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HARTCROWSER

Earth and Environmental Technologies

Pier 64/65 Sediment Quality Assessment
Port of Seattle Agreement No. P-032081
Elliott Bay/Seattle, Washington

Prepared for
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Seattle, Tacoma, Richland, Anchorage, Portland, San Francisco

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INTRODUCTION

Sediment contamination within urban embayments of Puget Sound has been identified by the regulatory agencies as a primary environmental quality concern. Accumulations of a variety of particle-associated contaminants within surface sediments, particularly in nearshore areas closest to industrial development, have been observed during recent investigations. Such chemical accumulations are often associated with impacts to the endemic biological community inhabiting these areas. The transport of these sediment contaminants to the main basin of Puget Sound is also of concern.

Previous investigations within Elliott Bay reported that the concentrations of contaminants of potential concern -- notably lead and polycyclic aromatic hydrocarbons (PAHs) -- appear to be locally elevated within the Pier 64/65 area of the central Seattle waterfront (Figure 1; Romberg et al., 1984; PTI and Tetra Tech, 1988; Metro, 1988). Sediments in these areas are also suspected as residual contaminant sources to the main basins of Elliott Bay and Puget Sound (Curl et al., 1988). However, these prior investigations did not identify a probable local source associated with nearshore contaminant accumulations. Chemical accumulations in this area could be the result of historical releases in the site vicinity and/or transport from a more distant source.

As part of the Port of Seattle's plan to redevelop the central waterfront area, the State, the Port, and the City of Seattle have signed a memorandum of understanding to develop a short-stay marina at Pier 64/65, which the Port will manage. Although dredging does not appear to be necessary to construct the marina project, because of the concern associated with sediment contamination in this area, the Port's environmental investigations related to the proposed redevelopment included a sediment quality assessment. Hart Crowser, Inc. was retained to conduct a review of available historical information and existing sediment quality data, conduct limited field sampling and chemical analysis to fill in primary data gaps, and assess the need for and general scope of sediment remediation at the site, given the existing regulatory framework. The Port's environmental investigations also include other companion studies (e.g., biological sampling), not discussed in this report.

This report presents Hart Crowser's sediment quality assessment of the Pier 64/65 area. The report is structured into the following sections:

- **Preliminary Review of Existing Sediment Quality Data**
- **Sampling and Analysis Program**
- **Historical Development Summary**
- **Sediment Transport and Deposition**
- **Contaminant Distribution**
- **Remedial Alternatives**

Appendices to this report include a detailed description of field sampling methodologies (Appendix A) and chemical analysis quality assurance narratives and laboratory certificates pertaining to Hart Crowser's investigations (Appendix B).

PRELIMINARY REVIEW OF EXISTING SEDIMENT QUALITY DATA

Sediment quality data collected in the immediate Pier 64/65 area are available from a variety of sources, including the Elliott Bay Action Team (EBAT, September 1985 sampling; PTI and Tetra Tech, 1988), the Port of Seattle (December 1987 sampling; Doug Hotchkiss, Port of Seattle, unpublished data), and Metro (May 1988 sampling; Metro, 1988 and August 1989 sampling; Pat Romberg, Metro, unpublished data). The locations of the sampling points are presented on Figure 2. All samples were obtained as two- to six-point composites within a given location, including only the top 2 cm of sediment material, as generally described in the Puget Sound protocols (PSEP, 1986).

The chemical determinations performed on the samples varied between investigations. However, based on a preliminary quality assurance review of methods and quality control data, all data generated by these different studies conformed with established protocols (i.e., PSEP, 1986), and are believed to be comparable.

In some cases, data on the total organic carbon (TOC) content of the sediment were not collected. Since TOC data are necessary to normalize many of the organic determinations (such as PAH concentrations) for criteria comparisons, this parameter was estimated using regressions with surrogate parameters such as total volatile solids (TVS) and total solids (TS). The regression procedures, and the variability associated with these statistical estimations, are discussed in the **CONTAMINANT DISTRIBUTION** section below.

Based on a preliminary review of the existing data and on attempts to contour these data using a variety of computer techniques the following general conclusions emerged:

1) High concentrations of lead have been reported at some nearshore sampling locations (71,000 mg/kg dry weight [DW] at EBAT location SS-09). High concentrations of both high and low molecular weight PAHs have also been detected in nearshore sites, particularly at EBAT location SS-08 (total LPAHs at 630 mg/kg DW and 3,200 mg/kg TOC; total HPAHs at 3,200 mg/kg DW and 12,000 mg/kg TOC). These concentrations are well in excess of both draft sediment quality (P2) criteria and minimum cleanup levels (MCULs) scheduled to be proposed by the Washington State Department of Ecology (Ecology) under the Sediment Management Standards (WAC 173-204) and the Model Toxics Control Act (WAC 173-340);

2) The small-scale spatial variability of concentrations in the Pier 64/65 vicinity is very large, particularly within areas closest to the shoreline. Reported concentrations of lead and PAHs within 100-foot grid areas vary by more than 100-fold;

3) No significant pattern of concentration variations was evident in the existing data, particularly relative to the small-scale variability noted above. The concentrations of chemicals also appeared to be of a similar range across a large nearshore area of the Seattle waterfront (based on data reported in Romberg et al., 1984; PTI and Tetra Tech, 1988; and Evans-Hamilton, 1987); and

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4) Although the maximum concentrations of chemicals such as lead and PAHs are far in excess of the Ecology draft P2 and MCUL criteria, the median concentrations of these parameters were generally at or below the criteria. An exception to this pattern is mercury, which is present at levels above the criteria throughout the site vicinity.

SAMPLING AND ANALYSIS PROGRAM

Based on our preliminary review of the existing data, a number of sampling and analysis activities were identified and implemented to provide the data necessary to complete the assessment of sediment quality in the Pier 64/65 area within budget constraints. These activities included the following:

- Extensive surface composite samples (16-point composites of material in the top 2 cm) were collected within 100-foot grids around the locations of EBAT sample SS-09 (HC-SS01), EBAT sample SS-08 (HC-SS03), and midway between these locations (HC-SS02; Figure 2). As discussed above, reported sediment contaminant concentrations have been highest at former EBAT locations SS-08 and SS-09 (see Figure 1 and Appendix C). These are also the primary locations of widely variable sediment concentrations. The surficial sediment composite samples were analyzed for bulk parameters (TS, TVS, TOC), selected metals of primary concern (lead, mercury, and zinc), semivolatile organic compounds (including PAHs by EPA Method 8270; GC/MS), and polychlorinated biphenyls (PCBs by Method 8080; GC/ECD).

- Sediment cores were collected in two relatively undisturbed locations approximately 100 to 150 feet offshore to define the vertical profile of concentrations of key contaminants in post-development sediment deposits (i.e., post-1900; approximately 0 to 50 cm depth based on Nevissi and Schell, 1977; Carpenter et al., 1985; Lavelle et al., 1986; and Pat Romberg, Metro, personal communication, 1990). The locations of the borings (HC-B01 and HC-B02) are depicted on Figure 2. Sediment collected from the two coring locations was sectioned into discrete depth intervals (0 to 4 cm; 4 to 8 cm; 8 to 14 cm; 14 to 20 cm; 20 to 30 cm; 30 to 40 cm; and 40 to 50 cm -- based on measurements uncorrected for compaction). Selected core sections were analyzed for bulk parameters (TS, TVS, TOC), metals (lead and zinc), semivolatile organic compounds (EPA Method 8270;

GC/MS), and PCBs (Method 8080; GC/ECD). Core sections were also analyzed for Lead-210 activity (determined by alpha counting of the activity of the granddaughter product Polonium-210) to determine sedimentation and/or mixing rates and to reconstruct the history of contaminant deposition in the area.

- Two sediment trap bases were deployed by Battelle Marine Sciences Laboratory for this project approximately 100 feet north of the northern tip of Pier 63. The purpose of the traps was to further define current (versus historic) contaminant deposition and resuspension conditions. The locations of the sediment traps (denoted Pier 63A and Pier 63B) are depicted on Figure 2. Trap construction data and handling procedures are discussed in Appendix A. The contents of the traps were centrifuged upon retrieval, then analyzed for bulk parameters (TS, TOC), metals (lead, mercury, zinc and others by XRF), semivolatile organic compounds (EPA Method 8270; GC/MS), and PCBs (Method 8080; GC/ECD). Trap contents were also analyzed for Lead-210 activity (determined by alpha counting of the activity of the granddaughter product Polonium-210) to verify the dating and mixing data derived from the sediment coring analysis described above.

Sampling and analysis procedures are described in more detail in Appendices A and B.

HISTORICAL DEVELOPMENT SUMMARY

General Background

Pier 64/65 is located along the northern portion of the central Seattle waterfront. Little development occurred in this area of the waterfront prior to the late 1880s, in part due to a high bank rising east of the property. The Elliott Bay tideflats extended to the base of this hill approximately one block east of Alaskan Way. The only nearby waterfront commercial operations during this period consisted of a coal export dock operated in the 1870s at the foot of Pike Street by the Seattle Coal and Transportation Co. and the small Mitchell shipyard (1880s) halfway between Blanchard and Bell Streets. The uplands at this time were devoted primarily to residential use.

The real stimulus for waterfront development in the northern area was the railroads. The Seattle Lake Shore and Eastern Railway Co. obtained right-of-way and, in 1887, constructed tracks on pilings along the waterfront. The Great Northern Railroad entered Seattle in 1893, also along this waterfront corridor. These rail lines formed the basis for Railroad Avenue, now known as Alaskan Way, and provided the impetus for expansion of waterfront facilities. By 1893, wharfs had been built as far north as Virginia Street. The New York Paint Factory and Johnstone's Fish Packing Co. were located on a pier just south of Virginia Street.

Substantial growth and development occurred after 1900. Historic maps from 1905 indicate that the tideland area between the railroad tracks and the foot of the bluff had been filled, although the rail lines and street continued to be pile-supported. The precursor to Pier 64/65 was built between 1900 and 1905 by the United Warehouse Co. and additional warehouse facilities lined the east side of Alaskan Way. Some of these initially housed cement, which likely was used during construction of the Great Northern railroad tunnel under the city between 1902 and 1905. The concrete batch plant for this construction was located just south of Virginia Street on Elliott Avenue.

Most of the waterfront at this time was operated by private concerns. The advent of the Port of Seattle in 1911 and their construction of the Pier 66 facilities in 1915 signaled a change. The agenda of the port was to consolidate the waterfront under their authority. Meanwhile, additional facilities related to intermodal transhipment, particularly rail and truck warehousing storage, developed east of Alaskan Way. These structures provided additional support to the pier activities, which included both storage and processing. The Port of Seattle purchased Pier 64/65 in 1930.

Tidelands Filling and Regrades

According to the Seattle Engineering Division (Blanchard, 1978) the initial waterfront fill in the Pier 64/65 area resulted from the regrading in 1898 of First Avenue between Pine Street and Denny Way. This leveling of First Avenue constituted the beginning of the first Denny Hill regrade activity, which occurred between 1898 and 1911. Most of the material from the Denny regrade and other street regrades (Pike and Pine Streets were also substantially altered between 1903 and 1905) was sluiced into Elliott Bay west of the Pier 64 to Pier 70 area. A pile-supported dispersion flume was extended sequentially out into the bay and reached a maximum extent of 1,200 feet beyond the harbor line. Approximately 5.5 million cubic yards were removed during the first major regrade period. A main hydraulic pumping station was located south of Virginia Street and adjacent to Elliott Avenue in 1907.

Subsequent completion of the Denny regrade resulted in additional offshore spoils disposal in the same general area between 1928 and 1931. Unlike the first hydraulic disposal, the approximately 4.2 million cubic yards was loaded on tipable barges by a conveyor belt system along Battery Street and deposited about 800 feet west of Piers 66 and 67. The final fill placement was too high for safe navigation and required dredging.

Newspapers in 1929 suggest that the area under the Alaskan Way street corridor still required fill. They noted that several hundred cubic yards of fill were sorely needed to fill the "death trap Railroad Avenue".

The final waterfront improvement correcting the Alaskan Way (Railroad Avenue) problem occurred in 1934. Seattle city engineers designed a precast concrete seawall for the outer edge of the street. Fill was barged in, placed by bucket, and sluiced into place.

Pier 64/65 Development

As noted above, initial development of the Pier 64/65 location occurred between 1900 and 1905 and was operated by the United Warehouse Co. The pier, known as the Oriental Dock, paralleled Alaskan Way for approximately 550 feet from Virginia Street north and extended only 130 feet west of Alaskan Way. Sanborn fire insurance maps for that time show two general storage warehouses on the dock. Two additional warehouses were located east of Alaskan Way and the rail lines. One of these landside warehouses contained a cold storage facility with an ammonia compressor system. Notations for the other indicate storage of salt and cement. Specifics on the range of materials handled and warehoused are not known. This area of the waterfront, however, served primarily lumber and fishing interests, with a number of fish processing facilities located at nearby piers. Salt and cold storage would indicate that United Warehouse also served the fisheries industry.

Little detail was found covering the period from 1905 until the Port purchased the property in 1930. The original pier extended north to the margin of Pier 66, and was presumably in existence when that facility was constructed. Port documents, however, indicate that when they obtained the property from the Pacific Coast Co., the portion north of Lenora Street had been removed, and the extension and shed for Pier 65 had been constructed. New pilings were driven to the outer harbor line by the Port in May of 1930 for construction of Pier 64. The final configuration of the pier consisted of one platform with two sheds supported by approximately 2,500 creosoted pilings. The Port maintained an inspection and replacement program for pilings into the 1980s on a five-year inspection cycle. Although information is incomplete, Port documents suggest that, in the latter years of use, approximately 25 to 50 pilings were being replaced in the older pier sections within each 5-year period.

Documents suggest that the original warehouse at Pier 64 had been demolished to construct a new facility serving passenger and terminal facilities for the Canadian Pacific Railroad's steamship line. The terminal function was the primary use of this shed through its active history. Minor leases of space occurred in the 1960s and 1970s to a sailmaker and a heating equipment supply dealer.

Pier 65 in its early years served a variety of small storage and commercial ventures. The principal activities appear to be associated with fish processing and packing. These included the wholesale facilities of Leslie Salt Co. from the 1930s to 1950s and fish wholesaling and packing by the Newport Fish Co. (1940s and 1950s) and the New England Fish Co. (1960s and 1970s). It appears from Port documents that some of the wastes from the fish processing operations discharged to the waters below the dock until 1975 when a new drain system to the Alaskan Way sewer line was installed. Other short lived or minor activities at the pier included sail manufacturing, wholesale druggist supply, and a restaurant. In the late 1940s, both the National Construction Co. and an independent contractor are listed as tenants.

Pier 64/65 was demolished after it partially collapsed in 1987.

Adjacent Uses

As noted above, the United Warehouse Co. operated a cold storage and warehouse facility east of Alaskan Way beginning around 1905. The cold storage facilities operated under the Washington Cold Storage Co. from the 1930s to at least the 1960s. The warehouse portion of this building served as a grocery warehouse until the 1970s, when small wholesale distributors located in the northern portion. The predominant goods stored included wine, furniture, and industrial sealants. The warehouse area, which originally housed cement and salt, was located immediately north of Lenora and became a fish fertilizer operation in the 1930s. After World War II until the present, this facility has served as a warehouse distribution center for a variety of small truck lines.

Piers 62 and 63 to the south appear to have been built around the 1920s. Up until the 1950s they served a wholesale fish processing function and as a warehouse for the Virginia Dock and Trading Co. They subsequently became a truckline warehousing and transfer dock from the 1950s to the 1970s.

The Port of Seattle facility to the north has operated since 1915. It has housed Port offices and a major cold storage facility for many years, although the cold storage function is no longer active and the space has been converted. The other major activity at the Bell Street terminal portion has been fish processing and wholesale distribution. In addition, Leslie Salt occupied space in the 1950s. Aside from the wholesale goods storage activities at this location, one other business deserves mention. Between 1948 and 1958, the Commercial Ship Drydock Co. was listed as a major tenant of Pier 66 facilities.

Details of sewage and other waste disposal from piers and surrounding facilities are scant. Although onshore facilities appear to have been connected to the Seattle sewer system beginning in the 1930s, a large (though undetermined) portion of these wastewaters were likely discharged directly into Elliott Bay through a number of local outfalls. These discharges persisted through the early 1970s, when the Elliott Bay Interceptor was constructed to convey combined (sanitary and storm) sewer flows to the West Point Treatment Plant. No combined sewer overflow (CSO) outfalls occur in the Pier 64/65 locality.

Upland Soil Quality

A number of soil borings and groundwater samples have been collected from upland areas located immediately northeast (and hydraulically upgradient) from Pier 64/65 (Hart Crowser, unpublished property assessments conducted for Port of Seattle). The data indicate that both the surface fill and associated groundwater in the vicinity are relatively free of metal and organic contaminants of general concern (e.g., lead and total petroleum hydrocarbons). Isolated and relatively low concentrations of petroleum hydrocarbons have been reported in some soil and groundwater samples collected in the area, apparently due to small spills and other related occurrences associated with underground piping and storage tanks. However, the concentrations encountered in these areas were well below levels reported in the nearshore sediments. Based on these data, a local ongoing upland source of lead and PAH contaminants to the Pier 64/65 area is not indicated. However, stormwater discharges and CSO from adjacent commercial land uses may represent a continuing source of these contaminants.

SEDIMENT TRANSPORT AND DEPOSITION

Sediments in the Pier 64/65 area may be derived from a variety of sources, including seasonal runoff from the Duwamish River, shoreline erosion from areas not protected by bulkheads (notably Magnolia Bluff to the northwest), stormwater/CSO discharges, and Denny regrade shoaling deposits (Curl et al., 1988). The immediate shoreline area has been protected by bulkheads since 1934, limiting potential erosion.

The net surface current in the vicinity has been reported as counterclockwise (northwesterly; Evans-Hamilton, 1987; Curl et al., 1988). Accordingly, recent sediment deposits in the Pier 64/65 area are likely derived predominantly from sources to the south. Based on the significant net currents recorded in the area (3 to 4 cm/sec; observed during periods of relatively low discharge from the Duwamish River), it is probable that contaminant inputs along the entire Seattle shoreline (including the Harbor Island/Duwamish area) could contribute to sediments in the site vicinity. This condition will be discussed in more detail in subsequent sections of this report.

Sediment Deposits

The predominant sediment depositional feature in the Pier 64 through Pier 69 area is the Denny regrade shoal. In the early 1900s approximately 10 million cubic yards of material were removed from Denny Hill and dumped into Elliott Bay west of today's Pier 66/67. Based on historical bathymetrical charts and recent seismic reflection data of Elliott Bay (Loeffler et al., 1989; and personal communication with Mark Holmes of USGS), the center of the spoil bank is located between 600 feet and 800 feet west of Pier 66/67 with thicknesses ranging between 20 feet to 100 feet. Sediment samples collected from the shoal area consist of sandy gravels (core of the shoal bank) and sandy muds (flanks).

The spoil bank probably does not extend into the former Pier 64/65 area based on recent geophysical data (Loeffler et al., 1989; and personal communication with Mark Holmes of USGS). Subsurface materials encountered during two geotechnical investigations in the Pier 66 area showed that sand and gravelly fill (Denny regrade material) thicknesses decrease significantly from Pier 66 to the south (Shannon & Wilson, 1988; AGS, Inc., 1988). For example, fill encountered near the Port of Seattle office buildings (boring B-205) was over 30 feet thick compared with no observance of fill in boring B-204 located at the southern end of Pier 66.

Generally, mudline sediments south of Pier 66 are very soft, slightly sandy silt with thicknesses ranging between 3 feet and 16 feet (Shannon & Wilson, 1988; Loeffler, et al., 1989). In the absence of Denny regrade fill material, the silts are typically underlain by a medium dense sand.

Sediment Trap Deposition

The sedimentation rate within the Pier 64/65 area is a major factor determining the susceptibility of an area to sediment contamination and the ability of such sediments to recover over time. The sedimentation rate in the study area was determined using both Lead-210 dating of in-place sediments and sediment traps deployed in the same general area. These data are discussed below, and are compared with other published information available for Elliott Bay and Central Puget Sound.

As stated previously, a pair of sediment traps was deployed off the northern corner of Pier 63 over a two-month period from May 2 to July 10, 1990 (see Figure 2 for locations). The openings of the sediment collectors were positioned approximately 0.75 meter above the sediment surface, in order to receive sediments possibly resuspended in the area, and transported via a relatively high turbidity nepheloid layer known to exist immediately above the bottom surface in other areas of Elliott Bay and central Puget Sound (Baker et al., 1985; Curl et al., 1988). A summary of trap deposition rates is presented in Table 1.

Table 1 - Sediment Trap Deposition Rates

Trap No.	Percent Solids	Accumulated Dry Weight in Grams	Sediment Flux in gm DW/cm^2-yr
Pier 63A	26.8	61.	0.86
Pier 63B	25.5	60.	0.84
Elliott Bay Mooring PS8501 (Curl et al., 1988)			0.0057
Central Puget Sound Mooring PS7 (Baker et al., 1985)			0.062

As summarized in Table 1, the measured sediment deposition rate in the Pier 64/65 sediment traps was approximately 0.85 gm DW/cm^2-yr, and varied little between replicate collectors. This value is approximately 100 to 200 times higher than rates reported during an 8-day sediment trap deployment during April 1985 in an open-water area of central Elliott Bay (Mooring PS8501; Curl et al., 1988). The Pier 64/65 sediment trap deposition rate is also approximately 10 to 15 times higher than the annual average rate observed in central Puget Sound (Mooring PS7; Baker et al., 1985). Nevertheless, the measured Pier 64/65 sediment trap flux is similar to observed sediment **accumulation** rates in sediment cores collected throughout Puget Sound, including Elliott Bay (Nevissi and Schell, 1977; Carpenter et al., 1985; Lavelle et al., 1986; Pat Romberg, Metro, personal communication). Sediment accumulation in these basins appears to be dominated by bedload-type transport from the shoreline areas, and may not be fully reflected in open-water sediment traps (Baker et al., 1985; Curl et al., 1988). Sediment delivery to the main basin of Puget Sound also appears to be relatively similar between seasons.

The origin of material accumulated within the Pier 64/65 sediment traps can be inferred from the results of chemical analyses of the trap contents. A summary of the trap data is presented in Table 2 (located at the end of the text). Based on the general similarity of the trap contents with local surface sediments, and the relatively low TOC and Lead-210 values compared with open-water depositional material (Baker et al., 1985), resuspension of bottom sediments along the Seattle waterfront is indicated as at least a partial source of material to the traps. Resuspension is also indicated by a consideration of deposition rates and Lead-210 flux (see below). The proportion of "new" material to the sediment traps, though likely important, cannot be reliably estimated with the available data.

The local area along the central Seattle waterfront which likely contributes to sediment deposition in the Pier 64/65 area can be estimated based on a consideration of trap deposition rates, ambient total suspended particulate (TSP) concentrations, and current speeds. Given an ambient average TSP concentration in the site vicinity of approximately 2 mg/L (Curl et al., 1988) and a local water column depth of 15 meters, the measured trap deposition rate (0.85 gm DW/cm_2-year) equates to an average water column TSP residence time of up to 0.8 day. At an ambient net current velocity of 3 to 4 cm/sec, the transport distance for suspended particulates may extend approximately 2 kilometers (1 mi). Based on these calculations, sediment accumulated within the Pier 64/65 traps could have originated from sources throughout much of the Seattle waterfront south of the site to Harbor Island (Figure 1). The chemical quality of material recovered from the traps thus may not be fully representative of local sediment or input conditions.

Accumulation in Sediment Cores

The physical displacement of sediment following initial deposition on the sediment surface may occur as a result of sediment burial, bioturbation, and resuspension, or combinations of these processes. A simple burial model often utilized in assessments of sediment deposition assumes that sediments can be represented as a simple two-layered system, with constant and relatively rapid mixing induced by bioturbation in the upper layer (Robbins, 1978; Christensen, 1982). The upper mixed layer is generally assumed to be equivalent to the biologically active zone. Under this model, no mixing is assumed to occur in the lower burial layer. By applying mathematical extensions of this model to observed Lead-210 profiles in the sediment, both the mixed depth and net sedimentation rate can be estimated.

Profiles of the total (supported) Lead-210 activity in the two sediment cores (HC-B01 and HC-B02) are depicted on Figure 3A. A composite total solids profile from these cores is also presented for comparative purposes on Figure 3B. The depth intervals sampled from both cores are not corrected on these figures for compaction, as described during the field observations (Appendix A; observed compaction range: 10 to 30 percent). The Lead-210 data reveal a significant ($P < 0.05$; regression) decline of activities with depth, consistent with the depositional model discussed above.

Although, as discussed below a variety of different interpretations of the Lead-210 data are possible, the Figure 3A data are nevertheless consistent with an upper mixed layer of approximately 10 cm. Near-surface declines in Lead-210 activity may be due to abundant barnacle shells and other surface debris observed in the upper sediments which would dilute the overall Lead-210 activity. Below a depth of approximately 10 cm, the Lead-210 activity decays in a nearly logarithmic pattern, consistent with the burial model. Assuming a "baseline" supported Lead-210 activity in these sediments of approximately 0.5 dpm/gm (based on Romberg et al., 1984; Carpenter et al., 1982 and 1985; Lavelle et al., 1986; and Hart Crowser, 1989) and following methodologies outlined in these references, the decline of Lead-210 with depth in these cores is consistent with a net accumulation rate of approximately 0.26 ± 0.04 gm DW/cm^2-yr. Both cores yielded nearly identical accumulation rates. Assuming a range of 10 to 30 percent observed core compaction, these data are equivalent to an apparent sedimentation rate of 0.8 ± 0.3 cm/yr. Similar values have been reported elsewhere in Elliott Bay (Nevissi and Schell, 1977; Carpenter et al., 1985; Lavelle et al., 1986; Pat Romberg, Metro, personal communication). Based on these data, and assuming a burial model, the 50 cm maximum depth of the cores corresponds to material deposited as early as 1880.

The average net sediment accumulation rate in the Pier 64/65 cores of 0.26 ± 0.04 gm DW/cm^2-yr, as derived using the Lead-210 profiles, is approximately 30 percent of the measured deposition rate in the traps (0.85 gm DW/cm^2-yr; Table 1). A similar ratio exists between accumulated Lead-210 in the sediments (corrected for decay) and the depositional Lead-210 flux as measured by the traps. Although these data could reflect seasonal variations in deposition, large seasonal variations in deposition rates have not been observed in central Puget Sound (Baker et al., 1985).

* *

We consider it more likely that the differences between accumulation and deposition rates in the Pier 64/65 area reflect resuspension. Given the observed ratios between deposition and accumulation rates, it is likely that approximately two-thirds of the material deposited in the traps was derived from resuspended sediment, with the remainder being "new" material. The location of such resuspension, however, cannot be determined, though sources throughout the central and southern Seattle waterfront are possible.

As discussed above, a number of investigators have applied the simple burial model or minor variants of this formulation to different areas of Puget Sound. These areas have included the main basin of Puget Sound and nearshore regions of Commencement Bay (Carpenter et al., 1985; Lavelle et al., 1986; Tetra Tech, 1988; D. Norton, Ecology, personal communication, 1989). Several of these investigators also examined bioturbation within the upper mixed layer of Puget Sound sediments. Their results suggest that the bioturbation-induced mixing depth in Puget Sound ranges from roughly 5 to 40 cm below the sediment surface, which encompasses nearly the entire Pier 64/65 coring depth. Furthermore, the Lead-210 pattern resulting from bioturbation (i.e., logarithmic decay) is often indistinguishable from the simple burial model, particularly in a relatively shallow core.

Considering the similar profile characteristics, it is not possible to differentiate between burial and bioturbation in the Pier 64/65 cores, based solely on a consideration of Lead-210 data. However, chemical data collected from the cores (presented later in this report) raise questions concerning the validity of the simple burial model in this situation. For example, the deepest core intervals sampled during this investigation exhibited some of the **highest** lead and PCB concentrations. The estimated (burial model) deposition dates of these deeper samples (collected at depths of 30 to 50 cm) range from approximately 1880 to 1945. However, peak lead and PCB inputs to Elliott Bay and Central Puget Sound appear to have occurred during the period 1950 to 1970 (based on deep-water coring data discussed by Romberg et al., 1984). Although these data certainly do not unequivocally prove that the burial model is invalid in this situation, there is nevertheless sufficient reason to question the simple burial model results.

Deviations from the simple burial model discussed above are typically associated in Puget Sound sediments with bioturbation-induced mixing (e.g., Carpenter et al., 1985; Lavelle et al., 1986). The degree of mixing is represented by an empirically derived mixing coefficient. Depending upon the mixing coefficient value and changes in source strength over time, contaminants can be moved to greater depths within a sediment environment where bioturbation processes occur. Although other forms of mixing may also be important in some locations of the Pier 64/65 area (e.g., physical disturbances due to piling), the locations of the coring samples in relatively undisturbed areas were generally selected against this condition (see Appendix A).

Nearly all studies of sediment displacement, including those conducted in Puget Sound, have addressed bioturbation as approximating a Gaussian diffusion process occurring throughout the biologically active zone (Robbins, 1978; Peng et al., 1979; Carpenter et al., 1982 and 1985; Christensen, 1982; O'Connor et al., 1983; Lavelle et al., 1985). The validity of the Gaussian model has been substantiated by a consideration of benthic infaunal distribution and behavioral patterns. The model has also been successfully applied in a number of locations where the net sedimentation rate is low enough to permit a specific evaluation of the bioturbation process. The Gaussian bioturbation model is also felt to apply in areas characterized by a zero net sedimentation rate, but nevertheless subject to sediment transfer through the activities of deposit feeding benthos.

The activity of Lead-210 can be used as a marker of mixing processes which have occurred over a time span comparable to the half life of the radioisotope. The activity of Lead-210 in bioturbated sediments is represented by the one-dimensional advection-diffusion equation:

$$-\frac{\partial}{\partial z}(vc) + \frac{\partial}{\partial z}\left(D\,\frac{\partial c}{\partial z}\right) - \lambda c = \frac{\partial c}{\partial t}$$

where c is the Lead-210 activity, z in dpm/cm^3 is the depth below the sediment-water interface, t in cm is the time, v in years is the sedimentation rate in cm/year, D is the mixing coefficient in cm^2/year (i.e., the bioturbation eddy diffusion coefficient), and λ is the radioactive decay constant for Lead-210. Steady-state solutions to the advective-diffusion equation can be applied to Lead-210 data to estimate the mixing coefficient.

Generally, the rate of biological mixing is estimated by comparing the vertical Lead-210 gradient observed within the biologically active zone with the gradient below this zone. The gradient below the biologically active zone is reflective only of the net sediment deposition or burial rate, while the gradient within this zone includes both the mixing and burial components. In the Pier 64/65 study area, however, Lead-210 activity gradients within and below the biologically active zone in the shallow sediment cores cannot be distinguished. Accordingly, an assessment of bioturbation rates in this case, derived entirely from an evaluation of surficial (0 to 50 cm) activity profiles, must assume a sediment accumulation rate.

For the purposes of this evaluation, the assumed deposition rate was set equal to zero. Bioturbation rates derived from this approximation may thus **overestimate** true values if net deposition occurs in these sediments. Based on procedures outlined in Lavelle et al. (1986), along with additional assumptions stated previously (e.g., baseline Lead-210 activity), the average calculated bioturbation rate in cores HC-B01 and HC-B02 is approximately 23 $\pm$ 12 cm^2/yr. This estimated range is similar to values reported for the main basin of Puget Sound (Lavelle et al., 1986) and elsewhere (Robbins, 1978; Dayal et al., 1979; Peng et al., 1979; Carpenter et. al., 1982; O'Connor et al., 1983).

At the apparent bioturbation rates, contaminant movement through the core could occur much faster than that characteristic of a simple burial model. Bioturbation may thus explain the presence of contaminants such as lead and PCBs at depth within the cores. Undoubtedly some combination of both processes (burial and bioturbation) is operable within the Pier 64/65 sediments, though the data are not sufficient to reliably determine the relative importance of each mechanism.

Key conclusions of the sediment transport and deposition evaluation discussed above are summarized as follows:

- Considerable sediment resuspension appears to occur in the site vicinity. Based on a comparison of sediment trap and in-place sediment data, approximately two-thirds of the material deposited in the study area may be resuspended material. The original source of these resuspended sediments cannot be determined with the available data, but may include large areas of the central and southern Seattle waterfront; and

- Both sediment burial and bioturbation may be important processes contributing to contaminant transport through the upper sediment layer (0 to 50 cm). Although the overall database is more consistent with bioturbation-induced transport, net sediment deposition in the Pier 64/65 area may also be occurring. Based on the observed Lead-210 profile, the upper-bound (zero bioturbation) sedimentation rate in this area is approximately 0.26 ± 0.04 gm DW/cm^2-yr, or 0.8 ± 0.3 cm/yr. Similarly, the upper-bound (zero sedimentation) bioturbation coefficient is approximately 23 ± 12 cm^2/yr. All these values are consistent with reported rates elsewhere in Elliott Bay and central Puget Sound.

CONTAMINANT DISTRIBUTION

As stated above, a variety of previous investigations have been performed in the Pier 64/65 vicinity which have evaluated contaminants present in surficial sediments.. Along with the recent data collected during this investigation, and summarized in Tables 2 and 3, the accumulated database collectively provides a basis to assess contaminant distributions in the study area.

Quality Assurance/Quality Control

Based on our review of previous data and a more in-depth validation of chemical data generated during this study, the entire database compiled for the Pier 64/65 vicinity appears to conform with PSEP (1986) protocols. During our data validation effort (discussed in detail in

Appendix B), some of the original laboratory reports were flagged with a "J" to denote that the associated concentration value is estimated (and likely biased somewhat high), given the results of surrogate recoveries above the control range. Other "J" flagged data indicated the confirmed presence of the analyte, but at a concentration below the sample detection limit. All semivolatile data reported by the laboratory were confirmed with mass spectrometry.

Aside from the absence of some analytes (e.g., TOC) in several of the previous studies, few limitations on the use of the data were identified. However, since TOC is a critical "normalization" parameter necessary for criteria comparisons, estimation of this analyte concentration based on surrogate parameters was investigated for this report. The lack of original TOC data occurs in the Port of Seattle December 1987 sampling (Doug Hotchkiss, Port of Seattle, unpublished data), and the Metro May 1988 sampling (Metro, 1988).

Total volatile solids (TVS) generally provides a measure of concentration of the same organic compounds determined in the TOC analysis. Since TVS was determined on the Port of Seattle samples, its relationship to TOC was investigated using all data available from the local database. A highly significant ($P < 0.001$; regression) relationship exists between these parameters, and is plotted on Figure 4A. The TVS:TOC regression relationship, which was utilized to estimate TOC concentrations in the Port of Seattle data set, is summarized as follows:

$$\text{Log (TOC; fraction DW)} = -0.20 + 1.13 * \text{Log (TVS; fraction DW)}$$

$$r^2 = 0.87;\ P < 0.001;\ \text{Prediction Uncertainty} = \pm\ 13\ \%$$

The original Metro data set (May 1988 sampling) did not include analyses for either TOC or TVS. However, a highly significant correlation ($P < 0.001$) is evident between TS and TOC, and can also be used as a basis for TOC estimation (Figure 4B). In this case, the correlation between TS and TOC likely reflects the physical association of higher water content with increased organic matter. The regression relationship is summarized as follows:

$$\text{Log (TOC; fraction DW)} = -2.5 - 2.99 * \text{Log (TS; fraction by weight)}$$

$$r^2 = 0.69;\ P < 0.001;\ \text{Prediction Uncertainty} = \pm\ 18\ \%$$

Although the TS:TOC relationship is somewhat less precise than the TVS:TOC regression, the statistical significance of the relationship is nevertheless strong enough to justify its use to normalize the original Metro data. Since the original Metro data represent the largest single source of sediment quality data within the study area (representing 9 sampling locations; Table 4), the information value contained in the normalized data is justified, even with the additional estimated 18 percent uncertainty. Given the very large spatial variability of concentrations observed within the study area, the additional uncertainty introduced through TOC estimation is likely to be insignificant.

Chemicals of Primary Concern

As discussed by PTI and Tetra Tech (1988) and Metro (1988), some of the previous sampling efforts conducted in the Pier 64/65 area included the determination of all or substantially all of the priority pollutants listed under EPA's Superfund program. Relative to the frequency of analytical detections reported in these investigations and considering potential aquatic life toxicity (as represented by P2 criteria), bioconcentration, and human health risks, a number of chemicals of primary concern were identified in the study area. As summarized by PTI and Tetra Tech (1988) and Metro (1988), the chemicals of primary concern include the following:

Lead
Mercury
Zinc
Low Molecular Weight PAHs (LPAHs)
High Molecular Weight PAHs (HPAHs)
Benzoic Acid
Bis(2-ethylhexyl)phthalate
Dibenzofuran
Polychlorinated Biphenyls (PCBs)

Although other chemicals were detected in the Pier 64/65 area, some at concentrations exceeding P2 criteria, the frequency and magnitude of such exceedences were far lower than those of the primary chemicals listed above. Furthermore, because of the strong spatial correlation observed between the various analytes, the nine primary chemicals or chemical groupings listed above can be used as suitable indicator parameters for risk assessment and remedial action purposes, similar to the Superfund program. Accordingly, the remainder of this discussion will focus on the nine primary contaminants identified above.

Depositional Sediment Quality

The chemical quality of the depositional sediments, as reflected in the Pier 63 sediment trap samples, is summarized in Table 2. The bulk chemistry of these materials is dominated by the presence of silicon (22 percent of dry weight; likely present as silicate), with substantial quantities of aluminum (6 percent), iron (4 percent), organic carbon (4 percent), and calcium (2 percent). The bulk chemistry of these materials is similar to depositional sediments of Puget Sound (Feely et al., 1986). As discussed above, the Lead-210 data indicate that a substantial portion of these depositional sediments is derived from resuspension.

Of the twelve metals analyzed in the trap material, only mercury -- present at 0.74 to 0.76 mg/kg DW -- exceeded P2 (0.41 mg/kg) criteria (Table 2). The draft MCUL of 0.59 mg/kg DW for mercury was also exceeded. All other metals, including lead at 156 to 186 mg/kg DW, were below the draft regulatory criteria. PCBs (measured at 7 mg/kg TOC) were also below the P2 criterion (11 mg/kg TOC).

The concentrations of LPAHs analyzed in the trap material (total LPAH levels of 354 to 438 mg/kg TOC) were generally equivalent to the P2 criterion of 370 mg/kg TOC, but lower than the draft MCUL of 780 mg/kg TOC (Table 2). The LPAHs were dominated by the presence of phenanthrene and anthracene, though all priority pollutant LPAHs were detected in these samples.

The concentrations of total HPAHs in the trap material ranged from 1,950 to 2,260 mg/kg TOC, which exceeded the P2 criterion of 960 mg/kg TOC, but was lower than the MCUL of 5,300 mg/kg TOC (Table 2). The total HPAH concentration was represented by a wide variety of individual compounds, and again all priority pollutant HPAHs were detected in the samples.

Surficial Sediment Concentration Distributions

As discussed above, extensive (16-point) surface sediment composite samples were collected from three nearshore areas of Pier 64/65 in an effort to obtain samples representative of the average concentrations within these 100-foot square grid zones (Figure 2). Previous samples collected within these areas indicated a very large spatial variability. A summary of concentrations encountered in the nearshore composites (HS-SS01, HC-SS02, and HC-SS03) is presented in Tables 2 and 3. A comparisons with previous data collected in the vicinity is presented in Table 4.

The metal concentrations detected in the surface composite samples were of a similar range compared with levels reported for the area from previous studies. The lead concentrations in these samples ranged from 420 to 704 mg/kg DW, which is higher than the median value observed within the entire study area, but considerably lower than the maximum concentration reported at EBAT sample SS-09 (PTI and Tetra Tech, 1988)(Tables 3 and 4). The surface composite samples contained concentrations of lead, mercury, and zinc which typically exceeded the P2 criteria; the maximum concentrations were typically equivalent to the MCUL.

The concentrations of all of the organic chemicals of principal concern identified in the study area (see listing above) exceeded P2 criteria in the nearshore surface sediment composite samples (Tables 3 and 4). For many of the analytes (especially LPAHs and HPAHs), the concentrations also exceeded draft MCUL criteria. Total HPAH concentrations, for example, ranged from 7,600 to 14,300 mg/kg TOC. These elevated values are the result both of the high dry weight concentrations (111,000 to 219,000 ug/kg DW total HPAH) and low TOC levels (1.5 percent DW) observed in these nearshore sediments.

In contrast to the lead data discussed above, the concentrations of organic chemicals of primary concern in the nearshore surface sediment samples were similar to maximum concentrations reported previously within the area (i.e., EBAT sample SS-08; PTI and Tetra Tech, 1988) (Table 4).

The areal distribution of contaminant concentrations within the Pier 64/65 area was assessed through the application of geostatistical contouring techniques (e.g., kriging and multiple regression; incorporating log-normal data transformation). All data summarized in Table 4 were included in this evaluation.

As a preliminary component of the geostatistical assessment, variations in concentration alongshore (i.e., in a northwest-southeast direction) were first examined. Based on the results of our evaluations, **no significant differences** ($P > 0.10$) in concentrations exist alongshore within the study area. The relatively minor variations in contaminant concentrations between Pier 62 and Pier 66 appear to be within the range of sampling variance observed during the various investigations.

Significant offshore (i.e., in a northeast to southwest direction; $P < 0.05$) variations in contaminant concentrations were observed for many of the chemicals of primary concern identified in the study area. The contoured surface distributions of several key contaminants -- lead, LPAH, and HPAH, are depicted on Figures 5, 6, and 7, respectively. For these contaminants (and correlated chemicals such as dibenzofuran), surface concentrations declined in an approximate logarithmic pattern with increasing distance from shore. The offshore concentration declines suggest a source of these contaminants close to shore, though the identity of such a possible source has not been determined. Potential sources could include releases associated with treated pilings and runoff from adjacent commercial properties and roadways.

Also washing off pier surfaces which contain street dust and creosote from decking planks

Based on the areal distributions presented on Figures 5, 6, and 7, surface sediments within a distance of approximately 200 feet from shore exceed the P2 criteria for all three parameters. Surface sediments within a distance of approximately 140 feet exceed the draft MCUL values for these chemicals. As stated previously, the data are not sufficient to identify the distance alongshore exceeding these criteria.

Although a relatively strong offshore variation in surface concentrations was observed for many of the primary contaminants such as lead and PAHs, no significant ($P > 0.10$) offshore variation was observed for other indicator chemicals such as mercury, zinc, and PCBs. Surface concentrations of these chemicals appeared to be similar throughout the entire study area, and are indicative of regional sources. Previous studies in the area, for example, have identified natural and anthropogenic discharges from the Duwamish River as important sources of these contaminants (Harper Owes, 1983; PTI and Tetra Tech, 1988). Nearly all surface concentrations of mercury within the study area exceeded the P2 criteria. A large fraction of the PCB data also exceeded these criteria.

Vertical Contaminant Profiles

Contaminant profiles within two cores collected in relatively consistent depositional environments in the study area (based on Lead-210 data) were examined as a component of this study. The cores -- HC-B01 and HC-B02 -- were located 150 feet and 100 feet offshore, respectively, in the vicinity of the contoured criteria boundaries (Figures 5 through 7). Chemical data collected from the borings are summarized in Table 3.

Overall, the surface (0 to 4 cm) contaminant concentrations observed in the borings were similar to contoured surface concentrations in the study area (Figures 5 through 7). The surface concentrations were also similar to or somewhat higher than values observed in the sediment traps (Table 2), which may simply reflect the more inshore location of the borings relative to the traps.

The concentrations of lead and zinc were relatively uniform throughout the coring depth (0 to 50 cm)(Table 3). Assuming a bioturbation-induced mixing model (see above), these data are consistent with an input which has been slowly reduced over time.

The concentrations of PCBs in the deepest sediments sampled were 5 to 9 times higher than concentrations observed on the surface. Peak PCB concentrations at depth within the cores were approximately 778 mg/kg TOC (33,000 ug/kg DW), well in excess of the P2 and MCUL criteria (Table 3). Higher concentrations may occur at deeper depths within the sediments. The PCB data are consistent with a relatively abrupt reduction in source strength during the recent past (PCB use and manufacture was banned in 1972 and 1974, respectively), and the recovery of these sediments via bioturbation. The low PCB concentration present in the sediment trap sample (7 mg/kg TOC; Table 2), is also consistent with continued PCB recovery. - and low levels in resuspended surface sediment.

dilution w/ new clean sediment or biodegradation

The concentrations of LPAHs and HPAHs were highest near the sediment surface (0 to 14 cm), and declined rapidly with increasing depth (Figures 8A and 8B). The depth of sediments exceeding the P2 criteria appeared to be restricted to the upper 50 cm (1.5 to 2.0 feet) of the sediment column. PAH concentrations exceeding MCUL values are confined approximately to the surface 14 to 20 cm (0.6 foot).

Could be resuspended particulates!

The PAH profile data are generally consistent with either a nearly constant or increasing source strength of PAHs to Pier 64/65 sediments over time. The relatively high concentrations of PAHs detected in the sediment trap samples are consistent with this hypothesis (Table 2). PAH concentrations measured in the surface sediments and trap samples are also well above depositional (i.e., particulate) concentrations reported elsewhere in Elliott Bay (Curl et al., 1988). Based on the range of reported half-lives of PAH (M. Riley, Parametrix, personal communication, 1990) declines in PAH concentrations with increasing depth within the sediment may also be influenced by natural degradation, particularly for the more labile LPAHs. However, the rather wide range of reported PAH half-lives does not permit a more precise assessment of the importance of decay in this case.

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Considering these data and the areal distribution contours presented on Figures 6 and 7, an ongoing PAH source close to the shoreline is likely. As stated previously, such a source has not been identified, but may include releases associated with treated pilings and runoff from adjacent commercial properties and roadways, including the Denny Way combined sewer overflow (Curl et al., 1988). Although industrial releases have been identified as major PAH sources elsewhere in Elliott Bay (e.g., Cubbage, 1989), in our opinion such sources do not occur close enough to the study area to be likely source candidates for the nearshore PAH contamination identified at Pier 64/65.

Sediments that coated the old pilings and were probaby high in creosote fell off into the water when the old pilings were removed.

Nearly all of the treated pilings within the Pier 64/65 area were removed during demolition in 1987, which would have controlled at least the local inputs arising from this potential source. However, the presence of numerous similar pilings south (and generally upstream) of the study area may represent an ongoing and potentially larger source of these materials. Little data are available, however, on release characteristics of weathered treated pilings; the importance of pilings as a potential PAH source in this case, therefore, is largely speculative.

REMEDIAL ALTERNATIVES

The contaminant distribution and sediment trap data summarized above permit a number of conclusions regarding the need for remediation, the ability of natural recovery to achieve existing regulatory criteria following source controls, and the appropriate scope of remediation activities. These issues are discussed below.

Although mercury, zinc, and PCB concentrations are elevated above P2 criteria in surface sediments of the study area, similar exceedences occur throughout the vicinity. For mercury, a natural source related to upstream deposits in the Green River is implicated, and is not likely to be addressed in a sediment remediation program. Zinc inputs appear to be declining (based on sediment trap and vertical profile data) and recovering within local sediments.

Similarly, PCB concentrations in local sediments (likely derived from regional sources) have recovered markedly and are currently below proposed MCUL values but still above P2 criteria. Further PCB recovery is expected. High concentrations of PCBs present at depth within the sediments appear to be largely isolated from the sediment surface.

Lead concentrations, though locally elevated in nearshore areas of Pier 64/65 within approximately 200 feet of the shoreline, nevertheless appear from the sediment trap and profile data to have declined over the recent past (sediment trap concentrations are currently well below P2 criteria). Sediment recovery is expected to reduce these concentrations in the future.

The rate of sediment lead recovery can be predicted using the sediment mixing and burial models discussed previously. Based on these models, and assuming inputs similar to the trap values (approx. 170 mg/kg DW), recovery of surface (0 to 2 cm) nearshore sediments (maximum composite concentration of 704 mg/kg DW) to the P2 criterion (450 mg/kg DW) is expected to occur within a period of approximately ten years. This conclusion would hold regardless of the specific sediment transport model employed (i.e., burial or bioturbation). Based on these data, additional sediment remediation to address local lead accumulations appears unnecessary. More detailed predictions of sediment recovery based on modeling are possible with the available data but were outside of the scope of this study.

PAH accumulations (and correlated contaminants such as dibenzofuran) present in nearshore Pier 64/65 sediments pose the greatest potential remediation need in the area. Not only are local concentrations of these chemicals substantially elevated relative to both P2 and MCUL criteria, but an ongoing source of these materials is indicated. Current inputs to the sediments, as reflected in sediment trap data, also exceed the P2 criteria. Natural recovery without additional source control, therefore, would not achieve compliance with this regulatory criterion. Sediment trap PAH concentrations, however, are below proposed MCUL criteria.

*

Without additional source controls, active remediation of local sediments (e.g., capping) would be unlikely to achieve the proposed (P2) sediment quality criteria. Unless current sources can be controlled, short-term improvements resulting from remediation actions will be mitigated as additional contaminated material is deposited and mixed into the new "clean" surface. Accordingly, we recommend that remedial actions **not** be implemented until such time as effective source controls are in place.

If 2/3's of current source is resuspension * * * then sediment remediation is source control.

Assuming that local PAH sources can be controlled at some point in the future, the ability of sediments to recover naturally can be assessed. Again using the sediment mixing and burial models described previously, the recovery time necessary to achieve compliance with P2 criteria can be assessed. For the modeling effort, which focused on total HPAHs because of a greater criterion exceedence, the following assumptions were made:

- The initial concentration of total HPAH was set equal to the maximum surface composite value of 14,300 mg/kg TOC;
- The mixed depth under the simple burial model was assumed to be 8 cm;
- The average sediment accumulation rate (0.26 gm DW/cm^2-yr) and average mixing coefficient (22 cm^2/yr) observed in cores HC-B01 and HC-B02 were assumed to be representative of conditions throughout the study area;
- The input HPAH level was assumed to be equal to the reported average HPAH concentration in open-water areas of Elliott Bay of approximately 100 mg/kg TOC (Curl et al., 1988); and
- The remedial action objective for HPAH was set equal to the P2 concentration of 960 mg/kg TOC. An alternative minimum cleanup

goal was also evaluated, based on the proposed MCUL for HPAH of 5,300 mg/kg TOC.

* Given the assumptions listed above and considering the alternative sediment transport models possible at Pier 64/65 (i.e., burial versus bioturbation), natural sediment recovery to P2 levels would likely occur over a period of approximately 10 to 40 years. The lower recovery times are generated under the bioturbation model, while longer recovery times are characteristic of the burial model. Additional refinement of the natural recovery predictions were outside of the scope of this study.

It is unlikely that source controls alone will be sufficient to achieve compliance with P2 criteria within a time frame of 10 years, which has been normally allowed by the regulatory agencies (see Commencement Bay Record of Decision and proposed Sediment Management Standards; WAC 173-204). However, given the assumptions listed above, achievement of the MCUL value is highly likely within ten years of source control. Depending upon the time frame to achieve source control and the ultimate cleanup objective; therefore, active sediment remediation may or may not be necessary to achieve regulatory compliance.

An appropriate method of active sediment remediation -- if required based on the success of PAH source control efforts -- may likely take the form of a sediment cap. Dredging of the contaminated material for remediation is not recommended for consideration based on the presence of high PCB concentrations at depth within the sediment column, the widespread distribution of similar contaminants, and high cost. A sediment cap could minimize the opportunity for biological access (e.g., via burrowing) to deeper contaminated sediments and prevent the further resuspension of existing contaminant accumulations.

The benthic community sampling and analysis of the Pier 64/65 area has revealed a community lacking larger, deeper burrowing organisms (Beak, 1990). These data are consistent with a biological mixing zone restricted to the upper 10 cm (G. Mauseth, Beak Consulting, Inc., personal communication, 1990).

For the purposes of providing a preliminary estimate of the cost of constructing a sediment cap in the Pier 64/65 area, sediments located between 50 feet and 200 feet offshore from the existing bulkhead were considered for remediation. Sediments in this area exceed the proposed P2 sediment quality criterion. Nearshore sediments located within 50 feet of the bulkhead are presently represented by relatively steep and coarse-grained riprap materials which provide substantial biological habitat. Accordingly, capping of the immediate (0 to 50 feet) nearshore area is not recommended.

Given a project width in the Pier 64/65 area of approximately 600 feet, a cap area of roughly 10,000 square yards may be appropriate for analysis. It should be noted, however, that contaminant concentrations similar to those observed in the Pier 64/65 area are believed to be present along much of the local Seattle waterfront. Remediation of these adjacent areas will likely be required to prevent recontamination of Pier 64/65 sediments. For this reason, we recommend that capping only be performed in the Pier 64/65 area as a component of a more extensive waterfront sediment remediation program.

This assumes resuspension is a major source of recontamination

The cap thickness required to effectively isolate contaminated sediments in the Pier 64/65 area can be estimated using the sediment coring data collected during this study. Based on the Lead-210 data collected from borings HC-B01 and HC-B02 (Figure 3A), the active biological mixing zone appears to be largely restricted to the top 10 cm. Similar biological mixing depths have also been reported in shallow-water environments elsewhere in Puget Sound (Tetra Tech, 1988), and is consistent with local benthic sampling data (Beak, 1990). Accordingly, a minimum 10 cm thickness could be considered for a sediment cap.

recommend cap thickness of 10 cm

Although the majority of the biological activity present in local sediments appears restricted to the top 10 cm, less intense (perhaps non-biological) mixing may nevertheless extend to deeper depths. For example, under the bioturbation model of sediment mixing, the Lead-210 data collected from the site are consistent with an average mixing coefficient of 22 cm^2/yr over the top 50 cm. The rate of mixing undoubtedly declines with increasing sediment depth, though additional data would be required to document such a condition. Furthermore, given the natural recovery modeling assumptions outlined previously, a cap thickness of up to 50 cm may be necessary to prevent long-term mixing of these deeper materials into the biologically active zone. Using the 50 cm (1.6 ft) depth as a conservative estimate of an

may need a 50 cm cap thickness

appropriate cap thickness, the total volume of imported capping material is thus approximately 5,500 cubic yards.

It should be noted that other studies of sediment capping in the Puget Sound region have addressed cap thicknesses up to 100 cm (3.2 ft), primarily to assure isolation from deep-burrowing organisms (Tetra Tech, 1988). However, such deep penetration is not considered relevant in the Pier 64/65 for the following reasons: (1) deeper burrowing species are largely absent in the site vicinity (Beak, 1990); (2) Lead-210 and chemical profile data indicate minimal mixing occurs between these deep sediments and the biological mixing zone; and (3) the extent of sediment contamination throughout much of the central Seattle waterfront may be more effectively remediated through greater areal coverage of capping material, rather than greater depth at individual locations. Again, these issues argue for capping of the Pier 64/65 area as a component of a more extensive waterfront remediation program.

Suitable regional sources of clean sediment capping material are available from Puget Sound dredging projects (e.g., Duwamish River or Snohomish River maintenance dredging operations). Along with the cost of the transport of this capping material, the total construction would likely include the costs of geotechnical investigations, turbidity controls, mitigation, monitoring, and permitting. For the purposes of this preliminary evaluation, we have estimated the unit cost associated with the entire capping operation at roughly $15 per square yard, based on our experience and on similar evaluations performed elsewhere in Puget Sound. Depending upon the source of the capping material and specific project requirements, however, the unit cost may range from roughly $5 to $40 per square yard. Further refinement of costs was outside of the scope of this study.

Based on a "typical" unit cost of approximately $15 per square yard, and a total potential capping area of 10,000 square yards, the approximate cost of a protective cap at Pier 64/65 is estimated at roughly $150,000. The range in costs for such a project, however, may vary from roughly $50,000 to $500,000.

LIMITATIONS

Work for this project was performed, and this letter report prepared, in accordance with generally accepted professional practices for the nature and conditions of the work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of the Port of Seattle for specific application to the referenced property. This report is not meant to represent a legal opinion. No other warranty, express or implied, is made.

It should be noted that Hart Crowser relied on verbal information provided by the individuals indicated above. Hart Crowser can only relay this information and cannot be responsible for its accuracy or completeness.

Any questions regarding our work and this letter report, the presentation of the information, and the interpretation of the data are welcome and should be referred to the project manager (the undersigned).

We trust that this report meets your needs.

Sincerely,

HART CROWSER, INC.

CLAYTON R. PATMONT
Sr. Associate

CRP:ob

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Table 2 - Summary of Selected Sediment Trap and Surficial Sediment Chemical Data - Pier 64/65

						Sediment Coring Data	
	Sediment Trap Data		Surface Sediment Composite Data			HC-B01	HC-B02
Chemical	Pier 63A	Pier 63B	HC-SS01	HC-SS02	HC-SS03	0 to 4 cm	0 to 4 cm
Bulk Parameters:							
Deposition Rate (gm DW/cm2-yr)	0.86	0.84					
210-Pb Activity (dpm/gm DW)	4.05	4.35				4.03	2.14
Total Solids (%)	26.8%	25.5%	55.1%	40.4%	60.4%	37.7%	34.4%
Total Organic Carbon (% DW)	3.9%	4.7%	1.5%	1.5%	1.5%	8.5%	14.9%
Metals (mg/kg DW):							
Aluminum	65,200	55,900					
Arsenic	16	15					
Calcium	18,200	16,900				9,880	3,860
Chromium	94	93					
Copper	118	117					
Iron	40,200	41,400					
Lead	156	186	486	704	420	569	1,180
Manganese	584	548					
Mercury	0.74	0.76	0.45	0.60	0.25		
Nickel	44	39					
Silicon	226,000	224,000					
Zinc	221	236	665	1,030	306	484	582
Low Weight PAHs (mg/kg DW):							
Naphthalene	0.13	0.33	1.6	3.3 J	1.8 J	5.4	8.4
Acenaphthalene	1.00	1.10	1.4	1.7 J	2.6 J	3.6 J	3.9
Acenaphthene	0.40	0.69	0.9	2.4 J	1.9 J	3.1 J	20.0
Fluorene	0.95	1.20	1.2	5.0 J	3.9 J	8.8	26.0
Phenanthrene	7.20	6.30	6.2	20.0 J	43.0	41.0	88.0
Anthracene	7.40	7.00	4.2	31.0 J	5.9	44.0	80.0
Total PP-LPAH	17.08	16.62	15.5	63.4 J	59.1	105.9	226.3
Total PP-LPAH (mg/kg TOC)	438	354	1,064	4,144 J	3,888	1,252	1,519
High Weight PAHs (mg/kg DW):							
Fluoranthene	13.00	15.00	11.0	33.0 J	57.0	87.0	62.0
Pyrene	12.00	13.00	28.0	48.0 J	54.0	81.0	140.0
Benzo(a)Anthracene	8.70	9.00	15.0	32.0 J	10.0	48.0	51.0
Chrysene	15.00	15.00	9.3	27.0 J	18.0	52.0	75.0
Benzo(b)Fluoranthene	11.00	11.00	0.6 U	11.0 J	8.4	4.6 U	57.0
Benzo(k)Fluoranthene	8.10	8.00	29.0	32.0 J	4.0 U	85.0	71.0
Benzo(a)Pyrene	10.00	10.00	8.1	17.0 J	7.2	42.0	64.0
Indeno(1,2,3-cd)Pyrene	4.80	4.80	4.3	7.7 J	3.2 J	13.0	29.0
Dibenzo(a,h)Anthracene	1.40	1.50	2.0	2.9 J	4.0 U	5.2	12.0
Benzo(g,h,i)Perylene	4.20	4.20	4.3	8.1 J	4.0 U	13.0	32.0
Total PP-HPAH	88.20	91.50	111.3	218.7 J	163.8	428.5	593.0
Total PP-HPAH (mg/kg TOC)	2,262	1,947	7,623	14,294 J	10,776	5,065	3,980
Polychlorinated Biphenyls:							
(mg/kg DW)	0.27		0.97	0.86	0.67	1.06	13.20
(mg/kg TOC)	7		66	56	44	13	89

NOTES:

a. "U" denotes that the analyte was not detected; value presented is the sample detection limit.

b. "J" denotes that the analyte was positively identified, but the associate numerical value is estimated.

Table 3 - Summary of Sediment Data Collected by Hart Crowser
Pier 64/65 Sediment Study

Page 1 of 2

Sampling Location	HC-SS01		HC-SS02		HC-SS03		HC-B01		HC-B01		HC-B01	
Depth	Surface		Surface		Surface		Surface to 4 cm		8 to 14 cm		20 to 30 cm	
Sediment Conventionals												
Total Solids (%)	55.1(34)	--	40.4(48)	--	60.4(51)	--	37.72(22)	--	31.84(19)	--	39.44(35)	--
Total Volatile Solids (%)	2.8	--	5.6	--	3.0	--	22.21	--	14.78	--	12.94	--
Total Organic Carbon (%)	1.46	--	1.53	--	1.52	--	8.46	--	4.95	--	5.49	--
Metals (mg/kg DW)												
Calcium	NA	--	NA	--	NA	--	9,880	--	9,260	--	8,880	--
Lead	486	--	704	--	420	--	569	--	366	--	485	--
Mercury	0.45	--	0.60	--	0.25	--	NA	--	NA	--	NA	--
Zinc	665	--	1,030	--	306	--	484	--	259	--	320	--
Semivolatile Organics												
	*(ppm)	*(ppm TOC	*(ppm)	*(ppm TOC	*(ppm)	*(ppm TOC	*(ppm)	*(ppm TOC)	*(ppm)	*(ppm TOC)	*(ppm)	*(ppm TOC)
Napthalene	1.6	110	3.3	216	1.8 J	118	5.4	64	4.1 J	83	1.2 J	22
2-Methylnaphthalene	0.38 J	26	1.2 J	78	0.50 J	33	2.6 J	31	1.3 J	26	2.9 U	--
Acenaphthylene	1.4	96	1.7 J	111	2.6 J	171	3.6 J	43	1.1 J	22	0.98 J	18
Acenaphthene	0.93	64	2.4	157	1.9 J	125	3.1 J	37	2.7 J	55	0.47 J	9
Fluorene	1.2	82	5.0	327	3.9 J	257	8.8	104	8.7	176	1.0 J	18
Phenanthrene	6.2	425	20	1,307	43	2,829	41	485	27	545	2.7 J	49
Anthracene	4.2	288	31	2,026	5.9	388	44	520	38	768	2.6 J	47
Total LPAHs	16	1,090	64.6	4,222	59.6	3,921	108.5	1,283	82.9	1,675	8.95	163
Flouranthene	11	753	33	2,157	57	3,750	87	1,028	43	869	3.4	62
Pyrene	28	1,918	48	3,137	54	3,553	81	957	100	2,020	29	528
Benzo(a)anthracene	15	1,027	32	2,092	10	658	48	567	37	747	3.0	55
Chrysene	9.3	637	27	1,765	18	1,184	52	615	56	1,131	4.5	82
Benzo(b)flouranthene	0.60 U	--	11	719	8.4	553	4.6 U	--	43	869	12	219
Benzo(k)fluoroanthene	29	1,986	32	2,092	4.0 U	--	85	5,556	52	1,051	6.3	115
Benzo(a)pyrene	8.1	555	17	1,111	7.2	474	42	2,745	39	788	7.3	133
Indeno(1,2,3-cd)pyrene	4.3	295	7.7	503	3.2 J	211	13	850	18	364	3.3	60
Dibenz(a,h)anthracene	2.0	137	2.9	190	4.0 U	--	5.2	340	7.1	143	1.4 J	26
Benzo(g,h,i)perylene	4.3	295	8.1	529	4.0 U	--	13	850	19	384	3.6	66
Total HPAH	111	7,603	218.7	14,294	157.8	10,382	426.2	13,508	414.1	8,366	73.8	1,344
Benzoic Acid	0.87 J	60	0.69 J	45	20 U	--	23 U	--	27 U	--	14 U	--
1,4-Dichlorobenzene	0.67	46	2.1 U	--	4.0 U	--	4.6 U	--	5.4 U	--	2.9 U	--
Dibenzofuran	0.53 J	36	1.6 J	105	1.8 J	118	2.8 J	33	2.8 J	57	0.57 J	10
Bis(2-Ethylhexyl)phthalate	1.8	123	1.6 J	105	1.5 J	99	1.8 J	21	2.2 J	44	2.4	44
PCBs												
Aroclor 1248	0.29 U	--	0.21 U	--	0.19 U	--	0.45	5	NA	--	NA	--
Aroclor 1254	0.26 J	18	0.46	30	0.27	18	0.18 U	--	NA	--	NA	--
Aroclor 1260	0.71	49	0.40	26	0.40	26	0.61	7	NA	--	NA	--
Total PCBs	0.97	67	0.86	56	0.67	44	1.06	13	NA	--	NA	--

NOTES:

NA	Indicates not analyzed.	U	Indicates compound below detection limit indicated.
*	Indicates based on dry weight.	J	Indicates value is considered a estimate.
--	Indicates not calculated.	( )	Indicates ATI duplicate result.
inc.	Indicates data for benzo(b)fluoroanthene and benzo(k)fluoroanthene are combined.		

Table 3 - Summary of Sediment Data Collected by Hart Crowser
Pier 64/65 Sediment Study

Sampling Location Depth	HC-B01 40 to 50 cm		HC-B02 Surface to 4 cm		HC-B02 8 to 14 cm		HC-B02 20 to 30 cm		HC-B02 30 to 40 cm		SEDIMENT QUALITY CRITERIA (Ecology, 1989)	MINIMUM CLEANUP LEVELS (Ecology, 1990)
Sediment Conventionals												
Total Solids (%)	42.53(42)	--	34.42(34)	--	30.85(31)	--	30.83(34)	--	42.74(38)	--	--	--
Total Volatile Solids (%)	11.9	--	19.29	--	22.01	--	21.02	--	14.06	--	--	--
Total Organic Carbon (%)	5.27	--	14.9	--	26.2	--	5.77	--	4.24	--	--	--
Metals (mg/kg DW)												
Calcium	6,800	--	3,860	--	4,210	--	7,000	--	8,500	--		
Lead	501	--	1,180	--	705	--	555	--	1,050	--	450	530
Mercury	NA	--	NA	--	NA	--	NA	--	NA	--	0.41	0.59
Zinc	592	--	582	--	283	--	307	--	480	--	410	960
Semivolatile Organics												
	*(ppm)	*(ppm TOC)	*(ppm)	*(ppm TOC)	*(ppm)	*(ppm TOC)	*(ppm)	*(ppm TOC)	*(ppm)	*(ppm TOC)		
Napthalene	4.4	83	8.4	56	2.2 J	8	1.3	23	2.7 U	--	99	170
2-Methylnaphthalene	0.80 J	15	3.6	24	0.61 J	2	3.0 U	--	2.7 U	--	64	120
Acenaphthylene	0.94 J	18	3.9	26	2.2 J	8	0.92 J	16	2.7 U	--	66	66
Acenaphthene	3.3	63	20	134	3.0 J	11	0.60 J	10	2.7 U	--	16	57
Fluorene	3.3	63	26	174	4.4	17	1.4 J	24	2.7 U	--	23	79
Phenanthrene	6.0	114	88	591	19	73	4.9	85	2.7 U	--	100	480
Anthracene	5.9	112	80	537	15	57	5.2	90	0.79 J	19	220	1200
Total LPAHs	24.64	468	229.9	1,543	46.41	177	14.32	248	0.79	19	370	780
Flouranthene	14	266	62	416	30	115	32	555	1.7 J	40	160	1200
Pyrene	43	816	140	940	53	202	36	624	2.7 U	--	1000	1400
Benzo(a)anthracene	7.3	139	51	342	26	99	9.7	168	2.7 U	--	110	270
Chrysene	9.8	186	75	503	26	99	13	225	2.7 U	--	110	460
Benzo(b)flouranthene	2.4 U	--	57	383	43	164	9.0	156	2.7 U	--	230	450
Benzo(k)fluoroanthene	14	266	71	477	53	202	14	243	2.7 U	--	inc.	inc.
Benzo(a)pyrene	5.7	108	64	430	22	84	8.8	153	2.7 U	--	99	210
Indeno(1,2,3-cd)pyrene	2.3 J	44	29	195	8.6	33	3.6	62	2.7 U	--	34	88
Dibenz(a,h)anthracene	0.72 J	14	12	81	4.3	16	1.8 J	31	2.7 U	--	12	33
Benzo(g,h,i)perylene	2.7	51	32	215	9.2	35	3.7	64	2.7 U	--	31	78
Total HPAH	99.52	1,888	593	3,980	275.1	1,050	131.6	2,281	1.7 J	40	960	5300
Benzoic Acid	12 U	--	15 U	--	2.3 JB	9	15 U	--	13 U	--	0.650	
1,4-Dichlorobenzene	2.4 U	--	3.0 U	--	3.3 U	--	3.0 U	--	2.7 U	--	3.1	
Dibenzofuran	2.5	47	11	74	1.6 J	6	3.0 U	--	2.7 U	--	15	58
Bis(2-Ethylhexyl)phthalat	0.32 J	6	2.2	15	1.9 J	7	3.0	52	2.0 J	47	47	
PCBs												
Aroclor 1248	0.96 J	18	3.7	25	NA	--	NA	--	19	448		
Aroclor 1254	1.0 U	--	1.3 U	--	NA	--	NA	--	1.0 U	--	--	
Aroclor 1260	2.2	42	9.5	64	NA	--	NA	--	14	330	--	
Total PCBs	3.16	60	13.2	89	NA	--	NA	--	33	778	12	65

NOTES:

NA	Indicates not analyzed.	U	Indicates compound below detection limit indicated.
*	Indicates based on dry weight.	J	Indicates value is considered a estimate.
--	Indicates not calculated.	( )	Indicates ATI duplicate result.
inc.	Indicates data for benzo(b)fluoroanthene and benzo(k)fluoroanthene are combined.		

Table 4 - Summary of Selected Surficial Sediment Chemical Data in the Pier 64/65 Area

Sampling Date	Location	Offshore Distance in Feet	Total Solids	Total Volatile Solids	Total Organic Carbon	Lead (ppm)	Mercury (ppm)	Zinc (ppm)	Total LPAH (ppb)	Total LPAH:TOC (ppm)	Total HPAH (ppb)	Total HPAH:TOC (ppm)	Dibenzofuran (ppb)	Dibenzofuran :TOC (ppm)	Total PCBs (ppb)	Total PCBs:TOC (ppm)
Sep-85	SS-07		37.6%	13.4%	8.0%	445	2.13	344	13,030	163	41,670	521	700	8.8	460	5.8
Sep-85	SS-08	80	24.8%	41.1%	26.6%	282	1.72	244	632,300	2,377	3,174,000	11,932	7,100	26.7	1,200 U	4.5
Sep-85	SS-09	90	38.7%	15.4%	10.3%	71,100	3.89	6,010	14,760	144	101,500	988	400	3.9	3,300	32.1
Sep-85	SS-10		47.7%	9.3%	4.0%	293	1.32	348	7,168	180	44,690	1,120	36 U	0.9 U	395 U	9.9
Sep-85	SS-11		41.1%	11.1%	5.1%	299	1.31	281	4,712	92	24,180	474	35 U	0.7 U	260	5.1
Dec-87	1-P65/66	90	35.0%	15.1%	7.5% E	250	-	490	44,250	589	101,190	1,347	2,000	26.6	NA	
Dec-87	2-P65/66	160	44.2%	8.3%	3.8% E	220	-	320	9,620	252	35,030	918	180	4.7	NA	
Dec-87	D 2-P65/66	160	43.7%	9.0%	4.2% E	-	-	-					-		-	
Dec-87	3-P63/64	80	27.6%	22.8%	12.0% E	1,100	-	290	2,690	22	12,340	103	68	0.6	NA	
Dec-87	4-P63/64	250	42.5%	8.0%	3.7% E	110	-	130	4,820	132	20,727	566	99	2.7	NA	
Dec-87	D 4-P63/64	250	-	-		-	-	-	1,382	38	7,830	214	39	1.1	NA	
Dec-87	5-P65/66	260	43.8%	10.3%	4.9% E	310	-	580	12,020	247	49,820	1,023	390	8.0	NA	
Dec-87	D 5-P65/66	260	-	-		310	-	600					-		-	
May-88	1	60	41.0%		4.7% E	292	2.70	341	17,146	365	84,915	1,806	634	13.5	2,659	56.6
May-88	2	90	28.0%		14.7% E	293	1.10	311	54,929	374	399,036	2,718	2,786	19.0	2,643	18.0
May-88	3	220	33.0%		9.0% E	175	0.88	197	20,636	230	72,106	802	1,394	15.5	1,313	14.6
May-88	4	250	31.0%		10.8% E	452	2.13	387	24,484	226	75,916	701	1,613	14.9	3,653	33.7
May-88	5	470	52.0%		2.3% E	94	0.96	115	9,090	393	35,000	1,514	163	7.1	617	26.7
May-88	6	250	25.0%		20.6% E	148	0.72	208	124,760	606	259,680	1,261	2,200	10.7	676	3.3
May-88	8	130	46.0%		3.3% E	261	1.44	185	22,043	661	95,522	2,865	891	26.7	1,888	56.6
May-88	25	220	36.0%		6.9% E	361	0.64	206	10,894	157	123,611	1,783	500 U	7.2 U	1,161	16.7
May-88	26	270	34.0%		8.2% E	262	1.18	324	34,494	419	121,471	1,477	1,676	20.4	2,971	36.1
Aug-89	18	290	35.0%		5.0%	202	2.75	227	12,760	256	92,700	1,861	320	6.4	750	15.1
Aug-89	20	260	46.0%		2.8%	152	1.08	129	3,830	139	22,410	812	120	4.3	360	13.0
May-90	B01-0004	150	37.7%	14.8%	8.5%	569		484	105,900	1,252	426,200	5,038	2,800 J	33.1 J	1,060	12.5
May-90	B02-0004	100	34.4%	19.3%	14.9%	1,180		582	226,300	1,519	593,000	3,980	11,000	73.8	13,200	88.6
Jun-90	HC-SS01	100	55.1%	2.8%	1.5%	486	0.45	665	15,500	1,062	111,000	7,603	530 J	36.3 J	970	66.4
Jun-90	HC-SS02	100	40.4%	5.6%	1.5%	704	0.60	1,030	63,400 J	4,144 J	218,700 J	14,294 J	1,600 J	104.6 J	860	56.2
Jun-90	HC-SS03	100	60.4%	3.0%	1.5%	420	0.25	306	59,100	3,888	157,800	10,382	1,800 J	118.4 J	670	44.1
Jul-90	TRAP-A	270	26.8%		3.9%	156	0.74	221	17,080	438	88,200	2,262			267	6.8
Jul-90	TRAP-B	220	25.5%		4.7%	186	0.76	236	16,620	354	91,500	1,947				
Sediment Quality Criterion						450	0.41	410		370		960		15.0		12.0
Minimum Cleanup Level						530	0.59	960		780		5,300		58.0		65.0

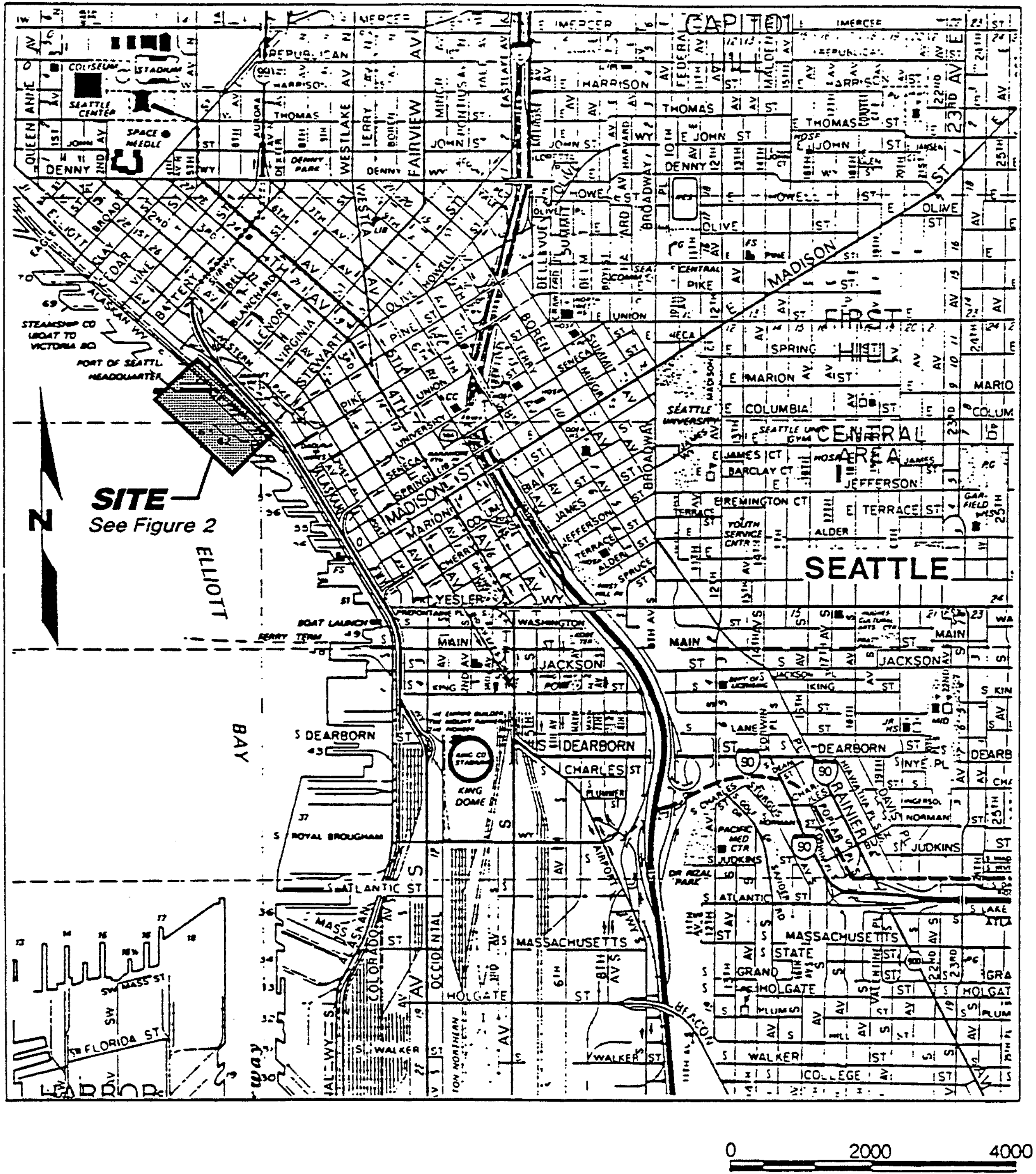
NOTES:

a. "U" denotes that the analyte was not detected;
value presented is the sample detection limit.

b. "J" denotes that the analyte was positively identified,
but the associate numerical value is estimated.

c. "E" denotes an estimated quantity; see text.

Vicinity Map



HARTCROWSER

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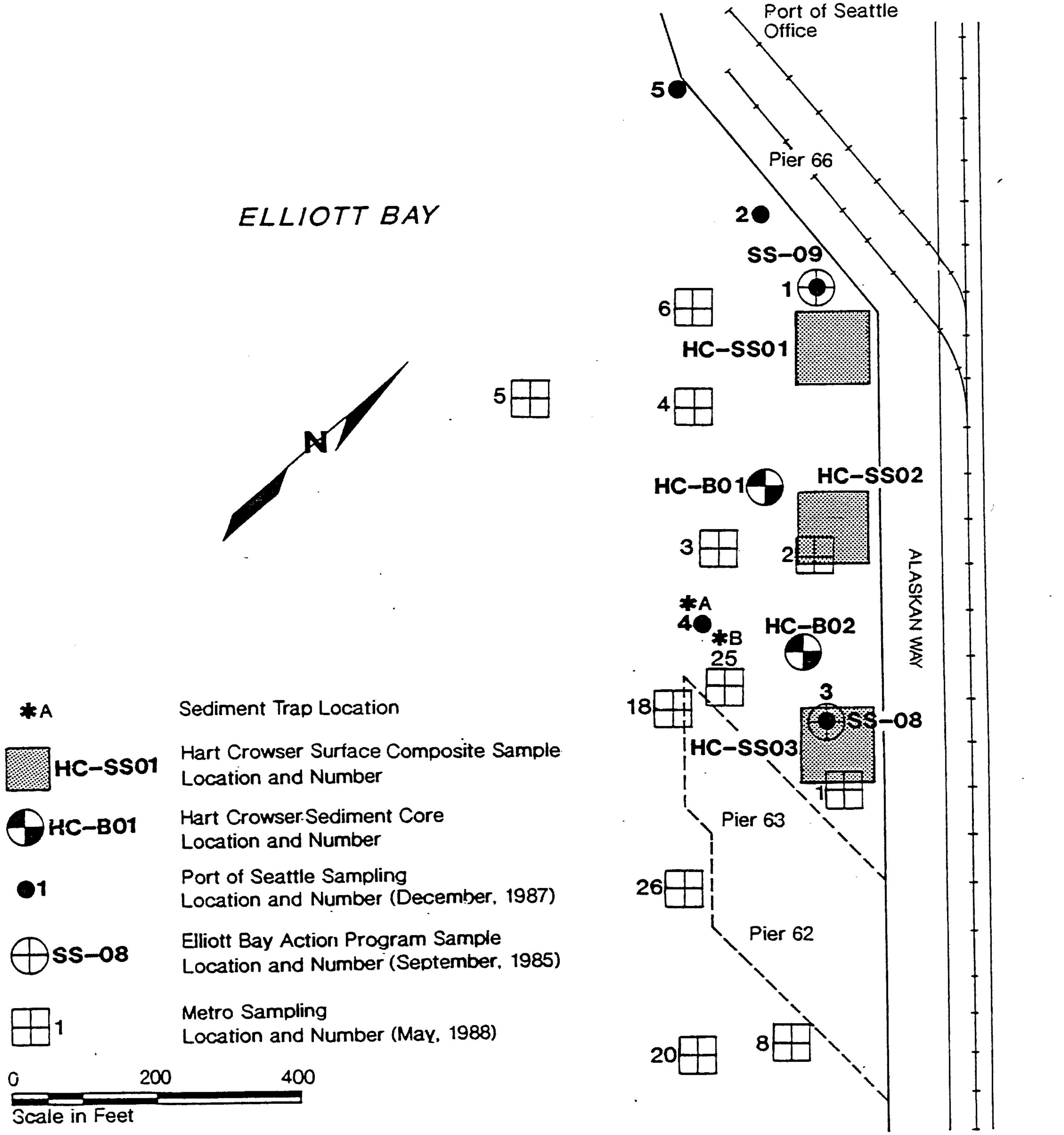
Figure 1

Site and Exploration Plan



✱A	Sediment Trap Location
▨ HC-SS01	Hart Crowser Surface Composite Sample Location and Number
HC-B01	Hart Crowser Sediment Core Location and Number
●1	Port of Seattle Sampling Location and Number (December, 1987)
⊕SS-08	Elliott Bay Action Program Sample Location and Number (September, 1985)
⊞1	Metro Sampling Location and Number (May, 1988)

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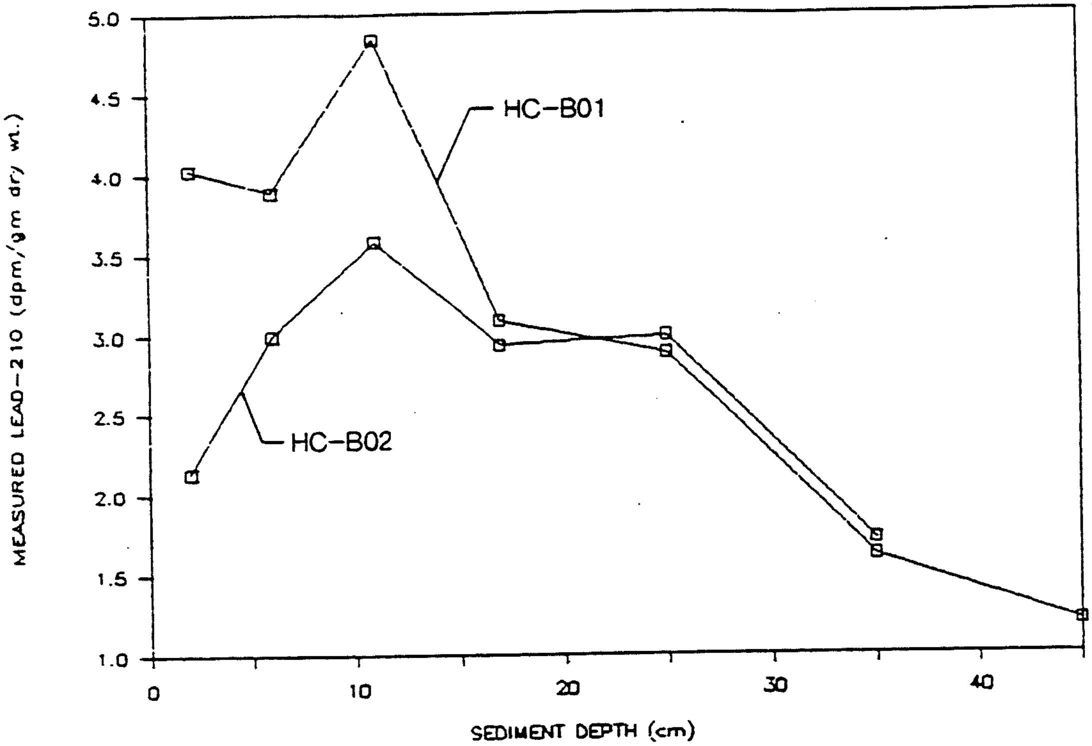
Figure 2

Lead – 210 Activity Profiles

Pier 64/65 Cores B01 and B02

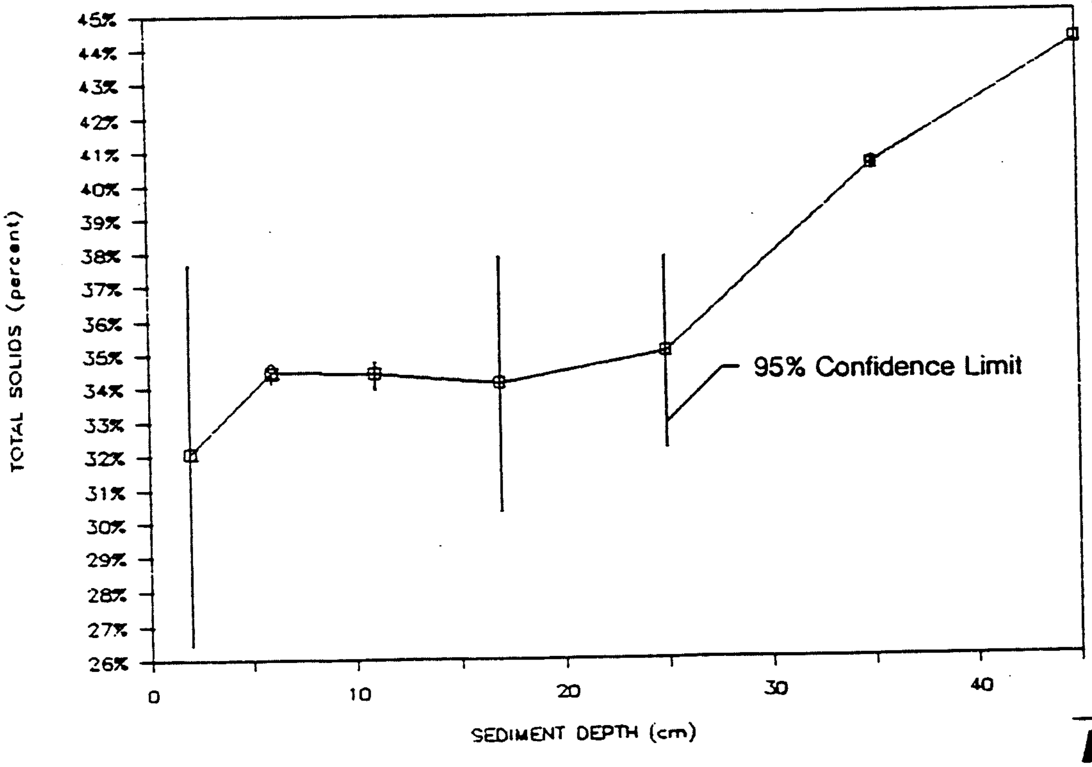
Figure 3A



Composite Total Solids Profile

Pier 64/65 Cores B01 and B02

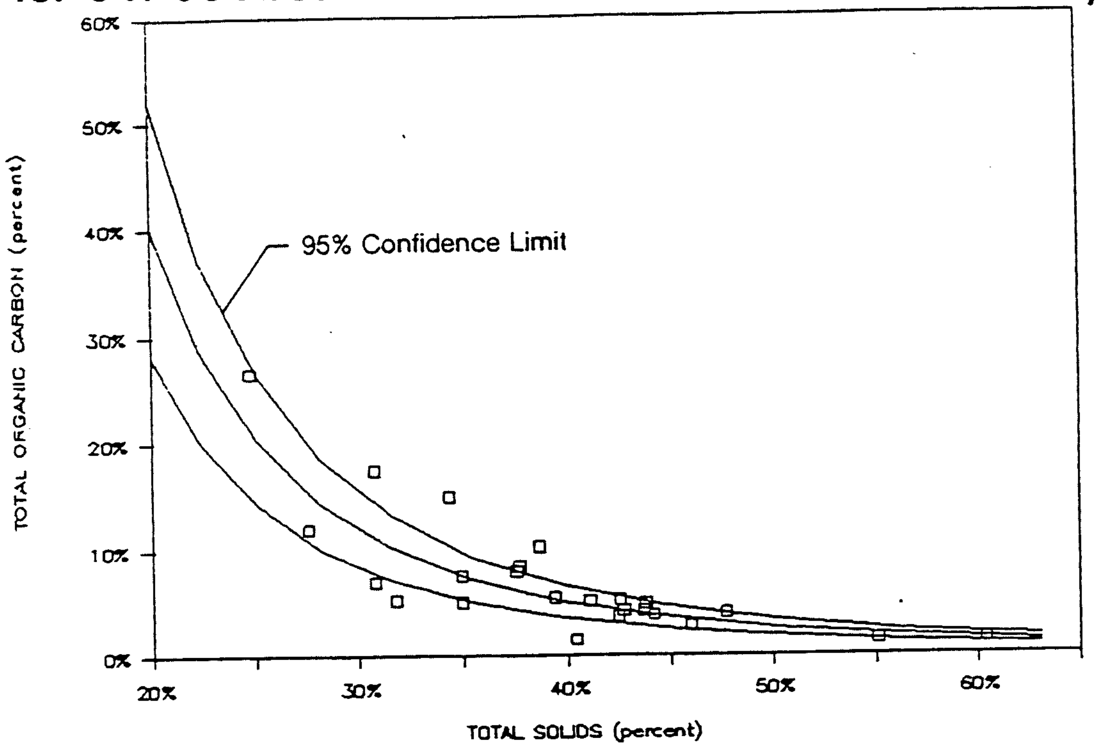
Figure 3B



Relationship between TS and TOC

Pier 64/65 Area Surficial Sediments

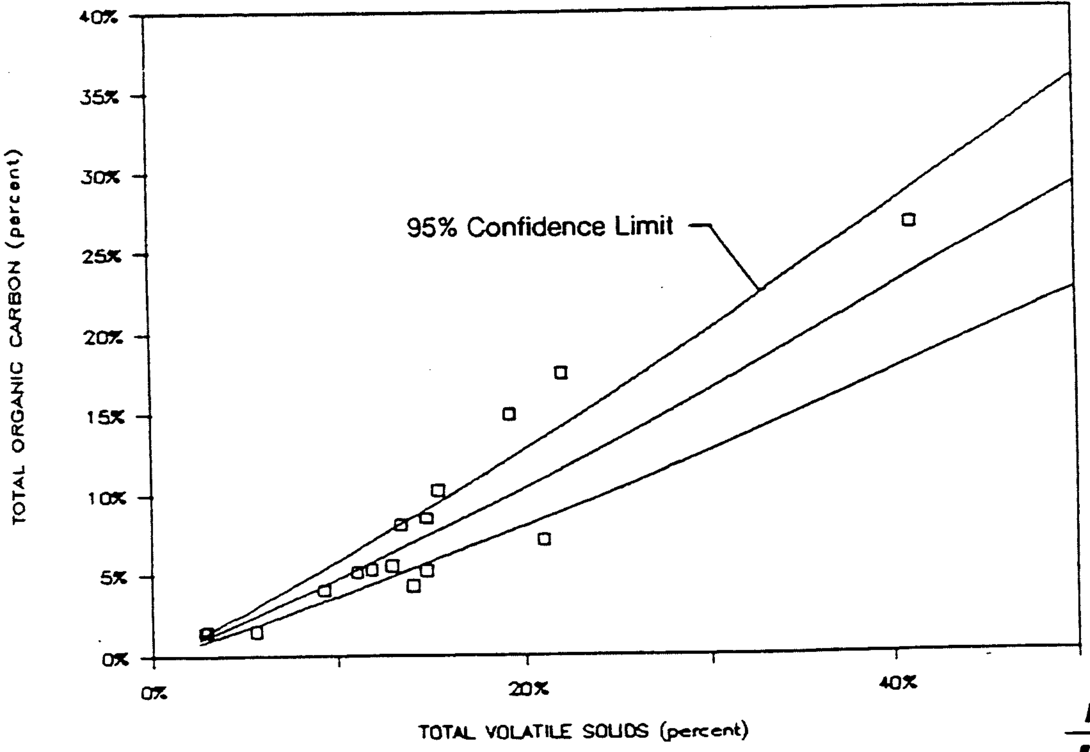
Figure 4A



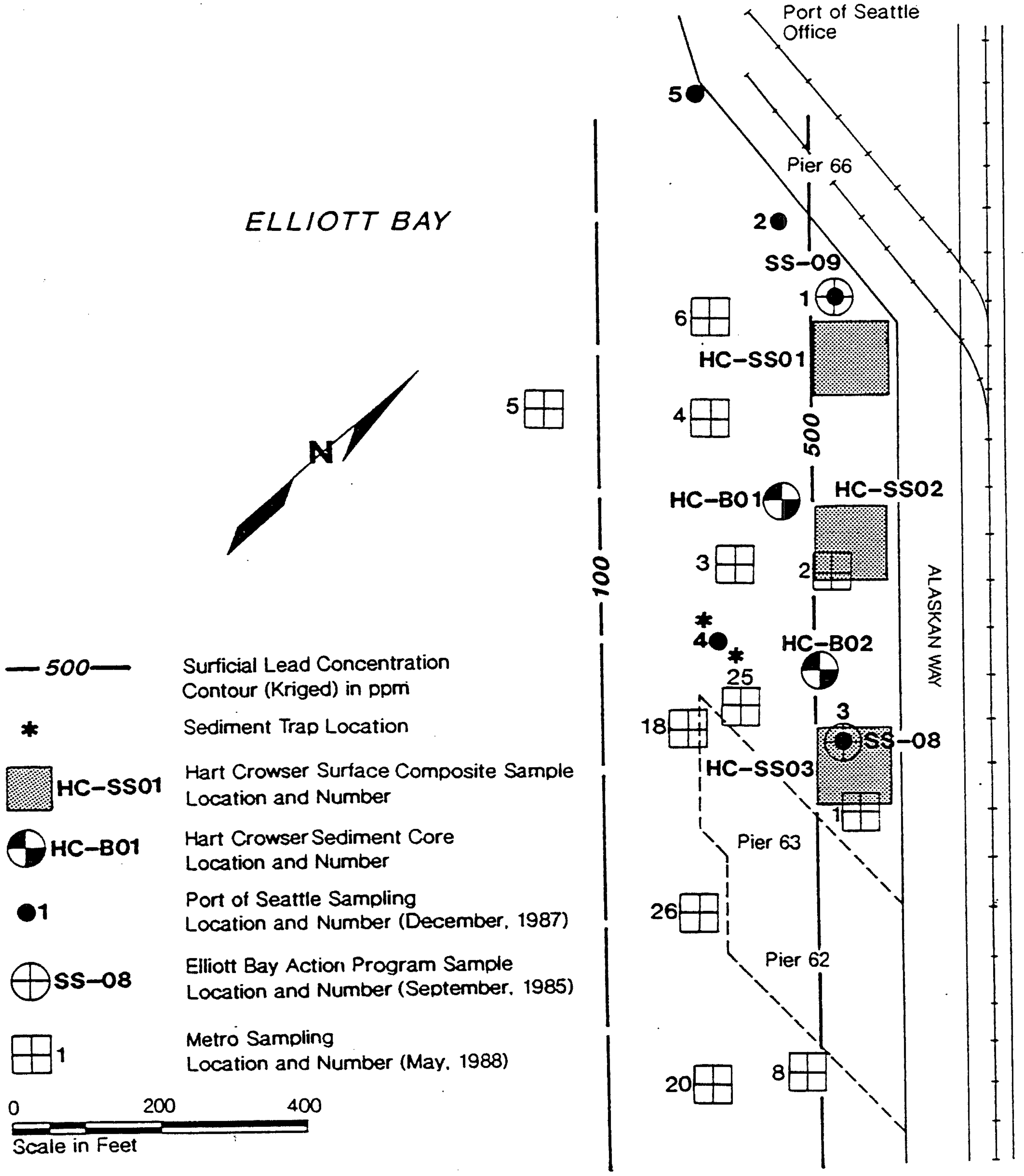
Relationship between TVS and TOC

Pier 64/65 Area Surficial Sediments

Figure 4B



Surficial Lead Concentrations Contour Map



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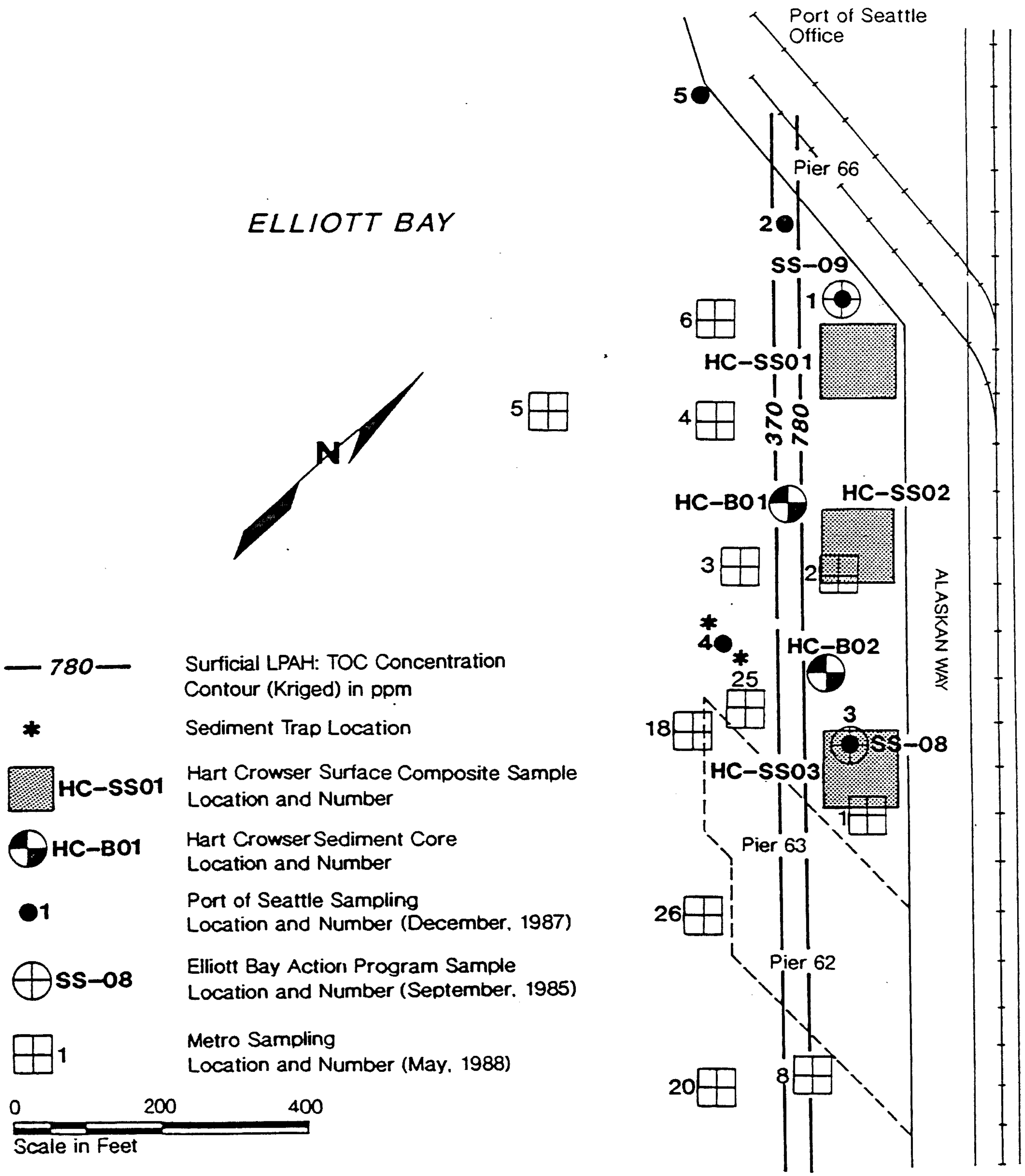
J-2854 *8/90*

Figure 5

Surficial LPAH: TOC Concentrations Contour Map



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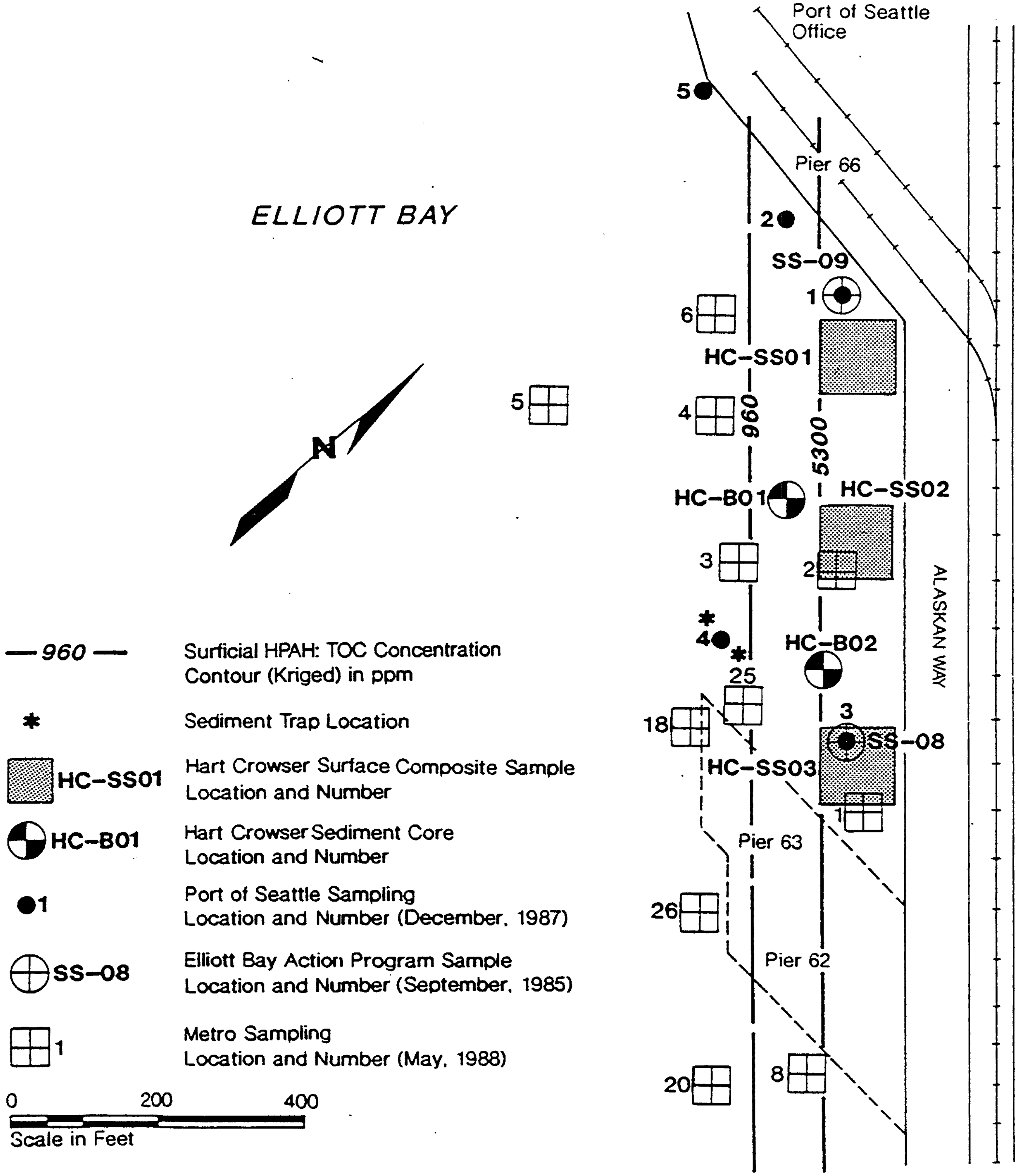
J-2854 8/90

Figure 6

Surficial HPAH: TOC Concentrations Contour Map



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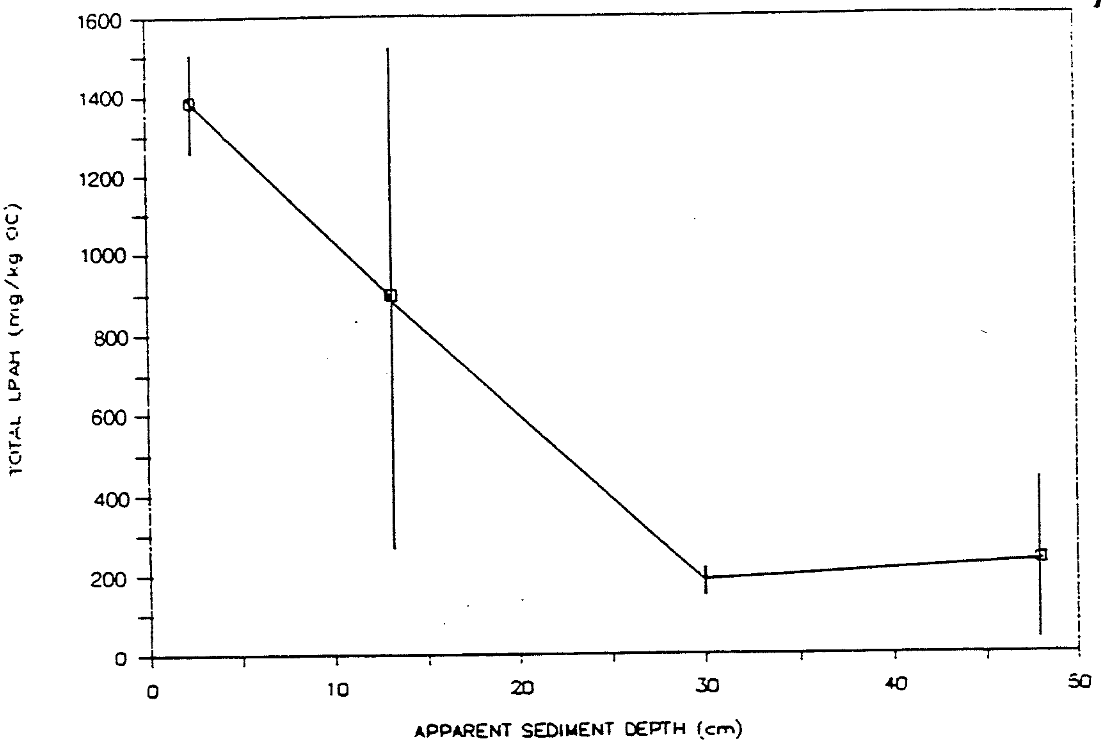
J-2854 8/90

Figure 7

Composite Total LPAH Profile

Pier 64/65 Cores B01 and B02

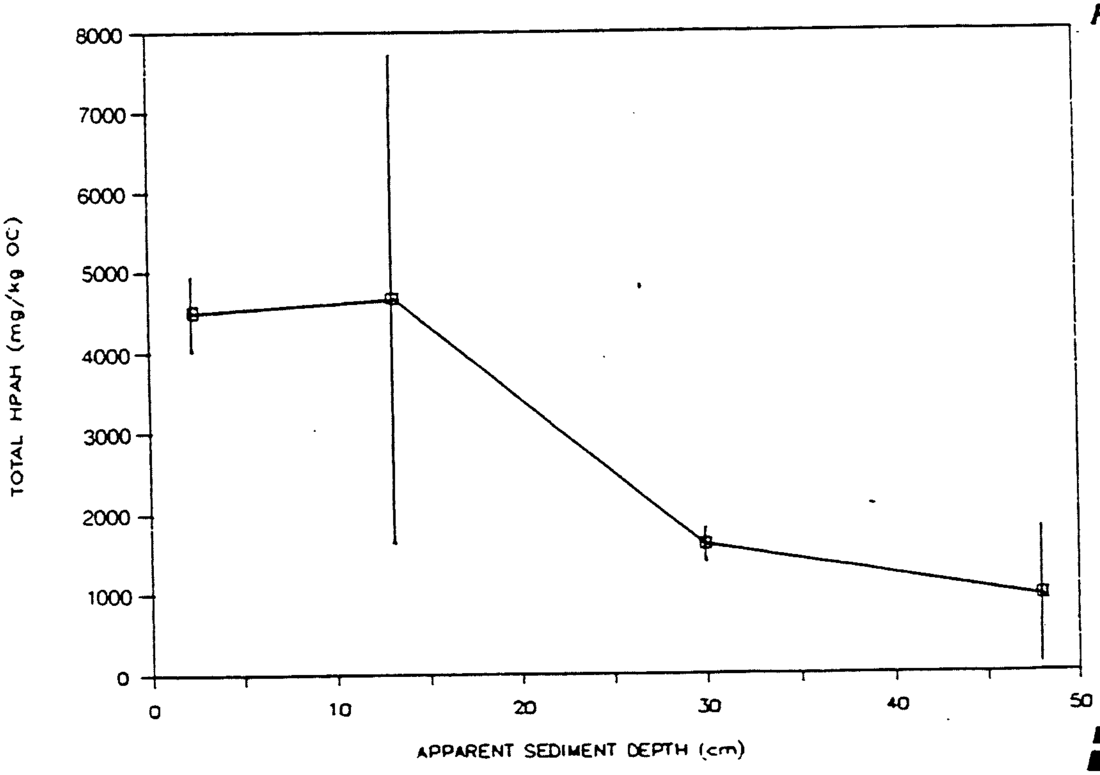
Figure 8A



Composite Total HPAH Profile

Pier 64/65 Cores B01 and B02

Figure 8B



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J-2854 9/90

Figure 8A/8B

APPENDIX C
FIELD EXPLORATION METHODS AND ANALYSIS

APPENDIX A
FIELD EXPLORATION METHODS AND ANALYSIS

This appendix documents the procedures Hart Crowser used in collecting sediment samples and the deployment of sediment traps in the location of former Pier 64/65. The discussion includes information on the following subjects:

- Introduction
- Station Positioning
- Diver Sediment Cores
- Surface Sediment Sampling
- Sediment Traps
- Decontamination Procedures

Introduction

Hart Crowser conducted the field work for this project in five segments. The first segment, which occurred on May 8, 1990, consisted of measuring and marking locations along the shoreline to be used as reference points during sampling. The second segment consisted of collecting diver sediment cores from two locations on May 9, 1990. The third segment consisted of collecting extensive composite surface (0 to 2 cm) grabs (16 point composites) within 100-foot grids in three locations on June 5, 1990. On May 2, 1990, two sediment traps were deployed in the Pier 64/65 area. On July 10, 1990, the sediment traps were retrieved by divers for observation and analysis. Our field representatives for the project were Clay Patmont and Mark Herrenkohl.

Sunchasers, Inc., of Seattle, Washington supplied a diver (supplied air), technician, and boat (24-foot-long) for in-place sediment sampling under subcontract to Hart Crowser. Battelle Marine Sciences Laboratory of Sequim, Washington, deployed and retrieved the sediment traps. Analytical Technologies, Inc., of Renton, Washington; Eureka Laboratories, Inc., of Sacramento, California; and Battelle Marine Sciences Laboratory performed the chemical analyses on the sediment samples collected during this study. In addition, Battelle Marine Sciences Laboratory performed the Lead-210 dating on the sediment cores.

The locations of the diver cores, composite surface grabs, and sediment traps are shown on Figure 2.

Sampling Location Positioning

Sampling location positioning was maintained by a combination of navigational equipment including visual fixes with a range finder (Lietz Model 600 Optical Tapemeasure), LORAN C, and water depth. In addition, we attached a line from Pier 66 to Piers 62/63, 100 feet from shore, and used it for reference.

Diver Sediment Cores

Diver collected sediment cores were obtained at two locations on the property as shown on Figure 2. Coring locations were selected in areas relatively free of development-related sediment disturbance (e.g., driven pile), based on diver observations. Mark Rice of Sunchasers, Inc., (diver with supplied air) collected the sediment cores. Sediments were collected by driving a 3½-foot-long, 3-inch-diameter stainless steel tube with a 3½-foot-long, 3-inch-diameter cellose-acetate-butyrate insert into the sediment interface. For each location, three cores were obtained from a depth of three feet. Sediment recovery was reduced due to compaction and sediment loss through the catcher. The sediment cores were sealed in the field and taken back to Hart Crowser's soils laboratory for extrusion, classification, sectioning, and compositing. The sediment cores from each location were sectioned into the following depths: 0 to 4 cm, 4 to 8 cm, 8 to 14 cm, 14 to 20 cm, 20 to 30 cm, 30 to 40 cm, and 40 to 50 cm (HC-B01 only). At each location the same section from each of three cores was composited. A portion of each composite sample was placed into a 4-ounce plastic jar (Lead-210 dating). The remaining sample was placed into two 16-ounce glass jars with teflon-lined screw caps (for chemical analysis). The samples were kept frozen until extraction and analysis by the laboratory. Sediment descriptions for cores taken at each location are briefly described in Table A-1 according to PSEP Protocols (PSEP, 1986) and ASTM D 2488.

Table A-1 - Description of Diver Cores

Sediment Location:	HC-B01
Sediment Penetration in centimeters:	90
Sediment Recovery in centimeters:	47.5 - 56
Sediment Classification:	

Depth in Centimeters	Description
0 to 4	Gray to black, slightly sandy SILT with abundant shell fragments, slight petroleum sheen and odor (creosote), and slight sulfide odor.
4 to 8	Black, slightly sandy SILT with moderate shell fragments, slight petroleum sheen and odor (creosote), and slight sulfide odor.
8 to 14	Black, slightly sandy SILT with scattered shell fragments, strong petroleum sheen and odor (creosote), and slight sulfide odor.
14 to 20	Black, slightly sandy SILT with abundant shell fragments (including scattered 1-centimeter-long barnacle shells), slight petroleum sheen and odor (creosote), and increasing sulfide odor.
20 to 30	Black, slightly sandy SILT with scattered wood fragments (up to 3-centimeters-long), moderate shell fragments, slight petroleum sheen and odor (creosote), and strong sulfide odor.
30 to 40	Black, slightly sandy SILT with abundant wood fragments (up to 3-centimeters-long), and moderate shell fragments, slight petroleum sheen and odor (creosote), and decreasing sulfide odor.

Table A-1 - Continued

Depth in Centimeters	Description
40 to 50	Black, slightly sandy to sandy SILT with scattered clam shells (3-centimeters-long), strong petroleum sheen and odor (creosote), and slight sulfide odor.

Sediment Location:	**HC-B02**
Sediment Penetration in centimeters:	90
Sediment Recovery in centimeters:	35 to 36
Sediment Classification:	

Depth in Centimeters	Description
0 to 4	Brown to gray, sandy SILT with a 2-centimeter-long worm, abundant shell fragments (predominately barnacle shells), and slight petroleum odor (creosote).
4 to 8	Black, slightly sandy to sandy SILT with abundant shell and wood fragments, strong petroleum sheen and odor (creosote), and slight sulfide odor.
8 to 14	Black, slightly sandy to sandy SILT with moderate shell and wood fragments, strong petroleum sheen and odor (creosote), and slight sulfide odor.
14 to 20	Black, slightly sandy SILT with trace shell and wood fragments, moderate petroleum sheen and odor (creosote), and increasing sulfide odor.
20 to 30	Black, slightly sandy SILT with trace shell and wood fragments, moderate petroleum sheen and odor (creosote), and strong sulfide odor.

Table A-1 - Continued

Depth in Centimeters	Description
30 to 40	Black, slightly sandy SILT with trace shell and wood fragments (one 4-centimeter-long, 3-centimeter-wide wood fragment), moderate petroleum sheen and odor (creosote), and decreasing sulfide odor.

Surface Sediment Sampling

We collected surface (0 to 2 cm) sediment samples from a 16-point grid at three locations on the property as shown on Figure 2. Sediment was collected from each location by a diver using 2-inch-diameter cellose-acetate-butyrate tubes inserted into the sediment interface. For each location, sixteen cores were obtained from a 100-foot by 100-foot grid to a depth of approximately 6 inches. The top 2 centimeters of each core was extruded into a 6-gallon stainless steel container and homogenized with a stainless steel spoon. The homogenized sample was then placed into two 16-ounce glass jars with teflon-lined screw caps (for chemical analysis). Sediment descriptions for surface samples collected at each location are briefly described in Table A-2 according to PSEP Protocols (PSEP, 1986) and ASTM D 2488.

Table A-2 - Description of Surface Sediment

Sediment Location:	<u>HC-SS01</u>
Sediment Description:	Black, slightly sandy to sandy SILT with moderate to abundant shell fragments (predominantly barnacle shells) and moderate petroleum sheen and odor (creosote).
Sediment Location:	<u>HC-SS02</u>
Sediment Description:	Black, slightly sandy to sandy SILT with moderate to abundant shell fragments (predominantly barnacle shells) and wood fragments, moderate petroleum sheen and odor (creosote), and slight sulfide odor.

Table A-2 - Continued

Sediment Location:	<u>HC-SS03</u>
Sediment Description:	Brown to black, slightly silty to silty, fine to medium SAND with moderate shell fragments (predominately barnacle shells), scattered root fragments, slight petroleum sheen and odor (creosote), and slight sulfide odor.

Sediment Traps

Sediment traps constructed of 6-inch-diameter PVC pipe (15.5-cm-diameter or 189 cm^2 opening) by 30-inch-long (76-cm) were deployed at one location in Elliott Bay (near Pier 63) on May 2, 1990. Two pairs of traps were deployed approximately 15 meters apart. The traps were supported vertically in a wooden base that was weighted with bricks. The traps had a baffle of 1 by 1-cm plastic grating to prevent large organisms from entering the traps. Traps contained 1.2 L of dense salt water (50 o/oo) and sodium azide (0.2%) as a preservative. Dye was also added to the preservative so visual examination of the recovered trap could determine whether the traps had been spilled or flushed.

The traps were recovered with scuba divers on July 10, 1990. The overlying water was decanted and the dyed water containing the sediments was transferred and composited from each pair of traps into a precleaned glass jug and returned to the laboratory. The sediment was centrifuged in teflon jars to remove excess water, weighed, and then split for chemistry and percent solids determination by freeze drying.

Decontamination Procedures

Sampling and testing equipment were routinely decontaminated in the field. Decontamination consisted of a scrub with detergent solution (Alconox), followed by a tap water rinse, followed by a thorough spray with deionized water.

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J-2854

APPENDIX B
QUALITY ASSURANCE AND LABORATORY DATA REPORTS

APPENDIX B
QUALITY ASSURANCE AND LABORATORY DATA REPORTS

As part of the Pier 64/65 Sediment Study, Hart Crowser personnel analyzed 11 sediment samples from three composite surface grabs and two composite diver cores for total solids (method EP 160.1), total volatile solids (method EPA 160.4), total organic carbon (method EP 9060), total lead (method SW 6010), total zinc (method SW 6010), semivolatile organics (method SW 8270), and PCBs (method SW 8080). In addition, selected samples were also analyzed for total calcium (method SW 6010) total mercury (method SW 7471) and Lead-210 (alpha counting of granddaughter product Polonium-210 by Battelle Marine Research Laboratory, Sequim). Samples were collected between May 9, 1990, and July 10, 1990.

Upon receipt from the laboratory, all analytical results underwent a Quality Assurance/Quality Control (QA/QC) review of laboratory and sample handling procedures. Review on the analytical data was based on protocols established by the Puget Sound Estuary Program (PSEP, 1986; 1989a; 1989b) and EPA Guidelines (EPA, 1988a; 1988b). In addition to sample results, the laboratory data reports include QA/QC data for laboratory reagent blanks or method blanks, surrogate spikes, matrix spike and matrix spike duplicates (MS/MSD), and blank spike samples.

In general, the analytical data were deemed acceptable for use in the Pier 64/65 Sediment Study. A more detailed evaluation of data quality is given below.

Detection Limits

Method detection limit goals specified by PSEP Protocols and EPA Guidelines were met for each analyte tested. Elevated detection limits were reported for several samples because of high analyte concentrations and subsequent dilution and matrix interference (see Case Narrative, Sediment Data Reports, Analytical Technologies, Inc.).

Holding Times

All samples were extracted and analyzed within the advised holding times specified by PSEP Protocols.

Calibration

Initial and continuing calibration results for all analyses were within PSEP and EPA acceptable limits.

Laboratory Reagent Blanks

Method or reagent blanks are analyzed to assess possible laboratory contamination of samples associated with all stages of preparation and analysis of sample extracts.

Organics. Reagent blanks were analyzed for semivolatile organics and PCB analyses. One reagent blank was analyzed for each batch of samples analyzed, for a total of two blanks per analysis. Contaminants were not present in the reagent blank samples with the exception of benzoic acid (estimated at 0.14 mg/kg) and di-n-butylphthalate (estimated at 0.10 mg/kg) (semivolatile organics).

If a compound is found in a blank but not in the samples, no action is taken. Benzoic acid was not detected in the sediment samples with the exception of sample HC-B02/8-14. The benzoic acid result for this sample was qualified with a B (i.e., found in blank).

Di-n-butylphthalate is a common field and laboratory contaminant at low concentrations. For common lab contaminants, sample results should be qualified by elevating the limit of detection when the sample concentration is less than 10 times the blank concentration. Sample concentrations of di-n-butylphthalate were not less than 10 times the blank concentration. The concentration of di-n-butylphthalate detected in sample HC-B02/8-14 (estimated at 0.72 mg/kg) was less than 10 times the blank result. Consequently, at the discretion of the laboratory reviewer, the sample was qualified with a B.

Inorganics. One method blank sample was analyzed for each batch of samples analyzed for total organic carbon and total metals. Contaminants were not present in the method blank samples.

Surrogate Recoveries

Organics. Surrogates are added to samples prior to extraction and analysis to monitor sample handling procedures, matrix effects, and purging inefficiency. All surrogate recoveries were within EPA control limits with the exception of the following:

Sample	Analysis	Surrogate	Recovery
HC-SS01	SW 8080	Dibutylchlorendate	0
HC-SS02	SW 8270	2-Fluorobiphenyl	124
		2,4,6-Tribromophenol	128
	SW 8080	Dibutylchlorendate	0
HC-SS03	SW 8080	Dibutylchlorendate	0
HC-B01/ 40-50	SW-8270	2-Fluorobiphenyl	124
	SW 8080	Decachlorobiphenyl	140
HC-B02/ 0-4	SW-8270	Terphenyl	160
HC-B02/ 30-40	SW-8270	2,4,6-Tribromophenol	2
	SW 8080	Dibutylchlorendate	154
		Decachlorobiphenyl	140

Based on PSEP Protocols and EPA Guidelines, if any two surrogates in the base/neutral or acid fraction are out of specification, but have recoveries greater than 10 percent, the positive results are considered estimates (J) and negative results are flagged with the sample quantitation limit as estimated (UJ). Consequently, base/neutral and acid fraction results for sample HC-SS02 are considered estimates, and may be biased high considering the elevated surrogate recoveries (124 to 128 percent).

At least one surrogate spike is required as a check on recovery of pesticides and PCB mixtures (PSEP, 1989). Because one surrogate recovery in each sample analyzed for PCBs was within control limits, no further action was required.

Inorganics. Surrogates were not required.

Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Organics. MS/MSD data are generated to determine precision and accuracy of the analytical method on a specific matrix (e.g, sediment). Matrix spike samples are preferred as QC samples only in the absence of a suitable reference material. A minimum of one MS/MSD pair is required for each 20 samples analyzed per PSEP Protocols.

A minimum of one MS/MSD pair was analyzed for each 20 samples submitted to the laboratory (method SW 8270: 1 MS and 2 MS/MSD; method SW 8080: 1 MS and 1 MS/MSD). Several matrix spike recovery (%R) values were outside the PSEP Protocol control limits (50 - 150 %). An explanation for the poor matrix spike recoveries is presented in the Case Narrative, Sediment Data Reports, Analytical Technologies, Inc.

Inorganics. MS/MSD pairs were not required.

Blank or Reagent Spike Samples

Blank or reagent spike samples are method blanks spiked with surrogate compounds and analytes. Such samples are useful in verifying acceptable method performance prior to and during routine analysis of samples. If a reference material is unavailable, a minimum of one blank spike sample is required for each method used per PSEP Protocols.

Organics. A minimum of one blank spike sample was analyzed for each chemical method. All blank spike recoveries were within EPA control limits.

Inorganics. Two reagent spike samples were analyzed for each chemical method. All reagent blank spike recoveries were within EPA control limits.

Chain of Custody

Proper chain of custody procedures were followed per PSEP Protocols and EPA Guidelines.

CONCLUSIONS

These qualifications do not limit our ability to form reliable interpretations of the entire data set.

PORTSEA.app

Hart Crowser
J-2354

SEDIMENT DATA REPORTS
EUREKA LABORATORIES, INC.

EUREKA LABORATORIES, INC.

Corporate Office:
6790 FLORIN PERKINS ROAD
SACRAMENTO, CA 95828
TEL: (916) 381-7953
FAX: (916) 381-4013

Branch Office:
12121 NORTHUP WAY, SUITE 212
BELLEVUE, WA 98005
TEL: (206) 885-0284
FAX: (206) 885-6162

Air Pollution
Chemical Analysis,
Research & Testing
Environmental Studies
Robotics
Toxicology

June 14, 1990

Mr. Mark Herrenkohl
HART CROWSER, INC.
1910 Fairview Avenue East
Seattle, WA 98102-3699

Reference: ELI No: WO-06-001
Project: Pier 64/65 Sediment Study
Job #: J-2854

Dear Mr. Herrenkohl:

Eureka Laboratories, Inc. is pleased to submit a laboratory report for the subject task. This report presents analytical results for four (4) sediment samples for the following analyses:

ANALYSIS	METHOD	SAMPLE ID.
Lead	EPA 6010	0-4, 8-14, 20-30, 40-50
Zinc	EPA 6010	same as above

Sincerely,
EUREKA LABORATORIES, INC.

By:
Shao-Pin Yo, Ph.D.
Laboratory Director

SPY/pvc

Attachment

EUREKA LABORATORIES, INC.

Corporate Office:
6790 FLORIN PERKINS ROAD
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12121 NORTHUP WAY, SUITE 212
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TEL: (206) 885-0284
FAX: (206) 885-6162

Air Pollution
Chemical Analysis,
Research & Testing
Environmental Studies
Robotics
Toxicology

RECEIVED
JUN 28 1990
HART-CROWSER INC.

June 26, 1990

Mr. Mark Herrenkohl
HART CROWSER, INC.
1910 Fairview Avenue East
Seattle, WA 98102-3699

Reference: ELI No: W0-06-006
Job #: J-2854
Project: Pier 64/65 Sediment Study

Dear Mr. Herrenkohl:

Eureka Laboratories, Inc. is pleased to submit a laboratory report for the subject project. This report presents analytical results for three (3) sediment samples for the following analyses:

ANALYSIS	METHOD	SAMPLE ID.
Total Solids	EPA 160.1	HC-SS01, HC-SS02, & HC-SS03
Total Volatile Solids	EPA 160.4	same as above
Total Carbons	EPA 9060	same as above
Zinc	EPA 6010	same as above
Lead	EPA 6010	same as above
Mercury	EPA 7471	same as above

Sincerely,
EUREKA LABORATORIES, INC.

By: Shao-Pin Yo
Shao-Pin Yo, ~~PH~~.D.
Laboratory Director

SPY/jj

Attachment

EUREKA LABORATORIES, INC.

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Air Pollution
Chemical Analysis,
Research & Testing
Environmental Studies
Robotics
Toxicology

July 31, 1990

Mr. Mark Herrenkohl
HART CROWSER, INC.
1910 Fairview Avenue East
Seattle, WA 98102-3699

Reference: ELI No: W0-07-001
Job #: J-2854
Project: Pier 64/65 Sediment Study

Dear Mr. Herrenkohl:

Eureka Laboratories, Inc. is pleased to submit a laboratory report for the subject project. This report presents analytical results for eight (8) sediment samples for the following analyses:

ANALYSIS	METHOD	SAMPLE ID.
Total Solids and Total Volatile Solids	EPA 160.3 EPA 160.4	HC-B01-0-4, HC-B01-8-14, HC-B01-20-30, HC-B01-40-50, HC-B02-0-4, HC-B02-8-14, HC-B02-20-30, HC-B02-30-40
Total Organic Carbons	EPA 9060	same as above
Calcium, Lead, and Zinc	EPA 6010	same as above

Sincerely,
EUREKA LABORATORIES, INC.

By: Shao-Pin Yo
Shao-Pin Yo, Ph.D.
Laboratory Director

SPY/jj

Attachment

Hart Crowser
J-2854

TOTAL SOLIDS AND TOTAL VOLATILE SOLIDS

TOTAL SOLIDS
EPA Method 160.1

EUREKA LABORATORIES, INC.
6790 Florin-Perkins Road
Sacramento, CA 95828
(916) 381-7953

Order No: WO-06-006
Hazardous Waste Testing
Certification: 108

CLIENT: HART CROWSER
JOB #: J-2854
PROJECT: PIER 64/65 SEDIMENT STUDY

DATE RECEIVED: 06/08/1990
DATE EXTRACTED: 06/18/1990
DATE COMPLETED: 06/20/1990
DATE SAMPLED: 06/05/1990

SAMPLE ID.	% SOLID
HC-SS01	55.1
HC-SS02	40.4
HC-SS03	60.4

Hung Nguyen
Chemist

June 26, 1990
Date

TOTAL VOLATILE SOLIDS
EPA Method 160.4

EUREKA LABORATORIES, INC.
6790 Florin-Perkins Road
Sacramento, CA 95828
(916) 381-7953

Order No: WO-06-006
Hazardous Waste Testing
Certification: 108

CLIENT: HART CROWSER
JOB #: J-2854
PROJECT: PIER 64/65 SEDIMENT STUDY

DATE RECEIVED: 06/08/1990
DATE EXTRACTED: 06/18/1990
DATE COMPLETED: 06/20/1990
DATE SAMPLED: 06/05/1990

SAMPLE ID.	% SOLID
HC-SS01	2.8
HC-SS02	5.6
HC-SS03	3.0

Hung Nguyen
Chemist

June 26, 1990
Date

TOTAL SOLIDS, EPA Method 160.3
and
TOTAL VOLATILE SOLIDS, EPA Method 160.4

EUREKA LABORATORIES, INC.
6790 Florin-Perkins Road
Sacramento, CA 95828
(916) 381-7953

Order No: WO-07-001
Hazardous Waste Testing
Certification: 108

CLIENT: HART CROWSER
JOB #: J-2854
PROJECT: PIER 64/65 SEDIMENT STUDY

DATE RECEIVED: 07/03/1990
DATE EXTRACTED: 07/12/1990
DATE COMPLETED: 07/13/1990
DATE SAMPLED: 05/09/1990

SAMPLE ID.	TS [% by weight]	TVS [% by weight]
HC-B01-0-4	37.72	22.21
HC-B01-8-14	31.84	14.78
HC-B01-20-30	39.44	12.94
HC-B01-40-50	42.53	11.90
HC-B02-0-4	34.42	19.29
HC-B02-8-14	30.85	22.01
HC-B02-20-30	30.83	21.02
HC-B02-30-40	42.74	14.06
HC-B01-20-30 DUPLICATE	39.19	13.15
HC-B01-20-30 TRIPLECATE	39.36	12.78

C. Cherry Leung
Cherry Leung
Chemist

July 31, 1990
Date

SUMMARY
TOTAL SOLIDS AND TOTAL VOLATILE SOLIDS

1. Heat evaporating disk at 104° C for one hour, then again at 550° C for one more hour.
2. Cool disk and weigh.
3. Mix samples and transfer about 25 gm to disk. Weigh sample and disks.
4. Heat sample and disk to 104° C until weight of disk and sample at constant weight. Record disk and dry sample.
5. Calculate Total Solids.

$$\%TS = \frac{(\text{weight of disk} + \text{dry sample}) - \text{weight of disk}}{(\text{weight of disk} + \text{wet sample}) - \text{weight of disk}} \times 100$$

6. Place disk with dry sample to muffle furnace at 250° C for one hour, then raise temperature to 550° C for 3 to 4 hours until disk and sample at constant weight.
7. Cool and weigh disk and sample.
   Calculation for Total Volatile Solids.

$$\%TVS = \frac{(A - C) \times 100}{A - B}$$

A = wt. of disk and dry sample at 104° C.
B = wt. of disk
C= wt. of disk and dry sample at 550° C.

TOTAL ORGANIC CARBON

TOTAL CARBONS
EPA METHOD 9060

EUREKA LABORATORIES, INC.
6790 Florin-Perkins Road
Sacramento, CA 95828
(916) 381-7953

Order No: WO-06-006
Hazardous Waste Testing
Certification: 108

CLIENT: HART CROWSER
JOB #: J-2854
PROJECT: PIER 64/65 SEDIMENT STUDY

DATE RECEIVED: 06/08/1990
DATE EXTRACTED: 06/12/1990
DATE COMPLETED: 06/13/1990
DATE SAMPLED: 06/05/1990

SAMPLE ID.	CONCENTRATION [mg/Kg (ppm)]
HC-SS01	14600
HC-SS02	15300
HC-SS03	15200
METHOD BLANK	<100

REAGENT SPIKE RECOVERY - 101%
REAGENT SPIKE RECOVERY DUPLICATE - 101%

DETECTION LIMIT: 100 [mg/Kg (ppm)]

Abdou Mekebri
Chemist

June 26, 1990
Date

TOTAL ORGANIC CARBONS
EPA METHOD 9060

EUREKA LABORATORIES, INC.
6790 Florin-Perkins Road
Sacramento, CA 95828
(916) 381-7953

Order No: WO-07-001
Hazardous Waste Testing
Certification: 108

CLIENT: HART CROWSER
JOB #: J-2854
PROJECT: PIER 64/65 SEDIMENT STUDY

DATE RECEIVED: 07/03/1990
DATE EXTRACTED: 07/09/1990
DATE COMPLETED: 07/25/1990
DATE SAMPLED: 05/09/1990

SAMPLE ID	TOC CONTENT [mg/Kg (ppm)]
HC-B01-0-4	84,600 *
HC-B01-8-14	49,500 *
HC-B01-20-30	54,900
HC-B01-40-50	52,700
HC-B02-0-4	149,000 *
HC-B02-8-14	262,000 *
HC-B02-20-30	57,700 *
HC-B02-30-40	42,400
METHOD BLANK	<100
DETECTION LIMIT: [mg/Kg (ppm)]	100

REAGENT SPIKE RECOVERY - 102% **
REAGENT SPIKE RECOVERY DUP. - 105% **

* Estimated value only.

** Reagent spike set is used due to matrix interference.

Abdou Mekebri
Chemist

July 31, 1990
Date

SAMPLE PREPARATION

1. Mix sediment samples by spatula before weighing.
2. Weight 10 g in scintillation vial.
3. Centrifuge for 5 minutes, then remove H_2O layer.
4. Dry samples in oven at 70° - 80° C.
5. Transfer approximately 0.5 g to a clean scintillation vial. (Grind first.)
6. Add HCL drop by drop until not further effervescence.
7. Centrifuge for 5 minutes, then remove H_2O layer.
8. Dry samples in oven at 70° - 80° C.
9. Ready for TOC analysis.

NOTE:

Five sample concentrations were too high to be measured by EPA Method or conventional sediment TOC Method (March 1986) which you have provided us.

We now use both your method and sediment dilution TOC Method provided by Dohrman Manufacture which enabled us to obtain an estimate value within ±10%.

TOTAL METALS

ZINC
EPA METHOD 6010

EUREKA LABORATORIES, INC.
6790 Florin-Perkins Road
Sacramento, CA 95828
(916) 381-7953

Order No: WO-06-006
Hazardous Waste Testing
Certification: 108

CLIENT: HART CROWSER
JOB #: J-2854
PROJECT: PIER 64/65 SEDIMENT STUDY

DATE RECEIVED: 06/08/1990
DATE EXTRACTED: 06/16/1990
DATE COMPLETED: 06/20/1990
DATE SAMPLED: 06/05/1990

SAMPLE ID.	UNITS [mg/Kg (ppm)]
HC-SS01	665
HC-SS02	1030
HC-SS03	306
METHOD BLANK	<2.5

REAGENT SPIKE RECOVERY - 93%
REAGENT SPIKE RECOVERY DUP. - 91%

DETECTION LIMIT: 2.5 [mg/Kg (ppm)]

Results are based on dry weight.

The detection limit for sediment is based on the dilution factor of 125.

Jean Hsu
Chemist

June 26, 1990
Date

LEAD
EPA METHOD 6010

EUREKA LABORATORIES, INC.
6790 Florin-Perkins Road
Sacramento, CA 95828
(916) 381-7953

Order No: WO-06-006
Hazardous Waste Testing
Certification: 108

CLIENT: HART CROWSER
JOB #: J-2854
PROJECT: PIER 64/65 SEDIMENT STUDY

DATE RECEIVED: 06/08/1990
DATE EXTRACTED: 06/16/1990
DATE COMPLETED: 06/20/1990
DATE SAMPLED: 06/05/1990

SAMPLE ID.	UNITS [mg/Kg (ppm)]
HC-SS01	486
HC-SS02	704
HC-SS03	420
METHOD BLANK	<12.5

REAGENT SPIKE RECOVERY - 88%
REAGENT SPIKE RECOVERY DUP. - 87%

DETECTION LIMIT: 12.5 [mg/Kg (ppm)]

Results are based on dry weight.

The detection limit for sediment is based on the dilution factor of 125.

Jean Hsu
Chemist

June 26, 1990
Date

MERCURY
EPA METHOD 7471

EUREKA LABORATORIES, INC.
6790 Florin-Perkins Road
Sacramento, CA 95828
(916) 381-7953

Order No: WO-06-006
Hazardous Waste Testing
Certification: 108

CLIENT: HART CROWSER
JOB #: J-2854
PROJECT: PIER 64/65 SEDIMENT STUDY

DATE RECEIVED: 06/08/1990
DATE EXTRACTED: 06/16/1990
DATE COMPLETED: 06/20/1990
DATE SAMPLED: 06/05/1990

SAMPLE ID.	UNITS [mg/Kg (ppm)]
HC-SS01	0.45
HC-SS02	0.60
HC-SS03	0.25
METHOD BLANK	<0.013

DETECTION LIMIT: 0.013 [mg/Kg (ppm)]

Results are based on wet weight.

The detection limit for sediment is based on the dilution factor of 125.

Jean Hsu
Chemist

June 26, 1990
Date

LEAD, ZINC
EPA METHOD 6010

EUREKA LABORATORIES, INC.
6790 Florin-Perkins Road
Sacramento, CA 95828
(916) 381-7953

Order No: WO-06-001
Hazardous Waste Testing
Certification: 108

CLIENT: HART CROWSER, INC.
JOB #: J-2854
PROJECT: PIER 64/65 SEDIMENT STUDY

DATE RECEIVED: 06/01/1990
DATE EXTRACTED: 06/05/1990
DATE COMPLETED: 06/12/1990
DATE SAMPLED: 05/09/1990

UNITS: [mg/Kg(ppm)](A)

SAMPLE ID.	LOCATION	LEAD	ZINC
0-4		569	484
8-14		366	259
20-30		485	320
40-50		501	592
METHOD BLANK		<12.5	<2.5
REAGENT SPIKE RECOVERY		76%	74%
REAGENT SPIKE RECOVERY DUP.		75%	73%
DETECTION LIMIT: [mg/Kg(ppm)]		12.5	2.5

Low spike recovery due to matrix interference.

The detection limit for sediment is based on the dilution factor of 125.

(A) Based on dry weight

Jean Hsu
Chemist

June 14, 1990
Date

CALCIUM, LEAD, AND ZINC
EPA METHOD 6010

EUREKA LABORATORIES, INC.
6790 Florin-Perkins Road
Sacramento, CA 95828
(916) 381-7953

Order No: WO-07-001
Hazardous Waste Testing
Certification: 108

CLIENT: HART CROWSER
JOB #: J-2854
PROJECT: PIER 64/65 SEDIMENT STUDY

DATE RECEIVED: 07/03/1990
DATE EXTRACTED: 07/11-14/1990
DATE COMPLETED: 07/17/1990
DATE SAMPLED: 05/09/1990

SAMPLE ID.	UNITS [mg/Kg (ppm)] CALCIUM	LEAD	ZINC
HC-B01-0-4	9880	-	-
HC-B01-8-14	9260	-	-
HC-B01-20-30	8880	-	-
HC-B01-40-50	6800	-	-
HC-B02-0-4	3860	1180	582
HC-B02-8-14	4210	705	283
HC-B02-20-30	7000	555	307
HC-B02-30-40	8500	1050	480
METHOD BLANK	<12.5	<12.5	<25
DETECTION LIMIT: [mg/Kg (ppm)]	12.5	12.5	25
REAGENT SPIKE RECOVERY	90%	88%	79%
REAGENT SPIKE RECOVERY DUP.	90%	89%	79%

These detection limits are based on the dilution factor of 125.

Josie Quiambao
Josie Quiambao
Chemist

July 31, 1990
Date

DIGESTION PROCEDURE SUMMARY

1. Dry a representative portion of sediment overnight at 60° C. Grind to 100 mesh.
2. Weight 0.2 gram of dried sample into the decomposition vessel.
3. Add 0.5 ml. conc. HNO_3 .
4. In a fume hood, warm on a hot plate at low setting for about 30 minutes. To aid digestion, add 5 drops of 30% H_2O_2
5. Cool to room temperature. Add 0.75 ml. conc. HCL and 3.0 ml. conc. HF. Seal the digestion vessel.
6. Heat in an oven for 2 hours at 105° C - 130° C.
7. Remove vessel from oven and cool to room temperature. Add 18 ml. of 2.5% boric acid. Reseal vessel and return to oven at 105° C - 130° C for one hour.
8. Remove vessel from oven and cool to room temperature. Filter and quantitatively transfer contents to a 25 ml. volumetric flask and bring to mark with deionized water.
9. The digestate is then ready for ICP analysis.

CHAIN OF CUSTODY

Sample Custody Record

DATE 5/1/90 PAGE 1 OF 1

HARTCROWSER

Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699

JOB NUMBER J 2834 LAB NUMBER

PROJECT MANAGER Mark Herrenkohl / [illegible]

PROJECT NAME Pier 64/65 Sediment Study

SAMPLED BY: MJH

LAB NO.	SAMPLE	TIME	STATION	MATRIX	Total Lead	Total Zinc	NO. OF CONTAINERS
	0-4	5/1/90	HC-B01	Sediment	☒	☒	1
	2-14	↓	↓	↓	☒	☒	1
	30-36	↓	↓	↓	☒	☒	1
	40-50	↓	↓	↓	☒	☒	1

OBSERVATIONS/COMMENTS/ COMPOSITING INSTRUCTIONS

Analyses should
follow Puget Sound
Estuary [illegible]
Protocols [illegible]

If you have any
questions, please
call Mark H. at
206-324-9530

RELINQUISHED BY	DATE	RECEIVED BY	DATE
SIGNATURE Mark J Herrenkohl	5/1/90	SIGNATURE [illegible]	[illegible]
PRINTED NAME Mark J. Herrenkohl	TIME 11:45	PRINTED NAME	TIME
COMPANY Hart Crowser		COMPANY	

RELINQUISHED BY	DATE	RECEIVED BY	DATE
SIGNATURE		SIGNATURE	
PRINTED NAME	TIME	PRINTED NAME	TIME
COMPANY		COMPANY	

TOTAL NUMBER OF CONTAINERS 4

METHOD OF SHIPMENT Fed X

SPECIAL SHIPMENT/HANDLING OR STORAGE REQUIREMENTS Make [illegible]
Received [illegible]
[illegible]

DISTRIBUTION:

1. PROVIDE WHITE AND YELLOW COPIES TO LABORATORY
2. RETURN PINK COPY TO PROJECT MANAGER
3. LABORATORY TO FILL IN SAMPLE NUMBER AND SIGN FOR RECEIPT
4. LABORATORY TO RETURN WHITE COPY TO HART CROWSER

Sample Custody Record

DATE 6/1/[illegible] PAGE 1 OF 1

HARTCROWSER

Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699

JOB NUMBER [illegible] LAB NUMBER

PROJECT MANAGER [illegible]

PROJECT NAME [illegible]

SAMPLED BY: MJH

TESTING *

LAB NO.	SAMPLE	TIME	STATION	MATRIX	Total Solids	Total Vol. Solids	Total Org. Carbon	Total Lead	Total Mercury	Total Zinc					NO. OF CONTAINERS	OBSERVATIONS/COMMENTS/ COMPOSITING INSTRUCTIONS
		6/5/90	HC SS01	Sediment	X	X	X	X	X	X					1	* [illegible]
		↓	HC SS02	↓	X	X	X	X	X	X					1	[illegible]
		↓	HC SS03	↓	X	X	X	X	X	X					1	[illegible]
																[illegible]
																If you have any
																questions please call
																Mark [illegible]
																206 324 [illegible]

RELINQUISHED BY	DATE	RECEIVED BY	DATE
Mark [illegible]	6/1/[illegible]	[illegible]	[illegible]
SIGNATURE Mark J. [illegible]	TIME	SIGNATURE [illegible]	TIME
PRINTED NAME [illegible]	1600	PRINTED NAME	[illegible]
COMPANY		COMPANY	

RELINQUISHED BY	DATE	RECEIVED BY	DATE
SIGNATURE	TIME	SIGNATURE	TIME
PRINTED NAME		PRINTED NAME	
COMPANY		COMPANY	

TOTAL NUMBER OF CONTAINERS 3

METHOD OF SHIPMENT [illegible]

SPECIAL SHIPMENT/HANDLING OR STORAGE REQUIREMENTS
Take [illegible] of [illegible]
analyses and [illegible]

DISTRIBUTION:
1. PROVIDE WHITE AND YELLOW COPIES TO LABORATORY
2. RETURN PINK COPY TO PROJECT MANAGER
3. LABORATORY TO FILL IN SAMPLE NUMBER AND SIGN FOR RECEIPT
4. LABORATORY TO RETURN WHITE COPY TO HART CROWSER

Sample Custody Record

DATE 7/3/9[illegible] PAGE 1 OF 1

HARTCROWSER

Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699

JOB NUMBER [illegible]
LAB NUMBER
PROJECT MANAGER [illegible]
PROJECT NAME [illegible]

SAMPLED BY: MJH

LAB NO.	SAMPLE	TIME	STATION	MATRIX	TESTING *: Total [illegible]	Total [illegible]	Total [illegible]	Total [illegible]	Total Solids	Total [illegible]					NO. OF CONTAINERS	OBSERVATIONS/COMMENTS/ COMPOSITING INSTRUCTIONS
	[illegible]	[illegible]	HC-B01	[illegible]			X	X	X	X					1	* [illegible]
	[illegible]						X	X	X	X					1	[illegible]
	[illegible]						X	X	X	X					1	[illegible]
	[illegible]						X	X	X	X					1	
	[illegible]		HC-B02		X	X	X	X	X	X					1	
	[illegible]				X	X	X	X	X	X					1	[illegible]
	[illegible]				X	X	X	X	X	X					1	[illegible]
	[illegible]				X	X	X	X	X	X					1	Mark [illegible]
																[illegible]
																[illegible]
																[illegible]

RELINQUISHED BY	DATE	RECEIVED BY	DATE
Mark [illegible] SIGNATURE	7/3/9[illegible]	SIGNATURE	
Mark [illegible] PRINTED NAME	TIME 0915	PRINTED NAME	TIME
HART CROWSER COMPANY		COMPANY	

RELINQUISHED BY	DATE	RECEIVED BY	DATE
SIGNATURE		SIGNATURE	[illegible]
PRINTED NAME	TIME	PRINTED NAME	TIME
COMPANY		COMPANY	

TOTAL NUMBER OF CONTAINERS 8

METHOD OF SHIPMENT [illegible]

SPECIAL SHIPMENT/HANDLING OR STORAGE REQUIREMENTS TAKE [illegible] OF SAMPLE FOR ANALYSIS FREEZE [illegible] Send to Hart Crowser AND [illegible]

DISTRIBUTION:

1. PROVIDE WHITE AND YELLOW COPIES TO LABORATORY
2. RETURN PINK COPY TO PROJECT MANAGER
3. LABORATORY TO FILL IN SAMPLE NUMBER AND SIGN FOR RECEIPT
4. LABORATORY TO RETURN WHITE COPY TO HART CROWSER

Hart Crowser
J-2854

SEDIMENT DATA REPORTS
ANALYTICAL TECHNOLOGIES, INC.

AnalyticalTechnologies,Inc. 560 Naches Avenue, S.W.; Suite 101, Renton, WA 98055, (206) 228-8335

ATI I.D. # 9006-067

August 1, 1990

Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, WA 98102-3699

Attention : Mark Herrenkohl

Project Number : 2854

Project Name : Pier 64/65 Sediment Study

On June 8, 1990 Analytical Technologies, Inc. received three sediment samples for analysis. The samples were analyzed with EPA methodology or equivalent methods as specified in the attached analytical schedule. The results, sample cross reference, and the quality control data are enclosed.

Dana M. Walker

Dana M. Walker
Project Manager

Frederick W. Grothkopp

Frederick W. Grothkopp
Technical Manager

FWG/elf

AnalyticalTechnologies,Inc. 560 Naches Avenue, S.W., Suite 101, Renton, WA 98055, (206) 228-8335

ATI I.D. # 9007-025

August 7, 1990

Hart Crowser, Inc.
1910 Fairview Avenue E.
Seattle, WA 98102-3699

Attention : Mark Herrenkohl

Project Number : J-2854

Project Name : PIER 64/65 Sediment Study

On July 5, 1990 Analytical Technologies, Inc. received eight sediment samples for analysis. The samples were analyzed with EPA methodology or equivalent methods as specified in the attached analytical schedule. The results, sample cross reference, and the quality control data are enclosed.

Dana M. Walker
Dana M. Walker
Project Manager

Frederick W. Grothkopp/DW
Frederick W. Grothkopp
Technical Manager

FWG/tc

AnalyticalTechnologies,Inc. 560 Naches Avenue, S.W., Suite 101, Renton, WA 98055, (206) 228-8335

ATI I.D. # 9008-171

September 13, 1990

Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, WA 98102-3699

Attention : Mark Herrenkohl

Project Number : J-2854

Project Name : PIER 64/65 Sediment Study

On July 5, 1990 Analytical Technologies, Inc. received eight sediment samples for analysis. The samples were analyzed with EPA methodology or equivalent methods as specified in the attached analytical schedule. The results, sample cross reference, and the quality control were sent to you on August 7, 1990, under ATI accession # 9007-025.

Three samples were reaccessioned for additional tests on August 22, 1990. Enclosed is the report for these additional analyses.

Dana M. Walker
Dana M. Walker
Project Manager

Frederick W. Grothkopp
Frederick W. Grothkopp
Technical Manager

FWG/hbb

SAMPLE CROSS REFERENCE SHEET

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY

ATI #	CLIENT DESCRIPTION	DATE SAMPLED	MATRIX
9006-067-1	HC-SS01	06/05/90	SEDIMENT
9006-067-2	HC-SS02	06/05/90	SEDIMENT
9006-067-3	HC-SS03	06/05/90	SEDIMENT

----- TOTALS -----

MATRIX	# SAMPLES
SEDIMENT	3

ATI STANDARD DISPOSAL PRACTICE

The samples from this project will be disposed of in thirty (30) days from the date of this report. If an extended storage period is required, please contact our sample control department before the scheduled disposal date.

SAMPLE CROSS REFERENCE SHEET

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY

ATI #	CLIENT DESCRIPTION	DATE SAMPLED	MATRIX
9007-025-1	0-4 HC-B01	05/09/90	SEDIMENT
9007-025-2	8-14 HC-B01	05/09/90	SEDIMENT
9007-025-3	20-30 HC-B01	05/09/90	SEDIMENT
9007-025-4	40-50 HC-B01	05/09/90	SEDIMENT
9007-025-5	0-4 HC-B02	05/09/90	SEDIMENT
9007-025-6	8-14 HC-B02	05/09/90	SEDIMENT
9007-025-7	20-30 HC-B02	05/09/90	SEDIMENT
9007-025-8	30-40 HC-B02	05/09/90	SEDIMENT

----- TOTALS -----

MATRIX	# SAMPLES
SEDIMENT	8

ATI STANDARD DISPOSAL PRACTICE

The samples from this project will be disposed of in thirty (30) days from the date of this report. If an extended storage period is required, please contact our sample control department before the scheduled disposal date.

ATI I.D. # 9008-171

SAMPLE CROSS REFERENCE SHEET

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY

ATI #	CLIENT DESCRIPTION	DATE SAMPLED	MATRIX
9008-171-1	8-14 HC-B01	05/09/90	SEDIMENT
9008-171-2	8-14 HC-B02	05/09/90	SEDIMENT
9008-171-3	20-30 HC-B02	05/09/90	SEDIMENT

----- TOTALS -----

MATRIX	# SAMPLES
SEDIMENT	3

ATI STANDARD DISPOSAL PRACTICE

The samples from this project will be disposed of in thirty (30) days from the date of this report. If an extended storage period is required, please contact our sample control department before the scheduled disposal date.

ATI I.D. # 9006-067

ANALYTICAL SCHEDULE

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY

ANALYSIS	TECHNIQUE	REFERENCE	LAB
SEMI-VOLATILE COMPOUNDS	GCMS	EPA 8270	R
POLYCHLORINATED BIPHENYLS (PCBs)	GC/ECD	EPA 8080	R
TOTAL SOLIDS	GRAVIMETRIC	METHOD 7-2.2	R

R = ATI - Renton
SD = ATI - San Diego
T = ATI - Tempe
PNR = ATI - Pensacola
FC = ATI - Fort Collins
SUB = Subcontract

ANALYTICAL SCHEDULE

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY

ANALYSIS	TECHNIQUE	REFERENCE	LAB
SEMI-VOLATILE COMPOUNDS	GCMS	EPA 8270	R
POLYCHLORINATED BIPHENYLS (PCBs)	GC/ECD	EPA 8080	R
TOTAL SOLIDS	GRAVIMETRIC	EPA 160.3	R

R = ATI - Renton
SD = ATI - San Diego
T = ATI - Tempe
PNR = ATI - Pensacola
FC = ATI - Fort Collins
SUB = Subcontract

ATI I.D. # 9008-171

ANALYTICAL SCHEDULE

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY

ANALYSIS	TECHNIQUE	REFERENCE	LAB
TOTAL ORGANIC CARBON	TOC ANALYZER	EPA 9060	SD

R = ATI - Renton
SD = ATI - San Diego
T = ATI - Tempe
PNR = ATI - Pensacola
FC = ATI - Fort Collins
SUB = Subcontract

CASE NARRATIVE

AnalyticalTechnologies,Inc. 560 Naches Avenue, S.W. Suite 101, Renton, WA 98055, (206) 228-8335

August 16, 1990

Hart Crowser
1910 Fairview Avenue E.
Seattle, WA 98102-3699

Attention: Mark Herrenkohl

Project Number: 2854

Project Name: PIER 64/65 Sediment Study

Case Narrative for 9006-067 and 9007-025

Sediments received by Analytical Technologies, Inc. (ATI) for the above-mentioned accession numbers were extracted and analyzed following the Puget Sound Estuary Program (PSEP). Two analytical test methods were initially requested: Polyaromatic Hydrocarbons (PAHs) by EPA 8270 GC/MS and Polychlorinated Biphenyls (PCBs) by EPA 8080.

Prior to the description of analytical methods performed on the samples, a comparison and explanation of why two sets of PAH data for 9006-067 were generated should be addressed. After the samples were received by the laboratory, the PAH request was modified to a full 8270 target list. Due to a communication problem within the laboratory the samples were extracted and cleaned up for the PAH only analysis. The primary difference between the two preps is in the PAH prep, silica gel cleanup is performed whereas for the 8270 full list, no silica gel cleanup is done. At this point the communication gap was closed and the samples were rextracted for the full 8270 target list. The results, in general, showed higher target PAH concentrations for the extracts that had been passed through silica gel as compared with the extracts that had not been passed through silica gel. We believe that the explanation for this is because of the higher concentration of polar interferences (silica gel would remove these materials) in the samples not cleaned up with silica gel. The presence of these polar materials was even evidenced by the color of the final extracts: opaque, dark brown to black for the extracts not treated with silica gel versus a transparent, slightly fluorescent yellow for silica gel treated extracts. It is our contention that the silica gel cleanup produced a better set of data for the PAHs compared to the extracts not treated with silica gel.

The following constitutes a brief summary of the preparative and instrumental techniques followed for both 9006-067 and 9007-025: For the 8270 analysis a 100 g (for 9007-025 a 50 g sample was used) sample was spiked with surrogates and then extracted with methylene chloride using a soxhlet extractor for 18 hours. The resulting extract was passed through sodium sulfate and concentrated to 10 ml. The 10 ml extract had a GPC cleanup performed and the resultant eluant was concentrated to a final volume of 1 ml. A 200 ul aliquot of the 1 ml extract was spiked with internal standards and transferred to an autosampler vial. The GC/MS was calibrated using a 5-point curve (20-160 ug/ml) and the MS tuned against DFTPP as per 8270. A daily 50 ug/ml calibration standard was run and all samples were quantitated against this standard. A 1 ul aliquot was injected into the GC for both samples and standards. Due to the high levels of PAHs in the samples, repeated runs of each extract were necessary to properly bracket the target concentrations within the calibration curve.

For the 8080 PCB analysis a 100 g sample (for 9007-025, a 50 g sample was used) was spiked with surrogates and then extracted with methylene chloride using a soxhlet extractor for 18 hours. The resulting extract was passed through sodium sulfate and concentrated to 10 ml. The 10 ml extract was cleaned up using GPC and then solvent replaced to hexane. The extract was then cleaned for GC/ECD interferences using Florisil. After reconcentrating, the extract had sulfur removed using TBA-sulfite, and finally a concentrated sulfuric acid cleanup to remove interfering organics. The final extract volume in hexane was 10 ml. The electron capture detector was calibrated at 5 points, a continuing calibration standard was run both to verify the calibration and to quantitate unknowns. Five discrete peaks were used to quantitate the PCBs. The analysis was a dual column method. An aliquot of the sample was simultaneously injected on both columns. The primary quantitation column was a 30 m DB-608 capillary, the secondary column was a 30 m DB-5 capillary. Each extract was run at least twice on each column both to bracket the concentration of the unknown within the calibration curve and to reduce the affects of the still present interferences.

Discussion:

The MS/MSD for the 8270 analysis showed poor recoveries for the spiked compounds due to the necessary dilutions and because of the presence of targets already in the sample. However, surrogate recoveries for all samples were well within normal recovery limits. Also, a matrix blank spike was run following the same extraction protocol as the samples and good results were obtained. Finally, some comment should be made regarding the reported detection limits. Because all of the samples had very high percent moistures (low total solids), both the reported values for the targets found in the samples and the detection limits themselves have been elevated much higher than for usual sediments. Most sediments have percent total solids of around 50% (Table 4, page 8 in the PSEP guidelines). The sediments in 9006-067 and 9007-025 had percent total solids of around 20-40 percent. In the worst cases, detection limits and targets will be increased by a factor of five or more over wet weight results. Therefore, the data must be viewed in the context of what the total soils were for each of the samples.

For the PCB analyses, MS/MSD results were also affected by the matrix and the presence of relatively high (as compared to the spiking levels) PCBs levels already in the samples. In general, surrogate recoveries for the samples were within normal limits. In 9006-067, the dibutylchlorendate recoveries were adversely affected by the higher level of interferences present than in the 9007-025 sample set. This was a result of the larger sample sizes used in the 9006-067 set. Also, it should be noted that the identification of the PCBs, specifically PCB 1254, in the 9006-067 sample set is an judgment call. In the 9007-025 sample set, because the level of interferences had been greatly reduced, the identification was much easier to make and it is felt it is a more accurate assessment.

Should there be any further questions regarding the analytical results, please feel free to call.

Dana Walker

Project Manager

TOTAL SOLIDS

ATI I.D. # 9006-067

GENERAL CHEMISTRY RESULTS

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY

SAMPLE MATRIX : SEDIMENT
UNITS : %

ATI I.D.#	CLIENT I.D.	TOTAL SOLIDS
9006-067-1	HC-SS01	34
9006-067-2	HC-SS02	48
9006-067-3	HC-SS03	51

GENERAL CHEMISTRY RESULTS

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY

SAMPLE MATRIX : SEDIMENT
UNITS : % SOLIDS

ATI I.D.#	CLIENT I.D.	TOTAL SOLIDS
9007-025-1	0-4 HC-B01	22
9007-025-2	8-14 HC-B01	19
9007-025-3	20-30 HC-B01	35
9007-025-4	40-50 HC-B01	42
9007-025-5	0-4 HC-B02	34
9007-025-6	8-14 HC-B02	31
9007-025-7	20-30 HC-B02	34
9007-025-8	30-40 HC-B02	38

ATI I.D. # 9006-067

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY

SAMPLE MATRIX : SEDIMENT
UNITS : %

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED RESULT	SPIKE ADDED	% REC
MOISTURE	9006-062-2	9.5	10	5	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT	: HART CROWSER, INC.	SAMPLE MATRIX	: SEDIMENT
PROJECT #	: J-2854		
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	UNITS	: % SOLIDS

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED RESULT	SPIKE ADDED	% REC
TOTAL SOLIDS	9007-025-7	34	33	3	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

TOTAL ORGANIC CARBON

ATI I.D. # 9008-171

GENERAL CHEMISTRY RESULTS

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY

SAMPLE MATRIX : SEDIMENT
UNITS : mg/Kg

ATI I.D.#	CLIENT I.D.	TOTAL ORGANIC CARBON
9008-171-1	8-14 HC-B01	56,900
9008-171-2	8-14 HC-B02	86,900
9008-171-3	20-30 HC-B02	82,800

ATI I.D. # 9008-171

GENERAL CHEMISTRY QUALITY CONTROL

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY

SAMPLE MATRIX : SEDIMENT
UNITS : mg/Kg

PARAMETER	ATI I.D.	SAMPLE RESULT	DUP RESULT	RPD	SPIKED RESULT	SPIKE ADDED	% REC
TOTAL ORGANIC CARBON	00840202	43,600	44,900	3	49,100	8,330	58

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Sample Result} - \text{Duplicate Result})}{\text{Average Result}} \times 100$$

SEMIVOLATILE ORGANICS

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : HC-SS01
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 (PSEP)
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 06/05/90
DATE RECEIVED : 06/08/90
DATE EXTRACTED : 07/03/90
DATE ANALYZED : 07/11/90
UNITS : mg/Kg
DILUTION FACTOR : 1

COMPOUND	RESULT
N-NITROSODIMETHYLAMINE	<0.60
PHENOL	<0.60
ANILINE	<0.60
BIS(2-CHLOROETHYL)ETHER	<0.60
2-CHLOROPHENOL	<0.60
1,3-DICHLOROBENZENE	<0.60
1,4-DICHLOROBENZENE	0.67
BENZYL ALCOHOL	<0.60
1,2-DICHLOROBENZENE	<0.60
2-METHYLPHENOL	<0.60
BIS(2-CHLOROISOPROPYL)ETHER	<0.60
4-METHYLPHENOL	<0.60
N-NITROSO-DI-N-PROPYLAMINE	<0.60
HEXACHLOROETHANE	<0.60
NITROBENZENE	<0.60
ISOPHORONE	<0.60
2-NITROPHENOL	<0.60
2,4-DIMETHYLPHENOL	<0.60
BENZOIC ACID	0.87 J
BIS(2-CHLOROETHOXY)METHANE	<0.60
2,4-DICHLOROPHENOL	<0.60
1,2,4-TRICHLOROBENZENE	<0.60
NAPHTHALENE	1.6
4-CHLOROANILINE	<0.60
HEXACHLOROBUTADIENE	<0.60
4-CHLORO-3-METHYLPHENOL	<0.60
2-METHYLNAPHTHALENE	0.38 J
HEXACHLOROCYCLOPENTADIENE	<0.60
2,4,6-TRICHLOROPHENOL	<0.60
2,4,5-TRICHLOROPHENOL	<3.0
2-CHLORONAPHTHALENE	<0.60
2-NITROANILINE	<3.0
DIMETHYLPHTHALATE	<0.60
ACENAPHTHYLENE	1.4
3-NITROANILINE	<3.0
ACENAPHTHENE	0.93
2,4-DINITROPHENOL	<3.0
4-NITROPHENOL	<3.0

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J = Estimated value.

ATI I.D. # 9006-067-1

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : HC-SS01
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 (PSEP)
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 06/05/90
DATE RECEIVED : 06/08/90
DATE EXTRACTED : 07/03/90
DATE ANALYZED : 07/11/90
UNITS : mg/Kg
DILUTION FACTOR : 1

COMPOUND	RESULT
DIBENZOFURAN	0.53 J
2,4-DINITROTOLUENE	<0.60
2,6-DINITROTOLUENE	<0.60
DIETHYLPHTHALATE	<0.60
4-CHLOROPHENYL-PHENYLETHER	<0.60
FLUORENE	1.2
4-NITROANILINE	<3.0
4,6-DINITRO-2-METHYLPHENOL	<3.0
N-NITROSODIPHENYLAMINE	<0.60
4-BROMOPHENYL-PHENYLETHER	<0.60
HEXACHLOROBENZENE	<0.60
PENTACHLOROPHENOL	<3.0
PHENANTHRENE	6.2
ANTHRACENE	4.2
DI-N-BUTYLPHTHALATE	<0.60
FLUORANTHENE	11
BENZIDINE	<6.0
PYRENE	28
BUTYLBENZYLPHTHALATE	<0.60
3,3-DICHLOROBENZIDINE	<1.2
BENZO(a)ANTHRACENE	15
BIS(2-ETHYLHEXYL)PHTHALATE	1.8
CHRYSENE	9.3
DI-N-OCTYLPHTHALATE	<0.60
BENZO(b)FLUORANTHENE	<0.60
BENZO(k)FLUORANTHENE	29
BENZO(a)PYRENE	8.1
INDENO(1,2,3-cd)PYRENE	4.3
DIBENZ(a,h,)ANTHRACENE	2.0
BENZO(g,h,i)PERYLENE	4.3

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	44
2-FLUOROBIPHENYL	62
TERPHENYL-d14	100
PHENOL-d6	52
2-FLUOROPHENOL	48
2,4,6-TRIBROMOPHENOL	56

J = Estimated value.

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT	HART CROWSER, INC.	DATE SAMPLED	06/05/90
PROJECT #	2854	DATE RECEIVED	06/08/90
PROJECT NAME	PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	07/03/90
CLIENT I.D.	HC-SS01	DATE ANALYZED	07/11/90
SAMPLE MATRIX	SEDIMENT	UNITS	mg/Kg
EPA METHOD	8270 (PSEP)	DILUTION FACTOR	1

RESULTS BASED ON DRY WEIGHT

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
OXYGENATED HYDROCARBON	342	11
BRANCHED UNSATURATED HYDROCARBON	1272	3.0
OXYGENATED HYDROCARBON	1307	3.4
SATURATED ALKANE	1453	2.1
BRANCHED AROMATIC HYDROCARBON	1492	1.3

AnalyticalTechnologies,Inc.

ATI I.D. # 9006-067-2

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : HC-SS02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 (PSEP)
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 06/05/90
DATE RECEIVED : 06/08/90
DATE EXTRACTED : 07/03/90
DATE ANALYZED : 07/30/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	RESULT
N-NITROSODIMETHYLAMINE	<2.1
PHENOL	<2.1
ANILINE	<2.1
BIS(2-CHLOROETHYL)ETHER	<2.1
2-CHLOROPHENOL	<2.1
1,3-DICHLOROBENZENE	<2.1
1,4-DICHLOROBENZENE	<2.1
BENZYL ALCOHOL	<2.1
1,2-DICHLOROBENZENE	<2.1
2-METHYLPHENOL	<2.1
BIS(2-CHLOROISOPROPYL)ETHER	<2.1
4-METHYLPHENOL	<2.1
N-NITROSO-DI-N-PROPYLAMINE	<2.1
HEXACHLOROETHANE	<2.1
NITROBENZENE	<2.1
ISOPHORONE	<2.1
2-NITROPHENOL	<2.1
2,4-DIMETHYLPHENOL	<2.1
BENZOIC ACID	0.69 J
BIS(2-CHLOROETHOXY)METHANE	<2.1
2,4-DICHLOROPHENOL	<2.1
1,2,4-TRICHLOROBENZENE	<2.1
NAPHTHALENE	3.3
4-CHLOROANILINE	<2.1
HEXACHLOROBUTADIENE	<2.1
4-CHLORO-3-METHYLPHENOL	<2.1
2-METHYLNAPHTHALENE	1.2 J
HEXACHLOROCYCLOPENTADIENE	<2.1
2,4,6-TRICHLOROPHENOL	<2.1
2,4,5-TRICHLOROPHENOL	<11
2-CHLORONAPHTHALENE	<2.1
2-NITROANILINE	<11
DIMETHYLPHTHALATE	<2.1
ACENAPHTHYLENE	1.7 J
3-NITROANILINE	<11
ACENAPHTHENE	2.4
2,4-DINITROPHENOL	<11
4-NITROPHENOL	<11

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J = Estimated value.

ATI I.D. # 9006-067-2

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : HC-SS02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 (PSEP)
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 06/05/90
DATE RECEIVED : 06/08/90
DATE EXTRACTED : 07/03/90
DATE ANALYZED : 07/30/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	RESULT	
DIBENZOFURAN	1.6	J
2,4-DINITROTOLUENE	<2.1	
2,6-DINITROTOLUENE	<2.1	
DIETHYLPHTHALATE	<2.1	
4-CHLOROPHENYL-PHENYLETHER	<2.1	
FLUORENE	5.0	
4-NITROANILINE	<11	
4,6-DINITRO-2-METHYLPHENOL	<11	
N-NITROSODIPHENYLAMINE	<2.1	
4-BROMOPHENYL-PHENYLETHER	<2.1	
HEXACHLOROBENZENE	<2.1	
PENTACHLOROPHENOL	<11	
PHENANTHRENE	20	
ANTHRACENE	31	
DI-N-BUTYLPHTHALATE	<2.1	
FLUORANTHENE	33	
BENZIDINE	<21	
PYRENE	48	
BUTYLBENZYLPHTHALATE	<2.1	
3,3-DICHLOROBENZIDINE	<4.2	
BENZO(a)ANTHRACENE	32	
BIS(2-ETHYLHEXYL)PHTHALATE	1.6	J
CHRYSENE	27	
DI-N-OCTYLPHTHALATE	<2.1	
BENZO(b)FLUORANTHENE	11	
BENZO(k)FLUORANTHENE	32	
BENZO(a)PYRENE	17	
INDENO(1,2,3-cd)PYRENE	7.7	
DIBENZ(a,h,)ANTHRACENE	2.9	
BENZO(g,h,i)PERYLENE	8.1	

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	96
2-FLUOROBIPHENYL	124 *
TERPHENYL-d14	136
PHENOL-d6	92
2-FLUOROPHENOL	104
2,4,6-TRIBROMOPHENOL	128 *

* Out of limits due to matrix interference and dilution.
J = Estimated value.

ATI I.D. # 9006-067-2

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : HC-SS02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 (PSEP)
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 06/05/90
DATE RECEIVED : 06/08/90
DATE EXTRACTED : 07/03/90
DATE ANALYZED : 07/30/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
OXYGENATED BRANCHED HYDROCARBON	1281	8.2
AROMATIC HYDROCARBON	1445	6.8
BENZOFLUORENE ISOMER	1483	11
BENZOFLUORENE ISOMER	1494	12
C20 CYCLIC AROMATIC	1851	9.3

Analytical Technologies, Inc.

ATI I.D. # 9006-067-3

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 06/05/90
PROJECT #	: 2854	DATE RECEIVED	: 06/08/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/03/90
CLIENT I.D.	: HC-SS03	DATE ANALYZED	: 07/17/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8270 (PSEP)	DILUTION FACTOR	: 10

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
N-NITROSODIMETHYLAMINE	<4.0
PHENOL	<4.0
ANILINE	<4.0
BIS(2-CHLOROETHYL)ETHER	<4.0
2-CHLOROPHENOL	<4.0
1,3-DICHLOROBENZENE	<4.0
1,4-DICHLOROBENZENE	<4.0
BENZYL ALCOHOL	<4.0
1,2-DICHLOROBENZENE	<4.0
2-METHYLPHENOL	<4.0
BIS(2-CHLOROISOPROPYL)ETHER	<4.0
4-METHYLPHENOL	<4.0
N-NITROSO-DI-N-PROPYLAMINE	<4.0
HEXACHLOROETHANE	<4.0
NITROBENZENE	<4.0
ISOPHORONE	<4.0
2-NITROPHENOL	<4.0
2,4-DIMETHYLPHENOL	<4.0
BENZOIC ACID	<20
BIS(2-CHLOROETHOXY)METHANE	<4.0
2,4-DICHLOROPHENOL	<4.0
1,2,4-TRICHLOROBENZENE	<4.0
NAPHTHALENE	1.8 J
4-CHLOROANILINE	<4.0
HEXACHLOROBUTADIENE	<4.0
4-CHLORO-3-METHYLPHENOL	<4.0
2-METHYLNAPHTHALENE	0.50 J
HEXACHLOROCYCLOPENTADIENE	<4.0
2,4,6-TRICHLOROPHENOL	<4.0
2,4,5-TRICHLOROPHENOL	<20
2-CHLORONAPHTHALENE	<4.0
2-NITROANILINE	<20
DIMETHYLPHTHALATE	<4.0
ACENAPHTHYLENE	2.6 J
3-NITROANILINE	<20
ACENAPHTHENE	1.9 J
2,4-DINITROPHENOL	<20
4-NITROPHENOL	<20

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J = Estimated value.

ATI I.D. # 9006-067-3

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 06/05/90
PROJECT #	: 2854	DATE RECEIVED	: 06/08/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/03/90
CLIENT I.D.	: HC-SS03	DATE ANALYZED	: 07/17/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8270 (PSEP)	DILUTION FACTOR	: 10

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
DIBENZOFURAN	1.8 J
2,4-DINITROTOLUENE	<4.0
2,6-DINITROTOLUENE	<4.0
DIETHYLPHTHALATE	<4.0
4-CHLOROPHENYL-PHENYLETHER	<4.0
FLUORENE	3.9 J
4-NITROANILINE	<20
4,6-DINITRO-2-METHYLPHENOL	<20
N-NITROSODIPHENYLAMINE	<4.0
4-BROMOPHENYL-PHENYLETHER	<4.0
HEXACHLOROBENZENE	<4.0
PENTACHLOROPHENOL	<20
PHENANTHRENE	43
ANTHRACENE	5.9
DI-N-BUTYLPHTHALATE	<4.0
FLUORANTHENE	57
BENZIDINE	<40
PYRENE	54
BUTYLBENZYLPHTHALATE	<4.0
3,3-DICHLOROBENZIDINE	<8.0
BENZO(a)ANTHRACENE	10
BIS(2-ETHYLHEXYL)PHTHALATE	1.5 J
CHRYSENE	18
DI-N-OCTYLPHTHALATE	<4.0
BENZO(b)FLUORANTHENE	8.4
BENZO(k)FLUORANTHENE	<4.0
BENZO(a)PYRENE	7.2
INDENO(1,2,3-cd)PYRENE	3.2 J
DIBENZ(a,h,)ANTHRACENE	<4.0
BENZO(g,h,i)PERYLENE	<4.0

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	43
2-FLUOROBIPHENYL	64
TERPHENYL-d14	114
PHENOL-d6	44
2-FLUOROPHENOL	42
2,4,6-TRIBROMOPHENOL	48

J = Estimated value.

ATI I.D. # 9006-067-3

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 06/05/90
PROJECT #	: 2854	DATE RECEIVED	: 06/08/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/03/90
CLIENT I.D.	: HC-SS03	DATE ANALYZED	: 07/17/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8270 (PSEP)	DILUTION FACTOR	: 10

RESULTS BASED ON DRY WEIGHT

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
BRANCHED AROMATIC HYDROCARBON	1249	12
UNSATURATED HYDROCARBON	1263	12
SATURATED ALKANE	1432	30
AROMATIC HYDROCARBON	1464	12
SUBSTITUTED AROMATIC HYDROCARBON	1553	12

Analytical Technologies, Inc. ATI I.D. # 9007-025-1

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 05/09/90
PROJECT #	: J-2854	DATE RECEIVED	: 07/05/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/13/90
CLIENT I.D.	: 0-4 HC-B01	DATE ANALYZED	: 07/23/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8270 PSEP	DILUTION FACTOR	: 5

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
N-NITROSODIMETHYLAMINE	<4.6
PHENOL	<4.6
ANILINE	<4.6
BIS(2-CHLOROETHYL)ETHER	<4.6
2-CHLOROPHENOL	<4.6
1,3-DICHLOROBENZENE	<4.6
1,4-DICHLOROBENZENE	<4.6
BENZYL ALCOHOL	<4.6
1,2-DICHLOROBENZENE	<4.6
2-METHYLPHENOL	<4.6
BIS(2-CHLOROISOPROPYL)ETHER	<4.6
4-METHYLPHENOL	<4.6
N-NITROSO-DI-N-PROPYLAMINE	<4.6
HEXACHLOROETHANE	<4.6
NITROBENZENE	<4.6
ISOPHORONE	<4.6
2-NITROPHENOL	<4.6
2,4-DIMETHYLPHENOL	<4.6
BENZOIC ACID	<23
BIS(2-CHLOROETHOXY)METHANE	<4.6
2,4-DICHLOROPHENOL	<4.6
1,2,4-TRICHLOROBENZENE	<4.6
NAPHTHALENE	5.4
4-CHLOROANILINE	<4.6
HEXACHLOROBUTADIENE	<4.6
4-CHLORO-3-METHYLPHENOL	<4.6
2-METHYLNAPHTHALENE	2.6 J
HEXACHLOROCYCLOPENTADIENE	<4.6
2,4,6-TRICHLOROPHENOL	<4.6
2,4,5-TRICHLOROPHENOL	<23
2-CHLORONAPHTHALENE	<4.6
2-NITROANILINE	<23
DIMETHYLPHTHALATE	<4.6
ACENAPHTHYLENE	3.6 J
3-NITROANILINE	<23
ACENAPHTHENE	3.1 J
2,4-DINITROPHENOL	<23
4-NITROPHENOL	<23

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J = Estimated value.

ATI I.D. # 9007-025-1

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 0-4 HC-B01
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/23/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	RESULT
DIBENZOFURAN	2.8 J
2,4-DINITROTOLUENE	<4.6
2,6-DINITROTOLUENE	<4.6
DIETHYLPHTHALATE	<4.6
4-CHLOROPHENYL-PHENYLETHER	<4.6
FLUORENE	8.8
4-NITROANILINE	<23
4,6-DINITRO-2-METHYLPHENOL	<23
N-NITROSODIPHENYLAMINE	<4.6
4-BROMOPHENYL-PHENYLETHER	<4.6
HEXACHLOROBENZENE	<4.6
PENTACHLOROPHENOL	<23
PHENANTHRENE	41
ANTHRACENE	44
DI-N-BUTYLPHTHALATE	<4.6
FLUORANTHENE	87
BENZIDINE	<46
PYRENE	81
BUTYLBENZYLPHTHALATE	<4.6
3,3-DICHLOROBENZIDINE	<9.3
BENZO(a)ANTHRACENE	48
BIS(2-ETHYLHEXYL)PHTHALATE	1.8 J
CHRYSENE	52
DI-N-OCTYLPHTHALATE	<4.6
BENZO(b)FLUORANTHENE	<4.6
BENZO(k)FLUORANTHENE	85
BENZO(a)PYRENE	42
INDENO(1,2,3-cd)PYRENE	13
DIBENZ(a,h,)ANTHRACENE	5.2
BENZO(g,h,i)PERYLENE	13

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	66
2-FLUOROBIPHENYL	98
TERPHENYL-d14	88
PHENOL-d6	60
2-FLUOROPHENOL	48
2,4,6-TRIBROMOPHENOL	66

J = Estimated value.

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 0-4 HC-B01
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/23/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
BRANCHED AROMATIC HYDROCARBON	1289	26
C17 CYCLIC AROMATIC HYDROCARBON	1491	28
C17 CYCLIC AROMATIC HYDROCARBON	1502	24
UNKNOWN	1832	30
UNKNOWN	2057	31

AnalyticalTechnologies,inc.

ATI I.D. # 9007-025-2

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 8-14 HC-B01
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/23/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	RESULT
N-NITROSODIMETHYLAMINE	<5.4
PHENOL	<5.4
ANILINE	<5.4
BIS(2-CHLOROETHYL)ETHER	<5.4
2-CHLOROPHENOL	<5.4
1,3-DICHLOROBENZENE	<5.4
1,4-DICHLOROBENZENE	<5.4
BENZYL ALCOHOL	<5.4
1,2-DICHLOROBENZENE	<5.4
2-METHYLPHENOL	<5.4
BIS(2-CHLOROISOPROPYL)ETHER	<5.4
4-METHYLPHENOL	<5.4
N-NITROSO-DI-N-PROPYLAMINE	<5.4
HEXACHLOROETHANE	<5.4
NITROBENZENE	<5.4
ISOPHORONE	<5.4
2-NITROPHENOL	<5.4
2,4-DIMETHYLPHENOL	<5.4
BENZOIC ACID	<27
BIS(2-CHLOROETHOXY)METHANE	<5.4
2,4-DICHLOROPHENOL	<5.4
1,2,4-TRICHLOROBENZENE	<5.4
NAPHTHALENE	4.1 J
4-CHLOROANILINE	<5.4
HEXACHLOROBUTADIENE	<5.4
4-CHLORO-3-METHYLPHENOL	<5.4
2-METHYLNAPHTHALENE	1.3 J
HEXACHLOROCYCLOPENTADIENE	<5.4
2,4,6-TRICHLOROPHENOL	<5.4
2,4,5-TRICHLOROPHENOL	<27
2-CHLORONAPHTHALENE	<5.4
2-NITROANILINE	<27
DIMETHYLPHTHALATE	<5.4
ACENAPHTHYLENE	1.1 J
3-NITROANILINE	<27
ACENAPHTHENE	2.7 J
2,4-DINITROPHENOL	<27
4-NITROPHENOL	<27

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J = Estimated value.

ATI I.D. # 9007-025-2

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 8-14 HC-B01
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/23/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	RESULT
DIBENZOFURAN	2.8 J
2,4-DINITROTOLUENE	<5.4
2,6-DINITROTOLUENE	<5.4
DIETHYLPHTHALATE	<5.4
4-CHLOROPHENYL-PHENYLETHER	<5.4
FLUORENE	8.7
4-NITROANILINE	<27
4,6-DINITRO-2-METHYLPHENOL	<27
N-NITROSODIPHENYLAMINE	<5.4
4-BROMOPHENYL-PHENYLETHER	<5.4
HEXACHLOROBENZENE	<5.4
PENTACHLOROPHENOL	<27
PHENANTHRENE	27
ANTHRACENE	38
DI-N-BUTYLPHTHALATE	<5.4
FLUORANTHENE	43
BENZIDINE	<54
PYRENE	100
BUTYLBENZYLPHTHALATE	<5.4
3,3-DICHLOROBENZIDINE	<11
BENZO(a)ANTHRACENE	37
BIS(2-ETHYLHEXYL)PHTHALATE	2.2 J
CHRYSENE	56
DI-N-OCTYLPHTHALATE	<5.4
BENZO(b)FLUORANTHENE	43
BENZO(k)FLUORANTHENE	52
BENZO(a)PYRENE	39
INDENO(1,2,3-cd)PYRENE	18
DIBENZ(a,h,)ANTHRACENE	7.1
BENZO(g,h,i)PERYLENE	19

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	78
2-FLUOROBIPHENYL	116
TERPHENYL-d14	110
PHENOL-d6	42
2-FLUOROPHENOL	52
2,4,6-TRIBROMOPHENOL	52

J = Estimated value.

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 05/09/90
PROJECT #	: J-2854	DATE RECEIVED	: 07/05/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/13/90
CLIENT I.D.	: 8-14 HC-B01	DATE ANALYZED	: 07/23/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8270 PSEP	DILUTION FACTOR	: 5

RESULTS BASED ON DRY WEIGHT

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
C17 CYCLIC AROMATIC HYDROCARBON	1491	26
C17 CYCLIC AROMATIC HYDROCARBON	1503	24
C18 CYCLIC AROMATIC HYDROCARBON	1659	25
C20 CYCLIC AROMATIC HYDROCARBON	1832	26
C20 CYCLIC AROMATIC HYDROCARBON	1861	46

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ATI I.D. # 9007-025-3

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 20-30 HC-B01
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/23/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
SUBSTITUTED HYDROCARBON	1455	18
UNKNOWN	1831	19
ALKANE	1847	17
BRANCHED HYDROCARBON	1990	16
UNKNOWN	2056	23

ATI I.D. # 9007-025-3

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 05/09/90
PROJECT #	: J-2854	DATE RECEIVED	: 07/05/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/13/90
CLIENT I.D.	: 20-30 HC-B01	DATE ANALYZED	: 07/23/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8270 PSEP	DILUTION FACTOR	: 5

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
DIBENZOFURAN	0.57 J
2,4-DINITROTOLUENE	<2.9
2,6-DINITROTOLUENE	<2.9
DIETHYLPHTHALATE	<2.9
4-CHLOROPHENYL-PHENYLETHER	<2.9
FLUORENE	1.0 J
4-NITROANILINE	<14
4,6-DINITRO-2-METHYLPHENOL	<14
N-NITROSODIPHENYLAMINE	<2.9
4-BROMOPHENYL-PHENYLETHER	<2.9
HEXACHLOROBENZENE	<2.9
PENTACHLOROPHENOL	<14
PHENANTHRENE	2.7 J
ANTHRACENE	2.6 J
DI-N-BUTYLPHTHALATE	0.56 JB
FLUORANTHENE	3.4
BENZIDINE	<29
PYRENE	29
BUTYLBENZYLPHTHALATE	<2.9
3,3-DICHLOROBENZIDINE	<5.8
BENZO(a)ANTHRACENE	3.0
BIS(2-ETHYLHEXYL)PHTHALATE	2.4
CHRYSENE	4.5
DI-N-OCTYLPHTHALATE	<2.9
BENZO(b)FLUORANTHENE	12
BENZO(k)FLUORANTHENE	6.3
BENZO(a)PYRENE	7.3
INDENO(1,2,3-cd)PYRENE	3.3
DIBENZ(a,h,)ANTHRACENE	1.4 J
BENZO(g,h,i)PERYLENE	3.6

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	74
2-FLUOROBIPHENYL	112
TERPHENYL-d14	94
PHENOL-d6	46
2-FLUOROPHENOL	48
2,4,6-TRIBROMOPHENOL	40

J = Estimated value.
B = Found in blank.

ATI I.D. # 9007-025-4

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 40-50 HC-B01
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/23/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	RESULT
DIBENZOFURAN	2.5
2,4-DINITROTOLUENE	<2.4
2,6-DINITROTOLUENE	<2.4
DIETHYLPHTHALATE	<2.4
4-CHLOROPHENYL-PHENYLETHER	<2.4
FLUORENE	3.3
4-NITROANILINE	<12
4,6-DINITRO-2-METHYLPHENOL	<12
N-NITROSODIPHENYLAMINE	<2.4
4-BROMOPHENYL-PHENYLETHER	<2.4
HEXACHLOROBENZENE	<2.4
PENTACHLOROPHENOL	<12
PHENANTHRENE	6.0
ANTHRACENE	5.9
DI-N-BUTYLPHTHALATE	<2.4
FLUORANTHENE	14
BENZIDINE	<24
PYRENE	43
BUTYLBENZYLPHTHALATE	<2.4
3,3-DICHLOROBENZIDINE	<4.8
BENZO(a)ANTHRACENE	7.3
BIS(2-ETHYLHEXYL)PHTHALATE	0.32 J
CHRYSENE	9.8
DI-N-OCTYLPHTHALATE	<2.4
BENZO(b)FLUORANTHENE	<2.4
BENZO(k)FLUORANTHENE	14
BENZO(a)PYRENE	5.7
INDENO(1,2,3-cd)PYRENE	2.3 J
DIBENZ(a,h,)ANTHRACENE	0.72 J
BENZO(g,h,i)PERYLENE	2.7

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	70
2-FLUOROBIPHENYL	124 *
TERPHENYL-d14	108
PHENOL-d6	48
2-FLUOROPHENOL	50
2,4,6-TRIBROMOPHENOL	64

J = Estimated value.

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 40-50 HC-B01
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/23/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
TRITHIOLANE	515	26
CYCLIC AROMATIC HYDROCARBON	1289	15
CYCLIC AROMATIC HYDROCARBON	1491	18
UNKNOWN	1991	19
UNKNOWN	2057	21

ATI I.D. # 9007-025-5

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 0-4 HC-B02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/23/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	RESULT
N-NITROSODIMETHYLAMINE	<3.0
PHENOL	<3.0
ANILINE	<3.0
BIS(2-CHLOROETHYL)ETHER	<3.0
2-CHLOROPHENOL	<3.0
1,3-DICHLOROBENZENE	<3.0
1,4-DICHLOROBENZENE	<3.0
BENZYL ALCOHOL	<3.0
1,2-DICHLOROBENZENE	<3.0
2-METHYLPHENOL	<3.0
BIS(2-CHLOROISOPROPYL)ETHER	<3.0
4-METHYLPHENOL	<3.0
N-NITROSO-DI-N-PROPYLAMINE	<3.0
HEXACHLOROETHANE	<3.0
NITROBENZENE	<3.0
ISOPHORONE	<3.0
2-NITROPHENOL	<3.0
2,4-DIMETHYLPHENOL	<3.0
BENZOIC ACID	<15
BIS(2-CHLOROETHOXY)METHANE	<3.0
2,4-DICHLOROPHENOL	<3.0
1,2,4-TRICHLOROBENZENE	<3.0
NAPHTHALENE	8.4
4-CHLOROANILINE	<3.0
HEXACHLOROBUTADIENE	<3.0
4-CHLORO-3-METHYLPHENOL	<3.0
2-METHYLNAPHTHALENE	3.6
HEXACHLOROCYCLOPENTADIENE	<3.0
2,4,6-TRICHLOROPHENOL	<3.0
2,4,5-TRICHLOROPHENOL	<15
2-CHLORONAPHTHALENE	<3.0
2-NITROANILINE	<15
DIMETHYLPHTHALATE	<3.0
ACENAPHTHYLENE	3.9
3-NITROANILINE	<15
ACENAPHTHENE	20
2,4-DINITROPHENOL	<15
4-NITROPHENOL	<15

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J = Estimated value.

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 05/09/90
PROJECT #	: J-2854	DATE RECEIVED	: 07/05/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/13/90
CLIENT I.D.	: 0-4 HC-B02	DATE ANALYZED	: 07/23/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8270 PSEP	DILUTION FACTOR	: 5

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
DIBENZOFURAN	11
2,4-DINITROTOLUENE	<3.0
2,6-DINITROTOLUENE	<3.0
DIETHYLPHTHALATE	<3.0
4-CHLOROPHENYL-PHENYLETHER	<3.0
FLUORENE	26
4-NITROANILINE	<15
4,6-DINITRO-2-METHYLPHENOL	<15
N-NITROSODIPHENYLAMINE	<3.0
4-BROMOPHENYL-PHENYLETHER	<3.0
HEXACHLOROBENZENE	<3.0
PENTACHLOROPHENOL	<15
PHENANTHRENE	88
ANTHRACENE	80
DI-N-BUTYLPHTHALATE	<3.0
FLUORANTHENE	62
BENZIDINE	<30
PYRENE	140
BUTYLBENZYLPHTHALATE	<3.0
3,3-DICHLOROBENZIDINE	<6.0
BENZO(a)ANTHRACENE	51
BIS(2-ETHYLHEXYL)PHTHALATE	2.2
CHRYSENE	75
DI-N-OCTYLPHTHALATE	<3.0
BENZO(b)FLUORANTHENE	57
BENZO(k)FLUORANTHENE	71
BENZO(a)PYRENE	64
INDENO(1,2,3-cd)PYRENE	29
DIBENZ(a,h,)ANTHRACENE	12
BENZO(g,h,i)PERYLENE	32

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	80
2-FLUOROBIPHENYL	120
TERPHENYL-d14	160 *
PHENOL-d6	54
2-FLUOROPHENOL	60
2,4,6-TRIBROMOPHENOL	66

* Out of limits due to matrix effect and dilution of sample.

AnalyticalTechnologies,Inc. ATI I.D. # 9007-025-5

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 05/09/90
PROJECT #	: J-2854	DATE RECEIVED	: 07/05/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/13/90
CLIENT I.D.	: 0-4 HC-B02	DATE ANALYZED	: 07/23/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8270 PSEP	DILUTION FACTOR	: 5

RESULTS BASED ON DRY WEIGHT

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
POLYAROMATIC HYDROCARBON	1196	21
CARBAZOLE	1227	9.7
SUBSTITUTED PHENANTHRENE	1291	13
POLYAROMATIC HYDROCARBON	1400	21
BENZO(B)FLOURENE ISOMER	1506	19

ATI I.D. # 9007-025-6

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 05/09/90
PROJECT #	: J-2854	DATE RECEIVED	: 07/05/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/13/90
CLIENT I.D.	: 8-14 HC-B02	DATE ANALYZED	: 07/26/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8270 PSEP	DILUTION FACTOR	: 5

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
N-NITROSODIMETHYLAMINE	<3.3
PHENOL	<3.3
ANILINE	<3.3
BIS(2-CHLOROETHYL)ETHER	<3.3
2-CHLOROPHENOL	<3.3
1,3-DICHLOROBENZENE	<3.3
1,4-DICHLOROBENZENE	<3.3
BENZYL ALCOHOL	<3.3
1,2-DICHLOROBENZENE	<3.3
2-METHYLPHENOL	<3.3
BIS(2-CHLOROISOPROPYL)ETHER	<3.3
4-METHYLPHENOL	<3.3
N-NITROSO-DI-N-PROPYLAMINE	<3.3
HEXACHLOROETHANE	<3.3
NITROBENZENE	<3.3
ISOPHORONE	<3.3
2-NITROPHENOL	<3.3
2,4-DIMETHYLPHENOL	<3.3
BENZOIC ACID	2.3 JB
BIS(2-CHLOROETHOXY)METHANE	<3.3
2,4-DICHLOROPHENOL	<3.3
1,2,4-TRICHLOROBENZENE	<3.3
NAPHTHALENE	2.2 J
4-CHLOROANILINE	<3.3
HEXACHLOROBUTADIENE	<3.3
4-CHLORO-3-METHYLPHENOL	<3.3
2-METHYLNAPHTHALENE	0.61 J
HEXACHLOROCYCLOPENTADIENE	<3.3
2,4,6-TRICHLOROPHENOL	<3.3
2,4,5-TRICHLOROPHENOL	<16
2-CHLORONAPHTHALENE	<3.3
2-NITROANILINE	<16
DIMETHYLPHTHALATE	<3.3
ACENAPHTHYLENE	2.2 J
3-NITROANILINE	<16
ACENAPHTHENE	3.0 J
2,4-DINITROPHENOL	<16
4-NITROPHENOL	<16

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J = Estimated value.
B = Found in blank.

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 8-14 HC-B02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/26/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	RESULT
DIBENZOFURAN	1.6 J
2,4-DINITROTOLUENE	<3.3
2,6-DINITROTOLUENE	<3.3
DIETHYLPHTHALATE	<3.3
4-CHLOROPHENYL-PHENYLETHER	<3.3
FLUORENE	4.4
4-NITROANILINE	<16
4,6-DINITRO-2-METHYLPHENOL	<16
N-NITROSODIPHENYLAMINE	<3.3
4-BROMOPHENYL-PHENYLETHER	<3.3
HEXACHLOROBENZENE	<3.3
PENTACHLOROPHENOL	<16
PHENANTHRENE	19
ANTHRACENE	15
DI-N-BUTYLPHTHALATE	0.72 JB
FLUORANTHENE	30
BENZIDINE	<33
PYRENE	53
BUTYLBENZYLPHTHALATE	<3.3
3,3-DICHLOROBENZIDINE	<6.6
BENZO(a)ANTHRACENE	26
BIS(2-ETHYLHEXYL)PHTHALATE	1.9 J
CHRYSENE	26
DI-N-OCTYLPHTHALATE	<3.3
BENZO(b)FLUORANTHENE	43
BENZO(k)FLUORANTHENE	53
BENZO(a)PYRENE	22
INDENO(1,2,3-cd)PYRENE	8.6
DIBENZ(a,h,)ANTHRACENE	4.3
BENZO(g,h,i)PERYLENE	9.2

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	100
2-FLUOROBIPHENYL	114
TERPHENYL-d14	106
PHENOL-d6	70
2-FLUOROPHENOL	56
2,4,6-TRIBROMOPHENOL	58

J = Estimated value.
B = Found in blank.

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 8-14 HC-B02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/26/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
SATURATED ALKANE	1455	15
BENZOFLUORENE ISOMER	1490	16
BENZOFLOURENE ISOMER	1501	12
C20 CYCLIC AROMATIC HYDROCARBON	1831	14
C20 CYCLIC AROMATIC HYDROCARBON	1860	23

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 20-30 HC-B02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/26/90
UNITS : mg/Kg
DILUTION FACTOR : 1

COMPOUND	RESULT
N-NITROSODIMETHYLAMINE	<3.0
PHENOL	<3.0
ANILINE	<3.0
BIS(2-CHLOROETHYL)ETHER	<3.0
2-CHLOROPHENOL	<3.0
1,3-DICHLOROBENZENE	<3.0
1,4-DICHLOROBENZENE	<3.0
BENZYL ALCOHOL	<3.0
1,2-DICHLOROBENZENE	<3.0
2-METHYLPHENOL	<3.0
BIS(2-CHLOROISOPROPYL)ETHER	<3.0
4-METHYLPHENOL	<3.0
N-NITROSO-DI-N-PROPYLAMINE	<3.0
HEXACHLOROETHANE	<3.0
NITROBENZENE	<3.0
ISOPHORONE	<3.0
2-NITROPHENOL	<3.0
2,4-DIMETHYLPHENOL	<3.0
BENZOIC ACID	<15
BIS(2-CHLOROETHOXY)METHANE	<3.0
2,4-DICHLOROPHENOL	<3.0
1,2,4-TRICHLOROBENZENE	<3.0
NAPHTHALENE	1.3
4-CHLOROANILINE	<3.0
HEXACHLOROBUTADIENE	<3.0
4-CHLORO-3-METHYLPHENOL	<3.0
2-METHYLNAPHTHALENE	<3.0
HEXACHLOROCYCLOPENTADIENE	<3.0
2,4,6-TRICHLOROPHENOL	<3.0
2,4,5-TRICHLOROPHENOL	<15
2-CHLORONAPHTHALENE	<3.0
2-NITROANILINE	<15
DIMETHYLPHTHALATE	<3.0
ACENAPHTHYLENE	0.92 J
3-NITROANILINE	<15
ACENAPHTHENE	0.60 J
2,4-DINITROPHENOL	<15
4-NITROPHENOL	<15

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J = Estimated value.

ATI I.D. # 9007-025-7

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 20-30 HC-B02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/26/90
UNITS : mg/Kg
DILUTION FACTOR : 1

COMPOUND	RESULT
DIBENZOFURAN	<3.0
2,4-DINITROTOLUENE	<3.0
2,6-DINITROTOLUENE	<3.0
DIETHYLPHTHALATE	<3.0
4-CHLOROPHENYL-PHENYLETHER	<3.0
FLUORENE	1.4 J
4-NITROANILINE	<15
4,6-DINITRO-2-METHYLPHENOL	<15
N-NITROSODIPHENYLAMINE	<3.0
4-BROMOPHENYL-PHENYLETHER	<3.0
HEXACHLOROBENZENE	<3.0
PENTACHLOROPHENOL	<15
PHENANTHRENE	4.9
ANTHRACENE	5.2
DI-N-BUTYLPHTHALATE	<3.0
FLUORANTHENE	32
BENZIDINE	<30
PYRENE	36
BUTYLBENZYLPHTHALATE	<3.0
3,3-DICHLOROBENZIDINE	<6.0
BENZO(a)ANTHRACENE	9.7
BIS(2-ETHYLHEXYL)PHTHALATE	3.0
CHRYSENE	13
DI-N-OCTYLPHTHALATE	<3.0
BENZO(b)FLUORANTHENE	9.0
BENZO(k)FLUORANTHENE	14
BENZO(a)PYRENE	8.8
INDENO(1,2,3-cd)PYRENE	3.6
DIBENZ(a,h,)ANTHRACENE	1.8 J
BENZO(g,h,i)PERYLENE	3.7

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	84
2-FLUOROBIPHENYL	112
TERPHENYL-d14	92
PHENOL-d6	60
2-FLUOROPHENOL	44
2,4,6-TRIBROMOPHENOL	42

J = Estimated value.

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 20-30 HC-B02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/26/90
UNITS : mg/Kg
DILUTION FACTOR : 1

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
C17 AROMATIC HYDROCARBON	1490	14
BENZOFLUORENE	1500	11
UNKNOWN	1830	11
C20 AROMATIC HYDROCARBON	1858	11
BRANCHED HYDROCARBON	2053	11

ATI I.D. # 9007-025-8

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 30-40 HC-B02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/22/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	RESULT
N-NITROSODIMETHYLAMINE	<2.7
PHENOL	<2.7
ANILINE	<2.7
BIS(2-CHLOROETHYL)ETHER	<2.7
2-CHLOROPHENOL	<2.7
1,3-DICHLOROBENZENE	<2.7
1,4-DICHLOROBENZENE	<2.7
BENZYL ALCOHOL	<2.7
1,2-DICHLOROBENZENE	<2.7
2-METHYLPHENOL	<2.7
BIS(2-CHLOROISOPROPYL)ETHER	<2.7
4-METHYLPHENOL	<2.7
N-NITROSO-DI-N-PROPYLAMINE	<2.7
HEXACHLOROETHANE	<2.7
NITROBENZENE	<2.7
ISOPHORONE	<2.7
2-NITROPHENOL	<2.7
2,4-DIMETHYLPHENOL	<2.7
BENZOIC ACID	<13
BIS(2-CHLOROETHOXY)METHANE	<2.7
2,4-DICHLOROPHENOL	<2.7
1,2,4-TRICHLOROBENZENE	<2.7
NAPHTHALENE	<2.7
4-CHLOROANILINE	<2.7
HEXACHLOROBUTADIENE	<2.7
4-CHLORO-3-METHYLPHENOL	<2.7
2-METHYLNAPHTHALENE	<2.7
HEXACHLOROCYCLOPENTADIENE	<2.7
2,4,6-TRICHLOROPHENOL	<2.7
2,4,5-TRICHLOROPHENOL	<13
2-CHLORONAPHTHALENE	<2.7
2-NITROANILINE	<13
DIMETHYLPHTHALATE	<2.7
ACENAPHTHYLENE	<2.7
3-NITROANILINE	<13
ACENAPHTHENE	<2.7
2,4-DINITROPHENOL	<13
4-NITROPHENOL	<13

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ATI I.D. # 9007-025-8

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 30-40 HC-B02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/22/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	RESULT
DIBENZOFURAN	<2.7
2,4-DINITROTOLUENE	<2.7
2,6-DINITROTOLUENE	<2.7
DIETHYLPHTHALATE	<2.7
4-CHLOROPHENYL-PHENYLETHER	<2.7
FLUORENE	<2.7
4-NITROANILINE	<13
4,6-DINITRO-2-METHYLPHENOL	<13
N-NITROSODIPHENYLAMINE	<2.7
4-BROMOPHENYL-PHENYLETHER	<2.7
HEXACHLOROBENZENE	<2.7
PENTACHLOROPHENOL	<13
PHENANTHRENE	<2.7
ANTHRACENE	0.79 J
DI-N-BUTYLPHTHALATE	<2.7
FLUORANTHENE	1.7 J
BENZIDINE	<27
PYRENE	<2.7
BUTYLBENZYLPHTHALATE	<2.7
3,3-DICHLOROBENZIDINE	<5.4
BENZO(a)ANTHRACENE	<2.7
BIS(2-ETHYLHEXYL)PHTHALATE	2.0 J
CHRYSENE	<2.7
DI-N-OCTYLPHTHALATE	<2.7
BENZO(b)FLUORANTHENE	<2.7
BENZO(k)FLUORANTHENE	<2.7
BENZO(a)PYRENE	<2.7
INDENO(1,2,3-cd)PYRENE	<2.7
DIBENZ(a,h,)ANTHRACENE	<2.7
BENZO(g,h,i)PERYLENE	<2.7

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	44
2-FLUOROBIPHENYL	72
TERPHENYL-d14	72
PHENOL-d6	28
2-FLUOROPHENOL	26
2,4,6-TRIBROMOPHENOL	2 *

* Out of limits due to matrix effect.
J = Estimated value.

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 05/09/90
PROJECT #	: J-2854	DATE RECEIVED	: 07/05/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/13/90
CLIENT I.D.	: 30-40 HC-B02	DATE ANALYZED	: 07/22/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8270 PSEP	DILUTION FACTOR	: 5

RESULTS BASED ON DRY WEIGHT

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
OXYGENATED HYDROCARBON	1247	6.5
C13-C17 BRANCHED HYDROCARBON	1493	8.0
OXYGENATED HYDROCARBON	1738	5.6
UNKNOWN	1850	9.1
UNKNOWN	2059	13

ATI I.D. # 9006-067

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : REAGENT BLANK
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 (PSEP)
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : N/A
DATE RECEIVED : N/A
DATE EXTRACTED : 07/03/90
DATE ANALYZED : 07/11/90
UNITS : mg/Kg
DILUTION FACTOR : 1

COMPOUND	RESULT
N-NITROSODIMETHYLAMINE	<0.20
PHENOL	<0.20
ANILINE	<0.20
BIS(2-CHLOROETHYL)ETHER	<0.20
2-CHLOROPHENOL	<0.20
1,3-DICHLOROBENZENE	<0.20
1,4-DICHLOROBENZENE	<0.20
BENZYL ALCOHOL	<0.20
1,2-DICHLOROBENZENE	<0.20
2-METHYLPHENOL	<0.20
BIS(2-CHLOROISOPROPYL)ETHER	<0.20
4-METHYLPHENOL	<0.20
N-NITROSO-DI-N-PROPYLAMINE	<0.20
HEXACHLOROETHANE	<0.20
NITROBENZENE	<0.20
ISOPHORONE	<0.20
2-NITROPHENOL	<0.20
2,4-DIMETHYLPHENOL	<0.20
BENZOIC ACID	<1.0
BIS(2-CHLOROETHOXY)METHANE	<0.20
2,4-DICHLOROPHENOL	<0.20
1,2,4-TRICHLOROBENZENE	<0.20
NAPHTHALENE	<0.20
4-CHLOROANILINE	<0.20
HEXACHLOROBUTADIENE	<0.20
4-CHLORO-3-METHYLPHENOL	<0.20
2-METHYLNAPHTHALENE	<0.20
HEXACHLOROCYCLOPENTADIENE	<0.20
2,4,6-TRICHLOROPHENOL	<0.20
2,4,5-TRICHLOROPHENOL	<1.0
2-CHLORONAPHTHALENE	<0.20
2-NITROANILINE	<1.0
DIMETHYLPHTHALATE	<0.20
ACENAPHTHYLENE	<0.20
3-NITROANILINE	<1.0
ACENAPHTHENE	<0.20
2,4-DINITROPHENOL	<1.0
4-NITROPHENOL	<1.0

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ATI I.D. # 9006-067

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : REAGENT BLANK
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 (PSEP)
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : N/A
DATE RECEIVED : N/A
DATE EXTRACTED : 07/03/90
DATE ANALYZED : 07/11/90
UNITS : mg/Kg
DILUTION FACTOR : 1

COMPOUND	RESULT
DIBENZOFURAN	<0.20
2,4-DINITROTOLUENE	<0.20
2,6-DINITROTOLUENE	<0.20
DIETHYLPHTHALATE	<0.20
4-CHLOROPHENYL-PHENYLETHER	<0.20
FLUORENE	<0.20
4-NITROANILINE	<1.0
4,6-DINITRO-2-METHYLPHENOL	<1.0
N-NITROSODIPHENYLAMINE	<0.20
4-BROMOPHENYL-PHENYLETHER	<0.20
HEXACHLOROBENZENE	<0.20
PENTACHLOROPHENOL	<1.0
PHENANTHRENE	<0.20
ANTHRACENE	<0.20
DI-N-BUTYLPHTHALATE	<0.20
FLUORANTHENE	<0.20
BENZIDINE	<2.0
PYRENE	<0.20
BUTYLBENZYLPHTHALATE	<0.20
3,3-DICHLOROBENZIDINE	<0.41
BENZO(a)ANTHRACENE	<0.20
BIS(2-ETHYLHEXYL)PHTHALATE	<0.20
CHRYSENE	<0.20
DI-N-OCTYLPHTHALATE	<0.20
BENZO(b)FLUORANTHENE	<0.20
BENZO(k)FLUORANTHENE	<0.20
BENZO(a)PYRENE	<0.20
INDENO(1,2,3-cd)PYRENE	<0.20
DIBENZ(a,h,)ANTHRACENE	<0.20
BENZO(g,h,i)PERYLENE	<0.20

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	70
2-FLUOROBIPHENYL	80
TERPHENYL-d14	96
PHENOL-d6	70
2-FLUOROPHENOL	66
2,4,6-TRIBROMOPHENOL	78

ATI I.D. # 9006-067

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : REAGENT BLANK
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 (PSEP)
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : N/A
DATE RECEIVED : N/A
DATE EXTRACTED : 07/03/90
DATE ANALYZED : 07/11/90
UNITS : mg/Kg
DILUTION FACTOR : 1

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
BENZALDEHYDE	342	3.8
OXYGENATED HYDROCARBON	1366	1.6
SATURATED ALKANE	1455	3.6
BRANCHED HYDROCARBON	1618	2.0

ATI I.D. # 9007-025

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : REAGENT BLANK
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : N/A
DATE RECEIVED : N/A
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/22/90
UNITS : mg/Kg
DILUTION FACTOR : 1

COMPOUND	RESULT
N-NITROSODIMETHYLAMINE	<0.20
PHENOL	<0.20
ANILINE	<0.20
BIS(2-CHLOROETHYL)ETHER	<0.20
2-CHLOROPHENOL	<0.20
1,3-DICHLOROBENZENE	<0.20
1,4-DICHLOROBENZENE	<0.20
BENZYL ALCOHOL	<0.20
1,2-DICHLOROBENZENE	<0.20
2-METHYLPHENOL	<0.20
BIS(2-CHLOROISOPROPYL)ETHER	<0.20
4-METHYLPHENOL	<0.20
N-NITROSO-DI-N-PROPYLAMINE	<0.20
HEXACHLOROETHANE	<0.20
NITROBENZENE	<0.20
ISOPHORONE	<0.20
2-NITROPHENOL	<0.20
2,4-DIMETHYLPHENOL	<0.20
BENZOIC ACID	0.14 J
BIS(2-CHLOROETHOXY)METHANE	<0.20
2,4-DICHLOROPHENOL	<0.20
1,2,4-TRICHLOROBENZENE	<0.20
NAPHTHALENE	<0.20
4-CHLOROANILINE	<0.20
HEXACHLOROBUTADIENE	<0.20
4-CHLORO-3-METHYLPHENOL	<0.20
2-METHYLNAPHTHALENE	<0.20
HEXACHLOROCYCLOPENTADIENE	<0.20
2,4,6-TRICHLOROPHENOL	<0.20
2,4,5-TRICHLOROPHENOL	<1.0
2-CHLORONAPHTHALENE	<0.20
2-NITROANILINE	<1.0
DIMETHYLPHTHALATE	<0.20
ACENAPHTHYLENE	<0.20
3-NITROANILINE	<1.0
ACENAPHTHENE	<0.20
2,4-DINITROPHENOL	<1.0
4-NITROPHENOL	<1.0

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J = Estimated value.

SEMI-VOLATILE ORGANICS ANALYSIS
DATA SUMMARY (CONTINUED)

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : REAGENT BLANK
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : N/A
DATE RECEIVED : N/A
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/22/90
UNITS : mg/Kg
DILUTION FACTOR : 1

COMPOUND	RESULT
DIBENZOFURAN	<0.20
2,4-DINITROTOLUENE	<0.20
2,6-DINITROTOLUENE	<0.20
DIETHYLPHTHALATE	<0.20
4-CHLOROPHENYL-PHENYLETHER	<0.20
FLUORENE	<0.20
4-NITROANILINE	<1.0
4,6-DINITRO-2-METHYLPHENOL	<1.0
N-NITROSODIPHENYLAMINE	<0.20
4-BROMOPHENYL-PHENYLETHER	<0.20
HEXACHLOROBENZENE	<0.20
PENTACHLOROPHENOL	<1.0
PHENANTHRENE	<0.20
ANTHRACENE	<0.20
DI-N-BUTYLPHTHALATE	0.10 J
FLUORANTHENE	<0.20
BENZIDINE	<2.0
PYRENE	<0.20
BUTYLBENZYLPHTHALATE	<0.20
3,3-DICHLOROBENZIDINE	<0.41
BENZO(a)ANTHRACENE	<0.20
BIS(2-ETHYLHEXYL)PHTHALATE	<0.20
CHRYSENE	<0.20
DI-N-OCTYLPHTHALATE	<0.20
BENZO(b)FLUORANTHENE	<0.20
BENZO(k)FLUORANTHENE	<0.20
BENZO(a)PYRENE	<0.20
INDENO(1,2,3-cd)PYRENE	<0.20
DIBENZ(a,h,)ANTHRACENE	<0.20
BENZO(g,h,i)PERYLENE	<0.20

SURROGATE PERCENT RECOVERIES

NITROBENZENE-d5	78
2-FLUOROBIPHENYL	98
TERPHENYL-d14	92
PHENOL-d6	76
2-FLUOROPHENOL	58
2,4,6-TRIBROMOPHENOL	76

J = Estimated value.

ATI I.D. # 9007-025

SEMI-VOLATILE ORGANICS ANALYSIS
TENTATIVELY IDENTIFIED COMPOUNDS

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : REAGENT BLANK
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 PSEP
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : N/A
DATE RECEIVED : N/A
DATE EXTRACTED : 07/13/90
DATE ANALYZED : 07/22/90
UNITS : mg/Kg
DILUTION FACTOR : 1

COMPOUND	SCAN NUMBER	ESTIMATED CONCENTRATION
BENZALDEHYDE	345	1.6
OXYGENATED HYDROCARBON	1369	1.6
SATURATED C21-C22 ALKANE	1457	3.7
BRANCHED CYCLIC AROMATIC	1574	5.3
SUBSTITUTED HYDROCARBON	1619	1.0

SEMI-VOLATILE ORGANIC
QUALITY CONTROL DATA

CLIENT	: HART CROWSER, INC.	SAMPLE I.D.	: 9007-067-3
PROJECT #	: 2854	DATE EXTRACTED	: 07/03/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE ANALYZED	: 07/17/90
MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8270 (PSEP)	DILUTION FACTOR:	10

RESULTS BASED ON AS IS BASIS

COMPOUND	SAMPLE RESULT	SPIKE ADDED	SPIKED SAMPLE	% REC	DUP SPIKED SAMPLE	DUP % REC	RPD
1,2,4-TRICHLOROBENZENE	<4.0	2.0	1.3	63	N/A	N/A	N/A
ACENAPHTHENE	9.6	2.0	2.2	*	N/A	N/A	N/A
2,4-DINITROTOLUENE	<4.0	2.0	1	50	N/A	N/A	N/A
PYRENE	27.5	2.0	10	*	N/A	N/A	N/A
N-NITROSO-DI-N-PROPYLAMINE	<4.0	2.0	1.3	66	N/A	N/A	N/A
1,4-DICHLOROBENZENE	<4.0	2.0	1.4	71	N/A	N/A	N/A
PENTACHLOROPHENOL	<20	4.0	0	0*	N/A	N/A	N/A
PHENOL	<4.0	4.0	2.3	58	N/A	N/A	N/A
2-CHLOROPHENOL	<4.0	4.0	2.6	65	N/A	N/A	N/A
4-CHLORO-3-METHYLPHENOL	<4.0	4.0	2.7	68	N/A	N/A	N/A
4-NITROPHENOL	<20	4.0	0	0*	N/A	N/A	N/A

* Out of limits due to matrix effect.

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Spiked Sample Result} - \text{Duplicate Spike Sample Result})}{\text{Average of Spiked Sample}} \times 100$$

SEMI-VOLATILE ORGANIC
QUALITY CONTROL DATA

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
MATRIX : SEDIMENT
EPA METHOD : 8270 (PSEP)
RESULTS BASED ON AS IS BASIS

SAMPLE I.D. : BLANK SPIKE
DATE EXTRACTED : 07/03/90
DATE ANALYZED : 07/11/90
UNITS : mg/Kg
DILUTION FACTOR: 1

COMPOUND	SAMPLE RESULT	SPIKE ADDED	SPIKED SAMPLE	% REC	DUP SPIKED SAMPLE	DUP % REC	RPD
1,2,4-TRICHLOROBENZENE	<0.20	2.0	1.6	80	N/A	N/A	N/A
ACENAPHTHENE	<0.20	2.0	1.6	78	N/A	N/A	N/A
2,4-DINITROTOLUENE	<0.20	2.0	1.6	80	N/A	N/A	N/A
PYRENE	<0.20	2.0	2.1	104	N/A	N/A	N/A
N-NITROSO-DI-N-PROPYLAMINE	<0.20	2.0	1.2	62	N/A	N/A	N/A
1,4-DICHLOROBENZENE	<0.20	2.0	1.5	77	N/A	N/A	N/A
PENTACHLOROPHENOL	<1.0	4.0	3.5	88	N/A	N/A	N/A
PHENOL	<0.20	4.0	2.9	72	N/A	N/A	N/A
2-CHLOROPHENOL	<0.20	4.0	2.8	70	N/A	N/A	N/A
4-CHLORO-3-METHYLPHENOL	<0.20	4.0	2.8	70	N/A	N/A	N/A
4-NITROPHENOL	<1.0	4.0	3.1	78	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Spiked Sample Result} - \text{Duplicate Spike Sample Result})}{\text{Average of Spiked Sample}} \times 100$$

SEMI-VOLATILE ORGANIC
QUALITY CONTROL DATA

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
MATRIX : SEDIMENT
EPA METHOD : EPA 8270 PSEP
RESULTS BASED ON AS IS BASIS

SAMPLE I.D. : 9007-025-2
DATE EXTRACTED : 07/17/90
DATE ANALYZED : 07/23/90
UNITS : mg/Kg
DILUTION FACTOR : 5

COMPOUND	SAMPLE RESULT	SPIKE ADDED	SPIKED SAMPLE	% REC	DUP SPIKED SAMPLE	DUP % REC	RPD
1,2,4-TRICHLOROBENZENE	<1.0	2.0	1.76	88	2.1	105	5
ACENAPHTHENE	0.51	2.0	2.33	91	2.60	105	11
2,4-DINITROTOLUENE	<1.0	2.0	1.33	66	1.64	82	21
PYRENE	19	2.0	*	*	*	*	*
N-NITROSO-DI-N-PROPYLAMINE	<1.0	2.0	1.27	64	1.79	90	34
1,4-DICHLOROBENZENE	<1.0	2.0	1.81	90	1.89	94	4
PENTACHLOROPHENOL	<5.1	4.0	0	0	0	0	0**
PHENOL	<1.0	4.0	1.70	42	2.95	74	54**
2-CHLOROPHENOL	<1.0	4.0	2.72	68	3.32	83	20
4-CHLORO-3-METHYLPHENOL	<1.0	4.0	3.03	76	6.34	158	71**
4-NITROPHENOL	<5.1	4.0	1.72	43	2.00	50	15

* Result not attainable due to matrix interference. High sample result.

** Out of limits due to matrix effect and dilution of sample.

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Spiked Sample Result} - \text{Duplicate Spike Sample Result})}{\text{Average of Spiked Sample}} \times 100$$

SEMI-VOLATILE ORGANIC QUALITY CONTROL DATA

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
EPA METHOD : 8270

SAMPLE I.D. : BLANK SPIKE
DATE EXTRACTED : 07/17/90
DATE ANALYZED : 07/22/90
MATRIX : SEDIMENT
UNITS : mg/Kg

COMPOUND	SAMPLE RESULT	SPIKE ADDED	SPIKED SAMPLE	% REC	DUP SPIKED SAMPLE	DUP % REC	RPD
1,2,4-TRICHLOROBENZENE	<0.20	2.0	1.76	88	N/A	N/A	N/A
ACENAPHTHENE	<0.20	2.0	1.62	81	N/A	N/A	N/A
2,4-DINITROTOLUENE	<0.20	2.0	1.57	78	N/A	N/A	N/A
PYRENE	<0.20	2.0	1.78	84	N/A	N/A	N/A
N-NITROSO-DI-N-PROPYLAMINE	<0.20	2.0	1.56	78	N/A	N/A	N/A
1,4-DICHLOROBENZENE	<0.20	2.0	1.76	88	N/A	N/A	N/A
PENTACHLOROPHENOL	<1.0	4.0	2.55	64	N/A	N/A	N/A
PHENOL	<0.20	4.0	2.41	60	N/A	N/A	N/A
2-CHLOROPHENOL	<0.20	4.0	2.47	62	N/A	N/A	N/A
4-CHLORO-3-METHYLPHENOL	<0.20	4.0	3.35	84	N/A	N/A	N/A
4-NITROPHENOL	<1.0	4.0	2.84	71	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Spiked Sample Result} - \text{Duplicate Spike Sample Result})}{\text{Average of Spiked Sample}} \times 100$$

Hart Crowser
J-2854

POLYNUCLEAR AROMATIC HYDROCARBONS (SILICA GEL CLEANUP)

ATI I.D. # 9006-067-1

POLYNUCLEAR AROMATICS
DATA SUMMARY

CLIENT : HART CROWSER
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : HC-SS01
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 (PSEP)

DATE SAMPLED : 06/05/90
DATE RECEIVED : 06/08/90
DATE EXTRACTED : 06/11/90
DATE ANALYZED : 06/21/90
UNITS : mg/Kg
DILUTION FACTOR : 10

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
NAPHTHALENE	1.1
2-METHYLNAPHTHALENE	0.78
ACENAPHTHYLENE	1.2
ACENAPHTHENE	2.4
FLUORENE	6.6
PHENANTHRENE	28
ANTHRACENE	27
FLUORANTHENE	52
PYRENE	52
BENZO(a)ANTHRACENE	27
CHRYSENE	38
BENZO(b)FLUORANTHENE	44
BENZO(k)FLUORANTHENE	55
BENZO(a)PYRENE	25
INDENO(1,2,3-cd)PYRENE	10
DIBENZ(a,h)ANTHRACENE	3.8
BENZO(g,h,i)PERYLENE	10

SURROGATE PERCENT RECOVERIES

2-FLUOROBIPHENYL	75
TERPHENYL-d14	126

ATI I.D. # 9006-067-2

POLYNUCLEAR AROMATICS
DATA SUMMARY

CLIENT : HART CROWSER
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : HC-SS02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 (PSEP)

DATE SAMPLED : 06/05/90
DATE RECEIVED : 06/08/90
DATE EXTRACTED : 06/11/90
DATE ANALYZED : 06/21/90
UNITS : mg/Kg
DILUTION FACTOR : 10

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
NAPHTHALENE	2.0
2-METHYLNAPHTHALENE	2.0
ACENAPHTHYLENE	1.9
ACENAPHTHENE	4.9
FLUORENE	12
PHENANTHRENE	44
ANTHRACENE	40
FLUORANTHENE	67
PYRENE	77
BENZO(a)ANTHRACENE	47
CHRYSENE	45
BENZO(b)FLUORANTHENE	60
BENZO(k)FLUORANTHENE	76
BENZO(a)PYRENE	33
INDENO(1,2,3-cd)PYRENE	13
DIBENZ(a,h)ANTHRACENE	4.9
BENZO(g,h,i)PERYLENE	14

SURROGATE PERCENT RECOVERIES

2-FLUOROBIPHENYL	108
TERPHENYL-d14	132

ATI I.D. # 9006-067-3

POLYNUCLEAR AROMATICS
DATA SUMMARY

CLIENT	: HART CROWSER	DATE SAMPLED	: 06/05/90
PROJECT #	: 2854	DATE RECEIVED	: 06/08/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 06/11/90
CLIENT I.D.	: HC-SS03	DATE ANALYZED	: 06/21/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8270 (PSEP)	DILUTION FACTOR	: 10

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
NAPHTHALENE	1.0
2-METHYLNAPHTHALENE	0.60
ACENAPHTHYLENE	0.70
ACENAPHTHENE	2.3
FLUORENE	4.5
PHENANTHRENE	17
ANTHRACENE	11
FLUORANTHENE	24
PYRENE	25
BENZO(a)ANTHRACENE	12
CHRYSENE	14
BENZO(b)FLUORANTHENE	18
BENZO(k)FLUORANTHENE	23
BENZO(a)PYRENE	9.8
INDENO(1,2,3-cd)PYRENE	4.0
DIBENZ(a,h)ANTHRACENE	1.7
BENZO(g,h,i)PERYLENE	3.8

SURROGATE PERCENT RECOVERIES

2-FLUOROBIPHENYL	114
TERPHENYL-d14	128

ATI I.D. # 9006-067

POLYNUCLEAR AROMATICS
DATA SUMMARY

CLIENT : HART CROWSER
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : REAGENT BLANK
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8270 (PSEP)

DATE SAMPLED : N/A
DATE RECEIVED : N/A
DATE EXTRACTED : 06/11/90
DATE ANALYZED : 06/21/90
UNITS : mg/Kg
DILUTION FACTOR : 1

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
NAPHTHALENE	<0.10
2-METHYLNAPHTHALENE	<0.10
ACENAPHTHYLENE	<0.10
ACENAPHTHENE	<0.10
FLUORENE	<0.10
PHENANTHRENE	<0.10
ANTHRACENE	<0.10
FLUORANTHENE	<0.10
PYRENE	<0.10
BENZO(a)ANTHRACENE	<0.10
CHRYSENE	<0.10
BENZO(b)FLUORANTHENE	<0.10
BENZO(k)FLUORANTHENE	<0.10
BENZO(a)PYRENE	<0.10
INDENO(1,2,3-cd)PYRENE	<0.10
DIBENZ(a,h)ANTHRACENE	<0.10
BENZO(g,h,i)PERYLENE	<0.10

SURROGATE PERCENT RECOVERIES

2-FLUOROBIPHENYL	88
TERPHENYL-d14	102

ATI I.D. # 9007-067

POLYNUCLEAR AROMATICS
QUALITY CONTROL DATA

CLIENT	: HART CROWSER		SAMPLE I.D.	: BLANK SPIKE	
PROJECT #	: 2854		DATE EXTRACTED	: 06/12/90	
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY		DATE ANALYZED	: 06/20/90	
EPA METHOD	: 8270 (PSEP)		MATRIX	: SEDIMENT	
			UNITS	: mg/Kg	

COMPOUND	SAMPLE RESULT	SPIKE ADDED	SPIKED SAMPLE	% REC	DUP SPIKED SAMPLE	DUP % REC	RPD
ACENAPHTHENE	<0.1	1.0	0.51	51	0.43	43	17
PYRENE	<0.1	1.0	0.88	88	0.72	72	20

$$\% \text{ Recovery} = \frac{(\text{Spike Sample Result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Spiked Sample Result} - \text{Duplicate Spike Sample Result})}{\text{Average of Spiked Sample}} \times 100$$

PCBS

AnalyticalTechnologies,Inc.

ATI I.D. # 9006-067-1

POLYCHLORINATED BIPHENYLS (PCB) ANALYSIS
DATA SUMMARY

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : HC-SS01
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8080 (PCB) PSEP

DATE SAMPLED : 06/05/90
DATE RECEIVED : 06/08/90
DATE EXTRACTED : 06/16/90
DATE ANALYZED : 06/30/90
UNITS : mg/Kg
DILUTION FACTOR : 10

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
PCB 1016	<0.29
PCB 1221	<0.29
PCB 1232	<0.29
PCB 1242	<0.29
PCB 1248	<0.29
PCB 1254	0.26 J
PCB 1260	0.71

SURROGATE PERCENT RECOVERY

DIBUTYLCHLORENDATE	NOT RECOVERED
DECACHLOROBIPHENYL	150

J = Estimated value.

ATI I.D. # 9006-067-2

POLYCHLORINATED BIPHENYLS (PCB) ANALYSIS
DATA SUMMARY

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 06/05/90
PROJECT #	: 2854	DATE RECEIVED	: 06/08/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 06/16/90
CLIENT I.D.	: HC-SS02	DATE ANALYZED	: 06/30/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8080 (PCB) PSEP	DILUTION FACTOR	: 10

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
PCB 1016	<0.21
PCB 1221	<0.21
PCB 1232	<0.21
PCB 1242	<0.21
PCB 1248	<0.21
PCB 1254	0.46
PCB 1260	0.40

SURROGATE PERCENT RECOVERY

DIBUTYLCHLORENDATE	NOT RECOVERED
DECACHLOROBIPHENYL	96

ATI I.D. # 9006-067-3

POLYCHLORINATED BIPHENYLS (PCB) ANALYSIS
DATA SUMMARY

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 06/05/90
PROJECT #	: 2854	DATE RECEIVED	: 06/08/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 06/16/90
CLIENT I.D.	: HC-SS03	DATE ANALYZED	: 06/30/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8080 (PCB) PSEP	DILUTION FACTOR	: 10

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
PCB 1016	<0.19
PCB 1221	<0.19
PCB 1232	<0.19
PCB 1242	<0.19
PCB 1248	<0.19
PCB 1254	0.27
PCB 1260	0.40

SURROGATE PERCENT RECOVERY

DIBUTYLCHLORENDATE	NOT RECOVERED
DECACHLOROBIPHENYL	158

POLYCHLORINATED BIPHENYLS (PCB) ANALYSIS
DATA SUMMARY

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 05/09/90
PROJECT #	: J-2854	DATE RECEIVED	: 07/05/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/12/90
CLIENT I.D.	: 0-4 HC-B01	DATE ANALYZED	: 07/23/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8080 (PCB)	DILUTION FACTOR	: 1

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
PCB 1016	<0.18
PCB 1221	<0.18
PCB 1232	<0.18
PCB 1242	<0.18
PCB 1248	0.45
PCB 1254	<0.18
PCB 1260	0.61

SURROGATE PERCENT RECOVERY

DIBUTYLCHLORENDATE	54
DECACHLOROBIPHENYL	121

ATI I.D. # 9007-025-4

POLYCHLORINATED BIPHENYLS (PCB) ANALYSIS
DATA SUMMARY

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 05/09/90
PROJECT #	: J-2854	DATE RECEIVED	: 07/05/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/12/90
CLIENT I.D.	: 40-50 HC-B01	DATE ANALYZED	: 07/23/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8080 (PCB)	DILUTION FACTOR	: 1

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
PCB 1016	<1.0
PCB 1221	<1.0
PCB 1232	<1.0
PCB 1242	<1.0
PCB 1248	0.96 J
PCB 1254	<1.0
PCB 1260	2.2

SURROGATE PERCENT RECOVERY

DIBUTYLCHLORENDATE	73
DECACHLOROBIPHENYL	140 *

* Out of limits due to matrix interference.

J = Estimated value.

POLYCHLORINATED BIPHENYLS (PCB) ANALYSIS
DATA SUMMARY

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : 0-4 HC-B02
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8080 (PCB)
RESULTS BASED ON DRY WEIGHT

DATE SAMPLED : 05/09/90
DATE RECEIVED : 07/05/90
DATE EXTRACTED : 07/12/90
DATE ANALYZED : 07/23/90
UNITS : mg/Kg
DILUTION FACTOR : 1

COMPOUND	RESULT
PCB 1016	<1.3
PCB 1221	<1.3
PCB 1232	<1.3
PCB 1242	<1.3
PCB 1248	3.7
PCB 1254	<1.3
PCB 1260	9.5

SURROGATE PERCENT RECOVERY

DIBUTYLCHLORENDATE	74
DECACHLOROBIPHENYL	129

ATI I.D. # 9007-025-8

POLYCHLORINATED BIPHENYLS (PCB) ANALYSIS
DATA SUMMARY

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: 05/09/90
PROJECT #	: J-2854	DATE RECEIVED	: 07/05/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/12/90
CLIENT I.D.	: 30-40 HC-B02	DATE ANALYZED	: 07/23/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8080 (PCB)	DILUTION FACTOR	: 1

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
PCB 1016	<1.0
PCB 1221	<1.0
PCB 1232	<1.0
PCB 1242	<1.0
PCB 1248	19
PCB 1254	<1.0
PCB 1260	14

SURROGATE PERCENT RECOVERY

DIBUTYLCHLORENDATE	154 *
DECACHLOROBIPHENYL	140 *

* Out of limits due to matrix interference.

ATI I.D. # 9006-067

POLYCHLORINATED BIPHENYLS (PCB) ANALYSIS
DATA SUMMARY

CLIENT : HART CROWSER, INC.
PROJECT # : 2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
CLIENT I.D. : REAGENT BLANK
SAMPLE MATRIX : SEDIMENT
EPA METHOD : 8080 (PCB) PSEP

DATE SAMPLED : N/A
DATE RECEIVED : N/A
DATE EXTRACTED : 06/16/90
DATE ANALYZED : 06/29/90
UNITS : mg/Kg
DILUTION FACTOR : 1

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
PCB 1016	<0.010
PCB 1221	<0.010
PCB 1232	<0.010
PCB 1242	<0.010
PCB 1248	<0.010
PCB 1254	<0.010
PCB 1260	<0.010

SURROGATE PERCENT RECOVERY

DIBUTYLCHLORENDATE	NOT RECOVERED
DECACHLOROBIPHENYL	106

POLYCHLORINATED BIPHENYLS (PCB) ANALYSIS
DATA SUMMARY

CLIENT	: HART CROWSER, INC.	DATE SAMPLED	: N/A
PROJECT #	: J-2854	DATE RECEIVED	: N/A
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE EXTRACTED	: 07/12/90
CLIENT I.D.	: REAGENT BLANK	DATE ANALYZED	: 07/20/90
SAMPLE MATRIX	: SEDIMENT	UNITS	: mg/Kg
EPA METHOD	: 8080 (PCB)	DILUTION FACTOR	: 1

RESULTS BASED ON DRY WEIGHT

COMPOUND	RESULT
PCB 1016	<0.040
PCB 1221	<0.040
PCB 1232	<0.040
PCB 1242	<0.040
PCB 1248	<0.040
PCB 1254	<0.040
PCB 1260	<0.040

SURROGATE PERCENT RECOVERY

DIBUTYLCHLORENDATE	74
DECACHLOROBIPHENYL	106

POLYCHLORINATED BIPHENYLS (PCB)
QUALITY CONTROL

CLIENT	: HART CROWSER, INC.	SAMPLE ID	: BLANK SPIKE
PROJECT #	: 2854	DATE EXTRACTED	: 06/16/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE ANALYZED	: 06/29/90
EPA METHOD	: 8080 (PCB) PSEP	MATRIX	: SEDIMENT
		UNITS	: mg/Kg

COMPOUND	SAMPLE RESULT	CONC SPIKED	SPIKED SAMPLE	% REC	DUP SPIKED SAMPLE	DUP % RECOVERY	RPD
PCB 1260	<0.010	0.10	0.111	111	0.105	105	5

$$\% \text{ Recovery} = \frac{(\text{Spike Sample result} - \text{Sample Result})}{\text{Spike Concentration}} \text{ X } 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Spiked Sample Result} - \text{Duplicate Spike Sample Result})}{\text{Average of Spiked Sample}} \text{ X } 100$$

POLYCHLORINATED BIPHENYLS (PCB)
QUALITY CONTROL

CLIENT	: HART CROWSER, INC.	SAMPLE ID	: 9007-025-8
PROJECT #	: J-2854	DATE EXTRACTED	: 07/12/90
PROJECT NAME	: PIER 64/65 SEDIMENT STUDY	DATE ANALYZED	: 07/23/90
EPA METHOD	: 8080 (PCB)	MATRIX	: SEDIMENT
		UNITS	: mg/Kg

COMPOUND	SAMPLE RESULT	CONC SPIKED	SPIKED SAMPLE	% REC	DUP SPIKED SAMPLE	DUP % RECOVERY	RPD
PCB 1260	14	5.0	18.4	88	24.5	210*	28*

* Out of limits due to matrix interference.

$$\% \text{ Recovery} = \frac{(\text{Spike Sample result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Spiked Sample Result} - \text{Duplicate Spike Sample Result})}{\text{Average of Spiked Sample}} \times 100$$

POLYCHLORINATED BIPHENYLS (PCB)
QUALITY CONTROL

CLIENT : HART CROWSER, INC.
PROJECT # : J-2854
PROJECT NAME : PIER 64/65 SEDIMENT STUDY
EPA METHOD : 8080 (PCB)

SAMPLE ID : BLANK SPIKE
DATE EXTRACTED : 07/12/90
DATE ANALYZED : 07/22/90
MATRIX : SEDIMENT
UNITS : mg/Kg

COMPOUND	SAMPLE RESULT	CONC SPIKED	SPIKED SAMPLE	% REC	DUP SPIKED SAMPLE	DUP % RECOVERY	RPD
PCB 1260	<0.040	0.20	0.218	109	N/A	N/A	N/A

$$\% \text{ Recovery} = \frac{(\text{Spike Sample result} - \text{Sample Result})}{\text{Spike Concentration}} \times 100$$

$$\text{RPD (Relative \% Difference)} = \frac{(\text{Spiked Sample Result} - \text{Duplicate Spike Sample Result})}{\text{Average of Spiked Sample}} \times 100$$

CHAIN OF CUSTODY

Sample Custody Record

DATE 6/2/90 PAGE 1 OF 1

HARTCROWSER [illegible]

Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699

JOB NUMBER [illegible] LAB NUMBER

PROJECT MANAGER [illegible]

PROJECT NAME [illegible]

SAMPLED BY: [illegible]

LAB NO.	SAMPLE	TIME	STATION	MATRIX	[illegible]	[illegible]	Total Solids									NO. OF CONTAINERS	OBSERVATIONS/COMMENTS/ COMPOSITING INSTRUCTIONS
1		6/4/90	HC-SS01	[illegible]	X	X	X									1	[illegible]
2		↓	HC-SS02	↓	X	X	X									1	[illegible]
3		↓	HC-SS03	↓	X	X	X									1	[illegible]
[illegible]	[illegible]	[illegible]															[illegible]
																	[illegible]
																	[illegible]
																	[illegible]
																	[illegible]

RELINQUISHED BY	DATE	RECEIVED BY	DATE
[illegible] SIGNATURE	6/8/[illegible]	[illegible] SIGNATURE	[illegible]
[illegible] PRINTED NAME	TIME	[illegible] PRINTED NAME	TIME
[illegible] COMPANY	1230	[illegible] COMPANY	[illegible]

RELINQUISHED BY	DATE	RECEIVED BY	DATE
SIGNATURE		SIGNATURE	
PRINTED NAME	TIME	PRINTED NAME	TIME
COMPANY		COMPANY	

TOTAL NUMBER OF CONTAINERS 3

METHOD OF SHIPMENT [illegible]

SPECIAL SHIPMENT/HANDLING OR STORAGE REQUIREMENTS [illegible]

DISTRIBUTION:

1. PROVIDE WHITE AND YELLOW COPIES TO LABORATORY
2. RETURN PINK COPY TO PROJECT MANAGER
3. LABORATORY TO FILL IN SAMPLE NUMBER AND SIGN FOR RECEIPT
4. LABORATORY TO RETURN WHITE COPY TO HART CROWSER

Sample Custody Record

DATE 7/3/[illegible] PAGE 1 OF ____

HARTCROWSER

Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699

JOB NUMBER [illegible] LAB NUMBER ____
PROJECT MANAGER [illegible]
PROJECT NAME [illegible]

SAMPLED BY: [illegible]

LAB NO.	SAMPLE	TIME	STATION	MATRIX	TESTING: [illegible]	TESTING: [illegible]	TESTING: [illegible]									NO. OF CONTAINERS	OBSERVATIONS/COMMENTS/ COMPOSITING INSTRUCTIONS
																	[illegible]
[illegible]	[illegible]	5/1/[illegible]	HC-B01	[illegible]	X	X	X									1	☆ [illegible]
[illegible]	[illegible]	↓	↓	↓	X		X									1	[illegible]
[illegible]	[illegible]				X		X									1	[illegible]
[illegible]	[illegible]				X	X	X									1	[illegible]
[illegible]	0-4		HC-B02		X	X	X									1	Total [illegible]
[illegible]	[illegible]		↓		X		X									1	[illegible]
[illegible]	[illegible]				X		X									1	
[illegible]	30-40				X	X	X									1	[illegible]
																	[illegible]
																	[illegible]
																	[illegible]

RELINQUISHED BY	DATE	RECEIVED BY	DATE
SIGNATURE [illegible]	7/5	SIGNATURE [illegible]	[illegible]
PRINTED NAME [illegible]	TIME 1030	PRINTED NAME [illegible]	TIME [illegible]
COMPANY [illegible]		COMPANY [illegible]	

RELINQUISHED BY	DATE	RECEIVED BY	DATE
SIGNATURE		SIGNATURE	
PRINTED NAME	TIME	PRINTED NAME	TIME
COMPANY		COMPANY	

TOTAL NUMBER OF CONTAINERS 8

METHOD OF SHIPMENT [illegible]

SPECIAL SHIPMENT/HANDLING OR STORAGE REQUIREMENTS [illegible]
[illegible]
to Hart Crowser [illegible]

DISTRIBUTION: [illegible]

1. PROVIDE WHITE AND YELLOW COPIES TO LABORATORY
2. RETURN PINK COPY TO PROJECT MANAGER
3. LABORATORY TO FILL IN SAMPLE NUMBER AND SIGN FOR RECEIPT
4. LABORATORY TO RETURN WHITE COPY TO HART CROWSER

9005-171

HARTCROWSER

Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699

Sample Custody Record

DATE 7/3/90 PAGE 1 OF ____

JOB NUMBER J-2854 LAB NUMBER ____

PROJECT MANAGER Clay Patmont / Mark Herrenkohl

PROJECT NAME PIER 64/65 Sediment Study

SAMPLED BY: MJH

LAB NO.	SAMPLE	TIME	STATION	MATRIX	SEMIVOA ORGANICS (SW 8270)	PCBs (SW 8080)	Total Solids		TOC						NO. OF CONTAINERS
	✓0-4	5/9/90	HC-B01	SEDIMENT	X	X	X								1
-1	✓8-14	↓	↓	↓	X		X		X						1
	✓20-30				X		X								1
	✓40-50				X	X	X								1
	✓0-4		HC-B02		X	X	X								1
-2	✓8-14		↓		X		X		X						1
-3	✓20-30				X		X		X						1
	✓30-40				X	X	X								1

TESTING ★

OBSERVATIONS/COMMENTS/ COMPOSITING INSTRUCTIONS

ATTN: DANA

★ Analyses will follow Puget Sound Estuary Program (PSEP) Protocols for Sediments Including MS/MSD QC data.

If you have any questions, please call Mark Herrenkohl 324-9530

RELINQUISHED BY	DATE	RECEIVED BY	DATE
Mark J Herrenkohl SIGNATURE	7/5	SIGNATURE	[illegible]
MARK J. HERRENKOHL PRINTED NAME	TIME	[illegible] PRINTED NAME	TIME
HART CROWSER COMPANY	1030	ATI COMPANY	1225

RELINQUISHED BY	DATE	RECEIVED BY	DATE
SIGNATURE		SIGNATURE	
PRINTED NAME	TIME	PRINTED NAME	TIME
COMPANY		COMPANY	

TOTAL NUMBER OF CONTAINERS 8

METHOD OF SHIPMENT COURIER

SPECIAL SHIPMENT/HANDLING OR STORAGE REQUIREMENTS TAKE PORTION OF SAMPLE to complete analyses and return immediately to Hart Crowser ATTN: MARK HERRENKOHL

KEEP FROZEN

DISTRIBUTION:

1. PROVIDE WHITE AND YELLOW COPIES TO LABORATORY
2. RETURN PINK COPY TO PROJECT MANAGER
3. LABORATORY TO FILL IN SAMPLE NUMBER AND SIGN FOR RECEIPT
4. LABORATORY TO RETURN WHITE COPY TO HART CROWSER

Hard Copy
[illegible]

SEDIMENT TRAP DATA REPORTS
[illegible] EARTH SCIENCES LABORATORY

Battelle
Pacific Northwest Division
Marine Sciences Laboratory
439 West Sequim Bay Road
Sequim, Washington 98382
(206) 683-4151

September 13, 1990

Dr. Clay Patmont
Hart Crowser, Inc.
1910 Fairview Avenue East
Seattle, Washington 98102-3699

Dear Clay:

This letter report summarizes the sediment trap field and chemistry tasks conducted for Hart Crowser this spring and summer.

Sediment traps constructed of 6-inch diameter PVC pipe (15.5 cm diameter or 189 cm^2 opening) by 30-inch long (76 cm) were deployed at three stations in Eagle Harbor (EH-1 near ferry yard, EH-2 near Wykoff, and EH-3 east of the ferry dock) and one station in Elliott Bay (near Pier 63) on May 2, 1990. At each station, two pairs of traps were deployed approximately 15 meters apart. The traps were supported vertically in a wooden base that was weighted with bricks. The traps had a baffle of 1 x 1-cm plastic grating to prevent large organisms from entering the traps. Traps contained 1.2 L of dense salt water (50 ‰) and sodium azide (0.2%) as a preservative. Dye was also added to the preservative so visual examination of the recovered trap could determine whether the traps had been spilled or flushed.

The traps were recovered by either grappling (EH-1 on July 2, 1990) or with scuba divers on July 10, 1990. The overlying water was decanted and the dyed water containing the sediments was transferred and composited from each pair of traps into a precleaned glass jug and returned to the laboratory. The sediment was centrifuged in teflon jars to remove excess water, weighed and then split for chemistry and % solids determination by freeze drying.

RESULTS

The following weights and fluxes of sediment were obtained over a 2-month period.

Trap No.	% solids	Dry weight per pair of traps (g)	Sediment flux g/cm^2 yr
EH-1A	30.1	108	1.71
EH-1B	30.9	108	1.71
EH-2A	25.6	97	1.36
EH-2B	27.0	99	1.39
EH-3A	34.5	124	1.74
EH-3B	35.0	125	1.75
Pier 63A	26.8	61	0.85
Pier 63B	25.5	60	0.84

The concentration of metals was determined by X-ray fluorescence, except for Hg which was determined by cold vapor atomic absorption. Certified reference sediments were analyzed to demonstrate accuracy. Both pairs of traps from Pier 63 were analyzed to provide an indication of precision for field replicates. Lead-210 activity was determined by alpha counting of the granddaughter Po-210. Total organic carbon concentrations were determined by measuring the quantity of CO_2 produced during combustion. The concentrations of 17 PAH compounds were determined by GC-MS. The extraction and total PCB concentration in sample Pier 63A was determined by GC-ECD.

DISCUSSION

The flux of sediment measured by the traps was extremely consistent between pairs of traps; however, the differences between stations may be related to local resuspension.

The concentrations of metals, TOC, solids, and Pb-210 are typical for surface sediments near the sediment trap stations. This indicates that local surface sediments have a major influence on the chemistry of suspended matter. The concentrations of PAHs were relatively high with concentrations of Pier 63A being higher than EH-2. The total PCB concentration in Pier 63A trap material was 267 μg/kg.

Enclosed are three invoices and three *Agreement for Work Authorizations*: one for field sampling in Eagle Harbor, one for Eagle Harbor chemistry, and one for the Elliott Bay field and chemistry. Please sign and return the authorizations to me.

If you need additional information, please call me at 206/683-4151 or FAX 206/681-3699.

Sincerely,

E.A. Crecelius/at

Eric A. Crecelius
Senior Research Scientist

:at

Enclosures: Chemistry Tables
Field Logs
Invoices
Work Authorization Agreements

Concentrations of Metals, TOC, Solids, and Pb-210 in Sediment Traps From Elliott Bay (May and June, 1990)

	(μg/g dry weight except where noted)	
	PIER 63A	PIER 63B
Al%	6.52	5.59
Si%	22.6	22.4
Ca%	1.82	1.69
Cr	94	93
Mn	584	548
Fe%	4.02	4.14
Ni	44	39
Cu	118	117
Zn	221	236
As	16	15
Hg	0.74	0.76
Pb	156	186
TOC %	3.9	4.7
Solids %	26.8	25.5
Pb-210 (dpm/g)	4.05	4.35

Quality Assurance Samples
Certified Reference Sediments

(μg/g dry weight except where noted)

	CRM PACS-1		CRM-1646		MESS-1	
	This Study	Certified	This Study	Certified	This Study	Certified
Al%	6.42	6.4	7.49	6.25	6.37	5.83
Si%	26.0	26.0	29.6	None	30.0	31.5
Ca%	2.07	2.09	0.89	0.83	0.53	0.48
Cr	109	113	81	76	65	71
Mn	475	470	354	375	502	513
Fe%	4.84	4.87	3.39	3.35	3.05	3.05
Ni	51	44	37	32	33.0	29.5
Cu	420	452	21	18	23.2	25.1
Zn	796	824	133	138	190	191
As	169	211	13	11.6	10.1	10.6
Hg	4.61	4.57	-	-	-	-
Pb	386	404	25	28.2	33.6	34.0

PROJECT HART-CROWSER

PAH'S
UNITS ng/g dry wt

DA

COMPOUND	EH-1A	EH-2A	EH-3A	SRM BLANK				
NAPHTHALENE	62	300	100	<14				
ACENAPHTHALENE	180	270	160	<15				
ACENAPHTHENE	81	500	170	<21				
FLUORENE	150	740	250	<21				
DIBENZO THIOPHENE	73	260	120	<16				
PHENANTHRENE	960	3500	1500	<15				
ANTHRACENE	630	1200	790	<16				
FLUORANTHENE	2200	4300	2500	<16				
PYRENE	2000	3400	1900	<14				
BENZO (a) ANTHRACENE	980	2000	1100	<15				
CHRYSENE	2000	3200	2100	<15				
BENZO (b) FLUORANTHENE	1800	2400	1600	<12				
BENZO (k) FLUORANTHENE	1200	1700	900	<12				
BENZO (a) PYRENE	1000	1500	930	<13				
INDENO(1,2,3-c,d)PYRENE	630	760	500	<11				
DIBENZO (a,h) ANTHRACEN	180	250	145%	<10				
BENZO (g,h,i) PERYLENE	550	560	430	<10				
SURROGATE RECOVERY %								
d8 NAPHTHALENE	28	43	33	52				
d10 FLUORENE	65	46	63	46				
d12CHRYSENE	117	98	117	67				

PROJECT HART-CROWSER

PAH'S

UNITS ng/g dry wt

DA

COMPOUND	PIER 63A	PIER 63B	BLANK
NAPHTHALENE	130	330	<14
ACENAPHTHALENE	1000	1100	<15
ACENAPHTHENE	400	690	<21
FLUORENE	950	1200	<21
DIBENZO THIOPHENE	390	450	<16
PHENANTHRENE	7200	6300	<15
ANTHRACENE	7400	7000	<16
FLUORANTHENE	13000	15000	<16
PYRENE	12000	13000	<14
BENZO (a) ANTHRACENE	8700	9000	<15
CHRYSENE	15000	15000	<15
BENZO (b) FLUORANTHENE	11000	11000	<12
BENZO (k) FLUORANTHENE	8100	8000	<12
BENZO (a) PYRENE	10000	10000	<13
INDENO(1,2,3-c,d)PYRENE	4800	4800	<11
DIBENZO (a,h) ANTHRACEN	1400	1500	<10
BENZO (g,h,i) PERYLENE	4200	4200	<10
SURROGATE RECOVERY %			
d8 NAPHTHALENE	17	35	52
d10 FLUORENE	49	62	46
d12CHRYSENE	129	120	67

HART CROWSER PROJECT

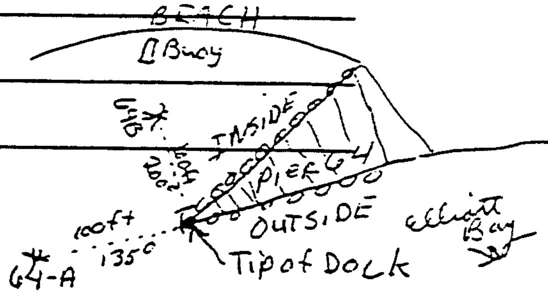
May, 1990

Sediment TRAP Installation Data

Station #: Pier-64-A Elliott Bay

Date: 5/2/90 Time: 1330 hrs

Station Description: Near the dock @ Pier-64 on a line 100ft from the tip of the dock and parallel to the outside of the dock at a bearing of 135°.



Loran C: Latitude: 47°35.33

Longitude: 122°23.28

TD1: 27996.9 TD2: 42291.2

Bottom Depth: 65 ft feet

TRAP ASSEMBLY #: #1

COMMENTS:

1 - Position of Grapple Lines: Parallel to outside of dock.

2 - Weather: Cloudy with partial clearing, no rain, no wind.

HART CROWSER PROJECT

May, 1990

Sediment TRAP Installation Data

Station #: Pier 64-B Elliott Bay

Date: 5/2/90

Time: 1350

Station Description: Same as 64-A.
The trap was deployed on the inside of the dock
100ft from the tip at a bearing of 200°.
(see diagram for 64-A)

Loran C:

Latitude: } Same as 64-A
Longitude:

TD1:

TD2:

Bottom Depth: 49 feet

TRAP ASSEMBLY #: #7

COMMENTS:

1 - Position of Grapple Lines: Paralell to the inside of the dock

2 - Weather: Cloudy with partial clearing, no rain or wind.