Assessment of Burrard Inlet Water and Sediment Quality 2000

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Executive Summary

This document summarizes the results of water and sediment quality analyses conducted on samples collected throughout the Burrard Inlet in December, 2000. Results are compared with applicable water quality objectives (Water Management 1990) and/or water quality guidelines (Nagpal *et al.* 1998).

Water Column

Water column samples collected at all sites had concentrations of PCBs below detection limits (<0.1 µg/L). However, this detection limit is 1000 times the guideline for maximum concentrations of 0.1 ng/L, making a useful interpretation of these data impossible. Chlorophenol concentrations were below the objectives in all instances.

Metals concentrations (including barium, boron, cadmium, chromium, iron, lead, nickel and zinc) were below the applicable objective and/or guideline levels in marine waters throughout the Burrard Inlet. In the case of arsenic and copper, while concentrations were below detection limits (<0.06 and <0.006 mg/L, respectively), objective limits were considerably lower than these limits (0.01 mg/L and 0.003 mg/L, respectively) and therefore an accurate assessment of potential impacts of these metals on aquatic life cannot be determined.

MTBE concentrations in all samples collected throughout the Burrard Inlet had concentrations below detection limits (<0.001 mg/L) and the most stringent water quality guideline (0.02 mg/L).

Sediments

Concentrations of PCBs in sediment samples exceeded the objective of 0.03 µg/g dry weight in four of seven samples analyzed, with a maximum concentration of 0.101 µg/g in the Coal Harbour site. Chlorophenol concentrations were below objective values in all instances.

Concentrations of all of the various PAH species analyzed in sediments exceeded objective values in a number of the different sediment samples collected. The least number of exceedences occurred for acenaphthene, in which only six of the 27 samples had concentrations exceeding the objective value, while both benzo(g,h,i)perylene and indeno(1,2,3,c-d)pyrene concentrations exceeded the applicable objective value in 26 of the 27 samples collected.

Concentrations of all metals for which sediment objectives exist exceeded the applicable objectives in at least one of the samples collected in Burrard Inlet. This includes arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc.

A special case-study was made of the False Creek East End area, whereby sediment samples were collected at nine sub-sites within this area and analyzed for PAHs and metals.

All of the various PAH species at all of the False Creek sampling sites were present in concentrations which exceeded the applicable objectives for the protection of aquatic life, by factors ranging between about 4 and 2500 times. The highest single exceedence was for phenanthrene, where a maximum concentration of 385 µg/g was measured.

Concentrations of arsenic, cadmium, chromium, copper, lead, silver and zinc exceeded the sediment quality guidelines in a number of the False Creek sites. In addition, while no objective has been proposed for nickel concentrations in False Creek sediments, concentrations of this metal frequently exceeded the sediment quality guideline for the protection of aquatic life (Nagpal *et al.* 1998)

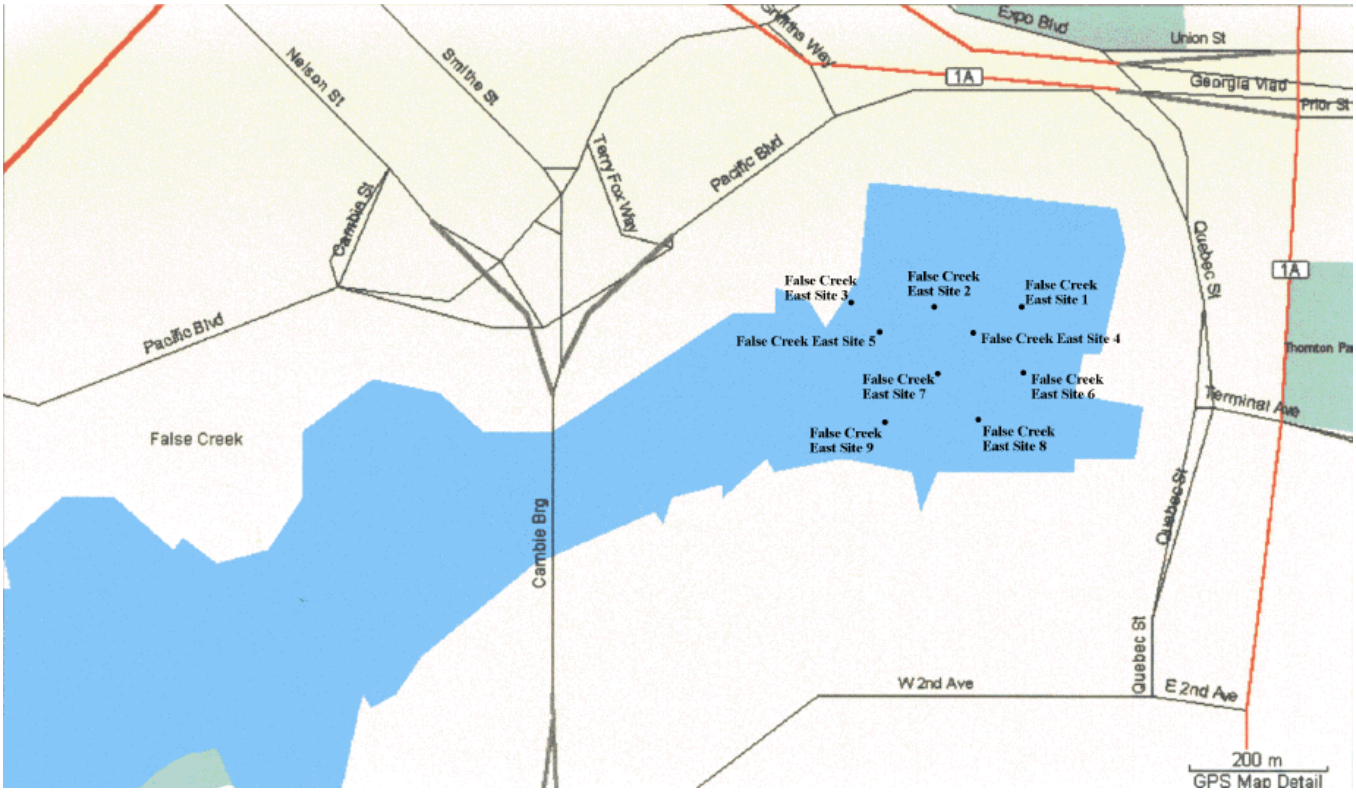
1.0 Introduction

The Burrard Inlet is an inlet located on the Georgia Basin, between the City of Vancouver and North Vancouver, and includes the busy Vancouver Harbour. The inlet can be divided into a number of reaches based on constrictions in the inlet - the Outer Burrard Inlet stretches from the mouth of the Georgia Basin to the 1st Narrows Bridge, Vancouver Harbour stretches between the 1st and 2nd Narrows, that portion of the inlet between 2nd Narrows and Roche Point, the Port Moody Arm terminating at the east end of the inlet, and the Indian Arm, which stretches north from Deep Cove (Figure 1). Freshwater tributaries to the inlet include False Creek, the Capilano River, Lynn Creek and School House Brook. There are a number of permitted discharges to the inlet, as well as combined sewer overflows, stormwater discharges, discharges from marinas, and the relatively high potential for accidental spills due to high levels of shipping activity within the inlet. In addition, False Creek passes through a highly industrialized area of Vancouver, and is therefore subject to various sources of contamination.

A Water Quality Assessment and Objectives Report was prepared for the Burrard Inlet area (including the area between the outer Burrard Inlet and Port Moody, as well as the Indian Arm and various tributaries) in 1990, utilizing water quality and sediment data collected primarily between 1972 and December 1985 (Nijman and Swain, 1990). However, more recent data (to 1990) were also referenced on occasion when they existed. In that report, a number of Water Quality Objectives were proposed for both the inlet and a number of the larger freshwater tributaries to the inlet (see Appendix I). This report analyzes water and sediment quality data collected at a number of sites within the Burrard Inlet / False Creek area. Comparisons will be made to existing water quality objectives, or, when these have not been proposed, to existing water quality guidelines for the relevant medium (marine water or sediments).

Figure 1. Location of Burrard Inlet Sites.

Figure 2. Location of False Creek East End Sub-Sites 1- 9.



2.0 Site Locations and Monitoring Schedule

Water and sediment samples were collected at a number of sites throughout the Burrard Inlet in early December 2000 (Table 1). Water samples were collected at one site in the Outer Burrard Inlet (English Bay at Locarno Park), three sites between the 1st and 2nd Narrows (Coal Harbour, Vancouver Harbour at Clarke Drive and Vancouver Harbour at the Vancouver Wharves), one site between 2nd Narrows and Roche Point (Second Narrows Chevron), one site in Port Moody Arm (Port Moody IOCO), and one site in Indian Arm (Indian Arm at Cable Crossing) (Figure 1). Water samples were also collected at two sites in the Outer Burrard Inlet (the Vancouver Yacht Club in English Bay and Granville Island in West False Creek), two sites in the inlet between 1st and 2nd Narrows (Mosquito Creek and Coal Harbour), one site in Port Moody Arm (Port Moody Arm Reed Point), and one site in Indian Arm (Deep Cove) and analyzed for methyl tertiary-butyl ether (MTBE) only (Figure 1).

Phleger core sediment samples were collected at four sites in the Outer Burrard Inlet (two sites at the Vancouver Yacht Club in English Bay and two sites near Granville Island in West False Creek), four sites between the 1st and 2nd Narrows (two sites in Coal Harbour, and two sites near Mosquito Creek), two sites in Port Moody Arm (at the Reed Point Marina), and one site in the Indian Arm (at the Deep Cove Marina) (Table 1, Figure 1).

Ponar grab samples were collected a total of five locations: one site in Coal Harbour, one site at the Vancouver Harbour at the Vancouver Wharves, one site in Vancouver Harbour at Clarke Drive, one site at the Second Narrows Chevron, and one site at the Port Moody IOCO.

2.1 False Creek Locations and Monitoring Schedule

One water sample was collected in False Creek, at the East End site (EMS ID E207814) on December 12. Sediment samples were also collected at this site on the same day, as well as at nine sub-sites in the same general vicinity (False Creek East End sites 1-9) (see Figure 2).

Table 1. Sampling schedule for water quality and sediment sampling in the Burrard Inlet, 2000

		Sampling Date		
Site Name	EMS ID	Water - General Chemistry	Water - MTBE	Sediment
English Bay - Locarno Park	E207812	Dec. 9		
Vancouver Yacht Club - English Bay Site 1			Dec. 9	Dec. 9
Vancouver Yacht Club - English Bay Site 2				Dec. 9
Granville Island in W. False Creek Site 1			Dec. 9	Dec. 9
Granville Island in W. False Creek Site 2				Dec. 9
False Creek East End	E207814			Dec. 12
Coal Harbour - Site 1			Dec. 12	Dec. 12
Coal Harbour - Site 2				Dec. 12
Coal Harbour	E208813	Dec. 12		Dec. 12
Vancouver Harbour - Vancouver Wharves	E207816	Dec. 12		Dec. 12
Mosquito Creek - Site 1			Dec. 12	Dec. 12
Mosquito Creek - Site 2				Dec. 12
Vancouver Harbour - Clarke Drive	E207818	Dec. 12		Dec. 12
Second Narrows Chevron	E207821	Dec. 10		Dec. 10
Port Moody IOCO	E207823	Dec. 10		Dec. 10
Port Moody Arm - Reed Point Site 1			Dec. 9	Dec. 10
Port Moody Arm - Reed Point Site 2				Dec. 10
Indian Arm Deep Cove - Site 1			Dec. 9	Dec. 10
Indian Arm Deep Cove - Site 2				Dec. 10
Indian Arm at Cable Crossing	0300080	Dec. 10		

3.0 Description of Sampling Methodology

Integrated Resource Consultants Inc., a consulting firm with considerable experience, collected all water and sediment samples. Sampling was conducted by trained personnel who followed Resource Inventory Committee (RIC) standards for both water (Cavanagh *et al.* 1994) and sediment (RIC 1997) sampling.

Water samples were collected using a 3-L Van Dorn at a depth of 0.5 metres below the surface of the water at each site.

Sediment samples were collected at the various sites listed in Section 2.0 using a Phleger core, with an optimum core depth of approximately 30 cm. Cores were then split into two sub-samples, the first consisting of the first 15 cm of the core, and the second sub-sample consisting of the sediment core between 15 and 30 cm in depth. In other locations, Ponar grab samples were collected from surface sediment.

All samples (water and sediment) were placed on ice in coolers after collection and transported to the Pacific Environmental Science Centre (PESC) for analysis. All water samples were analyzed for chlorophenols, polychlorinated biphenyls (PCB's), metals, nutrients and general physical parameters including total suspended solids and turbidity. All Ponar grab samples and the Phleger core samples collected at the False Creek East End site were analyzed for PCBs, chlorophenols, PAHs, and metals. The remaining Phleger core samples were analyzed for polycyclic aromatic hydrocarbons (PAH) and metals only.

4.0 Results and Discussion

In this section, both water column and sediment parameters will be compared with existing water quality objectives established for the Burrard Inlet (see Appendix I) (Nijman and Swain 1990), or the applicable water/sediment quality guidelines in those instances where objectives have not been established. For the purposes of determining compliance with guidelines and objectives, the water uses that are being protected in the Burrard Inlet include: sensitive aquatic life and wildlife, and primary (*e.g.* swimming, water skiing) and secondary (*e.g.* canoeing, boating) contact recreation. In False Creek, both aquatic life and wildlife values are protected, as well as primary contact near the mouth of the creek.

4.1 Water Column

Water samples were collected at six sites throughout the Burrard Inlet (English Bay at Locarno Park, Vancouver Harbour at Clarke Drive, Vancouver Harbour at Vancouver Wharves, Second Narrows Chevron, Port Moody IOCO and Indian Arm at Cable Crossing), as well as one site in False Creek (False Creek East End), and analyzed for chlorophenols, PCBs, metals and nutrients. Samples were also collected at five other sites (Vancouver Yacht Club in English Bay, Granville Island in West False Creek, Mosquito Creek, Port Moody Arm at Reed Point and Deep Cove) and analyzed for MTBE only. One sample was collected at Coal Harbour and analyzed for both the general chemical parameters (chlorophenols, PCBs, metals and nutrients) as well as MTBE. Water quality results from these sites are included in Appendix II.

4.1.1 PCBs and Chlorophenols

All of the PCBs sampled at these eight sites were present in concentrations below detection limits (<0.1 µg/L), as were both tetra- and pentachlorophenol (detection limits of <0.005 µg/L 2,3,4,5 - tetrachlorophenol, <0.002 µg/L 2,3,4,6 - tetrachlorophenol, and <0.005 µg/L pentachlorophenol). However, although there are currently no water quality objectives proposed for PCB concentrations in water in the Burrard Inlet, the guidelines for the protection of freshwater and marine aquatic life from PCBs range between 0.00025 ng/L for 3,3',4,4',5-pentachlorobiphenyl and 0.04 ng/L for 3,3',4,4'-tetrachlorobiphenyl, and the total concentration of all PCB's should not exceed 0.1 ng/L. Therefore, the detection limits for the analytical method used to measure this parameter were too high by a factor of at least 1000, and so it is not possible to determine if PCB's are a concern at these sites.

A water quality objective of a maximum of 0.2 µg/L has been proposed for the total concentration of chlorophenols in the Burrard Inlet between 1st and 2nd Narrows. The detection limits for both tetra- and pentachlorophenol are well below this objective. Therefore, chlorophenols are not a concern at present at these sites.

4.1.2 Metals

Concentrations of aluminum at the seven marine sites ranged from below detection limits (<0.06 mg/L) at Port Moody Arm, Indian Arm, Second Narrows Chevron and Coal Harbour to a maximum of 0.19 mg/L at Vancouver Harbour at Vancouver Wharves. The concentration of aluminum measured at the False Creek East End site was 0.12 mg/L.

There is currently no water quality guideline for aluminum concentrations in marine waters, and no objective has been proposed for either Burrard Inlet or False Creek.

A water quality objective of 0.01 mg/L is in place for arsenic in waters between 1st Narrows and Roche Point. Arsenic concentrations measured at all of the sites were below detection limits (<0.06 mg/L); however, this detection limit is six times the water quality objective limit, making it impossible to interpret the data relative to the objective value. It is recommended that future analyses of water samples collected at these sites use a method with a detection limit of lower than 0.01 mg/L, preferably 0.001 mg/L.

A water quality objective has been proposed for barium concentrations between 2nd Narrows and Roche Point. The objective is that maximum total barium concentrations should not exceed 0.5 mg/L. As concentrations of this metal ranged between 0.003 mg/L at Vancouver Harbour - Vancouver Wharves to a maximum of 0.01 mg/L at Locarno Park, it does not appear that this metal is a concern.

Boron concentrations measured at the seven sites ranged from 2.45 mg/L at the Indian Arm site to 3.25 mg/L at Coal Harbour. While there is no water quality objective for this metal, the water quality guideline for the protection of marine aquatic life is a maximum value of 5 mg/L, and so it appears that boron concentrations are not a concern.

Total cadmium concentrations were below detection limits (<0.006 mg/L) at all of the sites monitored, and therefore well below the 0.043 mg/L maximum objective for waters between the 1st Narrows and Port Moody Arm.

A water quality objective of a maximum of 0.05 mg/L exists for total chromium concentrations in False Creek as well as between 2nd Narrow and Port Moody Arm. The majority of sites monitored in 2000 had concentrations below detection limits (<0.006 mg/L), although the Indian Arm at Cable Crossing site had a concentration equal to the detection limit (0.006 mg/L), and the Port Moody IOCO site had a concentration of 0.009 mg/L. These values are well below the objective, and so chromium does not appear to be a concern in the waters of Burrard Inlet.

Concentrations of both total cobalt and total copper were below detection limits (<0.006 mg/L for both metals) for all samples collected. There is no guideline for cobalt concentrations in marine waters. However, the objective for copper concentrations in the Burrard Inlet is an average value not exceeding 0.002 mg/L and a maximum value not exceeding 0.003 mg/L. Therefore, the detection limit used to analyze copper concentrations is too high to determine if the water quality objective is being exceeded.

Preferably, an analytical method with a detection limit of 0.0002 mg/L would be used to analyze copper.

A water quality objective of 0.3 mg/L has been proposed for total iron concentrations in the majority of Burrard Inlet, except for the reach between 2nd Narrows and Roche Point. Iron concentrations measured at the eight monitoring locations ranged between 0.06 mg/L at Port Moody IOCO to a maximum of 0.185 mg/L at Locarno Park in English Bay, and were therefore below the maximum objective value.

Lead concentrations were below detection limits (<0.06 mg/L) at all sites. However, the water quality objective for lead concentrations in Burrard Inlet is an average value of 0.002 mg/L and a maximum of 0.14 mg/L. While the maximum value was met in all instances, the detection limit was too high to determine if the average objective was exceeded. A minimum of five samples in a 30-day period are required to calculate an average, and so if this sampling frequency is ever met, the analytical method used to determine lead concentrations should have a detection limit significantly lower than 0.002 mg/L (preferably 0.0002 mg/L).

Nickel concentrations were also below detection limits at all sites (<0.02 mg/L), but again, while the detection limit is below the maximum objective (0.075 mg/L) it exceeds the average objective of 0.008 mg/L. Again, should sampling frequencies increase to the point where an average value could be calculated, a more sensitive analytical method should be employed.

The final objective for metals concentrations in the Burrard Inlet water column applies to zinc. The objective for a maximum concentration is 0.095 mg/L, while the average objective is to be 0.086 mg/L. Zinc concentrations were below both of these limits at all of the sites, ranging from 0.032 mg/L at Indian Arm to a maximum of 0.046 mg/L at Coal Harbour.

4.1.3 MTBE

In early December 2000, water samples were collected at the Vancouver Yacht Club, Granville Island in West False Creek, Mosquito Creek and Coal Harbour in the Vancouver Harbour, the Reed Point Marina in Port Moody Arm, and the Deep Cove Yacht Club in Indian Arm and analyzed for MTBE. Concentrations of MTBE in all of these samples was below detection limits (<0.001 mg/L). The most stringent guideline for this parameter is 0.02 mg/L to protect primary contact recreation, and so MTBE is not a concern at these sites.

4.2 Sediment Quality

In December 2000, Phleger core samples were collected at 11 different sampling locations throughout the Burrard Inlet, and Ponar grab samples were collected at another five locations. Sediment cores were split into upper and lower portions (0-15 cm depth and 15-30 cm depth), to give an indication if long-term changes are occurring in

the concentrations of contaminants. Sediment quality results from these sites are included in Appendix III.

4.2.1 Sediment Composition

The majority of the sites sampled had sediment compositions that were classified as loams, ranging from silt loams at the Vancouver Yacht Club in English Bay, Mosquito Creek and Port Moody Reed Point sites through silt-clay loams at Coal Harbour Site 2, sandy loams at Vancouver Harbour Vancouver Wharves, and simply loams at Coal Harbour Site 1. The Port Moody IOCO site had sediments classified as clays, while the Second Narrows Chevron and Vancouver Harbour at Clarke Drive sites were classified as sands.

4.2.2 PCBs and Chlorophenols

The majority of samples analyzed for PCBs had concentrations below detection limit (<0.005 µg/g). Exceptions to this were Aroclor 1254 and Aroclor 1260, which were present in measurable concentrations at number of the sites. Concentrations of Aroclor 1254 were measurable at five of the seven sites, with values ranging from a 0.015 µg/g to a maximum of 0.074 µg/g. Aroclor 1260 was measurable at two of the sites (False Creek East End in the shallow core sample, and Coal Harbour in the grab sample), with a maximum concentration of 0.068 µg/g. The current water quality objective for PCBs in sediment in the Burrard Inlet is a maximum of 0.03 µg/g dry weight, and this objective was exceeded in four of the seven samples analyzed for these parameters (Port Moody IOCO, Coal Harbour, Vancouver Harbour at Clarke Drive and False Creek East End in the shallow core sample). The highest concentration of total PCBs was 0.101 µg/g at the Coal Harbour site.

Concentrations of tetrachlorophenol were below detection limits (<0.0005 µg/g) at all of the sites where it was tested, and concentrations of pentachlorophenol were below detection limits (<0.0002 µg/g) at four of the seven sampling locations. Concentrations of pentachlorophenol in the remaining three samples ranged from 0.0006 µg/g at Vancouver Harbour at Clarke Drive to 0.0008 µg/g at Vancouver Harbour at Vancouver Wharves. The water quality objective (applicable only for the Burrard Inlet between the 1st and 2nd Narrows) is a maximum chlorophenol concentration of 0.01 µg/g dry weight, and so the two Vancouver Harbour samples had concentrations less than the objective. Therefore, it does not appear that chlorophenol concentrations are a concern in the Burrard Inlet.

4.2.3 Polycyclic Aromatic Hydrocarbons (PAHs)

PAH concentrations were above detection limits for almost all samples and for almost all species of PAH. The objectives apply to almost the entire Burrard Inlet, with the exception of Indian Arm. Because of this exclusion, sediment quality data for PAHs in Indian Arm is not considered in this section. A total of 27 samples were collected at the

other sites, including all of the Ponar grab samples and both the deep and shallow core portions of the Phleger cores collected at the remaining sites.

The long-term objective for acenaphthylene concentrations in the Burrard Inlet is a maximum of 0.06 µg/g. This objective was exceeded in seven of the 27 samples collected, with a maximum concentration of 0.23 µg/g at the Port Moody Reed Point Site 2 in the deeper segment of the core sample. The fact that concentrations of this PAH were almost invariably higher in the deeper core sample at all sites indicates that it may be decreasing in recent years.

The sediment quality objective for acenaphthene in the Burrard Inlet is 0.05 µg/g dry weight. This objective was exceeded by six of 27 samples, with values ranging from 0.06 µg/g to 0.12 µg/g at Vancouver Harbour at Vancouver Wharves. Again, concentrations appear to be generally higher in the deeper sediment cores, suggesting that concentrations may be decreasing.

Anthracene concentrations exceeded the sediment quality objective of 0.1 µg/g for Burrard Inlet in 16 of 27 samples collected, with values ranging from 0.11 to 0.38 µg/g. The highest concentration was recorded in the deeper core sample from the Vancouver Yacht Club in English Bay Site 2.

The sediment quality objective for benzo(a)anthracene is 0.13 µg/g for the Burrard Inlet. This value was exceeded by 18 of the 27 samples collected, with a maximum value of 1.04 µg/g recorded at the shallower core sample collected at the Vancouver Yacht Club at English Bay Site 2.

Concentrations of benzo(a)pyrene ranged from 0.04 µg/g in the deeper cores from Mosquito Creek Site 1 and Coal Harbour Site 1 to a maximum of 0.82 µg/g in the deeper core segment from the Vancouver Yacht Club at English Bay Site 2. The objective for this parameter is 0.16 µg/g, and this value was exceeded by 18 of 27 samples. The maximum recorded value occurred in the deeper core sample from the Vancouver Yacht Club at English Bay Site 2.

The sediment quality objective for benzofluoranthenes in Burrard Inlet sediments is a maximum of 0.32 µg/g. This objective was exceeded by 20 of 27 values, with a maximum concentration of 2.41 µg/g in the deeper core sample from the Vancouver Yacht Club in English Bay Site 2.

The sediment quality objective of 0.07 µg/g for benzo(g,h,i)perylene was exceeded by 26 of the 27 samples collected, with a maximum concentration of 0.32 µg/g measured in both the shallow portion of the core from the False Creek East End site and the shallow core from the Granville Island in West False Creek Site 2.

Twenty-two of the 27 samples collected throughout the Burrard Inlet had chrysene concentrations exceeding the objective of 0.14 µg/g. The maximum concentration (1.83

µg/g) was measured in the deeper core of the sample collected at the Vancouver Yacht Club Site 2.

The sediment quality objective for dibenz(a,h)anthracene was exceeded by relatively few of the samples, with only nine of 27 values higher than the objective value of 0.06 µg/g. The maximum exceedence occurred at Coal Harbour Site 1, in the shallow portion of the Phleger core collected.

A total of 25 of the 27 samples collected in the Burrard Inlet had fluoranthene concentrations exceeding the sediment quality objective of 0.14, with a maximum concentration of 1.39 µg/g occurring in the shallow core portion of the sample collected at the Vancouver Yacht Club at English Bay Site 2.

The sediment quality objective for fluorene in the Burrard Inlet is only 0.05 µg/g, and 15 of the 27 samples collected had concentrations higher than this. The highest concentration (0.16 µg/g) was found in the deeper core portion of the sample from the Vancouver Yacht Club at English Bay Site 2.

Almost all (26 of 27 samples) had indeno(1,2,3-c,d)pyrene concentrations exceeding the sediment quality objective of 0.06 µg/g, with a maximum value of 0.38 µg/g measured in the shallow portion of the core collected from Granville Island in West False Creek Site 2.

The sediment quality objective for naphthalene (0.2 µg/g) was exceeded by 10 of 27 samples collected at the sites throughout the Burrard Inlet. The maximum concentration was almost five times the objective value, at 0.97 µg/g, and was found in the deeper portion of the core collected at Granville Island in West False Creek Site 2.

The maximum phenanthrene objective of 0.15 µg/g was exceeded in 25 of the 27 samples, with a maximum value of 0.78 µg/g in the deeper core portion of the sample from the Vancouver Yacht Club in English Bay Site 2.

The final PAH measured in all of the sediment samples was pyrene, which has a maximum objective of 0.26 µg/g for the Burrard Inlet excluding Indian Arm. Concentrations of this PAH were generally extremely high, with 23 of the 27 samples exceeding the objective and the maximum concentration an extremely high 4.11 µg/g in the deeper core sample collected at Vancouver Yacht Club in English Bay Site 2.

It is obvious from this discussion that PAHs continue to be a significant concern throughout the Burrard Inlet, and especially in the English Bay and Granville Island areas. Of the fifteen PAHs analyzed in this section, the sites sampled at the Vancouver Yacht Club in English Bay tested higher than all other locations a total of nine times. The Granville Island in West False Creek was a distant second, with the highest concentration for a total of three of the 15 PAHs analyzed.

4.2.4 Metals

Sediment quality objectives proposed for all metals apply to the entire Burrard Inlet except for Indian Arm. This represents a total of 27 samples from the various sites, including Ponar grabs and Phleger cores, and considers the upper and lower portions of the cores as separate samples.

The sediment quality objective for arsenic concentrations in the Burrard Inlet is a maximum of 20 µg/g dry weight. This value was exceeded by only one of the 27 samples, with a concentration of 23 µg/g at the Granville Island in West False Creek Site 2 (deeper core segment). Concentrations at the remaining sites ranged between below detection limits (<8 µg/g) and 19 µg/g.

The second metal for which a sediment quality objective exists is cadmium. The long-term objective for this metal is a maximum of 1.0 µg/g dry weight. The objective was exceeded by 17 of 27 samples, with a maximum concentration of 2.5 µg/g found in the Ponar grab sample collected from Vancouver Harbour at Vancouver Wharves.

Concentrations of total chromium in sediment ranged from 24 µg/g in the Ponar grab sample from Vancouver Harbour at Clarke Drive to 68.8 µg/g the Port Moody Arm Reed Point Site 1 in the deeper sediment core. The maximum sediment quality objective for this metal is 60 µg/g dry weight, and this objective was exceeded by six of the 27 samples collected at the various sites.

A long-term total copper sediment concentration objective of 100 µg/g dry weight exists for the Burrard Inlet. A total of 18 of the 27 samples analyzed for this metal had concentrations exceeding this objective, with a maximum concentration of 985 µg/g at Vancouver Harbour at Vancouver Wharves. This value (almost ten times the objective value) was considerably higher than the next highest value, 239 µg/g, measured at the Coal Harbour Site 2 in the deeper portion of the core. However, the highest concentrations of copper were almost invariably found at the sites located between 1st and 2nd Narrows.

There is currently no sediment quality guideline for total iron concentrations in marine sediments. Concentrations at the various sites monitored in the Burrard Inlet ranged from 15,900 µg/g at Vancouver Harbour at Clarke Drive to 48,800 µg/g in the deeper portion of the core collected at Granville Island in West False Creek Site 2.

The sediment quality objective for total lead concentrations in the Burrard Inlet is a maximum of 30 µg/g dry weight. This value was exceeded by all samples save one (the deeper core from the False Creek East End site, which had a concentration of 24 µg/g). The maximum concentration measured was about nine times the objective value, at 269 µg/g, and occurred at Granville Island in West False Creek Site 1, in the deeper core segment.

No sediment quality objective or guideline for sediments exists for manganese concentrations in the Burrard Inlet. Concentrations at the various Burrard Inlet sites ranged from 95.5 µg/g at Vancouver Harbour - Clarke Drive to 450 µg/g at the Mosquito Creek Site 1 (deeper core).

The sediment quality objective for mercury in Burrard Inlet is 0.15 µg/g dry weight. Mercury concentrations were measured only in the Ponar grab samples and the core samples collected at the False Creek East End site. Six of the seven samples had concentrations exceeding the objective, with a maximum concentration of 1.76 µg/g measured at the Vancouver Harbour at Clarke Drive site.

Concentrations of total nickel in sediments ranged from 23 µg/g in the grab sample collected at the Second Narrows Chevron to a maximum of 52 µg/g measured at both the Vancouver Yacht Club in English Bay Site 2 (shallow core) and the Granville Island in West False Creek Site 2 (shallow core). No objective has been proposed for this metal in the Burrard Inlet, but the lowest effects limit guideline for nickel in marine waters is 30 µg/g (Nagpal *et al.* 1998). The guideline value was exceeded by 22 of the 27 samples analyzed throughout the Burrard Inlet (excluding Indian Arm).

While no objective exists for silver concentrations in Burrard Inlet sediments, a marine low-effects guideline of 1.0 µg/g dry weight has been developed (Nagpal *et al.* 1998). All of the samples measured had concentrations below the detection limit (<2 µg/g) with the exception of Vancouver Harbour at Clarke Drive, where a concentration of 4 µg/g was measured. However, because the detection limit used for this metal is twice the guideline value, no useful interpretation of these data can be made.

A sediment quality objective of 150 µg/g dry weight has been proposed for zinc concentrations in Burrard Inlet sediments. Concentrations of zinc measured at the various sites ranged from 73.7 µg/g in the deeper core collected from the False Creek East End site to 575 µg/g at the Vancouver Harbour at Vancouver Wharves site. A total of 19 of the 27 samples had concentrations exceeding the sediment quality objective for zinc.

4.3 False Creek East End - Special Case Study

In addition to the water and sediment samples collected at the False Creek East End site that have already been discussed in the previous sections, additional Phleger core sediment samples were collected at nine sub-sites at the False Creek East End. These samples were divided into upper and lower segments (0-15 cm depth and 15-30 cm depth) in the same manner as samples collected for the main study. Sediment samples were analyzed for PAHs and total metals concentrations.

4.3.1 Sediment Texture

The composition of all sediment cores collected at the False Creek sites ranged between loams and silt-clay loams at all sites. This is similar to the composition of sediments collected at the Burrard Inlet sites (see Section 4.2.1).

4.3.2 PAHs

PAH concentrations in sediment cores collected from the nine sites in False Creek showed an extremely consistent pattern. All values for all of the PAH species exceeded the applicable objectives for the protection of aquatic life, by factors ranging between about 4 and 2500 times. The highest single exceedence was for phenanthrene, where a maximum concentration of 385 µg/g was measured at Site 6 in the deeper core segment, compared to a sediment quality objective value for the Burrard Inlet (including False Creek) of only 0.15 µg/g. A distribution pattern was also clear, with the highest concentrations of all PAHs occurring almost invariably at sites 1, 2, 6 and 7 and lowest at Site 9 (compare total PAH values, Appendix IV). At the sites where PAH concentrations were highest, a comparison of values in the upper and lower segments shows a dramatic increase in PAH concentrations in the deeper sediment cores, suggesting that PAH depositions are decreasing at these sites. At sites 4 and 5 this trend appears to be reversed, with concentrations almost twice as high in the surface sediment core than in the deeper core. False Creek passes through a heavily industrialized area, and is subject to considerable contamination from PAHs. One matter that is somewhat confusing is the fact that Site 4 (which is surrounded by sites 1, 2, 6, and 7) does not show high concentrations of PAHs. The reason for this is unclear. While PAHs are obviously a considerable threat to aquatic life in False Creek, it appears that concentrations of these substances may be decreasing over time.

4.3.3 Metals

Arsenic concentrations at the nine False Creek sites ranged from 12 µg/g at Site 9 in the deeper core to 41 µg/g at Site 3 in both the shallow and deep cores. A total of six of the 18 samples collected and analyzed had concentrations of arsenic exceeding the sediment quality objective of 20 µg/g dry weight, including both samples from sites 3 and 6, and the deeper core sample only from sites 1 and 2.

Cadmium concentrations were as high or higher than the maximum objective value of 1.0 µg/g dry weight for all samples collected at the nine False Creek sites. Values ranged from 1 µg/g in the deeper core from Site 5 to 6.2 µg/g in the deeper core from Site 2. The majority of samples had concentrations two to three times the objective value.

The sediment quality objective for chromium in False Creek is 60 µg/g dry weight, a value that was exceeded by 10 of the 18 sub-samples collected. The maximum chromium concentration measured was approximately 1.5 times the objective value (91.4 µg/g) and occurred in the deeper core segment from Site 2. Other sites with

higher-than-average chromium concentrations were sites 4 and 6. There was no obvious trend as to whether chromium concentrations are increasing or decreasing over time in False Creek sediments.

Sixteen of the 18 sub-samples collected at the nine False Creek Sites had copper concentrations exceeding the maximum sediment quality objective of 100 µg/g for Burrard Inlet. The two values below the objective value were 79.1 µg/g (at the deeper core from Site 5) and 99.3 µg/g (at the deeper core from Site 9). Concentrations at the other sites ranged from 103 µg/g in the deeper core segment from Site 3 to 238 µg/g in the shallow core from Site 2. This implies that copper continues to be deposited. Site 6 also had relatively high sediment copper concentrations.

No sediment quality objective exists for iron concentrations in Burrard Inlet sediments, nor is there a guideline. Concentrations ranged from 31,200 µg/g in the deeper core from Site 5 to 44,800 µg/g measured at both the deeper core from Site 2 and the shallow core from Site 6.

Concentrations of lead measured in the False Creek sediments exceeded the sediment quality objective value of 30 µg/g by a minimum of a factor of four in all instances. Values ranged from 123 µg/g in the deeper portion of the Site 5 core to a maximum of 355 µg/g in the deeper core from Site 2. Site 6 also had high lead concentrations in the sediment collected there.

Mercury were not measured in the sediments, and therefore it cannot be determined if concentrations exceeded the objective of 0.15 µg/g for False Creek.

No sediment quality objective exists for nickel concentrations in False Creek sediments, but the guideline is 30 µg/g. Concentrations at the nine sites ranged from 30 µg/g in the deeper portion of the Site 3 core to 48 µg/g in the deeper portion of the Site 2 core. Therefore, all but the lowest value exceeded the guideline for nickel. Nickel values seem to be at about the same concentration in both the surface and deep samples from the same sites.

Silver concentrations were generally below detection limits (<2 µg/g) at the various False Creek sites. Exceptions to this were two values equal to the detection limit (2 µg/g) in the deeper core from Site 7 and the shallow core from Site 9, a value of 6 µg/g in the deeper core from Site 5, and a maximum value of 11 µg/g in the deeper core from Site 2. No objective exists for silver concentrations in Burrard Inlet sediments, but the guideline for the protection of aquatic life gives a lowest effects level value of 1.0 µg/g. Therefore, while this guideline was definitely exceeded by four of the samples, a more sensitive analytical methodology is necessary to determine if exceedences also occurred at the other sites.

Zinc concentrations at the nine False Creek sites invariably exceeded the sediment quality objective of 150 µg/g, with values ranging between 274 µg/g in the deeper Site 5 core to a maximum of 1010 µg/g in the deeper Site 2 core.

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Appendix I. Summary of Proposed Water Quality Objectives for Burrard Inlet

Water Body	False Creek	Outer Burrard Inlet	First to Second Narrows	Second Narrows to Roche Point	Port Moody area	Indian Arm
designated use	aquatic life, wildlife	recreation, aquatic life, wildlife				
microbiological indicators	fecal coliforms: ≤ 200/100 mL geometric mean enterococci: ≤ 20/100 mL geometric mean					
suspended solids	10 mg/L maximum increase					N/A
turbidity	5 NTU maximum increase					N/A
chlorine produced oxidants	N/A			≤ 3 µg/L average		N/A
total ammonia-nitrogen	≤ 1 mg/L average; 2.5 mg/L maximum	N/A	≤ 1 mg/L average; 2.5 mg/L maximum			N/A
dissolved oxygen	6.5 mg/L minimum					
weak acid dissociable cyanide	N/A				1 µg/L maximum	N/A
sulphide, undissociated H_2S	N/A		2 µg/L maximum	N/A	2 µg/L maximum	N/A
pH	N/A			6.5 to 8.5	N/A	
total barium	N/A			0.5 mg/L	N/A	
total arsenic (in water)	N/A		10 µg/L maximum		N/A	
total cadmium (in water)	N/A		≤ 9 µg/L mean and 43 µg/L maximum			
total copper (in water)	≤ 2 µg/L mean and 3 µg/L maximum					
total chromium (in water)	50 µg/L maximum	N/A		50 µg/L maximum		N/A
total arsenic (in sediments)	20 µg/g dry weight maximum					N/A

total cadmium (in sediments)	1 µg/g dry weight maximum interim value: < 9 µg/g mean and 43 µg/g maximum	1 µg/g dry weight maximum			< 9 µg/g mean and 43 µg/g maximum
total chromium (in sediments)	60 µg/g dry weight maximum				N/A
total copper (in sediments)	100 µg/g dry weight maximum				N/A
total lead (in sediments)	30 µg/g dry weight maximum				N/A
total nickel (in sediments)	45 µg/g dry weight maximum				N/A
total mercury (in sediments)	0.15 µg/g dry weight maximum				N/A
total lead (in water)	≤ 2 µg/L mean and 140 µg/L maximum				
total lead (in fish muscle)	0.8 µg/g wet weight maximum				
total mercury (in water)	0.02 µg/L mean and 2 µg/L maximum			N/A	
total mercury (in fish tissue)	0.5 µg/g weight wet maximum			N/A	
total nickel (in water)	≤ 8 µg/L mean and 75 µg/L maximum	N/A	≤ 8 µg/L mean and 75 µg/L maximum	N/A	
total zinc (in water)	≤ 0.086 mg/L mean and 0.095 mg/L maximum				
total zinc (in sediment)	150 µg/g dry weight maximum				N/A
PCBs (in sediment)	0.03 µg/g dry weight maximum				N/A
PCBs (in fish tissue)	0.5 µg/g wet weight maximum				N/A
Chlorophenols (in sediment)	N/A	0.01 µg/g dry weight maximum	N/A		
Chlorophenols (in fish tissue)	N/A	0.1 µg/g wet weight maximum	N/A		
Chlorophenols (in water)	N/A	0.2 µg/L maximum	N/A		
tributyl tin	10 ng/L maximum		N/A	10 ng/L maximum	
phenols	N/A		1 µg/L maximum		N/A

styrene	N/A			0.05 mg/L maximum	N/A
1,2-dichloroethane or ethylene dichloride	N/A	≤ 0.2 mg/L mean and 2 mg/L maximum	N/A		
total LPAHs (in sediment)	0.5 µg/g dry weight maximum in sediment, long-term				N/A
naphthalene (in sediment)	0.2 µg/g dry weight maximum in sediment, long-term				N/A
acenaphthylene (in sediment)	0.06 µg/g dry weight maximum in sediment, long-term				N/A
acenaphthene (in sediment)	0.05 µg/g dry weight maximum in sediment, long-term				N/A
fluorene (in sediment)	0.05 µg/g dry weight maximum in sediment, long-term				N/A
phenanthrene (in sediment)	0.15 µg/g dry weight maximum in sediment, long-term				N/A
anthracene (in sediment)	0.1 µg/g dry weight maximum in sediment, long-term				N/A
total LHAHs (in sediment)	1.2 µg/g dry weight maximum in sediment, long-term				N/A
fluoranthene (in sediment)	0.17 µg/g dry weight maximum in sediment, long-term				N/A
pyrene (in sediment)	0.26 µg/g dry weight maximum in sediment, long-term				N/A
benzo(a)anthracene (in sediment)	0.13 µg/g dry weight maximum in sediment, long-term				N/A
chrysene (in sediment)	0.14 µg/g dry weight maximum in sediment, long-term				N/A
benzo-fluoranthene (in sediment)	0.32 µg/g dry weight maximum in sediment, long-term				N/A
benzo(a)pyrene (in sediment)	0.16 µg/g dry weight maximum in sediment, long-term				N/A
indeno (1,2,3-c,d) pyrene (in sediment)	0.06 µg/g dry weight maximum in sediment, long-term				N/A
dibenzo (a,h) anthacene (in sediment)	0.06 µg/g dry weight maximum in sediment, long-term				N/A
benzo (g,h,i) perylene (in sediment)	0.07 µg/g dry weight maximum in sediment, long-term				N/A

Water bodies	**Capilano River and Lynn Creek**	**School House Brook**
designated water uses	drinking water, recreation, aquatic life and wildlife	recreation, aquatic life and wildlife
phenols	1 µg/L maximum	
total chromium	2 µg/L maximum	
total iron	3 µg/L maximum	
total zinc	15 µg/L maximum	
microbiological indicators	fecal coliforms: ≤ 200/100 mL geometric mean *Escherichia coli*: ≤ 77/100 mL geometric mean enterococci: ≤ 20/100 mL geometric mean	N/A
total ammonia-nitrogen	ammonia tables	N/A
total nitrite-nitrogen	nitrite table	N/A
periphyton chlorophyll-*a*	50 mg/m^2 maximum	N/A
dissolved oxygen	11 mg/L minimum for salmonid embryo and larval stages 8 mg/L minimum for all other salmonid life stages	N/A
total cadmium	0.2 µg/L maximum	N/A
total cobalt	2 µg/L average 0.094 (hardness) + 2 µg/L maximum	N/A
total mercury	0.5 µg/g wet weight in fish flesh	N/A
total mercury	0.02 µg/L average; 0.1 µg/L maximum in water	N/A
chlorophenols	0.2 µg/L in water 0.1 µg/g wet weight in fish tissue 0.01 µg/g dry weight in sediment	N/A
PCBs	1 ng/L in water 0.5 µg/g wet weight in fish flesh 0.03 µg/g dry weight in sediment	N/A
temperature	N/A	1^o C increase over the u/s site
pH	N/A	6.5 to 9.0
total lead	N/A	see footnote #12

Appendix II. Results of Water Column Sampling in Burrard Inlet 2000

	E207818	E207816	E207814	E207813	E207812	E207823	300080	E207821
	Vancouver Harbour Clarke Drive	Vancouver Harbour Vancouver Wharves	False Creek East End	Coal Harbour	English Bay Locarno Park	Port Moody IOCO	Indian Arm at Cable Crossing	Second Narrows Chevron
	Dec. 10	Dec. 12	Dec. 12	Dec. 12	Dec. 9	Dec. 10	Dec. 10	Dec. 10
	10:50	0:00	13:25	11:30	0:00	0:00	0:00	0:00
Residue, Non-filterable	38	27	26	83	24	22	19	19
Turbidity (NTU)	2.3	2.4	1.9	1.2	2.8	0.62	0.17	0.77
2,3,4,5 - Tetrachlorophenol (µg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
2,3,4,6 - Tetrachlorophenol (µg/L)	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
2,4,6 - Tribromophenol, surrogate (%)	117	110	108	94	107	>130	107	123
Pentachlorophenol (µg/L)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Monobromobiphenyl (%)	97	99	95	98	93	89	89	93
Aroclor 1016 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1221 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1232 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1242 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1248 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Aroclor 1254 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1260 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aroclor 1262 (µg/L)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Aluminum	0.15	0.19	0.12	<0.06	0.09	<0.06	<0.06	<0.06
Antimony	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Arsenic	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Barium	0.004	0.003	0.008	0.009	0.01	0.009	0.008	0.008
Beryllium	0.005	0.005	0.005	0.004	0.004	0.004	0.003	0.004
Boron	2.95	2.87	3.19	3.25	3.13	2.97	2.45	3.19
Cadmium	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Calcium	275	267	285	288	278	263	215	282.6
Chromium	<0.006	<0.006	<0.006	<0.006	<0.006	0.009	0.006	<0.006
Cobalt	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Copper	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Iron	0.11	0.12	0.107	0.042	0.185	0.06	0.019	0.064
Lead	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Magnesium	950	944	951	924	863	846	673	918
Manganese	<0.001	0.003	0.005	0.004	0.007	0.007	0.002	0.003
Molybdenum	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus	0.3	0.3	0.3	0.3	0.3	0.2	<3	0.3
Potassium	292	292	293	284	267	260	208	285
Selenium	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Silicon	1.74	1.75	2.02	1.8	2.06	2.01	1.54	1.8
Silver	0.01	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	7890	7815	7879	7666	7130	6985	5490	7594
Strontium	4.94	4.82	5.39	5.49	5.3	5.01	4.12	5.39

Appendix II (continued)

	Vancouver Harbour Clarke Drive	Vancouver Harbour Vancouver Wharves	False Creek East End	Coal Harbour	English Bay Locarno Park	Port Moody IOCO	Indian Arm at Cable Crossing	Second Narrows Chevron
	Dec. 10	Dec. 12	Dec. 12	Dec. 12	Dec. 9	Dec. 10	Dec. 10	Dec. 10
Sulphur	702	694	698	675	637	622	490	672
Tin	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06	<0.06
Titanium	<0.002	<0.002	<0.002	<0.002	0.006	0.002	<0.002	<0.002
Vanadium	0.02	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	0.037	0.036	0.044	0.046	0.043	0.041	0.032	0.04
Nitrogen - Ammonia	0.005	0.011	0.05	0.009	0.008	0.049	<0.005	0.006

Appendix III. Results of Sediment Sampling in Burrard Inlet 2000.

Table 1. Sediment data for Vancouver Yacht Club in English Bay sites 1 and 2 (deep and shallow cores)

	Vancouver Yacht Club in English Bay Site 1	Vancouver Yacht Club in English Bay Site 1	Vancouver Yacht Club in English Bay Site 2	Vancouver Yacht Club in English Bay Site 2
	09-Dec-00	09-Dec-00	09-Dec-00	09-Dec-00
	0:00	0:00	0:00	0:00
(all units µg/g dry weight unless otherwise stated)	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Carbon, Total Organic	14400	12600	18800	18300
D: Dry Sieve, 2.00mm, %< by wt.	100	99.9	93.98	96.19
G: Wet Sieve, 0.250mm, % entire sample by wt.	84.67	61.91	87.55	89.14
H: Wet Sieve 0.125mm, % entire sample by wt.	79.5	50.58	86.47	88.11
K: Pipette, 0.053 mm, %< by wt.	75.36	46.42	83.48	86.48
M: Pipette, 0.002mm, %< by wt.	22.65	15.19	25.99	27.63
N: Gravel, >2.00mm, dry sieve, %< by wt.	<0.01	0.1	6.02	3.81
O: Sand, <2.00 mm>0.053mm, pipette, % entire sample by wt.	24.64	53.48	10.5	9.71
P: Silt, <0.053mm>0.002mm, pipette, % entire sample by wt.	52.71	31.24	57.49	58.85
Q: Clay, <0.002mm, pipette, % entire sample by wt.	22.65	15.19	25.99	27.63
Textural Category	Silt Loam	Sandy Loam	Silt Clay Loam	Silt Clay Loam
Aluminum	33803	33536	33839	29186
Antimony	<8	<8	<8	<8
Arsenic	13	12	11	<8
Barium	186	184	193	145
Beryllium	0.8	0.7	0.9	0.7
Boron	109	108	109	105

Cadmium	<0.8	<0.8	<0.8	1.1
Calcium	12193	13072	20465	16347
Chromium	55.8	55.2	56.6	53.1
Cobalt	12.3	12.8	12.4	10.5
Copper	79.3	61.3	63.6	65.5
Iron	39800	39900	38300	37800
Lead	58	48	44	44
Magnesium	14111	13687	14277	14209
Manganese	421	419	414	405
Molybdenum	<2	<2	<2	<2
Nickel	50	50	52	50
Phosphorus	943	861	882	867
Potassium	6679	6596	6988	5497
Selenium	<8	<8	<8	<8
Silicon	948	1162	1051	781
Silver	<2	<2	<2	<2
Sodium	7146	6693	8271	8569
Strontium	90.4	95.4	126	104

	Vancouver Yacht Club in English Bay Site 1	Vancouver Yacht Club in English Bay Site 1	Vancouver Yacht Club in English Bay Site 2	Vancouver Yacht Club in English Bay Site 2
(all units µg/g dry weight unless otherwise stated)	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Sulphur	5304	6112	7762	8584
Tin	<8	<8	<8	<8
Titanium	1990	2050	1990	1860
Vanadium	108	109	107	99
Zinc	149	130	130	133
Acenaphthene-d10, surrogate	81	80	82	78
Acenaphthene	0.03	0.05	0.04	0.05
Acenaphthylene	0.03	0.04	0.04	0.05
Anthracene	0.15	0.17	0.35	0.38
Benzo(a)anthracene	0.42	0.34	1.04	0.09
Benzo(a)pyrene	0.34	0.59	0.71	0.82
Benzo(b)fluoranthene	0.58	0.98	1.21	1.43

Benzo(g,h,i)perylene	0.13	0.2	0.23	0.25
Benzo(k)fluoranthene	0.42	0.68	0.87	0.98
Chrysene	0.66	0.78	1.71	1.83
Chrysene-d12, surrogate	78	84	86	76
Dibenz(a,h)anthracene	0.06	0.1	0.08	0.09
Fluoranthene	0.44	0.39	1.39	1.16
Fluorene	0.06	0.09	0.15	0.16
Indeno(1,2,3-cd)pyrene	0.18	0.33	0.31	0.35
Naphthalene	0.08	0.07	0.08	0.1
Naphthalene-d8, surrogate	71	47	69	68
Perylene-d12, surrogate	72	84	82	71
Phenanthrene	0.23	0.28	0.62	0.78
Phenanthrene-d10, surrogate	95	100	100	93
Pyrene	0.95	2.07	2.75	4.11

Table 2. Sediment data for Mosquito Creek sites 1 and 2 (deep and shallow cores).

	Mosquito Creek Site 1	Mosquito Creek Site 1	Mosquito Creek Site 2	Mosquito Creek Site 2
	12-Dec-00	12-Dec-00	12-Dec-00	12-Dec-00
	0:00	0:00	0:00	0:00
(all units µg/g dry weight unless otherwise stated)	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Carbon, Total Organic	27300	32900	33700	29000
D: Dry Sieve, 2.00mm, %< by wt.	99.95	100	99.81	100
G: Wet Sieve, 0.250mm, % entire sample by wt.	99.76	99.95	99.69	99.89
H: Wet Sieve 0.125mm, % entire sample by wt.	81.87	99.57	99.44	99.55
K: Pipette, 0.053 mm, %< by wt.	80.36	88.48	93.32	90.67
M: Pipette, 0.002mm, %< by wt.	22.6	19.55	26.28	22.37
N: Gravel, >2.00mm, dry sieve, %< by wt.	0.05	<0.01	0.19	<0.01
O: Sand, <2.00 mm>0.053mm, pipette, % entire sample by wt.	19.59	11.52	6.49	9.33
P: Silt, <0.053mm>0.002mm,	57.76	69.93	67.04	68.31

pipette, % entire sample by wt.				
Q: Clay, <0.002mm, pipette, % entire sample by wt.	22.6	19.55	26.28	22.37
Textural Category	Silt Loam	Silt Loam	Silt Loam	Silt Loam
Aluminum	26980	31078	28638	27443
Antimony	<8	<8	<8	<8
Arsenic	9	<8	8	9
Barium	100	105	116	99.5
Beryllium	0.4	0.6	0.5	0.4
Boron	105	123	112	112
Cadmium	1.6	<0.8	2.1	1.2
Calcium	11030	16294	13325	12249
Chromium	34.6	38.1	42.6	31.7
Cobalt	8.7	8.4	11	8.8
Copper	239	55.8	633	130
Iron	35000	40600	36100	34600
Lead	90	31	168	108
Magnesium	11037	13011	11455	10302
Manganese	389	450	409	398
Molybdenum	3	2	4	2
Nickel	33	37	40	29
Phosphorus	921	833	951	930
Potassium	4002	4736	4507	3787
Selenium	<8	<8	<8	<8
Silicon	763	760	721	683
Silver	<2	<2	<2	<2
Sodium	7548	7836	9297	7449
Strontium	85.8	116	98.9	100

Table 2 (continued)

	Mosquito Creek Site 1	Mosquito Creek Site 1	Mosquito Creek Site 2	Mosquito Creek Site 2
(all units µg/g dry weight unless otherwise stated)	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Sulphur	10921	16786	13603	14563
Tin	<8	<8	<8	9
Titanium	2020	2320	2060	2070
Vanadium	100	125	99	98
Zinc	214	103	360	175
Acenaphthene-d10, surrogate	82	76	77	75
Acenaphthene	0.03	0.02	0.03	0.05
Acenaphthylene	0.02	0.02	0.03	0.05
Anthracene	0.06	0.03	0.1	0.11
Benzo(a)anthracene	0.13	0.05	0.17	0.17
Benzo(a)pyrene	0.14	0.04	0.2	0.18
Benzo(b)fluoranthene	0.21	0.06	0.28	0.23
Benzo(g,h,i)perylene	0.11	0.05	0.16	0.15
Benzo(k)fluoranthene	0.17	0.05	0.23	0.21
Chrysene	0.19	0.04	0.26	0.28
Chrysene-d12, surrogate	66	61	60	57
Dibenz(a,h)anthracene	0.04	0.02	0.05	0.05
Fluoranthene	0.31	0.11	0.4	0.44
Fluorene	0.03	0.02	0.05	0.06
Indeno(1,2,3-cd)pyrene	0.12	0.06	0.19	0.15
Naphthalene	0.11	0.11	0.15	0.2
Naphthalene-d8, surrogate	79	74	75	51
Perylene-d12, surrogate	73	61	64	63
Phenanthrene	0.18	0.08	0.25	0.29
Phenanthrene-d10, surrogate	81	73	75	73
Pyrene	0.46	0.16	0.77	0.78

Table 3. Sediment data for Coal Harbour sites 1 and 2 (deep and shallow cores)

	Coal Harbour Site 1	Coal Harbour Site 1	Coal Harbour Site 2	Coal Harbour Site 2
	12-Dec-00	12-Dec-00	12-Dec-00	12-Dec-00
	0:00	0:00	0:00	0:00
(all units µg/g dry weight unless otherwise stated)	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Carbon, Total Organic	36100	53100	31000	30100
D: Dry Sieve, 2.00mm, %< by wt.	91.15	96.78	100	99.22
G: Wet Sieve, 0.250mm, % entire sample by wt.	87.31	91.94	99.64	99.11
H: Wet Sieve 0.125mm, % entire sample by wt.	82.41	83.52	99.27	98.76
K: Pipette, 0.053 mm, %< by wt.	67.31	66.16	96.3	96.26
M: Pipette, 0.002mm, %< by wt.	23.97	22.31	34.19	36.5
N: Gravel, >2.00mm, dry sieve, %< by wt.	8.85	3.22	<0.01	0.78
O: Sand, <2.00 mm>0.053mm, pipette, % entire sample by wt.	23.85	30.62	3.7	2.96
P: Silt, <0.053mm>0.002mm, pipette, % entire sample by wt.	43.34	43.85	62.11	59.76
Q: Clay, <0.002mm, pipette, % entire sample by wt.	23.97	22.31	34.19	36.5
Textural Category	Loam	Loam	Silt Clay Loam	Silt Clay Loam
Aluminum	24936	21780	33414	28675
Antimony	<8	<8	<8	<8
Arsenic	11	<8	11	14
Barium	132	103	170	142
Beryllium	0.6	0.4	0.8	0.7
Boron	99	102	114	110
Cadmium	1.4	1.6	1.3	1.6
Calcium	20847	14571	19774	17478
Chromium	35.5	28.3	51.4	49.2
Cobalt	8.9	7.5	10.6	9.4

Copper	108	37.7	224	235
Iron	30100	24200	37400	36600
Lead	70	46	89	136
Magnesium	9955	9016	13085	12690
Manganese	346	310	408	394
Molybdenum	4	<2	<2	3
Nickel	30	27	41	43
Phosphorus	765	677	1008	909
Potassium	4534	3964	6240	4964
Selenium	<8	<8	<8	<8
Silicon	696	710	742	759
Silver	<2	<2	<2	<2
Sodium	8879	9082	12463	11527
Strontium	131	104	123	114
Sulphur	14390	12685	13128	14361
Tin	11	<8	<8	8
Titanium	1780	1710	2030	1830
Vanadium	79	69	102	96

	Coal Harbour Site 1	Coal Harbour Site 1	Coal Harbour Site 2	Coal Harbour Site 2
(all units µg/g dry weight unless otherwise stated)	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Zinc	152	82.8	219	237
Acenaphthene-d10, surrogate	80	78	68	80
Acenaphthene	0.02	0.03	0.02	0.04
Acenaphthylene	0.02	0.02	0.02	0.05
Anthracene	0.21	0.05	0.09	0.16
Benzo(a)anthracene	0.37	0.07	0.16	0.27
Benzo(a)pyrene	0.24	0.04	0.16	0.36
Benzo(b)fluoranthene	0.46	0.12	0.32	0.4
Benzo(g,h,i)perylene	0.19	0.09	0.17	0.31
Benzo(k)fluoranthene	0.29	0.05	0.19	0.38
Chrysene	0.4	0.05	0.16	0.39
Chrysene-d12, surrogate	72	56	56	64

Dibenz(a,h)anthracene	0.14	0.03	0.05	0.1
Fluoranthene	1.2	0.18	0.34	0.56
Fluorene	0.04	0.03	0.03	0.06
Indeno(1,2,3-cd)pyrene	0.35	0.17	0.29	0.34
Naphthalene	0.08	0.18	0.09	0.18
Naphthalene-d8, surrogate	70	69	62	76
Perylene-d12, surrogate	73	67	55	70
Phenanthrene	0.74	0.13	0.19	0.36
Phenanthrene-d10, surrogate	83	78	68	80
Pyrene	1.27	0.19	0.56	1.01

Table 4. Sediment data for False Creek East and Granville Island in West False Creek sites 1 and 2 (deep and shallow cores)

	E207814	E207814				
	False Creek East End	False Creek East End	Granville Island in W. False Ck Site 1	Granville Island in W. False Ck Site 1	Granville Island in W. False Ck Site 2	Granville Island in W. False Ck Site 2
(all units µg/g dry weight unless otherwise stated)	Dec. 12	Dec. 12	Dec. 9	Dec. 9	Dec. 9	Dec. 9
	0-15 cm	15-30cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Carbon, Total Organic	30100	11300	27100	29000	25700	31200
D: Dry Sieve, 2.00mm, %< by wt.	99.82	99.54	92.4	95.52	99.91	74
G: Wet Sieve, 0.250mm, % entire sample by wt.	86.21	99.32	81.68	73.22	92.75	54.8
H: Wet Sieve 0.125mm, % entire sample by wt.	72.89	97.31	74.9	53.35	90.61	50.84
K: Pipette, 0.053 mm, %< by wt.	65.92	65.7	70.76	46	89.17	48.18
M: Pipette, 0.002mm, %< by wt.	24.75	13.42	26	17.9	32.21	17.04
N: Gravel, >2.00mm, dry sieve, %< by wt.	0.18	0.46	7.6	1.48	0.09	26
O: Sand, <2.00 mm>0.053mm, pipette,	33.91	33.83	21.64	52.52	10.73	25.82

% entire sample by wt.						
P: Silt, <0.053mm>0.002mm, pipette, % entire sample by wt.	41.17	52.28	44.76	28.1	56.97	31.14
Q: Clay, <0.002mm, pipette, % entire sample by wt.	24.75	13.42	26	17.9	32.21	17.04
Textural Category	Loam	Silt Loam	Clay Loam	Sandy Loam	Silt Clay Loam	Loam
Moisture content	48	40.2				
2,3,4,5 - Tetrachlorophenol	<0.0005	<0.0005				
2,3,4,6 - Tetrachlorophenol	<0.0005	<0.0005				
2,4,6 - Tribromophenol, surrogate	85	115				
Pentachlorophenol	<0.0002	<0.0002				
Aroclor 1016	<0.005	<0.005				
Aroclor 1221	<0.005	<0.005				
Aroclor 1232	<0.005	<0.005				
Aroclor 1242	<0.005	<0.005				
Aroclor 1248	<0.005	<0.005				
Aroclor 1254	<0.005	0.015				
Aroclor 1260	0.068	<0.005				
Aroclor 1262	<0.005	<0.005				
Monobromobiphenyl	89	101				
Aluminum	37094	14898	41046	35106	39228	40858
Antimony	<8	<8	<8	<8	<8	<8
Arsenic	14	<8	15	15	19	23
Barium	209	56.2	228	182	218	249
Beryllium	2.3	0.4	1.2	1.1	1.1	1.3
Boron	109	68	125	114	129	146
Cadmium	1.8	<0.8	1.1	0.9	0.9	2.1
Calcium	16071	6395	27599	40016	24016	34536
Chromium	59.5	32.7	60.5	48.9	62.6	68.3
Cobalt	12.7	10	12	13.4	11.8	11.1

Copper	134	29.6	128	91.5	201	181
(all units µg/g dry weight unless otherwise stated)	False Creek East End	False Creek East End	Granville Island in W. False Ck Site 1	Granville Island in W. False Ck Site 1	Granville Island in W. False Ck Site 2	Granville Island in W. False Ck Site 2
	0-15 cm	15-30cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Iron	37600	26800	41900	40700	45000	48800
Lead	129	24	93	269	99	180
Magnesium	12394	9663	14751	12560	14882	15526
Manganese	418	279	448	472	444	458
Molybdenum	3	<2	2	<2	2	3
Nickel	43	35	49	41	52	51
Phosphorus	910	835	940	784	1032	875
Potassium	6261	2097	8175	6379	7638	8069
Selenium	<8	<8	<8	<8	<8	<8
Silicon	784	634	885	914	999	875
Silver	<2	<2	<2	<2	<2	<2
Sodium	9820	4147	9999	7131	9402	8918
Strontium	115	44.3	145	191	141	189
Sulphur	9185	1491	10202	10935	9017	13226
Tin	13	<8	17	13	15	16
Titanium	1890	1200	2000	2240	1980	1870
Vanadium	110	64	118	127	115	119
Zinc	332	73.7	228	183	252	466
Mercury	0.412	0.051				
Acenaphthene-d10, surrogate	74	84	78	83	86	78
Acenaphthene	0.06	0.04	0.04	0.11	0.06	0.09
Acenaphthylene	0.12	0.06	0.04	0.17	0.09	0.12
Anthracene	0.24	0.06	0.09	0.17	0.21	0.2
Benzo(a)anthracene	0.42	0.23	0.16	0.2	0.49	0.32
Benzo(a)pyrene	0.5	0.18	0.16	0.22	0.56	0.48
Benzo(b)fluoranthene	0.38	0.15	0.24	0.27	0.78	0.6
Benzo(g,h,i)perylene	0.32	0.11	0.12	0.19	0.32	0.29

Benzo(k)fluoranthene	0.42	0.15	0.19	0.22	0.59	0.48
Chrysene	0.5	0.21	0.22	0.23	0.91	0.49
Chrysene-d12, surrogate	60	71	69	68	82	72
Dibenz(a,h)anthracene	0.1	0.04	0.05	0.05	0.09	0.08
Fluoranthene	0.7	0.36	0.37	0.58	1.22	0.69
Fluorene	0.09	0.04	0.05	0.14	0.09	0.11
Indeno(1,2,3-cd)pyrene	0.34	0.15	0.15	0.2	0.38	0.35
Naphthalene	0.39	0.2	0.21	0.97	0.35	0.5
Naphthalene-d8, surrogate	72	67	63	70	73	67
Perylene-d12, surrogate	60	64	66	68	81	73
Phenanthrene	0.34	0.16	0.23	0.52	0.46	0.48
Phenanthrene-d10, surrogate	71	93	90	91	102	91
Pyrene	1.24	0.46	0.65	0.83	1.83	1.78

Table 5. Sediment data for Port Moody Arm and Indian Arm sites 1 and 2 (deep and shallow cores)

	Port Moody Arm Reed Point Site 1	Port Moody Arm Reed Point Site 1	Port Moody Arm Reed Point Site 2	Port Moody Arm Reed Point Site 2	Deep Cove Site 1	Deep Cove Site 2
(all units µg/g dry weight unless otherwise stated)	Dec. 10	Dec. 10	Dec. 10	Dec. 10	Dec. 10	Dec. 10
	0-15 cm	15-30cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Carbon, Total Organic	36000	16200	38200	33000	19400	36500
D: Dry Sieve, 2.00mm, %< by wt.	100	99.79	98.13	99.76	99.21	95.69
G: Wet Sieve, 0.250mm, % entire sample by wt.	99.38	97.9	93.66	96.88	42.9	56.71
H: Wet Sieve 0.125mm, % entire sample by wt.	98.09	96.63	89.87	93.1	25.51	26.79

K: Pipette, 0.053 mm, %< by wt.	94.99	93.45	80.69	87.85	8.65	9.6
M: Pipette, 0.002mm, %< by wt.	25.33	35.17	30.79	30.23	2.08	3.08
N: Gravel, >2.00mm, dry sieve, %< by wt.	<0.01	0.21	1.87	0.24	0.79	4.31
O: Sand, <2.00 mm>0.053mm, pipette, % entire sample by wt.	5.01	6.34	17.44	11.91	90.57	86.09
P: Silt, <0.053mm>0.002mm, pipette, % entire sample by wt.	69.65	57.27	49.9	57.63	6.57	6.52
Q: Clay, <0.002mm, pipette, % entire sample by wt.	25.33	35.17	30.79	30.23	2.08	3.08
Textural Category	Silt Loam	Silt Clay Loam	Silt Clay Loam	Silt Clay Loam	Sand	Sand
Aluminum	37915	41672	36055	37793	13623	14327
Antimony	<8	<8	<8	<8	<8	<8
Arsenic	15	15	16	14	<8	<8
Barium	184	207	161	176	38.6	45.9
Beryllium	0.8	0.9	0.8	0.7	0.3	0.3
Boron	131	138	126	132	69	63
Cadmium	1.9	1.1	1.5	<0.8	<0.8	0.9
Calcium	14565	11038	18106	10477	7151	11948
Chromium	60.8	68.8	53.9	59	11.2	16.4
Cobalt	10	10.6	11.3	11.5	5.7	5.3
Copper	140	114	129	117	25.9	35.5
Iron	38900	40100	38700	40700	19900	19200
Lead	82	107	88	110	30	30
Magnesium	12420	12738	11505	12302	4890	5356
Manganese	385	404	380	397	220	256
Molybdenum	5	4	4	4	<2	<2
Nickel	34	47	33	38	17	15
Phosphorus	963	879	967	875	644	584
Potassium	7490	7954	6424	6816	1350	1793
Selenium	<8	<8	<8	<8	<8	<8

Silicon	945	1180	881	828	799	940
Silver	<2	<2	<2	<2	<2	<2
Sodium	15298	11843	11939	11527	5542	4989
Strontium	119	109	128	104	64.6	86.6
(all units µg/g dry weight unless otherwise stated)	Port Moody Arm Reed Point Site 1	Port Moody Arm Reed Point Site 1	Port Moody Arm Reed Point Site 2	Port Moody Arm Reed Point Site 2	Deep Cove Site 1	Deep Cove Site 2
	0-15 cm	15-30cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Sulphur	15657	13985	1075	12500	1889	2629
Tin	<8	29	<8	<8	<8	<8
Titanium	1780	1750	1897	2070	1350	1530
Vanadium	109	115	105	112	74	69
Zinc	242	200	220	186	54.9	75.8
Acenaphthene-d10, surrogate	48	52	72	87	53	57
Acenaphthene	0.02	0.04	0.05	0.06	<0.02	<0.02
Acenaphthylene	0.03	0.13	0.11	0.23	<0.02	<0.02
Anthracene	0.08	0.11	0.22	0.12	<0.02	<0.02
Benzo(a)anthracene	0.12	0.1	0.34	0.13	0.03	0.03
Benzo(a)pyrene	0.1	0.12	0.23	0.16	<0.02	<0.02
Benzo(b)fluoranthene	0.17	0.16	0.34	0.2	0.03	0.03
Benzo(g,h,i)perylene	0.08	0.15	0.21	0.21	0.02	0.02
Benzo(k)fluoranthene	0.12	0.11	0.31	0.14	0.03	0.02
Chrysene	0.15	0.12	0.59	0.15	0.02	0.02
Chrysene-d12, surrogate	50	47	63	72	55	60
Dibenz(a,h)anthracene	0.04	0.05	0.06	0.06	<0.02	<0.02
Fluoranthene	0.23	0.29	0.52	0.41	0.06	0.05
Fluorene	0.03	0.06	0.11	0.08	<0.02	<0.02
Indeno(1,2,3-cd)pyrene	0.1	0.14	0.21	0.19	<0.02	0.04
Naphthalene	0.12	0.38	0.42	0.6	<0.02	<0.02
Naphthalene-d8,	42	41	59	76	42	46

surrogate						
Perylene-d12, surrogate	56	50	54	74	63	58
Phenanthrene	0.18	0.32	0.52	0.44	<0.02	0.18
Phenanthrene-d10, surrogate	61	58	81	94	64	67
Pyrene	0.05	0.55	1.03	0.72	0.05	0.05

Table 6. Sediment data for Ponar grab samples collected at Burrard Inlet sites.

	E207823	E207821	E207813	E207816	E207818
	Port Moody IOCO	Second Narrows Chevron	Coal Harbour	Vancouver Harbour Vancouver Wharves	Vancouver Harbour Clarke Drive
(all units µg/g dry weight unless otherwise stated)	Dec. 10	Dec. 10	Dec. 12	Dec. 12	Dec. 12
Carbon, Total Organic	41300	14000	28700	23000	40600
D: Dry Sieve, 2.00mm, %< by wt.	99.68	75.88	99.45	76.33	86.75
G: Wet Sieve, 0.250mm, % entire sample by wt.	95.41	9.48	98	57.53	21.19
H: Wet Sieve 0.125mm, % entire sample by wt.	92.26	3.63	96.46	42.14	9.14
K: Pipette, 0.053 mm, %< by wt.	89.31	2.97	88.12	28.98	6.63
M: Pipette, 0.002mm, %< by wt.	46.09	1.16	28.49	10.46	2.45
N: Gravel, >2.00mm, dry sieve, %< by wt.	0.32	24.12	0.55	23.67	13.25
O: Sand, <2.00 mm>0.053mm, pipette, % entire sample by wt.	10.37	72.91	11.33	47.36	80.11
P: Silt, <0.053mm>0.002mm, pipette, % entire sample by wt.	43.22	1.81	59.63	18.52	4.18
Q: Clay, <0.002mm, pipette, % entire sample by wt.	46.09	1.16	28.49	10.46	2.45
Textural Category	Clay	Sand	Silt Clay	Sandy	Sand

			Loam	Loam	
Moisture content	72	18.2	57.9	42.5	31.2
2,3,4,5 - Tetrachlorophenol	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
2,3,4,6 - Tetrachlorophenol	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
2,4,6 - Tribromophenol, surrogate	84	61	70	89	71
Pentachlorophenol	0.0007	<0.0002	<0.0002	0.0008	0.0006
Monobromobiphenyl	99	104	96	108	116
Aroclor 1016	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1221	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1232	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1242	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1248	<0.005	<0.005	<0.005	<0.005	<0.005
Aroclor 1254	0.044	<0.005	0.074	0.03	0.041
Aroclor 1260	<0.005	<0.005	0.027	<0.005	<0.005
Aroclor 1262	<0.005	<0.005	<0.005	<0.005	<0.005
Aluminum	30200	13617	33938	23682	4450
Antimony	<8	<8	<8	<8	<8
Arsenic	14	<8	16	11	11
Barium	120	60	190	104	39.4
Beryllium	0.7	2	2.2	2.1	1.9
Boron	134	97	111	94	55
Cadmium	2.3	<0.8	<0.8	2.5	1.1
Calcium	13130	108710	13145	11781	11862
Chromium	60.5	31	49.4	38	24
Cobalt	10.1	7.1	11.7	10.8	5
Copper	132.9	56	194	985	199
Iron	36600	39700	36100	33300	15900
Lead	85	101	101	126	168
Magnesium	13768	5166	12380	10109	3998
(all units µg/g dry weight unless otherwise stated)	Port Moody IOCO	Second Narrows Chevron	Coal Harbour	Vancouver Harbour Vancouver Wharves	Vancouver Harbour Clarke Drive
Manganese	354	322	411	349	95.5
Molybdenum	3	<2	<2	7	9

Nickel	38	23	41	44	30
Phosphorus	1231	689	1412	1122	960
Potassium	6079	1694	6428	3731	1289
Selenium	<8	<8	<8	<8	<8
Silicon	1166	1129	857	797	1557
Silver	<2	<2	<2	<2	4
Sodium	19931	18675	10562	8135	9385
Strontium	106	667	111	84.7	60.2
Sulphur	16176	4155	6863	10145	4866
Tin	<8	17	8	<8	24
Titanium	1680	1830	1980	1710	173
Vanadium	92	147	103	92	26
Zinc	204	120	182	575	268
Mercury	0.219	0.65	0.453	0.181	1.76
Acenaphthene-d10, surrogate	69	59	78	80	82
Acenaphthene	0.04	<0.02	0.02	0.12	<0.04
Acenaphthylene	0.05	<0.02	0.03	0.02	<0.04
Anthracene	0.27	<0.02	0.06	0.25	0.04
Benzo(a)anthracene	0.74	0.06	0.16	0.33	0.11
Benzo(a)pyrene	0.39	0.23	0.17	0.24	0.09
Benzo(b)fluoranthene	0.65	0.1	0.19	0.26	0.1
Benzo(g,h,i)perylene	0.18	0.15	0.13	0.13	0.08
Benzo(k)fluoranthene	0.43	0.03	0.18	0.25	0.09
Chrysene	0.95	0.12	0.22	0.49	0.12
Chrysene-d12, surrogate	62	51	67	86	82
Dibenz(a,h)anthracene	0.1	<0.02	0.04	0.05	<0.04
Fluoranthene	1.09	0.11	0.41	0.66	0.28
Fluorene	0.11	<0.02	0.03	0.1	<0.04
Indeno(1,2,3-cd)pyrene	0.23	0.07	0.14	0.16	0.09
Naphthalene	0.21	<0.02	0.11	0.25	0.15
Naphthalene-d8, surrogate	57	48	75	77	80
Perylene-d12, surrogate	64	63	68	83	90
Phenanthrene	0.54	0.05	0.26	0.35	0.17
Phenanthrene-d10,	77	67	77	83	84

surrogate					
Pyrene	1.53	0.19	0.47	0.59	0.23

Appendix IV. Summary of sediment data collected at False Creek East sub-sites 1-9

	False Creek East Site 1	False Creek East Site 1	False Creek East Site 2	False Creek East Site 2	False Creek East Site 3	False Creek East Site 3	False Creek East Site 4	False Creek East Site 4	False Creek East Site 5	False Creek East Site 5
	Dec.12	Dec.12	Dec.12	Dec.12	Dec.12	Dec.12	Dec.12	Dec.12	Dec.12	Dec.12
(all units µg/g dry weight unless otherwise stated)	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Carbon, Total Organic	31500	53500	34600	48400	28500	27300	33900	37700	39300	28200
D: Dry Sieve, 2.00mm, %< by wt.	97.36	82.48	98.63	93.44	100	99.65	99.73	97.96	98.97	96.71
G: Wet Sieve, 0.250mm, % sample by wt.	81.01	71.45	82.38	75.2	98.73	97.1	96.42	90.26	90.29	84.27
H: Wet Sieve 0.125mm, % sample by wt.	74.24	65.28	69.44	65.15	96.47	91.16	92.47	85.43	90.12	72.41
K: Pipette, 0.053 mm, %< by wt.	67.76	60.15	58.86	60.6	89.6	78.2	87.63	82.42	72.71	52.98
M: Pipette, 0.002mm, %< by wt.	23.43	21.27	20.71	24.03	30.55	22.1	28.22	29.58	24.52	18.23
N: Gravel, >2.00mm, dry sieve, %< by wt.	2.64	17.52	1.37	6.56	<0.01	0.35	0.27	2.04	1.03	3.29
O: Sand, <2.00 mm>0.053mm, pipette, % sample by wt.	29.61	22.33	39.77	32.85	10.4	21.45	12.11	15.53	26.26	43.73
P: Silt, <0.053mm>0.002 mm, pipette, % sample by wt.	44.33	38.88	38.15	36.57	59.05	56.09	59.41	52.84	48.19	34.75
Q: Clay,	23.43	21.27	20.71	24.03	30.55	22.1	28.22	29.58	24.52	18.23

<0.002mm, pipette, % entire sample by wt.										
Textural Category	Loam	Loam	Loam	Loam	Silt Clay Loam	Silt Loam	Silt Clay Loam	Silt Clay Loam	Loam	Loam
Aluminum	37542	41953	40490	41675	33722	32453	40147	37421	37008	25811
Antimony	<8	<8	<8	13	<8	<8	<8	<8	<8	<8
Arsenic	17	21	19	26	41	41	16	14	19	13
Barium	174	225	224	290	179	173	219	238	213	132
Beryllium	0.7	1.1	1.2	1.1	1.9	1.8	1	1.1	1	0.6
Boron	115	126	121	140	97	89	119	125	112	91
Cadmium	1.2	2.3	1.6	6.2	1.6	1.8	1.8	2.8	1.6	1
Calcium	20198	29903	24941	17556	90423	88094	23502	31146	28605	18384
Chromium	51.7	61.6	61	91.4	48.4	42.6	61	63	60.7	44.6
Cobalt	12.8	12.5	11.2	11.6	10.6	8.5	12.5	11.5	11	10.9
Copper	125	148	156	238	124	103	144	139	136	79.1
Iron	40400	41300	41900	44800	32900	30600	40100	39100	38680	31200
Lead	127	209	181	355	136	154	169	190	170	123
Magnesium	13387	13564	12323	13276	11158	9510	13248	12926	12022	10307
Manganese	454	436	411	441	385	380	439	427	428	359
Molybdenum	<2	<2	<2	4	<2	<2	<2	3	2	<2
Nickel	37	43	40	48	36	30	40	41	38	34
Phosphorus	1032	917	950	1049	792	755	900	874	817	754

(all units µg/g dry weight unless otherwise stated)	False Creek East Site 1	False Creek East Site 1	False Creek East Site 2	False Creek East Site 2	False Creek East Site 3	False Creek East Site 3	False Creek East Site 4	False Creek East Site 4	False Creek East Site 5	False Creek East Site 5
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Potassium	5498	6234	6593	7041	5673	4932	6852	6859	6228	3966
Selenium	12	13	11	<8	<8	<8	8	9	<8	8

Silicon	772	844	898	881	953	895	739	808	856	855
Silver	<2	<2	<2	11	<2	<2	<2	<2	<2	6
Sodium	8991	10090	9325	11775	8721	7838	10332	10705	9791	6438
Strontium	122	161	145	152	248	250	140	180	154	114
Sulphur	9097	13768	9790	18090	10602	10777	13021	16029	12429	10633
Tin	<8	12	8	28	9	11	10	19	14	<8
Titanium	2270	1970	1590	1930	1640	1610	1990	1930	1970	1700
Vanadium	118	119	120	134	98	91	115	113	111	85
Zinc	316	542	427	1010	322	314	386	450	379	274
Acenaphthene-d10, surrogate (%)	48	70	71	70	69	75	72	72	72	73
Acenaphthene	0.25	2.66	0.69	0.48	0.25	0.55	0.57	0.46	0.44	0.22
Acenaphthylene	0.31	2.68	0.9	2.17	0.34	0.8	1.03	0.73	0.61	0.29
Anthracene	0.71	6.86	1.78	3.11	0.83	1.28	1.57	1.02	1.35	0.61
Benzo(a)anthracene	1.24	10.7	3.68	6.6	1.74	2.72	2.57	1.55	2.4	1.28
Benzo(a)pyrene	1.65	10.2	4.28	11.1	2.02	2.77	2.86	1.77	2.73	1.24
Benzo(b)fluoranthene	1.55	6.78	3	8.26	2.2	2.54	2.08	1.39	2.2	0.92
Benzo(g,h,i)perylene	1.04	4.86	2.19	5.19	1.01	1.38	1.14	0.93	1.13	0.55
Benzo(k)fluoranthene	1.22	6.78	3.16	7.8	1.63	2.13	2.08	1.3	2.02	0.89
Chrysene	1.33	13.4	3.91	8.96	1.92	2.81	2.54	1.6	2.53	1.22
Chrysene-d12, surrogate (%)	46	64	66	65	61	67	67	67	67	67
Dibenz(a,h)anthracene	0.36	1.57	0.8	1.77	0.4	0.51	0.34	0.24	0.35	0.17
Fluoranthene	2.2	20.1	6.04	8.35	3.59	9.61	4.12	2.8	4.03	2.24
Fluorene	0.51	1.67	1.02	1.17	0.44	0.83	0.94	0.69	0.76	0.32
Indeno(1,2,3-cd)pyrene	1.49	5.82	3.16	6.42	1.59	2.14	1.4	1.06	1.43	0.69
Naphthalene	2.42	7.27	1.98	5.29	1.09	2.47	11.5	3.96	2.88	0.91
Naphthalene-d8, surrogate (%)	<40	60	60	62	58	66	59	60	60	60
Perylene-d12, surrogate (%)	47	65	68	67	60	68	67	66	66	67

Phenanthrene	1.79	8.18	4.91	6.13	1.91	2.4	2.68	2	2.95	1.08
Phenanthrene-d10, surrogate (%)	54	76	79	75	72	80	86	86	86	86
Pyrene	4.81	30.8	9.48	26.2	7.2	11.5	7.89	4.71	7.84	3.21

	False Creek East Site 6	False Creek East Site 7	False Creek East Site 7	False Creek East Site 8	False Creek East Site 8	False Creek East Site 9	False Creek East Site 9
	12-Dec-00	12-Dec-00	12-Dec-00	12-Dec-00	12-Dec-00	12-Dec-00	12-Dec-00
(all units µg/g dry weight unless otherwise stated)	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Carbon, Total Organic	62200	32800	31500	32200	37800	32500	24400
D: Dry Sieve, 2.00mm, %< by wt.	94.17	99.46	88.86	99.46	96.64	97.61	98.53
G: Wet Sieve, 0.250mm, % entire sample by wt.	90.18	94.8	66.59	94.92	83.42	81.73	75.9
H: Wet Sieve 0.125mm, % entire sample by wt.	88.16	89.93	52.94	90.35	72.24	75.62	61.1
K: Pipette, 0.053 mm, %< by wt.	87.53	83.97	41.8	83.86	63.85	71.47	50.11
M: Pipette, 0.002mm, %< by wt.	30.42	30.4	12.8	29.04	20.73	25.6	16.17
N: Gravel, >2.00mm, dry sieve, %< by wt.	5.83	0.54	11.14	0.54	3.36	2.39	1.47
O: Sand, <2.00 mm>0.053mm, pipette, % entire sample by wt.	6.63	15.49	47.06	15.59	32.79	26.14	48.42
P: Silt, <0.053mm>0.002mm, pipette, % entire sample by wt.	57.12	53.75	28.99	54.83	43.11	45.87	33.94
Q: Clay, <0.002mm, pipette, % entire sample by wt.	30.42	30.4	12.8	29.04	20.73	25.6	16.17
Textural Category	Silt Clay Loam	Silt Clay Loam	Loam	Silt Clay Loam	Loam	Loam	Loam
Aluminum	37275	30479	29165	36112	35139	35633	34944
Antimony	<8	<8	<8	<8	<8	18	<8

Arsenic	22	13	13	16	13	17	12
Barium	266	175	194	206	205	436	225
Beryllium	0.9	0.9	0.8	1	0.9	1	1.1
Boron	131	114	102	113	112	121	99
Cadmium	4	2.4	3.4	3	2.6	3.2	2.2
Calcium	20996	23336	29697	27575	26199	28188	36202
Chromium	75.9	56.7	53.8	59.6	61.6	60.7	60
Cobalt	12.6	11.8	10.6	10	11.7	13.8	10.5
Copper	192	162	142	150	137	188	99.3
Iron	43100	38800	34500	38500	37400	39900	34800
Lead	292	180	204	159	225	160	139
Magnesium	14101	12827	10609	12669	11544	12758	10571
Manganese	434	409	406	424	436	421	421
Molybdenum	5	3	2	3	3	3	<2
Nickel	47	46	41	43	38	41	36
Phosphorus	1049	902	838	890	918	884	768

	False Creek East Site 6	False Creek East Site 7	False Creek East Site 7	False Creek East Site 8	False Creek East Site 8	False Creek East Site 9	False Creek East Site 9
(all units µg/g dry weight unless otherwise stated)	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Potassium	6815	4838	4482	6128	5668	5975	6173
Selenium	8	<8	<8	<8	<8	<8	17
Silicon	882	822	731	821	856	848	777
Silver	<2	<2	2	<2	<2	2	<2
Sodium	13927	10049	7124	10886	8392	9702	6845
Strontium	160	131	168	157	162	161	192
Sulphur	18829	12344	11985	12329	14103	11774	11269
Tin	21	17	22	16	16	13	14
Titanium	2010	1750	1860	1900	870	1940	1770
Vanadium	117	101	97	109	106	112	104
Zinc	766	416	449	397	527	379	356
Acenaphthene-d10, surrogate (%)	65	77	70	76	69	68	73
Acenaphthene	91.2	0.39	15.7	0.13	1.65	0.13	0.12

Acenaphthylene	91.5	0.83	8.56	0.26	0.64	0.18	0.21
Anthracene	118	1.36	13.2	0.47	2.87	0.44	0.44
Benzo(a)anthracene	78.6	2.2	9.08	0.94	2.92	0.97	0.82
Benzo(a)pyrene	46.1	2.69	6.83	0.82	2.54	1.07	1.07
Benzo(b)fluoranthene	33.6	2.03	3.81	0.92	1.76	0.99	0.98
Benzo(g,h,i)perylene	17.8	1.36	2.18	0.76	1.05	0.51	0.57
Benzo(k)fluoranthene	35.3	2	3.38	1.05	1.8	0.84	0.88
Chrysene	74	2.34	8.27	1.13	2.9	0.99	0.91
Chrysene-d12, surrogate (%)	61	69	70	64	70	67	73
Dibenz(a,h)anthracene	3.5	0.34	0.7	0.2	0.32	0.17	0.16
Fluoranthene	172	3.57	19.4	1.4	6.93	1.47	1.31
Fluorene	117	0.76	12.6	0.21	1.54	0.17	0.2
Indeno(1,2,3-cd)pyrene	27.7	1.52	2.75	0.77	1.29	0.66	0.67
Naphthalene	384	3.47	23.8	0.8	1.92	0.49	0.78
Naphthalene-d8, surrogate (%)	52	63	68	73	58	53	60
Perylene-d12, surrogate (%)	63	75	69	70	71	69	75
Phenanthrene	385	2.58	37.1	0.84	3.88	0.8	0.82
Phenanthrene-d10, surrogate (%)	95	89	89	76	87	84	91
Pyrene	199	6.43	23	3.09	8.28	2.45	2.4