SEDIMENT SAMPLING REPORT
SEATTLE COMMONS PARCEL C
SEATTLE, WASHINGTON

1.0 INTRODUCTION

Shannon & Wilson, Inc. is pleased to submit the results of the sediment sampling effort at the referenced property. This work was authorized by your signing of our proposal dated February 25, 1994. The scope of work for this project was set forth in the De Minimus Consent Decree and the Sampling and Analysis Plan developed for the Seattle Commons. The scope of work included the collection and analysis of sediment samples from three locations in Lake Union. The data from this sampling event were interpreted to determine if there are localized biological impacts at the site that are higher than other areas of Lake Union (as defined by the Washington Department of Ecology) and whether contributing factors to the impacts can be identified. Also included in our scope of work is groundwater sampling at one specific location (MW-1) on a quarterly basis. The results of the first quarterly MW-1 sampling were submitted to you in our report dated April 12, 1994 (Shannon & Wilson, 1994). The second quarterly sampling of MW-1 has been completed, and the results will be sent under separate cover following completion of laboratory analysis.

Previous field investigations involving this site have been conducted by Hart Crowser (1990), Shannon & Wilson (1991), and Enviros (1993). These reports detail the results of previous environmental soil and groundwater sampling at and adjacent to the site and present descriptions of the site hydrogeologic conditions.

2.0 SITE DESCRIPTION

The Parcel C property is located on Block 84 of the Lake Union Shorelands, in the south half of the southeast quarter of Section 30, Township 25 North, Range 4 East, City of Seattle, King County, Washington (Figure 1). It is situated on the southern extreme of the west shore of Lake Union, along Westlake Avenue North. The site is covered with fill soils from the Denny Regrade and from other unknown sources. The thickness of the sandy fill at well MW-1 is approximately 9 feet. Based on measurements of groundwater levels in

multiple wells in the vicinity by Enviros (1993), shallow groundwater flow is to the east, into Lake Union.

Lake Union has been the site of industrial and commercial uses for more than 75 years. These operations have degraded water quality and have resulted in contaminated sediments in some parts of the lake (Cubbage, 1992). The area immediately north of the site (Parcel B) has been previously used for repairing and repainting the hulls of ships.

3.0 SEDIMENT SAMPLING INVESTIGATION

Our representatives sampled sediment from three locations on Parcel C on March 4, 1994 (Figure 1). The sediments were sampled and analyzed in accordance with the Puget Sound Estuary Program (PSEP) protocols, as required by the Sampling and Analysis Plan. The sediments were collected using a stainless steel Van Veen sampler. The sample from the sediments nearest to shore (SED1) was collected by personnel standing in the water, and the two other samples (SED2 and SED3) were collected from a canoe. Sampling locations were measured with respect to permanent site features. Station keeping for the SED2 and SED3 locations was maintained by tying off the canoe to the docks with two ropes. A incremented tape was tied between the canoe and the dock to assist in maintaining a relatively constant position. Each sample required multiple retrievals of the sampling device to obtain sufficient sample volume. With each individual sample retrieval, sediment from approximately the top 2 centimeters of material retrieved was placed in a stainless steel bowl. Once sufficient volume had been collected, the sediment was homogenized with a stainless steel spoon and transferred to labelled laboratory containers. Samples were collected and initially analyzed for bioassays (Microtox and Hyallella Azteca), grain-size distribution, butyl tin series (monobutyl, dibutyl, and tribuyl), polychlorinated biphenyls (PCBs), total volatile solids, percent solids, total organic carbon, ammonia, sulfide, and priority pollutant metals. Upon the later request of the Washington Department of Ecology (Ecology), analyses for polyaromatic hydrocarbons (PAHs) were also performed using archived sample material. Upon collection, the samples were stored in coolers on ice until delivery to the laboratory later the same day. Chain-of-custody was maintained for all samples.

Prior to and after the collection of each sample, the sampling equipment was decontaminated using the following procedure:

- Detergent wash (Liquinox and deionized water)
- Distilled water rinse
- Methanol rinse
- Distilled water rinse
- Dilute (10%) nitric acid rinse
- SEMI-grade distilled water rinse.

The residual methanol and the rinse water generated immediately after the methanol rinse were allowed to evaporate from an aluminum pan. The wash water was placed in a 35-gallon steel drum and left on the site pending the receipt of sediment laboratory results. An equipment rinsate sample (ER1) was collected off of the sampling equipment. This rinsate sample consisted of SEMI-grade distilled water which was poured over/into the decontaminated sampling equipment following collection of sediment sample SED1.

Field observations for each sediment sampling location are presented in Table 1. The near-shore sample (SED1) appeared to be relatively free of visible contamination. It consisted of a gray, sandy gravel with a trace of silt and common debris and organics (bricks, wood, glass, nails, leaves, etc.). The two other samples (SED2 and SED3) consisted of black, silty sand with common debris (wood, metal, glass, plastic, etc.) and finely disseminated organics. These two samples appeared to be contaminated, each displaying a slight sheen and odor. Grain-size distribution plots for these samples are contained in Appendix A. The laboratory data reports for the samples are also presented in Appendix A. The laboratory analytical results are summarized in Table 2.

4.0 DISCUSSION

Currently there are no numerical freshwater sediment quality standards for Washington State. Pursuant to the consent decree for the site, the sediment sampling results were submitted directly to Ecology for review and interpretation. These data did not include the results of sediment PAH analyses, which were performed at a later date at Ecology's request

based on the results of the metals and bioassay analyses. The letter which presents Ecology's review is included in Appendix B and is summarized below. A discussion of the PAH analyses is also included below.

4.1 Bioassay Results

A recent Ecology study of Lake Union sediments by Cubbage (1992) indicated a general lakewide Hyalella Azteca mortality range of 10 to 26 percent. At the site, Hyalella mortalities at SED1 and SED2 were somewhat higher than this lakewide average but not statistically distinguishable from it. The Hyalella mortality at SED3 (54 percent), however, was found to be significantly higher than the lakewide average, exceeding the narrative standard of "minor adverse effects". Hyalella mortality is known to be sensitive to PAH concentrations in sediments.

Lakewide decreases in Microtox luminescence have been found to range from 0 to 90 percent. These decreases may be correlated to the presence of a variety of metals. A significant decrease in Microtox luminescence was observed for SED2 and SED3 (69.4 and 96 percent, respectively), indicating exceedance of the narrative standard of "minor adverse effects". No luminescence decrease was observed for SED1.

4.2 Chemical Results

Butyl tin concentrations at stations SED2 and SED3 were found to exceed biological effects levels established by NOAA and the Puget Sound Dredged Disposal Analysis (PSDDA) program (30 ug/kg). However, it is not yet known how relevant these effects levels are to the freshwater areas of the Puget Sound region. Little data exists concerning the butyl tin compounds distribution in the lake; however, they are primarily related to the presence of shipbuilding operations or marinas. The relatively high butyl tin concentrations in SED2 and SED3 may have contributed to the toxicity associated in these samples.

PCB levels at the three sampling stations range from 7.3 to 95 ug/kg (dry weight) or 0.73 to 8.2 mg/kg-TOC (normalized for organic carbon content). These concentrations are generally below median PCB concentrations measured elsewhere in the lake and are also

below draft EPA sediment standards as well as effects levels developed by other researchers in the U.S. and Canada.

Metals concentrations at all three stations are within the range of concentrations measured elsewhere in the lake. Metals at SED1 are not particularly high in comparison to effects levels in the literature. Copper, lead, and zinc concentrations are somewhat higher at SED2 and SED3, falling within the range of low to medium effects levels used as criteria or guidelines by other sediment quality programs. Therefore, these metals may be a contributing factor to the toxicity associated with SED2 and SED3.

Lake-wide PAH concentrations range from 110 to 800,000 ug/kg (dry weight). PAHs were detected in all three sediment samples, with total concentrations ranging from 361 to 21,480 ug/kg (dry weight) or 36 to 1,090 mg/kg-TOC. These levels are at or below the median lakewide PAH concentrations measured by Cubbage (1992). The highest PAH concentrations (976 and 1,090 mg/kg-TOC at SED2 and SED3, respectively) correlate to the highest Microtox toxicity determined during the course of the Parcel C study. The highest Hyalella mortality rate also occurred at SED3, which exhibited the highest PAH concentration. It appears that PAHs may be a contributing factor to toxicity at the site, possibly in combination with other compounds.

Quality assurance objectives for the sample data were generally met. There were some anomalous spike recoveries for the organotin analyses for SED1 and ER1. The spike recovery for monobutyl tin was low for SED1. Monobutyl tin was not recovered from the spike blank and spike blank duplicate for ER1, so all results for monobutyl tin in this sample were considered suspect, and no detection limit was reported. The percent recoveries were outside acceptable quality control limits for cadmium and selenium. An accurate recovery was not possible for selenium or thallium in the reference material. Also, the reference material was not certified for selenium.

At the request of Ecology, we contacted RETEC, a Seattle firm which has been performing a sediment characterization study at the adjacent property to the north of the site, Parcel B. RETEC's client would not allow us to review their data, but we obtained some general information about their analytical results. According to RETEC, Parcel B was formerly used for the bottom painting of ships. This is a possible source for the butyl tin compounds

detected at Parcel B and C. Divers collecting the Parcel B sediment samples reported the presence of paint chips on the bottom. They also indicated that the black sediment increased in thickness from north to south across the property from a few inches to about 2 feet. RETEC indicated that their analytical results were similar to those obtained for Parcel C, with the near-shore sediments being characterized by lower toxicity and fewer PAHs and butyl tin compounds than the sediments collected from farther to the east. Metals were found both close to and farther from shore, but concentrations were generally higher to the east.

5.0 CONCLUSIONS

With the exception of a few metals, the contaminant concentrations at the site are generally highest in the two samples collected relatively far from shore. This contaminant distribution may be at least partially a function of grain size, since most contaminants concentrate in the fines fraction, and the SED1 sample had the fewest fines of the three samples. If the contamination is related to past ship repair/repainting activities on or near the site, then the near-shore sediments may be less contaminated due to distance from the source, as well, since the vessels were probably anchored some distance from shore.

Samples SED2 and SED3 exceed the "minor adverse effects" level and will eventually require remediation. The decrease in luminescence observed for SED2 and SED3 and the amphipod mortalities at SED3 may be related to the metals, butyl tin compounds, and/or PAHs present in these samples. The area of contamination apparently extends beyond the property boundaries to the north and possibly to the east and south.

6.0 CLOSURE

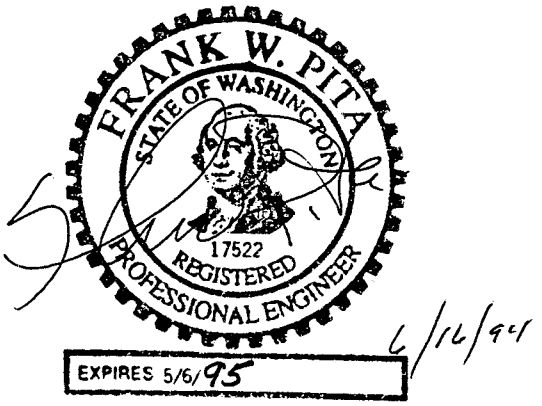
This report was prepared for the exclusive use of the Seattle Commons and their representatives. The findings we have presented in this report are based on limited research and on the sampling and analysis that we conducted at the site. This report does not evaluate the site and structures for the presence of asbestos, radon, or wetlands, and it is not a geotechnical investigation. Our findings should not be construed to be definitive of the

sediment quality at the site. The data presented in this report should be considered representative of the time of our site investigation. Changes in the conditions of the site can occur with the passage of time, whether they be due to natural processes or the works of man. In addition, changes in government codes, regulations, or laws may occur. Due to such changes, our observations and recommendation applicable to this site may need to be revised wholly or in part, due to changes beyond our control.

We appreciate this opportunity to be of service to you. If you have any questions concerning this work, please call.

SHANNON & WILSON, INC.

Paul L. Van Horne
Hydrogeologist



6/16/94

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Enviros, Inc., 1993, Final Report: Limited Groundwater Investigation of the Lake Union Air Property, Seattle, Washington: Report prepared by Enviros, Inc., Kirkland, WA, job no. 921017.02, for Seattle Commons, March 25.

Hart Crowser, Inc., 1990, Environmental Services Lake Union Air Property - Levin Property: Report prepared by Hart Crowser, Inc., Seattle, WA, for Koll Company, July.

Shannon & Wilson, Inc., 1994, First Quarterly Environmental Monitoring Report, Seattle Commons Parcel C, Seattle, Washington: Report prepared by Shannon & Wilson, Inc., Seattle, WA, job no. T-1524-01, for Seattle Commons, April 12.

Shannon & Wilson, Inc., 1991, Environmental Assessment Lake Union Air Property, Seattle, Washington: Report prepared by Shannon & Wilson, Inc., Seattle, WA, job no. T-1223-01, for Seattle Department of Parks and Recreation, April.

TABLE 1
SEDIMENT SAMPLING LOCATIONS

Sample Station	Latitude	Longitude	Approximate Water Depth (feet)	Comments
SED1	47°37'42"	122°20'16"	1	Scattered debris
SED2	47°37'42"	122°20'16"	13.0	Scattered debris; slight sheen and odor
SED3	47°37'42"	122°20'16"	21	Scattered debris; slight sheen and odor

TABLE 2
SEDIMENT SAMPLING RESULTS

Sample Designation	Butyl Tins			PCB Dry Weight (µg/kg)	PCB OC-Normalized (mg/kg-TOC)	Total Organic Carbon (%C)	Total Volatile Solids (mg/kg)	Ammonia (mg-N/kg)	Sulfide Solids (%)	Sulfide (mg/kg)
	Tributyl Tin (µg/kg)	Dibutyl Tin (µg/kg)	Butyl Tin (µg/kg)							
SED1	12 U	12 U	12 U	7.3 J (Aroclor 1254)	0.73 (Aroclor 1254)	0.996	12,600	7.35	82.75	2.69
SED2	300	130	60	95 (Aroclor 1254)	8.19 (Aroclor 1254)	1.16	40,700	15.0	68.88	24.7
SED3	250	160	50	78 (Aroclor 1254)	3.96 (Aroclor 1254)	1.97	29,800	34.5	45.85	42.4

NOTES:

U — No analyte was detected. The reported value is the lower limit of detection.

J — Indicates an estimated value when that result is less than the calculated detection limit.

TABLE 2
SEDIMENT SAMPLING RESULTS (CONT.)

Semivolatile Organic Compound	SED1		SED2		SED3	
	Dry Weight (µg/kg)	OC-Normalized (mg/kg-TOC)	Dry Weight (µg/kg)	OC-Normalized (mg/kg-TOC)	Dry Weight (µg/kg)	OC-Normalized (µg/kg)
Naphthalene	10 U		160	13.8	350	17.8
2-Methylnaphthalene	17 U		66 U		120	6.1
Acenaphthylene	17 U		66 U		140	7.1
Acenaphthene	17 U		170	14.7	210	10.7
Fluorene	17 U		140	12.1	250	12.7
Phenanthrene	52	5.2	1,200	103.4	1,500	76.1
Anthracene	17 U		320	27.6	580	29.4
Total LPAH	**52**	**5**	**1,990**	**172**	**3,150**	**160**
Fluoranthene	55	5.5	2,000	172.4	2,800	142.1
Pyrene	55	5.5	1,900	163.8	3,000	152.3
Benzo (a) anthracene	27	2.7	740	63.8	1,600	81.2
Chrysene	36	3.6	930	80.2	2,100	106.6
Benzo (b) fluoranthene	24	2.4	860	74.1	2,100	106.6
Benzo (k) fluoranthene	29	2.9	420	36.2	1,100	55.8
Benzo (a) pyrene	25	2.5	910	78.4	2,100	106.6
Indeno (1,2,3-cd) pyrene	28	2.8	770	66.4	1,800	91.4
Dibenz (a,h) anthracene	17 U		120	10.3	230	11.7
Benzo (g,h,i) perylene	30	3.0	680	58.6	1,500	76.1
Total HPAH	**309**	**31**	**9,330**	**804**	**18,330**	**930**
Total PAH	**361**	**36**	**11,320**	**976**	**21,480**	**1,090**
Dibenzofuran	17 U		66 U		110	5.6

NOTE:

U No analyte was detected. The reported value is the lower limit of detection.

TABLE 2
SEDIMENT SAMPLING RESULTS (CONT.)

Sample Designation	Total Metals												
	Antimony (mg/kg)	Arsenic (mg/kg)	Beryllium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Selenium (mg/kg)	Silver (mg/kg)	Thallium (mg/kg)	Zinc (mg/kg)
SED1	2.7	19	0.8	0.40	95	41.0	52	0.05 U	47	2 U	0.08	0.2	119
SED2	3.5	13	0.8	1.2	79	101	137	0.19	51	4	0.53	0.2 U	243
SED3	4	13	0.9	2.1	76	90.1	190	0.69	56	4	1.1	0.2 U	369

TABLE 2
SEDIMENT SAMPLING RESULTS (CONT.)

Sample Designation	Average Percent Survival for Acute Amphipod Test (n=5)	Microtox Test (Percent Light Change)*
West Beach Control	88	6.2
SED1	68	6.2
SED2	72	69.4
SED3	46**	96.0

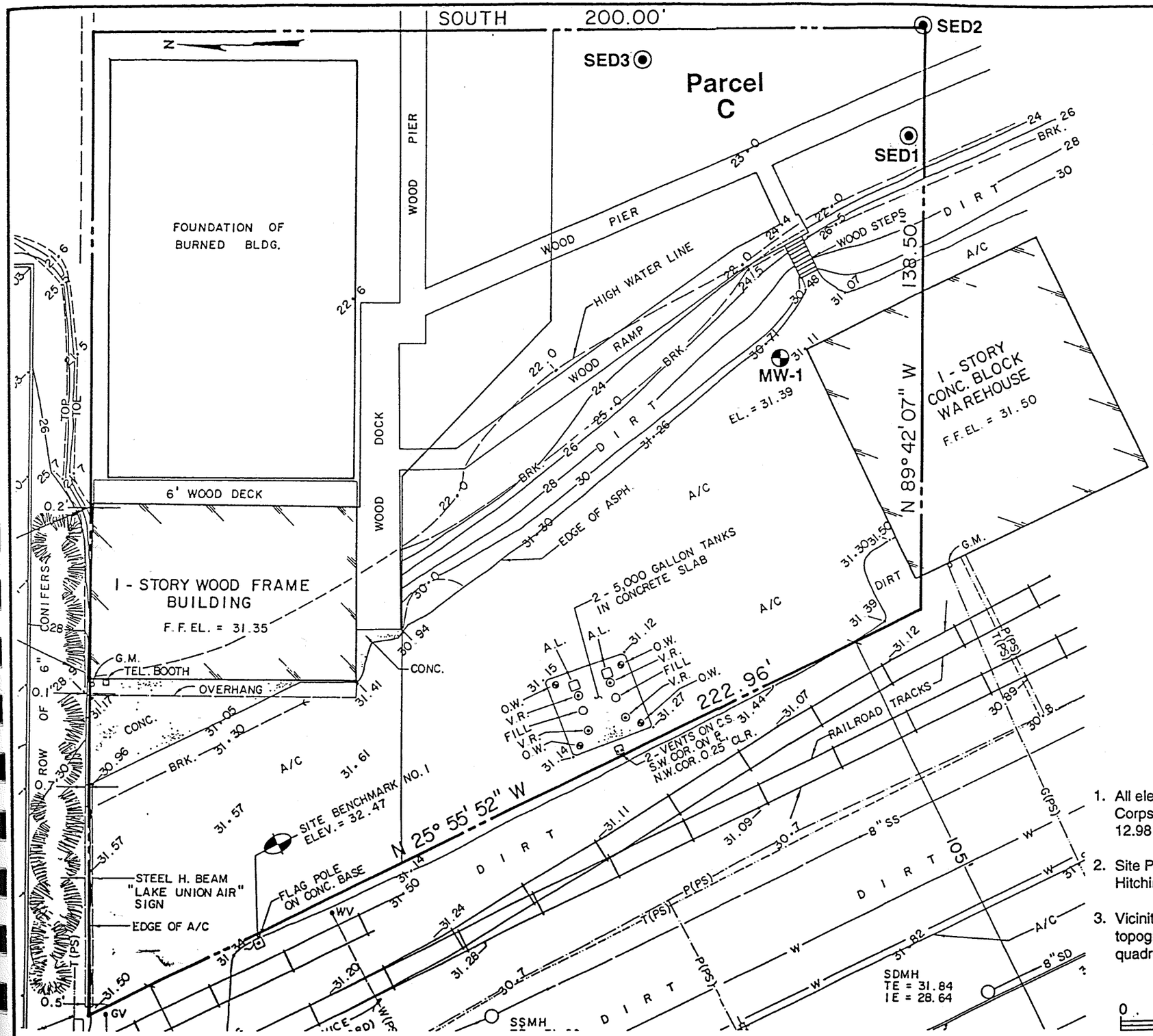
NOTES:

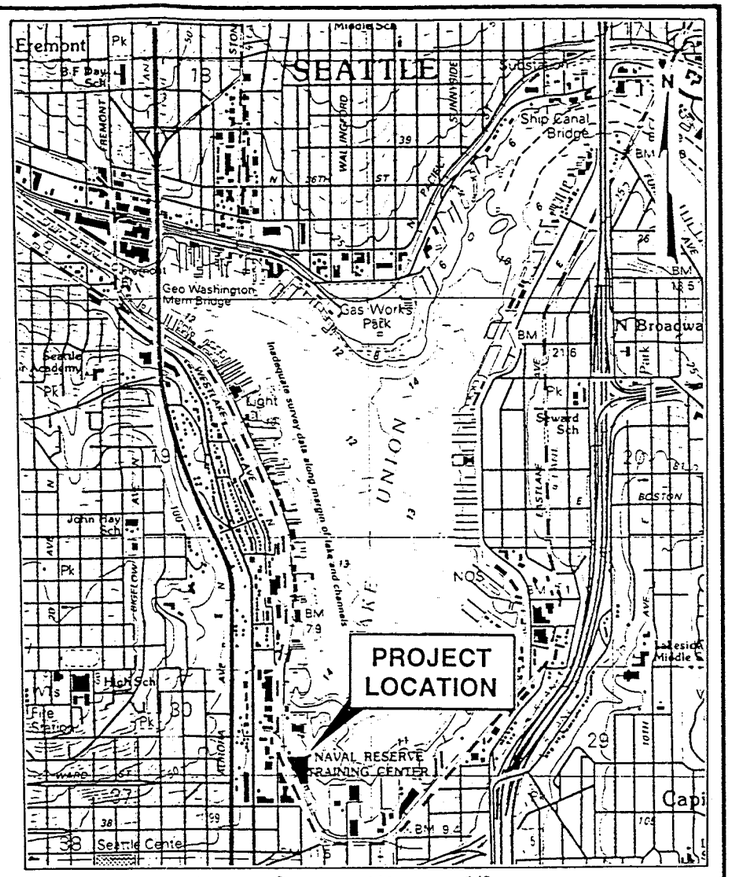
Amphipod test organism: Hyalella azteca

Microtox test organism: Photobacterium phosphoreum

* Reported for the highest concentration only and normalized to the percent light change for the blank sample.

** Statistically significant ($p \leq 0.05$) from the control.





NOTES

1. All elevations are based on U.S. Corps of Engineers Datum. Subtract 12.98 feet for City of Seattle Datum.
2. Site Plan prepared by Bush, Roed & Hitchins, Inc., dated 8-3-92.
3. Vicinity map taken from USGS topographic map of Seattle North quadrangle, dated 1983.

0 10 25 50

Scale in Feet

LEGEND

MW-1 Monitoring Well Designation and Approximate Location

SED1 Sediment Sampling Site Designation and Approximate Location

Seattle Commons
Parcel C Environmental Monitoring
Seattle, Washington

VICINITY MAP
SITE AND EXPLORATION PLAN

April 1994 T-1524-01

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. 1