84.3	85
	108	89.6	86
	108	101	86
	112	119	87
	116	119	87
	116	120	87
	116	270	90
	129	377	90
	209	406	96
	253	567	97.6
	257	675	98
	284	754	101
	300	1080	106
	304	1130	111
	354		113
	394		114
	1460		120
	2090		122
	2500		130
			130
			131
			133
			137
			145
			145
			158
			161
			173
			190
			203
			210
			210
			212
			227
			238
			243
			254
			262
			264
			269
			271
			281
			296
			333
			337
			354
			359
			368
			369
			370
			374
			375
			391
			407
			423
			435
			443
			527
			550
			593
			683
			1770
			2010
			4150

Appendix C

APPENDIX C. OPTIMAL PERCENTILE RESULTS

The results of the optimal percentile analysis presented in Section 3 are provided in this appendix. For each level of effects (statistical significance only, SQS, and CSL) there are two sets of results provided – the one above is for the data set containing individual PAHs and Aroclors, and the one below is for the same data set containing only summed PAHs and PCBs. In this lower data set, blank spaces indicate individual PAHs and Aroclors that are not present in that data set.

Five sets of percentiles are shown for each of the two data sets. These correspond to different levels of false negatives that Ecology could select to base their SQVs on, and range from 5-25% false negatives, in increments of 5%. The first page shows the reliability results for each of these sets of percentiles for all six reliability parameters. The remaining pages show the chemical concentrations associated with the optimal percentiles of the no-hit distribution corresponding to the selected false negative rates. The false negative and false positive rates are repeated on each page for reference.

STATISTICAL SIGNIFICANCE ONLY:					
UNSUMMED PAHs and PCBs % False Negatives	% False Positives	% Sensitivity	2003% Efficiency	1988% Efficiency	% Reliability
5	70	95	30	78	77
10	54	90	46	82	78
15	42	85	58	84	78
19	37	81	63	85	76
25	26	75	74	89	75
STATISTICAL SIGNIFICANCE ONLY:					
SUMMED PAHs and PCBs % False Negatives	% False Positives	% Sensitivity	2003% Efficiency	1988% Efficiency	% Reliability
5	68	95	32	79	78
10	50	90	50	83	79
14	43	86	57	84	78
19	34	81	66	86	77
25	22	75	78	90	76

STATISTICAL SIGNIFICANCE ONLY:						
UNSUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**	**2-Methylnaphthalene**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Antimony**
5	70	12	60	14	39	1.50
10	54	12	95	16	64	2.4
15	42	12	120	19	92	2.7
19	37	12	154	20	101	2.7
25	26	12	186	24	345	2.7
STATISTICAL SIGNIFICANCE ONLY:						
SUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**					**Antimony**
5	68					1.5
10	50					2.4
14	43					2.7
19	34					2.7
25	22					2.7

STATISTICAL SIGNIFICANCE ONLY:							
UNSUMMED PAHs and PCBs	% False	Aroclor	Aroclor				
% False Negatives	Positives	1254	1260	Arsenic	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(g,h,i)perylene
5	70	120	130	4.9	62	49	46
10	54	131	130	6.1	101	128	73
15	42	156	130	9.5	154	183	179
19	37	172	130	13.6	175	224	205
25	26	186	130	21.4	257	301	225
STATISTICAL SIGNIFICANCE ONLY:							
SUMMED PAHs and PCBs	% False						
% False Negatives	Positives			Arsenic			
5	68			4.9			
10	50			6.1			
14	43			7.5			
19	34			10.8			
25	22			19.0			

STATISTICAL SIGNIFICANCE ONLY:							
UNSUMMED PAHs and PCBs	**% False**		**Butyl**				
% False Negatives	**Positives**	**Bis(2-ethylhexyl) phthalate**	**benzyl phthalate**	**Cadmium**	**Chromium**	**Chrysene**	**Copper**
5	70	170	88	0.24	36	72	28
10	54	216	108	0.39	47	137	34
15	42	327	222	0.83	52	222	42
19	37	380	286	1.13	52	270	49
25	26	561	362	1.69	61	360	61

STATISTICAL SIGNIFICANCE ONLY:							
SUMMED PAHs and PCBs	**% False**		**Butyl**				
% False Negatives	**Positives**	**Bis(2-ethylhexyl) phthalate**	**benzyl phthalate**	**Cadmium**	**Chromium**		**Copper**
5	68	170	88	0.24	36		28
10	50	216	108	0.39	47		34
14	43	280	157	0.80	50		39
19	34	351	265	0.91	52		44
25	22	462	330	1.39	58		58

STATISTICAL SIGNIFICANCE ONLY:					
UNSUMMED PAHs and PCBs	**% False**			**Dimethyl**	
% False Negatives	**Positives**	**Dibenz(a,h)anthracene**	**Dibenzofuran**	**phthalate**	**Di-n-octyl phthalate**
5	70	20	9	46	0
10	54	25	9	46	26
15	42	33	9	46	26
19	37	42	9	46	26
25	26	70	9	46	26
STATISTICAL SIGNIFICANCE ONLY:					
SUMMED PAHs and PCBs	**% False**			**Dimethyl**	
% False Negatives	**Positives**			**phthalate**	**Di-n-octyl phthalate**
5	68			46	0
10	50			46	26
14	43			46	26
19	34			46	26
25	22			46	26

STATISTICAL SIGNIFICANCE ONLY:					
UNSUMMED PAHs and PCBs					
% False Negatives	% False Positives	Fluoranthene	Fluorene	High Molecular Weight PAH	Indeno(1,2,3-c,d)pyrene
5	70	87	45	150	53
10	54	146	62	335	84
15	42	258	76	484	167
19	37	415	94	614	212
25	26	689	121	982	282
STATISTICAL SIGNIFICANCE ONLY:					
SUMMED PAHs and PCBs					
% False Negatives	% False Positives				
5	68				
10	50				
14	43				
19	34				
25	22				

STATISTICAL SIGNIFICANCE ONLY:								
UNSUMMED PAHs and PCBs								
% False Negatives	**% False Positives**	**Lead**	**Low Molecular Weight PAH**	**Mercury**	**Naphthalene**	**Nickel**	**Phenanthrene**	**Pyrene**
5	70	19	56	0.10	21	30	65	91
10	54	39	109	0.15	29	39	109	140
15	42	51	154	0.28	33	47	190	279
19	37	97	175	0.30	37	48	315	379
25	26	172	199	0.43	48	54	527	577
STATISTICAL SIGNIFICANCE ONLY:								
SUMMED PAHs and PCBs								
% False Negatives	**% False Positives**	**Lead**		**Mercury**		**Nickel**		
5	68	19		0.10		30		
10	50	39		0.15		39		
14	43	48		0.23		45		
19	34	75		0.30		47		
25	22	144		0.39		50		

STATISTICAL SIGNIFICANCE ONLY:						
UNSUMMED PAHs and PCBs	**% False**		**Total**	**Total**		
% False Negatives	**Positives**	**Silver**	**benzofluoranthenes (b+k (+j))**	**Polychlorinated Biphenyls**	**Tributyltin**	**Zinc**
5	70	0.26	87	19	11	77
10	54	0.30	248	51	20	86
15	42	0.43	339	78	26	120
19	37	0.45	444	92	31	142
25	26	1.80	630	107	35	191
STATISTICAL SIGNIFICANCE ONLY:						
SUMMED PAHs and PCBs	**% False**			**Total**		
% False Negatives	**Positives**	**Silver**	**PAHs (molar)**	**Polychlorinated Biphenyls**	**Tributyltin**	**Zinc**
5	68	0.26	1.9	19	11	77
10	50	0.30	2.9	51	20	86
14	43	0.38	6.4	64	23	109
19	34	0.45	10.0	87	29	133
25	22	1.60	12.8	101	34	173

SQS:					
UNSUMMED PAHs and PCBs	**% False**		**2003%**	**1988%**	
% False Negatives	**Positives**	**% Sensitivity**	**Efficiency**	**Efficiency**	**% Reliability**
5	69	95	31	76	76
10	51	90	49	80	78
15	42	85	58	82	77
20	35	80	65	84	76
24	24	76	76	88	76
SQS:					
SUMMED PAHs and PCBs	**% False**		**2003%**	**1988%**	
% False Negatives	**Positives**	**% Sensitivity**	**Efficiency**	**Efficiency**	**% Reliability**
5	68	95	32	76	76
10	51	90	49	80	78
15	44	85	56	82	77
20	32	80	68	85	76
25	24	75	76	88	75

SQS:								
UNSUMMED PAHs and PCBs	**% False**						**Aroclor**	**Aroclor**
% False Negatives	**Positives**	**2-Methylnaphthalene**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Antimony**	**1254**	**1260**
5	69	12	65	14	46	1.7	120	130
10	51	12	99	18	83	2.7	134	130
15	42	12	149	21	269	2.7	158	130
20	35	12	165	24	334	3.1	170	130
24	24	12	221	40	406	4.0	187	130
SQS:								
SUMMED PAHs and PCBs	**% False**							
% False Negatives	**Positives**					**Antimony**		
5	68					1.7		
10	51					2.4		
15	44					2.7		
20	32					3.0		
25	24					3.7		

SQS:						
UNSUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**	**Arsenic**	**Benzo(a)anthracene**	**Benzo(a)pyrene**	**Benzo(g,h,i)perylene**	**Bis(2-ethylhexyl) phthalate**
5	69	4.9	74	84	57	180
10	51	6.2	132	149	94	324
15	42	9.3	177	230	201	403
20	35	10.6	190	260	210	527
24	24	22.4	343	378	307	1120
SQS:						
SUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**	**Arsenic**				**Bis(2-ethylhexyl) phthalate**
5	68	4.9				180
10	51	6.1				224
15	44	7.5				280
20	32	10.6				489
25	24	19.0				771

SQS:								
UNSUMMED PAHs and PCBs	**% False**							
% False Negatives	**Positives**	**Butyl benzyl phthalate**	**Cadmium**	**Chromium**	**Chrysene**	**Copper**	**Dibenz(a,h)anthracene**	**Dibenzofuran**
5	69	124	0.30	38	83	30	22	348
10	51	232	0.61	46	175	38	32	446
15	42	312	0.91	51	268	46	47	517
20	35	340	1.13	52	310	51	90	543
24	24	405	2.07	61	541	63	1330	602
SQS:								
SUMMED PAHs and PCBs	**% False**							
% False Negatives	**Positives**	**Butyl benzyl phthalate**	**Cadmium**	**Chromium**		**Copper**		
5	68	124	0.30	38		30		
10	51	109	0.39	48		35		
15	44	157	0.80	50		39		
20	32	333	1.00	52		51		
25	24	384	1.69	57		61		

SQS:							
UNSUMMED PAHs and PCBs	**% False**					**High Molecular**	
% False Negatives	**Positives**	**Dimethyl phthalate**	**Di-n-octyl phthalate**	**Fluoranthene**	**Fluorene**	**Weight PAH**	**Indeno(1,2,3-c,d)pyrene**
5	69	46	0	112	48	178	63
10	51	46	0	190	66	452	100
15	42	46	0	401	88	1200	202
20	35	46	0	498	108	1850	218
24	24	46	0	1210	141	4630	306
SQS:							
SUMMED PAHs and PCBs	**% False**						
% False Negatives	**Positives**	**Dimethyl phthalate**	**Di-n-octyl phthalate**				
5	68	46	0				
10	51	46	0				
15	44	46	0				
20	32	46	0				
25	24	46	0				

SQS:									
UNSUMMED PAHs and PCBs	**% False**		**Low Molecular**						
% False Negatives	**Positives**	**Lead**	**Weight PAH**	**Mercury**	**Naphthalene**	**Nickel**	**Phenanthrene**	**Pyrene**	**Silver**
5	69	18	113	0.10	21	29	75	107	0.25
10	51	46	206	0.17	30	37	147	182	0.30
15	42	76	517	0.28	33	46	290	379	0.43
20	35	107	690	0.30	40	47	359	420	0.45
24	24	194	16100	0.44	56	54	665	980	1.80
SQS:									
SUMMED PAHs and PCBs	**% False**								
% False Negatives	**Positives**	**Lead**		**Mercury**		**Nickel**			**Silver**
5	68	18		0.10		29			0.25
10	51	41		0.15		41			0.30
15	44	48		0.23		45			0.38
20	32	96		0.30		47			0.43
25	24	172		0.43		49			1.60

SQS:					
UNSUMMED PAHs and PCBs	**% False**	**Total**	**Total**		
% False Negatives	**Positives**	**benzofluoranthenes (b+k (+j))**	**Polychlorinated Biphenyls**	**Tributyltin**	**Zinc**
5	69	121	22	9	77
10	51	290	55	20	96
15	42	451	80	27	129
20	35	564	89	30	149
24	24	693	110	36	200
SQS:					
SUMMED PAHs and PCBs	**% False**		**Total**		
% False Negatives	**Positives**	**PAHs (molar)**	**Polychlorinated Biphenyls**	**Tributyltin**	**Zinc**
5	68	2.2	22	9	77
10	51	2.9	53	21	88
15	44	6.4	64	24	109
20	32	10.8	87	29	144
25	24	17.8	103	34	193

CSL:					
UNSUMMED PAHs and PCBs	**% False**		**2003%**	**1988%**	
% False Negatives	**Positives**	**% Sensitivity**	**Efficiency**	**Efficiency**	**% Reliability**
5	59	95	41	62	68
9	57	91	43	62	67
13	50	87	50	63	68
20	43	80	57	65	68
25	37	75	63	67	69
CSL:					
SUMMED PAHs and PCBs	**% False**		**2003%**	**1988%**	
% False Negatives	**Positives**	**% Sensitivity**	**Efficiency**	**Efficiency**	**% Reliability**
5	58	95	42	62	69
10	54	90	46	62	68
15	48	85	52	64	69
19	43	81	57	65	69
25	38	75	62	66	69

CSL:								
UNSUMMED PAHs and PCBs	**% False**						**Aroclor**	**Aroclor**
% False Negatives	**Positives**	**2-Methylnaphthalene**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Antimony**	**1254**	**1260**
5	59	147	110	31	155	0.4	134	65
9	57	151	115	34	177	0.5	140	68
13	50	162	147	50	300	0.5	142	80
20	43	170	201	124	353	2.3	168	103
25	37	172	225	134	355	2.7	178	110
CSL:								
SUMMED PAHs and PCBs	**% False**							
% False Negatives	**Positives**					**Antimony**		
5	58					0.4		
10	54					0.5		
15	48					0.5		
19	43					1.6		
25	38					2.3		

CSL:						
UNSUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**	**Arsenic**	**Benzo(a)anthracene**	**Benzo(a)pyrene**	**Benzo(g,h,i)perylene**	**Bis(2-ethylhexyl) phthalate**
5	59	6.1	130	171	177	336
9	57	6.6	140	197	186	355
13	50	8.6	174	251	216	420
20	43	11.7	276	360	280	580
25	37	13.3	329	439	295	713
CSL:						
SUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**	**Arsenic**				**Bis(2-ethylhexyl) phthalate**
5	58	6.0				322
10	54	6.6				355
15	48	8.6				420
19	43	9.5				539
25	38	11.7				580

CSL:								
UNSUMMED PAHs and PCBs	**% False**							
% False Negatives	**Positives**	**Butyl benzyl phthalate**	**Cadmium**	**Chromium**	**Chrysene**	**Copper**	**Dibenz(a,h)anthracene**	**Dibenzofuran**
5	59	164	0.69	39	177	41	142	112
9	57	166	0.79	41	185	41	182	126
13	50	192	0.90	44	255	44	259	164
20	43	227	1.13	50	394	52	300	180
25	37	230	1.20	52	493	54	319	196
CSL:								
SUMMED PAHs and PCBs	**% False**							
% False Negatives	**Positives**	**Butyl benzyl phthalate**	**Cadmium**	**Chromium**		**Copper**		
5	58	164	0.69	39		40		
10	54	166	0.80	41		41		
15	48	192	0.90	44		44		
19	43	223	0.96	48		50		
25	38	227	1.13	50		52		

CSL:						
UNSUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**	**Dimethyl phthalate**	**Di-n-octyl phthalate**	**Fluoranthene**	**Fluorene**	**High Molecular Weight PAH**
5	59	96	66	218	105	2940
9	57	103	66	236	112	3370
13	50	120	67	364	126	12100
20	43	139	67	684	179	16400
25	37	144	70	757	183	17800
CSL:						
SUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**	**Dimethyl phthalate**	**Di-n-octyl phthalate**			
5	58	93	66			
10	54	103	66			
15	48	120	67			
19	43	132	67			
25	38	139	67			

CSL:								
UNSUMMED PAHs and PCBs	**% False**			**Low Molecular**				
% False Negatives	**Positives**	**Indeno(1,2,3-c,d)pyrene**	**Lead**	**Weight PAH**	**Mercury**	**Naphthalene**	**Nickel**	**Phenanthrene**
5	59	160	46	1080	0.17	51	34	162
9	57	176	48	2140	0.21	54	34	190
13	50	218	75	2680	0.28	60	40	310
20	43	311	94	3390	0.36	100	45	587
25	37	330	103	3860	0.39	111	45	726
CSL:								
SUMMED PAHs and PCBs	**% False**							
% False Negatives	**Positives**		**Lead**		**Mercury**		**Nickel**	
5	58		41		0.17		34	
10	54		48		0.21		34	
15	48		75		0.28		40	
19	43		83		0.30		43	
25	38		94		0.36		45	

CSL:							
UNSUMMED PAHs and PCBs	**% False**			**Total**	**Total**		
% False Negatives	**Positives**	**Pyrene**	**Silver**	**benzofluoranthenes (b+k (+j))**	**Polychlorinated Biphenyls**	**Tributyltin**	**Zinc**
5	59	230	0.30	291	67	26	114
9	57	250	0.30	313	68	29	117
13	50	334	0.36	497	75	37	123
20	43	580	0.43	657	107	120	142
25	37	646	0.44	790	115	198	147
CSL:							
SUMMED PAHs and PCBs	**% False**				**Total**		
% False Negatives	**Positives**		**Silver**	**PAHs (molar)**	**Polychlorinated Biphenyls**	**Tributyltin**	**Zinc**
5	58		0.30	5.9	66	25	110
10	54		0.30	6.8	68	29	117
15	48		0.36	10.0	75	37	123
19	43		0.40	13.4	95	63	135
25	38		0.43	17.7	107	120	142

Appendix D

APPENDIX D. FLOATING PERCENTILE RESULTS

The results of the floating percentile analysis presented in Section 3 are provided in this appendix. For each level of effects (statistical significance only, SQS, and CSL) there are two sets of results provided – the one above is for the data set containing individual PAHs and Aroclors, and the one below is for the same data set containing only summed PAHs and PCBs. In this lower data set, blank spaces indicate individual PAHs and Aroclors that are not present in that data set.

Five sets of percentiles are shown for each of the two data sets. These correspond to different levels of false negatives that Ecology could select to base their SQVs on, and range from 5-25% false negatives, in increments of 5%. The first page shows the reliability results for each of these sets of percentiles for all six reliability parameters. The remaining pages show the chemical concentrations derived by the floating percentile method corresponding to the selected false negative rates. The false negative and false positive rates are repeated on each page for reference.

STATISTICAL SIGNIFICANCE ONLY:					
UNSUMMED PAHs and PCBs	**% False**		**2003%**	**1988%**	
% False Negatives	**Positives**	**% Sensitivity**	**Efficiency**	**Efficiency**	**% Reliability**
4	55	96	45	82	82
10	39	90	61	86	82
15	26	85	74	89	82
20	20	80	80	92	81
25	16	75	84	93	78
STATISTICAL SIGNIFICANCE ONLY:					
SUMMED PAHs and PCBs	**% False**		**2003%**	**1988%**	
% False Negatives	**Positives**	**% Sensitivity**	**Efficiency**	**Efficiency**	**% Reliability**
5	57	95	43	82	81
10	42	90	58	85	81
15	33	85	67	87	80
20	28	80	72	89	78
25	24	75	76	89	75

STATISTICAL SIGNIFICANCE ONLY:						
UNSUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**	**2-Methylnaphthalene**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Antimony**
4	55	470	1060	470	600	0.4
10	39	470	1060	470	600	0.4
15	26	470	1060	470	600	0.4
20	20	470	1060	470	600	0.6
25	16	470	1060	470	600	0.6
STATISTICAL SIGNIFICANCE ONLY:						
SUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**					**Antimony**
5	57					0.4
10	42					0.4
15	33					0.4
20	28					0.4
25	24					0.4

STATISTICAL SIGNIFICANCE ONLY:						
UNSUMMED PAHs and PCBs	**% False**	**Aroclor**	**Aroclor**			
% False Negatives	**Positives**	**1254**	**1260**	**Arsenic**	**Benzo(a)anthracene**	**Benzo(a)pyrene**
4	55	230	140	4.6	4260	3300
10	39	230	140	7.5	4260	3300
15	26	230	140	20.0	4260	3300
20	20	230	140	31.0	4260	3300
25	16	230	140	31.0	4260	3300
STATISTICAL SIGNIFICANCE ONLY:						
SUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**			**Arsenic**		
5	57			4.6		
10	42			7.0		
15	33			8.5		
20	28			31.0		
25	24			55.0		

STATISTICAL SIGNIFICANCE ONLY:					
UNSUMMED PAHs and PCBs	% False				
% False Negatives	Positives	Benzo(g,h,i)perylene	Bis(2-ethylhexyl) phthalate	Butyl benzyl phthalate	Cadmium
4	55	4020	220	260	0.3
10	39	4020	220	260	0.3
15	26	4020	230	260	0.6
20	20	4020	330	260	0.7
25	16	4020	550	260	0.9
STATISTICAL SIGNIFICANCE ONLY:					
SUMMED PAHs and PCBs	% False				
% False Negatives	Positives		Bis(2-ethylhexyl) phthalate	Butyl benzyl phthalate	Cadmium
5	57		220	480	0.6
10	42		220	480	0.6
15	33		220	480	1.0
20	28		220	480	1.0
25	24		230	480	1.0

STATISTICAL SIGNIFICANCE ONLY:						
UNSUMMED PAHs and PCBs	% False					
% False Negatives	Positives	Chromium	Chrysene	Copper	Dibenz(a,h)anthracene	Dibenzofuran
4	55	95	5940	35	300	400
10	39	95	5940	35	300	400
15	26	95	5940	50	300	400
20	20	95	5940	50	300	400
25	16	95	5940	80	300	400
STATISTICAL SIGNIFICANCE ONLY:						
SUMMED PAHs and PCBs	% False					
% False Negatives	Positives	Chromium		Copper		
5	57	100		35		
10	42	100		35		
15	33	100		42		
20	28	100		48		
25	24	100		75		

STATISTICAL SIGNIFICANCE ONLY: UNSUMMED PAHs and PCBs						
% False Negatives	% False Positives	Dimethyl phthalate	Di-n-octyl phthalate	Fluoranthene	Fluorene	High Molecular Weight PAH
4	55	46	26	2000	200	3000
10	39	46	26	5000	200	3000
15	26	46	26	5000	200	3000
20	20	46	26	5000	200	3000
25	16	46	26	5000	200	3000

STATISTICAL SIGNIFICANCE ONLY: SUMMED PAHs and PCBs			
% False Negatives	% False Positives	Dimethyl phthalate	Di-n-octyl phthalate
5	57	46	26
10	42	46	26
15	33	46	26
20	28	46	26
25	24	46	26

STATISTICAL SIGNIFICANCE ONLY:							
UNSUMMED PAHs and PCBs	% False			Low Molecular			
% False Negatives	Positives	Indeno(1,2,3-c,d)pyrene	Lead	Weight PAH	Mercury	Naphthalene	Nickel
4	55	4120	335	500	0.30	100	53
10	39	4120	335	500	0.30	100	53
15	26	4120	335	500	0.50	100	55
20	20	4120	335	500	0.50	100	53
25	16	4120	335	500	0.50	100	53
STATISTICAL SIGNIFICANCE ONLY:							
SUMMED PAHs and PCBs	% False						
% False Negatives	Positives		Lead		Mercury		Nickel
5	57		350		0.20		39
10	42		350		0.20		39
15	33		350		0.20		60
20	28		350		0.20		60
25	24		350		0.50		60

STATISTICAL SIGNIFICANCE ONLY:					
UNSUMMED PAHs and PCBs	% False				Total
% False Negatives	Positives	Phenanthrene	Pyrene	Silver	benzofluoranthenes (b+k (+j))
4	55	6100	3000	0.55	140
10	39	6100	3000	0.55	300
15	26	6100	3000	0.55	450
20	20	6100	3000	0.55	650
25	16	6100	3000	0.55	650
STATISTICAL SIGNIFICANCE ONLY:					
SUMMED PAHs and PCBs	% False				
% False Negatives	Positives			Silver	PAHs (molar)
5	57			2.20	6
10	42			2.20	7
15	33			2.20	14
20	28			2.20	15
25	24			2.20	20

STATISTICAL SIGNIFICANCE ONLY:				
UNSUMMED PAHs and PCBs	**% False**	**Total**		
% False Negatives	**Positives**	**Polychlorinated Biphenyls**	**Tributyltin**	**Zinc**
4	55	50	75	120
10	39	60	75	120
15	26	60	75	140
20	20	60	75	250
25	16	60	75	250
STATISTICAL SIGNIFICANCE ONLY:				
SUMMED PAHs and PCBs	**% False**	**Total**		
% False Negatives	**Positives**	**Polychlorinated Biphenyls**	**Tributyltin**	**Zinc**
5	57	120	200	100
10	42	120	200	100
15	33	120	200	100
20	28	120	200	250
25	24	120	200	250

SQS: UNSUMMED PAHs and PCBs % False Negatives	% False Positives	% Sensitivity	2003% Efficiency	1988% Efficiency	% Reliability
5	57	95	43	79	80
10	44	90	56	82	80
15	26	85	74	88	82
20	20	80	80	90	80
25	15	75	85	92	78

SQS: SUMMMED PAHs and PCBs % False Negatives	% False Positives	% Sensitivity	2003% Efficiency	1988% Efficiency	% Reliability
5	55	95	45	80	80
10	45	90	55	82	80
15	33	85	67	85	80
20	26	80	74	87	78
25	23	75	77	88	76

SQS:							
UNSUMMED PAHs and PCBs	**% False**						**Aroclor**
% False Negatives	**Positives**	**2-Methylnaphthalene**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Antimony**	**1254**
5	57	470	1060	470	1200	0.4	230
10	44	470	1060	470	1200	0.4	230
15	26	470	1060	470	1200	0.4	230
20	20	470	1060	470	1200	0.6	230
25	15	470	1060	470	1200	0.6	230
SQS:							
SUMMMED PAHs and PCBs	**% False**						
% False Negatives	**Positives**					**Antimony**	
5	55					0.4	
10	45					0.4	
15	33					0.4	
20	26					32.0	
25	23					32.0	

SQS: **UNSUMMED PAHs and PCBs** **% False Negatives**	**% False Positives**	**Aroclor 1260**	**Arsenic**	**Benzo(a)anthracene**	**Benzo(a)pyrene**	**Benzo(g,h,i)perylene**
5	57	140	4.6	4260	3300	4020
10	44	140	6.0	4260	3300	4020
15	26	140	20	4260	3300	4020
20	20	140	31	4260	3300	4020
25	15	140	31	4260	3300	4020
SQS: **SUMMMED PAHs and PCBs** **% False Negatives**	**% False Positives**		**Arsenic**			
5	55		6.2			
10	45		6.2			
15	33		8.5			
20	26		30			
25	23		30			

SQS:							
UNSUMMED PAHs and PCBs	**% False**						
% False Negatives	**Positives**	**Bis(2-ethylhexyl) phthalate**	**Butyl benzyl phthalate**	**Cadmium**	**Chromium**	**Chrysene**	**Copper**
5	57	220	260	0.27	95	5940	80
10	44	220	260	0.29	95	5940	80
15	26	230	260	0.60	95	5940	80
20	20	330	260	0.78	95	5940	80
25	15	550	260	0.97	95	5940	80
SQS:							
SUMMMED PAHs and PCBs	**% False**						
% False Negatives	**Positives**	**Bis(2-ethylhexyl) phthalate**	**Butyl benzyl phthalate**	**Cadmium**	**Chromium**		**Copper**
5	55	240	480	1.0	100		80
10	45	240	480	1.0	100		80
15	33	240	480	1.0	100		80
20	26	240	480	1.0	100		80
25	23	300	480	6.0	100		80

SQS: UNSUMMED PAHs and PCBs % False Negatives	% False Positives	Dibenz(a,h)anthracene	Dibenzofuran	Dimethyl phthalate	Di-n-octyl phthalate
5	57	800	400	46	26
10	44	800	400	46	26
15	26	800	400	46	26
20	20	800	400	46	26
25	15	800	400	46	26
SQS: SUMMMED PAHs and PCBs % False Negatives	**% False Positives**			**Dimethyl phthalate**	**Di-n-octyl phthalate**
5	55			46	45
10	45			46	45
15	33			46	45
20	26			46	45
25	23			46	45

SQS: UNSUMMED PAHs and PCBs % False Negatives	% False Positives	Fluoranthene	Fluorene	High Molecular Weight PAH	Indeno(1,2,3-c,d)pyrene	Lead
5	57	11000	1000	31000	4120	335
10	44	11000	1000	31000	4120	335
15	26	11000	1000	31000	4120	335
20	20	11000	1000	31000	4120	335
25	15	11000	1000	31000	4120	335
SQS:						
SUMMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**					**Lead**
5	55					350
10	45					350
15	33					350
20	26					1200
25	23					1200

SQS: UNSUMMED PAHs and PCBs % False Negatives	% False Positives	Low Molecular Weight PAH	Mercury	Naphthalene	Nickel	Phenanthrene	Pyrene	Silver
5	57	6600	0.50	500	60	6100	8800	2.0
10	44	6600	0.50	500	60	6100	8800	2.0
15	26	6600	0.50	500	60	6100	8800	2.0
20	20	6600	0.50	500	60	6100	8800	2.0
25	15	6600	0.50	500	60	6100	8800	2.0

SQS: SUMMMED PAHs and PCBs % False Negatives	% False Positives		Mercury		Nickel			Silver
5	55		0.17		28			2.2
10	45		0.20		60			2.2
15	33		0.30		60			2.2
20	26		0.30		60			2.2
25	23		0.30		60			2.2

SQS:					
UNSUMMED PAHs and PCBs	% False	Total	Total		
% False Negatives	Positives	benzofluoranthenes (b+k (+j))	Polychlorinated Biphenyls	Tributyltin	Zinc
5	57	140	60	75	120
10	44	300	60	75	120
15	26	11000	60	75	140
20	20	11000	60	75	250
25	15	11000	60	75	250
SQS:					
SUMMMED PAHs and PCBs	% False		Total		
% False Negatives	Positives	PAHs (molar)	Polychlorinated Biphenyls	Tributyltin	Zinc
5	55	2.7	120	200	80
10	45	9.5	120	200	80
15	33	15	120	200	100
20	26	15	150	220	100
25	23	21	150	220	140

CSL:			
UNSUMMED PAHs and PCBs	**% False**		**2003%**
% False Negatives	**Positives**	**% Sensitivity**	**Efficiency**
5	50	95	50
10	37	90	63
15	26	85	74
20	23	80	77
25	21	75	79
CSL:			
SUMMED PAHs and PCBs	**% False**		**2003%**
% False Negatives	**Positives**	**% Sensitivity**	**Efficiency**
5	50	95	50
10	44	90	56
15	24	85	76
20	17	80	83
25	16	75	84

CSL:							
UNSUMMED PAHs and PCBs	**% False**						**Aroclor**
% False Negatives	**Positives**	**2-Methylnaphthalene**	**Acenaphthene**	**Acenaphthylene**	**Anthracene**	**Antimony**	**1254**
5	50	555	1320	640	1580	0.4	340
10	37	555	1320	640	1580	0.6	340
15	26	555	1320	640	1580	0.6	340
20	23	555	1320	640	1580	0.6	340
25	21	555	1320	640	1580	0.6	340
CSL:							
SUMMED PAHs and PCBs	**% False**						
% False Negatives	**Positives**					**Antimony**	
5	50					0.6	
10	44					0.6	
15	24					0.6	
20	17					0.6	
25	16					0.6	

CSL:						
UNSUMMED PAHs and PCBs	% False	Aroclor				
% False Negatives	Positives	1260	Arsenic	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(g,h,i)perylene
5	50	140	7.7	5800	4810	5200
10	37	140	51	5800	4810	5200
15	26	140	51	5800	4810	5200
20	23	140	51	5800	4810	5200
25	21	140	51	5800	4810	5200
CSL:						
SUMMED PAHs and PCBs	% False					
% False Negatives	Positives		Arsenic			
5	50		7.6			
10	44		8			
15	24		51			
20	17		51			
25	16		51			

CSL:						
UNSUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**	**Bis(2-ethylhexyl) phthalate**	**Butyl benzyl phthalate**	**Cadmium**	**Chromium**	**Chrysene**
5	50	320	370	1	100	6400
10	37	320	370	1	100	6400
15	26	320	370	1	100	6400
20	23	400	370	1.5	100	6400
25	21	500	370	1.5	100	6400
CSL:						
SUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**	**Bis(2-ethylhexyl) phthalate**	**Butyl benzyl phthalate**	**Cadmium**	**Chromium**	
5	50	300	600	6	100	
10	44	300	600	6	100	
15	24	300	600	6	100	
20	17	345	600	6	100	
25	16	410	600	6	100	

CSL:						
UNSUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**	**Copper**	**Dibenz(a,h)anthracene**	**Dibenzofuran**	**Dimethyl phthalate**	**Di-n-octyl phthalate**
5	50	830	840	440	440	45
10	37	830	840	440	440	45
15	26	830	840	440	440	45
20	23	830	840	440	440	45
25	21	830	840	440	440	45
CSL:						
SUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**	**Copper**			**Dimethyl phthalate**	**Di-n-octyl phthalate**
5	50	44			180	100
10	44	44			180	100
15	24	450			180	100
20	17	450			180	100
25	16	450			180	100

CSL:						
UNSUMMED PAHs and PCBs	**% False**			**High Molecular**		
% False Negatives	**Positives**	**Fluoranthene**	**Fluorene**	**Weight PAH**	**Indeno(1,2,3-c,d)pyrene**	**Lead**
5	50	230	3000	54800	5300	430
10	37	400	3000	54800	5300	430
15	26	15000	3000	54800	5300	430
20	23	15000	3000	54800	5300	430
25	21	15000	3000	54800	5300	430
CSL:						
SUMMED PAHs and PCBs	**% False**					
% False Negatives	**Positives**					**Lead**
5	50					430
10	44					430
15	24					430
20	17					430
25	16					430

CSL:								
UNSUMMED PAHs and PCBs	**% False**	**Low Molecular**						
% False Negatives	**Positives**	**Weight PAH**	**Mercury**	**Naphthalene**	**Nickel**	**Phenanthrene**	**Pyrene**	**Silver**
5	50	9200	0.5	1310	70	7600	16000	2.5
10	37	9200	0.5	1310	70	7600	16000	2.5
15	26	9200	0.75	1310	70	7600	16000	2.5
20	23	9200	0.75	1310	70	7600	16000	2.5
25	21	9200	0.75	1310	70	7600	16000	2.5
CSL:								
SUMMED PAHs and PCBs	**% False**							
% False Negatives	**Positives**		**Mercury**		**Nickel**			**Silver**
5	50		0.5		30			3
10	44		0.5		38			3
15	24		0.5		70			3
20	17		3		70			3
25	16		3		70			3

CSL:					
UNSUMMED PAHs and PCBs	**% False**	**Total**	**Total**		
% False Negatives	**Positives**	**benzofluoranthenes (b+k (+j))**	**Polychlorinated Biphenyls**	**Tributyltin**	**Zinc**
5	50	13800	120	60	125
10	37	13800	120	75	125
15	26	13800	120	75	160
20	23	13800	120	75	160
25	21	13800	120	75	250
CSL:					
SUMMED PAHs and PCBs	**% False**		**Total**		
% False Negatives	**Positives**	**PAHs (molar)**	**Polychlorinated Biphenyls**	**Tributyltin**	**Zinc**
5	50	9	120	6600	125
10	44	14	120	6600	125
15	24	50	120	6600	150
20	17	88	120	6600	450
25	16	90	120	6600	450

FINAL
QUARTERLY GROUNDWATER SAMPLING REPORT FOR JULY 2004

at

2737 West Commodore Way and
2750 West Commodore Way
Seattle, Washington

Prepared for

Time Oil Company
2737 West Commodore Way
Seattle, WA 98199
(206) 285-2400

November 2004

Prepared by

TETRA TECH FW, INC.

12100 NE 195th, Suite 200
Bothell, WA 98011
(425) 482-7600

CONTENTS

CONTENTS

FIGURES

TABLES

ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
°C	degrees Celsius
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HDPE	high-density polyethylene
mg/L	milligrams per liter
mL/min	milliliters per minute
mS/cm	millisiemens per centimeter
msl	mean sea level
µg/L	micrograms per liter
MTCA	Model Toxics Control Act
NOAA	National Oceanic and Atmospheric Administration
NTU	nephelometric turbidity unit
NWTPH-Dx	Northwest total petroleum hydrocarbon-diesel range hydrocarbons
NWTPH-Gx	Northwest total petroleum hydrocarbon-gasoline range hydrocarbons
ORP	oxidation reduction potential
PCP	pentachlorophenol
sim	selective ion monitoring
SQuiRT™	Screening Quick Reference Tables
TOC	Time Oil Company
VOC	volatile organic compound

1. INTRODUCTION

Investigations to assess groundwater levels and specific chemical concentrations were conducted at two Time Oil Company (TOC) properties located at 2737 West Commodore Way and 2750 West Commodore Way, Seattle, Washington (Figure 1-1). TOC retained Tetra Tech FW, Inc. (TtFW) to conduct quarterly groundwater monitoring at these properties as part of an independent cleanup action.

Monitoring wells at the properties are sampled on a quarterly basis, which began in July 2001. This quarterly report presents the results of the July 2004 groundwater sampling activities at 2737 and 2750 West Commodore Way. The document also serves as an annual report summarizing trends in data collected over the last year of sampling (October 2003 through July 2004). Figure 1-2 provides a plan view of the properties relative to one another. The report is organized as follows:

- **Section 1** briefly describes the purpose and organization of the report.
- **Section 2** describes the field methods used to measure water levels and to collect samples.
- **Section 3** presents the groundwater level data.
- **Section 4** presents the analytical results.
- **Section 5** describes the conclusions and provides recommendations for future actions.
- **Appendix A** provides the data packages from the analytical laboratory for July 2004.

2. METHODS AND PROCEDURES

Field activities for July 2004 at the two TOC properties included water level measurement and quarterly groundwater sampling. This section presents a brief description of the specific methods and procedures used for quarterly monitoring.

2.1 GROUNDWATER ELEVATION SURVEY

Groundwater elevations are determined each quarter by measuring the depth to water in 28 wells at 2737 West Commodore Way and 7 wells at 2750 West Commodore Way. The depth to water measurements are collected on a single day and subtracted from the survey level at the top of the well casing to calculate the potentiometric surface (water table elevation).

Before measuring the depth to groundwater in the first well, the water level indicator is calibrated by visually comparing the markings on the tape to the markings on a measurement tape. After removing the well cap and allowing the well to stabilize, the probe is lowered into the well until the sound alarm is activated, indicating that the probe has touched the water surface. The static depth to water is read directly from the tape by holding the tape to the permanent mark on the well casing or cap. The probe is then raised and lowered to confirm the reading. An oil/water interface probe is then used in a similar manner in wells where floating product is suspected to be present.

2.2 GROUNDWATER SAMPLING

Groundwater samples are collected each quarter using a low-flow micro-purging technique in accordance with U.S. Environmental Protection Agency (EPA) guidelines (EPA 1996, EPA/540/S-95/504). Each monitoring well is micro-purged (300 to 500 milliliters per minute [mL/min]) using a peristaltic pump with disposable high-density polyethylene (HDPE) tubing. A small section of thick-walled silicon is used around the head of the peristaltic pump to achieve the pressures necessary to draw the groundwater up the well. Groundwater samples are collected in laboratory-supplied glassware and hand delivered to the laboratory each evening after sampling.

Groundwater sampling was conducted in July 2004 in accordance with the following sampling procedures:

1. Calibrate field instruments in accordance with the manufacturer's directions. Record all calibration data in the field log book.
2. Confirm well identification using site map.
3. Measure the depth to water at each well. Record the depth to water. Decontaminate the water level meter before each measurement.
4. Carefully lower the HDPE tubing into the well with as little disturbance to the groundwater as possible. Place the intake at the middle of the screen interval. Set pump rate to ensure the water column in the well does not drop more than 0.2 feet below the initial water level reading.
5. Purge the well at a flow rate of 300 to 500 mL/min. Monitor water level to ensure minimal drawdown. Monitor water quality parameters every 3 to 5 minutes during purging (turbidity, pH, temperature, conductivity, oxidation reduction potential [ORP], and dissolved oxygen) using in-line monitoring equipment. Stabilization is achieved if three successive readings are within ±0.1 pH units, ±1 degree Celsius (°C) for temperature, ±10 percent for conductivity, ±10 percent for dissolved oxygen, and ± 10 millivolts for ORP.
6. When water quality parameters are stable for three consecutive readings, turn off the pump and remove the tubing from the well or leave the tubing in place securing it at the surface within the well head. Place the tubing in a sealed, labeled plastic bag. Replace the well cap and seal the monument.
7. Return within 24 hours and insert the appropriate HDPE tubing into the well. Connect the pump and adjust the pump flow to a rate of approximately 200 mL/min. Collect samples for volatile organic compounds (VOC) and gasoline analyses first. Fill the containers so that no headspace exists.
8. Increase the flow rate to approximately 300 to 500 mL/min while maintaining minimal to no drawdown and collect the remaining samples.

2.3 GROUNDWATER ANALYSES

Groundwater samples were collected on July 13 through July 20, 2004, using laboratory-supplied glassware. The groundwater samples were delivered to the laboratory each evening after sampling and, depending on the specific data needs, were analyzed for all or some of the following contaminants:

- Gasoline range hydrocarbons, using Washington State Department of Ecology's (Ecology's) Northwest total petroleum hydrocarbon-gasoline (NWTPH-Gx) method;
- Benzene, toluene, ethylbenzene, xylene (BTEX) using EPA Method 8021B;
- Diesel and Lube oil range hydrocarbons, using Ecology's Northwest total petroleum hydrocarbon-diesel extended (NWTPH-Dx) method; and
- Pentachlorophenol (PCP), using EPA Method 8270-sim (selective ion monitoring).

The groundwater samples analyzed for diesel and oil underwent a silica gel cleanup before analysis. This cleanup was done to remove naturally occurring organic material that may interfere with the analysis. Groundwater samples were analyzed by North Creek Analytical Laboratories, Inc., in Bothell, Washington.

The sampling during July 2004 was an annual sampling event; therefore, additional modifications to the sampling list were made. Table 2-1 shows the wells sampled in July 2004 and the respective analyses. Many of the wells that are not routinely sampled (i.e., 01MW-06, 01MW-15,) were added to see if conditions had changed since the wells were removed from the sampling program. PCP analysis was added to some wells to ensure that the extent of PCP-impacted groundwater was defined.

3. GROUNDWATER LEVEL DATA

Field activities conducted at the TOC properties included the quarterly collection of water level measurements. This section describes the collection of July 2004 water level measurements and summarizes groundwater flow directions beneath 2737 and 2750 West Commodore Way.

Measurements for depth to water were made using an electronic measuring tape with markings every 0.01 foot. All water levels were measured on a single day. Measurements were subtracted from surveyed measuring point elevations to produce the water level elevations. Where present, the thickness and specific gravity (0.8) of free phase product fuel on the water table was considered when calculating the elevation of the water table.

3.1 2737 WEST COMMODORE WAY

Water level measurements were collected from 28 wells at 2737 West Commodore Way on July 12, 2004. Table 3-1 provides the well construction information, and Table 3-2 shows the groundwater elevations in feet above mean sea level (msl). Table 3-3 shows the groundwater elevations and fuel thickness for the last four quarters. In general, the water levels have decreased slightly relative to April 2004, possibly due to seasonal variation. The groundwater elevations during the four quarter period are generally consistent showing a slight seasonal increase in January and April. Figure 3-2 shows the locations of the wells at 2737 West Commodore Way and the water table elevation (potentiometric space). The hydrograph shown in Figure 3-1 demonstrates the general consistency of the groundwater elevations. Groundwater flows to the north toward the Ship Canal. The groundwater flow direction north of the Lower Tank Yard appears to be bifurcated, possibly by the fiber-grained material in the vicinity of Wells 01MW-16 and 01MW-10. The groundwater gradient at the site differs in the tank yards relative to the rest of the site. The gradient across the tank yards (Wells 01MW-17 to 01MW-23) is approximately 0.006 feet per foot and steepens towards the north wall of the Lower Tank Yard. The unpaved surface of the tank yards allows for greater infiltration, resulting in higher groundwater elevations and mounding. The gradient outside the tank yards (Well 01MW-01 to Well MW-09) is approximately 0.028 feet per foot.

3.2 2750 WEST COMMODORE WAY

Water level measurements were collected from seven wells at 2750 West Commodore Way on July 12, 2004. In general, the water levels at 2750 West Commodore Way have decreased slightly, relative to April 2004, possibly due to seasonal variation. The wells on the east side of the property (Wells 02MW-04, 02MW-05, and 02MW-06) show a slight increase in the elevation of the potentiometric surface. The slight increases in these wells are not consistent with historical data or with trends seen in other wells on the property. The groundwater elevations over the four quarter period are generally consistent and show an increase in water elevations in January. Figure 3-3 shows the groundwater elevation trends, including the seasonal increase in April 2004. Figure 3-4 shows the locations of the wells and potentiometric surface at 2750 West Commodore Way. Groundwater flows to the north toward the Ship Canal. The groundwater gradient from Wells 02MW-05 to Well 02MW-02 is approximately 0.010 feet per foot toward the north based on the potentiometric surface map.

4. ANALYTICAL RESULTS

The MTCA Method A Cleanup Levels for groundwater are intended to provide conservative cleanup levels for drinking water beneficial uses at sites undergoing routine cleanup actions or those sites with relatively few hazardous substances. Because the groundwater beneath the TOC sites is not used as a source of drinking water or for municipal supply, comparison of groundwater concentrations to the MTCA Method A Cleanup Levels is not technically appropriate. The primary point of exposure to groundwater beneath the sites is through the discharge of groundwater to the nearby Ship Canal, a freshwater body on the north side of 2750 West Commodore Way. Based on this exposure scenario (no groundwater use but discharge to a water body), groundwater concentrations were compared to the National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRT™) values. These values provide screening levels for acute and chronic exposures to both freshwater and saltwater.

The SQuiRT™ values are non-promulgated values developed by the Coastal Protection and Restoration Division of NOAA to protect aquatic habitats that may be affected by hazardous waste sites. They are applicable for use at these TOC sites based on the site-specific groundwater use. Because the SQuiRT™ values are non-promulgated values, concentrations above the SQuiRT™ values do not indicate a regulatory exceedance. It is important to remember that between the various wells and the point of exposure, various chemical, physical, and biological processes occur that are likely to reduce the contaminant concentrations. Therefore, a concentration in a well is most likely not the same concentration at the point of exposure. If SQuiRT™ values were not available for a particular analyte, then the MTCA Method A default values were used.

Table 4-1 presents the groundwater parameters measured during sampling. The turbidity sensor on the water quality meter was not functioning properly during the July 2004 sampling event; therefore, suspect values are not reported in Table 4-1. Tables 4-2 and 4-3 show analytical results for the groundwater samples collected in July 2004 at 2737 and 2750 West Commodore Way, respectively. The footnotes at the bottom of each table identify the applicable action levels.

Appendix A contains the laboratory data packages for the samples collected. The data packages are presented in their entirety to allow the reader to evaluate the data relative to the quality control data associated with the environmental samples.

4.1 QUARTERLY GROUNDWATER SAMPLING AT 2737 WEST COMMODORE WAY

The following analytes were detected above the applicable action levels (Table 4-2):

- PCP was detected above the NOAA SQuiRT™ value (15 micrograms per liter [μg/L]) in Wells 01MW-22, 01MW-23, 01MW-26, and 01MW-27 at concentrations ranging from 40.5 (01MW-26) to 350 μg/L (01MW-23).
- Diesel range hydrocarbons were detected above the MTCA Method A Cleanup Level (0.5 milligrams per liter [mg/L]) in Wells 01MW-03, 01MW-09, 01MW-18, 01MW-19, 01MW-22, 01MW-23, 01MW-24, 01MW-28, and 01MW-29 at concentrations ranging from 0.540 mg/L (01MW-23) to 19.2 mg/L (01MW-09).
- Lube Oil range hydrocarbons were detected above the MTCA Method A Cleanup Level in Well 01MW-03 at a concentration of 0.938 mg/L.
- Gasoline range hydrocarbons were detected above the MTCA Method A Cleanup Level (800 μg/L with benzene present) in Wells 01MW-02, 01MW-03, 01MW-04, 01MW-09, 01MW-12, 01MW-18, 01MW-19, 01MW-21, 01MW-22, 01MW-23, 01MW-24, 01MW-27, 01MW-28, and 01MW-29. The concentrations in these wells ranged from 986 μg/L (Well 01MW-21) to 19,900 μg/L (Well 01MW-19).
- Benzene was detected above the NOAA SQuiRT™ value (5,300 μg/L) in Wells 01MW-24, 01MW-27, and 01MW-29 at concentrations of 6,750 μg/L, 6,220 μg/L, and 5,410 μg/L, respectively.
- Total xylenes were detected above the MTCA Method A Cleanup Level (1,000 μg/L) in Wells 01MW-18, 01MW-19, and 01MW-28 at concentrations of 1,360 μg/L, 3,190 μg/L, and 1,250 μg/L (1,230 μg/L in the duplicate sample), respectively.

4.2 QUARTERLY GROUNDWATER SAMPLING AT 2750 WEST COMMODORE WAY

The following analyte was detected above the applicable action level (Table 4-3):

- Gasoline was detected above the MTCA Method A Cleanup Level (800 μg/L with benzene present) in Well 01MW-04 at a concentration of 4,800 μg/L (4,800 μg/L in the duplicate sample).

5. CONCLUSIONS AND RECOMMENDATIONS

The following subsections describe the extent of impacted groundwater beneath the two properties and annual trends, if any. Figures 5-1 through 5-3 show concentration contour maps for diesel, gasoline, and benzene, respectively.

5.1 2737 WEST COMMODORE WAY

The following discussion summarizes the annual data for each analyte monitored. Table 5-1 shows the data collected from July 2001 through July 2004 at 2737 West Commodore Way.

PCP

PCP concentrations exceeded the NOAA SQuiRT™ level in 4 of the 15 wells sampled in July 2004. The concentrations of PCP detected in July 2004 were similar to those detected in previous quarters. Well 01MW-01 is the only well routinely sampled for PCP, due to its proximity to the former fuel line from the former PCP/Diesel Mixing Area. PCP is consistently below the NOAA SQuiRT™ value in this well. Other wells were sampled for PCP in July during the annual event. The concentration (40.5 μg/L) in Well 01MW-26 is higher than the previous year by an order of magnitude, while the concentration in 01MW-27 is consistent. This may indicate a change in conditions west of the Lower Tank Yard. The concentrations detected in the wells in the Lower Tank Yard (01MW-21, 01MW-22, and 01MW-23) were similar to previous results.

The PCP-impacted groundwater plume appears to be centered around the Lower Tank Yard and the Former PCP/Diesel Mixing Area.

Diesel Range Hydrocarbon

Diesel range hydrocarbon concentrations exceeded the MTCA Method A Cleanup Level in 9 of the 24 wells sampled in July 2004. The concentrations in July 2004 were similar to those measured in April 2004 with a few exceptions. In general, the data from wells with concentrations above the reporting limit do not indicate any discernable trends with the exception of 01MW-28.

The diesel plume appears to be centralized beneath the Former Manifold Area (01MW-23, 01MW-24, and 01MW-25) and the Former PCP/Diesel Mixing Area (01MW-22) in the Lower Tank Yard. The diesel plume is interpreted to extend towards the north due to the presence of free phase product in Wells 01MW-10 and 01MW-16 north of the Loading Rack.

The analytical data indicate that diesel concentrations are present above the MTCA Method A Cleanup Level in Wells 01MW-03, 01MW-18, 01MW-19, and 01MW-09. A review of the chromatograms for the samples relative to the standards supplied by the laboratory indicate that gasoline is present in all of the wells. However, diesel is present only in 01MW-09. The plume north of the Office Building on Figure 5-1 (diesel-impacted groundwater) is based on the analytical results and may be more representative of gasoline-impacted groundwater.

In addition, the chromatograms for Wells 01MW-28 and 01MW-29 indicate that diesel range hydrocarbons are primarily present. The elevated gasoline range hydrocarbon concentrations may be due to the high concentration of diesel and/or co-eluting peaks.

Lube Oil Range Hydrocarbons

Lube oil range hydrocarbon concentrations exceeded the MTCA Method A Cleanup Level in 1 of 24 (01MW-03) wells sampled in July 2004. This well is sampled quarterly with no detections above the method reporting limit during the previous quarter. The detection in July 2004 is not consistent with the previous data.

Gasoline Range Hydrocarbons

Gasoline range hydrocarbon concentrations exceeded the MTCA Method A Cleanup Level for gasoline with benzene present in 14 of the 24 wells sampled in July 2004. The concentrations in July 2004 were similar to those measured in April 2004, with a few exceptions, and were also consistent with the previous quarters through the four quarter period. The concentration of gasoline in 01MW-02 and 01MW-09 were an order of magnitude lower than April 2004. The change in 01MW-02 is not consistent with historical data. The change in 01MW-09 may be due to the passive skimmer installed in the well and other nearby wells. The concentration of gasoline in other wells is fairly consistent.

The gasoline plume appears to be centralized beneath the Former Manifold Area (01MW-24 and 01MW-25) and the Former PCP/Diesel Mixing Area (01MW-21 and 01MW-22) in the Lower Tank Yard. The gasoline plume is interpreted to extend towards the north due to the presence of free phase product in Wells 01MW-10 and 01MW-16 north of the Loading Rack.

Gasoline concentrations exceed the MTCA Method A Cleanup Level in several wells in front of the Office Building. It is not clear whether the gasoline-impacted groundwater in front of the Office Building is associated with a separate source (possibly the former or current UST), or associated with the source near the Lower Tank Yard.

Benzene

Benzene was detected above the NOAA SQuiRT™ level (5,300 µg/L) in 3 of the 24 wells sampled in July 2004. In general, the concentrations of benzene are consistent with historical detections.

Toluene

Toluene was not detected above the NOAA SQuiRT™ value in any of the wells, nor has it since quarterly sampling began in July 2001.

Ethylbenzene

Ethylbenzene was not detected above the NOAA SQuiRT™ value in any of the wells, nor has it since quarterly sampling began in July 2001.

Xylene

Total xylenes (m, p, and o-isomers combined) were detected above the MTCA Method A Cleanup Level in 3 of the 24 wells sampled in July 2004. The concentrations detected in Wells 01MW-18, 01MW-19, and 01MW-28 are consistent with the results from the previous quarter (August 2003).

5.2 2750 WEST COMMODORE WAY

The following discussion summarizes the annual data for each analyte monitored. Table 5-2 shows the data collected from July 2001 through July 2004 at 2750 West Commodore Way.

Diesel Range Hydrocarbons

Diesel range hydrocarbons have not been detected above the method reporting limit in any wells from October 2003 to July 2004.

Lube Oil Range Hydrocarbons

Lube oil range hydrocarbons were not detected above the method reporting limit in any of the wells from October 2003 through July 2004.

Gasoline Range Hydrocarbons

Gasoline range hydrocarbon concentrations exceeded the MTCA Method A Cleanup Level for gasoline with benzene present in one of the seven wells (Well 02MW-04). The concentrations in Well 02MW-04 were consistent for all four quarters with the exception of April where the concentrations increased one order of magnitude (12,200 μg/L). In July the concentrations were decreased (4,800 μg/L).

Benzene

Benzene was detected in two of the seven wells sampled (Wells 02MW-03 and 02MW-04). None of the concentrations detected were above the NOAA SQuiRT™ value and the data are relatively consistent from quarter to quarter.

Toluene

Toluene was detected in one of the seven wells sampled (Well 02MW-04). None of the concentrations were above the NOAA SQuiRT™ value.

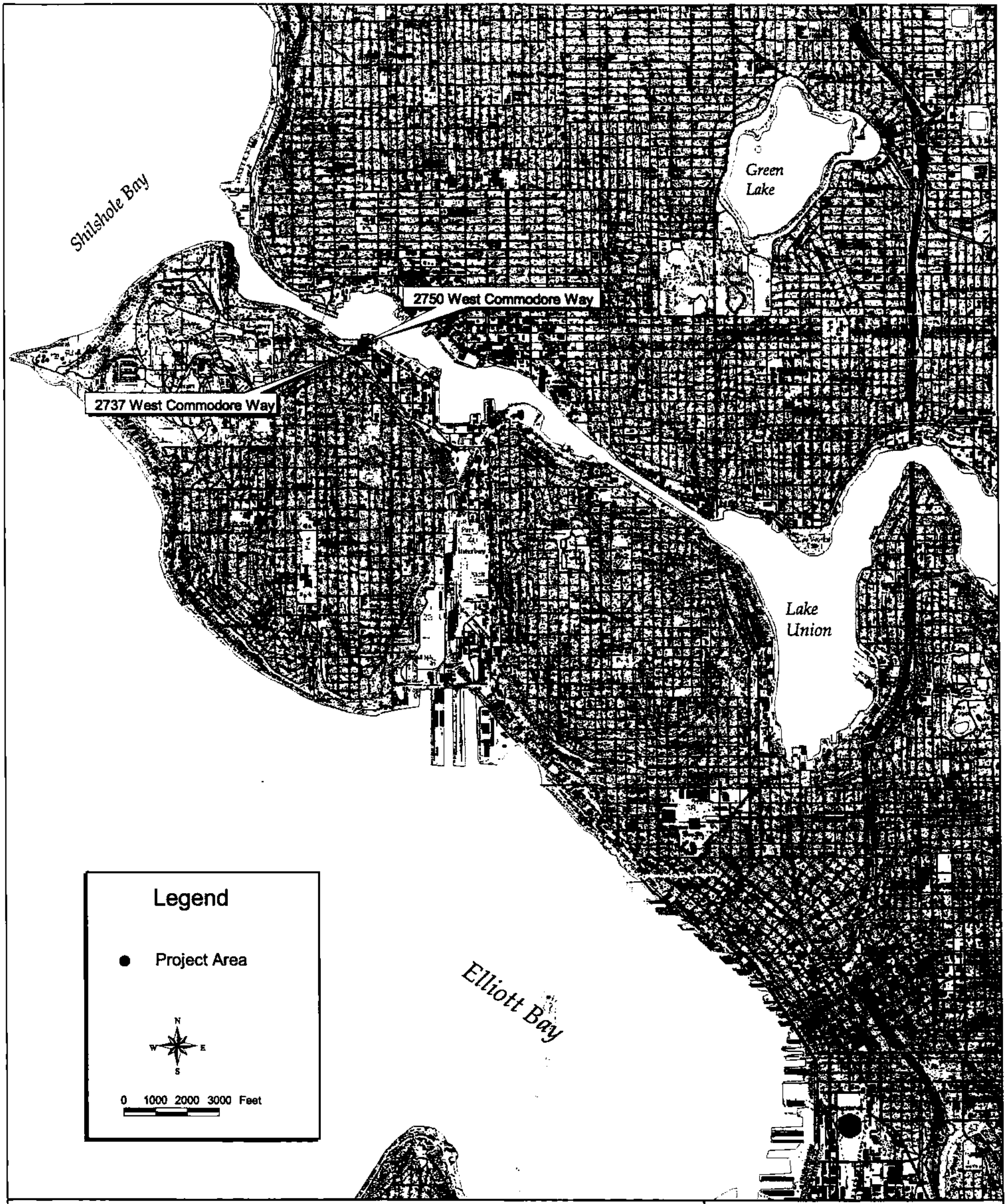
Ethylbenzene

Ethylbenzene was consistently detected above the method reporting limit in Well 02MW-04. The concentrations have been relatively consistent since July 2001.

Xylene

Xylene was detected in Wells 02MW-01, 02MW-03, 02MW-04, and 02MW-07. None of the concentrations were above the MTCA Method A Cleanup Level. The detections in Wells 02MW-01 and 02MW-03 were limited to October 2003 and the detections in Wells 02MW-04 and 02MW-07 were consistent.

FIGURES



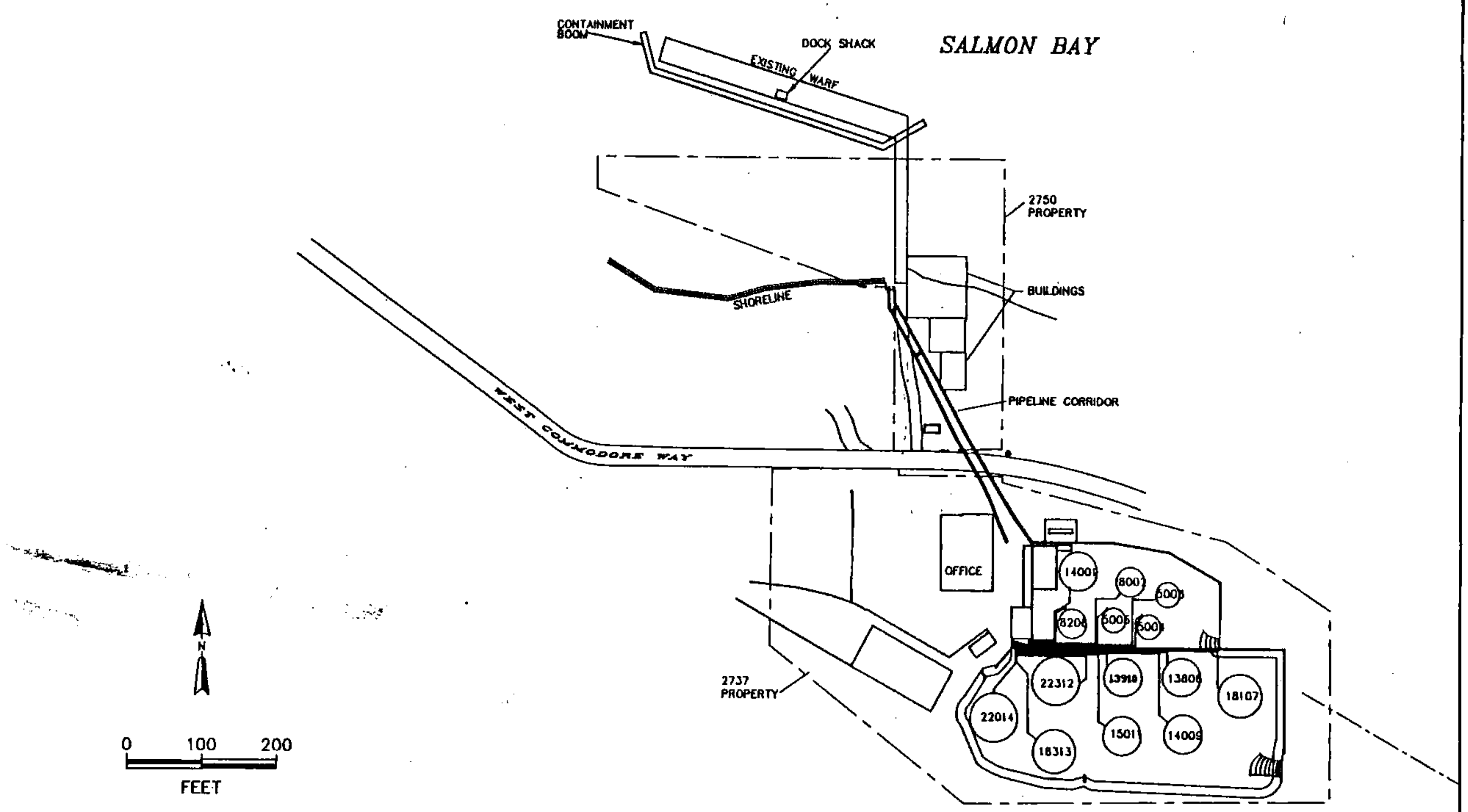
Time Oil Company
Quarterly Groundwater Sampling

c:\projects\time_oil\wic_map_2001.apr December 2001

Figure 1-1

Locations of 2737 and 2750
West Commodore Way

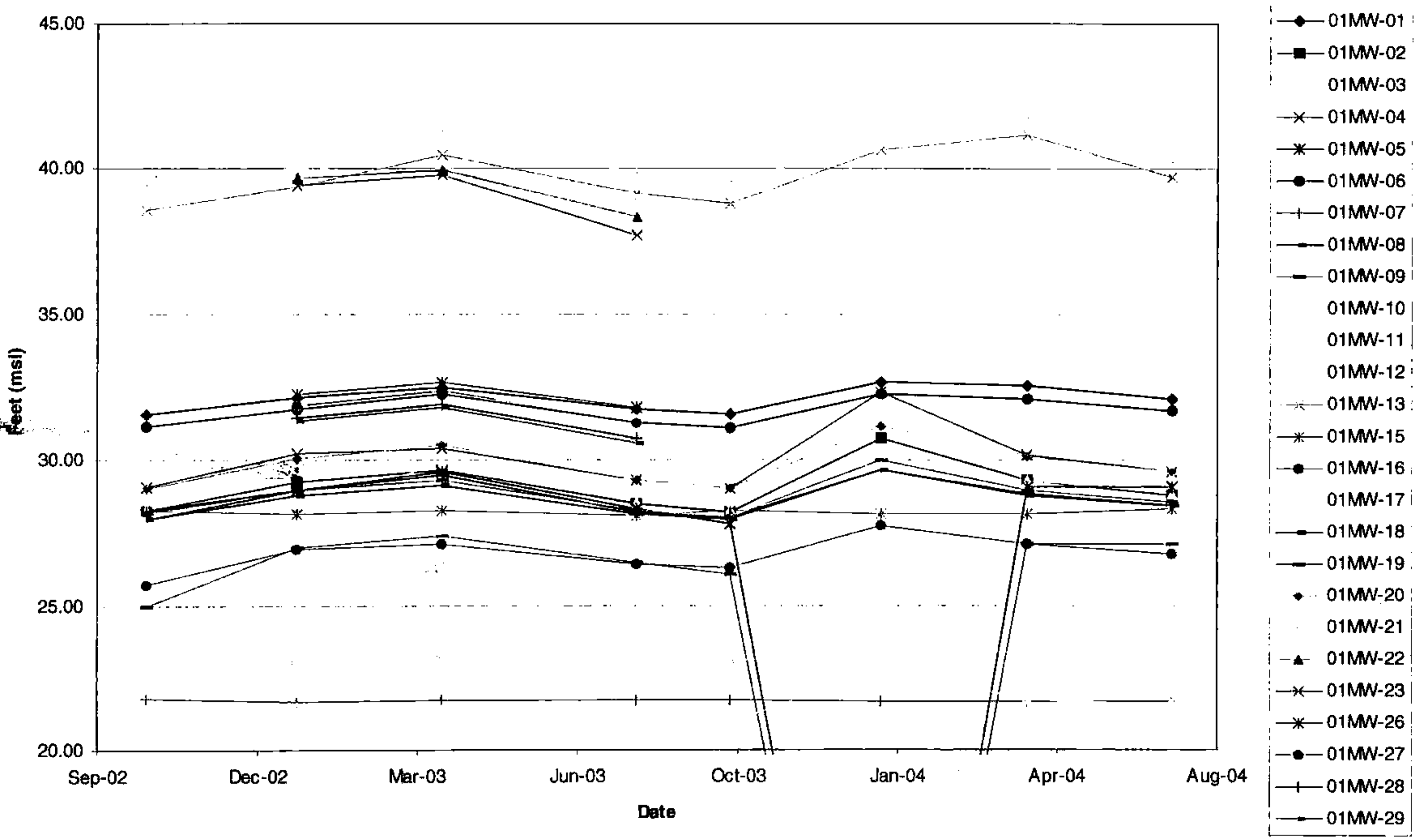
I:\Projects\23063312\dwg\ETIOFG07.dwg 03/18/2003 09:12:16 AM PST



TETRA TECH FW, INC.

Figure 1-2
Layout of 2737 and 2750
West Commodore Way

Figure 3-1. Hydrograph for Monitoring Wells at 2737 West Commodore Way



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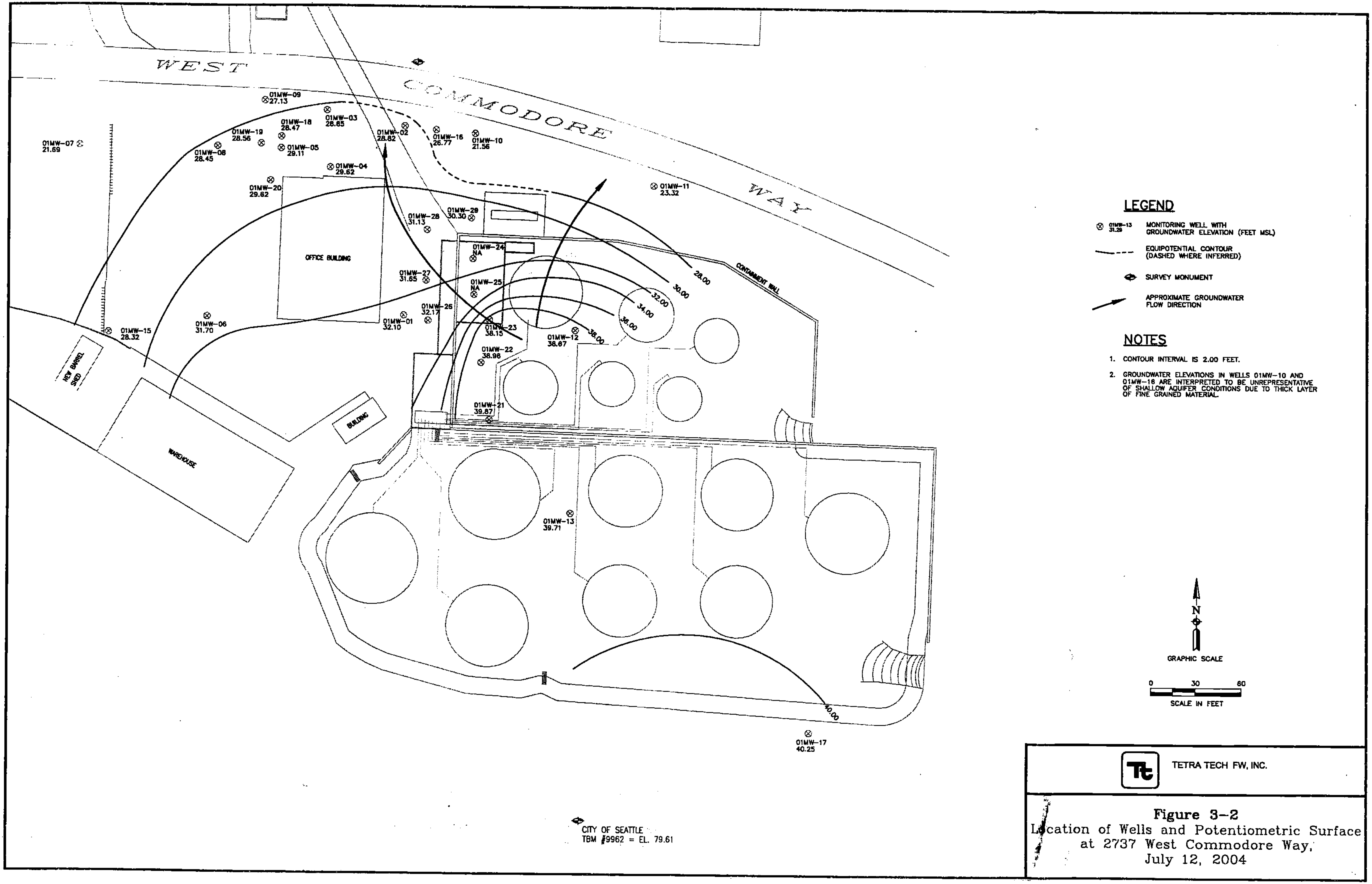


LEGEND

- 01MW-13 31.29 MONITORING WELL WITH GROUNDWATER ELEVATION (FEET MSL)
- EQUIPOTENTIAL CONTOUR (DASHED WHERE INFERRED)
- SURVEY MONUMENT
- APPROXIMATE GROUNDWATER FLOW DIRECTION

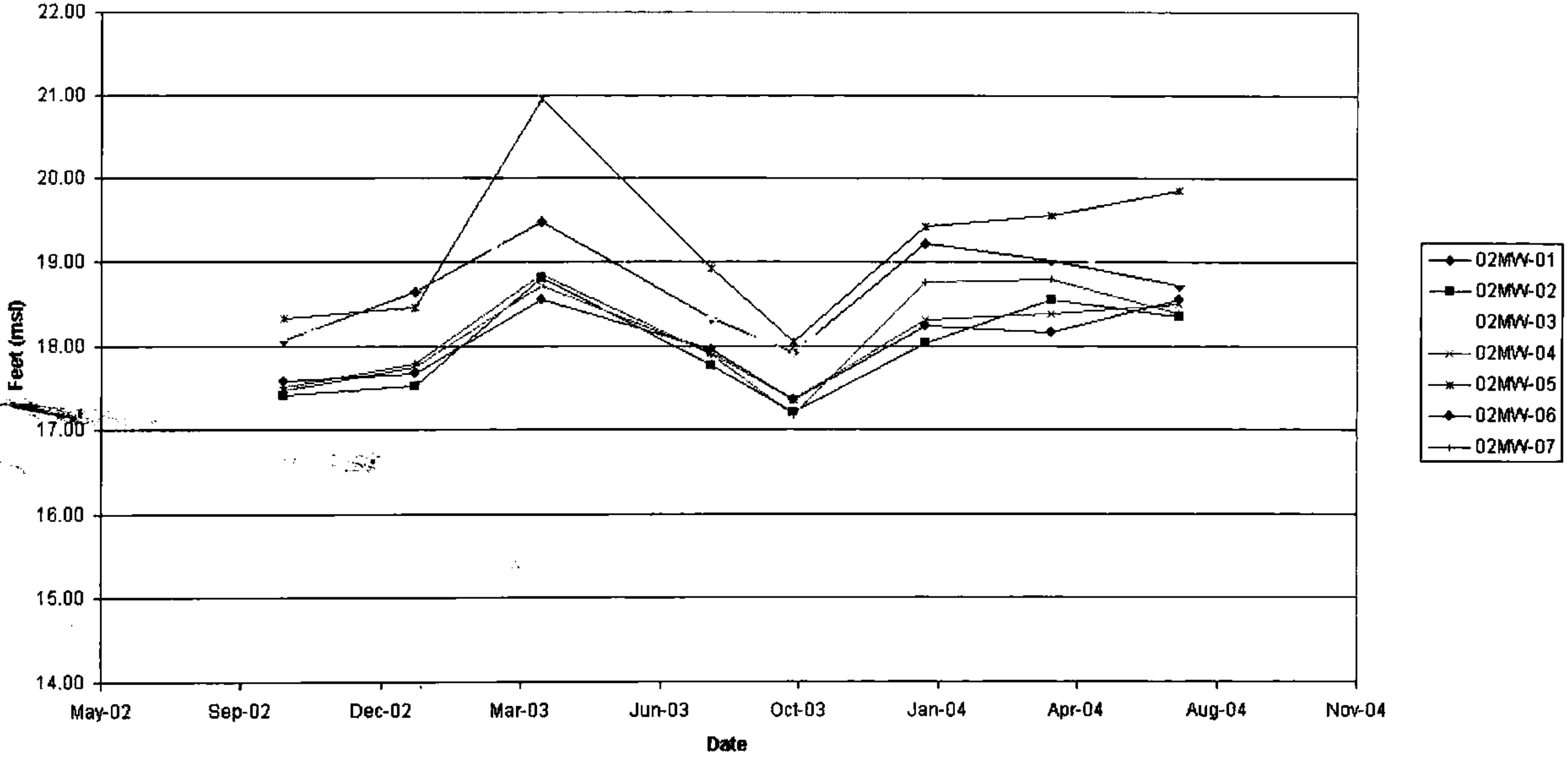
NOTES

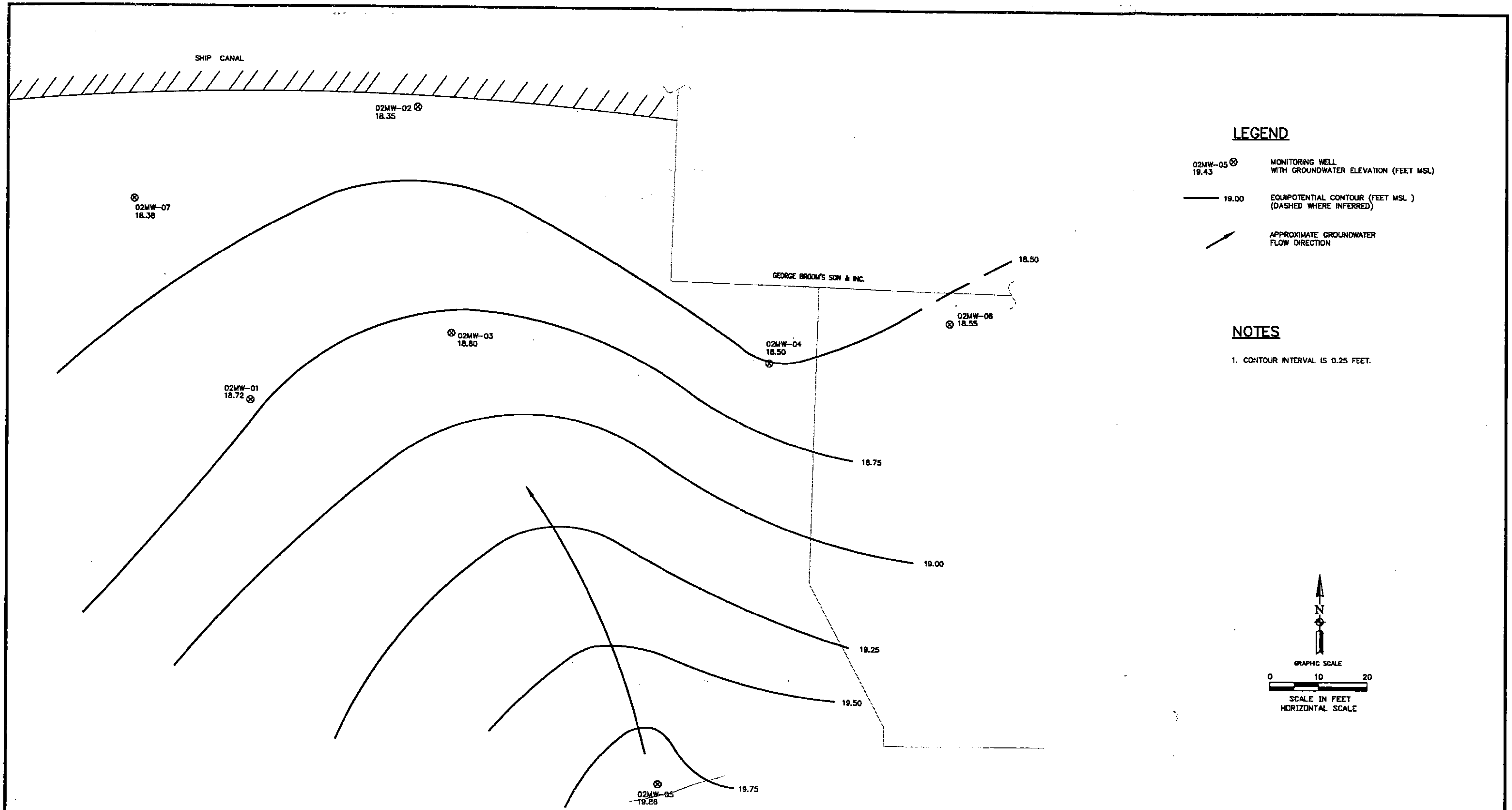
1. CONTOUR INTERVAL IS 2.00 FEET.
2. GROUNDWATER ELEVATIONS IN WELLS 01MW-10 AND 01MW-16 ARE INTERPRETED TO BE UNREPRESENTATIVE OF SHALLOW AQUIFER CONDITIONS DUE TO THICK LAYER OF FINE GRAINED MATERIAL.

TETRA TECH FW, INC.

Figure 3-2
Location of Wells and Potentiometric Surface
at 2737 West Commodore Way,
July 12, 2004

Figure 3-3. Hydrograph for Monitoring Wells at 2750 West Commodore Way

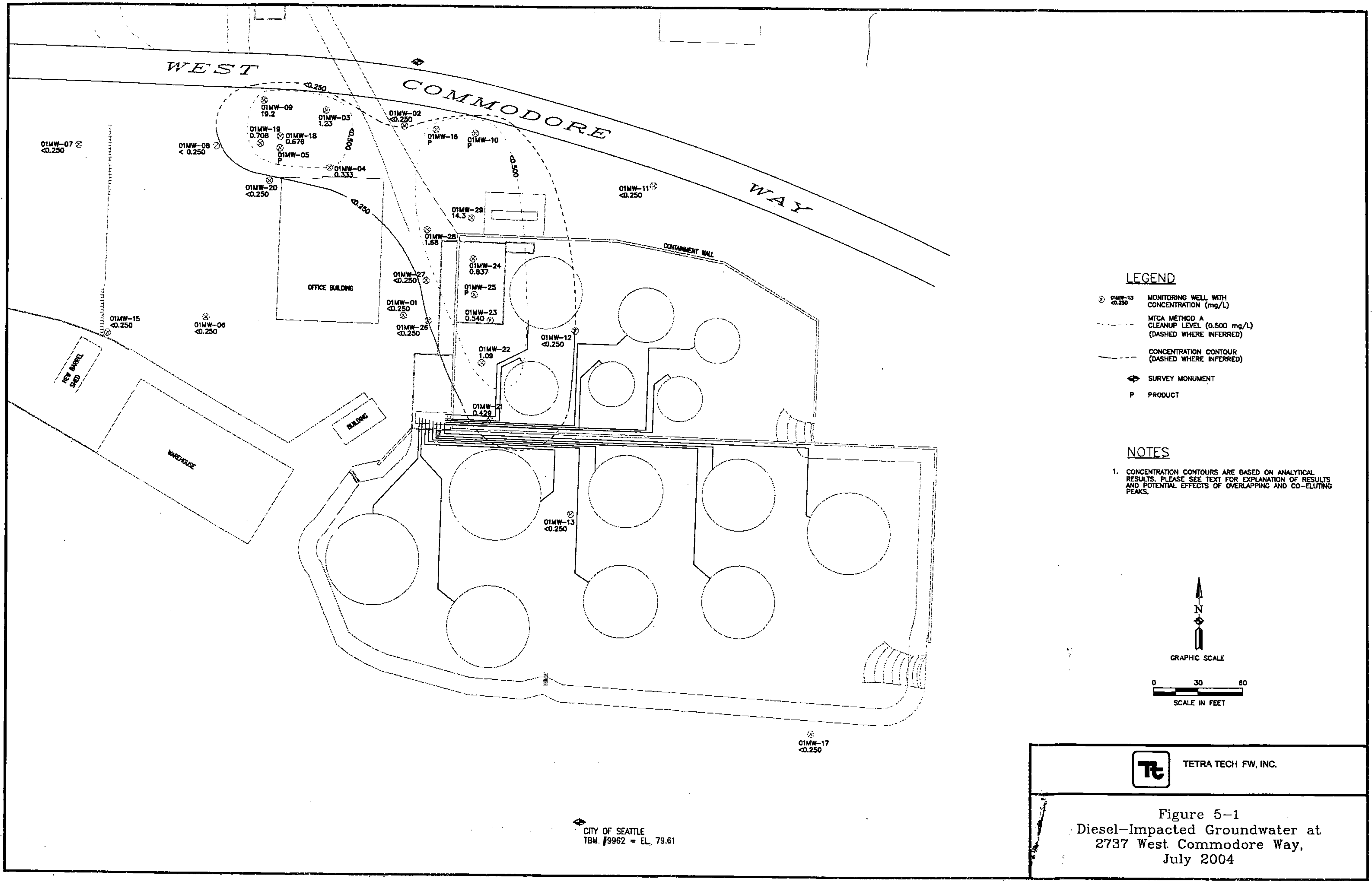




TETRA TECH FW, INC.

Figure 3-4
Location of Wells
and Potentiometric Surface at
2750 West Commodore Way,
July 12, 2004

I:\PROJECTS\23063312\DWG\JULY 2004 - QUARTER\ETIOFG3-4_7-04.DWG
PLOT/UPDATE: SEP 02 2004 14:06:30



NOTES

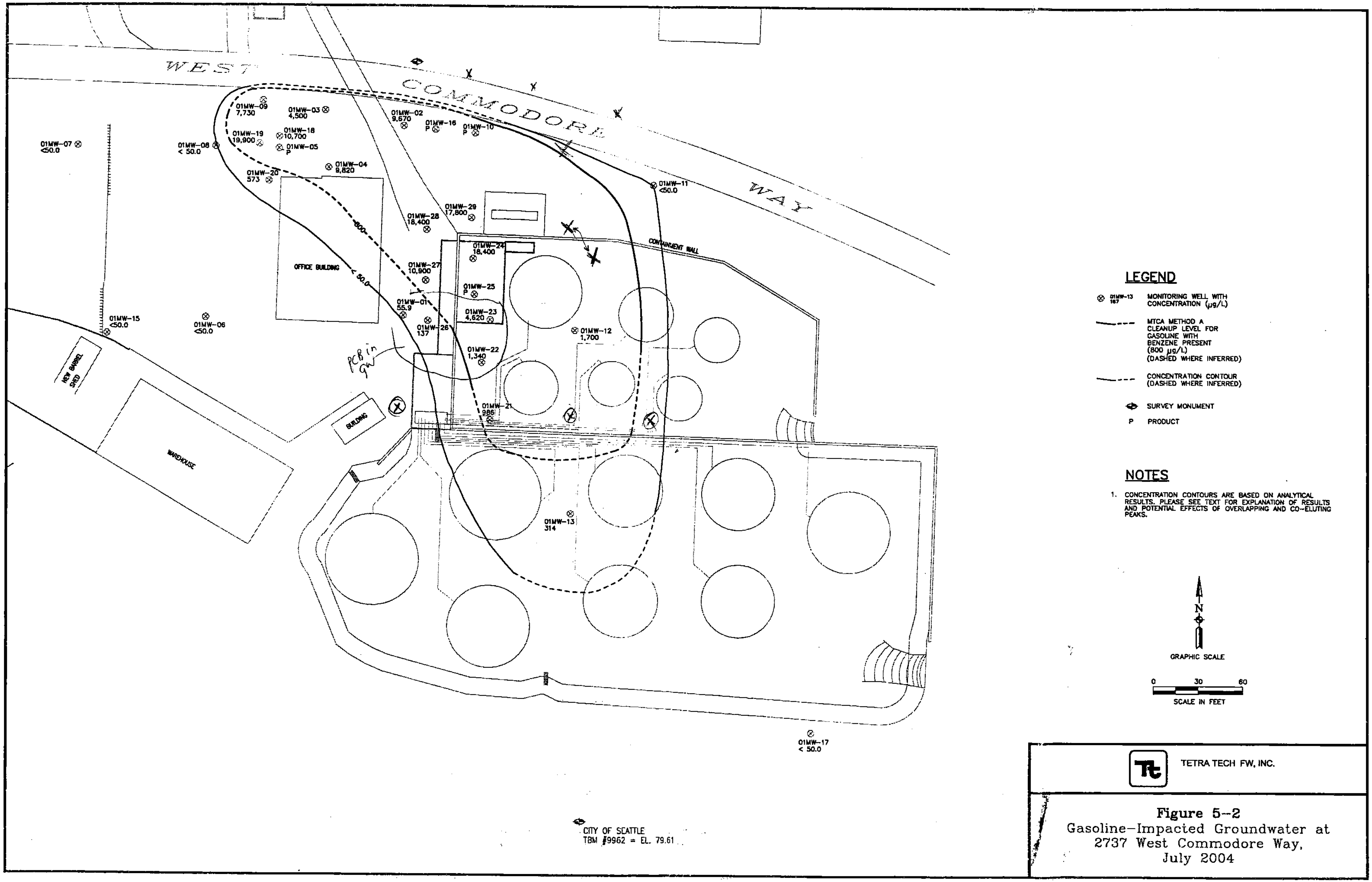
1. CONCENTRATION CONTOURS ARE BASED ON ANALYTICAL RESULTS. PLEASE SEE TEXT FOR EXPLANATION OF RESULTS AND POTENTIAL EFFECTS OF OVERLAPPING AND CO-ELUTING PEAKS.

TETRA TECH FW, INC.

Figure 5-1
Diesel-Impacted Groundwater at
2737 West Commodore Way,
July 2004

I:\Projects\23063312\dwg\July 2004 - Quarter\ETIOFG5-1.dwg 8/24/2004 9:26:24 AM PST

I:\Projects\23063312\dwg\July 2004 - Quarter\ETIDFG5-2.dwg 8/24/2004 9:19:40 AM PST



LEGEND

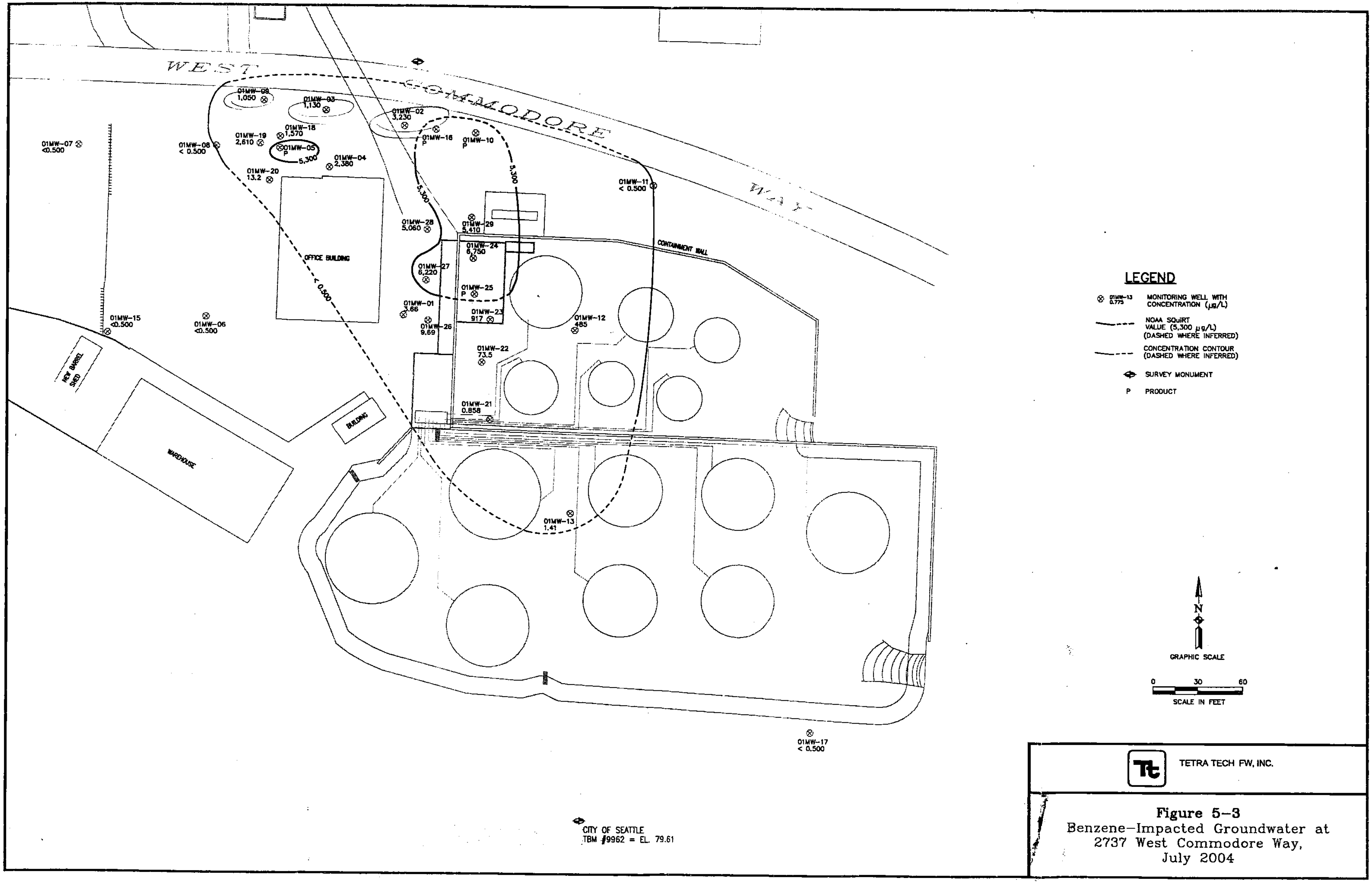
⊗ 01MW-13 167	MONITORING WELL WITH CONCENTRATION (μg/L)
———- - -	MTCA METHOD A CLEANUP LEVEL FOR GASOLINE WITH BENZENE PRESENT (800 μg/L) (DASHED WHERE INFERRED)
——- - -	CONCENTRATION CONTOUR (DASHED WHERE INFERRED)
⊕	SURVEY MONUMENT
P	PRODUCT

NOTES

1. CONCENTRATION CONTOURS ARE BASED ON ANALYTICAL RESULTS. PLEASE SEE TEXT FOR EXPLANATION OF RESULTS AND POTENTIAL EFFECTS OF OVERLAPPING AND CO-ELUTING PEAKS.

TETRA TECH FW, INC.

Figure 5-2
Gasoline-Impacted Groundwater at 2737 West Commodore Way, July 2004



TETRA TECH FW, INC.

Figure 5-3
Benzene-Impacted Groundwater at
2737 West Commodore Way,
July 2004

I:\Projects\23063312\dwg\July 2004 - Quarter\ETIDFG5-3.dwg 8/24/2004 9:13:30 AM PST

TABLES

Table 2-1. July 2004 Sampling Matrix

Well	NWTPH-Gx/BTEX	NWTPH-Dx	PCP	Sample Type
2737 West Commodore Way				
01MW-01	1	1	1	Environmental
01MW-02	1	1	na	Environmental
01MW-03	1	1	na	Environmental
01MW-04	1	1	na	Environmental
01MW-05	Sample not collected due to presence of free-phase product			
01MW-06	1	1	1	Environmental
01MW-07	1	1	na	Environmental
01MW-08	1	1	na	Environmental
01MW-09	1	1	1	Environmental
01MW-10	Sampled not collected due to insufficient groundwater			
01MW-11	1	1	na	Environmental
01MW-12	1	1	na	Environmental
01MW-13	1	1	na	Environmental
01MW-15	1	1	1	Environmental
01MW-16	Sampled not collected due to insufficient groundwater			
01MW-17	1	1	na	Environmental
01MW-18	1	1	1	Environmental
01MW-19	1	1	1	Environmental
01MW-20	1	1	1	Environmental
01MW-21	1	1	1	Environmental
01MW-22	1	1	1	Environmental
01MW-23	1	1	1	Environmental
01MW-24	1	1	1	Environmental
01MW-25	Sample not collected due to presence of free-phase product			
01MW-26	1	1	1	Environmental
01MW-27	1	1	1	Environmental
01MW-28	1	1	1	Environmental
01MW-28	1	1	1	Field Duplicate
01MW-29	1	1	1	Environmental
2750 West Commodore Way				
02MW-01	1	1	na	Environmental
02MW-02	1	1	na	Environmental
02MW-03	1	1	na	Environmental
02MW-04	1	1	na	Environmental
02MW-04	1	1	na	Field Duplicate
02MW-05	1	1	na	Environmental
02MW-06	1	1	na	Environmental
02MW-07	1	1	na	Environmental

Abbreviations and Acronyms:
BTEX – benzene, toluene, ethylbenzene, xylene
Dx – diesel range hydrocarbons
Gx – gasoline range hydrocarbons
na – not included in analytical suite
NWTPH – northwest total petroleum hydrocarbon
PCP – pentachlorophenol

Table 3-1. Well Construction Details at West Commodore Way Properties

Well	Coordinate (WA State Plane)		Top of Casing Elevation (Feet msl)	Ground Elevation (Feet msl)	Total Depth of Boring (Feet bgs)	Total Depth of Well (Feet bgs)	Depth of Screen Interval (Feet bgs)	Elevation of Screen Interval (Feet msl)
	Northing (Feet)	Easting (Feet)						
2737 West Commodore Way								
01MW-01	245454.603	1256198.248	46.48	46.76	25.00	25.25	10 – 25	36.76 – 21.76
01MW-02	245585.027	1256198.518	44.78	45.15	25.00	24.91	10 – 25	35.15 – 20.15
01MW-03	245597.585	1256160.493	44.35	44.75	25.20	25.15	10 – 25	34.75 – 19.75
01MW-04	245563.117	1256163.148	45.08	45.56	25.00	24.90	10 – 25	35.56 – 20.56
01MW-05	245569.311	1256114.025	45.40	45.77	25.00	24.88	10 – 25	35.77 – 20.77
01MW-06	245452.677	1256064.638	47.74	48.23	25.00	25.10	10 – 25	38.23 – 23.23
01MW-07	245570.711	1255975.885	45.17	45.53	30.00	28.17	15 – 30	30.53 – 15.53
01MW-08	245570.471	1256070.985	45.21	45.63	25.00	24.93	10 – 25	35.63 – 20.63
01MW-09	245602.062	1256103.039	43.91	44.37	25.00	24.70	10 – 25	34.37 – 19.37
01MW-10	245580.377	1256246.968	45.02	45.35	25.00	24.90	10 – 25	35.35 – 20.35
01MW-11	245545.081	1256368.920	46.10	46.45	30.00	29.90	15 – 30	31.45 – 16.45
01MW-12	245444.877	1256316.069	45.84	46.29	20.00	20.00	5 – 20	40.84 – 25.84
01MW-13	245317.347	1256313.287	46.36	46.81	20.00	19.88	15 – 20	31.81 – 26.81
01MW-15	245441.314	1255996.388	50.89	50.89	30.12	30.00	10 – 30	40.89 – 20.89
01MW-16	245582.687	1256220.015	44.95	44.95	22.50	20.00	10 – 20	34.95 – 24.95
01MW-17	245166.941	1256477.520	59.42	59.42	30.00	30.00	15 – 30	44.42 – 29.42
01MW-18	245577.28	1256114.23	45.18	45.68	26.50	25.00	5 – 20	40.68 – 25.68
01MW-19	245572.45	1256100.62	45.35	45.85	31.50	25.00	5 – 20	40.85 – 25.78
01MW-20	245546.99	1256107.08	46.27	46.77	26.50	25.00	5 – 20	41.77 – 26.77
01MW-21	245382.3	1256257.4	46.21	46.52	23.50	22.92	5 – 22	41.21 – 23.79
01MW-22	245422.2	1256251.7	46.11	46.47	25.00	24.70	5 – 24	41.11 – 21.92
01MW-23	245451.9	1256257.4	45.81	46.11	20.50	19.45	5 – 19	40.81 – 26.86
01MW-24	245494.0	1256245.7	na	44.59	21.00	19.40	5 – 19	39.59 – 25.69
01MW-25	245469.4	1256246.5	na	44.61	20,50	17.32	5 – 16	39.61 – 28.29
01MW-26	245451.1	1256215.0	46.24	46.71	20.50	19.85	5 – 19	41.24 – 27.39
01MW-27	245479.0	1256213.5	46.33	46.70	21.50	19.65	5 – 19	41.33 – 27.68
01MW-28	245513.8	1256214.2	45.54	46.30	25.50	24.61	5 – 24	40.54 – 21.93
01MW-29	245522.2	1256244.6	45.57	45.92	20.50	19.75	5 – 19	40.57 – 26.82
2750 West Commodore Way								
02MW-01	245789.704	1255985.066	24.19	24.72	20.00	19.60	10 – 20	15.22 – 5.22
02MW-02	245848.029	1256019.016	20.06	20.57	10.00	9.90	5 – 10	16.07 – 11.07
02MW-03	245801.020	1256026.193	27.86	28.41	20.00	19.75	10 – 20	18.91 – 8.91
02MW-04	245795.225	1256092.088	27.17	27.59	20.00	20.05	10 – 20	18.09 – 8.09
02MW-05	245706.854	1256069.207	36.59	37.05	35.00	33.85	20 –35	17.55 – 2.55
02MW-06	245803.277	1256129.549	26.54	27.00	20.00	19.97	10 – 20	17.50 – 7.50
02MW-07	245828.584	1255960.724	20.85	21.39	12.00	12.20	2 – 12	19.89 – 9.89

Abbreviations and Acronyms:
bgs – below ground surface
msl – mean sea level
na – no data available
WA – Washington

Table 3-2. Water Levels Measured at West Commodore Way Properties on July 12, 2004

Well	Top of Casing Elevation (Feet msl)	Ground Elevation (Feet msl)	Total Depth of Well (Feet bgs)	Depth to Product (Feet bgs)	Depth to Water (Feet bgs)	Product Thickness (Feet)	Water Elevation (Feet msl)
2737 West Commodore Way							
01MW-01	46.48	46.76	25.25	np	14.38	0.00	32.10
01MW-02	44.78	45.15	24.91	np	15.96	0.00	28.82
01MW-03	44.35	44.75	25.15	np	15.50	0.00	28.85
01MW-04	45.08	45.56	24.90	np	15.46	0.00	29.62
01MW-05[1/]	45.40	45.77	24.88	15.47	19.57	4.10	29.11
01MW-06	47.74	48.23	25.10	np	16.04	0.00	31.70
01MW-07	45.17	45.53	28.17	np	23.48	0.00	21.69
01MW-08	45.21	45.63	24.93	np	16.76	0.00	28.45
01MW-09[1/]	43.91	44.37	24.70	na	16.78	na	27.13
01MW-10	45.02	45.35	24.90	23.32	24.03	0.71	21.56
01MW-11	46.10	46.45	29.90	np	22.78	0.00	23.32
01MW-12	45.84	46.29	20.00	np	7.17	0.00	38.67
01MW-13	46.36	46.81	19.88	np	6.65	0.00	39.71
01MW-15	50.89	50.89	30.00	np	22.57	0.00	28.32
01MW-16	44.95	44.95	20.00	17.93	19.20	1.27	26.77
01MW-17	59.42	59.42	30.00	np	19.17	0.00	40.25
01MW-18	45.18	45.68	25.00	np	16.71	0.00	28.47
01MW-19	45.35	45.85	25.00	np	16.79	0.00	28.56
01MW-20	46.27	46.77	25.00	np	16.65	0.00	29.62
01MW-21	46.21	46.52	25.00	np	6.34	0.00	39.87
01MW-22	46.11	46.47	25.00	7.15	7.17	0.02	38.96
01MW-23[1/]	45.81	46.11	25.00	7.64	7.74	0.10	38.15
01MW-24	na	44.59	25.00	7.85	8.15	0.30	na
01MW-25	na	44.61	25.00	6.83	9.24	2.41	na
01MW-26	46.24	46.71	25.00	np	14.07	0.00	32.17
01MW-27	46.33	46.7	25.00	np	14.68	0.00	31.65
01MW-28	45.54	46.3	25.00	14.13	15.51	1.38	31.13
01MW-29[1/]	45.57	45.92	25.00	15.26	15.32	0.06	30.30
2750 West Commodore Way							
02MW-01	24.19	24.72	19.60	np	5.47	0.00	18.72
02MW-02	20.06	20.57	9.90	np	1.71	0.00	18.35
02MW-03	27.86	28.41	19.75	np	9.06	0.00	18.80
02MW-04	27.17	27.59	20.05	np	8.67	0.00	18.50
02MW-05	36.59	37.05	33.85	np	16.73	0.00	19.86
02MW-06	26.54	27.00	19.97	np	7.99	0.00	18.55
02MW-07	20.85	21.39	12.20	np	2.47	0.00	18.38

Abbreviations and Acronyms:

bgs – below ground surface
msl – mean sea level
na – water level was not determined due to presence of product
np – no product detected

Notes:

[1/] Water elevation may be influenced by passive product skimmer installed in the well.

Table 3-3. Cumulative Groundwater Elevations, October 2003 – July 2004

Well	October 2003		January 2004		April 2004		July 2004	
	Fuel Thickness (Feet)	Water Elevation (Feet msl)	Fuel Thickness (Feet)	Water Elevation (Feet msl)	Fuel Thickness (Feet)	Water Elevation (Feet msl)	Fuel Thickness (Feet)	Water Elevation (Feet msl)
2737 West Commodore Way								
01MW-01	0.00	31.56	0.00	32.69	0.00	32.55	0.00	32.10
01MW-02	0.00	28.23	0.00	30.78	0.00	29.29	0.00	28.82
01MW-03	0.00	28.32	0.00	31.27	0.00	29.32	0.00	28.85
01MW-04	0.00	29.04	0.00	32.30	0.00	30.16	0.00	29.62
01MW-05[1/]	1.90	27.79	na	na	4.10	29.11	4.10	29.11
01MW-06	0.00	31.11	0.00	32.24	0.00	32.08	0.00	31.70
01MW-07	0.00	21.72	0.00	21.67	0.00	21.68	0.00	21.69
01MW-08	0.00	27.97	0.00	29.66	0.00	28.81	0.00	28.45
01MW-09[1/]	na	26.09	na	na	0.00	27.13	na	27.13
01MW-10	0.49	20.91	1.65	22.84	0.90	21.76	0.71	21.56
01MW-11	0.00	23.07	0.00	23.50	0.00	23.38	0.00	23.32
01MW-12	0.00	37.33	0.00	40.69	0.00	40.32	0.00	38.67
01MW-13	0.00	38.78	0.00	40.64	0.00	41.18	0.00	39.71
01MW-15	0.00	28.28	0.00	28.16	0.00	28.16	0.00	28.32
01MW-16	1.36	26.30	2.43	27.73	2.24	27.10	1.27	26.77
01MW-17	0.00	39.55	0.00	41.02	0.00	41.78	0.00	40.25
01MW-18	0.00	28.03	0.00	29.69	0.00	28.88	0.00	28.47
01MW-19	0.00	28.07	0.00	30.02	0.00	28.97	0.00	28.56
01MW-20	0.00	29.05	0.00	31.19	0.00	30.13	0.00	29.62
01MW-21	0.00	38.52	0.00	39.70	0.00	39.99	0.00	39.87
01MW-22	0.08	37.74	0.20	39.41	0.50	40.13	0.02	38.96
01MW-23[1/]	na	na	na	na	0.05	40.04	0.10	38.15
01MW-24	0.11	na	0.39	na	0.15	na	0.30	na
01MW-25	na	na	na	na	na	na	2.41	na
01MW-26	0.00	31.54	0.00	32.73	0.00	32.03	0.00	32.17
01MW-27	0.00	30.96	0.00	32.43	0.00	32.70	0.00	31.65
01MW-28	0.29	30.66	0.93	32.20	1.08	31.62	1.38	31.13
01MW-29[1/]	0.01	29.57	na	na	0.03	31.29	0.06	30.30
2750 West Commodore Way								
02MW-01	0.00	17.91	0.00	19.22	0.00	19.01	0.00	18.72
02MW-02	0.00	17.21	0.00	18.03	0.00	18.55	0.00	18.35
02MW-03	0.00	17.90	0.00	19.37	0.00	19.10	0.00	18.80
02MW-04	0.00	17.35	0.00	18.31	0.00	18.39	0.00	18.50
02MW-05	0.00	18.05	0.00	19.43	0.00	19.55	0.00	19.86
02MW-06	0.00	17.35	0.00	18.23	0.00	18.15	0.00	18.55
02MW-07	0.00	17.17	0.00	18.75	0.00	18.79	0.00	18.38

Abbreviations and Acronyms:
msl – mean sea level
na – water level was not determined due to presence of product

Notes:

[1/] Water elevation may be influenced by passive product skimmer installed in the well.

Table 4-1. Well Sampling Parameters, July 2004

Well	pH	ORP (mv)	Temperature (Celsius)	Dissolved O_2 (mg/L)	Conductivity (mS/cm)	Turbidity (NTU)
			2737 West Commodore Way			
01MW-01	6.79	-13.6	15.24	0.10	443	na
01MW-02	6.74	-124.5	15.91	1.07	570	na
01MW-03	6.61	-95.6	15.52	0.84	297	na
01MW-04	6.37	-54.7	15.66	0.44	291	na
01MW-06	7.22	-119.6	15.19	0.12	785	na
01MW-07	6.79	-62.1	16.02	0.38	703	4.1
01MW-08	7.01	-109.8	16.01	0.65	757	0.2
01MW-09	6.80	-121.3	16.58	0.93	407	13.3
01MW-11	7.12	-145.2	14.91	1.66	552	na
01MW-12	6.57	-72.4	14.99	0.01	701	na
01MW-13	6.61	-39.9	15.13	na	619	1.1
01MW-15	7.12	-118.9	13.59	0.16	630	na
01MW-17	7.28	261.5	13.87	na	761	2.2
01MW-18	6.59	-105	17.32	1.01	534	na
01MW-19	6.67	-124.6	17.09	0.71	481	0.3
01MW-20	6.53	-70.8	16.83	0.19	232	7.4
01MW-21	6.57	-102.4	14.44	0.02	437	na
01MW-22	6.76	-55.4	13.67	0.01	369	na
01MW-23	6.63	-133.6	14.72	0.04	512	na
01MW-24	6.56	-83.8	15.72	0.01	659	na
01MW-26	6.78	-73.6	14.26	0.08	465	na
01MW-27	6.72	-99.8	14.56	0.07	663	na
01MW-28	6.73	-119.9	15.53	0.02	656	3.0
01MW-29	6.66	-93.5	15.02	0.01	874	83.2
			2750 West Commodore Way			
02MW-01	6.42	-45.6	14.48	0.81	482	17.6
02MW-02	6.59	-79.8	16.08	0.31	475	0.0
02MW-03	6.47	-17.0	14.19	1.41	792	na
02MW-04	6.58	-57.6	14.64	1.80	640	na
02MW-05	6.47	-103.0	14.96	1.22	662	1.8
02MW-06	6.45	-153.6	12.96	1.03	361	na
02MW-07	6.52	-84.4	18	0.29	468	3.6

Abbreviations and Acronyms:

mg/L – milligrams per liter
mS/cm – millisiemens per centimeter
mv – millivolts
na – value not recorded due to meter malfunction
NTU – nephelometric turbidity unit

Table 4-2. Groundwater Results from 2737 West Commodore Way, July 2004

Sample	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)		Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)
Action Level	15[1/]	0.5[2/]	0.5[2/]	800[3/]	1,000[4/]	5,300[5/]	17,500[5/]	32,000[5/]	1,000[2/]
01MW-01	8.94	< 0.250	< 0.500	55.9		3.66	0.766	< 0.500	1.80
01MW-02	na	< 0.250	< 0.500	***9,670***		3,230	97.0	146	441
01MW-03	na	***1.23***	***0.938***	***4,500***		1,130	60.8	41.4	82.5
01MW-04	na	0.333	< 0.500	***9,820***		2,380	570	236	828
01MW-06	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
01MW-07	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
01MW-08	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
01MW-09	< 0.500	***19.2***	< 0.500	***7,730***		1,050	48.0	232	942
01MW-11	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
01MW-12	na	< 0.250	< 0.500	***1,700***		485	5.90	11.3	15.8
01MW-13	na	< 0.250	< 0.500	314		1.41	< 0.500	< 0.500	2.54
01MW-15	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
01MW-17	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
01MW-18	< 0.500	***0.676***	< 0.500	***10,700***		1,570	124	283	***1,360***
01MW-19	1.32	***0.708***	< 0.500	***19,900***		2,610	945	522	***3,190***
01MW-20	< 0.500	< 0.250	< 0.500	573		13.2	3.86	21.9	29.5
01MW-21	3.51	0.429	< 0.500	***986***		0.858	< 0.500	10.6	1.32
01MW-22	***191***	***1.09***	< 0.500	***1,340***		73.5	0.943	4.71	10.2
01MW-23	***350***	***0.540***	< 0.500	***4,620***		917	10.0	61.4	139
01MW-24	< 0.500	***0.837***	< 0.500	***18,400***		***6,750***	35.0	261	816
01MW-26	***40.5***	< 0.250	< 0.500	137		9.69	0.706	3.56	4.92
01MW-27	***50.7***	< 0.250	< 0.500	***10,900***		***6,220***	43.9	70.4	50.0
01MW-28A	2.44	***1.44***	< 0.500	***17,900***		5,060	1,910	343	***1,230***
01MW-28B	2.28	***1.68***	< 0.500	***18,400***		5,030	1,810	355	***1,250***
RPD	*7%*	*15%*	*nc*	*3%*		*1%*	*5%*	*3%*	*2%*
01MW-29	9.11	***14.3***	< 0.500	***17,800***		***5,410***	167	256	718

Abbreviations and acronyms:
mg/L – milligram per liter
µg/L – microgram per liter
MTCA – Model Toxics Control Act
NOAA – National Oceanic and Atmospheric Administration
na – no analysis requested
nc – not calculated
RPD – relative percent difference
SQuiRT™ – Screening Quick Reference Table
< symbol indicates result is less than reporting limit (in parenths)

Notes:
Results above action levels in bold and italics
[1/] NOAA SQuiRT™ value for freshwater continuous concentration
[2/] MTCA Method A
[3/] MTCA Method A gasoline range with benzene present
[4/] MTCA Method A gasoline range without benzene present
[5/] NOAA SQuiRT™ value for freshwater maximum concentration

Table 4-3. Groundwater Results from 2750 West Commodore Way, July 2004

Sample	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)		Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylenes (µg/L)
Action Level	0.5[2/]	0.5[2/]	800[3/]	1,000[4/]	5,300[5/]	17,500[5/]	32,000[5/]	1,000[2/]
02MW-01	< 0.250	< 0.500	< 50.0		< 0.791	< 0.500	< 0.500	< 1.00
02MW-02	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
02MW-03	< 0.250	< 0.500	< 50.0		< 0.718	< 0.500	< 0.500	< 1.00
02MW-04A	< 0.250	< 0.500	***4,800***		35.9	54.5	308	584
02MW-04B	< 0.250	< 0.500	***4,800***		34.2	54.5	305	570
RPD	*nc*	*nc*	*0%*		*5%*	*0%*	*1%*	*2%*
02MW-05	< 0.250	< 0.500	209		< 0.500	< 0.500	< 0.500	< 1.00
02MW-06	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
02MW-07	< 0.250	< 0.500	131		< 0.500	< 0.500	< 0.500	1.52

Abbreviations and acronyms:
mg/L – milligram per liter
µg/L – microgram per liter
MTCA – Model Toxics Control Act
NOAA – National Oceanic and Atmospheric Administration
nc – not calculated
RPD – relative percent difference
SQuiRT™ – Screening Quick Reference Table
< symbol indicates result is less than reporting limit (in parenths)

Notes:
Results above action levels in bold and italics
[1/] NOAA SQuiRT™ value for freshwater continuous concentration
[2/] MTCA Method A
[3/] MTCA Method A gasoline range with benzene present
[4/] MTCA Method A gasoline range without benzene present
[5/] NOAA SQuiRT™ value for freshwater maximum concentration

Table 5-1. Cumulative Groundwater Results, July 2001 – July 2004, 2737 West Commodore Way

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)	MTBE (µg/L)	Total Lead (µg/L)	Dissolved Lead (µg/L)
Action Level		15[1/]	0.5[2/]	0.5[2/]	800[3/] | 1,000[4/]	5,300[5/]	17,500[5/]	32,000[5/]	1,000[2/]	20[2/]	15[2/]	15[2/]
01MW-01	Jul-01	3.94	*1.11*	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	na
01MW-01	Oct-01	3.55	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-01	Jan-02	2.02	< 0.250	< 0.500	51.5	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-01	Apr-02	2.84	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-01	Jul-02	6.84	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-01A	Oct-02	6.37	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-01B	Oct-02	7.13	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-01A	Jan-03	7.33	< 0.250	< 0.500	< 50.0	< 1.00	< 1.00	< 1.00	< 3.00	< 5.00	na	na
01MW-01B	Jan-03	6.06	< 0.250	< 0.500	< 50.0	< 1.00	< 1.00	< 1.00	< 3.00	< 5.00	na	na
01MW-01A	Apr-03	5.57	0.429	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-01B	Apr-03	8.04	0.454	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-01	Aug-03	6.06	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-01	Jan-04	11.2	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-01A	Apr-04	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-01B	Apr-04	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-01	Jul-04	8.94	< 0.250	< 0.500	*55.9*	3.66	0.766	< 0.500	1.80	na	na	na
01MW-02	Jul-01	na	*5.01*	<1.50	*14,800*	*6,900*	162	262	*1,110*	na	< 1.00	na
01MW-02	Oct-01	< 0.500	0.264	< 0.500	*10,100*	4,290	71.2	159	741	na	< 1.00	< 1.00
01MW-02	Jan-02	< 0.500	0.330	< 0.500	*13,000*	3,280	645	373	*1,610*	na	< 1.00	< 1.00
01MW-02	Apr-02	< 0.500	0.479	< 0.500	*27,500*	*11,200*	658	340	*1,390*	na	< 1.00	< 1.00
01MW-02A	Jul-02	< 0.500	0.377	< 0.500	*17,500*	*7,060*	250	230	970	na	< 1.00	< 1.00
01MW-02B	Jul-02	< 0.500	0.294	< 0.500	*17,600*	*6,380*	230	212	892	na	< 1.00	< 1.00
01MW-02	Oct-02	na	0.412	< 0.500	*10,700*	2,780	888	303	*1,580*	na	na	na
01MW-02	Jan-03	na	*0.502*	< 0.500	*31,100*	*9,860*	988	278	*1,570*	< 500	na	na
01MW-02	Apr-03	na	*0.817*	< 0.500	*11,600*	4,630	218	229	561	na	na	na
01MW-02	Aug-03	na	*1.62*	< 0.500	*14,800*	*5,540*	133	200	713	na	na	na
01MW-02	Jan-04	na	< 0.250	< 0.500	*9,820*	3,900	295	312	*1,030*	na	na	na
01MW-02	Jan-04	na	< 0.250	< 0.500	*10,500*	3,950	307	300	*1,050*	na	na	na
01MW-02	Apr-04	na	0.428	< 0.500	*21,800*	*8,680*	213	310	857	na	na	na
01MW-02	Jul-04	na	< 0.250	< 0.500	*9,670*	3,230	97.0	146	441	na	na	na

Table 5-1. Cumulative Groundwater Results, July 2001 – July 2004, 2737 West Commodore Way (continued)

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)	MTBE (µg/L)	Total Lead (µg/L)	Dissolved Lead (µg/L)
Action Level		$15^{1/}$	$0.5^{2/}$	$0.5^{2/}$	$800^{3/}$ $1,000^{4/}$	$5,300^{5/}$	$17,500^{5/}$	$32,000^{5/}$	$1,000^{2/}$	$20^{2/}$	$15^{2/}$	$15^{2/}$
01MW-03	Jul-01	na	***2.84***	<1.50	***24,500***	***11,900***	238	414	515	na	< 1.00	na
01MW-03A	Oct-01	< 0.500	0.491	< 0.500	***18,500***	***11,700***	82.1	237	138	na	< 1.00	< 1.00
01MW-03B	Oct-01	2.24	0.379	< 0.500	***9,200***	4,330	39.9	114	66.3	na	< 1.00	< 1.00
01MW-03A	Jan-02	< 0.500	0.443	< 0.500	***1,070***	98.8	4.56	7.94	9.53	na	< 1.00	< 1.00
01MW-03B	Jan-02	< 0.500	0.440	< 0.500	***1,070***	98.3	4.45	8.28	9.36	na	< 1.00	< 1.00
01MW-03A	Apr-02	< 0.500	0.427	< 0.500	753	50.8	3.68	9.85	9.23	na	< 1.00	< 1.00
01MW-03B	Apr-02	< 0.500	0.463	< 0.500	751	62.7	4.65	12.2	11.1	na	1.17	< 1.00
01MW-03	Jul-02	< 0.500	***0.512***	< 0.500	***21,000***	***8,990***	416	324	588	na	< 1.00	< 1.00
01MW-03	Oct-02	na	***0.897***	< 0.500	***18,000***	***8,350***	97.5	244	671	na	na	na
01MW-03	Jan-03	na	< 0.250	< 0.500	618	170	< 5.00	< 5.00	< 15.0	< 25.0	na	na
01MW-03	Apr-03	na	***0.879***	< 0.500	***1,070***	135	7.12	< 2.50	12.7	na	na	na
01MW-03	Aug-03	na	***2.09***	< 0.500	***31,500***	***13,900***	232	355	449	na	na	na
01MW-03	Jan-04	na	0.404	< 0.500	***1,040***	302	10.1	7.09	17.3	na	na	na
01MW-03	Apr-04	na	***0.508***	< 0.500	***1,060***	83.5	4.64	2.56	12.1	na	na	na
01MW-03	Jul-04	na	***1.23***	***0.938***	***4,500***	1,130	60.8	41.4	82.5	na	na	na
01MW-04	Jul-01	na	***1.79***	<1.50	***6,460***	1,210	204	134	***1,470***	na	< 1.00	na
01MW-04	Oct-01	< 0.500	0.398	< 0.500	***4,020***	68.1	82.3	261	***1,130***	na	< 1.00	< 1.00
01MW-04	Jan-02	< 0.500	< 0.250	< 0.500	***5,920***	< 25.0	123	486	***2,030***	na	< 1.00	< 1.00
01MW-04	Apr-02	< 0.500	< 0.250	< 0.500	***840***	< 1.25	10.7	76	342	na	< 1.00	< 1.00
01MW-04	Jul-02	< 0.500	< 0.250	< 0.500	***17,300***	4,130	1,360	309	***1,470***	na	< 1.00	< 1.00
01MW-04	Oct-02	na	na	na	na	na	na	na	na	na	na	na
01MW-04	Aug-03	< 0.500	***1.90***	< 0.500	***1,840***	1,190	155	51.7	141	na	< 1.00	< 1.00
01MW-04	Jul-04	na	0.333	< 0.500	***9,820***	2,380	570	236	828	na	< 1.00	< 1.00
01MW-06	Jul-01	2.17	***0.718***	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	na
01MW-06	Oct-01	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-06	Jan-02	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-06	Apr-02	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-06	Jul-02	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00

Table 5-1. Cumulative Groundwater Results, July 2001 – July 2004, 2737 West Commodore Way (continued)

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)		Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)	MTBE (µg/L)	Total Lead (µg/L)	Dissolved Lead (µg/L)
Action Level		15$^{1/}$	0.5$^{2/}$	0.5$^{2/}$	800$^{3/}$	1,000$^{4/}$	5,300$^{5/}$.	17,500$^{5/}$	32,000$^{5/}$	1,000$^{2/}$	20$^{2/}$	15$^{2/}$	15$^{2/}$
01MW-06	Oct-02	na	na	na	na		na	na	na	na	na	na	na
01MW-06	Aug-03	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-06	Jul-04	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-07	Jul-01	na	***1.45***	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	na
01MW-07	Oct-01	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	1.11	< 1.00
01MW-07	Jan-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-07	Apr-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-07	Jul-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-07	Oct-02	na	na	na	na		na	na	na	na	na	na	na
01MW-07	Aug-03	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-07	Jul-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-08	Jul-01	na	***0.662***	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	na
01MW-08	Oct-01	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-08	Jan-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-08	Apr-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-08	Jul-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-08	Oct-02	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-08	Jan-03	na	< 0.250	< 0.500	< 50.0		< 1.00	< 1.00	< 1.00	< 3.00	< 5.00	na	na
01MW-08	Apr-03	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-08	Aug-03	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-08	Jan-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-08	Apr-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-08	Jul-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-09	Jul-01	na	***5.72***	< 0.500	***1,830***		213	114	48.1	230	na	< 1.00	< 1.00
01MW-09	Oct-01	< 0.500	0.336	< 0.500	***6,940***		1,030	422	247	***1,250***	na	1.16	< 1.00
01MW-09	Jan-02	< 0.500	< 0.250	< 0.500	480		67.2	32.4	17.6	81.1	na	1.01	3.58
01MW-09	Apr-02	< 0.500	< 0.250	< 0.500	***860***		134	37	25.0	106	na	1.16	< 1.00

Table 5-1. Cumulative Groundwater Results, July 2001 – July 2004, 2737 West Commodore Way (continued)

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)		Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)	MTBE (µg/L)	Total Lead (µg/L)	Dissolved Lead (µg/L)
Action Level		15[1/]	0.5[2/]	0.5[2/]	800[3/]	1,000[4/]	5,300[5/]	17,500[5/]	32,000[5/]	1,000[2/]	20[2/]	15[2/]	15[2/]
01MW-09	Jul-02	No Sample Collected Due to Product											
01MW-09	Oct-02	No Sample Collected Due to Product											
01MW-09	Apr-03	na	***1.13***	< 0.500	***8,370***		1,140	690	221	***1,070***	na	na	na
01MW-09	Aug-03	na	***8.63***	< 0.500	***11,400***		1,370	335	314	***1,500***	na	na	na
01MW-09	Jan-04	na	0.451	< 0.500	***937***		340	10.4	12.2	47.6	na	na	na
01MW-09	Apr-04	na	***3.92***	< 0.500	***16,200***		3,310	183	573	***2,580***	na	na	na
01MW-09	Jul-04	< 0.500	***19.2***	< 0.500	***7,730***		1,050	48.0	232	942	na	na	na
01MW-11	Jul-01	na	***1.53***	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	na
01MW-11	Oct-01	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-11	Jan-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-11	Apr-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-11	Jul-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-11	Oct-02	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-11	Jan-03	na	< 0.250	< 0.500	< 50.0		< 1.00	< 1.00	< 1.00	< 3.00	< 5.00	na	na
01MW-11	Apr-03	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-11	Aug-03	na	0.294	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-11	Jan-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-11	Apr-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-11	Jul-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-12	Jul-01	na	***6.55***	<1.50	***1,350***		482	8.84	14.0	26.4	na	< 1.00	na
01MW-12	Oct-01	1.68	***0.731***	< 0.500	***1,300***		385	9.22	14.0	24.8	na	< 1.00	< 1.00
01MW-12	Jan-02	< 0.500	< 0.250	< 0.500	***1,130***		360	8.11	11.7	22.1	na	< 1.00	< 1.00
01MW-12	Apr-02	< 0.500	< 0.250	< 0.500	***1,600***		545	7.37	11.9	21.7	na	< 1.00	< 1.00
01MW-12	Jul-02	< 0.500	< 0.250	< 0.500	***1,720***		671	9.65	15.8	24.9	na	< 1.00	< 1.00
01MW-12	Oct-02	na	< 0.250	< 0.500	***1,710***		619	7.70	9.31	18.0	na	na	na
01MW-12	Jan-03	na	< 0.250	< 0.500	***1,410***		295	< 10.0	11.8	< 30.0	< 50.0	na	na
01MW-12	Apr-03	na	***4.22***	< 0.500	***1,480***		417	5.89	10.3	17.1	na	na	na
01MW-12	Aug-03	na	***4.09***	< 0.500	***1,430***		583	6.68	11.7	17.4	na	na	na

Table 5-1. Cumulative Groundwater Results, July 2001 – July 2004, 2737 West Commodore Way (continued)

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)	MTBE (µg/L)	Total Lead (µg/L)	Dissolved Lead (µg/L)
Action Level		$15^{1/}$	$0.5^{2/}$	$0.5^{2/}$	$800^{3/}$ $1{,}000^{4/}$	$5{,}300^{5/}$	$17{,}500^{5/}$	$32{,}000^{5/}$	$1{,}000^{2/}$	$20^{2/}$	$15^{2/}$	$15^{2/}$
01MW-12	Jan-04	na	< 0.250	< 0.500	***1,130***	336	6.10	12.0	17.2	na	na	na
01MW-12	Apr-04	na	0.471	< 0.500	***1,330***	441	6.24	9.62	14.6	na	na	na
01MW-12	Jul-04	na	< 0.250	< 0.500	***1,700***	485	5.90	11.3	15.8	na	na	na
01MW-13	Jul-01	na	***3.90***	<1.50	221	1.26	< 0.500	< 0.500	2.31	na	< 1.00	na
01MW-13	Oct-01	2.73	***1.29***	< 0.500	207	1.28	< 0.500	< 0.500	2.06	na	< 1.00	< 1.00
01MW-13	Jan-02	< 0.500	< 0.250	< 0.500	160	< 0.500	< 0.500	< 0.500	1.62	na	< 1.00	< 1.00
01MW-13	Apr-02	< 0.500	< 0.250	< 0.500	204	0.978	< 0.500	0.533	2.00	na	< 1.00	< 1.00
01MW-13	Jul-02	< 0.500	< 0.250	< 0.500	304	1.19	< 0.500	< 0.500	2.86	na	< 1.00	< 1.00
01MW-13	Oct-02	na	< 0.250	< 0.500	149	< 0.500	< 0.500	< 0.500	1.55	na	na	na
01MW-13	Jan-03	na	< 0.250	< 0.500	246	< 1.00	< 1.00	< 1.00	< 3.00	< 5.00	na	na
01MW-13	Apr-03	na	***0.688***	< 0.500	199	0.771	< 0.500	< 0.500	1.95	na	na	na
01MW-13	Aug-03	na	***2.60***	< 0.500	137	0.520	< 0.500	< 0.500	1.77	na	na	na
01MW-13	Jan-04	na	< 0.250	< 0.500	167	0.775	< 0.500	< 0.500	1.85	na	na	na
01MW-13	Apr-04	na	0.257	< 0.500	325	2.23	0.730	2.14	3.28	na	na	na
01MW-13	Jul-04	na	< 0.250	< 0.500	314	1.41	< 0.500	< 0.500	2.54	na	na	na
01MW-15	Jul-01	1.66	0.484	<0.500	< 50.0	< 0.500	< 0.500	< 0.500	<1.00	na	< 1.00	na
01MW-15	Oct-01	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-15	Jan-02	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-15	Apr-02	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-15	Jul-02	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-15	Oct-02	na	na	na	na	na	na	na	na	na	na	na
01MW-15	Aug-03	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-15	Jul-04	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-16A	Jul-01	2.54	***11.1***	<2.50	***11,000***	3,910	123	261	891	na	< 1.00	na
01MW-16B	Jul-01	2.09	***9.62***	<2.50	***9,390***	3,700	122	209	745	na	< 1.00	< 1.00
01MW-16	Oct-01	< 0.500	0.448	< 0.500	***11,500***	3,670	113	274	984	na	< 1.00	< 1.00
01MW-16	Jan-02	< 0.500	***0.674***	< 0.500	***13,400***	***5,300***	116	250	906	na	< 1.00	< 1.00

Table 5-1. Cumulative Groundwater Results, July 2001 – July 2004, 2737 West Commodore Way (continued)

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)		Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)	MTBE (µg/L)	Total Lead (µg/L)	Dissolved Lead (µg/L)
Action Level		15[1/]	0.5[2/]	0.5[2/]	800[3/]	1,000[4/]	5,300[5/]	17,500[5/]	32,000[5/]	1,000[2/]	20[2/]	15[2/]	15[2/]
01MW-16	Apr-02	No Sample Collected Due to Product											
01MW-16	Jul-02	No Sample Collected Due to Product											
01MW-16	Oct-02	No Sample Collected Due to Product											
01MW-16	Apr-03	< 1,010	***3.83***	< 0.926	***13,300***		4,100	75.5	227	754	na	na	na
01MW-16	Jul-04	No Sample Collected Due to Product											
01MW-17	Jul-01	<0.500	***0.884***	<0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	na
01MW-17	Oct-01	1.65	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-17	Jan-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-17	Apr-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-17	Jul-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	< 1.00	< 1.00
01MW-17	Oct-02	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-17	Jan-03	na	< 0.250	< 0.500	< 50.0		< 1.00	< 1.00	< 1.00	< 3.00	< 5.00	na	na
01MW-17	Apr-03	na	0.273	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-17	Aug-03	na	0.327	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-17	Jan-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-17	Apr-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-17	Jul-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na	na
01MW-18	Aug-03	< 0.500	***1.12***	< 0.500	***7,160***		1,410	276	272	***1,010***	na	na	na
01MW-18	Jul-04	< 0.500	***0.676***	< 0.500	***10,700***		1,570	124	283	***1,360***	na	na	na
01MW-19	Jul-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	2.88	< 1.00
01MW-19	Aug-03	< 0.500	***1.46***	< 0.500	***15,800***		3,070	1,390	562	***3,160***	na	na	na
01MW-19	Jul-04	1.32	***0.708***	< 0.500	***19,900***		2,610	945	522	***3,190***	na	na	na
01MW-20	Jul-02	< 0.500	< 0.250	< 0.500	***16,700***		1,640	1,390	468	***2,840***	na	3.45	< 1.00
01MW-20	Aug-03	< 0.500	< 0.250	< 0.500	132		4.74	1.08	6.67	6.85	na	na	na
01MW-20	Jul-04	< 0.500	< 0.250	< 0.500	573		13.2	3.86	21.9	29.5	na	na	na

Table 5-1. Cumulative Groundwater Results, July 2001 – July 2004, 2737 West Commodore Way (continued)

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)	MTBE (µg/L)	Total Lead (µg/L)	Dissolved Lead (µg/L)
Action Level		15[1/]	0.5[2/]	0.5[2/]	800[3/] 1,000[4/]	5,300[5/]	17,500[5/]	32,000[5/]	1,000[2/]	20[2/]	15[2/]	15[2/]
01MW-21	Jan-03	***24.2***	***1.64***	< 0.500	743	< 1.00	< 1.00	7.26	10.3	< 5.00	na	na
01MW-21	Apr-03	***26.8***	***4.47***	< 0.500	***930***	1.03	< 0.500	22.1	1.66	na	na	na
01MW-21	Aug-03	***30.4***	***3.21***	< 0.500	592	0.828	< 0.500	11.1	1.34	na	na	na
01MW-21	Jul-04	3.51	0.429	< 0.500	***986***	0.858	< 0.500	10.6	1.32	na	na	na
01MW-22	Jan-03	***400***	***1.57***	< 0.500	294	11	< 1.00	< 1.00	< 3.00	< 5.00	na	na
01MW-22	Aug-03	***160***	***5.08***	***1.32***	***892***	73.2	1.77	8.44	12	na	na	na
01MW-22	Jul-04	***191***	***1.09***	< 0.500	***1,340***	73.5	0.943	4.71	10.2	na	na	na
01MW-23	Apr-03	***198***[6/]	na	na	na	na	na	na	na	na	na	na
01MW-23	Jul-04	***350***	***0.540***	< 0.500	***4,620***	917	10.0	61.4	139	na	na	na
01MW-24	Jan-03	***222***	***6.13***	< 0.500	***19,800***	***5,400***	< 50.0	211	827	< 5.00	na	na
01MW-24	Jul-04	< 0.500	***0.837***	< 0.500	***18,400***	***6,750***	35.0	261	816	na	na	na
01MW-25	Apr-03	< 75.0[6/]	na	na	na	na	na	na	na	na	na	na
01MW-25	Aug-03	***181***	***13.0***	***1.67***	***15,700***	***6,670***	< 50.0	278	738	na	na	na
01MW-25	Jul-04	No Sample Collected Due to Product										
01MW-26	Jan-03	***33.2***	***1.38***	< 0.500	***4,180***	352	87.4	45.3	413	< 5.00	na	na
01MW-26	Apr-03	4.08	***0.967***	< 0.500	228	35.1	11.5	5.54	20.2	na	na	na
01MW-26	Aug-03	2.34	***1.40***	< 0.500	119	5.70	1.17	3.39	6.12	na	na	na
01MW-26	Jul-04	***40.5***	< 0.250	< 0.500	137	9.69	0.706	3.56	4.92	na	na	na
01MW-27	Jan-03	***46.4***	0.330	< 0.500	***11,300***	4,230	211	68.0	158	< 5.00	na	na
01MW-27	Apr-03	***56.9***	***1.98***	< 0.500	***15,500***	***6,090***	227	88.1	197	na	na	na
01MW-27	Aug-03	***79.4***	***3.17***	< 0.500	***14,800***	***6,180***	53.0	73.5	< 100	na	na	na
01MW-27	Jul-04	***50.7***	< 0.250	< 0.500	***10,900***	***6,220***	43.9	70.4	50.0	na	na	na

Table 5-1. Cumulative Groundwater Results, July 2001 – July 2004, 2737 West Commodore Way (continued)

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)	MTBE (µg/L)	Total Lead (µg/L)	Dissolved Lead (µg/L)
Action Level		15[1]	0.5[2]	0.5[2]	800[3] 1,000[4]	5,300[5]	17,500[5]	32,000[5]	1,000[2]	20[2]	15[2]	15[2]
01MW-28	Apr-03	***24.6***	***5.02***	< 0.500	***28,400***	***6,390***	2,870	401	***2,250***	na	na	na
01MW-28A	Aug-03	***21.7***	***4.63***	< 0.500	***199,000***	3,670	1,410	448	***1,520***	na	na	na
01MW-28B	Aug-03	***22.0***	***4.12***	< 0.500	***210,000***	3,580	1,380	478	***1,680***	na	na	na
01MW-28A	Jul-04	2.44	***1.44***	< 0.500	***17,900***	***5,060***	1,910	343	***1,230***	na	na	na
01MW-28B	Jul-04	2.28	***1.68***	< 0.500	***18,400***	***5,030***	1,810	355	***1,250***	na	na	na
01MW-29	Apr-03	< 50	***9.51***	***0.689***	***18,600***	***6,160***	171	285	632	na	na	na
01MW-29	Jul-04	9.11	***14.3***	< 0.500	***17,800***	***5,410***	167	256	718	na	na	na

Abbreviations and acronyms:
mg/L – milligram per liter
µg/L – microgram per liter
MTCA – Model Toxics Control Act
NOAA – National Oceanic and Atmospheric Administration
na – no analysis requested
SQuiRT™ – Screening Quick Reference Table
< symbol indicates result is less than reporting limit (in parenths)

Notes:
Results above action levels in bold and italics
[1] NOAA SQuiRT™ value for freshwater continuous concentration
[2] MTCA Method A
[3] MTCA Method A gasoline range with benzene present
[4] MTCA Method A gasoline range without benzene present
[5] NOAA SQuiRT™ value for freshwater maximum concentration

Table 5-2. Cumulative Groundwater Results, July 2001 – July 2004, 2750 West Commodore Way

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)		Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylenes (µg/L)	Total Lead (µg/L)	Dissolved Lead (µg/L)
Action Level		$15^{1/}$	$0.5^{2/}$	$0.5^{2/}$	$800^{3/}$	$1{,}000^{4/}$	$5{,}300^{5/}$	$17{,}500^{5/}$	$32{,}000^{5/}$	$1{,}000^{2/}$	$15^{2/}$	$15^{2/}$
02MW-01	Jul-01	na	*0.500*	< 0.500	119		44.4	0.662	< 0.500	1.15	< 1.00	na
02MW-01	Oct-01	< 0.500	< 0.250	< 0.500	235		81.3	1.41	< 0.500	2.84	< 1.00	< 1.00
02MW-01	Jan-02	< 0.500	< 0.250	< 0.500	< 50.0		4.67	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-01	Apr-02	< 0.500	< 0.250	< 0.500	< 50.0		4.24	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-01	Jul-02	< 0.500	< 0.250	< 0.500	182		67.5	1.20	< 0.500	2.39	< 1.00	< 1.00
02MW-01	Oct-02	na	< 0.250	< 0.500	327		82.0	2.37	< 0.500	7.62	na	na
02MW-01	Jan-03	na	< 0.250	< 0.500	134		28.9	< 1.00	< 1.00	< 3.00	na	na
02MW-01	Apr-03	na	< 0.250	< 0.500	5.55		< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-01	Aug-03	na	< 0.250	< 0.500	158		37.8	0.869	< 0.500	< 1.00	na	na
02MW-01	Oct-03	na	< 0.250	< 0.500	201		64.4	2.41	< 0.500	6.92	na	na
02MW-01	Jan-04	na	< 0.250	< 0.500	< 50.0		1.32	< 0.500	< 0.500	< 1.00	na	na
02MW-01	Apr-04	na	< 0.250	< 0.500	< 50.0		2.54	< 0.500	< 0.500	< 1.00	na	na
02MW-01	Jul-04	na	< 0.250	< 0.500	< 50.0		7.91	< 0.500	< 0.500	< 1.00	na	na
02MW-02	Jul-01	na	*0.679*	< 0.500	< 50		< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	na
02MW-02	Oct-01	2.21	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-02	Jan-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-02	Apr-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-02	Jul-02	< 0.500	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-02	Oct-02	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-02	Jan-03	na	< 0.250	< 0.500	< 50.0		< 1.00	< 1.00	< 1.00	< 3.00	na	na
02MW-02	Apr-03	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-02	Aug-03	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-02	Oct-03	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-02	Jan-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-02	Apr-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-02	Jul-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-03	Jul-01	na	*0.619*	< 0.500	90.4		38.6	0.664	< 0.500	< 1.00	< 1.00	na
02MW-03	Oct-01	< 0.500	< 0.250	< 0.500	109		46.6	1.16	< 0.500	< 1.00	< 1.00	< 1.00
02MW-03	Jan-02	< 0.500	< 0.250	< 0.500	< 50.0		7.84	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-03	Apr-02	< 0.500	< 0.250	< 0.500	< 50.0		7.21	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-03	Jul-02	< 0.500	< 0.250	< 0.500	143		63.4	2.17	< 0.500	< 1.00	< 1.00	< 1.00
02MW-03	Oct-02	na	< 0.250	< 0.500	122		37.0	0.572	< 0.500	1.70	na	na
02MW-03	Jan-03	na	< 0.250	< 0.500	56.7		17.7	< 1.00	< 1.00	< 3.00	na	na
02MW-03	Apr-03	na	< 0.250	< 0.500	10.5		< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-03	Aug-03	na	< 0.250	< 0.500	< 50.0		3.42	< 0.500	< 0.500	< 1.00	na	na
02MW-03	Oct-03	na	< 0.250	< 0.500	261		123	1.59	< 0.500	2.72	na	na
02MW-03	Jan-04	na	< 0.250	< 0.500	< 50.0		0.787	< 0.500	< 0.500	< 1.00	na	na
02MW-03	Apr-04	na	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-03	Jul-04	na	< 0.250	< 0.500	< 50.0		0.718	< 0.500	< 0.500	< 1.00	na	na
02MW-04	Jul-01	na	*1.41*	< 0.500	*4,270*		23.9	231	165	484	4.68	na
02MW-04A	Oct-01	< 0.500	< 0.250	< 0.500	*4,070*		21.4	262	285	594	6.50	6.06
02MW-04B	Oct-01	< 0.500	< 0.250	< 0.500	*3,890*		21.7	257	291	590	6.68	4.01
02MW-04A	Jan-02	< 0.500	< 0.250	< 0.500	*4,070*		21.4	262	285	594	4.35	3.24
02MW-04B	Jan-02	< 0.500	< 0.250	< 0.500	*3,890*		21.7	257	291	590	5.27	< 1.00
02MW-04A	Apr-02	< 0.500	< 0.250	< 0.500	*3,280*		19.1	172	255	525	5.34	2.88
02MW-04B	Apr-02	< 0.500	< 0.250	< 0.500	*3,440*		21.0	193	288	591	4.86	3.42
02MW-04A	Jul-02	< 0.500	< 0.250	< 0.500	*4,640*		23.8	165	330	558	5.54	3.68

Table 5-2. Cumulative Groundwater Results, July 2001 – July 2004, 2750 West Commodore Way (continued)

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylenes (µg/L)	Total Lead (µg/L)	Dissolved Lead (µg/L)
Action Level		$15^{1/}$	$0.5^{2/}$	$0.5^{2/}$	$800^{3/}$ $1{,}000^{4/}$	$5{,}300^{5/}$	$17{,}500^{5/}$	$32{,}000^{5/}$	$1{,}000^{2/}$	$15^{2/}$	$15^{2/}$
02MW-04B	Jul-02	< 0.500	< 0.250	< 0.500	***4,770***	21.3	178	362	612	5.32	2.91
02MW-04A	Oct-02	na	< 0.250	< 0.500	***3,200***	24.6	47.5	284	225	na	na
02MW-04B	Oct-02	na	< 0.250	< 0.500	***3,020***	24.6	45.9	288	226	na	na
02MW-04A	Jan-03	na	< 0.250	< 0.500	***4,720***	16.4	162	304	502	na	na
02MW-04B	Jan-03	na	< 0.250	< 0.500	***4,720***	15.0	170	294	542	na	na
02MW-04A	Apr-03	na	***0.555***	< 0.500	***7,130***	24.6	796	363	735	na	na
02MW-04B	Apr-03	na	0.462	< 0.500	***6,640***	21.7	187	351	710	na	na
02MW-04A	Aug-03	na	0.483	< 0.500	***4,610***	32.6	92.7	333	605	na	na
02MW-04B	Aug-03	na	0.416	< 0.500	***4,170***	29.0	81.3	299	526	na	na
02MW-04A	Oct-03	na	< 0.250	< 0.500	***2,720***	31.7	29.0	333	162	na	na
02MW-04B	Oct-03	na	< 0.250	< 0.500	***2,580***	33.6	28.6	316	163	na	na
02MW-04A	Jan-04	na	< 0.250	< 0.500	***4,190***	27.0	115	276	572	na	na
02MW-04B	Jan-04	na	< 0.250	< 0.500	***3,640***	23.9	105	253	522	na	na
02MW-04A	Apr-04	na	< 0.250	< 0.500	***12,200***	30.6	286	878	***2,030***	na	na
02MW-04B	Apr-04	na	< 0.250	< 0.500	***10,700***	17.5	265	741	***1,880***	na	na
02MW-04A	Jul-04	na	< 0.250	< 0.500	***4,800***	35.9	54.5	308	584	na	na
02MW-04B	Jul-04	na	< 0.250	< 0.500	***4,800***	34.2	54.5	305	570	na	na
02MW-05	Jul-01	na	***0.997***	< 0.500	51.8	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	na
02MW-05	Oct-01	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-05	Jan-02	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-05	Apr-02	< 0.500	< 0.250	< 0.500	295	1.20	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-05	Jul-02	< 0.500	< 0.250	< 0.500	102	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-05	Oct-02	na	< 0.250	< 0.500	61.6	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-05	Jan-03	na	< 0.250	< 0.500	191	< 1.00	< 1.00	1.42	< 3.00	na	na
02MW-05	Apr-03	na	0.280	< 0.500	608	1.71	< 0.500	19.1	< 1.00	na	na
02MW-05	Aug-03	na	0.271	< 0.500	63.8	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-05	Oct-03	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-05	Jan-04	na	< 0.250	< 0.500	326	< 0.500	< 0.500	1.03	< 1.00	na	na
02MW-05	Apr-04	na	< 0.250	< 0.500	364	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-05	Jul-04	na	< 0.250	< 0.500	209	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW06A	Jul-01	na	***0.923***	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	na
02MW06B	Jul-01	na	***0.897***	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	na
02MW-06	Oct-01	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-06	Jan-02	0.991	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-06	Apr-02	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-06	Jul-02	< 0.500	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-06	Oct-02	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-06	Jan-03	na	< 0.250	< 0.500	< 50.0	< 1.00	< 1.00	< 1.00	< 3.00	na	na
02MW-06	Apr-03	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-06	Aug-03	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-06	Oct-03	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-06	Jan-04	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-06	Apr-04	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-06	Jul-04	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na

Table 5-2. Cumulative Groundwater Results, July 2001 – July 2004, 2750 West Commodore Way (continued)

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylenes (µg/L)	Total Lead (µg/L)	Dissolved Lead (µg/L)
Action Level		15[1]	0.5[2]	0.5[2]	800[3] 1,000[4]	5,300[5]	17,500[5]	32,000[5]	1,000[2]	15[2]	15[2]
02MW-07	Jul-01	na	0.417	< 0.500	244	< 0.500	< 0.500	< 0.500	2.79	< 1.00	na
02MW-07	Oct-01	2.15	< 0.250	< 0.500	69.7	< 0.500	< 0.500	< 0.500	< 1.00	< 1.00	< 1.00
02MW-07	Jan-02	1.64	< 0.250	< 0.500	92.5	< 0.500	< 0.500	< 0.500	1.47	< 1.00	< 1.00
02MW-07	Apr-02	< 0.500	< 0.250	< 0.500	251	< 0.500	< 0.500	0.655	6.96	< 1.00	< 1.00
02MW-07	Jul-02	< 0.500	< 0.250	< 0.500	242	< 0.500	< 0.500	< 0.500	2.71	< 1.00	< 1.00
02MW-07	Oct-02	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-07	Jan-03	na	< 0.250	< 0.500	146	< 1.00	< 1.00	< 1.00	< 3.00	na	na
02MW-07	Apr-03	na	< 0.250	< 0.500	177	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-07	Aug-03	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-07	Oct-03	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00	na	na
02MW-07	Jan-04	na	< 0.250	< 0.500	182	< 0.500	< 0.500	< 0.500	2.09	na	na
02MW-07	Apr-04	na	< 0.250	< 0.500	143	< 0.500	< 0.500	< 0.500	1.38	na	na
02MW-07	Jul-04	na	< 0.250	< 0.500	131	< 0.500	< 0.500	< 0.500	1.52	na	na

Abbreviations and acronyms:

mg/L – milligram per liter
µg/L – microgram per liter
MTCA – Model Toxics Control Act
NOAA – National Oceanic and Atmospheric Administration
na – no analysis requested
RPD – relative percent difference
SQuiRT™ – Screening Quick Reference Table
< symbol indicates result is less than reporting limit (in parenths)

Notes:

Results above action levels in bold and italics
[1] NOAA SQuiRT™ value for freshwater continuous concentration
[2] MTCA Method A
[3] MTCA Method A gasoline range with benzene present
[4] MTCA Method A gasoline range without benzene present
[5] NOAA SQuiRT™ value for freshwater maximum concentration

APPENDIX A

LABORATORY DATA PACKAGES

nca™
www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
425.420.9200 fax 425.420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588
Anchorage 2000 W. International Airport Road, Suite A10, Anchorage, AK 99502-1119
907.563.9200 fax 907.563.9210

27 July 2004

Bryan Graham
Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011
RE: Time Oil-West Commodore Way

Enclosed are the results of analyses for samples received by the laboratory on 07/14/04 16:24. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Amar Gill
Project Manager

nca™
www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
425.420.9200 fax 425.420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588
Anchorage 2000 W. International Airport Road, Suite A10, Anchorage, AK 99502-1119
~~907.563.9200 fax 907.563.9210~~

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306
Project Manager: Bryan Graham

Reported:
07/27/04 13:09

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
01MW-07	B4G0357-01	Water	07/14/04 08:15	07/14/04 16:24
01MW-TB1	B4G0357-02	Water	07/14/04 08:00	07/14/04 16:24
02MW-02	B4G0357-03	Water	07/14/04 08:50	07/14/04 16:24
02MW-07	B4G0357-04	Water	07/14/04 09:10	07/14/04 16:24
02MW-01	B4G0357-05	Water	07/14/04 09:20	07/14/04 16:24
02MW-03	B4G0357-06	Water	07/14/04 09:35	07/14/04 16:24
02MW-05	B4G0357-07	Water	07/14/04 09:50	07/14/04 16:24
02MW-04A	B4G0357-08	Water	07/14/04 10:10	07/14/04 16:24
02MW-04B	B4G0357-09	Water	07/14/04 10:20	07/14/04 16:24
02MW-06	B4G0357-10	Water	07/14/04 10:30	07/14/04 16:24

North Creek Analytical - Bothell

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306
Project Manager: Bryan Graham

Reported:
07/27/04 13:09

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-07 (B4G0357-01) Water Sampled: 07/14/04 08:15 Received: 07/14/04 16:24									
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G20003	07/20/04	07/20/04	NWTPH-Gx/8021B	
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*101 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*94.2 %*	*68-140*			"	"	"	"	
01MW-TB1 (B4G0357-02) Water Sampled: 07/14/04 08:00 Received: 07/14/04 16:24									
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G20003	07/20/04	07/20/04	NWTPH-Gx/8021B	
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*98.5 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*90.2 %*	*68-140*			"	"	"	"	
02MW-02 (B4G0357-03) Water Sampled: 07/14/04 08:50 Received: 07/14/04 16:24									
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G20003	07/20/04	07/20/04	NWTPH-Gx/8021B	
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*100 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*91.0 %*	*68-140*			"	"	"	"	

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306
Project Manager: Bryan Graham

Reported:
07/27/04 13:09

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B
North Creek Analytical - Bothell

02MW-07 (B4G0357-04) Water Sampled: 07/14/04 09:10 Received: 07/14/04 16:24

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Gasoline Range Hydrocarbons	**131**	50.0	ug/l	1	4G20003	07/20/04	07/20/04	NWTPH-Gx/8021B	
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	**1.52**	1.00	"	"	"	"	"	"	1-06
Surrogate: 4-BFB (FID)	*106 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*91.2 %*	*68-140*			"	"	"	"	

02MW-01 (B4G0357-05) Water Sampled: 07/14/04 09:20 Received: 07/14/04 16:24

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G20003	07/20/04	07/20/04	NWTPH-Gx/8021B	
Benzene	**7.91**	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*100 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*90.2 %*	*68-140*			"	"	"	"	

02MW-03 (B4G0357-06) Water Sampled: 07/14/04 09:35 Received: 07/14/04 16:24

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G20003	07/20/04	07/20/04	NWTPH-Gx/8021B	
Benzene	**0.718**	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*98.8 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*91.5 %*	*68-140*			"	"	"	"	

North Creek Analytical - Bothell

Amar Gill, Project Manager

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	07/27/04 13:09

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
02MW-05 (B4G0357-07) Water	**Sampled: 07/14/04 09:50**		**Received: 07/14/04 16:24**						
Gasoline Range Hydrocarbons	**209**	50.0	ug/l	1	4G20003	07/20/04	07/20/04	NWTPH-Gx/8021B	G-02
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*95.2 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*92.1 %*	*68-140*			"	"	"	"	
02MW-04A (B4G0357-08) Water	**Sampled: 07/14/04 10:10**		**Received: 07/14/04 16:24**						
Gasoline Range Hydrocarbons	**4800**	500	ug/l	10	4G20003	07/20/04	07/21/04	NWTPH-Gx/8021B	
Benzene	**35.9**	5.00	"	"	"	"	"	"	
Toluene	**54.5**	5.00	"	"	"	"	"	"	
Ethylbenzene	**308**	5.00	"	"	"	"	"	"	
Xylenes (total)	**584**	10.0	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*107 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*96.2 %*	*68-140*			"	"	"	"	
02MW-04B (B4G0357-09) Water	**Sampled: 07/14/04 10:20**		**Received: 07/14/04 16:24**						
Gasoline Range Hydrocarbons	**4800**	250	ug/l	5	4G20003	07/20/04	07/20/04	NWTPH-Gx/8021B	
Benzene	**34.2**	2.50	"	"	"	"	"	"	
Toluene	**54.5**	2.50	"	"	"	"	"	"	
Ethylbenzene	**305**	2.50	"	"	"	"	"	"	
Xylenes (total)	**570**	5.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*124 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*99.2 %*	*68-140*			"	"	"	"	

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306
Project Manager: Bryan Graham

Reported:
07/27/04 13:09

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
2MW-06 (B4G0357-10) Water	**Sampled: 07/14/04 10:30**	**Received: 07/14/04 16:24**							
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G20003	07/20/04	07/20/04	NWTPH-Gx/8021B	
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*98.8 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*91.5 %*	*68-140*			"	"	"	"	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	07/27/04 13:09

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G20003: Prepared 07/20/04 Using EPA 5030B (P/T)										
Blank (4G20003-BLK1)										
Gasoline Range Hydrocarbons	ND	50.0	ug/l							
Benzene	ND	0.500	"							
Toluene	ND	0.500	"							
Ethylbenzene	ND	0.500	"							
Xylenes (total)	ND	1.00	"							
Surrogate: 4-BFB (FID)	*46.4*		"	*48.0*		*96.7*	*58-144*			
Surrogate: 4-BFB (PID)	*43.4*		"	*48.0*		*90.4*	*68-140*			
LCS (4G20003-BS1)										
Gasoline Range Hydrocarbons	515	50.0	ug/l	502		103	80-120			
Benzene	6.75	0.500	"	6.21		109	80-120			
Toluene	35.3	0.500	"	34.9		101	80-120			
Ethylbenzene	8.74	0.500	"	8.38		104	80-120			
Xylenes (total)	42.9	1.00	"	40.6		106	80-120			
Surrogate: 4-BFB (FID)	*50.5*		"	*48.0*		*105*	*58-144*			
Surrogate: 4-BFB (PID)	*42.8*		"	*48.0*		*89.2*	*68-140*			
LCS Dup (4G20003-BSD1)										
Gasoline Range Hydrocarbons	479	50.0	ug/l	502		95.4	80-120	7.24	25	
Benzene	6.55	0.500	"	6.21		105	80-120	3.01	25	
Toluene	34.2	0.500	"	34.9		98.0	80-120	3.17	25	
Ethylbenzene	8.40	0.500	"	8.38		100	80-120	3.97	25	
Xylenes (total)	40.8	1.00	"	40.6		100	80-120	5.02	25	
Surrogate: 4-BFB (FID)	*47.6*		"	*48.0*		*99.2*	*58-144*			
Surrogate: 4-BFB (PID)	*43.0*		"	*48.0*		*89.6*	*68-140*			
Matrix Spike (4G20003-MS1)					**Source: B4G0357-01**					
Gasoline Range Hydrocarbons	518	50.0	ug/l	502	44.6	94.3	58-129			
Benzene	7.28	0.500	"	6.21	ND	117	46-130			
Toluene	34.5	0.500	"	34.9	0.133	98.5	60-124			
Ethylbenzene	8.64	0.500	"	8.38	ND	103	56-141			
Xylenes (total)	41.9	1.00	"	40.6	ND	103	66-132			
Surrogate: 4-BFB (FID)	*50.8*		"	*48.0*		*106*	*58-144*			
Surrogate: 4-BFB (PID)	*43.4*		"	*48.0*		*90.4*	*68-140*			

North Creek Analytical - Bothell

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306
Project Manager: Bryan Graham

Reported:
07/27/04 13:09

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G20003: Prepared 07/20/04 Using EPA 5030B (P/T)										
Matrix Spike Dup (4G20003-MSD1)					**Source: B4G0357-01**					
Gasoline Range Hydrocarbons	494	50.0	ug/l	502	44.6	89.5	58-129	4.74	25	
Benzene	6.86	0.500	"	6.21	ND	110	46-130	5.94	40	
Toluene	32.9	0.500	"	34.9	0.133	93.9	60-124	4.75	40	
Ethylbenzene	8.08	0.500	"	8.38	ND	96.4	56-141	6.70	40	
Xylenes (total)	39.6	1.00	"	40.6	ND	97.5	66-132	5.64	40	
Surrogate: 4-BFB (FID)	*52.6*		"	*48.0*		*110*	*58-144*			
Surrogate: 4-BFB (PID)	*43.7*		"	*48.0*		*91.0*	*68-140*			

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	07/27/04 13:09

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G17007: Prepared 07/17/04 Using EPA 3510C										
Blank (4G17007-BLK1)										
Diesel Range Hydrocarbons	ND	0.250	mg/l							
Lube Oil Range Hydrocarbons	ND	0.500	"							
Surrogate: 2-FBP	*0.272*		"	*0.270*		*101*	*50-150*			
Surrogate: Octacosane	*0.179*		"	*0.195*		*91.8*	*50-150*			
LCS (4G17007-BS1)										
Diesel Range Hydrocarbons	1.47	0.250	mg/l	2.00		73.5	45-105			
Surrogate: 2-FBP	*0.266*		"	*0.270*		*98.5*	*50-150*			
LCS Dup (4G17007-BSD1)										
Diesel Range Hydrocarbons	1.62	0.250	mg/l	2.00		81.0	45-105	9.71	50	
Surrogate: 2-FBP	*0.264*		"	*0.270*		*97.8*	*50-150*			
Batch 4G23014: Prepared 07/23/04 Using EPA 3520C										
Blank (4G23014-BLK1)										
Diesel Range Hydrocarbons	ND	0.250	mg/l							
Lube Oil Range Hydrocarbons	ND	0.500	"							
Surrogate: 2-FBP	*0.203*		"	*0.270*		*75.2*	*50-150*			
Surrogate: Octacosane	*0.161*		"	*0.195*		*82.6*	*50-150*			
LCS (4G23014-BS1)										
Diesel Range Hydrocarbons	1.30	0.250	mg/l	2.00		65.0	45-105			
Surrogate: 2-FBP	*0.218*		"	*0.270*		*80.7*	*50-150*			
LCS Dup (4G23014-BSD1)										
Diesel Range Hydrocarbons	0.998	0.250	mg/l	2.00		49.9	45-105	26.3	50	
Surrogate: 2-FBP	*0.150*		"	*0.270*		*55.6*	*50-150*			

Notes and Definitions

G-02	The chromatogram for this sample does not resemble a typical gasoline pattern. Please refer to the sample chromatogram.
I-06	The analyte concentration may be artificially elevated due to coeluting compounds or components.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

nca

11720 North Creek Pkwy N Suite 400, Bothell, WA 98011-9508 425-420-9200 FAX 420-9210 ☐
11115 E Montgomery Suite B, Spokane, WA 99206-4776 509-924-9200 FAX 924-9290 ☐
9405 SW Nimbus Ave, Beaverton, OR 97008-7132 503-906-9200 FAX 906-9210 ☑
20332 Empire Ave Suite F-1, Bend, OR 99701-5711 541-383-9310 FAX 382-7588 ☐
3209 Denali St, Anchorage, AK 99503-4030 907-334-9200 FAX 334-9210 ☐

CHAIN OF CUSTODY REPORT

Work Order #: B4G0357

CLIENT: Time Oil Company
REPORT TO: Scott Sloan (cc BGraham@ttfwi)
ADDRESS: 2737 W Commodore Way
Seattle WA 98199
PHONE: 206 286 6457 FAX:

INVOICE TO: Same as left

P.O. NUMBER:

TURNAROUND REQUEST
in Business Days *

Organic & Inorganic Analyses
[✓ 10] STD. ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1

Petroleum Hydrocarbon Analyses
[✓ [illegible]] STD. ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1

☐ OTHER Specify:

** Turnaround Requests less than standard may incur Rush Charges.*

PROJECT NAME: Quarterly Groundwater Monitoring July04
PROJECT NUMBER: 2306
SAMPLED BY: E TOBEY & R. Weingarz

PRESERVATIVE / REQUESTED ANALYSES

CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	HCl NWTPH Gx/BTEX	HCl NWTPH Dx												MATRIX (W, S, O)	# OF CONT.	LOCATION / COMMENTS	NCA WO ID
1 01MW-07	07/14/04 0815	X	X												W	5	-	01
2 01MW-TB1	07/14/04 0800	X													W	3	-	02
3 02MW-02	07/14/04 0850	X	X												W	5	-	03
4 02MW-07	07/14/04 0910	X	X												W	5	-	04
5 02MW-01	07/14/04 0920	X	X												W	5	-	05
6 02MW-03	07/14/04 0935	X	X												W	5	-	06
7 02MW-05	07/14/04 0950	X	X												W	5	-	07
8 02MW-04A	07/14/04 1010	X	X												W	5	-	08
9 02MW-04B	07/14/04 1020	X	X												W	5	-	09
10 02MW-06	07/14/04 1030	X	X												W	5	-	10

RELEASED BY: Ellen Tobey
PRINT NAME: Ellen Tobey FIRM: TTFWI DATE: 7/14/04 TIME: 1624
RECEIVED BY: Cathy Gamble
PRINT NAME: Cathy Gamble FIRM: NCA DATE: 7/14/04 TIME: 1624

RELEASED BY: DATE:
PRINT NAME: FIRM: TIME:
RECEIVED BY: DATE:
PRINT NAME: FIRM: TIME:

ADDITIONAL REMARKS: Silica gel cleanup on diesel samples

TEMP:

PAGE 1 OF 1

COC REV 1/03

w/CS

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
425.420.9200 fax 425.420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588
Anchorage 2000 W. International Airport Road, Suite A10, Anchorage, AK 99502-1119
907.563.9200 fax 907.563.9210

02 August 2004

Bryan Graham
etra Tech FW, Inc. - Bothell
12100 NE 195th St
othell, WA/USA 98011
RE: Time Oil-West Commodore Way

nclosed are the results of analyses for samples received by the laboratory on 07/15/04 16:51. If you have any questions concerning this report, please feel free to contact me.

incerely,

mar Gill
Project Manager

North Creek Analytical, Inc.
Environmental Laboratory Network

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
425.420.9200 fax 425.420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588
Anchorage 2000 W. International Airport Road, Suite A10, Anchorage, AK 99502-1119
907.563.9200 fax 907.563.9210

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/02/04 13:31

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
01MW-TB2	B4G0407-01	Water	07/15/04 07:30	07/15/04 16:51
01MW-02	B4G0407-02	Water	07/15/04 07:50	07/15/04 16:51
01MW-03	B4G0407-03	Water	07/15/04 08:10	07/15/04 16:51
01MW-09	B4G0407-04	Water	07/15/04 08:35	07/15/04 16:51
01MW-08	B4G0407-05	Water	07/15/04 09:05	07/15/04 16:51
01MW-19	B4G0407-06	Water	07/15/04 09:25	07/15/04 16:51
01MW-18	B4G0407-07	Water	07/15/04 09:50	07/15/04 16:51
01MW-04	B4G0407-08	Water	07/15/04 10:10	07/15/04 16:51

North Creek Analytical - Bothell

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306.3312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/02/04 13:31

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-TB2 (B4G0407-01) Water Sampled: 07/15/04 07:30 Received: 07/15/04 16:51									
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G20005	07/21/04	07/21/04	NWTPH-Gx/8021B	
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*96.7 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*89.8 %*	*68-140*			"	"	"	"	
01MW-02 (B4G0407-02) Water Sampled: 07/15/04 07:50 Received: 07/15/04 16:51									
Gasoline Range Hydrocarbons	**9670**	2500	ug/l	50	4G20005	07/21/04	07/21/04	NWTPH-Gx/8021B	
Benzene	**3230**	25.0	"	"	"	"	"	"	
Toluene	**97.0**	25.0	"	"	"	"	"	"	
Ethylbenzene	**146**	25.0	"	"	"	"	"	"	
Xylenes (total)	**441**	50.0	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*100 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*92.3 %*	*68-140*			"	"	"	"	
01MW-03 (B4G0407-03) Water Sampled: 07/15/04 08:10 Received: 07/15/04 16:51									
Gasoline Range Hydrocarbons	**4500**	1000	ug/l	20	4G20005	07/21/04	07/21/04	NWTPH-Gx/8021B	
Benzene	**1130**	10.0	"	"	"	"	"	"	
Toluene	**60.8**	10.0	"	"	"	"	"	"	
Ethylbenzene	**41.4**	10.0	"	"	"	"	"	"	
Xylenes (total)	**82.5**	20.0	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*102 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*91.2 %*	*68-140*			"	"	"	"	

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/02/04 13:31

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
1MW-09 (B4G0407-04) Water Sampled: 07/15/04 08:35 Received: 07/15/04 16:51									
Gasoline Range Hydrocarbons	**7730**	2500	ug/l	50	4G20005	07/21/04	07/21/04	NWTPH-Gx/8021B	
Benzene	**1050**	25.0	"	"	"	"	"	"	
oluene	**48.0**	25.0	"	"	"	"	"	"	
Ethylbenzene	**232**	25.0	"	"	"	"	"	"	
Xylenes (total)	**942**	50.0	"	"	"	"	"	"	
rrogate: 4-BFB (FID)	*97.9 %*	*58-144*			"	"	"	"	
urrogate: 4-BFB (PID)	*91.7 %*	*68-140*			"	"	"	"	
01MW-08 (B4G0407-05) Water Sampled: 07/15/04 09:05 Received: 07/15/04 16:51									
asoline Range Hydrocarbons	ND	50.0	ug/l	1	4G20005	07/21/04	07/21/04	NWTPH-Gx/8021B	
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
thylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*93.3 %*	*58-144*			"	"	"	"	
rrogate: 4-BFB (PID)	*90.6 %*	*68-140*			"	"	"	"	
01MW-19 (B4G0407-06) Water Sampled: 07/15/04 09:25 Received: 07/15/04 16:51									
Gasoline Range Hydrocarbons	**19900**	5000	ug/l	100	4G20005	07/21/04	07/21/04	NWTPH-Gx/8021B	
enzene	**2610**	50.0	"	"	"	"	"	"	
Toluene	**945**	50.0	"	"	"	"	"	"	
Ethylbenzene	**522**	50.0	"	"	"	"	"	"	
ylenes (total)	**3190**	100	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*99.6 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*92.7 %*	*68-140*			"	"	"	"	

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mar Gill, Project Manager

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-18 (B4G0407-07) Water Sampled: 07/15/04 09:50 Received: 07/15/04 16:51									
Gasoline Range Hydrocarbons	**10700**	2500	ug/l	50	4G20005	07/21/04	07/21/04	NWTPH-Gx/8021B	
Benzene	**1570**	25.0	"	"	"	"	"	"	
Toluene	**124**	25.0	"	"	"	"	"	"	
Ethylbenzene	**283**	25.0	"	"	"	"	"	"	
Xylenes (total)	**1360**	50.0	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*102 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*92.9 %*	*68-140*			"	"	"	"	
01MW-04 (B4G0407-08) Water Sampled: 07/15/04 10:10 Received: 07/15/04 16:51									
Gasoline Range Hydrocarbons	**9820**	5000	ug/l	100	4G20005	07/21/04	07/21/04	NWTPH-Gx/8021B	
Benzene	**2380**	50.0	"	"	"	"	"	"	
Toluene	**570**	50.0	"	"	"	"	"	"	
Ethylbenzene	**236**	50.0	"	"	"	"	"	"	
Xylenes (total)	**828**	100	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*96.0 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*90.6 %*	*68-140*			"	"	"	"	

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/02/04 13:31

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-02 (B4G0407-02) Water	**Sampled: 07/15/04 07:50**	**Received: 07/15/04 16:51**							
Diesel Range Hydrocarbons	ND	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*111 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*95.3 %*	*50-150*			"	"	"	"	
01MW-03 (B4G0407-03) Water	**Sampled: 07/15/04 08:10**	**Received: 07/15/04 16:51**							
Diesel Range Hydrocarbons	**1.23**	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	D-08
Lube Oil Range Hydrocarbons	**0.938**	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*105 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*93.5 %*	*50-150*			"	"	"	"	
01MW-09 (B4G0407-04) Water	**Sampled: 07/15/04 08:35**	**Received: 07/15/04 16:51**							
Diesel Range Hydrocarbons	**19.2**	2.50	mg/l	10	4G20014	07/20/04	07/22/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	1	"	"	07/21/04	"	
Surrogate: 2-FBP	*98.1 %*	*50-150*			"	"	*07/22/04*	"	
Surrogate: Octacosane	*106 %*	*50-150*			"	"	*07/21/04*	"	
01MW-08 (B4G0407-05) Water	**Sampled: 07/15/04 09:05**	**Received: 07/15/04 16:51**							
Diesel Range Hydrocarbons	ND	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*108 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*98.9 %*	*50-150*			"	"	"	"	
01MW-19 (B4G0407-06) Water	**Sampled: 07/15/04 09:25**	**Received: 07/15/04 16:51**							
Diesel Range Hydrocarbons	**0.708**	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	D-08
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*110 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*96.2 %*	*50-150*			"	"	"	"	

North Creek Analytical - Bothell

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306.3312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/02/04 13:31

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-18 (B4G0407-07) Water Sampled: 07/15/04 09:50 Received: 07/15/04 16:51									
Diesel Range Hydrocarbons	**0.676**	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	D-08
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*114 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*104 %*	*50-150*			"	"	"	"	
01MW-04 (B4G0407-08) Water Sampled: 07/15/04 10:10 Received: 07/15/04 16:51									
Diesel Range Hydrocarbons	**0.333**	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	D-08
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*114 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*95.2 %*	*50-150*			"	"	"	"	

Amar Gill, Project Manager

Pentachlorophenol by GC/MS with Selected Ion Monitoring
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
1MW-09 (B4G0407-04) Water	**Sampled: 07/15/04 08:35**	**Received: 07/15/04 16:51**							
Pentachlorophenol	ND	0.500	ug/l	1	4G22015	07/22/04	07/30/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*78.2 %*	*22-162*			"	"	"	"	
1MW-19 (B4G0407-06) Water	**Sampled: 07/15/04 09:25**	**Received: 07/15/04 16:51**							
Pentachlorophenol	**1.32**	0.500	ug/l	1	4G22015	07/22/04	07/30/04	EPA 8270 Mod	
urrogate: 2,4,6-TBP	*91.6 %*	*22-162*			"	"	"	"	
1MW-18 (B4G0407-07) Water	**Sampled: 07/15/04 09:50**	**Received: 07/15/04 16:51**							
Pentachlorophenol	ND	0.500	ug/l	1	4G22015	07/22/04	07/30/04	EPA 8270 Mod	
urrogate: 2,4,6-TBP	*87.6 %*	*22-162*			"	"	"	"	

North Creek Analytical - Bothell

mar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306.3312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/02/04 13:31

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G20005: Prepared 07/21/04 Using EPA 5030B (P/T)										
Blank (4G20005-BLK1)										
Gasoline Range Hydrocarbons	ND	50.0	ug/l							
Benzene	ND	0.500	"							
Toluene	ND	0.500	"							
Ethylbenzene	ND	0.500	"							
Xylenes (total)	ND	1.00	"							
Surrogate: 4-BFB (FID)	*46.6*		"	*48.0*		*97.1*	*58-144*			
Surrogate: 4-BFB (PID)	*42.8*		"	*48.0*		*89.2*	*68-140*			
LCS (4G20005-BS1)										
Gasoline Range Hydrocarbons	464	50.0	ug/l	502		92.4	80-120			
Benzene	5.97	0.500	"	6.21		96.1	80-120			
Toluene	31.2	0.500	"	34.9		89.4	80-120			
Ethylbenzene	7.71	0.500	"	8.38		92.0	80-120			
Xylenes (total)	37.9	1.00	"	40.6		93.3	80-120			
Surrogate: 4-BFB (FID)	*51.5*		"	*48.0*		*107*	*58-144*			
Surrogate: 4-BFB (PID)	*43.5*		"	*48.0*		*90.6*	*68-140*			
LCS Dup (4G20005-BSD1)										
Gasoline Range Hydrocarbons	495	50.0	ug/l	502		98.6	80-120	6.47	25	
Benzene	6.51	0.500	"	6.21		105	80-120	8.65	25	
Toluene	34.0	0.500	"	34.9		97.4	80-120	8.59	25	
Ethylbenzene	8.41	0.500	"	8.38		100	80-120	8.68	25	
Xylenes (total)	41.1	1.00	"	40.6		101	80-120	8.10	25	
Surrogate: 4-BFB (FID)	*52.7*		"	*48.0*		*110*	*58-144*			
Surrogate: 4-BFB (PID)	*43.2*		"	*48.0*		*90.0*	*68-140*			
Matrix Spike (4G20005-MS1)					**Source: B4G0374-08**					
Gasoline Range Hydrocarbons	515	50.0	ug/l	502	27.1	97.2	58-129			
Benzene	6.53	0.500	"	6.21	ND	105	46-130			
Toluene	33.9	0.500	"	34.9	ND	97.1	60-124			
Ethylbenzene	8.34	0.500	"	8.38	ND	99.5	56-141			
Xylenes (total)	41.0	1.00	"	40.6	ND	101	66-132			
Surrogate: 4-BFB (FID)	*52.7*		"	*48.0*		*110*	*58-144*			
Surrogate: 4-BFB (PID)	*43.8*		"	*48.0*		*91.2*	*68-140*			

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/02/04 13:31

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G20005: Prepared 07/21/04 Using EPA 5030B (P/T)										
Matrix Spike Dup (4G20005-MSD1)					**Source: B4G0374-08**					
Gasoline Range Hydrocarbons	488	50.0	ug/l	502	27.1	91.8	58-129	5.38	25	
Benzene	6.69	0.500	"	6.21	ND	108	46-130	2.42	40	
Toluene	35.0	0.500	"	34.9	ND	100	60-124	3.19	40	
Ethylbenzene	8.56	0.500	"	8.38	ND	102	56-141	2.60	40	
Xylenes (total)	42.1	1.00	"	40.6	ND	104	66-132	2.65	40	
Surrogate: 4-BFB (FID)	*49.0*		"	*48.0*		*102*	*58-144*			
Surrogate: 4-BFB (PID)	*43.7*		"	*48.0*		*91.0*	*68-140*			

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/02/04 13:31

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G20014: Prepared 07/20/04 Using EPA 3520C										
Blank (4G20014-BLK1)										
Diesel Range Hydrocarbons	ND	0.250	mg/l							
Lube Oil Range Hydrocarbons	ND	0.500	"							
Surrogate: 2-FBP	*0.226*		"	*0.270*		*83.7*	*50-150*			
Surrogate: Octacosane	*0.187*		"	*0.195*		*95.9*	*50-150*			
LCS (4G20014-BS1)										
Diesel Range Hydrocarbons	1.26	0.250	mg/l	2.00		63.0	45-105			
Surrogate: 2-FBP	*0.181*		"	*0.270*		*67.0*	*50-150*			
LCS Dup (4G20014-BSD1)										
Diesel Range Hydrocarbons	1.64	0.250	mg/l	2.00		82.0	45-105	26.2	50	
Surrogate: 2-FBP	*0.308*		"	*0.270*		*114*	*50-150*			

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/02/04 13:31

Pentachlorophenol by GC/MS with Selected Ion Monitoring - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G22015: Prepared 07/22/04 Using EPA 3520C										
Blank (4G22015-BLK1)										
Pentachlorophenol	ND	0.500	ug/l							
Surrogate: 2,4,6-TBP	*37.0*		"	*50.0*		*74.0*	*22-162*			
LCS (4G22015-BS1)										
Pentachlorophenol	9.48	0.500	ug/l	20.0		47.4	20-128			
Surrogate: 2,4,6-TBP	*37.9*		"	*50.0*		*75.8*	*22-162*			
LCS Dup (4G22015-BSD1)										
Pentachlorophenol	14.0	0.500	ug/l	20.0		70.0	20-128	38.5	50	
Surrogate: 2,4,6-TBP	*42.4*		"	*50.0*		*84.8*	*22-162*			

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306.3312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/02/04 13:31

Notes and Definitions

D-08	Results in the diesel organics range are primarily due to overlap from a gasoline range product.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Amar Gill, Project Manager

nca

11720 North Creek Pkwy N Suite 400, Bothell, WA 98011-9508 425-420-9200 FAX 420-9210 ☑
11115 E Montgomery Suite B, Spokane, WA 99206-4776 509-924-9200 FAX 924-9290 ☐
9405 SW Nimbus Ave, Beaverton, OR 97008-7132 503-906-9200 FAX 906-9210 ☐
20332 Empire Ave Suite F-1, Bend, OR 97701-5711 541-383-9310 FAX 382-7588 ☐
3209 Denali St, Anchorage, AK 99503-4030 907-334-9200 FAX 334-9210 ☐

CHAIN OF CUSTODY REPORT

Work Order #: B4G0407

CLIENT: Time Oil Company
REPORT TO: Scott Sloan Ccc B Graham @TTFWI
ADDRESS: 2737 W. Commodore Way
Seattle WA 98199
PHONE: 206 2866457 FAX:

INVOICE TO: Same as left
P.O. NUMBER:

PROJECT NAME: Quarterly Groundwater Monitoring July 04
PROJECT NUMBER: 2306.3312.0012.0004
SAMPLED BY: E Tobey R WEINGARZ

TURNAROUND REQUEST
in Business Days *

Organic & Inorganic Analyses
☑ 10 STD. ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1

Petroleum Hydrocarbon Analyses
☑ 5 STD. ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1

☐ OTHER Specify:

** Turnaround Requests less than standard may incur Rush Charges.*

		PRESERVATIVE															
		HCl	HCl	—													
		REQUESTED ANALYSES															
CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	NWTPH Gx/BTEX	NWTPH Dx	PCP EPA 8270SIM										MATRIX (W, S, O)	# OF CONT.	LOCATION / COMMENTS	NCA WO ID
1 01MW-TB2	7/15/04 0730	X												W	1	–	01
2 01MW-02	7/15/04 0750	X	X											W	5	–	02
3 01MW-03	7/15/04 0810	X	X											W	5	–	03
4 01MW-09	7/15/04 0835	X	X	X										W	7	–	04
5 01MW-08	7/15/04 0905	X	X											W	5	–	05
6 01MW-19	7/15/04 0925	X	X	X										W	7	–	06
7 01MW-18	7/15/04 0950	X	X	X										W	7	–	07
8 01MW-04	7/15/04 1010	X	X											W	5	–	08
9																	
10																	

RELEASED BY: Ellen Tobey
PRINT NAME: Ellen Tobey FIRM: TTFWI DATE: 7/15/04 TIME: 1651
RECEIVED BY: Tom Blankinship
PRINT NAME: Blankinship FIRM: NCA DATE: 7/15/04 TIME: 1651

RELEASED BY:
PRINT NAME: FIRM: DATE: TIME:
RECEIVED BY:
PRINT NAME: FIRM: DATE: TIME:

ADDITIONAL REMARKS: Silica Gel Clean up on Diesel Samples 3coolers

TEMP: 3.2°c w/cs

PAGE 1 OF 1

COC REV 1/03

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Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
425.420.9200 fax 425.420.9210
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509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588
Anchorage 2000 W. International Airport Road, Suite A10, Anchorage, AK 99502-1119
907.563.9200 fax 907.563.9210

03 August 2004

Bryan Graham
Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011
RE: Time Oil-West Commodore Way

Enclosed are the results of analyses for samples received by the laboratory on 07/16/04 15:20. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Amar Gill
Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/03/04 09:42

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
01MW-TB03	B4G0420-01	Water	07/16/04 07:40	07/16/04 15:20
01MW-11	B4G0420-02	Water	07/16/04 07:50	07/16/04 15:20
01MW-06	B4G0420-03	Water	07/16/04 08:15	07/16/04 15:20
01MW-26	B4G0420-04	Water	07/16/04 08:45	07/16/04 15:20
01MW-27	B4G0420-05	Water	07/16/04 09:10	07/16/04 15:20
01MW-01	B4G0420-06	Water	07/16/04 09:40	07/16/04 15:20
01MW-15	B4G0420-07	Water	07/16/04 10:05	07/16/04 15:20
01MW-20	B4G0420-08	Water	07/16/04 10:40	07/16/04 15:20

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/03/04 09:42

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-TB03 (B4G0420-01) Water Sampled: 07/16/04 07:40 Received: 07/16/04 15:20									
Benzene	ND	0.500	ug/l	1	4G21008	07/21/04	07/22/04	NWTPH-Gx/8021B	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (PID)	*100 %*	*68-140*			"	"	"	"	
01MW-TB03 (B4G0420-01RE1) Water Sampled: 07/16/04 07:40 Received: 07/16/04 15:20									
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G22070	07/22/04	07/23/04	NWTPH-Gx/8021B	
Surrogate: 4-BFB (FID)	*86.5 %*	*58-144*			"	"	"	"	
01MW-11 (B4G0420-02) Water Sampled: 07/16/04 07:50 Received: 07/16/04 15:20									
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G21008	07/21/04	07/21/04	NWTPH-Gx/8021B	
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*107 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*101 %*	*68-140*			"	"	"	"	
01MW-06 (B4G0420-03) Water Sampled: 07/16/04 08:15 Received: 07/16/04 15:20									
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G21008	07/21/04	07/21/04	NWTPH-Gx/8021B	
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*97.3 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*102 %*	*68-140*			"	"	"	"	

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/03/04 09:42

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
1MW-26 (B4G0420-04) Water Sampled: 07/16/04 08:45 Received: 07/16/04 15:20									
Gasoline Range Hydrocarbons	**137**	50.0	ug/l	1	4G21008	07/21/04	07/21/04	NWTPH-Gx/8021B	
Benzene	**9.69**	0.500	"	"	"	"	"	"	
oluene	**0.706**	0.500	"	"	"	"	"	"	
thylbenzene	**3.56**	0.500	"	"	"	"	"	"	
Xylenes (total)	**4.92**	1.00	"	"	"	"	"	"	
urrogate: 4-BFB (FID)	*97.3 %*	*58-144*			"	"	"	"	
urrogate: 4-BFB (PID)	*95.0 %*	*68-140*			"	"	"	"	
01MW-27 (B4G0420-05) Water Sampled: 07/16/04 09:10 Received: 07/16/04 15:20									
asoline Range Hydrocarbons	**10900**	500	ug/l	10	4G21008	07/21/04	07/21/04	NWTPH-Gx/8021B	
Benzene	**6220**	50.0	"	100	"	"	07/22/04	"	
Toluene	**43.9**	5.00	"	10	"	"	07/21/04	"	
thylbenzene	**70.4**	5.00	"	"	"	"	"	"	
ylenes (total)	**50.0**	10.0	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*96.9 %*	*58-144*			"	"	"	"	
urrogate: 4-BFB (PID)	*100 %*	*68-140*			"	"	"	"	
01MW-01 (B4G0420-06) Water Sampled: 07/16/04 09:40 Received: 07/16/04 15:20									
Benzene	**3.66**	0.500	ug/l	1	4G21008	07/21/04	07/22/04	NWTPH-Gx/8021B	
oluene	**0.766**	0.500	"	"	"	"	"	"	
thylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	**1.80**	1.00	"	"	"	"	"	"	
urrogate: 4-BFB (PID)	*98.8 %*	*68-140*			"	"	"	"	
01MW-01 (B4G0420-06RE1) Water Sampled: 07/16/04 09:40 Received: 07/16/04 15:20									
Gasoline Range Hydrocarbons	**55.9**	50.0	ug/l	1	4G22070	07/22/04	07/23/04	NWTPH-Gx/8021B	
urrogate: 4-BFB (FID)	*80.2 %*	*58-144*			"	"	"	"	

mar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/03/04 09:42

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-15 (B4G0420-07) Water Sampled: 07/16/04 10:05 Received: 07/16/04 15:20									
Benzene	ND	0.500	ug/l	1	4G21008	07/21/04	07/22/04	NWTPH-Gx/8021B	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (PID)	*102 %*	*68-140*			"	"	"	"	
01MW-15 (B4G0420-07RE1) Water Sampled: 07/16/04 10:05 Received: 07/16/04 15:20									
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G22070	07/22/04	07/23/04	NWTPH-Gx/8021B	
Surrogate: 4-BFB (FID)	*80.4 %*	*58-144*			"	"	"	"	
01MW-20 (B4G0420-08) Water Sampled: 07/16/04 10:40 Received: 07/16/04 15:20									
Benzene	**13.2**	0.500	ug/l	1	4G21008	07/21/04	07/22/04	NWTPH-Gx/8021B	
Toluene	**3.86**	0.500	"	"	"	"	"	"	
Ethylbenzene	**21.9**	0.500	"	"	"	"	"	"	
Xylenes (total)	**29.5**	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (PID)	*107 %*	*68-140*			"	"	"	"	
01MW-20 (B4G0420-08RE1) Water Sampled: 07/16/04 10:40 Received: 07/16/04 15:20									
Gasoline Range Hydrocarbons	**573**	50.0	ug/l	1	4G22070	07/22/04	07/23/04	NWTPH-Gx/8021B	
Surrogate: 4-BFB (FID)	*110 %*	*58-144*			"	"	"	"	

North Creek Analytical - Bothell

Amar Gill, Project Manager

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/03/04 09:42

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
1MW-11 (B4G0420-02) Water Sampled: 07/16/04 07:50 Received: 07/16/04 15:20									
Diesel Range Hydrocarbons	ND	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
urrogate: 2-FBP	*107 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*101 %*	*50-150*			"	"	"	"	
1MW-06 (B4G0420-03) Water Sampled: 07/16/04 08:15 Received: 07/16/04 15:20									
iesel Range Hydrocarbons	ND	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
urrogate: 2-FBP	*96.5 %*	*50-150*			"	"	"	"	
urrogate: Octacosane	*84.0 %*	*50-150*			"	"	"	"	
01MW-26 (B4G0420-04) Water Sampled: 07/16/04 08:45 Received: 07/16/04 15:20									
iesel Range Hydrocarbons	ND	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	
ube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*100 %*	*50-150*			"	"	"	"	
urrogate: Octacosane	*97.9 %*	*50-150*			"	"	"	"	
1MW-27 (B4G0420-05) Water Sampled: 07/16/04 09:10 Received: 07/16/04 15:20									
Diesel Range Hydrocarbons	ND	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	
ube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
urrogate: 2-FBP	*100 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*83.3 %*	*50-150*			"	"	"	"	
1MW-01 (B4G0420-06) Water Sampled: 07/16/04 09:40 Received: 07/16/04 15:20									
iesel Range Hydrocarbons	ND	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
urrogate: 2-FBP	*93.2 %*	*50-150*			"	"	"	"	
urrogate: Octacosane	*87.4 %*	*50-150*			"	"	"	"	

North Creek Analytical - Bothell

mar Gill, Project Manager

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Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/03/04 09:42

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-15 (B4G0420-07) Water Sampled: 07/16/04 10:05 Received: 07/16/04 15:20									
Diesel Range Hydrocarbons	ND	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*83.7 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*76.3 %*	*50-150*			"	"	"	"	
01MW-20 (B4G0420-08) Water Sampled: 07/16/04 10:40 Received: 07/16/04 15:20									
Diesel Range Hydrocarbons	ND	0.250	mg/l	1	4G20014	07/20/04	07/21/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*93.8 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*88.7 %*	*50-150*			"	"	"	"	

Tetra Tech FW, Inc. - Bothell 12100 NE 195th St Bothell, WA/USA 98011	Project: Time Oil-West Commodore Way Project Number: 2306.3312.0012.0004 Project Manager: Bryan Graham	**Reported:** 08/03/04 09:42

Pentachlorophenol by GC/MS with Selected Ion Monitoring

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
1MW-06 (B4G0420-03) Water	**Sampled: 07/16/04 08:15**	**Received: 07/16/04 15:20**							
Pentachlorophenol	ND	0.500	ug/l	1	4G22015	07/22/04	07/30/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*91.1 %*	*22-162*			"	"	"	"	
1MW-26 (B4G0420-04) Water	**Sampled: 07/16/04 08:45**	**Received: 07/16/04 15:20**							
Pentachlorophenol	**40.5**	0.500	ug/l	1	4G22015	07/22/04	07/30/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*94.0 %*	*22-162*			"	"	"	"	
1MW-27 (B4G0420-05) Water	**Sampled: 07/16/04 09:10**	**Received: 07/16/04 15:20**							
Pentachlorophenol	**50.7**	0.500	ug/l	1	4G22015	07/22/04	07/30/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*95.8 %*	*22-162*			"	"	"	"	
01MW-01 (B4G0420-06) Water	**Sampled: 07/16/04 09:40**	**Received: 07/16/04 15:20**							
Pentachlorophenol	**8.94**	0.500	ug/l	1	4G22015	07/22/04	07/30/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*93.2 %*	*22-162*			"	"	"	"	
01MW-15 (B4G0420-07) Water	**Sampled: 07/16/04 10:05**	**Received: 07/16/04 15:20**							
Pentachlorophenol	ND	0.500	ug/l	1	4G22015	07/22/04	07/30/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*85.5 %*	*22-162*			"	"	"	"	
01MW-20 (B4G0420-08) Water	**Sampled: 07/16/04 10:40**	**Received: 07/16/04 15:20**							
Pentachlorophenol	ND	0.500	ug/l	1	4G22015	07/22/04	07/30/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*81.5 %*	*22-162*			"	"	"	"	

North Creek Analytical - Bothell

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306.3312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/03/04 09:42

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G21008: Prepared 07/21/04 Using EPA 5030B (P/T)										
Blank (4G21008-BLK1)										
Gasoline Range Hydrocarbons	ND	50.0	ug/l							
Benzene	ND	0.500	"							
Toluene	ND	0.500	"							
Ethylbenzene	ND	0.500	"							
Xylenes (total)	ND	1.00	"							
Surrogate: 4-BFB (FID)	*42.7*		"	*48.0*		*89.0*	*58-144*			
Surrogate: 4-BFB (PID)	*48.7*		"	*48.0*		*101*	*68-140*			
LCS (4G21008-BS1)										
Gasoline Range Hydrocarbons	490	50.0	ug/l	500		98.0	80-120			
Benzene	6.17	0.500	"	6.20		99.5	80-120			
Toluene	32.9	0.500	"	34.8		94.5	80-120			
Ethylbenzene	8.08	0.500	"	8.35		96.8	80-120			
Xylenes (total)	39.3	1.00	"	40.5		97.0	80-120			
Surrogate: 4-BFB (FID)	*52.4*		"	*48.0*		*109*	*58-144*			
Surrogate: 4-BFB (PID)	*48.5*		"	*48.0*		*101*	*68-140*			
LCS Dup (4G21008-BSD1)										
Gasoline Range Hydrocarbons	507	50.0	ug/l	500		101	80-120	3.41	25	
Benzene	6.19	0.500	"	6.20		99.8	80-120	0.324	25	
Toluene	32.7	0.500	"	34.8		94.0	80-120	0.610	25	
Ethylbenzene	8.20	0.500	"	8.35		98.2	80-120	1.47	25	
Xylenes (total)	40.0	1.00	"	40.5		98.8	80-120	1.77	25	
Surrogate: 4-BFB (FID)	*54.7*		"	*48.0*		*114*	*58-144*			
Surrogate: 4-BFB (PID)	*47.8*		"	*[illegible].0*		*99.6*	*68-140*			
Matrix Spike (4G21008-MS1)					**Source: B4G0428-01**					
Gasoline Range Hydrocarbons	513	50.0	ug/l	500	19.7	98.7	58-129			
Benzene	5.25	0.500	"	6.20	ND	84.7	46-130			
Toluene	28.9	0.500	"	34.8	0.111	82.7	60-124			
Ethylbenzene	6.93	0.500	"	8.35	ND	83.0	56-141			
Xylenes (total)	33.3	1.00	"	40.5	ND	82.2	66-132			
Surrogate: 4-BFB (FID)	*47.2*		"	*48.0*		*98.3*	*58-144*			
Surrogate: 4-BFB (PID)	*35.2*		"	*48.0*		*73.3*	*68-140*			

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/03/04 09:42

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G21008: Prepared 07/21/04 Using EPA 5030B (P/T)										
Matrix Spike Dup (4G21008-MSD1)					**Source: B4G0428-01**					
Gasoline Range Hydrocarbons	469	50.0	ug/l	500	19.7	89.9	58-129	8.96	25	
Benzene	5.22	0.500	"	6.20	ND	84.2	46-130	0.573	40	
Toluene	29.3	0.500	"	34.8	0.111	83.9	60-124	1.37	40	
Ethylbenzene	6.81	0.500	"	8.35	ND	81.6	56-141	1.75	40	
Xylenes (total)	33.2	1.00	"	40.5	ND	82.0	66-132	0.301	40	
Surrogate: 4-BFB (FID)	*44.6*		"	*48.0*		*92.9*	*58-144*			
Surrogate: 4-BFB (PID)	*35.3*		"	*48.0*		*73.5*	*68-140*			
Batch 4G22070: Prepared 07/22/04 Using EPA 5030B (P/T)										
Blank (4G22070-BLK1)										
Gasoline Range Hydrocarbons	ND	50.0	ug/l							
Benzene	ND	0.500	"							
Toluene	ND	0.500	"							
Ethylbenzene	ND	0.500	"							
Xylenes (total)	ND	1.00	"							
Surrogate: 4-BFB (FID)	*37.3*		"	*48.0*		*77.7*	*58-144*			
Surrogate: 4-BFB (PID)	*39.3*		"	*48.0*		*81.9*	*68-140*			
LCS (4G22070-BS1)										
Gasoline Range Hydrocarbons	588	50.0	ug/l	502		117	80-120			
Benzene	5.31	0.500	"	6.21		85.5	80-120			
Toluene	29.1	0.500	"	34.9		83.4	80-120			
Ethylbenzene	6.92	0.500	"	8.38		82.6	80-120			
Xylenes (total)	33.7	1.00	"	40.6		83.0	80-120			
Surrogate: 4-BFB (FID)	*47.7*		"	*48.0*		*99.4*	*58-144*			
Surrogate: 4-BFB (PID)	*34.1*		"	*48.0*		*71.0*	*68-140*			

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306.3312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/03/04 09:42

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B - Quality Control

North Creek Analytical - Bothell

Batch 4G22070: Prepared 07/22/04 Using EPA 5030B (P/T)

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
LCS Dup (4G22070-BSD1)										
Gasoline Range Hydrocarbons	563	50.0	ug/l	502		112	80-120	4.34	25	
Benzene	5.52	0.500	"	6.21		88.9	80-120	3.88	25	
Toluene	30.5	0.500	"	34.9		87.4	80-120	4.70	25	
Ethylbenzene	7.25	0.500	"	8.38		86.5	80-120	4.66	25	
Xylenes (total)	35.1	1.00	"	40.6		86.5	80-120	4.07	25	
Surrogate: 4-BFB (FID)	*44.5*		"	*48.0*		*92.7*	*58-144*			
Surrogate: 4-BFB (PID)	*34.4*		"	*48.0*		*71.7*	*68-140*			
Matrix Spike (4G22070-MS1)					**Source: B4G0433-13**					
Gasoline Range Hydrocarbons	464	50.0	ug/l	502	17.0	89.0	58-129			
Benzene	5.56	0.500	"	6.21	ND	89.5	46-130			
Toluene	31.0	0.500	"	34.9	0.536	87.3	60-124			
Ethylbenzene	7.23	0.500	"	8.38	ND	86.3	56-141			
Xylenes (total)	35.3	1.00	"	40.6	ND	86.9	66-132			
Surrogate: 4-BFB (FID)	*39.0*		"	*48.0*		*81.2*	*58-144*			
Surrogate: 4-BFB (PID)	*34.5*		"	*48.0*		*71.9*	*68-140*			
Matrix Spike Dup (4G22070-MSD1)					**Source: B4G0433-13**					
Gasoline Range Hydrocarbons	485	50.0	ug/l	502	17.0	93.2	58-129	4.43	25	
Benzene	5.20	0.500	"	6.21	ND	83.7	46-130	6.69	40	
Toluene	29.2	0.500	"	34.9	0.536	82.1	60-124	5.98	40	
Ethylbenzene	6.80	0.500	"	8.38	ND	81.1	56-141	6.13	40	
Xylenes (total)	33.2	1.00	"	40.6	ND	81.8	66-132	6.13	40	
Surrogate: 4-BFB (FID)	*49.0*		"	*48.0*		*102*	*58-144*			
Surrogate: 4-BFB (PID)	*36.0*		"	*48.0*		*75.0*	*68-140*			

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/03/04 09:42

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G20014: Prepared 07/20/04 Using EPA 3520C										
Blank (4G20014-BLK1)										
Diesel Range Hydrocarbons	ND	0.250	mg/l							
ube Oil Range Hydrocarbons	ND	0.500	"							
Surrogate: 2-FBP	*0.226*		"	*0.270*		*83.7*	*50-150*			
Surrogate: Octacosane	*0.187*		"	*0.195*		*95.9*	*50-150*			
CS (4G20014-BS1)										
Diesel Range Hydrocarbons	1.26	0.250	mg/l	2.00		63.0	45-105			
Surrogate: 2-FBP	*0.181*		"	*0.270*		*67.0*	*50-150*			
CS Dup (4G20014-BSD1)										
Diesel Range Hydrocarbons	1.64	0.250	mg/l	2.00		82.0	45-105	26.2	50	
urrogate: 2-FBP	*0.308*		"	*0.270*		*114*	*50-150*			

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306.3312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/03/04 09:42

Pentachlorophenol by GC/MS with Selected Ion Monitoring - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G22015: Prepared 07/22/04 Using EPA 3520C										
Blank (4G22015-BLK1)										
Pentachlorophenol	ND	0.500	ug/l							
Surrogate: 2,4,6-TBP	*37.0*		"	*50.0*		*74.0*	*22-162*			
LCS (4G22015-BS1)										
Pentachlorophenol	9.48	0.500	ug/l	20.0		47.4	20-128			
Surrogate: 2,4,6-TBP	*37.9*		"	*50.0*		*75.8*	*22-162*			
LCS Dup (4G22015-BSD1)										
Pentachlorophenol	14.0	0.500	ug/l	20.0		70.0	20-128	38.5	50	
Surrogate: 2,4,6-TBP	*42.4*		"	*50.0*		*84.8*	*22-162*			

Amar Gill, Project Manager

Notes and Definitions

DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

Amar Gill, Project Manager

nca

11720 North Creek Pkwy N Suite 400, Bothell, WA 98011-9508	425-420-9200	FAX 420-9210	☑
11115 E Montgomery Suite B, Spokane, WA 99206-4776	509-924-9200	FAX 924-9290	☐
9405 SW Nimbus Ave, Beaverton, OR 97008-7132	503-906-9200	FAX 906-9210	☐
20332 Empire Ave Suite F-1, Bend, OR 99701-5711	541-383-9310	FAX 382-7588	☐
3209 Denali St, Anchorage, AK 99503-4030	907-334-9200	FAX 334-9210	☐

CHAIN OF CUSTODY REPORT

Work Order #: B4G0420

CLIENT: Time Oil Company

REPORT TO: Scott Sloan (cc B Graham @ TTFWI)

ADDRESS: 2737 W. Commodore Way
Seattle WA 98199

PHONE: 206 286 6457 FAX:

INVOICE TO: Same as Left

P.O. NUMBER:

PROJECT NAME: Quarterly Groundwater Monitoring July 04

PROJECT NUMBER: 2306.3317.0012.0004

SAMPLED BY: E Tobey RWEINGARZ

TURNAROUND REQUEST

in Business Days *

Organic & Inorganic Analyses

☑ 10 STD. ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1

Petroleum Hydrocarbon Analyses

☑ 5 STD. ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1

☐ OTHER Specify:

** Turnaround Requests less than standard may incur Rush Charges.*

	CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	NWTPH Gx/BTEX	NWTPH Dx	RCP EPA8270 SIM	MATRIX (W, S, O)	# OF CONT.	LOCATION / COMMENTS	NCA WO ID
	PRESERVATIVE		HCl	HCl	-				
1	01MW-TB03	7/16/04 0740	X			W	1	-	01
2	01MW-11	7/16/04 0750	X	X		W	5	-	02
3	~~01MW-06~~	7/16/04 0815	X	X	X	W	7	-	03
4	01MW-26	7/16/04 0845	X	X	X	W	7	-	04
5	01MW-27	7/16/04 0910	X	X	X	W	7	-	05
6	01MW-01	7/16/04 0940	X	X	X	W	7	-	06
7	01MW-15	7/16/04 1005	X	X	X	W	7	-	07
8	01MW-20	7/16/04 1040	X	X	X	W	7	-	08
9									
10									

Samples were not @2-6o upon receipt!

RELEASED BY: Ellen D Tobey DATE: 7/16/04
PRINT NAME: Ellen D Tobey FIRM: TTFWI TIME: 1520

RECEIVED BY: Tom Blankinship DATE: 7/16/04
PRINT NAME: Blankinship FIRM: NCA TIME: 1520

RELEASED BY: DATE:
PRINT NAME: FIRM: TIME:

RECEIVED BY: DATE:
PRINT NAME: FIRM: TIME:

ADDITIONAL REMARKS: Silica Gel Clean up on Diesel Samples (3 coolers)

TEMP: 8.5 w/cs

PAGE 1 OF 1

COC REV 1/03

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Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
425.420.9200 fax 425.420.9210
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509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588
Anchorage 2000 W. International Airport Road, Suite A10, Anchorage, AK 99502-1119
907.563.9200 fax 907.563.9210

17 August 2004

Bryan Graham
Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011
RE: Time Oil-West Commodore Way

Enclosed are the results of analyses for samples received by the laboratory on 07/19/04 16:34. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Amar Gill
Project Manager

North Creek Analytical, Inc.
Environmental Laboratory Network

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907.563.9200 fax 907.563.9210

CASE NARRATIVE for B4G0467

Client: Tetra Tech FW, Inc.
Project Manager: Bryan Graham
Project Name: Time Oil West Commodore Way
Project Number: 2306.3312.0012.0004

1.0 DESCRIPTION OF CASE

Four (4) water samples were submitted for the analysis of:

- Gasoline Hydrocarbons and BTEX by NWTPH-G and 8021B
- Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up
- Pentachlorophenol by GC/MS with Selective Ion Monitoring

2.0 COMMENTS ON SAMPLE RECEIPT

The sample was received 19th July 2004 at a temperature of 5.3°C and logged in 20th July 2004.

3.0 PREPARATION AND ANALYSIS

Gasoline Hydrocarbons and BTEX by NWTPH-G and 8021B

No additional anomalies or discrepancies were associated with this analysis other than those already qualified in the data.

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up

The samples were initially extracted into analytical batch, 4G21010. During preparation a portion of the Blank Spike Duplicate (BSD) extract was lost. Upon analysis low spike and surrogate recoveries were observed in the BSD along with a high Relative Percent Difference (RPD) from the batch Blank Spike (BS). Since the BSD was the only indicator for batch extraction precision re-extraction was recommended.

The samples were re-extracted within method established hold times in analytical batch 4G27027. Both surrogates in the analytical batch Blank were below the method established control limits. The Relative Percent Difference (RPD) for the Diesel Range Hydrocarbon spikes was above the method established control limit. The project sample surrogates were within control limits but due to the other analytical batch specific issues the samples were re-extracted. The samples were re-extracted into analytical batch 4H03067 outside the method established hold time. All batch

Amar Gill
Project Manager
North Creek Analytical

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Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
425.420.9200 fax 425.420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588
Anchorage 2000 W. International Airport Road, Suite A10, Anchorage, AK 99502-1119
907.563.9200 fax 907.563.9210

CASE NARRATIVE for B4G0467

QC surrogate and spike recoveries were within control limits in analytical batch 4H03067. Both the original and re-extracted sample results were reported for client review. No additional anomalies or discrepancies were associated with this analysis other than those already qualified in the data.

Pentachlorophenol by GC/MS with Selective Ion Monitoring
No additional anomalies or discrepancies were associated with this analysis other than those already qualified in the data.

Amar Gill
Project Manager
North Creek Analytical

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425.420.9200 fax 425.420.9210
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509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
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~~907.563.9200 fax 907.563.9210~~

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 23063312.0012.0004
Project Manager: Bryan Graham

Reported:
08/17/04 16:11

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
01MW-TB04	B4G0467-01	Water	07/19/04 08:00	07/19/04 16:34
01MW-29	B4G0467-02	Water	07/19/04 08:35	07/19/04 16:34
01MW-28A	B4G0467-03	Water	07/19/04 08:55	07/19/04 16:34
01MW-28B	B4G0467-04	Water	07/19/04 09:05	07/19/04 16:34

North Creek Analytical - Bothell

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

mar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 23063312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/17/04 16:11

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B

North Creek Analytical - Bothell

01MW-TB04 (B4G0467-01) Water Sampled: 07/19/04 08:00 Received: 07/19/04 16:34

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G25003	07/25/04	07/25/04	NWTPH-Gx/8021B	
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*94.2 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*97.9 %*	*68-140*			"	"	"	"	

01MW-29 (B4G0467-02) Water Sampled: 07/19/04 08:35 Received: 07/19/04 16:34

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Gasoline Range Hydrocarbons	**17800**	5000	ug/l	100	4G25003	07/25/04	07/25/04	NWTPH-Gx/8021B	
Benzene	**5410**	50.0	"	"	"	"	"	"	
Toluene	**167**	50.0	"	"	"	"	"	"	
Ethylbenzene	**256**	50.0	"	"	"	"	"	"	
Xylenes (total)	**718**	100	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*100 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*99.8 %*	*68-140*			"	"	"	"	

01MW-28A (B4G0467-03) Water Sampled: 07/19/04 08:55 Received: 07/19/04 16:34

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
Gasoline Range Hydrocarbons	**17900**	1000	ug/l	20	4G25003	07/25/04	07/25/04	NWTPH-Gx/8021B	
Benzene	**5060**	50.0	"	100	"	"	07/25/04	"	
Toluene	**1910**	10.0	"	20	"	"	07/25/04	"	
Ethylbenzene	**343**	10.0	"	"	"	"	"	"	
Xylenes (total)	**1230**	20.0	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*104 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*107 %*	*68-140*			"	"	"	"	

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 23063312.0012.0004
Project Manager: Bryan Graham

Reported:
08/17/04 16:11

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
1MW-28B (B4G0467-04) Water	**Sampled: 07/19/04 09:05**	**Received: 07/19/04 16:34**							
Gasoline Range Hydrocarbons	**18400**	500	ug/l	10	4G25003	07/25/04	07/25/04	NWTPH-Gx/8021B	
Benzene	**5030**	50.0	"	100	"	"	07/25/04	"	
oluene	**1810**	50.0	"	"	"	"	"	"	
thylbenzene	**355**	5.00	"	10	"	"	07/25/04	"	
Xylenes (total)	**1250**	10.0	"	"	"	"	"	"	
urrogate: 4-BFB (FID)	*99.8 %*	*58-144*			"	"	"	"	
urrogate: 4-BFB (PID)	*111 %*	*68-140*			"	"	"	"	

North Creek Analytical - Bothell

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mar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 23063312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/17/04 16:11

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-29 (B4G0467-02) Water Sampled: 07/19/04 08:35 Received: 07/19/04 16:34									X
Diesel Range Hydrocarbons	**11.1**	2.50	mg/l	10	4G21010	07/21/04	07/23/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	1	"	"	07/22/04	"	
Surrogate: 2-FBP	*%*	*50-150*			"	"	*07/23/04*	"	*S-02*
Surrogate: Octacosane	*90.8 %*	*50-150*			"	"	*07/22/04*	"	
01MW-29 (B4G0467-02RE1) Water Sampled: 07/19/04 08:35 Received: 07/19/04 16:34									X
Diesel Range Hydrocarbons	**14.3**	2.50	mg/l	10	4G27027	07/27/04	07/31/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	5.00	"	"	"	"	"	"	
Surrogate: 2-FBP	*135 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*76.4 %*	*50-150*			"	"	"	"	
01MW-29 (B4G0467-02RE2) Water Sampled: 07/19/04 08:35 Received: 07/19/04 16:34									X
Diesel Range Hydrocarbons	**11.3**	2.50	mg/l	10	4H03067	08/03/04	08/10/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	5.00	"	"	"	"	"	"	
Surrogate: 2-FBP	*92.5 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*93.5 %*	*50-150*			"	"	"	"	
01MW-28A (B4G0467-03) Water Sampled: 07/19/04 08:55 Received: 07/19/04 16:34									X
Diesel Range Hydrocarbons	**0.763**	0.250	mg/l	1	4G21010	07/21/04	07/22/04	NWTPH-Dx	A-01
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*88.6 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*91.3 %*	*50-150*			"	"	"	"	
01MW-28A (B4G0467-03RE1) Water Sampled: 07/19/04 08:55 Received: 07/19/04 16:34									X
Diesel Range Hydrocarbons	**1.43**	0.250	mg/l	1	4G27027	07/27/04	07/29/04	NWTPH-Dx	A-01
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*102 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*84.8 %*	*50-150*			"	"	"	"	

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 23063312.0012.0004
Project Manager: Bryan Graham

Reported:
08/17/04 16:11

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-28A (B4G0467-03RE2) Water Sampled: 07/19/04 08:55 Received: 07/19/04 16:34									X
Diesel Range Hydrocarbons	**1.44**	0.250	mg/l	1	4H03067	08/03/04	08/10/04	NWTPH-Dx	A-01
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*110 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*108 %*	*50-150*			"	"	"	"	
01MW-28B (B4G0467-04) Water Sampled: 07/19/04 09:05 Received: 07/19/04 16:34									X
Diesel Range Hydrocarbons	**0.402**	0.250	mg/l	1	4G21010	07/21/04	07/22/04	NWTPH-Dx	A-01
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*58.4 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*76.1 %*	*50-150*			"	"	"	"	
01MW-28B (B4G0467-04RE1) Water Sampled: 07/19/04 09:05 Received: 07/19/04 16:34									X
Diesel Range Hydrocarbons	**1.68**	0.250	mg/l	1	4G27027	07/27/04	08/01/04	NWTPH-Dx	A-01
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*161 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*123 %*	*50-150*			"	"	"	"	
01MW-28B (B4G0467-04RE2) Water Sampled: 07/19/04 09:05 Received: 07/19/04 16:34									X
Diesel Range Hydrocarbons	**0.888**	0.250	mg/l	1	4H03067	08/03/04	08/10/04	NWTPH-Dx	A-01
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*105 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*98.4 %*	*50-150*			"	"	"	"	

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 23063312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/17/04 16:11

Pentachlorophenol by GC/MS with Selected Ion Monitoring

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-29 (B4G0467-02) Water Sampled: 07/19/04 08:35 Received: 07/19/04 16:34									
Pentachlorophenol	**9.11**	2.50	ug/l	5	4G22015	07/22/04	07/30/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*94.1 %*	*22-162*			"	"	"	"	
01MW-28A (B4G0467-03) Water Sampled: 07/19/04 08:55 Received: 07/19/04 16:34									
Pentachlorophenol	**2.44**	0.500	ug/l	1	4G22015	07/22/04	07/30/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*78.0 %*	*22-162*			"	"	"	"	
01MW-28B (B4G0467-04) Water Sampled: 07/19/04 09:05 Received: 07/19/04 16:34									
Pentachlorophenol	**2.28**	0.500	ug/l	1	4G22015	07/22/04	07/30/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*82.2 %*	*22-162*			"	"	"	"	

North Creek Analytical - Bothell

Amar Gill, Project Manager

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Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G25003: Prepared 07/25/04 Using EPA 5030B (P/T)										
Blank (4G25003-BLK1)										
Gasoline Range Hydrocarbons	ND	50.0	ug/l							
Benzene	ND	0.500	"							
Toluene	ND	0.500	"							
Ethylbenzene	ND	0.500	"							
Xylenes (total)	ND	1.00	"							
Surrogate: 4-BFB (FID)	*37.5*		"	*48.0*		*78.1*	*58-144*			
Surrogate: 4-BFB (PID)	*47.4*		"	*48.0*		*98.8*	*68-140*			
LCS (4G25003-BS1)										
Gasoline Range Hydrocarbons	597	50.0	ug/l	500		119	80-120			
Benzene	6.36	0.500	"	6.20		103	80-120			
Toluene	33.3	0.500	"	34.8		95.7	80-120			
Ethylbenzene	8.43	0.500	"	8.35		101	80-120			
Xylenes (total)	39.9	1.00	"	40.5		98.5	80-120			
Surrogate: 4-BFB (FID)	*51.1*		"	*48.0*		*106*	*58-144*			
Surrogate: 4-BFB (PID)	*45.9*		"	*48.0*		*95.6*	*68-140*			
LCS Dup (4G25003-BSD1)										
Gasoline Range Hydrocarbons	567	50.0	ug/l	500		113	80-120	5.15	25	
Benzene	6.46	0.500	"	6.20		104	80-120	1.56	25	
Toluene	33.6	0.500	"	34.8		96.6	80-120	0.897	25	
Ethylbenzene	8.44	0.500	"	8.35		101	80-120	0.119	25	
Xylenes (total)	40.2	1.00	"	40.5		99.3	80-120	0.749	25	
Surrogate: 4-BFB (FID)	*52.1*		"	*48.0*		*109*	*58-144*			
Surrogate: 4-BFB (PID)	*47.1*		"	*48.0*		*98.1*	*68-140*			
Matrix Spike (4G25003-MS1)					**Source: B4G0367-03**					
Gasoline Range Hydrocarbons	512	50.0	ug/l	500	39.0	94.6	58-129			
Benzene	6.57	0.500	"	6.20	ND	106	46-130			
Toluene	33.6	0.500	"	34.8	0.262	95.8	60-124			
Ethylbenzene	8.46	0.500	"	8.35	0.167	99.3	56-141			
Xylenes (total)	40.5	1.00	"	40.5	ND	100	66-132			
Surrogate: 4-BFB (FID)	*46.8*		"	*48.0*		*97.5*	*58-144*			
Surrogate: 4-BFB (PID)	*47.3*		"	*48.0*		*98.5*	*68-140*			

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B - Quality Control

North Creek Analytical - Bothell

Batch 4G25003: Prepared 07/25/04 Using EPA 5030B (P/T)

Matrix Spike Dup (4G25003-MSD1) **Source: B4G0367-03**

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Gasoline Range Hydrocarbons	510	50.0	ug/l	500	39.0	94.2	58-129	0.391	25	
Benzene	6.48	0.500	"	6.20	ND	105	46-130	1.38	40	
Toluene	33.5	0.500	"	34.8	0.262	95.5	60-124	0.298	40	
Ethylbenzene	8.37	0.500	"	8.35	0.167	98.2	56-141	1.07	40	
Xylenes (total)	39.9	1.00	"	40.5	ND	98.5	66-132	1.49	40	
Surrogate: 4-BFB (FID)	*48.9*		"	*48.0*		*102*	*58-144*			
Surrogate: 4-BFB (PID)	*46.0*		"	*48.0*		*95.8*	*68-140*			

Amar Gill, Project Manager

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G21010: Prepared 07/21/04 Using EPA 3520C										
Blank (4G21010-BLK1)										
Diesel Range Hydrocarbons	ND	0.250	mg/l							
Lube Oil Range Hydrocarbons	ND	0.500	"							
Surrogate: 2-FBP	*0.228*		"	*0.270*		*84.4*	*50-150*			
Surrogate: Octacosane	*0.171*		"	*0.195*		*87.7*	*50-150*			
LCS (4G21010-BS1)										
Diesel Range Hydrocarbons	1.35	0.250	mg/l	2.00		67.5	45-105			
Surrogate: 2-FBP	*0.218*		"	*0.270*		*80.7*	*50-150*			
LCS Dup (4G21010-BSD1)										X
Diesel Range Hydrocarbons	0.554	0.250	mg/l	2.00		27.7	45-105	83.6	50	
Surrogate: 2-FBP	*0.0840*		"	*0.270*		*31.1*	*50-150*			
Batch 4G27027: Prepared 07/27/04 Using EPA 3520C										
Blank (4G27027-BLK1)										X
Diesel Range Hydrocarbons	ND	0.250	mg/l							
Lube Oil Range Hydrocarbons	ND	0.500	"							
Surrogate: 2-FBP	*0.0950*		"	*0.270*		*35.2*	*50-150*			
Surrogate: Octacosane	*0.0803*		"	*0.195*		*41.2*	*50-150*			
LCS (4G27027-BS1)										X
Diesel Range Hydrocarbons	1.54	0.250	mg/l	2.00		77.0	45-105			
Surrogate: 2-FBP	*0.235*		"	*0.270*		*87.0*	*50-150*			
LCS (4G27027-BS2)										X
Lube Oil Range Hydrocarbons	1.55	0.500	mg/l	2.00		77.5	50-150			
Surrogate: Octacosane	*0.153*		"	*0.195*		*78.5*	*50-150*			

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up - Quality Control
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G27027: Prepared 07/27/04 Using EPA 3520C										
LCS Dup (4G27027-BSD1)										X
Diesel Range Hydrocarbons	0.923	0.250	mg/l	2.00		46.2	45-105	50.1	50	
Surrogate: 2-FBP	*0.145*		"	*0.270*		*53.7*	*50-150*			
Surrogate: Octacosane	*0.0998*		"	*0.195*		*51.2*	*50-150*			
LCS Dup (4G27027-BSD2)										X
Lube Oil Range Hydrocarbons	1.58	0.500	mg/l	2.00		79.0	60-140	1.92	40	
Surrogate: Octacosane	*0.197*		"	*0.195*		*101*	*50-150*			
Matrix Spike (4G27027-MS1)					**Source: B4G0359-05**					X
Diesel Range Hydrocarbons	1.61	0.250	mg/l	1.89	0.0439	82.9	37-126			
Surrogate: 2-FBP	*0.239*		"	*0.255*		*93.7*	*50-150*			
Matrix Spike Dup (4G27027-MSD1)					**Source: B4G0359-05**					X
Diesel Range Hydrocarbons	1.41	0.250	mg/l	1.89	0.0439	72.3	50-150	13.2	50	
Surrogate: 2-FBP	*0.198*		"	*0.255*		*77.6*	*50-150*			
Batch 4H03067: Prepared 08/03/04 Using EPA 3520C										
Blank (4H03067-BLK1)										
Diesel Range Hydrocarbons	ND	0.250	mg/l							
Lube Oil Range Hydrocarbons	ND	0.500	"							
Surrogate: 2-FBP	*0.264*		"	*0.270*		*97.8*	*50-150*			
Surrogate: Octacosane	*0.187*		"	*0.195*		*95.9*	*50-150*			
LCS (4H03067-BS1)										
Diesel Range Hydrocarbons	1.53	0.250	mg/l	2.00		76.5	45-105			
Surrogate: 2-FBP	*0.241*		"	*0.270*		*89.3*	*50-150*			

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 23063312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/17/04 16:11

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4H03067: Prepared 08/03/04 Using EPA 3520C										
LCS Dup (4H03067-BSD1)										
Diesel Range Hydrocarbons	1.30	0.250	mg/l	2.00		65.0	45-105	16.3	50	
Surrogate: 2-FBP	*0.191*		"	*0.270*		*70.7*	*50-150*			

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Amar Gill, Project Manager

Pentachlorophenol by GC/MS with Selected Ion Monitoring - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G22015: Prepared 07/22/04 Using EPA 3520C										
Blank (4G22015-BLK1)										
Pentachlorophenol	ND	0.500	ug/l							
Surrogate: 2,4,6-TBP	*37.0*		"	*50.0*		*74.0*	*22-162*			
LCS (4G22015-BS1)										
Pentachlorophenol	9.48	0.500	ug/l	20.0		47.4	20-128			
Surrogate: 2,4,6-TBP	*37.9*		"	*50.0*		*75.8*	*22-162*			
LCS Dup (4G22015-BSD1)										
Pentachlorophenol	14.0	0.500	ug/l	20.0		70.0	20-128	38.5	50	
Surrogate: 2,4,6-TBP	*42.4*		"	*50.0*		*84.8*	*22-162*			

Amar Gill, Project Manager

Notes and Definitions

A-01	There is gasoline range products contributing to the diesel result.
S-02	The surrogate recovery for this sample cannot be accurately quantified due to interference from coeluting organic compounds present in the sample.
X	See case narrative.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

nca

11720 North Creek Pkwy N Suite 400, Bothell, WA 98011-9508 425-420-9200 FAX 420-9210 ☐
11115 E Montgomery Suite B, Spokane, WA 99206-4776 509-924-9200 FAX 924-9290 ☐
9405 SW Nimbus Ave, Beaverton, OR 97008-7132 503-906-9200 FAX 906-9210 ☐
20332 Empire Ave Suite F-1, Bend, OR 99701-5711 541-383-9310 FAX 382-7588 ☐
3209 Denali St, Anchorage, AK 99503-4030 907-334-9200 FAX 334-9210 ☐

CHAIN OF CUSTODY REPORT

Work Order #: B4G0467

CLIENT: Time Oil (cc)
REPORT TO: ~~Scott Sloan~~ Jim Sims (cc B. Graham@ttfwi)
ADDRESS: 2737 W Commodore Way
PHONE: 206 2866457 FAX:
PROJECT NAME: Quarterly Groundwater Monitoring July 04
PROJECT NUMBER: 2306.3312.0012.0004
SAMPLED BY: E Tobey

INVOICE TO: Same as left
P.O. NUMBER:

TURNAROUND REQUEST
in Business Days *
Organic & Inorganic Analyses
☑ 10 STD. ☐ 7 ☐ 5 ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1
Petroleum Hydrocarbon Analyses
☑ 5 STD. ☐ 4 ☐ 3 ☐ 2 ☐ 1 ☐ <1
☐ OTHER Specify:
Turnaround Requests less than standard may incur Rush Charges.

		PRESERVATIVE																
		HCl	HCl	-														
		REQUESTED ANALYSES																
CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	NWTPH Gx/BTEX	NW TPH Dx	PCP EPA 8270												MATRIX (W, S, O)	# OF CONT.	LOCATION / COMMENTS	NCA WO ID
1 01MW-TB04	7/19/04 0800	X													W	1		-01
2 01MW-29	7/19/04 0835	X	X	X											W	7		-02
3 01MW-28A	7/19/04 0855	X	X	X											W	7		-03
4 01MW-28B	7/19/04 0905	X	X	X											W	7		-04
5																		
6																		
7																		
8																		
9																		
10																		

RELEASED BY: Ellen D Tobey DATE: 7/19/04 RECEIVED BY: Tom Blankinship DATE: 7/19/04
PRINT NAME: Ellen D Tobey FIRM: TTFWI TIME: 1634 PRINT NAME: Blankinship FIRM: NCA TIME: 1634

RELEASED BY: DATE: ~~7/19/04~~ RECEIVED BY: DATE:
PRINT NAME: FIRM: TIME: PRINT NAME: FIRM: TIME:

ADDITIONAL REMARKS: Silica Gel Clean up on Diesel Samples 2 coolers
TEMP: 5.3°C w/cs
PAGE 1 OF 1

COC REV 1/03

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Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
425.420.9200 fax 425.420.9210
Spokane East 11115 Montgomery, Suite B, Spokane, WA 99206-4776
509.924.9200 fax 509.924.9290
Portland 9405 SW Nimbus Avenue, Beaverton, OR 97008-7132
503.906.9200 fax 503.906.9210
Bend 20332 Empire Avenue, Suite F-1, Bend, OR 97701-5711
541.383.9310 fax 541.382.7588
Anchorage 2000 W. International Airport Road, Suite A10, Anchorage, AK 99502-1119
907.563.9200 fax 907.563.9210

17 August 2004

Bryan Graham
Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011
RE: Time Oil-West Commodore Way

Enclosed are the results of analyses for samples received by the laboratory on 07/20/04 15:01. If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Amar Gill
Project Manager

nca™
www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
425.420.9200 fax 425.420.9210
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907.563.9200 fax 907.563.9210

CASE NARRATIVE for B4G0577

Client: Tetra Tech FW, Inc.
Project Manager: Bryan Graham
Project Name: Time Oil West Commodore Way
Project Number: 2306.3312.0012.0004

1.0 DESCRIPTION OF CASE

Eight (8) water samples were submitted for the analysis of:

- Gasoline Hydrocarbons and BTEX by NWTPH-G and 8021B
- Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up
- Pentachlorophenol by GC/MS with Selective Ion Monitoring

2.0 COMMENTS ON SAMPLE RECEIPT

The sample was received 20th July 2004 at a temperature of 3.1°C and logged in 22nd July 2004.

3.0 PREPARATION AND ANALYSIS

Gasoline Hydrocarbons and BTEX by NWTPH-G and 8021B
No additional anomalies or discrepancies were associated with this analysis other than those already qualified in the data.

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up
The surrogate recoveries for project samples, 01MW-21 and 01MW-22 were below the method control limits in analytical batch 4G25001. Since additional sample volume was provided the samples were re-extracted and re-analyzed as part of analytical batch 4G03011. The surrogate recoveries and batch spike recoveries were all within control limits for the re-extracted project samples and quality control samples in analytical batch 4G03011. Both the original and re-extracted results were provided for project samples 01MW-21 and 01MW-22. No additional anomalies or discrepancies were associated with this analysis other than those already qualified in the data.

Pentachlorophenol by GC/MS with Selective Ion Monitoring
No additional anomalies or discrepancies were associated with this analysis other than those already qualified in the data.

Amar Gill
Project Manager
North Creek Analytical

www.ncalabs.com

Seattle 11720 North Creek Pkwy N, Suite 400, Bothell, WA 98011-8244
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907.563.9200 fax 907.563.9210

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/17/04 10:30

ANALYTICAL REPORT FOR SAMPLES

Sample ID	Laboratory ID	Matrix	Date Sampled	Date Received
01MW-TB05	B4G0577-01	Water	07/20/04 07:50	07/20/04 15:01
01MW-17	B4G0577-02	Water	07/20/04 08:05	07/20/04 15:01
01MW-13	B4G0577-03	Water	07/20/04 08:25	07/20/04 15:01
01MW-12	B4G0577-04	Water	07/20/04 08:55	07/20/04 15:01
01MW-21	B4G0577-05	Water	07/20/04 09:15	07/20/04 15:01
01MW-22	B4G0577-06	Water	07/20/04 09:45	07/20/04 15:01
01MW-23	B4G0577-07	Water	07/20/04 10:16	07/20/04 15:01
01MW-24	B4G0577-08	Water	07/20/04 11:00	07/20/04 15:01

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/17/04 10:30

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-TB05 (B4G0577-01) Water Sampled: 07/20/04 07:50 Received: 07/20/04 15:01									
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G26007	07/26/04	07/26/04	NWTPH-Gx/8021B	
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*104 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*93.5 %*	*68-140*			"	"	"	"	
01MW-17 (B4G0577-02) Water Sampled: 07/20/04 08:05 Received: 07/20/04 15:01									
Gasoline Range Hydrocarbons	ND	50.0	ug/l	1	4G26007	07/26/04	07/26/04	NWTPH-Gx/8021B	
Benzene	ND	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	ND	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*100 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*90.6 %*	*68-140*			"	"	"	"	
01MW-13 (B4G0577-03) Water Sampled: 07/20/04 08:25 Received: 07/20/04 15:01									
Gasoline Range Hydrocarbons	**314**	50.0	ug/l	1	4G26007	07/26/04	07/26/04	NWTPH-Gx/8021B	
Benzene	**1.41**	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	ND	0.500	"	"	"	"	"	"	
Xylenes (total)	**2.54**	1.00	"	"	"	"	"	"	J-06
Surrogate: 4-BFB (FID)	*104 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*94.2 %*	*68-140*			"	"	"	"	

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/17/04 10:30

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-12 (B4G0577-04) Water	**Sampled: 07/20/04 08:55**	**Received: 07/20/04 15:01**							
Gasoline Range Hydrocarbons	**1700**	250	ug/l	5	4G26007	07/26/04	07/26/04	NWTPH-Gx/8021B	
Benzene	**485**	2.50	"	"	"	"	"	"	
Toluene	**5.90**	2.50	"	"	"	"	"	"	
Ethylbenzene	**11.3**	2.50	"	"	"	"	"	"	
Xylenes (total)	**15.8**	5.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*108 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*94.0 %*	*68-140*			"	"	"	"	
01MW-21 (B4G0577-05) Water	**Sampled: 07/20/04 09:15**	**Received: 07/20/04 15:01**							
Gasoline Range Hydrocarbons	**986**	50.0	ug/l	1	4G26007	07/26/04	07/26/04	NWTPH-Gx/8021B	G-02
Benzene	**0.858**	0.500	"	"	"	"	"	"	
Toluene	ND	0.500	"	"	"	"	"	"	
Ethylbenzene	**10.6**	0.500	"	"	"	"	"	"	
Xylenes (total)	**1.32**	1.00	"	"	"	"	"	"	I-06
Surrogate: 4-BFB (FID)	*144 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*108 %*	*68-140*			"	"	"	"	
01MW-22 (B4G0577-06) Water	**Sampled: 07/20/04 09:45**	**Received: 07/20/04 15:01**							
Gasoline Range Hydrocarbons	**1340**	50.0	ug/l	1	4G26007	07/26/04	07/26/04	NWTPH-Gx/8021B	G-02
Benzene	**73.5**	0.500	"	"	"	"	"	"	
Toluene	**0.943**	0.500	"	"	"	"	"	"	
Ethylbenzene	**4.71**	0.500	"	"	"	"	"	"	
Xylenes (total)	**10.2**	1.00	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*138 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*104 %*	*68-140*			"	"	"	"	

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306.3312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/17/04 10:30

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-23 (B4G0577-07) Water	**Sampled: 07/20/04 10:16**	**Received: 07/20/04 15:01**							
Gasoline Range Hydrocarbons	**4620**	500	ug/l	10	4G26007	07/26/04	07/26/04	NWTPH-Gx/8021B	
Benzene	**917**	5.00	"	"	"	"	"	"	
Toluene	**10.0**	5.00	"	"	"	"	"	"	
Ethylbenzene	**61.4**	5.00	"	"	"	"	"	"	
Xylenes (total)	**139**	10.0	"	"	"	"	"	"	
Surrogate: 4-BFB (FID)	*110 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*94.8 %*	*68-140*			"	"	"	"	
01MW-24 (B4G0577-08) Water	**Sampled: 07/20/04 11:00**	**Received: 07/20/04 15:01**							
Gasoline Range Hydrocarbons	**18400**	2500	ug/l	50	4G26007	07/26/04	07/26/04	NWTPH-Gx/8021B	
Benzene	**6750**	50.0	"	100	"	"	07/26/04	"	
Toluene	**35.0**	25.0	"	50	"	"	07/26/04	"	
Ethylbenzene	**261**	25.0	"	"	"	"	"	"	
Xylenes (total)	**816**	50.0	"	"	"	"	"	"	I-06
Surrogate: 4-BFB (FID)	*103 %*	*58-144*			"	"	"	"	
Surrogate: 4-BFB (PID)	*93.8 %*	*68-140*			"	"	"	"	

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/17/04 10:30

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-17 (B4G0577-02) Water Sampled: 07/20/04 08:05 Received: 07/20/04 15:01									
Diesel Range Hydrocarbons	ND	0.250	mg/l	1	4G25001	07/25/04	07/31/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*88.6 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*84.8 %*	*50-150*			"	"	"	"	
01MW-13 (B4G0577-03) Water Sampled: 07/20/04 08:25 Received: 07/20/04 15:01									
Diesel Range Hydrocarbons	ND	0.250	mg/l	1	4G25001	07/25/04	08/01/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*92.9 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*104 %*	*50-150*			"	"	"	"	
01MW-12 (B4G0577-04) Water Sampled: 07/20/04 08:55 Received: 07/20/04 15:01									
Diesel Range Hydrocarbons	ND	0.250	mg/l	1	4G25001	07/25/04	07/31/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*80.4 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*90.2 %*	*50-150*			"	"	"	"	
01MW-21 (B4G0577-05) Water Sampled: 07/20/04 09:15 Received: 07/20/04 15:01									X
Diesel Range Hydrocarbons	ND	0.250	mg/l	1	4G25001	07/25/04	08/01/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*43.9 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*40.9 %*	*50-150*			"	"	"	"	
01MW-21 (B4G0577-05RE1) Water Sampled: 07/20/04 09:15 Received: 07/20/04 15:01									X
Diesel Range Hydrocarbons	**0.429**	0.250	mg/l	1	4H03011	08/03/04	08/04/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*60.8 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*66.8 %*	*50-150*			"	"	"	"	

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306.3312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/17/04 10:30

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-22 (B4G0577-06) Water Sampled: 07/20/04 09:45 Received: 07/20/04 15:01									**X**
Diesel Range Hydrocarbons	ND	0.250	mg/l	1	4G25001	07/25/04	07/31/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*32.6 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*33.5 %*	*50-150*			"	"	"	"	
01MW-22 (B4G0577-06RE1) Water Sampled: 07/20/04 09:45 Received: 07/20/04 15:01									**X**
Diesel Range Hydrocarbons	**1.09**	0.250	mg/l	1	4H03011	08/03/04	08/04/04	NWTPH-Dx	
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*76.5 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*78.8 %*	*50-150*			"	"	"	"	
01MW-23 (B4G0577-07) Water Sampled: 07/20/04 10:16 Received: 07/20/04 15:01									
Diesel Range Hydrocarbons	**0.540**	0.250	mg/l	1	4G25001	07/25/04	08/01/04	NWTPH-Dx	D-08
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*74.5 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*85.3 %*	*50-150*			"	"	"	"	
01MW-24 (B4G0577-08) Water Sampled: 07/20/04 11:00 Received: 07/20/04 15:01									
Diesel Range Hydrocarbons	**0.837**	0.250	mg/l	1	4G25001	07/25/04	08/01/04	NWTPH-Dx	D-08
Lube Oil Range Hydrocarbons	ND	0.500	"	"	"	"	"	"	
Surrogate: 2-FBP	*85.1 %*	*50-150*			"	"	"	"	
Surrogate: Octacosane	*77.2 %*	*50-150*			"	"	"	"	

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/17/04 10:30

Pentachlorophenol by GC/MS with Selected Ion Monitoring
North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Dilution	Batch	Prepared	Analyzed	Method	Notes
01MW-21 (B4G0577-05) Water Sampled: 07/20/04 09:15 Received: 07/20/04 15:01									
Pentachlorophenol	**3.51**	0.500	ug/l	1	4G27009	07/27/04	07/31/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*71.4 %*	*22-162*			"	"	"	"	
01MW-22 (B4G0577-06) Water Sampled: 07/20/04 09:45 Received: 07/20/04 15:01									
Pentachlorophenol	**191**	2.50	ug/l	5	4G27009	07/27/04	07/31/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*93.2 %*	*22-162*			"	"	"	"	
01MW-23 (B4G0577-07) Water Sampled: 07/20/04 10:16 Received: 07/20/04 15:01									
Pentachlorophenol	**350**	2.50	ug/l	5	4G27009	07/27/04	07/31/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*88.3 %*	*22-162*			"	"	"	"	
01MW-24 (B4G0577-08) Water Sampled: 07/20/04 11:00 Received: 07/20/04 15:01									**Q-28**
Pentachlorophenol	ND	2.50	ug/l	5	4G27009	07/27/04	07/31/04	EPA 8270 Mod	
Surrogate: 2,4,6-TBP	*93.6 %*	*22-162*			"	"	"	"	

North Creek Analytical - Bothell

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/17/04 10:30

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G26007: Prepared 07/26/04 Using EPA 5030B (MeOH)										
Blank (4G26007-BLK1)										
Gasoline Range Hydrocarbons	ND	50.0	ug/l							
Benzene	ND	0.500	"							
Toluene	ND	0.500	"							
Ethylbenzene	ND	0.500	"							
Xylenes (total)	ND	1.00	"							
Surrogate: 4-BFB (FID)	*46.0*		"	*48.0*		*95.8*	*58-144*			
Surrogate: 4-BFB (PID)	*42.7*		"	*48.0*		*89.0*	*68-140*			
LCS (4G26007-BS1)										
Gasoline Range Hydrocarbons	486	50.0	ug/l	502		96.8	80-120			
Benzene	6.48	0.500	"	6.21		104	80-120			
Toluene	33.7	0.500	"	34.9		96.6	80-120			
Ethylbenzene	8.40	0.500	"	8.38		100	80-120			
Xylenes (total)	41.1	1.00	"	40.6		101	80-120			
Surrogate: 4-BFB (FID)	*49.2*		"	*48.0*		*102*	*58-144*			
Surrogate: 4-BFB (PID)	*43.0*		"	*48.0*		*89.6*	*68-140*			
LCS Dup (4G26007-BSD1)										
Gasoline Range Hydrocarbons	515	50.0	ug/l	502		103	80-120	5.79	25	
Benzene	6.62	0.500	"	6.21		107	80-120	2.14	25	
Toluene	34.4	0.500	"	34.9		98.6	80-120	2.06	25	
Ethylbenzene	8.51	0.500	"	8.38		102	80-120	1.30	25	
Xylenes (total)	41.6	1.00	"	40.6		102	80-120	1.21	25	
Surrogate: 4-BFB (FID)	*52.8*		"	*48.0*		*110*	*58-144*			
Surrogate: 4-BFB (PID)	*43.5*		"	*48.0*		*90.6*	*68-140*			
Matrix Spike (4G26007-MS1)					**Source: B4G0544-01**					
Gasoline Range Hydrocarbons	558	50.0	ug/l	502	72.3	96.8	58-129			
Benzene	6.44	0.500	"	6.21	0.189	101	46-130			
Toluene	33.4	0.500	"	34.9	0.156	95.3	60-124			
Ethylbenzene	8.18	0.500	"	8.38	ND	97.6	56-141			
Xylenes (total)	40.0	1.00	"	40.6	0.547	97.2	66-132			
Surrogate: 4-BFB (FID)	*52.3*		"	*48.0*		*109*	*58-144*			
Surrogate: 4-BFB (PID)	*43.0*		"	*48.0*		*89.6*	*68-140*			

Amar Gill, Project Manager

Gasoline Hydrocarbons (Benzene to Naphthalene) and BTEX by NWTPH-G and EPA 8021B - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G26007: Prepared 07/26/04 Using EPA 5030B (MeOH)										
Matrix Spike Dup (4G26007-MSD1)					**Source: B4G0544-01**					
Gasoline Range Hydrocarbons	547	50.0	ug/l	502	72.3	94.6	58-129	1.99	25	
Benzene	6.22	0.500	"	6.21	0.189	97.1	46-130	3.48	40	
Toluene	32.6	0.500	"	34.9	0.156	93.0	60-124	2.42	40	
Ethylbenzene	7.95	0.500	"	8.38	ND	94.9	56-141	2.85	40	
Xylenes (total)	38.9	1.00	"	40.6	0.547	94.5	66-132	2.79	40	
Surrogate: 4-BFB (FID)	*52.5*		*"*	*48.0*		*109*	*58-144*			
Surrogate: 4-BFB (PID)	*43.1*		*"*	*48.0*		*89.8*	*68-140*			

Tetra Tech FW, Inc. - Bothell
12100 NE 195th St
Bothell, WA/USA 98011

Project: Time Oil-West Commodore Way
Project Number: 2306.3312.0012.0004
Project Manager: Bryan Graham

Reported:
08/17/04 10:30

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G25001: Prepared 07/25/04 Using EPA 3520C										
Blank (4G25001-BLK1)										
Diesel Range Hydrocarbons	ND	0.250	mg/l							
Lube Oil Range Hydrocarbons	ND	0.500	"							
Surrogate: 2-FBP	*0.219*		"	*0.270*		*81.1*	*50-150*			
Surrogate: Octacosane	*0.158*		"	*0.195*		*81.0*	*50-150*			
LCS (4G25001-BS1)										
Diesel Range Hydrocarbons	1.31	0.250	mg/l	2.00		65.5	45-105			
Surrogate: 2-FBP	*0.243*		"	*0.270*		*90.0*	*50-150*			
LCS (4G25001-BS2)										
Lube Oil Range Hydrocarbons	1.26	0.500	mg/l	2.00		63.0	50-150			
Surrogate: 2-FBP	*0.242*		"	*0.270*		*89.6*	*50-150*			
Surrogate: Octacosane	*0.217*		"	*0.195*		*111*	*50-150*			
LCS Dup (4G25001-BSD1)										
Diesel Range Hydrocarbons	0.962	0.250	mg/l	2.00		48.1	45-105	30.6	50	
Surrogate: 2-FBP	*0.146*		"	*0.270*		*54.1*	*50-150*			
LCS Dup (4G25001-BSD2)										
Lube Oil Range Hydrocarbons	1.35	0.500	mg/l	2.00		67.5	50-150	6.90	50	
Surrogate: Octacosane	*0.182*		"	*0.195*		*93.3*	*50-150*			
Batch 4H03011: Prepared 08/03/04 Using EPA 3520C										
Blank (4H03011-BLK1)										
Diesel Range Hydrocarbons	ND	0.250	mg/l							
Lube Oil Range Hydrocarbons	ND	0.500	"							
Surrogate: 2-FBP	*0.139*		"	*0.270*		*51.5*	*50-150*			
Surrogate: Octacosane	*0.127*		"	*0.195*		*65.1*	*50-150*			

North Creek Analytical - Bothell

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Amar Gill, Project Manager

Tetra Tech FW, Inc. - Bothell	Project: Time Oil-West Commodore Way	
12100 NE 195th St	Project Number: 2306.3312.0012.0004	**Reported:**
Bothell, WA/USA 98011	Project Manager: Bryan Graham	08/17/04 10:30

Semivolatile Petroleum Products by NWTPH-Dx with Acid/Silica Gel Clean-up - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4H03011: Prepared 08/03/04 Using EPA 3520C										
LCS (4H03011-BS1)										
Diesel Range Hydrocarbons	1.45	0.250	mg/l	2.00		72.5	45-105			
Surrogate: 2-FBP	*0.207*		"	*0.270*		*76.7*	*50-150*			
LCS Dup (4H03011-BSD1)										
Diesel Range Hydrocarbons	0.931	0.250	mg/l	2.00		46.6	45-105	43.6	50	
Surrogate: 2-FBP	*0.147*		"	*0.270*		*54.4*	*50-150*			

Amar Gill, Project Manager

Pentachlorophenol by GC/MS with Selected Ion Monitoring - Quality Control

North Creek Analytical - Bothell

Analyte	Result	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch 4G27009: Prepared 07/27/04 Using EPA 3520C										
Blank (4G27009-BLK1)										
Pentachlorophenol	ND	0.500	ug/l							
Surrogate: 2,4,6-TBP	*33.6*		"	*50.0*		*67.2*	*45-135*			
LCS (4G27009-BS1)										
Pentachlorophenol	10.1	0.500	ug/l	20.0		50.5	45-135			
Surrogate: 2,4,6-TBP	*35.1*		"	*50.0*		*70.2*	*45-135*			
LCS Dup (4G27009-BSD1)										
Pentachlorophenol	10.5	0.500	ug/l	20.0		52.5	45-135	3.88	50	
Surrogate: 2,4,6-TBP	*34.6*		"	*50.0*		*69.2*	*45-135*			
Matrix Spike (4G27009-MS1)					**Source: B4G0619-02**					
Pentachlorophenol	13.8	0.500	ug/l	18.9	ND	73.0	20-130			
Surrogate: 2-FP	*ND*		"	*47.2*			*60-120*			
Surrogate: 2,4,6-TBP	*30.7*		"	*47.2*		*65.0*	*22-162*			
Surrogate: 2-FBP	*27.1*		"	*47.2*		*57.4*	*30-150*			
Matrix Spike Dup (4G27009-MSD1)					**Source: B4G0619-02**					
Pentachlorophenol	14.3	0.500	ug/l	19.2	ND	74.5	20-130	3.56	50	
Surrogate: 2-FP	*ND*		"	*48.1*			*60-120*			
Surrogate: 2,4,6-TBP	*30.2*		"	*48.1*		*62.8*	*22-162*			
Surrogate: 2-FBP	*29.2*		"	*48.1*		*60.7*	*30-150*			

Notes and Definitions

D-08	Results in the diesel organics range are primarily due to overlap from a gasoline range product.
G-02	The chromatogram for this sample does not resemble a typical gasoline pattern. Please refer to the sample chromatogram.
I-06	The analyte concentration may be artificially elevated due to coeluting compounds or components.
Q-28	This sample was re-analyzed at a dilution due to matrix related internal standard failure at the initial final volume.
X	See case narrative.
DET	Analyte DETECTED
ND	Analyte NOT DETECTED at or above the reporting limit
NR	Not Reported
dry	Sample results reported on a dry weight basis
RPD	Relative Percent Difference

nca

11720 North Creek Pkwy N Suite 400, Bothell, WA 98011-9508 425-420-9200 FAX 420-9210 ☑
11115 E Montgomery Suite B, Spokane, WA 99206-4776 509-924-9200 FAX 924-9290 ☐
9405 SW Nimbus Ave, Beaverton, OR 97008-7132 503-906-9200 FAX 906-9210 ☐
20332 Empire Ave Suite F-1, Bend, OR 99701-5711 541-383-9310 FAX 382-7588 ☐
3209 Denali St, Anchorage, AK 99503-4030 907-334-9200 FAX 334-9210 ☐

CHAIN OF CUSTODY REPORT

Work Order #: B4G0577

CLIENT: Time Oil

REPORT TO: Jim Sims (cc B Graham @ ttfwi)
ADDRESS: 2737 W Commodore Way
Seattle WA
PHONE (206)2866457 FAX:

INVOICE TO: Same as Left

P.O. NUMBER:

PROJECT NAME: Quarterly Groundwater Monitoring July 04
PROJECT NUMBER: 2306.3312.0012.0004
SAMPLED BY: E Tobey

TURNAROUND REQUEST in Business Days *

Organic & Inorganic Analyses
[✓ 10] 7 5 4 3 2 1 <1
STD.

Petroleum Hydrocarbon Analyses
[✓ 5] 4 3 2 1 <1
STD.

OTHER Specify:

* Turnaround Requests less than standard may incur Rush Charges.

PRESERVATIVE: HCl | HCl | –

REQUESTED ANALYSES

	CLIENT SAMPLE IDENTIFICATION	SAMPLING DATE/TIME	NW TPH GX/BTEX	NW TPH DX	PCP EPA 8270si											MATRIX (W, S, O)	# OF CONT.	LOCATION / COMMENTS	NCA WO ID
1	01MW-TB05	7/20/04 0750	X													W	1		01
2	01MW-17	7/20/04 0805	X	X												W	5		02
3	01MW-13	7/20/04 0825	X	X												W	5		03
4	01MW-12	7/20/04 0855	X	X												W	5		04
5	01MW-21	7/20/04 0915	X	X	X											W	7		05
6	01MW-22	7/20/04 0945	X	X	X											W	7		06
7	01MW-23	7/20/04 1016	X	X	X											W	7		07
8	01MW-24	7/20/04 1100	X	X	X											W	7		08
9																			
10																			

RELEASED BY: Ellen D Tobey DATE: 7/20/04
PRINT NAME: Ellen D Tobey FIRM: TTFWI TIME: 1501

RECEIVED BY: Colette Weaver DATE: 7/20/04
PRINT NAME: Colette Weaver FIRM: NCA TIME: 1501

RELEASED BY: DATE:
PRINT NAME: FIRM: TIME:

RECEIVED BY: DATE:
PRINT NAME: FIRM: TIME:

ADDITIONAL REMARKS: Silica Gel Clean up on Diesel Samples

3 Coolers w/ [illegible]

TEMP: 3.1c w/cs

PAGE 1 OF 1

COC REV 1/03

DRAFT
QUARTERLY GROUNDWATER SAMPLING REPORT FOR NOVEMBER 2004

at

2737 West Commodore Way and
2750 West Commodore Way
Seattle, Washington

Prepared for

Time Oil Company

March 2005

Prepared by

TETRA TECH EC, INC.

12100 NE 195th, Suite 200
Bothell, WA 98011

DRAFT
QUARTERLY GROUNDWATER SAMPLING REPORT FOR NOVEMBER 2004

at

2737 West Commodore Way and
2750 West Commodore Way
Seattle, Washington

Prepared for

Time Oil Company
2737 West Commodore Way
Seattle, WA 98199
(206) 285-2400

March 2005

Prepared by

TETRA TECH EC, INC.

12100 NE 195th, Suite 200
Bothell, WA 98011
(425) 482-7600

CONTENTS

ACRONYMS AND ABBREVIATIONS

bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, and xylene
°C	degrees Celsius
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
HDPE	high-density polyethylene
mg/L	milligrams per liter
mL/min	milliliters per minute
mS/cm	millisiemens per centimeter
msl	mean sea level
μg/L	micrograms per liter
MTCA	Model Toxics Control Act
NOAA	National Oceanic and Atmospheric Administration
NTU	nephelometric turbidity unit
NWTPH-Dx	Northwest total petroleum hydrocarbon-diesel range hydrocarbons
NWTPH-Gx	Northwest total petroleum hydrocarbon-gasoline range hydrocarbons
ORP	oxidation reduction potential
PCP	pentachlorophenol
sim	selective ion monitoring
SQuiRT™	Screening Quick Reference Tables
TOC	Time Oil Company
VOC	volatile organic compound

1. INTRODUCTION

Investigations to assess groundwater levels and specific chemical concentrations were conducted at two Time Oil Company (TOC) properties located at 2737 West Commodore Way and 2750 West Commodore Way, Seattle, Washington (Figure 1-1). TOC retained Tetra Tech ~~FW~~ EC, Inc. (Tt~~FW~~EC), formerly Tetra Tech FW, to conduct quarterly groundwater monitoring at these properties as part of an independent cleanup action.

Monitoring wells at the properties are sampled on a quarterly basis, which began in July 2001. This quarterly report presents the results of the November 2004 groundwater sampling activities at 2737 and 2750 West Commodore Way. Figure 1-2 provides a plan view of the properties relative to one another. The report is organized as follows:

- **Section 1** briefly describes the purpose and organization of the report.
- **Section 2** describes the field methods used to measure water levels and to collect samples.
- **Section 3** presents the groundwater level data.
- **Section 4** presents the analytical results.
- **Section 5** describes the conclusions and provides recommendations for future actions.
- **Appendix A** provides the data packages from the analytical laboratory for November 2004.

2. METHODS AND PROCEDURES

Field activities for November 2004 at the two TOC properties included water level measurement and quarterly groundwater sampling. This section presents a brief description of the specific methods and procedures used for quarterly monitoring.

2.1 GROUNDWATER ELEVATION SURVEY

Groundwater elevations are determined each quarter by measuring the depth to water in 28 wells at 2737 West Commodore Way and 7 wells at 2750 West Commodore Way. The depth to water measurements are collected on a single day and subtracted from the survey level at the top of the well casing to calculate the potentiometric surface (water table elevation).

Before measuring the depth to groundwater in the first well, the water level indicator is calibrated by visually comparing the markings on the tape to the markings on a measurement tape. After removing the well cap and allowing the well to stabilize, the probe is lowered into the well until the sound alarm is activated, indicating that the probe has touched the water surface. The static depth to water is read directly from the tape by holding the tape to the permanent mark on the well casing or cap. The probe is then raised and lowered to confirm the reading. An oil/water interface probe is then used in a similar manner in wells where floating product is suspected to be present.

2.2 GROUNDWATER SAMPLING

Groundwater samples are collected each quarter using a low-flow micro-purging technique in accordance with U.S. Environmental Protection Agency (EPA) guidelines (EPA 1996, EPA/540/S-95/504). Each monitoring well is micro-purged (300 to 500 milliliters per minute [mL/min]) using a peristaltic pump with disposable high-density polyethylene (HDPE) tubing. A small section of thick-walled silicon is used around the head of the peristaltic pump to achieve the pressures necessary to draw the groundwater up the well. Groundwater samples are collected in laboratory-supplied glassware and hand delivered to the laboratory each evening after sampling.

Groundwater sampling was conducted in November 2004 in accordance with the following sampling procedures:

1. Calibrate field instruments in accordance with the manufacturer's directions. Record all calibration data in the field log book.
2. Confirm well identification using site map.
3. Measure the depth to water at each well. Record the depth to water. Decontaminate the water level meter before each measurement.
4. Carefully lower the HDPE tubing into the well with as little disturbance to the groundwater as possible. Place the intake at the middle of the screen interval. Set pump rate to ensure the water column in the well does not drop more than 0.2 feet below the initial water level reading.
5. Purge the well at a flow rate of 300 to 500 mL/min. Monitor water level to ensure minimal drawdown. Monitor water quality parameters every 3 to 5 minutes during purging (turbidity, pH, temperature, conductivity, oxidation reduction potential [ORP], and dissolved oxygen) using in-line monitoring equipment. Stabilization is achieved if three successive readings are within ±0.1 pH units, ±1 degree Celsius (^{o}C) for temperature, ±10 percent for conductivity, ±10 percent for dissolved oxygen, and ± 10 millivolts for ORP.
6. When water quality parameters are stable for three consecutive readings, turn off the pump and remove the tubing from the well or leave the tubing in place securing it at the surface within the well head. Place the tubing in a sealed, labeled plastic bag. Replace the well cap and seal the monument.
7. Return within 24 hours and insert the appropriate HDPE tubing into the well. Connect the pump and adjust the pump flow to a rate of approximately 200 mL/min. Collect samples for volatile organic compounds (VOC) and gasoline analyses first. Fill the containers so that no headspace exists.
8. Increase the flow rate to approximately 300 to 500 mL/min while maintaining minimal to no drawdown and collect the remaining samples.

2.3 GROUNDWATER ANALYSES

Groundwater samples were collected on November 17 through November 19, 2004, using laboratory-supplied glassware. Table 2-1 shows the wells sampled in November 2004. The groundwater samples were delivered to the laboratory each evening after sampling and, depending on the specific data needs, were analyzed for all or some of the following contaminants:

- Gasoline range hydrocarbons, using Washington State Department of Ecology's (Ecology's) Northwest total petroleum hydrocarbon-gasoline (NWTPH-Gx) method;
- Benzene, toluene, ethylbenzene, xylene (BTEX) using EPA Method 8021B;
- Diesel and Lube oil range hydrocarbons, using Ecology's Northwest total petroleum hydrocarbon-diesel extended (NWTPH-Dx) method; and
- Pentachlorophenol (PCP), using EPA Method 8270-sim (selective ion monitoring).

The groundwater samples analyzed for diesel and oil underwent a silica gel cleanup before analysis. This cleanup was done to remove naturally occurring organic material that may interfere with the analysis. Groundwater samples were analyzed by North Creek Analytical Laboratories, Inc., in Bothell, Washington.

3. GROUNDWATER LEVEL DATA

Field activities conducted at the TOC properties included the quarterly collection of water level measurements. This section describes the collection of November 2004 water level measurements and summarizes groundwater flow directions beneath 2737 and 2750 West Commodore Way.

Measurements for depth to water were made using an electronic measuring tape with markings every 0.01 foot. All water levels were measured on a single day. Measurements were subtracted from surveyed measuring point elevations to produce the water level elevations. Where present, the thickness and specific gravity (0.8) of free phase product fuel on the water table was considered when calculating the elevation of the water table.

3.1 2737 WEST COMMODORE WAY

Water level measurements were collected from 28 wells at 2737 West Commodore Way on November 17, 2004. Table 3-1 provides the well construction information, and Table 3-2 shows the groundwater elevations in feet above mean sea level (msl). In general, the water levels have increased slightly relative to July 2004, possibly due to seasonal variation. The groundwater elevations during the four quarter period are generally consistent showing a slight seasonal decrease (average 0.10 feet) relative to July 2004. Figure 3-1 shows the locations of the wells at 2737 West Commodore Way and the water table elevation (potentiometric space). Groundwater flows to the north toward the Ship Canal. The groundwater flow direction north of the Lower Tank Yard appears to be bifurcated, possibly by the fiber-grained material in the vicinity of Wells 01MW-16 and 01MW-10. The groundwater gradient at the site differs in the tank yards relative to the rest of the site. The gradient across the tank yards (Wells 01MW-17 to 01MW-23) is approximately 0.003 feet per foot and steepens towards the north wall of the Lower Tank Yard. The unpaved surface of the tank yards allows for greater infiltration, resulting in higher groundwater elevations and mounding. The gradient outside the tank yards (Well 01MW-01 to Well MW-09) is approximately 0.029 feet per foot.

3.2 2750 WEST COMMODORE WAY

Water level measurements were collected from seven wells at 2750 West Commodore Way on November 17, 2004. In general, the water levels at 2750 West Commodore Way have decreased (average 0.63 feet), relative to July 2004. The only exception is Well 02MW-05, which has shown an increase in groundwater elevation for the past year. Figure 3-2 shows the locations of the wells and potentiometric surface at 2750 West Commodore Way. Groundwater flows to the north toward the Ship Canal. The groundwater gradient from Wells 02MW-05 to Well 02MW-02 is approximately 0.017 feet per foot toward the north based on the potentiometric surface map.

4. ANALYTICAL RESULTS

The MTCA Method A Cleanup Levels for groundwater are intended to provide conservative cleanup levels for drinking water beneficial uses at sites undergoing routine cleanup actions or those sites with relatively few hazardous substances. Because the groundwater beneath the TOC sites is not used as a source of drinking water or for municipal supply, comparison of groundwater concentrations to the MTCA Method A Cleanup Levels is not technically appropriate. The primary point of exposure to groundwater beneath the sites is through the discharge of groundwater to the nearby Ship Canal, a freshwater body on the north side of 2750 West Commodore Way. Based on this exposure scenario (no groundwater use but discharge to a water body), groundwater concentrations were compared to the National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Tables (SQuiRT™) values. These values provide screening levels for acute and chronic exposures to both freshwater and saltwater.

The SQuiRT™ values are non-promulgated values developed by the Coastal Protection and Restoration Division of NOAA to protect aquatic habitats that may be affected by hazardous waste sites. They are applicable for use at these TOC sites based on the site-specific groundwater use. Because the SQuiRT™ values are non-promulgated values, concentrations above the SQuiRT™ values do not indicate a regulatory exceedance. It is important to remember that between the various wells and the point of exposure, various chemical, physical, and biological processes occur that are likely to reduce the contaminant concentrations. Therefore, a concentration in a well is most likely not the same concentration at the point of exposure. If SQuiRT™ values were not available for a particular analyte, then the MTCA Method A default values were used.

Table 4-1 presents the groundwater parameters measured during sampling. Tables 4-2 and 4-3 show analytical results for the groundwater samples collected in November 2004 at 2737 and 2750 West Commodore Way, respectively. The footnotes at the bottom of each table identify the applicable action levels.

Appendix A contains the laboratory data packages for the samples collected. The data packages are presented in their entirety to allow the reader to evaluate the data relative to the quality control data associated with the environmental samples.

4.1 QUARTERLY GROUNDWATER SAMPLING AT 2737 WEST COMMODORE WAY

The following analytes were detected above the applicable action levels (Table 4-2):

- PCP was detected above the NOAA SQuiRT™ value (15 micrograms per liter [µg/L]) in Well 01MW-26 at a concentration of 20.3 µg/L (20.9 µg/L in duplicate sample).
- Diesel range hydrocarbons were detected above the MTCA Method A Cleanup Level (0.5 milligrams per liter [mg/L]) in Wells 01MW-03 and 01MW-09 at concentrations of 0.925 mg/L (01MW-03) and 0.736 mg/L (01MW-09).
- Gasoline range hydrocarbons were detected above the MTCA Method A Cleanup Level (800 µg/L with benzene present) in Wells 01MW-02, 01MW-03, 01MW-09, 01MW-12, and 01MW-26. The concentrations in these wells ranged from 1,130 µg/L (1,120 µg/L in duplicate sample) (Well 01MW-26) to 20,100 µg/L (Well 01MW-02).
- Benzene was detected above the NOAA SQuiRT™ value (5,300 µg/L) in Well 01MW-02 at a concentration of 8,600 µg/L.

4.2 QUARTERLY GROUNDWATER SAMPLING AT 2750 WEST COMMODORE WAY

The following analyte was detected above the applicable action level (Table 4-3):

- Gasoline was detected above the MTCA Method A Cleanup Level (800 µg/L with benzene present) in Well 01MW-04 at a concentration of 3,340 µg/L (3,250 µg/L in the duplicate sample).

5. CONCLUSIONS AND RECOMMENDATIONS

The following subsections describe the extent of impacted groundwater beneath the two properties. Figures 5-1 through 5-3 show concentration contour maps for diesel, gasoline, and benzene, respectively.

5.1 2737 WEST COMMODORE WAY

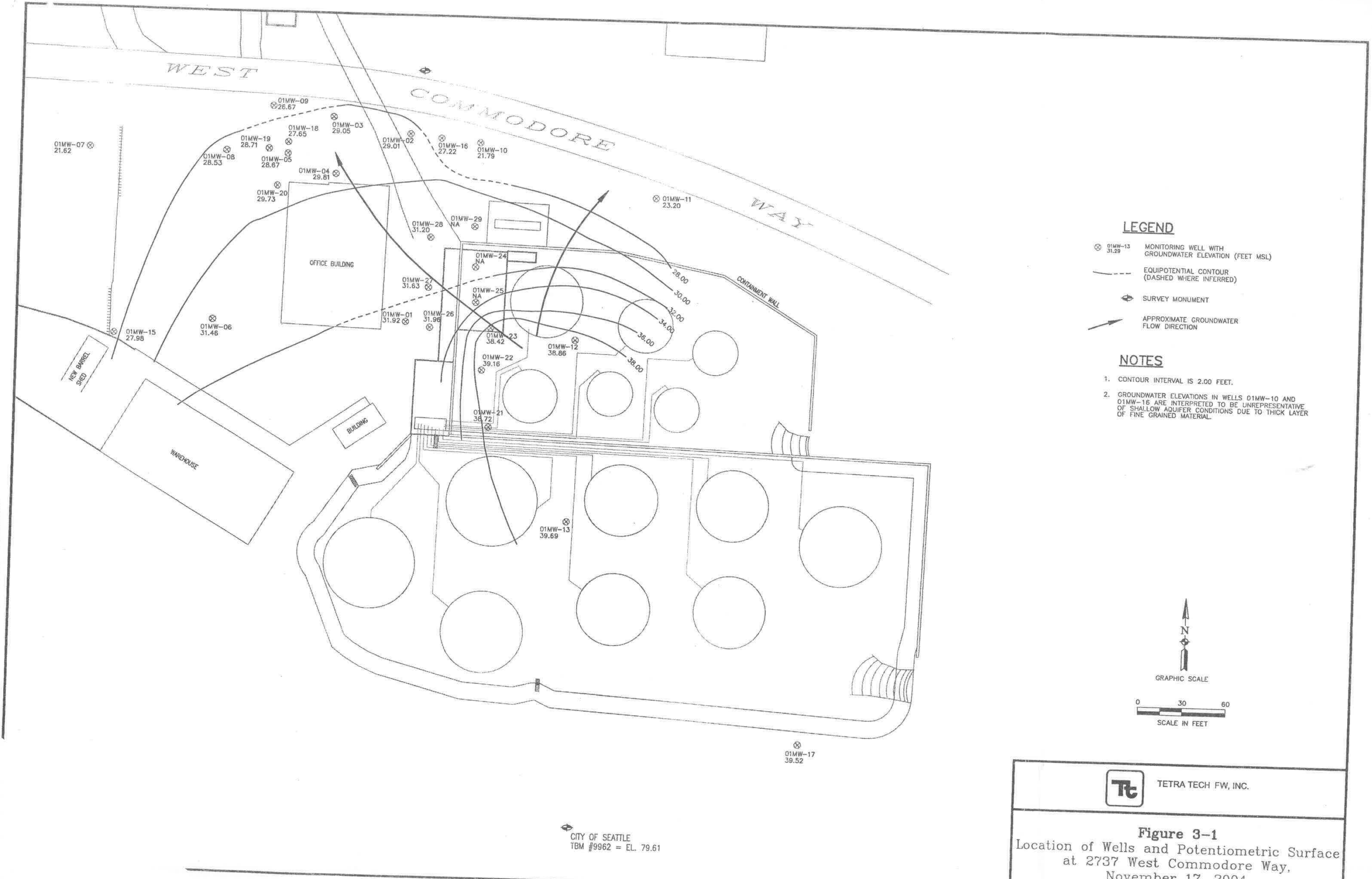
The concentrations of diesel in groundwater are similar to those detected in July 2004. The diesel plume appears to be centralized beneath the former manifold area (01MW-24 and 01MW-25) and the former PCP/Diesel Mixing Area (01MW-21 and 01MW-22) in the Lower Tank Yard. The diesel plume is interpreted to extend towards the north due to the presence of product in Wells 01MW-16, 01MW-10, and 01MW-28.

In general the concentrations of gasoline have increased slightly in Wells 01MW-03 and 01MW-02 relative to those measured in July 2004. The concentrations in Well 01MW-09 are variable and may be influenced by the free-phase product present. The northern extent of the gasoline-impacted groundwater on the property is indicated above the MTCA Method A Cleanup Level by Well 01MW-02 north of the Former Loading Dock and Well 01MW-09 northwest of the office building.

5.2 2750 WEST COMMODORE WAY

Gasoline was the only analyte detected above the MTCA Method A Cleanup Level in groundwater at the property. The exceedance of gasoline concentrations was limited to Well 02MW-04 at a concentration of 3,340 μg/L (3,250 μg/L in the duplicate sample). The gasoline-impacted groundwater does not appear to be migrating toward the Ship Canal based on the lack of detection in the well (01MW-02) near the shoreline.

FIGURES



LEGEND

⊗ 01MW-13 31.29	MONITORING WELL WITH GROUNDWATER ELEVATION (FEET MSL)
—— - - -	EQUIPOTENTIAL CONTOUR (DASHED WHERE INFERRED)
⯁	SURVEY MONUMENT
↗	APPROXIMATE GROUNDWATER FLOW DIRECTION

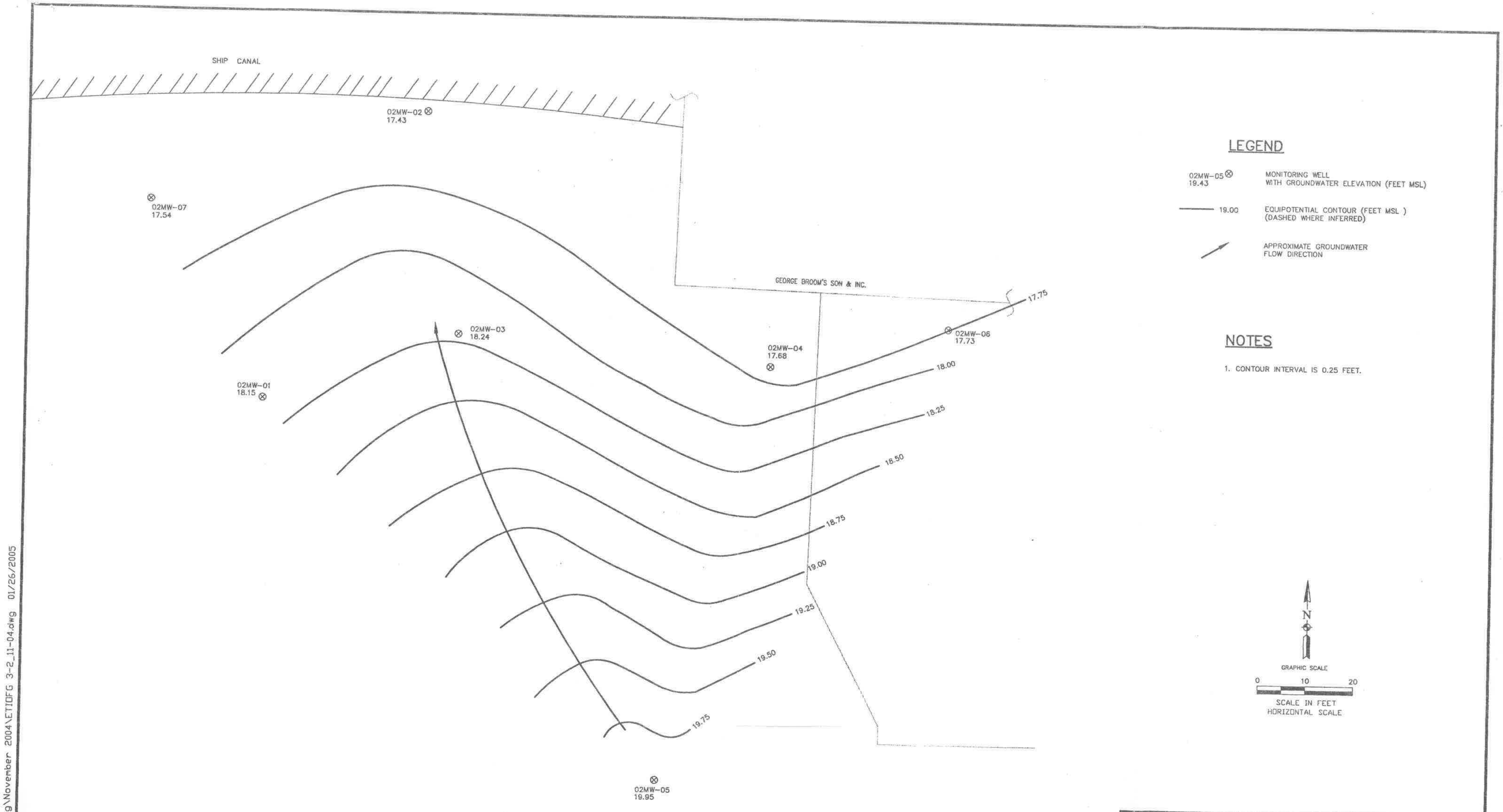
NOTES

1. CONTOUR INTERVAL IS 2.00 FEET.
2. GROUNDWATER ELEVATIONS IN WELLS 01MW-10 AND 01MW-16 ARE INTERPRETED TO BE UNREPRESENTATIVE OF SHALLOW AQUIFER CONDITIONS DUE TO THICK LAYER OF FINE GRAINED MATERIAL.

TETRA TECH FW, INC.

Figure 3-1
Location of Wells and Potentiometric Surface
at 2737 West Commodore Way,
November 17, 2004

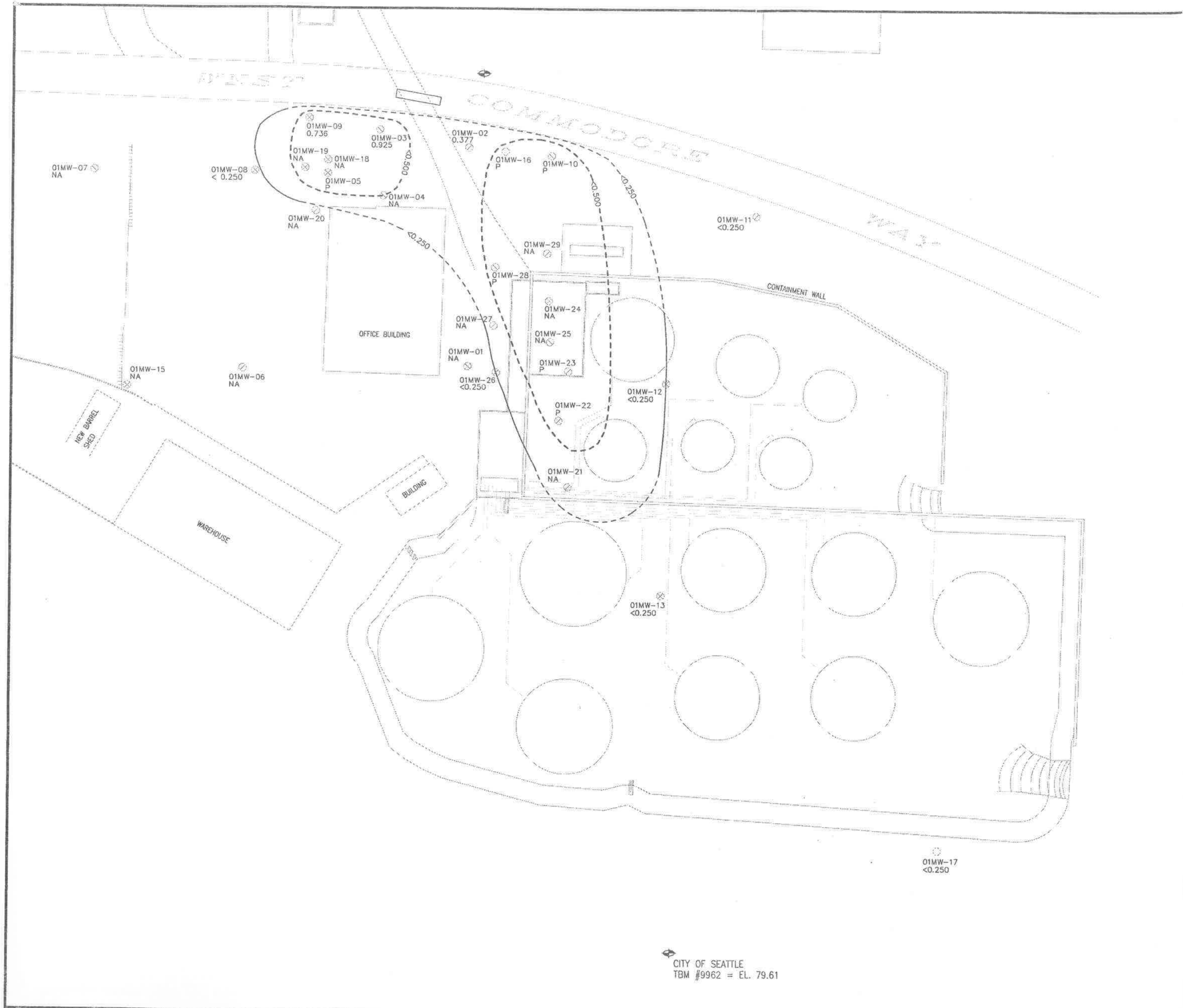
November 2004\ETIOFG 3-1_11-04.dwg 01/26/2005



TETRA TECH FW, INC.

Figure 3–2
Location of Wells
and Potentiometric Surface at
2750 West Commodore Way,
November 17, 2004

I:\Projects\23063312\dwg\November 2004\ETIDFG 3-2_11-04.dwg 01/26/2005



LEGEND

01MW-13 <0.250	MONITORING WELL WITH CONCENTRATION (mg/L)
—— - - -	MTCA METHOD A CLEANUP LEVEL (0.500 mg/L) (DASHED WHERE INFERRED)
—— - - -	CONCENTRATION CONTOUR (DASHED WHERE INFERRED)
⯁	SURVEY MONUMENT
P	PRODUCT

NOTES

1. CONCENTRATION CONTOURS ARE BASED ON ANALYTICAL RESULTS. PLEASE SEE TEXT FOR EXPLANATION OF RESULTS.

N

GRAPHIC SCALE

0 30 60

SCALE IN FEET

TETRA TECH FW, INC.

Figure 5–1
Diesel–Impacted Groundwater at
2737 West Commodore Way,
November 2004

I:\Projects\23063312\dwg\November 2004\ETIDFG 5-1_11-04.dwg 01/26/05

TABLES

Table 2-1. November 2004 Sampling Matrix

Well	NWTPH-Gx/BTEX	NWTPH-Dx	PCP	Sample Type
		2737 West Commodore Way		
01MW-02	1	1	na	Environmental
01MW-03	1	1	na	Environmental
01MW-08	1	1	na	Environmental
01MW-09	1	1	1	Environmental
01MW-11	1	1	na	Environmental
01MW-12	1	1	na	Environmental
01MW-13	1	1	na	Environmental
01MW-17	1	1	na	Environmental
01MW-26	1	1	1	Environmental
01MW-26	1	1	1	Field Duplicate
		2750 West Commodore Way		
02MW-01	1	1	na	Environmental
02MW-02	1	1	na	Environmental
02MW-04	1	1	na	Environmental
02MW-04	1	1	na	Field Duplicate
02MW-05	1	1	na	Environmental
02MW-07	1	1	na	Environmental

Abbreviations and Acronyms:

BTEX – benzene, toluene, ethylbenzene, xylene
Dx – diesel range hydrocarbons
Gx – gasoline range hydrocarbons
na – not included in analytical suite
NWTPH – northwest total petroleum hydrocarbon
PCP – pentachlorophenol

Table 3-1. Well Construction Details at West Commodore Way Properties

Well	Coordinate (WA State Plane)		Top of Casing Elevation (Feet msl)	Ground Elevation (Feet msl)	Total Depth of Boring (Feet bgs)	Total Depth of Well (Feet bgs)	Depth of Screen Interval (Feet bgs)	Elevation of Screen Interval (Feet msl)
	Northing (Feet)	Easting (Feet)						
2737 West Commodore Way								
01MW-01	245454.603	1256198.248	46.48	46.76	25.00	25.25	10 – 25	36.76 – 21.76
01MW-02	245585.027	1256198.518	44.78	45.15	25.00	24.91	10 – 25	35.15 – 20.15
01MW-03	245597.585	1256160.493	44.35	44.75	25.20	25.15	10 – 25	34.75 – 19.75
01MW-04	245563.117	1256163.148	45.08	45.56	25.00	24.90	10 – 25	35.56 – 20.56
01MW-05	245569.311	1256114.025	45.40	45.77	25.00	24.88	10 – 25	35.77 – 20.77
01MW-06	245452.677	1256064.638	47.74	48.23	25.00	25.10	10 – 25	38.23 – 23.23
01MW-07	245570.711	1255975.885	45.17	45.53	30.00	28.17	15 – 30	30.53 – 15.53
01MW-08	245570.471	1256070.985	45.21	45.63	25.00	24.93	10 – 25	35.63 – 20.63
01MW-09	245602.062	1256103.039	43.91	44.37	25.00	24.70	10 – 25	34.37 – 19.37
01MW-10	245580.377	1256246.968	45.02	45.35	25.00	24.90	10 – 25	35.35 – 20.35
01MW-11	245545.081	1256368.920	46.10	46.45	30.00	29.90	15 – 30	31.45 – 16.45
01MW-12	245444.877	1256316.069	45.84	46.29	20.00	20.00	5 – 20	40.84 – 25.84
01MW-13	245317.347	1256313.287	46.36	46.81	20.00	19.88	15 – 20	31.81 – 26.81
01MW-15	245441.314	1255996.388	50.89	50.89	30.12	30.00	10 – 30	40.89 – 20.89
01MW-16	245582.687	1256220.015	44.95	44.95	22.50	20.00	10 – 20	34.95 – 24.95
01MW-17	245166.941	1256477.520	59.42	59.42	30.00	30.00	15 – 30	44.42 – 29.42
01MW-18	245577.28	1256114.23	45.18	45.68	26.50	25.00	5 – 20	40.68 – 25.68
01MW-19	245572.45	1256100.62	45.35	45.85	31.50	25.00	5 – 20	40.85 – 25.78
01MW-20	245546.99	1256107.08	46.27	46.77	26.50	25.00	5 – 20	41.77 – 26.77
01MW-21	245382.3	1256257.4	46.21	46.52	23.50	22.92	5 – 22	41.21 – 23.79
01MW-22	245422.2	1256251.7	46.11	46.47	25.00	24.70	5 – 24	41.11 – 21.92
01MW-23	245451.9	1256257.4	45.81	46.11	20.50	19.45	5 – 19	40.81 – 26.86
01MW-24	245494.0	1256245.7	na	44.59	21.00	19.40	5 – 19	39.59 – 25.69
01MW-25	245469.4	1256246.5	na	44.61	20.50	17.32	5 – 16	39.61 – 28.29
01MW-26	245451.1	1256215.0	46.24	46.71	20.50	19.85	5 – 19	41.24 – 27.39
01MW-27	245479.0	1256213.5	46.33	46.70	21.50	19.65	5 – 19	41.33 – 27.68
01MW-28	245513.8	1256214.2	45.54	46.30	25.50	24.61	5 – 24	40.54 – 21.93
01MW-29	245522.2	1256244.6	45.57	45.92	20.50	19.75	5 – 19	40.57 – 26.82
2750 West Commodore Way								
02MW-01	245789.704	1255985.066	24.19	24.72	20.00	19.60	10 – 20	15.22 – 5.22
02MW-02	245848.029	1256019.016	20.06	20.57	10.00	9.90	5 – 10	16.07 – 11.07
02MW-03	245801.020	1256026.193	27.86	28.41	20.00	19.75	10 – 20	18.91 – 8.91
02MW-04	245795.225	1256092.088	27.17	27.59	20.00	20.05	10 – 20	18.09 – 8.09
02MW-05	245706.854	1256069.207	36.59	37.05	35.00	33.85	20 –35	17.55 – 2.55
02MW-06	245803.277	1256129.549	26.54	27.00	20.00	19.97	10 – 20	17.50 – 7.50
02MW-07	245828.584	1255960.724	20.85	21.39	12.00	12.20	2 – 12	19.89 – 9.89

Abbreviations and Acronyms:

bgs – below ground surface
msl – mean sea level
na – no data available
WA – Washington

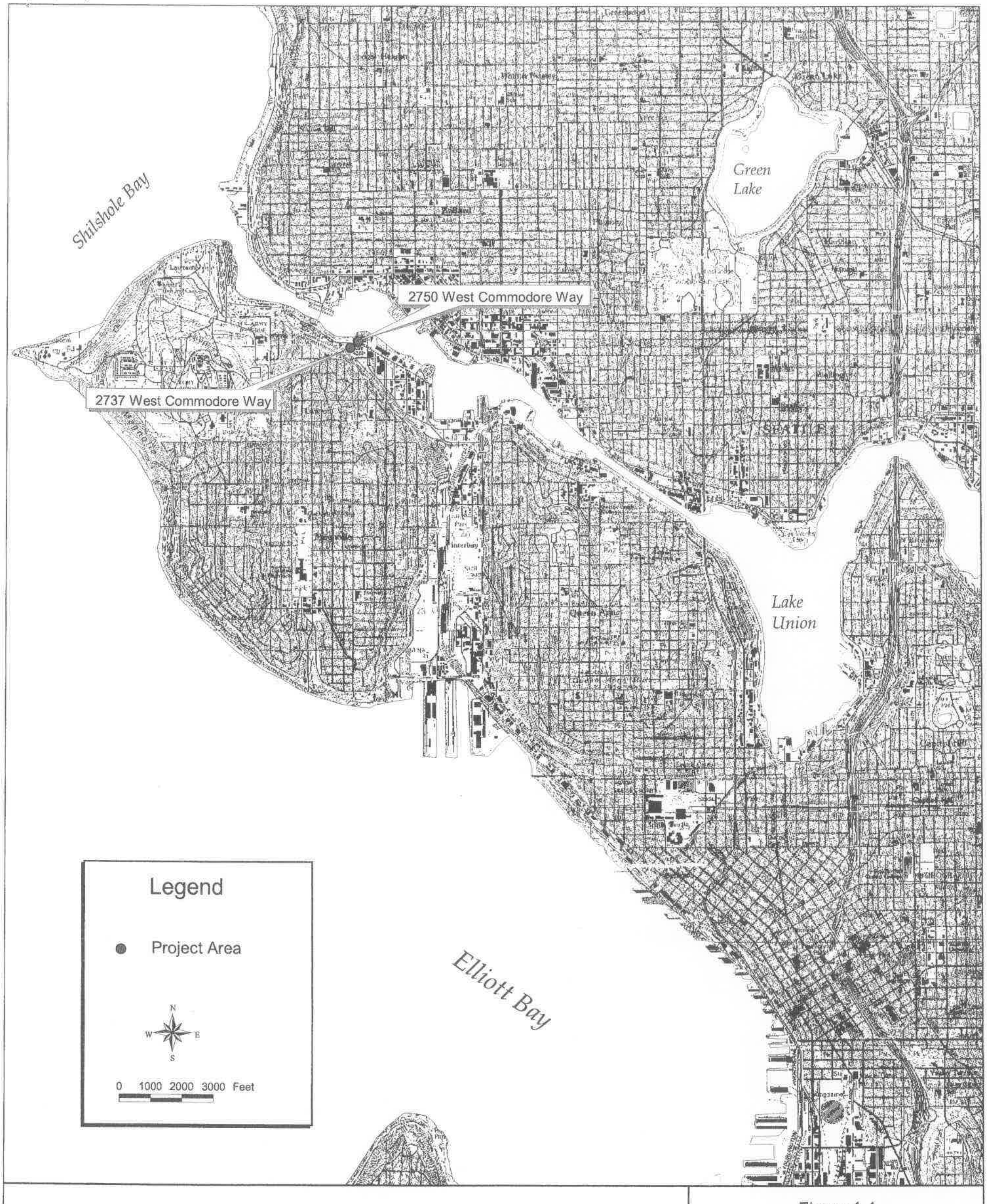


Figure 1-1

Time Oil Company
Quarterly Groundwater Sampling

Locations of 2737 and 2750
West Commodore Way

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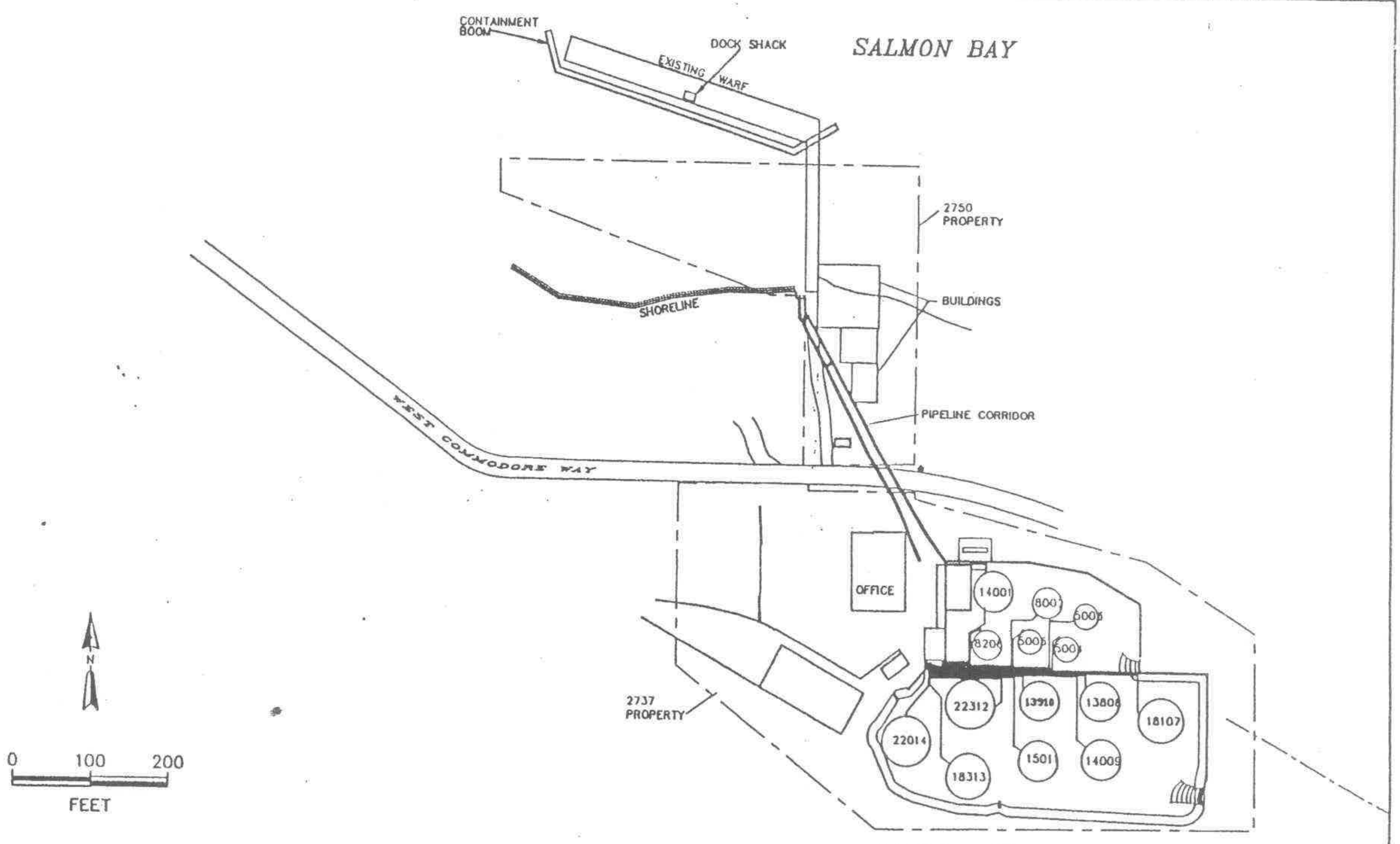

TETRA TECH FW, INC.

Figure 1–2
Layout of 2737 and 2750
West Commodore Way

Table 3-2. Water Levels Measured at West Commodore Way Properties on November 17, 2004

Well	Top of Casing Elevation (Feet msl)	Ground Elevation (Feet msl)	Total Depth of Well (Feet bgs)	Depth to Product (Feet bgs)	Depth to Water (Feet bgs)	Product Thickness (Feet)	Water Elevation (Feet msl)
2737 West Commodore Way							
01MW-01	46.48	46.76	25.25	np	14.56	0.00	31.92
01MW-02	44.78	45.15	24.91	np	15.77	0.00	29.01
01MW-03	44.35	44.75	25.15	np	15.30	0.00	29.05
01MW-04	45.08	45.56	24.90	np	15.27	0.00	29.81
01MW-05[1/]	45.40	45.77	24.88	16.25	18.65	2.40	28.67
01MW-06	47.74	48.23	25.10	np	16.28	0.00	31.46
01MW-07	45.17	45.53	28.17	np	23.55	0.00	21.62
01MW-08	45.21	45.63	24.93	np	16.68	0.00	28.53
01MW-09[1/]	43.91	44.37	24.70	np	17.24	0.00	26.67
01MW-10	45.02	45.35	24.90	22.95	24.35	1.40	21.79
01MW-11	46.10	46.45	29.90	np	22.90	0.00	23.20
01MW-12	45.84	46.29	20.00	np	6.98	0.00	38.86
01MW-13	46.36	46.81	19.88	np	6.67	0.00	39.69
01MW-15	50.89	50.89	30.00	np	22.91	0.00	27.98
01MW-16	44.95	44.95	20.00	17.67	17.97	0.30	27.22
01MW-17	59.42	59.42	30.00	np	19.90	0.00	39.52
01MW-18	45.18	45.68	25.00	np	17.53	0.00	27.65
01MW-19	45.35	45.85	25.00	np	16.64	0.00	28.71
01MW-20	46.27	46.77	25.00	np	16.54	0.00	29.73
01MW-21	46.21	46.52	25.00	np	7.49	0.00	38.72
01MW-22	46.11	46.47	25.00	6.95	6.97	0.02	39.16
01MW-23[1/]	45.81	46.11	25.00	7.37	7.48	0.11	38.42
01MW-24	na	44.59	25.00	na	na	na	na
01MW-25	na	44.61	25.00	na	na	na	na
01MW-26	46.24	46.71	25.00	np	14.28	0.00	31.96
01MW-27	46.33	46.7	25.00	np	14.70	0.00	31.63
01MW-28	45.54	46.3	25.00	14.03	15.58	1.55	31.20
01MW-29[1/]	45.57	45.92	25.00	na	na	na	na
2750 West Commodore Way							
02MW-01	24.19	24.72	19.60	np	6.04	0.00	18.15
02MW-02	20.06	20.57	9.90	np	2.63	0.00	17.43
02MW-03	27.86	28.41	19.75	np	9.62	0.00	18.24
02MW-04	27.17	27.59	20.05	np	9.49	0.00	17.68
02MW-05	36.59	37.05	33.85	np	16.64	0.00	19.95
02MW-06	26.54	27.00	19.97	np	8.81	0.00	17.73
02MW-07	20.85	21.39	12.20	np	3.31	0.00	17.54

Abbreviations and Acronyms:

bgs – below ground surface
msl – mean sea level
na – water level was not determined due to presence of product
np – no product detected

Notes:

[1/] Water elevation may be influenced by passive product skimmer installed in the well.

Table 4-1. Well Sampling Parameters, November 2004

Well	pH	Temperature (Celsius)	Conductivity (mS/cm)	Turbidity (NTU)
2737 West Commodore Way				
01MW-02	6.7	14.4	623	1.0
01MW-03	6.6	15.3	361	0.0
01MW-08	7.0	12.9	812	8.0
01MW-09	6.8	15.2	632	48.0
01MW-11	7.0	13.9	623	6.0
01MW-12	6.6	12.2	683	0.0
01MW-13	6.6	12.8	778	0.0
01MW-17	7.1	11.4	865	13.0
01MW-26	6.6	15.0	491	0.0
2750 West Commodore Way				
02MW-01	6.3	13.2	370	4.8
02MW-02	6.5	13.3	420	0.0
02MW-04	6.6	13.5	737	0.0
02MW-05	6.3	15.6	779	34.0
02MW-07	6.4	12.7	98	3.0

Abbreviations and Acronyms:
mS/cm – millisiemens per centimeter
NTU – nephelometreic turbidity unit

Table 4-2. Groundwater Results from 2737 West Commodore Way, November 2004

Sample	**PCP** (µg/L)	**Diesel** (mg/L)	**Oil** (mg/L)	**Gas** (µg/L)	**Benzene** (µg/L)	**Toluene** (µg/L)	**Ethylbenzene** (µg/L)	**Xylene** (µg/L)
Action Level	15[1/]	0.5[2/]	0.5[2/]	800[3/] 1,000[4/]	5,300[5/]	17,500[5/]	32,000[5/]	1,000[2/]
01MW-02	na	0.377	< 0.500	***20,100***	***8,600***	68.0	207	572
01MW-03	na	***0.925***	< 0.500	***9,320***	3,110	27.0	121	91.4
01MW-08	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-09	na	***0.736***	< 0.500	***5,620***	808	25.9	205	559
01MW-11	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-12	na	< 0.250	< 0.500	***1,320***	276	6.53	16.1	20.5
01MW-13	na	< 0.250	< 0.500	391	1.71	< 0.500	0.774	2.99
01MW-17	na	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-26A	***20.3***	< 0.250	< 0.500	***1,130***	131	6.94	55.0	38.6
01MW-26B	***20.9***	< 0.250	< 0.500	***1,210***	143	7.83	60.2	38.4
RPD	*3%*	*nc*	*nc*	*6.8%*	*9%*	*12%*	*9%*	*1%*

Abbreviations and acronyms:
mg/L – milligram per liter
µg/L – microgram per liter
MTCA – Model Toxics Control Act
NOAA – National Oceanic and Atmospheric Administration
na – no analysis requested
nc – not calculated
RPD – relative percent difference
SQuiRT™ – Screening Quick Reference Table
% - percent
< symbol indicates result is less than reporting limit

Notes:
Results above action levels in bold and italics
[1/] NOAA SQuiRT™ value for freshwater continuous concentration
[2/] MTCA Method A
[3/] MTCA Method A gasoline range with benzene present
[4/] MTCA Method A gasoline range without benzene present
[5/] NOAA SQuiRT™ value for freshwater maximum concentration

Table 4-3. Groundwater Results from 2750 West Commodore Way, November 2004

Sample	Diesel (mg/L)	Oil (mg/L)	Gas (μg/L)		Benzene (μg/L)	Toluene (μg/L)	Ethylbenzene (μg/L)	Xylenes (μg/L)
Action Level	0.5[2/]	0.5[2/]	800[3/]	1,000[4/]	5,300[5/]	17,500[5/]	32,000[5/]	1,000[2/]
02MW-01	< 0.250	< 0.500	188		48.4	1.24	0.682	4.46
02MW-02	< 0.250	< 0.500	< 50.0		< 0.500	< 0.500	< 0.500	< 1.00
02MW-04A	< 0.250	< 0.500	***3,340***		22.7	25.6	215	220
02MW-04B	< 0.250	< 0.500	***3,250***		21.7	24.1	188	211
RPD	*nc*	*nc*	*3%*		*5%*	*6%*	*13%*	*4%*
02MW-05	< 0.250	< 0.500	178		< 0.500	< 0.500	< 0.500	< 1.00
02MW-07	< 0.250	< 0.500	80.4		< 0.500	< 0.500	< 0.500	1.27

Abbreviations and acronyms:

mg/L – milligram per liter
μg/L – microgram per liter
MTCA – Model Toxics Control Act
NOAA – National Oceanic and Atmospheric Administration
nc – not calculated
RPD – relative percent difference
SQuiRT™ – Screening Quick Reference Table
% - percent
< symbol indicates result is less than reporting limit

Notes:

Results above action levels in bold and italics
[1/] NOAA SQuiRT™ value for freshwater continuous concentration
[2/] MTCA Method A
[3/] MTCA Method A gasoline range with benzene present
[4/] MTCA Method A gasoline range without benzene present
[5/] NOAA SQuiRT™ value for freshwater maximum concentration

Annual Event/Fourth Quarter 2005
Groundwater Monitoring Event
Site #01-600
Seattle, Washington

December 20, 2005

Prepared for

Time Oil Co.
2737 West Commodore Way
Seattle, Washington

LANDAU
ASSOCIATES
130 2nd Avenue South
Edmonds, WA 98020
(425) 778-0907

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

This report presents the results of the annual groundwater monitoring event conducted in fourth quarter 2005 (October 2005) by Landau Associates on behalf of Time Oil Co. (Time Oil) at the Time Oil Seattle Terminal, Site No. 01-600 (the site). The site is located at 2737 and 2750 West Commodore Way in Seattle, Washington (Figure 1). The two properties are adjacent to each other but on opposite sides of Commodore Way and, for the purposes of this report, will be discussed concurrently. These activities are being conducted by Time Oil as part of an independent cleanup action in progress under a Voluntary Cleanup Program agreement with the Washington State Department of Ecology (Ecology).

2.0 SITE BACKGROUND

The site is an inactive tank farm facility that was used to store gasoline, diesel, and various other liquid fuels and fuel additives. The site is surrounded by commercial and industrial properties to the east, south, and west and by the Lake Washington Ship Canal to the north. A site map showing the site topography, structures, and the locations of the groundwater monitoring wells is provided on Figure 2.

Time Oil has conducted investigations at the site since 1991, including underground storage tank (UST) removal, site assessments, monitoring well installation, and petroleum-impacted soil removal. Passive skimmer pumps were installed at five monitoring well locations beginning in 2001 and a dual-phase extraction (DPE) system was pilot-tested and permitted in 2003-04. Also, product vacuum extractions have been conducted on a periodic basis and monthly extractions are planned for the remainder of 2005. Additional future planned activities in 2005 include tank farm demolition, additional UST removal, and pipeline removal below the pier. Quarterly groundwater monitoring is expected to continue through at least 2008.

3.0 GROUNDWATER MONITORING

Quarterly groundwater monitoring activities began at the site in July 2001. Tetra Tech EC, Inc. conducted the groundwater monitoring activities through the first quarter of 2005. Landau Associates began groundwater monitoring and skimmer pump operation and maintenance during the second quarter of 2005. Landau Associates collected groundwater elevation data from 35 onsite monitoring wells, groundwater samples from 33 onsite monitoring wells (Figures 3, 4, 5, 6, 7, and 8), and product samples from 6 monitoring wells. Nineteen of these wells are sampled on an annual basis; the remainder of the wells are sampled on a quarterly basis. The results of the fourth quarter 2005 event are provided in the following sections.

3.1 GROUNDWATER ELEVATIONS

Groundwater elevation data and product thickness measurements, where observed, were collected on October 24, 2005; these data are shown in Table 1. The depth to water and/or product at each location ranged from 2.46 to 23.54 ft below the top of casing. The groundwater elevation data indicate an approximate groundwater flow direction to the north toward the Ship Canal, as shown on Figure 3. Product was observed in 9 of the 35 monitoring wells (01MW-05, 01MW-10, 01MW-16, 01MW-22 through 01MW-25, 01MW-28, and 01MW-29) at thicknesses ranging from 0.25 ft (01MW-22) to 3.07 ft (01MW-05). Product thickness and the specific gravity of the product (0.8, based on an average estimate of the specific gravity of gasoline and oils) were taken into account in the calculation of the groundwater elevations, as shown in Table 1.

3.2 GROUNDWATER SAMPLING METHODOLOGY

Groundwater samples were collected on October 24 through 26 from 33 onsite groundwater monitoring wells (Figure 3, Table 2). Prior to sampling, the depth to water in each well was measured using a decontaminated electronic oil/water interface probe. New polyethylene tubing was installed in wells (where no tubing was present from previous sampling events) and the wells were purged using a peristaltic pump and low-flow groundwater sampling techniques until the water quality parameters [turbidity, pH, temperature, conductivity, oxidation-reduction potential (ORP), and dissolved oxygen (DO)] were stable (concurrent readings within 10 percent). The groundwater samples were then collected and replicate water quality parameters were measured during sample collection to verify groundwater stability. Groundwater samples were collected directly into sample containers provided by North Creek Analytical Laboratories, Inc. (NCA), stored in a sample cooler on ice, and submitted with chain-of-custody documentation to NCA.

Groundwater samples collected from wells that contained measurable product were collected by inserting ⅝-inch back-pressured polyethylene tubing into the well and through the product layer. Smaller diameter tubing (⅜-inch) was back-pressured and inserted into the ⅝-inch tubing to minimize introduction of product into the groundwater sample. Groundwater was collected using a peristaltic pump, as described above.

3.3 PRELIMINARY GROUNDWATER SCREENING LEVELS

To provide some context for evaluation of the analytical results from the quarterly monitoring event, the data were compared to available published regulatory values for preliminary screening purposes. The preliminary screening levels for detected analytes are referenced in Table 2.

Previous quarterly groundwater monitoring reports prepared by Tetra Tech (2005) used the National Oceanic and Atmospheric Administration (NOAA) Screening Quick Reference Table (SQuiRT) values. These values were taken from the National Ambient Water Quality Criteria for protection of aquatic organisms. The portion of the Lake Washington Ship Canal (Ship Canal) that is adjacent to the site has been designated as "Lake Class" in Chapter 173-201A-130 (58) of the Washington Administrative Code defining Water Quality Standards for Surface Waters of the State of Washington. The "Lake Class" designation specifically defines the current or potential future use for the Ship Canal as drinking water; fish/shellfish migration, rearing, spawning, or harvesting; wildlife habitat; recreation; and commerce and navigation.

Therefore, the appropriate preliminary screening levels for this site for assessment of groundwater concentrations that are protective of surface water in the Ship Canal are the Ecology Model Toxics Control Act (MTCA) Method B Fresh Surface Water criteria for the protection of groundwater as fresh surface water (Ecology 2001). For each analyte, the most conservative appropriate Method B value was used as the screening level. Typically, these values are analogous to the National Ambient Water Quality Criteria for protection of human health (water ingestion and fish consumption). Where no MTCA Method B values were available (e.g., diesel-range, gasoline-range, and lube oil-range petroleum hydrocarbons), MTCA Method A criteria for the protection of groundwater as drinking water were used.

4.0 GROUNDWATER ANALYTICAL RESULTS

Groundwater samples were analyzed for benzene, toluene, ethylbenzene, and xylenes (BTEX) using U.S. Environmental Protection Agency (EPA) Method 8021, and gasoline-range total petroleum hydrocarbons (TPH) using Ecology Method NWTPH-Gx. Selected samples were also analyzed for diesel-range TPH using Ecology Method NWTPH-Dx and pentachlorophenol (PCP) using EPA Method 8270-SIM. In addition to the 33 groundwater samples, two field duplicate samples, 01MW-59 and 02MW-25, were collected from 01MW-09 and 02MW-05, respectively. Both duplicate samples were analyzed for BTEX and gasoline-range TPH, for quality assurance/quality control purposes. Sample 01MW-59 was also analyzed for diesel-range TPH. The laboratory analytical data report and data validation memorandum are provided in Appendix A. The analytical results from the groundwater monitoring event completed on October 24 through 26, 2005 are included in Table 2. A comparison of the analytical results for each analyte throughout 2005 is summarized in Table 3. The laboratory analytical results for samples of product collected from six wells (01MW-16, 01MW-22, 01MW-23, 01MW-25, 01MW-28, and 01MW-29) are provided in Table 4. The analytical results for all analytes at each monitoring well are shown on Figure 4. Concentration contours for the gasoline-range petroleum hydrocarbon concentrations in groundwater for the October 2005 event are shown on Figure 5; the benzene concentrations are contoured on Figure 6, the diesel-range petroleum hydrocarbon concentrations are contoured on Figure 7, and the PCP concentrations are contoured on Figure 8. For Figures 5, 6, and 7, the minimum contour represents the preliminary groundwater screening level. A summary of the analytical results is provided below by property.

4.1 2737 WEST COMMODORE WAY (MAIN PROPERTY)

- Diesel-range petroleum hydrocarbons were detected in the groundwater samples from wells 01MW-02, 01MW-03, 01MW-09, 01MW-18, 01MW-19, and 01MW-21 at concentrations ranging from 0.256 to 1.44 milligrams per liter (mg/L); concentrations at four of the six samples contained concentrations greater than the MTCA Method A preliminary screening level of 0.5 mg/L.

- Lube oil-range petroleum hydrocarbons were not detected in any of the groundwater samples collected during fourth quarter 2005.

- Gasoline-range petroleum hydrocarbons were detected in the groundwater samples from wells 01MW-02, 01MW-03, 01MW-04, 01MW-09, 01MW-12, 01MW-13, 01MW-18, 01MW-19, 01MW-20, 01MW-21, 01MW-26, and 01MW-27 at concentrations ranging from 363 to 25,700 micrograms per liter (μg/L); concentrations at 10 of the 12 locations contained concentrations greater than the MTCA Method A preliminary screening level of 800 μg/L (when benzene is present).

- Benzene was detected in groundwater samples from wells 01MW-02, 01MW-03, 01MW-04, 01MW-09, 01MW-12, 01MW-13, 01MW-18, 01MW-19, 01MW-20, 01MW-21, 01MW-26, and 01MW-27 at concentrations ranging from 1.38 to 9,840 µg/L, with the maximum concentration observed at well 01MW-03. All of the detected benzene concentrations are greater than the MTCA Method B preliminary screening level of 1.2 µg/L.

- Toluene was detected in groundwater samples from wells 01MW-02, 01MW-03, 01MW-04, 01MW-09, 01MW-12, 01MW-18, 01MW-19, 01MW-20, 01MW-26, and 01MW-27 at concentrations ranging from 2.88 to 986 µg/L, which are all less than the MTCA Method B preliminary screening level of 1,000 µg/L.

- Ethylbenzene was detected in groundwater samples from wells 01MW-02, 01MW-03, 01MW-04, 01MW-09, 01MW-12, 01MW-18, 01MW-19, 01MW-20, 01MW-26, and 01MW-27 at concentrations ranging from 14.3 to 894 µg/L. Only one sample (01MW-19 with a concentration of 894 µg/L) was above the MTCA Method B preliminary screening level of 700 µg/L.

- Total xylenes were detected in groundwater samples from wells 01MW-02, 01MW-03, 01MW-04, 01MW-09, 01MW-12, 01MW-13, 01MW-18, 01MW-19, 01MW-20, 01MW-21, 01MW-26, and 01MW-27 at concentrations ranging from 2.26 to 4,610 µg/L, which are all less than the MTCA Method B preliminary screening level of 10,000 µg/L.

- PCP was detected in the groundwater samples from 01MW-01, 01MW-22, 01MW-23, and 01MW-26 at concentrations of 6.79, 273, 19.8, and 9 µg/L, respectively. All detected concentrations are greater than the MTCA Method B preliminary screening level of 0.01 µg/L.

4.2 2750 WEST COMMODORE WAY (ADJACENT TO SHIP CANAL)

- Concentrations of all analyzed constituents (gasoline-range hydrocarbons and BTEX) were below laboratory reporting limits at the two wells closest to the Ship Canal, 02MW-02 and 02MW-07, and in well 02MW-06. Except as listed below, concentrations of analyzed constituents were also below laboratory reporting limits.

- Gasoline-range petroleum hydrocarbons were detected at a concentration greater than the MTCA Method A preliminary screening level of 800 µg/L (when benzene is present) in the groundwater sample from well 02MW-04, at an estimated concentration of 3,990 µg/L. Gasoline-range petroleum hydrocarbons were also detected at wells 02MW-01 and 02MW-05 at concentrations of 379 and 335 µg/L, respectively.

- Benzene was detected at concentrations greater than the MTCA Method B preliminary screening level of 1.2 µg/L in groundwater samples from wells 02MW-01 and 02MW-04 at concentrations of 52.2 and 29.2 µg/L, respectively. In addition, benzene was detected at well 02MW-03 at a concentration of 0.894 µg/L.

- Toluene was detected in the groundwater sample from well 02MW-04 at a concentration of 262 µg/L, which is less than the MTCA Method B preliminary screening level of 1,000 µg/L.

- Ethylbenzene was detected in groundwater samples from wells 02MW-01 and 02MW-04 at concentrations of 1.38 µg/L and 24.9 µg/L, respectively, which are less than the MTCA Method B preliminary screening level of 700 µg/L.

- Total xylenes were detected in groundwater samples from wells 02MW-01 and 02MW-04 at concentrations of 3.84 and 263 µg/L, respectively, which are less than the MTCA Method B preliminary cleanup level of 10,000 µg/L.

4.3 PRODUCT SAMPLING

Passive skimmer pumps are currently installed in monitoring wells 01MW-05, 01MW-09, 01MW-23, 01MW-25, and 01MW-29. Product (if present) was not removed from the passive skimmers during fourth quarter 2005. In an effort to determine whether the product on site contains PCP, product samples from wells 01MW-16, 01MW-22, 01MW-23, 01MW-25, 01MW-28, and 01MW-29 were collected and analyzed for PCP. The product results are provided in Table 4. The results indicate that the product in all the wells sampled consists predominantly of diesel- and lube oil-range petroleum constituents and does not contain PCP. This information will be used to identify appropriate disposal options for product removed from the passive skimmers and during planned monthly batch vacuum extractions of product from site wells.

5.0 SUMMARY AND CONCLUSIONS

Gasoline-range petroleum hydrocarbons and benzene were detected at concentrations exceeding MTCA screening levels in wells on both properties in areas including the northern portion of the tank farm and the office building toward Commodore Way and in isolated areas to the north of Commodore Way, as shown on Figures 3, 5, and 6. On the south side of Commodore Way, diesel-range petroleum hydrocarbons also exceeded MTCA screening levels, as shown on Figure 7, but in a less widespread area of the tank farm. PCP exceeded the MTCA screening level where analyzed, but only in the former PCP mixing area (Figure 8). The maximum concentrations of gasoline-range petroleum hydrocarbons and benzene constituents occur in areas north and east of the office building on the 2737 Commodore Way property. Overall, concentrations of the petroleum constituents exceeding the MTCA preliminary screening levels are greater on the 2737 Commodore Way property than on the 2750 Commodore Way property (adjacent to the Ship Canal) and appear to decrease between the two areas. However, this decrease could reflect the distribution of monitoring well locations between the two areas.

In general, detected analytes were found to have decreased from levels observed in the third quarter of 2005 (July) on both the 2737 and 2750 Commodore Way properties (Table 3), with the exception of monitoring wells 01MW-03, 01MW-12, and 02MW-01. During fourth quarter 2005, there were no detections of target analytes in wells 02MW-02 or 02MW-07, which are located adjacent to the Ship Canal and downgradient from the site (Figure 4).

Due to only a 1-liter capacity and quarterly maintenance, the passive skimmer pumps are not able to remove a quantity of product that will have a measurable impact on the groundwater quality. Monthly batch vacuum extractions of product from site wells should be more effective in removing the product. Due to potential concentrations of PCP in the product, the vacuum extractions are scheduled to begin following the determination of a proper disposal method and facility. Based on the lack of PCP in the product, it is anticipated that vacuum extractions will be conducted in the near future to remove the product in areas where there is not a potential for the extractions to influence the PCP distribution in groundwater.

6.0 USE OF THIS REPORT

This quarterly groundwater report has been prepared by Landau Associates for the exclusive use of Time Oil for specific application to the Seattle Terminal No. 01-600 site. Services for this project were conducted in accordance with the Environmental Services Contract between Time Oil Co. and Landau Associates, Inc. Landau Associates has performed our services in accordance with generally accepted engineering and consulting standards for environmental work in effect at the time and locality services were performed. The reuse of information, conclusions, and recommendations provided herein by Time Oil or others in connection with any site other than the Seattle Terminal without Landau Associates' written permission shall be at the sole risk of Time Oil and without liability to Landau Associates.

This document has been prepared under the supervision and direction of the following key staff.

LANDAU ASSOCIATES, INC.

Evalyn I. Albright
Senior Staff Environmental Scientist

Rebekah Brooks, L.G.
Associate Hydrogeologist

EIA/RB/ccy
No. 231028.010.011

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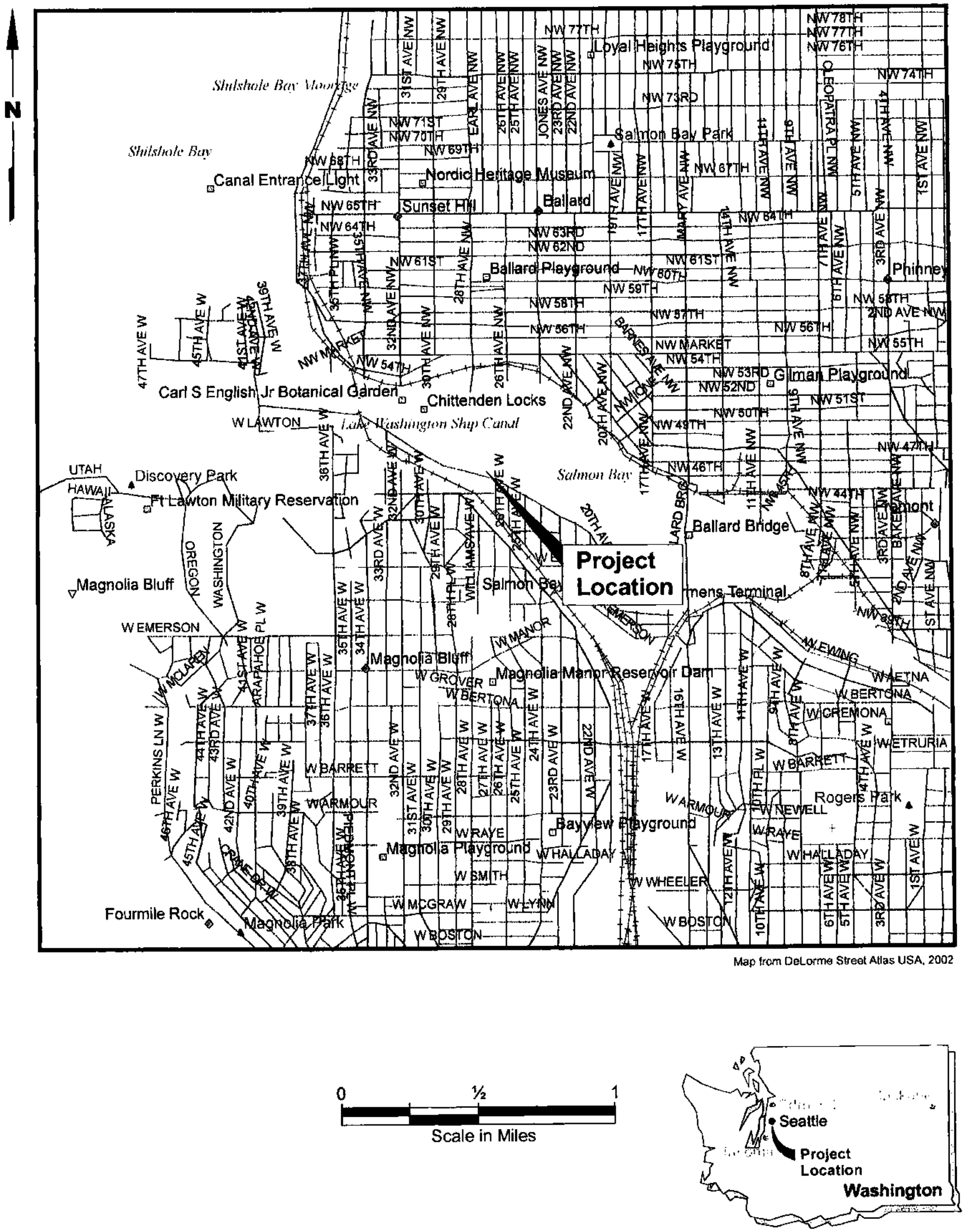
Tetra Tech. 2005. Draft: *Quarterly Groundwater Sampling Report for January 2005, 2737 West Commodore Way and 2750 West Commodore Way, Seattle, Washington.* March.

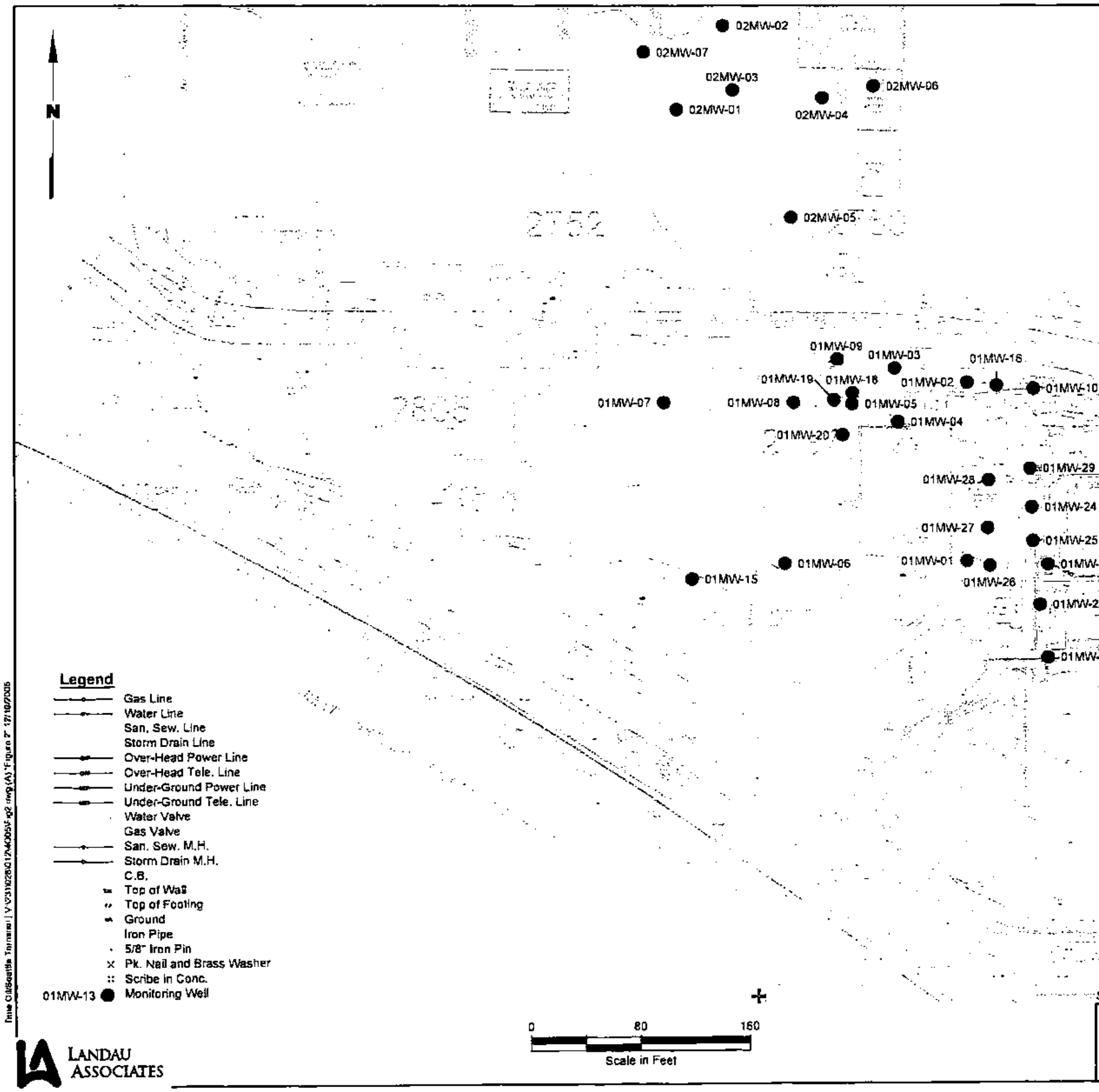


Map from DeLorme Street Atlas USA, 2002

Time Oil/Seattle Terminal | V:\231\028\012\4Q05\Fig1.cdr 12/19/2005

LANDAU ASSOCIATES

Time Oil Seattle Terminal Seattle, Washington	**Vicinity Map**	Figure 1



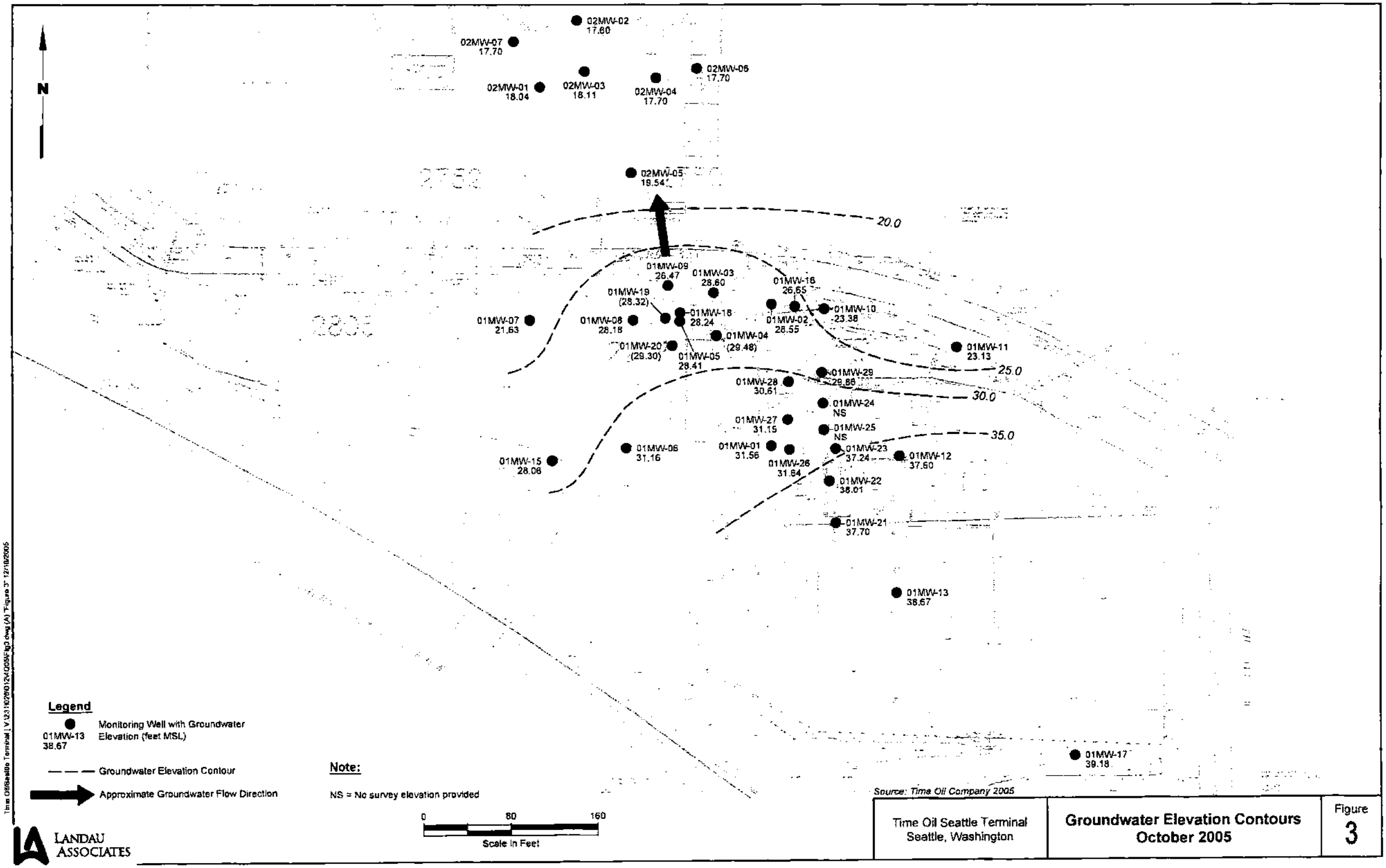
Source: *Time Oil Company 2005*

Time Oil Seattle Terminal
Seattle, Washington

Site Plan and Monitoring Well Locations

Figure
2

Time Oil/Seattle Terminal | V:\231\028\012\400\05F-02.dwg (A) "Figure 2" 12/10/2005



Legend

● 01MW-13 38.67 Monitoring Well with Groundwater Elevation (feet MSL)

— — — Groundwater Elevation Contour

➡ Approximate Groundwater Flow Direction

Note:

NS = No survey elevation provided

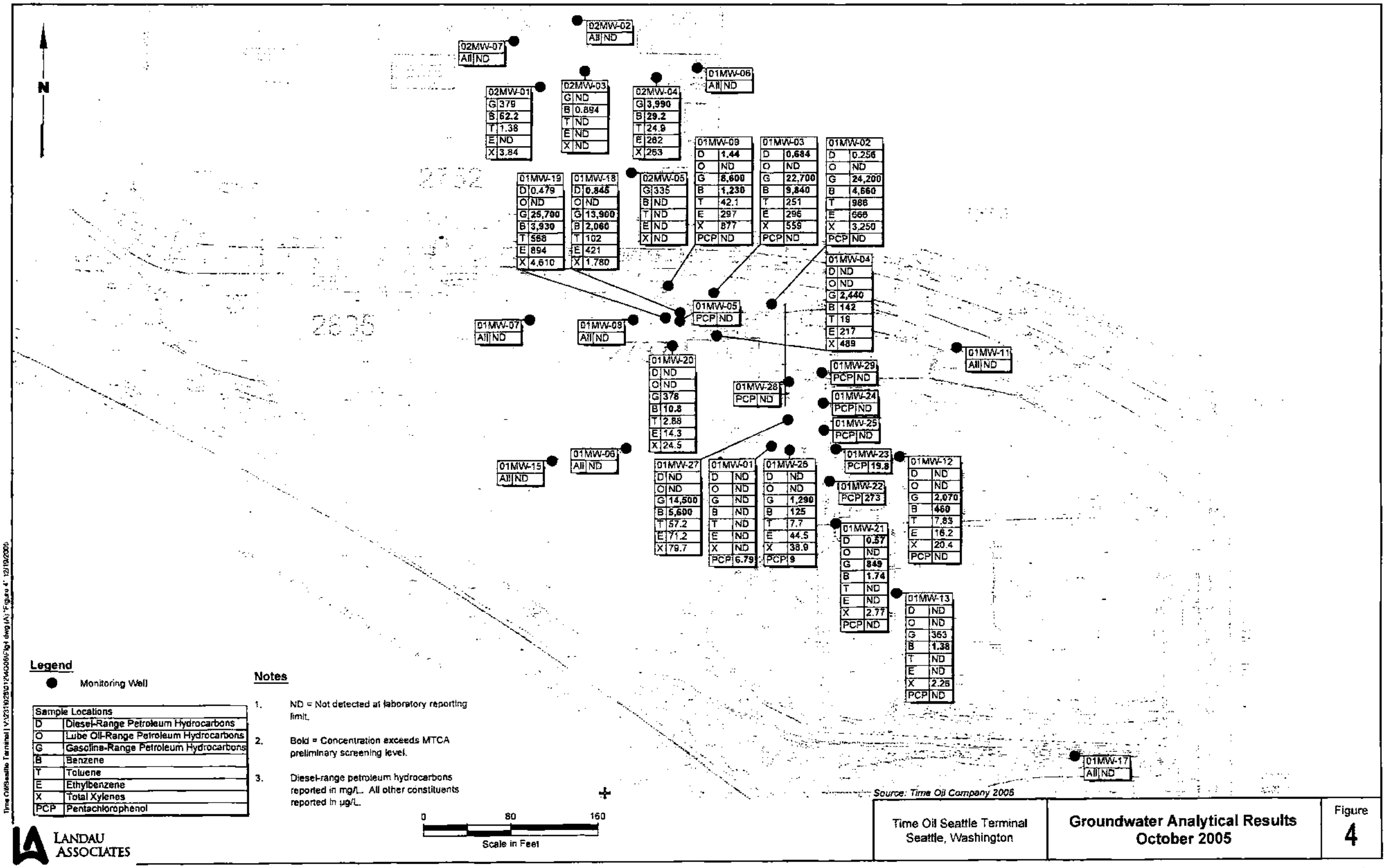
Source: *Time Oil Company 2005*

LANDAU ASSOCIATES

Time Oil Seattle Terminal
Seattle, Washington

Groundwater Elevation Contours
October 2005

Figure
3



Source: Time Oil Company 2005

Legend

● Monitoring Well

Sample Locations	
D	Diesel-Range Petroleum Hydrocarbons
O	Lube Oil-Range Petroleum Hydrocarbons
G	Gasoline-Range Petroleum Hydrocarbons
B	Benzene
T	Toluene
E	Ethylbenzene
X	Total Xylenes
PCP	Pentachlorophenol

Notes

1. ND = Not detected at laboratory reporting limit.
2. Bold = Concentration exceeds MTCA preliminary screening level.
3. Diesel-range petroleum hydrocarbons reported in mg/L. All other constituents reported in µg/L.

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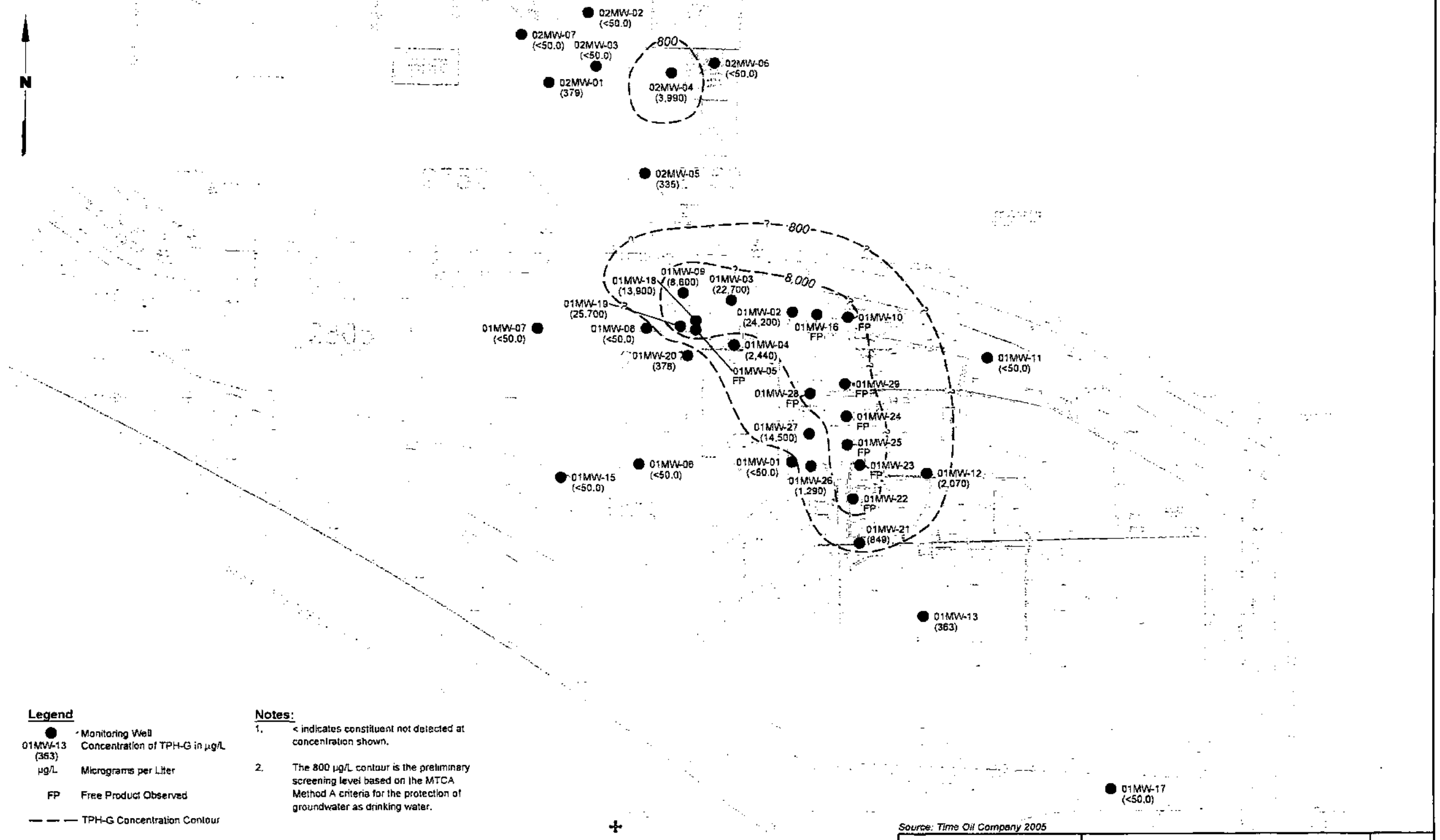
Time Oil Seattle Terminal
Seattle, Washington

Groundwater Analytical Results
October 2005

Figure
4

Time Oil/Seattle Terminal | V:\231\028\012\4\006\Fig4.dwg (A) "Figure 4" 12/19/2005



Legend

●	Monitoring Well
01MW-13 (363)	Concentration of TPH-G in µg/L
µg/L	Micrograms per Liter
FP	Free Product Observed
— — —	TPH-G Concentration Contour

Notes:

1. < indicates constituent not detected at concentration shown.
2. The 800 µg/L contour is the preliminary screening level based on the MTCA Method A criteria for the protection of groundwater as drinking water.

Source: Time Oil Company 2005

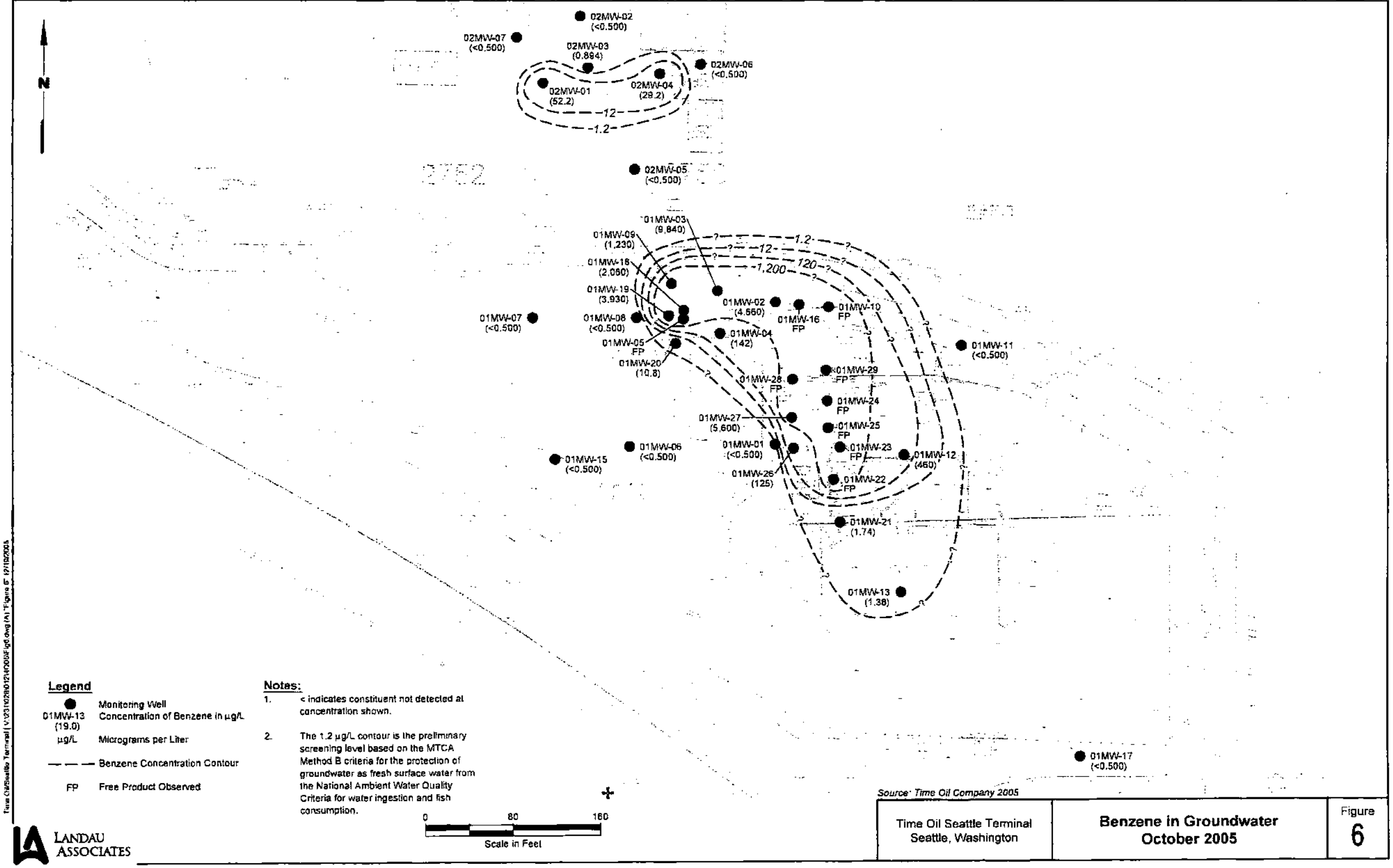
LANDAU ASSOCIATES

Time Oil Seattle Terminal
Seattle, Washington

Gasoline-Range Petroleum Hydrocarbons in Groundwater October 2005

Figure
5

Time Oil/Seattle Terminal | V:\231\028\012\400\05\Fig5.dwg (A) "Figure 5" 12/19/2005



Legend

● 01MW-13 (19.0)	Monitoring Well Concentration of Benzene in µg/L
µg/L	Micrograms per Liter
— — —	Benzene Concentration Contour
FP	Free Product Observed

Notes:

1. < indicates constituent not detected at concentration shown.
2. The 1.2 µg/L contour is the preliminary screening level based on the MTCA Method B criteria for the protection of groundwater as fresh surface water from the National Ambient Water Quality Criteria for water ingestion and fish consumption.

Source: *Time Oil Company 2005*

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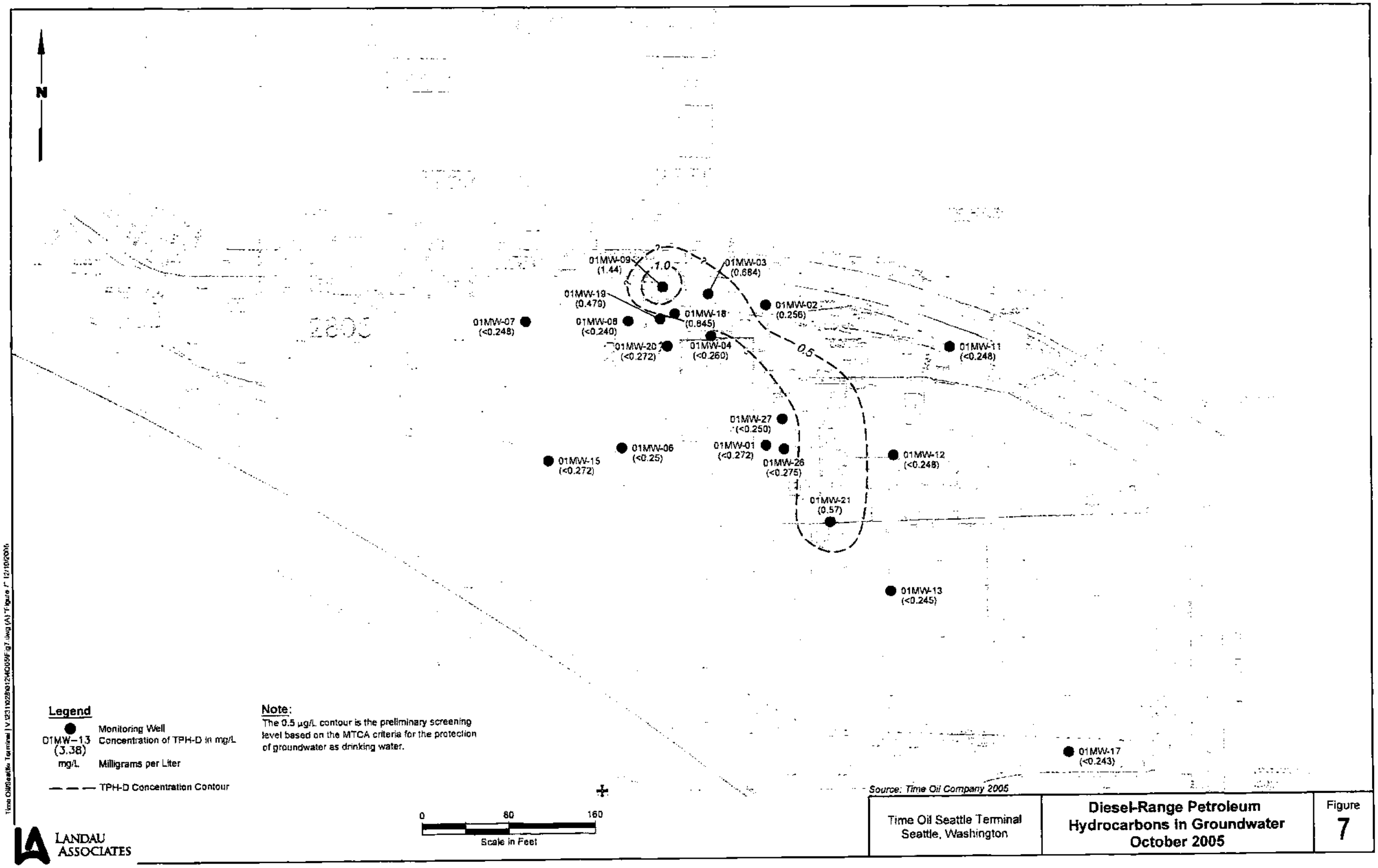
Time Oil Seattle Terminal
Seattle, Washington

Benzene in Groundwater
October 2005

Figure
6

Time Oil/Seattle Terminal | V:\231\028\012\4\005\Fig6.dwg (A) "Figure 6" 12/19/2005



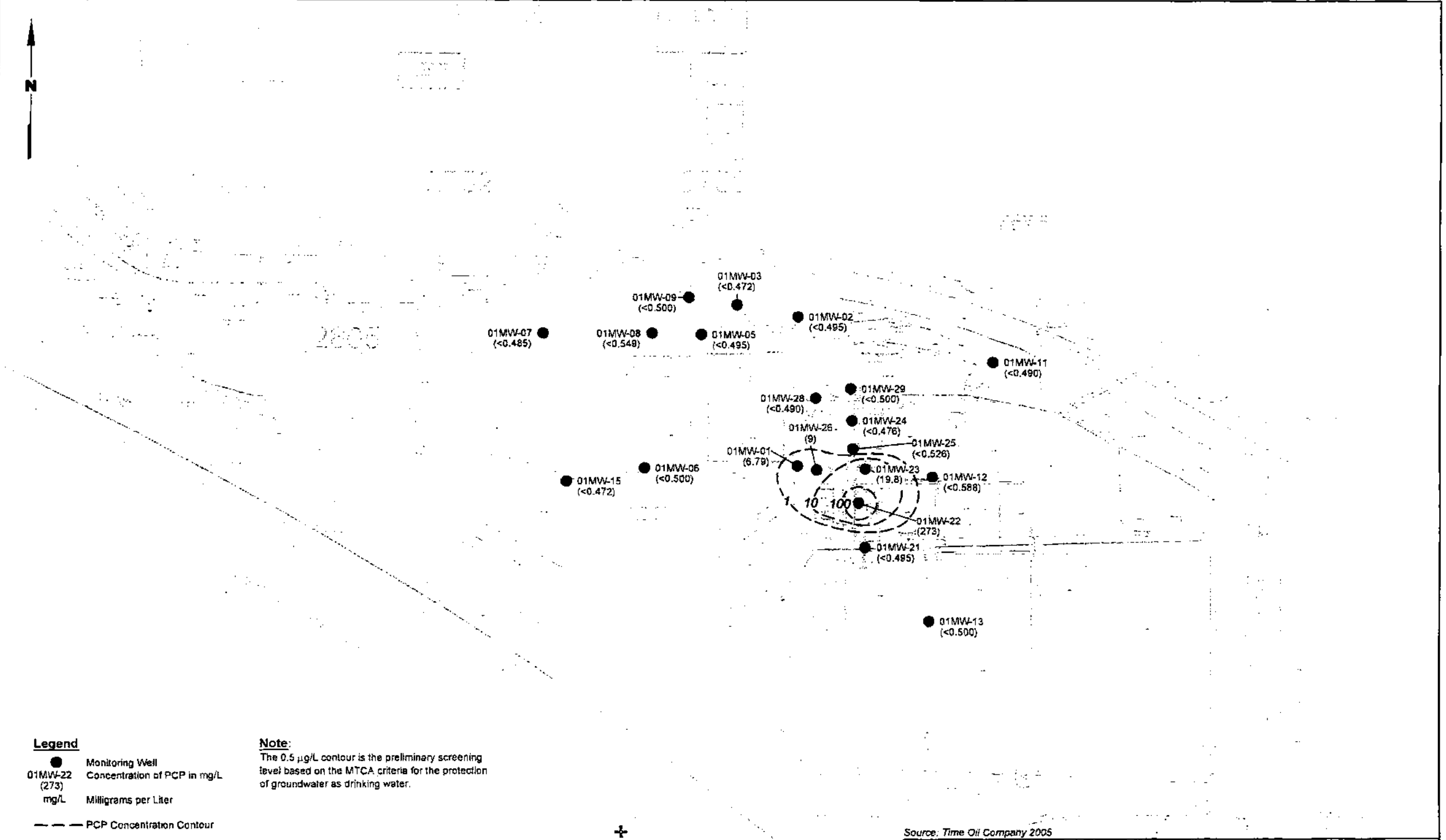
Note:
The 0.5 µg/L contour is the preliminary screening level based on the MTCA criteria for the protection of groundwater as drinking water.

Source: *Time Oil Company 2005*

Time Oil Seattle Terminal
Seattle, Washington

Diesel-Range Petroleum Hydrocarbons in Groundwater October 2005

Figure
7



Note:
The 0.5 µg/L contour is the preliminary screening level based on the MTCA criteria for the protection of groundwater as drinking water.

Source: Time Oil Company 2005

LANDAU ASSOCIATES

Time Oil Seattle Terminal
Seattle, Washington

PCP in Groundwater
October 2005

Figure
8

TABLE 1
GROUNDWATER ELEVATIONS
TIME OIL SITE #01-600 - SEATTLE TERMINAL
SEATTLE, WASHINGTON

Location	Well Casing Elevation	Time	Depth to Water	Depth to Product	Product Thickness	Groundwater Elevation	Comments
01MW-01	46.48	11:40	14.92			31.56	Product odor
01MW-02	44.78	12:20	16.23			28.55	Product odor
01MW-03	44.35	12:25	15.75			28.60	
01MW-04*	45.08	16:32	15.60			29.48	
01MW-05	45.40	12:45	19.45	16.38	3.07	28.41	Sheen, strong odor
01MW-06	47.74	9:39	16.58			31.16	Petroluem odor
01MW-07	45.17	9:52	23.54			21.63	
01MW-08	45.21	9:59	17.03			28.18	
01MW-09	43.91	10:05	17.44			26.47	Sheen, strong odor
01MW-10	45.02	11:55	23.47	21.18	2.29	23.38	Light colored product
01MW-11	46.10	10:10	22.97			23.13	Slight product odor
01MW-12	45.84	10:57	8.24			37.60	Strong product odor
01MW-13	46.36	9:32	7.69			38.67	
01MW-15	50.89	9:42	22.83			28.06	
01MW-16	44.95	12:10	19.40	18.03	1.37	26.65	Light colored product
01MW-17	59.42	9:27	20.24			39.18	
01MW-18	45.18	12:40	16.94			28.24	Strong product odor
01MW-19	45.35	12:30	17.03			28.32	Strong product odor
01MW-20	46.27	12:35	16.97			29.30	Strong product odor
01MW-21	46.21	10:20	8.51			37.70	Well under pressure; strong product odor
01MW-22	46.11	10:24	8.30	8.05	0.25	38.01	Dark black product
01MW-23	45.81	10:36	9.04	8.45	0.59	37.24	Dark black product
01MW-24	NS	11:05	9.37	9.10	0.27	---	Light colored product
01MW-25	NS	11:26	10.21	8.54	1.67	---	Dark black product
01MW-26	46.24	11:31	14.60			31.64	Product odor
01MW-27	46.33	11:43	15.18			31.15	Sheen on probe
01MW-28	45.54	11:48	16.50	14.54	1.96	30.61	Dark black product and light colored product
01MW-29	45.57	11:21	16.72	15.46	1.26	29.86	Light colored product
02MW-01	24.19	8:48	6.15			18.04	
02MW-02	20.06	8:28	2.46			17.60	
02MW-03	27.86	9:05	9.75			18.11	
02MW-04	27.17	9:01	9.47			17.70	
02MW-05	36.59	8:55	17.05			19.54	
02MW-06	26.54	8:58	8.84			17.70	
02MW-07	20.85	8:45	3.15			17.70	

All units in feet, mean sea level.

Where light nonaqueous phase liquid (LNAPL) thickness was measured, groundwater elevation was adjusted to account for the presence of LNAPL in the well using the method described in Lenhard and Parker (1990).

Water levels collected on 10/24/2005.

* Water level collected on 10/25/05.

NS - No survey elevation provided.

TABLE 2
GROUNDWATER ANALYTICAL DATA
TIME OIL SITE #01-600 - SEATTLE TERMINAL
SEATTLE, WASHINGTON

	Screening Criteria	01MW-01 B5J0554-12 10/25/2005	01MW-02 B5J0554-08 10/25/2005	01MW-03 B5J0554-15 10/25/2005	01MW-04 B5J0554-16 10/25/2005	01MW-05 B5J0581-13 10/26/2005	01MW-06 B5J0554-09 10/25/2005	01MW-07 B5J0545-09 10/24/2005	01MW-08 B5J0554-01 10/25/2005
DIESEL-RANGE HYDROCARBONS									
NWTPH-Dx (mg/L)									
Diesel Range Hydrocarbons	0.5 (a)	0.272 U	**0.256**	**0.684**	0.260 U	NA	0.25 U	0.248 U	0.240 U
Lube Oil Range Hydrocarbons	0.5 (a)	0.543 U	0.476 U	0.532 U	0.521 U	NA	0.500 U	0.495 U	0.481 U
GASOLINE AND BTEX									
NWTPH-Gx AND EPA METHOD 8021B (µg/L)									
Gasoline Range Hydrocarbons	800 (a)	50.0 U	**24,200**	**22,700**	**2,440**	NA	50.0 U	50.0 U	50.0 U
Benzene	1.2 (b)	0.500 U	**4,660**	**9,840**	**142**	NA	0.500 U	0.500 U	0.500 U
Toluene	1000 (b)	0.500 U	**986**	**251**	**19**	NA	0.500 U	0.500 U	0.500 U
Ethylbenzene	700 (b)	0.500 U	**666**	**296**	**217**	NA	0.500 U	0.500 U	0.500 U
Xylenes (total)	10,000 (b)	1.00 U	**3,250**	**569**	**489**	NA	1.00 U	1.00 U	1.00 U
PENTACHLOROPHENOL (PCP)									
EPA Method 8270-SIM (µg/L)									
Pentachlorophenol	0.01 (b)	**6.79**	0.495 U	0.472 U	NA	0.495 U	0.500 U	0.485 U	0.549 U

TABLE 2
GROUNDWATER ANALYTICAL DATA
TIME OIL SITE #01-600 - SEATTLE TERMINAL
SEATTLE, WASHINGTON

	Screening Criteria	01MW-09 B5J0554-05 10/25/2005	Dup of 01 MW - 09 01MW-59 B5J0554-06 10/25/2005	01MW-11 B5J0545-13 10/24/2005	01MW-12 B5J0554-11 10/25/2005	01MW-13 B5J0545-12 10/24/2005	01MW-15 B5J0554-02 10/25/2005	01MW-17 B5J0545-11 10/24/2005	01MW-18 B5J0554-07 10/25/2005
DIESEL-RANGE HYDROCARBONS									
NWTPH-Dx (mg/L)									
Diesel Range Hydrocarbons	0.5 (a)	**1.44** J	**0.619** J	0.248 U	0.248 U	0.245 U	0.272 U	0.243 U	**0.845**
Lube Oil Range Hydrocarbons	0.5 (a)	0.495 U	0.532 U	0.495 U	0.495 U	0.490 U	0.543 U	0.485 U	0.495 U
GASOLINE AND BTEX									
NWTPH-Gx AND EPA METHOD 8021B (µg/L)									
Gasoline Range Hydrocarbons	800 (a)	**8,600**	**9,480**	50.0 U	**2,070**	**363**	50.0 U	50.0 U	**13,900**
Benzene	1.2 (b)	**1,230**	**1,440**	0.500 U	**460**	**1.38**	0.500 U	0.500 U	**2,060**
Toluene	1000 (b)	**42.1**	**36.9**	0.500 U	**7.83**	0.500 U	0.500 U	0.500 U	**102**
Ethylbenzene	700 (b)	**297**	**285**	0.500 U	**16.2**	0.500 U	0.500 U	0.500 U	**421**
Xylenes (total)	10,000 (b)	**877**	**725**	1.00 U	**20.4**	**2.26**	1.00 U	1.00 U	**1,780**
PENTACHLOROPHENOL (PCP)									
EPA Method 8270-SIM (µg/L)									
Pentachlorophenol	0.01 (b)	0.500 U	0.485 U	0.490 U	0.588 U	0.500 U	0.472 U	NA	NA

TABLE 2
GROUNDWATER ANALYTICAL DATA
TIME OIL SITE #01-600 - SEATTLE TERMINAL
SEATTLE, WASHINGTON

	Screening Criteria	01MW-19 B5J0554-14 10/25/2005	01MW-20 B5J0554-13 10/25/2005	01MW-21 B5J0554-10 10/25/2005	01MW-22 B5J0545-11 10/26/2005	01MW-23 B5J0581-03 10/26/2005	01MW-24 B5J0581-07 10/26/2005	01MW-25 B5J0581-05 10/26/2005
DIESEL-RANGE HYDROCARBONS								
NWTPH-Dx (mg/L)								
Diesel Range Hydrocarbons	0.5 (a)	**0.479**	0.272 U	**0.57**	NA	NA	NA	NA
Lube Oil Range Hydrocarbons	0.5 (a)	0.500 U	0.543 U	0.481 U	NA	NA	NA	NA
GASOLINE AND BTEX								
NWTPH-Gx AND EPA METHOD 8021B (µg/L)								
Gasoline Range Hydrocarbons	800 (a)	**25,700**	**378**	**849**	NA	NA	NA	NA
Benzene	1.2 (b)	**3,930**	**10.8**	**1.74**	NA	NA	NA	NA
Toluene	1000 (b)	**568**	**2.88**	0.500 U	NA	NA	NA	NA
Ethylbenzene	700 (b)	**894**	**14.3**	0.500 U	NA	NA	NA	NA
Xylenes (total)	10,000 (b)	**4,610**	**24.5**	**2.77**	NA	NA	NA	NA
PENTACHLOROPHENOL (PCP)								
EPA Method 8270-SIM (µg/L)								
Pentachlorophenol	0.01 (b)	NA	NA	0.495 U	**273**	**19.8**	0.476 U	0.526 U

TABLE 2
GROUNDWATER ANALYTICAL DATA
TIME OIL SITE #01-600 - SEATTLE TERMINAL
SEATTLE, WASHINGTON

	Screening Criteria	01MW-26 B5J0554-03 10/25/2005	01MW-27 B5J0554-04 10/25/2005	01MW-28 B5J0581-10 10/26/2005	01MW-29 B5J0581-08 10/26/2005	02MW-01 B5J0545-03 10/24/2005	02MW-02 B5J0545-01 10/24/2005	02MW-03 B5J0545-06 10/24/2005
DIESEL-RANGE HYDROCARBONS								
NWTPH-Dx (mg/L)								
Diesel Range Hydrocarbons	0.5 (a)	0.275 U	0.250 U	NA	NA	NA	NA	NA
Lube Oil Range Hydrocarbons	0.5 (a)	0.549 U	0.500 U	NA	NA	NA	NA	NA
GASOLINE AND BTEX								
NWTPH-Gx AND EPA METHOD 8021B (µg/L)								
Gasoline Range Hydrocarbons	800 (a)	**1,290**	**14,500**	NA	NA	**379**	50.0 U	50.0 U
Benzene	1.2 (b)	**125**	**5,600**	NA	NA	**52.2**	0.500 U	**0.894**
Toluene	1000 (b)	**7.7**	**57.2**	NA	NA	**1.38**	0.500 U	0.500 U
Ethylbenzene	700 (b)	**44.5**	**71.2**	NA	NA	0.500 U	0.500 U	0.500 U
Xylenes (total)	10,000 (b)	**38.9**	**79.7**	NA	NA	**3.84**	1.00 U	1.00 U
PENTACHLOROPHENOL (PCP)								
EPA Method 8270-SIM (µg/L)								
Pentachlorophenol	0.01 (b)	**9**	NA	0.490 U	0.500 U	NA	NA	NA

TABLE 2
GROUNDWATER ANALYTICAL DATA
TIME OIL SITE #01-600 - SEATTLE TERMINAL
SEATTLE, WASHINGTON

	Screening Criteria	02MW-04 B5J0545-08 10/24/2005	02MW-05 B5J0545-05 10/24/2005	Dup of 02MW-05 02MW-25 B5J0545-04 10/24/2005	02MW-06 B5J0545-07 10/24/2005	02MW-07 B5J0545-02 10/24/2005
DIESEL-RANGE HYDROCARBONS						
NWTPH-Dx (mg/L)						
Diesel Range Hydrocarbons	0.5 (a)	NA	NA	NA	NA	NA
Lube Oil Range Hydrocarbons	0.5 (a)	NA	NA	NA	NA	NA
GASOLINE AND BTEX						
NWTPH-Gx AND EPA METHOD 8021B (µg/L)						
Gasoline Range Hydrocarbons	800 (a)	**3,990** J	**335**	**316**	50.0 U	50.0 U
Benzene	1.2 (b)	**29.2**	0.500 U	0.500 U	0.500 U	0.500 U
Toluene	1000 (b)	**24.9**	0.500 U	0.500 U	0.500 U	0.500 U
Ethylbenzene	700 (b)	**262**	0.500 U	0.500 U	0.500 U	0.500 U
Xylenes (total)	10,000 (b)	**263**	1.00 U	1.00 U	1.00 U	1.00 U
PENTACHLOROPHENOL (PCP)						
EPA Method 8270-SIM (µg/L)						
Pentachlorophenol	0.01 (b)	NA	NA	NA	NA	NA

Notes:

(a) Model Toxics Control Act (MTCA) Method A criteria for the protection of groundwater as drinking water

(b) Model Toxics Control Act (MTCA) Method B criteria for the protection of groundwater as fresh surface water. Values based on ambient water quality criteria for the protection of human health

NA = Indicates the compound was not analyzed for this sample

Bold indicates the compound was detected above the laboratory reporting limit

Box indicates exceedance of screening criteria

U = Indicates the compound was undetected at the reported concentration

J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.

TABLE 3
CUMULATIVE GROUNDWATER ANALYTICAL RESULTS
JANUARY 2005 TO PRESENT TIME OIL #01-600 SEATTLE TERMINAL

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)
MTCA Screening Level		*0.01 (b)*	*0.5 (a)*	*0.5 (a)*	*800 (a)*	*1.2 (b)*	*1000 (b)*	*700 (b)*	*10,000 (a)*
01MW-02	01/05/2005	NA	0.433	< 0.500	31,300	12,600	218	290	1,000
01MW-02	04/25/2005	NA	2.06	< 0.500	33,400	16,100	355	457	1,340
01MW-02	07/26/2005	NA	2.21	< 0.500	27,600	10,400	735	664	2,570
01MW-02	10/25/2005	< 0.495	0.256	< 0.476	24,200	4,660	986	666	3,250
01MW-03	01/05/2005	NA	0.762	< 0.500	2,720	729	17.1	32.6	24.7
01MW-03	04/25/2005	NA	1.12	< 0.500	5,690	2,550	13.4	23.5	27.1
01MW-03	07/26/2005	NA	0.998	< 0.500	4,200	957	13.4	10.5	35.3
01MW-03	10/25/2005	< 0.472	0.684	< 0.532	22,700	9,840	251	296	559
01MW-08	01/05/2005	NA	< 0.250	< 0.500	< 50.0	0.582	< 0.500	< 0.500	< 1.00
01MW-08	04/25/2005	NA	0.833	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-08	07/26/2005	NA	0.422	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-08	10/25/2005	< 0.549	< 0.240	< 0.481	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-09	01/05/2005	NA	0.646	< 0.500	6,300	1,130	45.7	231	872
01MW-09	04/25/2005	NA	1.78	< 0.500	7,620	1,200	63.4	281	972
01MW-09	07/26/2005	NA	20.9	< 0.500	9,450	900	41.9	261	964
01MW-09 DUP	07/26/2005	NA	5.1	< 1.00	9,840	1,160	47.1	304	1,110
01MW-09	10/25/2005	< 0.500	1.44	< 0.495	8,600	1,230	42.1	297	877
01MW-09 DUP	10/25/2005	< 0.485	0.619	< 0.532	9,480	1,440	36.9	285	725
01MW-11	01/05/2005	NA	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-11	04/25/2005	NA	1.23	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-11	07/26/2005	NA	1.19	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-11	10/24/2005	< 0.490	< 0.248	< 0.495	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-12	01/05/2005	NA	0.294	< 0.500	1,090	195	5.48	14.8	13
01MW-12	04/25/2005	NA	5.76	< 2.50	1,650	372	4.36	15.4	13.5
01MW-12	07/26/2005	NA	7.14	1.25	1,800	419	6.87	16.3	21.2
01MW-12	10/25/2005	< 0.588	< 0.248	< 0.495	2,070	460	7.83	16.2	20.4

TABLE 3
CUMULATIVE GROUNDWATER ANALYTICAL RESULTS
JANUARY 2005 TO PRESENT TIME OIL #01-600 SEATTLE TERMINAL

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)
MTCA Screening Level		*0.01 (b)*	*0.5 (a)*	*0.5 (a)*	*800 (a)*	*1.2 (b)*	*1000 (b)*	*700 (b)*	*10,000 (a)*
01MW-13	01/05/2005	NA	< 0.250	< 0.500	**376**	**1.99**	< 0.500	**1.03**	**1.24**
01MW-13	04/25/2005	NA	**3.38**	< 0.500	**374**	**2.28**	< 0.500	**1.49**	**2.51**
01MW-13	07/26/2005	NA	**4.7**	**1.23**	**522**	**2.08**	< 0.500	**0.864**	**3.69**
01MW-13	10/24/2005	< 0.500	< 0.245	< 0.490	**363**	**1.38**	< 0.500	< 0.500	**2.26**
01MW-17	01/05/2005	NA	< 0.250	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-17	04/25/2005	NA	**0.472**	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-17	07/26/2005	NA	**0.49**	< 0.500	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-17	10/24/2005	NA	< 0.243	< 0.485	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
01MW-26	01/05/2005	**21.3**	0.296	< 0.500	**1,050**	**98.6**	**6.16**	**40.1**	**45.4**
01MW-26	01/05/2005	**15.7**	< 0.250	< 0.500	**976**	**96.7**	**6.14**	**39.5**	**29.9**
01MW-26	04/25/2005	**16.9**	**1.88**	< 0.500	**827**	**74.5**	**5.51**	**23.8**	**33.0**
01MW-26	07/26/2005	**22.1**	**1.96**	**0.561**	**1,280**	**92.6**	**10.5**	**43.4**	**88.6**
01MW-26	10/25/2005	**9**	< 0.275	< 0.549	**1,290**	**125**	**7.7**	**44.5**	**38.9**
02MW-01	01/05/2005	NA	< 0.250	< 0.500	**172**	**51.5**	**1.01**	< 0.500	**2.53**
02MW-01	04/25/2005	NA	NA	NA	**188**	**36.2**	**0.863**	< 0.500	**1.86**
02MW-01	07/26/2005	NA	NA	NA	**205**	**48.9**	**1.04**	< 0.500	**2.3**
02MW-01	10/24/2005	NA	NA	NA	**379**	**52.2**	**1.38**	< 0.500	**3.84**
02MW-02	01/05/2005	NA	< 0.250	NA	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
02MW-02	04/25/2005	NA	NA	NA	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
02MW-02	07/26/2005	NA	NA	NA	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
02MW-02	10/24/2005	NA	NA	NA	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
02MW-04	01/05/2005	NA	< 0.250	< 0.500	**2,610**	**20.5**	**18.2**	**190**	**139**
02MW-04 DUP	01/05/2005	NA	< 0.250	< 0.500	**2,760**	**20.1**	**15.8**	**179**	**124**
02MW-04	04/25/2005	NA	NA	NA	**3,830**	**19.0**	**45.1**	**292**	**488**
02MW-04 DUP	04/25/2005	NA	NA	NA	**4,330**	**20.2**	**49.1**	**337**	**465**
02MW-04	07/26/2005	NA	NA	NA	**6,580**	**25.5**	**51**	**411**	**801**
02MW-04	10/24/2005	NA	NA	NA	**3,990**	**29.2**	**24.9**	**262**	**263**

TABLE 3
CUMULATIVE GROUNDWATER ANALYTICAL RESULTS
JANUARY 2005 TO PRESENT TIME OIL #01-600 SEATTLE TERMINAL

Sample	Date	PCP (µg/L)	Diesel (mg/L)	Oil (mg/L)	Gas (µg/L)	Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Xylene (µg/L)
MTCA Screening Level		*0.01 (b)*	*0.5 (a)*	*0.5 (a)*	*800 (a)*	*1.2 (b)*	*1000 (b)*	*700 (b)*	*10,000 (a)*
02MW-05	01/05/2005	NA	< 0.250	< 0.500	**310**	< 0.500	< 0.500	< 0.500	< 1.00
02MW-05	04/25/2005	NA	NA	NA	**575**	**0.922**	< 0.500	< 0.500	< 1.00
02MW-05	07/26/2005	NA	NA	NA	**503**	**0.781**	< 0.500	**0.54**	**1.08**
02MW-05 DUP	07/26/2005	NA	NA	NA	**505**	**0.727**	< 0.500	< 0.500	< 1.00
02MW-05	10/24/2005	NA	NA	NA	**335**	< 0.500	< 0.500	< 0.500	< 1.00
02MW-05 DUP	10/24/2005	NA	NA	NA	**316**	< 0.500	< 0.500	< 0.500	< 1.00
02MW-07	01/05/2005	NA	< 0.250	NA	**236**	< 0.500	< 0.500	< 0.500	**2.1**
02MW-07	04/25/2005	NA	NA	NA	**319**	< 0.500	< 0.500	**0.662**	**3.42**
02MW-07	07/26/2005	NA	NA	NA	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00
02MW-07	10/24/2005	NA	NA	NA	< 50.0	< 0.500	< 0.500	< 0.500	< 1.00

Notes:

NA = Indicates the compound was not analyzed for this sample.

< symbol indicates result is less than reporting limit.

(a) Model Toxics Control Act (MTCA) Method A criteria for the protection of groundwater as drinking water.

(b) Model Toxics Control Act (MTCA) Method B criteria for the protection of groundwater as fresh surface water. Values based on ambient water quality criteria for the protection of human health.

Bold indicates the compound was detected above the laboratory reporting limit.

Box indicates exceedance of screening criteria.

TABLE 4
PRODUCT ANALYTICAL DATA
TIME OIL SITE #01-600 - SEATTLE TERMINAL
SEATTLE, WASHINGTON

	Screening Criteria	01MW-16	01MW-22 B5J0545-11 10/26/2005	01MW-23 B5J0581-03 10/26/2005	01MW-25 B5J0581-05 10/26/2005	01MW-28 B5J0581-10 10/26/2005	01MW-29 B5J0581-08 10/26/2005
GROUNDWATER:							
PENTACHLOROPHENOL (PCP)							
EPA Method 8270-SIM (µg/L)							
Pentachlorophenol	0.01 (b)	NS	273	19.8	0.526 U	0.490 U	0.500 U
		01MW-16 PRODUCT B5J0581-12 10/26/2005	01MW-22 PRODUCT B5J0581-02 10/26/2005	01MW-23 PRODUCT B5J0581-04 10/26/2005	01MW-25 PRODUCT B5J0581-06 10/26/2005	01MW-28 PRODUCT B5J0581-11 10/26/2005	01MW-29 PRODUCT B5J0581-09 10/26/2005
PRODUCT:							
PENTACHLOROPHENOL (mg/kg)							
EPA 8270 Mod							
PCP		375 U	375 U	375 U	375 U	375 U	375 U
PETROLEUM HYDROCARBONS (mg/kg)							
NWTPH-HCID							
Diesel Range Hydrocarbons		**DET**	**DET** J	**DET**	**DET**	**DET**	**DET**
Gx Range Hydrocarbons		2000 U	2000 U	2000 U	2000 U	2000 U	2000 U
Heavy Fuel Oil Range Hydrocarbons		10000 U	10000 U	10000 U	10000 U	10000 U	10000 U
Insulating Oil Range Hydrocarbons		10000 U	10000 U	10000 U	10000 U	10000 U	10000 U
Kerosene Range Hydrocarbons		5000 U	5000 U	5000 U	5000 U	5000 U	5000 U
Lube Oil Range Hydrocarbons		10000 U	**DET**	**DET**	**DET**	10000 U	10000 U

Notes:
(a) Model Toxics Control Act (MTCA) Method A criteria for the protection of groundwater as drinking water
(b) Model Toxics Control Act (MTCA) Method B criteria for the protection of groundwater as fresh surface water.
Values based on ambient water quality criteria for the protection of human health
NA = Indicates the compound was not analyzed for this sample
NS = Not sampled.
Bold indicates the compound was detected above the laboratory reporting limit
Box indicates exceedance of screening criteria.
U = Indicates the compound was undetected at the reported concentration
J = Indicates the analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
DET indicates the compound was detected.

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TECHNICAL MEMORANDUM

TO: Mr. Christopher Maurer, PE
Site Manager, Washington State Department of Ecology

DATE: June 17, 2008

FROM: Mr. Thomas Cammarata, LG, LHG
Geochemist, Sound Environmental Strategies

SUBJECT: Sediment Quality
TOC Holdings Co. Facility No. 01-427 and 01-600
2737, 2750, and 2805 West Commodore Way
Seattle, Washington

VCP No: NW 1705

Sound Environmental Strategies Corporation (SES) has prepared this Technical Memorandum on behalf of TOC Holdings Co. (TOC) to respond to the Washington State Department of Ecology's (Ecology) request that TOC conduct a sediment quality investigation off-shore of the TOC Facility #01-427 and #01-600 located at 2737, 2750, and 2805 West Commodore Way in Seattle, Washington (herein referred to as the Property) (Figures 1 and 2). The request for a sediment quality investigation was presented in an Opinion Letter dated May 7, 2007 prepared by Ecology after completing a review of reports documenting remedial investigations conducted at the Property by others between 1997 and 2004. In the Opinion Letter, Ecology requested that sediment samples be collected near the product pipeline on both sides and both ends and upstream of the Shipping Terminal Wharf dock (the dock) located off-shore of the Property (Figure 2).

The purposes of this Technical Memorandum is to present Ecology with a summary of chemistry and biological test results for sediments samples collected proximate to the dock by Ecology in 1995 and 1997 and to provide Ecology with a rationale as to why additional sediment sampling is not warranted proximate to the dock and upstream of the dock. This Technical Memorandum includes a brief description and history of the Property and SES's current understanding of the sediment quality proximate to dock and in Salmon Bay.

PROPERTY DESCRIPTION

The Property includes a Former Bulk Terminal and Water Front Area that occupies upland and waterfront portions of Salmon Bay at 2737 and 2750 West Commodore Way (Figure 2). A pipeline utility corridor extends north from the lower tank yard of the Former Bulk Terminal beneath the West Commodore Way right-of-way (ROW) to the dock at the Water Front Area. A railroad loading dock associated with the Former Bulk Terminal extends across the west property boundary shared with ASKO Hydraulic at 2805 West Commodore Way (Figure 2). The pipeline utilidor and a former barrel inclines angle north across the Former Bulk Terminal, pass under the surface of West Commodore Way, and appears between the north embankment of the ROW and the dock at the shoreline of the Waterfront Area. The pipeline utilidor houses petroleum pipelines that delivered petroleum products to the Water Front Area. The former barrel inclines consisted of conveyance ramps that transported 55-gallon drums containing petroleum products to the Water Front Area. For a period of 3 months in 1967 the drums contained a mixture of diesel and pentachlorophenol (PCP) (Figure 2).

TOC leases aquatic land off-shore of the Water Front Area from the Washington State Department of Natural Resources (DNR). The DNR land is 26 feet under water and 195 feet from the shoreline and includes a portion of the dock (Figure 2).

PROPERTY HISTORY

TOC acquired the Waterfront Area and the Former Bulk Terminal in 1941. By 1944, TOC had developed a petroleum bulk storage plant at Former Bulk Terminal. The Former Bulk Terminal included a headquarters office building, a row of warehouses constructed on a railroad loading dock that extended west onto the ASKO Hydraulic property. Historical maps indicate that fourteen aboveground storage tanks (ASTs) containing petroleum products were located in the Former Tank Yard and at the Former Bulk Terminal (Figure 2).

Petroleum products were delivered to the Property via railroad and ship and stored in 14 bulk ASTs located in the Former Tank Yard. The approximate capacities of the bulk ASTs ranged from 0.5 to 2.2 million gallons each. The Water Front Area was used for staging of 55-gallon drums containing petroleum prior to loading on to ships (Figure 2).

During TOCs tenure at the Property, petroleum products were routinely transporting off the Property. The methods used to transport petroleum products off the Property included:

- Piped overhead to the Loading Racks and into tanker trucks.
- Pumped from USTs into fleet vehicles.
- Piped through the pipeline utilidor to the dock to fuel ships.
- Drummed at the shed at the Former Bulk Terminal and conveyed down the barrel incline to the dock for shipping, empty drums were returned via a separate incline.

USTs were formerly located next to the north end of the headquarter office at Former Bulk Terminal for fueling TOC fleet vehicles. In 1991, two USTs with capacities of 4,000 gallons and containing gasoline and diesel were replaced with a combined 3,000-gallon capacity UST containing gasoline and a 1,000-gallon capacity UST containing diesel. All USTs were removed in 2006 including a 3,000-gallon capacity UST containing a mixture of ethanol and toluene that was also located at the north end of the Former Tank Yard.

In 1967, wood preservative was prepared at the Former Bulk Terminal by mixing PCP with diesel. The preservative was then drummed for shipment and use overseas. The PCP Mixing Area was located at the west end of the Lower Tank Yard (Figure 2).

TOC historically used sheds located in the Water Front Area for vehicle repair and equipment lube activities. A used oil UST associated with repair and lube activities was located beneath the driveway west of the sheds, and west of the pipeline utilidor.

The machine shop at ASKO Hydraulic property was constructed in the late 1960s for the purpose of fleet vehicle repairs. TOC occupied and utilized the machine shop for engine repairs until 1974, when the machine shop was leased to Precision Engineering Specialists. ASKO Hydraulic has leased the machine shop from TOC Holdings Co. since 1976 and uses it for machining aerospace parts.

ON-SHORE ENVIRONMENTAL CONDITIONS

Environmental investigations conducted at the Property between 1997 and 2004 by others included subsurface investigations of soil and groundwater quality at the ASKO Hydraulics, Waterfront Area, and the Former Bulk Terminal (Figure 2). A detailed discussion of on-shore environmental conditions is presented in the *Final Cleanup Action Plan for Petroleum-Impacted Soil and Groundwater 2737 West Commondore Way Seattle, Washington,* dated May 2004, prepared by Foster Wheeler Environmental Corporation and the *Supplemental Remedial Investigation Report Seattle Terminal Properties TOC Holding Co. Facility Nos. 01-427 and 01-600, 2737, 2750, and 2805 West Commodore Way, Seattle Washington* prepared by SES (in preparation).

SEDIMENT QUALITY – SALMON BAY

The Property is located on the south shore of Salmon Bay, a narrow body of water located between Lake Union to the east and the Puget Sound to the west (Figures 1 and 2). Numerous industries are located along the shores of Salmon Bay, including marinas, dock facilities, and combined sewer overflows. In 1995 and 1997 Ecology conducted sediment quality investigations in Salmon Bay to evaluate the toxicity of the sediments. During both of these investigations sediment samples were collected proximate to the dock off-shore of the Property (Figure 2). A summary of chemical and biological test results for Ecology sediment quality investigations in Salmon Bay and off-shore of the Property is presented below.

1995 SEDIMENT QUALITY INVESTIGATION

In 1995 Ecology collected sediment samples from 29 areas in Salmon Bay and analyzed the samples for metals (arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc) semi-volatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), and tributyltins (TBT). Sediment sample 3B was collected between the dock and shore of the Property (Figure 2). A detailed discussion of sediment quality results from the 1995 investigation is presented in Chemical Contaminants in Salmon Bay Sediments Results of Phase II Sampling, dated November 1996, prepared by Ecology. A summary of chemical test results for sediment sample collected by Ecology in 1995 are as follows:

- All eight metals were detected in sediment samples collected from Salmon Bay, with exception of cadmium which was not detected at concentrations above the laboratory reporting limit in five sediment samples. Sediment sample 3B, collected by Ecology, between the dock and the shore of the Property, ranked number 4 out of 29 in overall metals concentrations for all sediment samples collected (Figure 2). Concentrations of arsenic, lead, mercury, and copper in sediment sample 3B exceeded Freshwater Sediment Quality Values (FSQVs) guidelines presented in the *Phase II Report: Development and Recommendations for SQVs for Freshwater Sediments in Washington State,* dated September 2003, prepared by Ecology. Concentrations of remaining metals in sediment sample 3B were below applicable FSQVs;

- High molecular weight polyaromatic hydrocarbons (HPAHs) and low molecular weight polyaromatic hydrocarbons (LPAHs) were the most frequently detected SVOCs in sediment samples collected by Ecology in Salmon Bay. The concentrations of HPAHs and LPAHs in sediment sample 3B exceeded the median concentrations of HPAHs and LPAHs for all sediment samples collected but were below applicable FSQVs. Concentrations of all remaining SVOCs in sediment sample 3B were below applicable FSQVs;
- PCBs were detected in all sediment samples collected by Ecology in Salmon Bay. The concentration of PCBs in sediment sample 3B was less than the median PCB concentration of all sediment samples collected. The concentration of PCBs in sediment sample 3B was below the applicable FSQV; and
- TBT was detected in all sediment samples collected by Ecology in Salmon Bay, with the exception of the sediment sample 5B, collected upstream of the dock. The concentration of TBT in sediment sample 3B was less than the median TBT concentration for all sediment samples. There are no bulk sediment FSQV for TBT.

1997 Sediment Quality Investigation

In 1997 Ecology collected sediment samples from 27 areas in Salmon Bay and analyzed the samples for metals, SVOCs, and TBT. Bioassays were conducted on 20 sediment samples collected. Sediment sample 3B2, collected at the west end of the Shipping Terminal Wharf, was analyzed for metals, SVOCs, PCBs, and TBT only (Figure 2). Bioassays were performed on sediment 3B3, collected at the east end of the Terminal Wharf. Bioassay test included 10-day *Hyalella azteca* survial, 10-day *Chironomus tentans* growth and survival, and 15-minute *Vibrio fisheri* luminescence. Sediment sample 3B3 was also was analyzed for metals, SVOCs, and TBT. A detailed discussion of sediment quality results from the 1997 investigation are presented in *Concentrations of Chemical Contaminants and Bioassay Response to Sediments in Salmon Bay, Seattle – Results of Phase III Sampling,* dated December 2000, prepared by Ecology. A summary of chemical and biological test results for all sediment samples collected by Ecology in 1997 were as follows:

- All eight metals were detected in sediment samples collected from Salmon Bay, with exception of cadmium which was not detected at concentrations above the laboratory reporting limit in two sediment samples. Sediment sample 3B2 ranked 10 out of 27 in overall metals concentrations for all sediment samples collected (Figure 2). Sediment sample 3B3 ranked 3 out of 27 in overall metals concentrations for all sediment samples collected (Figure 2). Concentrations of arsenic, mercury, cadmium, copper, and zinc in sediment samples 3B2 and 3B3 exceeded applicable FSQVs. The concentration of lead in sediment sample 3B2 was below the FSQV. The concentration of lead in sediment sample 3B3 exceeded the FSQV. Concentrations of remaining metals in sediment samples 3B2 and 3B3 were below applicable FSQVs ;

- HPAHs and LPAHs were the most frequently detected SVOCs in sediment samples collected. The concentrations of HPAHs and LPAHs in sediment sample 3B2 exceeded the median concentrations for HPAHs and LPAHs for all sediment samples collected. Concentration of HPAHs and LPAHs were below applicable FSQVs. The concentrations of HPAHs and LPAHs in sediment sample 3B3 were below the median concentrations for HPAHs and LPAHs for all sediment samples collected. Concentrations of HPAHs and LPAHs were below the applicable FSQVs. Concentrations of bis (2-ethylhexyl) phthalate, indeno (1,2,3-cd) pyrene, dibenzo (a,h) anthracene, and benzo (ghi) perylene in sediment sample 3B2 exceeded applicable FSQVs;

- Six sediment samples collected by Ecology in Salmon Bay were analyzed for PCBs. Samples 3B2 and 3B3 were not analyzed for PCBs. PCBs were detected in five of the six sediment samples analyzed;

- TBT was detected in all sediment samples collected. Concentrations of TBT in samples 3B2 and 3B3 were less than the median TBT value for all sediment samples. There are no bulk sediment FSQV for TBT; and

- All sediment samples for which bioassays were performed, had statistically significant bioassay responses for one or more tests relative to the reference sediment sample. Sediment sample 3B3 showed significant test results in three of four bioassays. Bioassays were not performed on sediment sample 3B2.

CONCLUSIONS

Three sediments samples were collected by Ecology proximate to the dock off-shore of the Property (Figure 2). The chemical and biological test results indicate that four sediment samples contained concentrations of select metals and PAHs that exceed applicable FSQVs. Bioassay results on one sediment sample collected proximate to the dock show statistically significant toxicity. These chemical and biological test results for the threesamples collected proximate the dock are similar to results for other sediment samples collected by Ecology in Salmon Bay during the 1995 and 1997 sediment investigation.

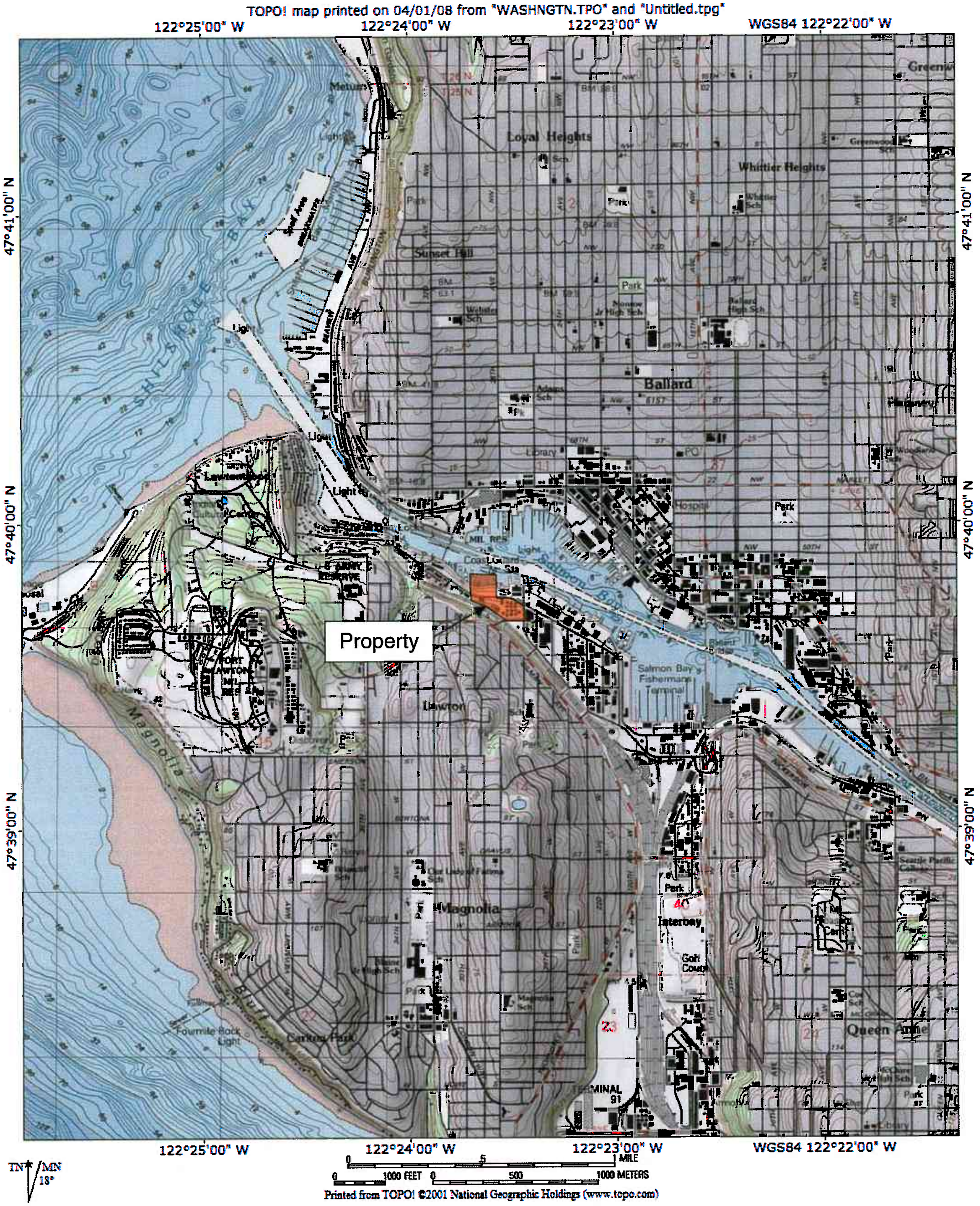
Based on the locations of sediment samples 3B, 3B2, and 3B3, proximate to the dock and location of sediment samples collected upstream of the dock, SES believes that the number and locations of sediment samples collected at the dock and up-stream of dock are sufficient to meet Ecology's request that TOC collect sediment samples proximate to the dock. Chemical and biological test results for sediments 3B, 3B2, and 3B3 also provide sufficient data to evaluate the impact of historical operation and on-shore contamination on sediment quality off-shore of the Property. Therefore, SES requests that Ecology reconsider its request for sediment sampling at the dock and upstream of dock.

Attachments: Figure 1, Property Location Map
Figure 2, Site Plan Showing Ecology Sediment Sample Locations

cc: Mr. Mark Chandler, TOC Holdings Co.

TC:syh

TOPO! map printed on 04/01/08 from "WASHNGTN.TPO" and "Untitled.tpg"



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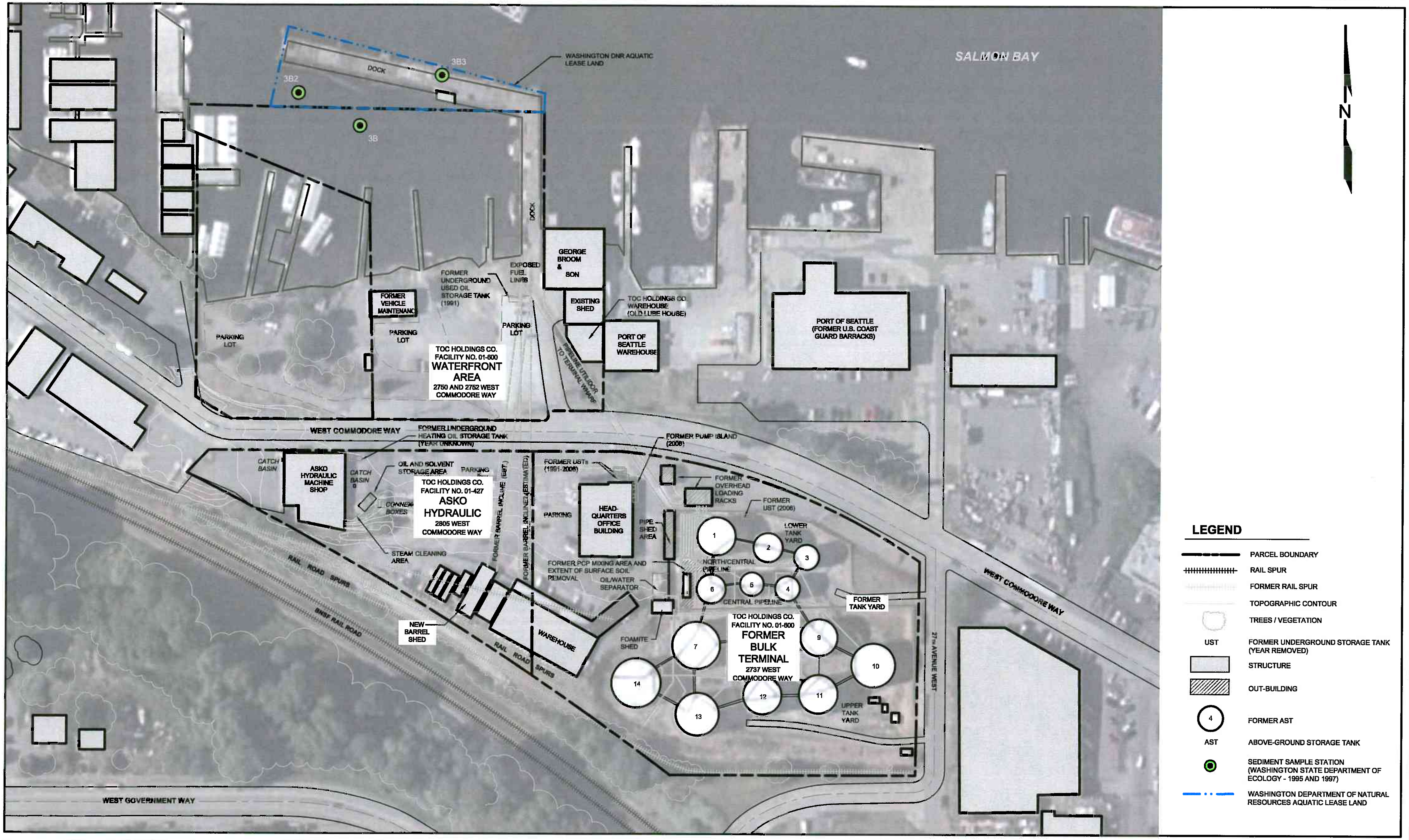
SOUND ENVIRONMENTAL STRATEGIES
www.soundenvironmental.com

Date: April 1, 2008 Drawn By: RLH Chk By: TJK SES Project No.: 0440-004-16 File ID: 01-600 fig 1 vicinity map.doc	TOC Holdings Co. Facility No. 01-600 & 01-427 Seattle Terminal Properties 2737, 2750, 2752, & 2805 West Commodore Way Seattle, Washington	**FIGURE 1** Property Location Map	

4/16/2008

P:\0440 TOC Holdings Co\01-600 Seattle Terminal\Technical\CAD\2008\01-600 F2.dwg



SOUND ENVIRONMENTAL STRATEGIES
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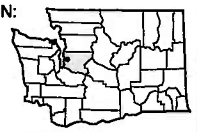
DATE: 03/26/2008
DRAWN BY:...............RLH
CHECKED BY: ....TJK
CAD FILE: 01-600 F2

PROJECT NAME: ....TOC HOLDINGS CO. FACILITY NO. 01-427 & 01-600
SES PROJECT NUMBER:.....0440-004-16
STREET ADDRESS:..............2737, 2750, 2752 & 2805 W. COMMODORE WAY
CITY, STATE:..........................SEATTLE, WASHINGTON

REGION:



0 25 50 75 100 125 250

APPROXIMATE SCALE IN FEET 1" = 125'

FIGURE 2

SITE PLAN SHOWING ECOLOGY SEDIMENT SAMPLE STATIONS

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