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Pacific and Yukon Region

PHTHALATE ESTERS IN HARBOUR AREAS OF SOUTH COASTAL BRITISH COLUMBIA

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PHTHALATE ESTERS IN HARBOUR AREAS OF SOUTH COASTAL BRITISH COLUMBIA

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BY

C.L. GARRETT

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ABSTRACT

This report summarizes information on phthalate esters in harbour areas of south coastal British Columbia, obtained from select studies conducted by Environment Canada, Commercial Chemicals Division, Pacific and Yukon Region between 1989 and 1992. This report also documents existing information on potential sources of phthalate esters to the British Columbia environment and existing Canadian and BC provincial regulations and environmental quality guidelines pertaining to these compounds.

A general overview of the toxicity and environmental levels of these compounds in other areas of the world has been presented to provide a broader context for the British Columbia data.

Résumé

Ce rapport résume des informations au sujet d'esters *phthalates* dans les zones de ports de la côte sud de la Colombie Britannique qui ont été obtenues dans certaines études faites entre 1989 et 1992 par le Ministère de l'environnement du Canada pour les régions du Pacifique et du Yukon. Ce rapport présente également de façon détaillée les informations qui existent déjà au sujet des provenances possibles des esters *phthalates* dans l'environnement de la Colombie Britannique et des réglementations qui existent au niveau du Canada et de la province de la CB et des directives de qualité de l'environnement qui se rapportent à ces composés.

Une vue d'ensemble générale de la toxicité et des niveaux des ces composés dans l'environnement dans d'autres régions du monde a été présentée pour donner un contexte plus large aux données concernant la Colombie Britannique.

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SUMMARY AND RECOMMENDATIONS

Summary

- Phthalate esters have been widely used as plasticizers in polyvinyl chloride resins, adhesives, cellulose film coatings, food wraps, plastic tubing, floor tiles, plastic furniture, upholstery, toys, shower curtains, and medical equipment. Smaller amounts have been used in cosmetics, insect repellents, insecticide carriers, lacquers, propellants, and defoaming agents in paper manufacturing.

- The manufacture of phthalate esters can result in their release to the environment, as can the manufacture, use and disposal of products containing these compounds. Other possible sources of phthalate esters to the environment include effluents from chemical, textile, paints, coatings, plastics, rubber, resin, and paper and allied products industries; wastewater from coal mines, coal preparation plants, and coal overflows; urban stormwater; wash water from commercial automatic vehicle washing facilities; stack emissions from coal-fired power plants and hazardous waste combustion; and flyash from municipal incinerators. Phthalate esters can be released to indoor air from carpets, vinyl flooring, and vinyl wall coverings.

- Limited information on the use of phthalate esters in select industry sectors in British Columbia is available. A use pattern survey of the paints and coatings industry in British Columbia identified the use of di-n-butyl phthalate (DBP) and di-n-octyl phthalate (DnOP) as plasticizing agents in the production of paints and coatings. Phthalate esters were detected in latex effluents, sludge effluents, and baghouse dusts (Krahn 1985a; Sigma 1985). Phthalate esters are also used as plasticizers by the resin and rubber industries in British Columbia but these compounds were not listed among the raw materials used by the plastics industry in the province. However, phthalate esters are likely contained in the resin bases which are imported into British Columbia and used in the manufacturing of plastic products (Krahn 1985b; Sigma 1986).

- There is little information on sources of phthalate esters to the environment in British Columbia. A study conducted for Environment Canada to determine sources and releases of toxic substances in wastewaters discharged to the Georgia Basin identified information on phthalate ester concentrations in effluents from Capital Regional District (CRD) wastewater treatment plants and from Greater Vancouver Regional District (GVRD) wastewater treatment plant effluents, combined sewer overflows, and urban runoff. However, this data was not considered adequate for estimating loadings (Environment Canada 1999).

- Recent upgrades at municipal waste treatment facilities and the implementation of municipal by-laws and source control initiatives to reduce the discharge of chemicals to storm sewers, have undoubtedly reduced releases of a variety of toxic substances (including phthalate esters)

to the British Columbia environment. In addition, although the presence of phthalate esters has not been measured at the many contaminated sites identified in British Columbia, the remediation of these sites, triggered by unacceptable levels of other toxic substances, would also have been effective in reducing environmental releases of phthalate esters.

- No information was available on the atmospheric deposition of phthalate esters in British Columbia, however, this has been shown to be an important source of these compounds to the Great Lakes.

- Information on concentrations of phthalate esters in the aquatic environment of British Columbia is limited and problems associated with sample contamination have been documented in virtually all studies to date. The measurement of concentrations of phthalate esters in environmental samples is difficult and requires great care during both sample collection and sample analysis. The wide use of these compounds in plastics can readily result in the inadvertent contamination of samples during both collection and analysis. A discussion of problems associated with the analysis of environmental samples for Environment Canada is presented in the discussion section in Appendix 1.2.1.

- Many of the sediment and biota samples collected during Environment Canada surveys conducted in south coastal harbour areas between 1989 and 1992 contained phthalate ester concentrations above the detection limit and the levels of background contamination detected in procedural blanks. However, quality control samples indicated that, for several of these samples, the detected concentrations may have been due, in part, to sample contamination. Therefore, the reported concentrations may have overestimated the concentrations present in these samples.

- Phthalate esters were detected in most blank samples run during the analyses of Environment Canada samples. However, blank corrected data revealed the presence of dimethyl phthalate (DMP), diethyl phthalate (DEP), di-n-butyl phthalate (DBP), butylbenzyl phthalate (BBP), bis(2-ethylhexyl) phthalate or di(2-ethylhexyl) phthalate (DEHP), and di-n-octyl phthalate (DnOP) in sediment and aquatic biota from several sites in the lower Fraser River and in Vancouver, Victoria, Esquimalt and Ladysmith harbours. While the detection limits for several of the phthalate ester compounds were high due to blank contamination, concentrations of several thousand ng/g dry weight were detected in some sediment samples. Phthalate esters were detected in biota in the hundreds of ng/g wet weight range with some samples containing more than 1000 ng/g. Phthalate esters were not detected in sediments or biota collected from reference areas.

- A small number of other studies have been conducted by other agencies in British Columbia and have reported similar concentrations of phthalate esters in sediments and aquatic biota .

- There are currently no Canadian sediment quality criteria for phthalate ester compounds, however, the concentrations of individual phthalate ester concentrations in British Columbia sediments exceeded the non-regulatory Puget Sound AET values (Table 1) and the Puget Sound Dredged Disposal Analysis Sediment Quality screening levels (Table 2) at some sites.

- Surf scoters collected by the Canadian Wildlife Service in Burrard Inlet in 1999 contained phthalate esters in the hundreds to thousands of ng/g range.

- bis(2-ethylhexyl) phthalate or di(2-ethylhexyl) phthalate (DEHP) and di-n-butyl phthalate (DBP) were detected more commonly and at higher concentrations than were other phthalate ester compounds in sediments, aquatic biota and surf scoters. This finding is in agreement with studies conducted in other areas of the world.

Recommendations

- Develop standardized procedures for the collection and analysis of samples in order to minimize sample contamination and improve data reliability. These procedures should include QA/QC samples and replicates to ensure analytical reliability and also the analysis of field blanks to measure the contamination of samples during collection and handling in the field.

- Compile a list of possible hot spots of environmental contamination in British Columbia wastewater receiving environments confirmed by selective sampling of sediments and biota and obtain loadings estimates from these plants.

- Obtain information on the atmospheric deposition of phthalate esters to the British Columbia environment.

- Obtain information on phthalate ester concentrations in species of shellfish and finfish harvested commercially and/or recreationally for human consumption.

- Due to the lack of adequate information on the bioaccumulative potential of phthalate ester compounds, and indications that much of the information in the current literature may overestimate BCFs for aquatic species, more reliable information is required.

- Information on the food-chain biomagnification of phthalate esters is lacking and should be obtained. It is expected that work currently being undertaken by researchers at Simon Fraser University will provide some information.

- Information is required on the toxicity of sediment-associated phthalate esters to local species of aquatic organisms.
- Information on the presence of phthalate esters in aquatic birds and mammals in British Columbia is needed.
- The need for the development of Canadian environmental quality guidelines should be considered.
- In view of the existence of Puget Sound screening levels for phthalate esters, the need for Canadian ocean disposal criteria for these compounds needs further discussion.

1. INTRODUCTION

Phthalate esters are esters of phthalic acid (1,2-benzene dicarboxylic acid). They were first introduced in the 1920s and have been widely used by industry since the 1940s. Phthalate esters have been widely used as plasticizers in polyvinyl chloride resins, adhesives, cellulose film coatings, food wraps, plastic tubing, floor tiles, plastic furniture, upholstery, toys, shower curtains, and medical equipment. Smaller amounts have been used in cosmetics, insect repellents, insecticide carriers, lacquers, propellants, and defoaming agents in paper manufacturing (Environment Canada/Health Canada 1993 a,b,c).

The manufacture of phthalate esters can result in their release to the environment (particularly to the atmosphere) as can the manufacture, use, and disposal of products containing these compounds. Other possible sources of phthalate esters to the environment include effluents from chemical, textile, paints, coatings, plastics, rubber, resin, and paper and allied products industries; wastewater from coal mines, coal preparation plants, and coal overflows; urban stormwater; wash water from commercial automatic vehicle washing facilities; stack emissions from coal-fired power plants and hazardous waste combustion; and flyash from municipal incinerators. Atmospheric deposition, by both dry and wet precipitation, is an important source of phthalate esters into the aquatic environment. Phthalate esters can be released to indoor air from carpets, vinyl flooring, and vinyl wall coverings (Environment Canada/Health Canada 1993 a,b,c).

The presence of phthalate esters in the environment is of concern. Their potential to produce adverse biological effects in a variety of aquatic organisms has been demonstrated in the laboratory. Bioaccumulation has been observed in aquatic organisms, but varies depending on the ability of individual species to metabolize these compounds. Although it has been suggested that biomagnification in the aquatic food chain is unlikely, studies on biomagnification are lacking (Environment Canada/Health Canada 1993 a,b,c).

Several of the commercially used phthalate esters have been detected in the atmosphere, surface water, sediment, and biota in Canada and other areas of the world. The highest environmental concentrations have been detected in industrial and urban areas. However, due to their widespread use, phthalate esters can occur in laboratory air and reagents as well as in analytical and sampling equipment. For this reason, considerable care must be taken to avoid contamination of samples during collection and analysis. Although more recent information on concentrations of phthalate esters in the environment is considered to be more reliable than data collected prior to the 1980s, care must be taken in the interpretation of the analytical results for these compounds (Environment Canada/Health Canada 1993 a,b,c).

This report summarizes information on phthalate ester compounds in the aquatic environment of British Columbia obtained from select studies conducted by Environment

Canada, Pacific and Yukon Region between 1989 and 1992. These studies were conducted to determine the presence of phthalate esters and other chemical contaminants in industrialized harbour areas of south coastal British Columbia. Problems associated with sample contamination have been documented in virtually all studies conducted in British Columbia, to date. The reliability of the analytical results presented in the report is discussed.

A general overview of the toxicity and environmental levels of these compounds in other areas of the world has been presented to provide a broader context for the British Columbia data.

This report also documents the existing legislation and guidelines controlling the use and release of these compounds in British Columbia.

2. USES AND SOURCES OF RELEASE

Phthalate esters[1] have been widely used by industry since the 1940s, mainly as plasticizers in polyvinyl chloride resins, adhesives, and cellulose film coatings. These compounds provide flexibility to products such as food wraps, plastic tubing, floor tiles, plastic furniture, upholstery, toys, shower curtains and medical equipment. Smaller amounts are used in cosmetics, insect repellents, insecticide carriers, lacquers, propellants, and defoaming agents in paper manufacturing. BBP was used in certain pest control products, however, the registration of these products in Canada expired at the end of 1996. The amount of phthalate esters in products varies, but can constitute over 50% by weight. Approximately 20 phthalate esters are used commercially but DEHP accounts for 40 to 50% of the annual global production of phthalate esters (Environment Canada/Health Canada 1993a,b,c; Environment Canada/Health Canada 2000; Giam *et al.* 1984; Pierce *et al.* 1980).

Canadian production, import, and use information was obtained for some phthalate esters in 1993. The total production of DEHP at the two Canadian manufacturing facilities in eastern Canada in 1993 was five kilotonnes. DnOP and BBP are not manufactured in Canada, while the production of DBP at Canadian facilities ceased in 1988. Phthalate esters are also imported into Canada as commercial chemicals (mainly from the United States) and in association with manufactured products (CIS 1992 a,b; Environment Canada/Health Canada 1993 a,b,c; Environment Canada/Health Canada 2000).

The manufacture of phthalate esters can result in their release to the environment, as can the manufacture, use and disposal of products containing these chemicals. Losses associated with the production of these chemicals are primarily to the atmosphere (Environment Canada/Health Canada 1993a).

Other possible sources of phthalate esters to the environment include effluents from chemical, textile, paints, coatings, plastics, rubber, resin, and paper and allied products industries; wastewater from coal mines, coal preparation plants, and coal storage transfer terminals; landfill leachate; wastewater treatment plants; combined sewer overflows; urban stormwater; wash water from commercial automatic vehicle washing facilities; stack emissions

[1] Phthalate esters are referred to by the following abbreviations:

DMP - dimethyl phthalate
DEP - diethyl phthalate
DBP - di-n-butyl phthalate
BBP - butylbenzyl phthalate
DEHP - bis(2-ethylhexyl)phthalate or di(2-ethylhexyl) phthalate
DnOP - di-n-octyl phthalate
DIDP - diisodecyl phthalate
DAP - diallyl phthalate
DIBP - diisobutyl phthalate

from coal-fired power plants and hazardous waste combustion; and flyash from municipal incinerators. Phthalate esters can be released to indoor air from carpets, vinyl flooring, and vinyl wall coverings (Atwater *et al.* 1990; Bauer and Hermann 1997,1998; Brownlee and Strachan 1977; Carry *et al.* 1989; Eiceman *et al.* 1979; Hargesheimer and Lewis 1987; Iannuzzi *et al.* 1997; Krahn 1985a,b; Kohli *et al.* 1989; Oman and Hynning 1993; Oppelt 1987; Paxeus 1996; Rogers *et al.* 1986; Webber and Lesage 1989).

Little information is available on the sources of phthalate esters to the environment in British Columbia. A study was conducted for Environment Canada to determine the sources and releases of selected toxic substances in wastewaters discharged to the Georgia Basin (Environment Canada 1999). The report noted that information was available on phthalate ester concentrations in effluents from Capital Regional District (CRD) wastewater treatment plants, and from Greater Vancouver Regional District (GVRD) wastewater treatment plant effluents, combined sewer overflows, and urban runoff. Phthalate esters were detected in the liquid effluent discharges and suspended solids from GVRD combined sewer outfalls (CSOs) in the Vancouver area at concentrations in the thousands of ng/L range and ng/g range, respectively. Phthalate esters were among the most abundant organic contaminants identified in wastewater treatment plant samples (raw influents, treated effluents, and effluent suspended solids) collected from Annacis Island, Iona Island, Lions Gate, and Lulu Island treatment plants in a 1997 Greater Vancouver Regional District (GVRD) study. DEHP and DEP were the dominant compounds detected in raw influents and in both primary and secondary treatment effluents. Concentrations of DMP were typically in the hundreds of ng/L in the influent and effluent, while DEP, DBP, BBP and DEHP were present in the thousands of ng/L range. Although the presence of DnOP was also detected, this compound could not be reliably quantified. Samples of suspended solids from effluents at the wastewater plants contained DBP, BBP and DEHP in the thousands of ng/g (dry weight) range, however, DMP, DEP, and DnOP were not present at concentrations above the limits of detection. DEHP was present at the highest concentrations in influent, effluent and suspended solids samples (GVRD 1998; Paine and Chapman 2000). Capital Regional District (CRD) also identified phthalate esters in wastewater discharges from the Clover Point, Macauley Point, Central Saanich, and Sidney outfalls on Vancouver Island (Environment Canada 1999). The three treatment plants located on the Saanich Peninsula (Central Saanich, Bazan Bay, and Sidney) are no longer operated by the CRD. Flows from these treatment plants have been diverted to the new Saanich Peninsula Wastewater Treatment Plant. The Central Saanich plant is now operated by the Tsawout First Nation and the Bazan Bay and Sidney treatment plants were decommissioned. In future, information on effluent concentrations of phthalate esters will be available for the Clover, Macaulay, and Saanich Peninsula wastewater treatment plants (Larose 2001).

Sample contamination was evident in the QA/QC data from both the CRD and GVRD studies. Due to difficulties associated with overcoming sample contamination problems, loadings estimates for phthalate esters were not included in the report on wastewater sources of

toxic substances prepared for Environment Canada. However, because of the environmental concerns associated with phthalate esters, the report recommended that improved methods be developed to control sample contamination and improve analytical reliability (Environment Canada 1999).

The National Pollutant Release Inventory (NPRI 1996) did not identify any industrial sources of phthalate esters in British Columbia, however, limited information on the use of phthalate esters in select British Columbia industry sectors is available. A use pattern survey of the paints and coatings industry of British Columbia in 1985 determined that approximately 16,000 litres of DBP and 3790 litres of DnOP were used annually by this industry as plasticizing agents in the production of paints and coatings. Phthalate esters were detected in latex effluents, sludge effluents and baghouse dusts (Krahn 1985a; Sigma 1985). A characterization of chemical use patterns in the plastics, rubber and resin industries in British Columbia in 1985 found that phthalate esters were used as plasticizers by the resin and rubber industries. The maximum consumption of DBP by the resin industry was >5000 kg/yr, while the rubber industry consumed <800 kg/yr of DBP and <1500 kg/yr of DnOP. Phthalate esters were not among the raw materials listed by the plastics industry in British Columbia. The plastics industry commonly utilizes various phthalate esters as plasticizers in the formulation of raw PVC and other plastic products, however, there were no such facilities identified in British Columbia. Phthalate esters are likely contained in the resin bases which are imported into British Columbia and used in the manufacturing of plastic products (Krahn 1985b; Sigma 1986).

Phthalate esters were not detected in effluent from a paper recycling plant in British Columbia in 1991 (detection limits ranged from 5 to 10 μg/L) (Swain and Walton 1992).

No information was available on the contribution of atmospheric deposition to phthalate esters loadings to the British Columbia environment, however, this has been shown to be an important source of phthalate esters to the Great Lakes (Eisenreich *et al.* 1981).

3. REGULATIONS, GUIDELINES AND CONTROLS

3.1 Controls on Release to the Environment

Federal and provincial legislation and regional government by-laws can be used to provide controls on the entry of phthalate esters into the environment.

Although the existing regulations under the federal *Canadian Environmental Protection Act* (CEPA) do not specifically address phthalate esters, the general provision of the federal *Fisheries Act* (subsection 36(3)) prohibits the deposit of substances that are deleterious to fish into a place where the substance may enter or does enter waters that are frequented by fish. Under this provision, the discharge of any quantity of a deleterious substance is prohibited, unless there is a regulation that permits that discharge. Under the *Fisheries Act,* any substance which may harm fish or alter fish habitat is considered deleterious.

Environment Canada and other government agencies have developed best management practices (BMPs) for a number of activities to minimize the input of contaminants into the environment. In particular, the implementation of the BMPs and pollution prevention practices prepared for shipyards, boat building and repair facilities; marinas and small boatyards; commercial car and truck wash facilities; and stormwater from select industrial facilities, would result in the reduction of phthalate ester releases to the environment .

The provincial *Waste Management Act* (WMA) controls the handling, disposal, and release of wastes from industrial, provincial, and municipal sources. Through a permitting system, this legislation enables allowable releases to be set for pollutants discharged in wastewater and released to the atmosphere. No permits currently contain requirements for phthalate ester compounds. Provincial Contaminated Sites Regulations under the authority of the WMA and criteria for various contaminants in soils and water of different use categories have been established. However, there are currently no criteria for phthalate esters.

Regional government by-laws such as the GVRD By-law 164 and CRD By-law 2922 have recently been implemented to control wastewater levels of contaminants at the source by limiting the levels entering the sewage system. Phthalate ester compounds are not currently included in the list of controlled substances under these By-Laws.

3.2 Environmental Quality Guidelines

Canadian interim environmental quality guidelines for the protection of aquatic life were developed by the Canadian Council of Ministers of the Environment (CCME). The

interim guidelines for phthalate ester compounds (di-n-butyl phthalate (DBP) and di(2-ethylhexyl) phthalate (DEHP)) are presented in Table 1. It was determined that insufficient information was available to set an interim guideline for di-n-octyl phthalate (DnOP). There are currently no Canadian guidelines for phthalate esters in marine water or in freshwater or marine sediments.

Table 1: Canadian Water Quality Guidelines for Phthalate Esters for the Protection of Aquatic Life (CCME 1999)

Phthalate Ester	Guideline value (µg/L)
DEHP	16*
DBP	19*

* Interim guideline

BC Ministry of Water, Land and Air Protection (BC WLAP) does not currently have approved provincial water quality or sediment quality guidelines for phthalate esters.

3.3 Human Health Guidelines

As a result of the review of the effects of four phthalate esters on human health under Section 11 of the *Canadian Environmental Protection Act* (CEPA 1988), it was concluded that:

- "dibutyl phthalate is not entering the environment in a quantity or concentration or under conditions that may constitute a danger to human life or health" (Environment Canada/Health Canada 1993b).
- "bis(2-ethylhexyl) phthalate may enter the environment in a quantity or concentration or under conditions that may constitute a danger in Canada to human health" (Environment Canada/Health Canada 1993a).
- "there is insufficient information to conclude whether DnOP is entering the environment in a quantity or concentration or under conditions that constitute a danger to human life or health" (Environment Canada/Health Canada 1993c).
- "BBP is not entering the environment in a quantity or concentration or under conditions constituting a danger in Canada to human life or health. Therefore, BBP is not considered to

be "toxic" as defined in Paragraph 11 (c) of CEPA" (Environment Canada/Health Canada 2000).

There are presently no Canadian guidelines on acceptable levels of phthalate ester compounds in fish and shellfish for human consumption. Incidents of elevated concentrations of phthalate esters in commercially important species would be reviewed by Health Canada on a case by case basis.

4. PRESENCE IN THE ENVIRONMENT

4.1 Toxicity to Aquatic Organisms

Adverse biological effects have been observed in a variety of aquatic organisms exposed to phthalate esters in laboratory experiments. These include decreased survival for various life stages of a wide range of aquatic organisms; decreased growth and photosynthetic activity in algae; decreased larval development in grass shrimp (*Palaemontes pugio*); reduced locomotor activity in *Gammarus pulex*; impaired reproduction, growth rate, fertility, and molting in *Daphnia magna*; and reproductive impairment, reduced growth, reduced locomotor activity and other cardiovascular toxicity, alterations in steroid metabolism, and weak estrogenic activity (for some phthalates) in fish (Acey *et al.* 1987; Buccafusco *et al.* 1981; Christiansen *et al.* 1998; DeFoe *et al.* 1990; EG&G 1984; Freeman *et al.* 1981; Gledhill *et al.* 1980; Knudsen and Pottinger 1999; Mayer *et al.* 1986; Patyna 1999; Randall *et al.* 1983; Rhodes *et al.* 1995; Staples *et al.* 1997b; Sabourault *et al.* 1999; Tagatz *et al.* 1983; Thuren and Woin 1991; Zou and Fingerman 1997).

The toxicity of phthalate ester compounds is determined by the configuration of the ester and its solubility in water (Adams *et al.* 1995). Low molecular weight phthalate esters (alkyl chain lengths of up to 4 carbon atoms) were acutely toxic in the µg/L to mg/L range. DMP, DEP, DBP, and BBP exhibited increased toxicity with decreased water solubilities. Higher molecular weight phthalate esters, such as DEHP and DIDP, which have alkyl chain lengths of 6 or more carbon atoms, have very low water solubilities and did not exhibit acute toxicity at water concentrations approaching solubility (Adams *et al.* 1995; Brown *et al.* 1998; DeFoe *et al.* 1990; Parkerton and Konkel 2000; Rhodes *et al.* 1995; Staples *et al.* 1997a, b). Staples *et al.* (1997b) observed that, of the 18 compounds for which toxicity information was available, only 6 compounds (DMP, DEP, DAP, DBP, DIBP, and BBP exhibited acute or chronic effects consistently. They concluded that, due to their very low solubilities, the presence of higher molecular weight phthalate esters in the environment was unlikely to present a toxic threat to most aquatic species.

Toxic effects have also been observed in aquatic organisms exposed to sediments containing phthalate esters, although the concentrations in sediments which were observed to cause toxic effects were generally higher than the concentrations in water which caused toxic effects. For example, a concentration of 4,000 µg/L (4 ppm) DBP in water caused reductions in the numbers of chordates, molluscs, arthropods, and annelids in field colonized communities, but no significant effects were observed following exposure to 100,000 ng/g (100 µg/g or 100 ppm) DBP in sediments. A concentration of 1,000,000 ng/g (1000 µg/g or1000 ppm) DBP in sediments affected only echinoderms and molluscs (Tagatz *et al.* 1983, 1986). Reduced success catching prey was observed in dragonfly larvae exposed to approximately 600,000 ng/g (600 µg/g or 600 ppm) DEHP in sediment (wet weight) for 3 to 9 weeks (Woin and Larsson 1987), but no effects on development from the larval to adult stage were observed in the midge, *Chironomus riparius*, exposed to sediment containing up to 10,000,000 ng/g (10,000 µg/g or 10,000 ppm) dry weight DEHP or DIDP (Brown *et al.* 1996).

There are no Canadian sediment quality guidelines for phthalate esters. In the late 1980s, the United States Environmental Protection Agency, United States Army Corps of Engineers, and the Washington State Departments of Ecology and Natural Resources jointly developed Apparent Effects Threshold (AET) values for Puget Sound (refer to Table 2). An AET is the concentration of a contaminant in sediment above which statistically significant adverse effects on an indicator organism are always expected to occur. AETs are not sediment quality guidelines but can be used as tools in developing sediment quality guidelines.

Table 2: 1988 Puget Sound AET Values for Phthalate Esters (ng/g) (normalized to dry weight) (Barrick *et al.* 1988)

Phthalate Ester	Amphipod AET	Oyster AET	Benthic AET	Microtox AET
Dimethyl phthalate (DMP)	>1,400	160	>1,400	71
Diethyl phthalate (DEP)	>1,200	>73	200	>48
Di-n-butyl phthalate (DBP)	1,400	1,400	>5,100	1,400
Butyl benzyl phthalate (BBP)	900	>470	900	63
Bis (2-ethylhexyl)phthalate) (DEHP)	>3,100	1,900	1,300	1,900
Di-n-octyl phthalate (DnOP)	>2,100	>420	6,200	no AET available

> indicates that a defined AET could not be established because there were no "effects" stations with chemical concentrations above the highest concentration among "no effects" stations

PSDDA (Puget Sound Dredged Disposal Analysis) developed screening level (SL) and maximum level (ML) values for a variety of chemicals for use in regulatory decision making regarding the disposal of dredged material in Puget Sound (PSDDA 2000). The screening level values are used as guidelines for identifying sediments requiring biological testing prior to unconfined open-water disposal. Although it is believed that the disposal of

sediments containing chemical contaminant concentrations below the screening levels is unlikely to result in unacceptable adverse effects to biota, biological testing may be required on sediments exceeding SL values. Maximum level values are the chemical concentrations in sediments above which the unconfined open-water disposal would be unacceptable and represent the upper limit for which biological testing may influence regulatory decision making. Table 3 lists PSDDA screening level values for phthalate ester compounds. Maximum level values have not been developed for phthalate esters.

Table 3: Puget Sound Dredged Disposal Analysis Sediment Quality Values for Phthalate Ester Compounds (PSDDA 2000) (ng/g dry weight)

Compound	Screening Level
Dimethyl phthalate (DMP)	1400
Diethyl phthalate (DEP)	1200
Di-n-butyl phthalate (DBP)	5100
Butyl benzyl phthalate (BBP)	970
Di-n-octyl phthalate (DnOP)	6200
Bis-(2-ethylhexyl) phthalate (DEHP)	8300

The *Canadian Environmental Protection Act* (CEPA 1988) Priority Substances List includes four phthalate ester compounds (DBP, DEHP, DnOP, BBP). Under the requirements of CEPA, these substances were assessed to determine whether they were "toxic" as defined under Section 11(a) of the Act. The CEPA assessment reports on these substances made the following conclusions relating to their potential for causing harmful effects on the environment.

Dibutyltin Phthalate (DBP): "it has been concluded that dibutyl phthalate is not entering the environment in a quantity or concentration or under conditions that may have a harmful effect on the environment" (Environment Canada/Health Canada 1993b).

Bis(2-ethylhexyl) Phthalate (DEHP): " there is insufficient information to conclude whether bis(2-ethylhexyl) phthalate is entering or may enter the environment in a quantity or concentration or under the conditions that are having a harmful effect on the environment" (Environment Canada/Health Canada 1993a).

Di-n-Octyl Phthalate (DnOP): "it has been concluded that DnOP is not entering the environment in a quantity or under conditions that are having a harmful effect on the environment" (Environment Canada/Health Canada 1993c).

Butylbenzyl Phthalate (BBP): it is concluded that butylbenzyl phthalate is not entering the environment in a quantity or concentration or under conditions having or that may have an immediate or long-term harmful effect on the environment (Environment Canada/Health Canada 2000).

4. 2 Fate in the Environment

The distribution and fate of phthalate esters in the environment is controlled by processes such as photo-oxidation in the atmosphere, partitioning to soils and bottom sediments, uptake by biota, and biodegradation in surface water, sediment, and soil. Photolysis and hydrolysis are ineffective degradation processes for phthalates in the aquatic environment (Giam *et al.* 1984; Howard 1991; Schwartzenbach *et al.* 1992; Vitali *et al.* 1997; Wolfe *et al.* 1980 a,b).

The behaviour of individual phthalate esters in the environment is determined largely by the length of the alkyl chain which affects their physical and chemical properties (Table 4). Aqueous solubilities and vapour pressures decrease significantly with increasing molecular weights of the compounds. Although, the solubilities of phthalate esters can be difficult to determine due to their tendency towards colloidal dispersion in water (Environment Canada/Health Canada 1993 a,b,c; 2000), most phthalate esters have low water solubilities. High octanol/water partition coefficient (K_{ow}) have been reported for phthalate esters, and it has been reported that the octanol-water partition coefficients (K_{ow}s) of phthalate esters increase by eight orders of magnitude as the alkyl chain length increases from 1 to 13 carbons. The low solubilities of phthalate esters cause them to bind to particulate matter in aquatic systems and settle out to the bottom sediments. The tendency to bind to suspended particles is further enhanced by increased salinity and decreased particle size. The particle composition, especially lipid content, also affects binding (Al-Omran and Preston 1987; Staples *et al.* 1997a,b).

Table 4: Chemical and Physical Properties of Specific Phthalate Ester Compounds (Defoe *et al.* 1990; Boese 1984; Giam *et al.* 1980; Environment Canada/Health Canada 1993 a,b,c; 2000)

	Vapour Pressure (Pa at 25°C)	Water Solubility (µg/L) (freshwater)	log K_{ow}
Phthalate Ester:			
DBP	0.01	1100 to 9600	4.31-4.79
BBP	0.001	2690	4.9
DnOP	0.02	20	5-9.9
DEHP	8.3×10^{-6} to 8.6×10^{-4}	270 to 400	5.11-9.61

Degradation of phthalate esters by both aerobic and anaerobic microbial populations has been reported, but proceeds more slowly under anaerobic conditions and low environmental temperatures. Microorganisms can degrade both high and low molecular weight phthalate esters, however, the lower molecular weight compounds degrade more rapidly and more completely than the higher molecular weight compounds. Estimated half-lives of phthalate esters in water are in the range of a few days to a few weeks, while estimated half-lives in sediments are in the range of weeks to months (Barron *et al.* 1987; Barron *et al.* 1988; Cartwright *et al.* 2000; Chauret *et al.* 1996; Ejlertsson and Svesson 1996; Ejlertsson *et al.* 1997; Gledhill *et al.* 1980; Howard 1991; Jianlong *et al.* 1995, 1996, 1997; Johnson and Lulves 1975; Johnson and Heitkamp 1984; Karara and Hayton 1988; Kleerebezem *et al.* 1999; Kurane 1986; Kurane *et al.* 1997a,b; Madsen *et al.* 1995; Saeger and Tucker 1976; Sandborn *et al.* 1975; Scholz and Diefenback 1996; Scholz *et al.* 1997; Shelton *et al.* 1984; Sodergren 1982; Stallings *et al.* 1973; Walker *et al.* 1984).

Phthalate esters can also be removed from aquatic systems as a result of uptake and metabolism by aquatic organisms. Uptake of phthalate esters by a variety of aquatic species has been observed, however, there is evidence that some laboratory studies have overestimated the potential for uptake. In general, bioconcentration factors (BCFs) are highest for algae, intermediate for invertebrates, and lowest for fish. This has been attributed to differences in the ability of various species to metabolize these compounds. This ability tends to be lower for molluscs than for crustaceans, and lower for crustaceans than for fish. The ability to metabolize these compounds appears to increase with the higher levels of the food chain. It has been suggested that biomagnification in the aquatic food chain is unlikely, however, studies on biomagnification are lacking (Barron *et al.* 1995; Brown and Thompson 1982; Carr *et al.* 1997; Staples *et al.* 1997a; Tarr *et al.* 1990; Wofford *et al.* 1981; Yan *et al.* 1995).

Phthalate esters are present in the atmosphere in both the vapour phase and in association with particulate matter. Temperature plays an important part in determining the distribution of phthalate esters in the atmosphere. At higher temperatures the vapour pressure of the phthalate compounds increases, resulting in greater volatilization of phthalates to the atmosphere and a tendency for larger amounts of phthalates to build up in the gaseous phase. Atmospheric deposition, by both dry and wet precipitation, is an important source of phthalate esters to the aquatic environment. It was estimated that approximately 48 tonnes of both DEHP and DBP were deposited to the Great Lakes annually, with inputs of these compounds to individual lakes ranging from 3.7 tonnes/year to Lake Ontario up to 16 tonnes/year to Lake Superior (Cautreels and Van Cauwenberghe 1978; Eisenreich *et al.* 1981; Giam *et al.* 1980; Hoff and Chan 1987; Thuren and Larsson 1990).

4.3 Concentrations in the Environment

4.3.1 General

Due to their widespread use, phthalate esters can occur in laboratory air and reagents as well as in analytical and sampling equipment. For this reason, considerable care must be taken to avoid the contamination of samples during collection and analysis. Much of the data in the literature was collected before contamination risks associated with the analysis and sampling for these compounds were widely recognized. This has led to the overestimation of the environmental concentrations of these compounds in many samples, particularly those collected before 1980. Although more recent information on concentrations of phthalate esters in the environment is considered to be more reliable, care must be taken in the interpretation of all analytical results for phthalate esters (Hites and Budde 1991; Ishida *et al.* 1980; Kohli *et al.* 1989; Pierce *et al.* 1980).

Several of the commercially used phthalate esters have been detected in the atmosphere, surface water, sediment, and biota in Canada and other areas of the world. Environmental concentrations of phthalate esters are highest in industrial and urban areas, particularly in the vicinity of facilities manufacturing or using these compounds. Freshwater sediments collected at two Swedish factories using phthalate esters contained up to 628,000 and 1,480,000 ng/g DEHP, while biota collected in the vicinity contained 1000 to 14,400 ng/g DEHP (Thuren 1986). Similarly, phthalate ester concentrations in surface waters and sediments from lakes and rivers in Italy were highest near urban and industrial wastewater inputs. Phthalate esters were not detected in water or sediment samples from sites upstream or from sites far removed from discharges. However, DEHP, DIBP, DEP, DBP, BBP and DnOP were detected in low µg/L concentrations in surface waters near industrial sites, while ng/g concentrations of DEHP were detected in sediments (Vitali *et al.* 1997). Rain and snow samples collected in Norway contained higher phthalate ester concentrations in urban areas than in remote sampling locations (Lunde *et al.* 1977). Atmospheric fallout of phthalate esters measured at various locations in Sweden was highest in close proximity to a smokestack at a factory using these compounds (Thuren and Larsson 1990). Available literature indicates that DEHP, the phthalate ester produced in the largest amounts globally, was detected in environmental samples more frequently and at higher concentrations than other phthalate ester compounds.

Information on phthalate ester concentrations in the Canadian environment is limited. DnOP, DBP, and DEHP were detected in the low ng/L range in water samples from the Niagara River in 1988-89 and St. Lawrence River in 1987. Some of the surface water samples collected from 80 locations in Alberta and two locations in British Columbia between 1985 and 1988 contained DnOP, DBP, and DEHP in the low µg/L range (Environment Canada/Health Canada 1993 a,b,c; Germain and Langlois 1988). Sediments from the St. Clair River near Sarnia, Ontario contained 15,000 ng/g of DnOP (Environment Canada/Health Canada 1993c).

Whole fish collected from Great Lakes harbours and tributaries in the United States contained maximum concentrations of DEHP and DBP exceeding 30,000 ng/g (wet weight). DnOP was not detected (Devault 1985). BBP concentrations did not exceed the detection limit of 200 ng/g in white suckers from Sackville River, Nova Scotia (Environment Canada 1997).

DBP concentrations of 14,100 ng/g and up to 19,100 ng/g (lipid basis) were detected in the yolks of eggs from double-crested cormorants and herring gulls from the Atlantic region of Canada, respectively. In addition, the blubber of common seals from the Atlantic coast of Canada contained 10,600 ng/g DEHP (lipid weight) (Zitko 1972).

4.3.2 British Columbia

Data on phthalate ester concentrations in the British Columbia environment obtained from Environment Canada sampling programs is presented in Appendix 5. Quality control information is presented in Appendix 4 and sampling and analytical methodologies are summarized in Appendix 1. Sample characteristics information for sediments (particle size, SFR, SVR) and biota (size, sex, number of individuals, moisture content, lipid content) is located in Appendix 3. Environment Canada sampling station co-ordinates are listed in Appendix 2. Site location maps (Map 1 to Map 13) are located at the end of this report.

Information on concentrations of phthalate esters in the aquatic environment of British Columbia is limited and, as in studies conducted elsewhere, problems associated with sample contamination have been documented. Phthalate ester concentrations in the sediments and biota of Fraser River, False Creek, Vancouver, Victoria, Esquimalt, and Ladysmith harbours were determined as a result of Environment Canada surveys conducted between 1989 and 1992. Phthalate esters were detected in most blank samples run during the analyses of these samples, however, blank corrected data revealed the presence of DMP, DEP, DBP, BBP, DEHP, and DnOP in sediment and aquatic biota from several sites in the lower Fraser River and in Vancouver, Victoria, Esquimalt and Ladysmith harbours. All of the Environment Canada data presented in this report have been blank corrected where required.

The measurement of concentrations of phthalate esters in environmental samples is difficult and requires great care during both sample collection and sample analysis. The wide use of these compounds in plastics can readily result in the inadvertent contamination of samples during both collection and analysis. Problems associated with the analysis of environmental samples collected by Environment Canada are outlined in the discussion section in Appendix 1.2.1.

Axys Analytical Ltd. in Sidney, BC analyzed the Environment Canada samples and concluded that, because the range of phthalate ester concentrations observed in procedural

blanks is so great, phthalate esters detected above the detection limit are subject to some uncertainty. It was suggested that positive results greater than the detection limit, but less than the limit of quantitation, be regarded as suspect. Axys suggested that the limit of quantitation be defined as a value ten times the standard deviation of the mean blank concentration.

Environment Canada samples analyzed for phthalate esters commonly contained concentrations above the detection limit, however, application of the criteria suggested by Axys revealed that many of these contained phthalate ester concentrations in the "suspect" range (higher than the detection limit but lower than the quantitation limit). As a result, the phthalate ester concentrations detected may be due, in part, to sample contamination and the concentrations reported for these samples may overestimate the actual concentrations. This should be considered when reviewing the data presented in this report.

4.3.2.1 Sediments

Maximum phthalate ester concentrations in sediments from the lower Fraser River (off wood preservation facilities), False Creek, Vancouver Harbour, Victoria Harbour and Esquimalt Harbour were >2900 ng/g, 6060 ng/g, 2600 ng/g, >24,000 ng/g, and >12,900 ng/g (dry weight), respectively. There are currently no Canadian sediment quality values for phthalate esters CCME (1999), however, the concentrations of individual phthalate ester compounds exceeded the non-regulatory Puget Sound AET values (Barrick *et al.* 1988) (refer to Table 2) and the Puget Sound Dredged Disposal Analysis Sediment Quality screening levels (PSDDA 1989) (refer to Table 3) at some sites. DMP, DBP, BBP and DnOP concentrations did not exceed the PSDDA screening levels at any sites, however, DMP and BBP concentrations exceeded the lowest Puget Sound AET values (for oyster and Microtox®) occasionally. DEP concentrations exceeded the PSDDA screening level of 1,200 ng/g at some sites in Esquimalt Harbour, while DEHP concentrations exceeded the PSDDA screening level of 8,300 ng/g in two samples from Rock Bay in Victoria Harbour and in one sample from Constance Cove in Esquimalt Harbour. Phthalate esters were not detected in the sediments from reference sites at Crescent Beach and the Queen Charlotte Islands.

Although the detection limits for DEHP and DBP were sometimes high due to high levels of blank contamination, these chemicals were usually present at higher concentrations than other phthalate compounds. However, according to the criteria suggested by Axys Analytical Ltd. (described above and also in the discussion section in Appendix 1.2.1), few sediment samples contained phthalate ester concentrations high enough to be above suspicion of laboratory artifacts. These included:

- di-n-butyl phthalate concentrations in sediments from one site off BC Cleanwood Preservers, two sites off Domtar Wood Preservers, False Creek Marina at the Market, Bayshore Inn Marina, and three sites in Victoria Harbour.
- diethyl phthalate concentrations in sediments from three sites in Victoria Harbour and two sites in Esquimalt Harbour
- di-n-octyl phthalate in sediments from two sites in Victoria Harbour

While the application of these criteria does not imply that the detection of phthalate esters in all other sediment samples was due to sample contamination, it indicates that the concentrations detected *may* have been overestimated.

Preliminary results from the analyses of sediments from False Creek, Indian Arm, and Port Moody and biota from False Creek by the Resource and Environmental Management Department of Simon Fraser University, detected the presence of DMP, DEP, DIBP, DBP, BBP, DEHP, DnOP, and DINP in all samples. Mean concentrations of individual compounds ranged from <1 to >2000 ng/g in sediments. The results of water sample analysis were not yet available. The data resembled those obtained during Environment Canada surveys both in range of concentrations detected and in the fact that DEHP and DBP were normally present at the highest concentrations (Mackintosh, unpublished).

Swain and Walton (1990a) reported that sample contamination and poor analytical precision prevented the accurate determination of phthalate esters in sediments collected from Boundary Bay. However, they concluded that the concentrations of DEHP were sufficiently elevated relative to the blank samples to conclude that this compound was present in the environment. DEHP concentrations in the ng/g dry weight were detected in sediments from Boundary Bay.

Swain and Walton (1990b) detected DEHP in sediments from most sites sampled in the lower Fraser River. Maximum concentrations (>1200 μg/g) were detected at Barnston Island and in Ewen Slough. Lower concentrations of other phthalate ester compounds were present at some sites. All concentrations were lower than the Washington State Department of Ecology Apparent Effects Threshold (AET) values for phthalate esters in Puget Sound sediments (Table 2). The authors cautioned that phthalate ester compounds were detected in the blank samples and that the analysis of duplicate samples indicated that the precision was poor, likely due to problems with contamination.

Rogers and Hall (1987) reported that sediments collected 0.5 km and 1 km downstream from the Iona wastewater treatment plant in the Fraser River estuary in 1982 contained DnOP, DBP and DEHP at concentrations in the hundreds of ng/g range. The concentrations of phthalate esters were highest in sediments from the station nearest the treatment plant.

Phthalate esters detected in sediment samples collected near the Iona Deep-Sea Outfall as part of the GVRD 2000 environmental monitoring program included DMP, DEP, DBP, BBP, DnOP and DEHP, however, only DMP, DEP and DEHP were detected in most of the samples. DMP and DEP were present in the very low ng/g range, while DEHP concentrations ranged from 83 to 12,000 ng/g dry weight (median of 470 ng/g) (Paine and Chapman 2000). The DEHP concentration at one station exceeded the Puget Sound Dredged Disposal Analysis Sediment Quality (PSDDA 2000) screening level of 8300 ng/g dry weight (refer to Table 3). The report cautioned that it was difficult to accurately measure phthalate esters in environmental samples because of the ease with which samples can be contaminated in the field and during analysis, and also because small pieces of plastic sometimes occur in sewage discharges and may have been present in some sediment samples (Paine and Chapman 2000).

4.3.2.2 Biota

Phthalate esters were detected in more than half of the aquatic biota samples collected during Environment Canada surveys in False Creek and Vancouver, Victoria, Esquimalt and Ladysmith harbours between 1989 and 1992. When present, total phthalate ester concentrations were typically in the hundreds of ng/g wet weight range. Concentrations of over 1000 ng/g were detected in mussels from one station in Vancouver Harbour, Dungeness crab from Victoria and Esquimalt harbours, English sole from False Creek, and clams from two stations in Ladysmith Harbour. DEHP was the predominant compound, however, DBP, DEP, BBP, DMP and DnOP were also detected in some samples (in decreasing order of frequency). Virtually no samples contained concentrations above the limit of quantitation as defined in Appendix 1.2.1 and, therefore, the phthalate ester concentrations in the biota samples may be due, in part, to contamination during analysis. Phthalate esters were not detected in biota collected from reference sites in Crescent Beach and Rivers Inlet.

DBP and DEHP were the predominant phthalate compounds detected in soft-shelled clams and Dungeness crab from Boundary Bay in 1989. Maximum concentrations of DBP and DEHP in clams and crabs (muscle and hepatopancreas) were in the hundreds of ng/g, wet weight. DMP, DEP, BBP and DnOP were detected at lower concentrations in some clams and crabs. DEHP was detected in many fish samples at concentrations well above the level of sample contamination, with maximum concentrations in the hundreds to thousands of ng/g range. BBP was present in butter sole (whole fish) at a maximum concentration of >1400 ng/g and in liver from starry flounder at >800 ng/g. DMP, DEP, and DnOP were not usually detected in the fish. The authors noted that the levels of several phthalate ester compounds were higher in the liver tissue of starry flounder compared to the muscle tissue. As with other studies, phthalate ester contamination was present in blank samples and some of the positive results were not considered meaningful. However, the authors noted that the concentrations of DEHP were

sufficiently elevated in comparison to the blank samples to conclude that this phthalate was present in the environment (Swain and Walton 1990a).

Phthalate ester concentrations were measured in surf scoters collected from Burrard Inlet by Canadian Wildlife Service (CWS) in 1999. DBP, DEHP, DEP and BBP were detected in all individuals tested. DBP and DEHP were present in higher concentrations (liver means in the mid to high hundreds of ng/g wet weight (ww), maximum in the thousands of ng/g ww range), compared to DEP and BBP (liver means in low hundreds of ng/g ww; maximum in the mid-hundreds of ng/g ww) (Wilson *et al.* in prep). There is no information on phthalate ester concentrations in aquatic mammals of British Columbia.

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APPENDIX 1

SAMPLING AND ANALYTICAL METHODOLOGY

1.1 Field Collection Methods

Sediment grabs were collected with a modified stainless steel Ponar Grab or a stainless steel Smith-MacIntyre grab. A minimum of three grabs were collected at each station. A relatively undisturbed sample of the top 2 cm of sediment from each grab was collected using a stainless steel spoon after carefully decanting overlying water. The surface material from each of the three grabs was composited and then thoroughly mixed in a stainless steel bucket. From the composited sample, three to four subsamples were collected for analyses for phthalate esters and other organic chemicals. Subsamples were also collected for trace metals, particle size, SVR, and SFR. Samples for phthalate ester compounds and other organic chemicals were collected in solvent rinsed and heat-treated 125 ml glass jars with heat-treated aluminum foil liners. Samples for trace metals, particle size, SVR, and SFR were collected in a kraft paper bag, enclosed in Whirlpak® bags. Samples were either frozen immediately (-20° C) or temporarily stored on ice in the field until samples could be transferred to lab freezers.

Fish, and some crab samples, were collected using a small otter trawl with a 3.8 cm mesh net and a 5.8 metre throat. The trawl was towed at a speed of approximately 1 to 1.5 knots. Trawl catches were sorted by species. Number of individuals, lengths, and weights were recorded and are presented in Appendix 3.2. At some locations crabs were also collected using crab traps. Mussels and oysters were collected by hand off rocks at low tide. At several sites mussels could not be found growing on rocks, particularly in harbour and marina locations. At these sites mussels were collected from dock structures and pilings at low tide. Clams were dug at low tide using clam shovels and garden forks.

Dissections were performed on teflon boards using sterilized stainless steel scalpels, scissors, and forceps. Tissues collected for analysis included: tail muscle from shrimp and prawns, leg muscle and hepatopancreas from crabs, dorsal muscle (skin removed, liver and gill (without gill arch) from fish, and soft tissue from bivalves. Tissues from individuals of like species and size from each location were composited. Samples were homogenized prior to analysis. Approximately 30 to 50 gram aliquots of homogenized tissue were placed in solvent-rinsed, heat treated 125 ml glass jars for phthalate ester and lipid content analysis and in Whirlpak® bags for metals analysis. The weight of each homogenized sample was recorded. Samples were kept frozen (-20° C) until analyzed.

1.2 Analytical Methods

The following information on analytical methodologies was provided by Axys Analytical Services Ltd. in Sidney, British Columbia and was extracted from the report "Polycyclic Aromatic Hydrocarbons and Phthalate Esters in Sediments and Biota from Select Priority Sites in British Columbia" prepared by Axys Analytical Services Ltd. for Environment Canada (February 1995).

1.2.1 Phthalate esters

1.2.1.1 Sample Handling

Upon receipt, all samples were stored frozen at -20 ° C until just prior to analysis. Samples were thawed and homogenized prior to subsampling for analysis.

1.2.1.2 Phthalate ester analysis

Analytical Methods

Summary:
All samples were spiked with perdeuterated phthalates (dimethyl-, diethyl-, di-n-butyl-, butylbenzyl-, bis(2-ethylhexyl-, and di-n-octyl phthalate) prior to analysis. Both sediment and tissue samples were solvent extracted on a shaker table and the extract separated on a silica gel column. The fraction containing the phthalate esters was analyzed by GC/MS.

1.) Extraction Methods:

Sediments
A subsample of homogenized sediment was dried for moisture determination. The sediment sample, to which an aliquot of surrogate standard had been added, was extracted with 1:1 dichloromethane:methanol by shaking on a shaker table for 30 minutes. The extraction procedure was repeated twice more with dichloromethane. The combined extracts were washed with solvent extracted distilled water to remove the methanol and dried over anhydrous sodium sulphate. The solvent was exchanged to hexane and the extract was concentrated in a Kuderna-Danish flask. Activated copper was added to the extract to remove the sulphur. The extract was ready for column cleanup.

Tissues
A subsample of homogenized tissue was dried for moisture determination. The tissue sample, to which an aliquot of surrogate standard had been added, was extracted with 1:1 dichloromethane:methanol by shaking on a shaker table for 30 minutes. The extraction

procedure was repeated twice more with dichloromethane. The combined extracts were washed with solvent extracted distilled water to remove the methanol and dried over anhydrous sodium sulphate. The solvent was exchanged to hexane and the extract was concentrated in a Kuderna-Danish flask. The extract was placed on a calibrated gel permeation column and eluted with 1:1 dichloromethane:hexane. The 125-300 mL fraction was collected and evaporated to a small volume prior to cleanup and separation on a silica gel column.

2.) Column Cleanup

The sample extract was loaded onto a silica gel column and eluted with pentane (discarded) followed by dichloromethane (F2, retain) followed by 1:3 isopropanol:pentane (F3, retain). F3 contained the phthalate esters. The dichloromethane fraction was concentrated in a Kuderna-Danish flask. The extract was then transferred to a microvial and an aliquot of recovery standard was added (benzo(b)fluoranthene d-12 and fluoranthene d-10). The extract was ready for analysis by GC/MS.

3.) GC/MS Analysis

Sample extracts were analyzed by gas chromatography (GC) with detection by mass spectrometer (MS). Analysis of the extract was carried out using a Finnigan Incos 50 mass spectrometer equipped with a Varian 3400 gas chromatograph with a CTC autosampler and a DG 10 Data system. The chromatographic separation was carried out using a Restek$_x$-5 column (30 m, 0.25 mm i.d. x 0.25 μm film thickness). The mass spectrometer was operated in the El mode (70 Ev) using Multiple Ion Detection (MID) to enhance sensitivity, acquiring two characteristic ions for each target analyte and surrogate standard. A split/splitless injection sequence was used.

Quality Assurance/Quality Control

Samples were worked up in batches along with accompanying QC samples. Each batch was analyzed as a unit. The data were reviewed and evaluated in relation to the batch QC samples. The QC data must meet specific requirements in order for the batch data to be acceptable.

Procedural Blanks:

A procedural blank was worked up with each batch of samples. The procedural blanks for phthalate esters had significant amounts of phthalate esters present, and it was necessary to blank-correct the sample data. This was done by compiling the data from all the procedural blanks, and determining a mean and standard deviation for each target analyte.

The sample data were blank corrected using the mean blank concentration. The blank-corrected concentration was then compared to the detection limit, defined as three times

the standard deviation of the mean blank concentration. Any concentration less than the detection limit was reported as "not detected" (ND). A summary of the blanks is presented in Appendix 4.

The following two anomalous concentrations were excluded from the statistical analysis by t-tests and Q-tests:

i.) the procedural blank # 408 had 3100 ng of benzylbutyl phthalate present, a concentration about 80 times higher than the mean concentration in the blanks; and

ii.) the procedural blank from batch # 313 had 9000 ng of di-n-butyl phthalate present, a concentration about 20 times higher than the mean concentration in the blanks.

For samples from the two batches associated with these procedural blanks, benzylbutyl phthalate and di-n-butyl phthalate were present in elevated concentrations similar to the above procedural blank concentrations. It was not possible to report positive concentrations of these phthalate esters which were unequivocally distinguishable from background sources. Consequently, the concentration of benzylbutyl phthalate in samples from the batch associated with procedural blank #408 has been reported as not detected (ND). The concentration of di-n-butyl phthalate in samples from the batch associated with blank #313 has been reported as not detected (ND).

Duplicates:

A sample was analyzed in duplicate in every analysis batch to demonstrate the precision of the method. In total 13 samples (22% of the samples) were analyzed in duplicate for phthalate esters. Agreement between the duplicate samples generally satisfied Axys' QA/QC criterion for duplicate samples and the data are acceptable.

Surrogate Standard Recovery:

The recovery of each surrogate standard was monitored by comparing its response to that of the recovery standard added just prior to analysis. Surrogate standard recoveries were reported with each sample. Generally, surrogate standard recoveries satisfy Axys' QA/QC criteria and are acceptable.

Analyte concentrations have been corrected for incomplete recovery, based on the recovery of the surrogate standards. The percent recovery of surrogate is reported as an overall indication of the quality of the analysis. However, the quantitation of analyte concentrations is not affected by low surrogate recoveries as indicated by the data for reference samples. Acceptable recoveries of target analytes is achieved in reference samples even in the case of low surrogate recoveries.

Reference Samples:

A "known" reference sample was analyzed with each batch of samples to demonstrate the accuracy of the method. Sediment batches were analyzed with a sediment spiked with phthalate esters. Tissue batches were analyzed with a tissue sample spiked with phthalate esters. The analytical results for the spiked samples were compared to the expected values for the spiked samples. Recoveries of the target analytes were acceptable, in the range of 70-130% of the expected value.

Detection Limits:

Detection limits for phthalate esters were defined as three times the standard deviation of the mean blank concentration. Detection limits were reported for each sample. The sample detection limit was determined by dividing the calculated detection limit (3 times the standard deviation) by the sample weight. Due to the great variability in procedural blanks data, phthalate ester detection limits are high.

Blind Duplicates:

Blind duplicate samples were prepared by Environment Canada and submitted to Axys Analytical Ltd. for analysis. These samples were prepared by homogenizing the sample and subsampling the homogenized sample for analysis.

The results of the blind sample analyses are very comparable except for the result for di-n-butyl phthalate in the Bayshore Inn Marina subsamples. Although di-n-butyl phthalate was not detected in the subsample from this site, the blind duplicate contained 1500 ng/g of this compound. This result creates some uncertainty about the concentration of di-n-butyl phthalate in this sample, which may be a "false positive", perhaps an artifact of the above compositing and subsampling procedures. However, another subsample of the Bayshore Inn Marina sediment sample, which was analyzed in a different batch of samples, contained 1300 ng/g di-n-butyl phthalate. This value is in good agreement with the blind duplicate sample which contained 1500 ng/g. It is, therefore, possible that a lack of adequate homogenization prior to the subsampling of this sediment sample may be responsible for the lack of agreement in the analytical results of the split samples.

Discussion of Phthalate Ester Analysis:

The measurement of concentrations of phthalate esters in environmental samples is a challenging task considering the prevalence of phthalate esters in the general environment. Phthalate esters are widely used in the manufacture of plastics and great care must be taken during both the sampling process and laboratory analysis to avoid contact (direct and indirect) with plastics.

Analytically, it is not difficult to detect phthalate esters in environmental samples. Axys uses the isotope dilution method of quantitation, with a full suite of per-deuterated surrogates. This method has been demonstrated to be a rugged method which permits the positive identification of the compounds of interest. The recovery of phthalate esters in spiked samples is generally good and confirms the quality of the methodology. However, the quantitation of phthalate esters, and the ability to distinguish a positive result above background levels is a more difficult task. The detection limits for the method are severely limited by background levels of phthalate esters in the laboratory environment. Even with the use of strict sub-sampling and analysis protocols, phthalate esters are readily detected in laboratory procedural blanks at extremely variable and significant concentrations (refer to Appendix 4).

The variability in the procedural blanks from one analysis batch to another is an indication of the difficulty in assessing the level at which any particular sample may be contaminated from background sources of phthalate esters. The best way to handle the variability is a statistical treatment of a number of procedural blanks and blank correct the sample data using the mean concentration of each analyte in the blank.

The detection limits, based on the standard deviation of the mean blank concentration, are relatively high. The detection limits reflect the uncertainty associated with the analysis of phthalate esters. The consequence of high detection limits is that phthalate ester concentrations in the majority of samples are reported as not detected. However, because the range of phthalate esters concentrations observed in the procedural blanks is so great, phthalate esters detected above the detection limit are subject to some uncertainty. A limit of quantitation, typically defined as ten times the standard deviation of the mean blank concentration, needs to be considered. Consequently, any positive result which is greater than the detection limit, but less than the limit of quantitation, must be regarded as suspect and possibly due to laboratory artifacts.

The above treatment of data can account for contributions of phthalate esters from the laboratory environment. However, any contamination which may occur during the sampling procedures, transport, or storage of samples cannot be accounted for. Considering the prevalence of phthalate esters, some assessment of the degree of contamination from the time of sampling to time of analysis is required in order to correctly interpret the analytical data.

1.2.2 Particle Size Analysis

The Environment Canada Sediment Lab conducted the particle size analysis for sediment samples from Laboratory 1 Batches 1 through 8 using the pipette method (Black, 1965). Samples were dried and passed through a series of sieves with decreasing mesh sizes for grain separation. The amount collected from each sieve was weighed and the percent composition of the total weight calculated to determine particle size distribution. Mesh sizes used for grain separation were as follows:

silt and clay	- <0.063 mm (-230 mesh)
very fine sand	- 0.063 - 0.125 mm (230 mesh)
fine sand	- 0.125 - 0.250 mm (120 mesh)
medium sand	- 0.250 - 0.500 mm (60 mesh)
coarse sand	- 0.500 - 1.000 mm (35 mesh)
very coarse sand	- 1.000 - 2.000 mm (18 mesh)
granules	- >2.00 mm (10 mesh)

Soilcon Laboratories Ltd. conducted the particle size analysis for sediment samples from Laboratory 1 Batch 9 using the following procedure.

For standard texture the following size fractions are tested for: 250, 125, 53, and 2 μm. Particle size analysis is done by the pipette method on air dry soil/sediment, which has passed through a 2 mm sieve (USDI 1962; Lavkulich 1981; Sheldrick and Wang 1993). Organic matter is removed from a 40 g (± 0.5 g) sub-sample of soil/sediment using hydrogen peroxide. A dispersant, 0.4 N sodium pyrophosphate, and water is added to the soil/sediment to break apart any fine soil particles. The solution of soil/sediment, sodium pyrophosphate, and water is blended in an electric 'milk-shake' style mixer. The blended liquid is then transferred to a 1000 mL cylinder and brought up to volume.

The soil suspension is stirred with a plunger for a minimum of 30 seconds to ensure the sample is homogenous. Samples of the suspended soil are taken in a 20 mL volumetric pipette at predetermined time intervals dependent on the temperature of the liquid and the size of the particles one wants to measure.

Following pipette analysis, the remaining contents of the cylinder are wet sieved to determine the various sand fractions.

There is no certified reference material for soil/sediment particle size analysis. Soilcon, however, has it's own standards for particle size, which are analyzed on a regular basis. In addition, the 53 μm size fraction is determined both by pipetting and wet sieving. These two values must be within 5% of each other to be accepted. If the difference exceeds 5%, the sample is repeated.

References:

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1.2.3 SFR/SVR Analysis

Sediment residue analysis was conducted at the Pacific Environmental Science Centre. Samples were oven dried and then ignited at 550° C in a muffle furnace. The loss of weight on ignition represents the sediment volatile residue (SVR), and the remaining residue represents the sediment fixed residue (SFR). Volatile residue is only an approximate measure of the organic content as results may also reflect loss of water at crystallization, loss of volatile organic matter before combustion, incomplete oxidation, and decomposition of mineral salts during combustion. For a detailed description of the residue analysis refer to APHA (1985) or Swingle and Davidson (1979).

References:

APHA/ AWAA/WPCF. 1985. Standard Methods for the Examination of Water and Wastewater. 14th Edition. Washington, D.C.

Swingle, R.B. and J. W. Davidson. 1979. Environmental Laboratory Manual, Laboratory Services, Department of Environment and Department of Fisheries and Oceans.

1.2.4 Lipid Content

The following description of analytical methodology was provided by Axys Analytical Services in Sidney, British Columbia.

Gravimetric lipid analyses were carried out on extracts during either the extraction procedure for organotin compounds or the extraction procedure for PCB congeners and coplanars (many of the samples were also analyzed for PCBs). The percentage lipid was determined using a wet tissue weight.

Colourimetric lipid analyses were carried out on a small number of tissue samples. A lipid extract was prepared by homogenizing dry tissue sample with chloroform/methanol (2:1) and filtering the residue. The filtrate was made up to a volume of 100 mL.

The lipid concentration was quantified colourimetrically using the sulphophosphovanillin method of Barnes and Blackstock (1973). A portion of the lipid extract (0.5 mL) was placed in a test tube, the solvent evaporated under a stream of nitrogen, and concentrated sulphuric acid added (0.5 mL). The stoppered tubes were heated in a water bath (100° C) for 10 minutes. When cool, an aliquot (0.1 mL) of extract was transferred to a test tube, and phosphovanillin reagent (2.5 mL) was added. After 30 minutes the absorbance was measured at 520 nm against a procedural blank. A calibration curve was made with a cholesterol standard. Total lipid concentration was calculated using a conversion factor given by Barnes and Blackstock (1973) which equates 80 mg cholesterol standard with 100 mg total lipid.

Reference:

Barnes. H. and J. Blackstock. 1973. *J. Exp. Mar. Bio. Ecol.* **12**: 103-1189

APPENDIX 2

SAMPLING STATION CO-ORDINATES

APPENDIX 2.1 **Sampling Station Co-ordinates cont.**

Sediment Samples:

Site No.	Location	Latitude	Longitude	Depth (m)
FRASER RIVER				
FR-16	Koppers International	49° 13.381′	122° 55.852′	
	Station 1			2.5
	Station 2			5
	Station 3			4
FR-20	BC Cleanwood Preservers	49°11.030′	122° 54.909′	
	Station 1			5
	Station 2			13
	Station 3			4
	Station 4			5
FR-17	Domtar Wood Preservers	49° 11.280′	122° 57.780′	
	Station 1			2
	Station 2			2
	Station 3			3
	Station 4			2
FR-19	Princeton Wood Preservers	49° 11.908′	122° 54.000′	
	Station 1			1
	Station 2			5.5
	Station 3			5
	Station 4			3.5
FR-18	Domtar/Liverpool Site	49°12.723′	122° 52.995′	
	Station 1			.75
	Station 2			1.5
	Station 3			1
	Station 4			10

APPENDIX 2.1 **Sampling Station Co-ordinates cont.**

Sediment Samples:

Site No.	Location	Latitude	Longitude	Depth (m)
FALSE CREEK				
False Creek Area:				
FC-1	Marina at Market			
	Station 3	49°16.310'	123°08.178'	3
	Station 4	49°16.280'	123°08.178'	6
	Station 5	49°16.255'	123°08.166'	4
FC-4	Outer creek - midchannel			
	Station 1	49°16.630'	123°08.244'	8
FC-5	At Granville Ferries			
	Station 1	49°16.480'	123°08.064'	7.5
FC-6	Off Granville Island Hotel			
	Station 1	49°16.200'	123°07.706'	6
FC-7	Off Marina at Monk McQueen's			
	Station 1	49°16.136'	123°07.264'	6
FC-8	Off Monk McQueen's; near Cambie Bridge			
	Station 1	49°16.292'	123°06.861'	7
FC-9	Inside Cambie Bridge off dumpsite			
	Station 1	49°16.429'	123°06.339'	9
FC-10	Northeast corner			
	Station 1	49°16.503'	123°06.237'	7

APPENDIX 2.1 **Sampling Station Co-ordinates cont.**

Sediment Samples:

Site No.	Location	Latitude	Longitude	Depth (m)
BURRARD INLET				
BI-1	Vancouver Outer Harbour (Pacific Environment Institute) Station 2	49° 19.72'	123° 13.52'	54
BI-2	Vancouver Wharves Station 4	49° 18.546'	123° 06.963'	19
BI-3	L&K Lumber Station 2a	49° 18.654'	123° 06.700'	14
BI-4	Vancouver Shipyard/Seaspan Station 4	49° 18.644'	123° 06.333'	8
BI-5	Versatile Pacific (was Burrard Yarrows) Station 5	49° 18.367'	123° 04.663'	18
BI-7	Saskatchewan Wheat Pool Station 1	49° 18.267'	123° 03.507'	14
BI-8	Neptune Terminals Station 2a	49° 18.197'	123° 03.131'	15.7
BI-9	Seaboard Terminals Station 1x	49° 18.061'	123° 02.621'	15.5
BI-10	Lynnterm Station 4	48° 17.803'	123° 01.634'	15
BI-14	Boulder Rock Station 1	49°18.20 '	122°56.36 '	28
BI-15	IOCO Station 1	49°17.84 '	122°53.13 '	12
BI-17	Port Moody Station 1	49°17.50 '	122°55.66 '	21

APPENDIX 2.1 **Sampling Station Co-ordinates cont.**

Sediment Samples:

Site No.	Location	Latitude	Longitude	Depth (m)
BURRARD INLET cont.				
BI-18	Alberta Wheat Pool			
	Station 1	49° 17.528'	123° 01.888'	20
BI-19	Central Harbour			
	Station 1	49° 17.95 '	123° 05.00 '	34
BI-23	Vanterm			
	Station 1	49° 17.357'	123° 04.374'	16
	Station 2	49° 17.345'	123° 04.305'	19-28
	Station 3	49° 17.345'	123° 04.122'	13
BI-24	United Grain Growers			
	Station 1	49° 17.334'	123° 04.633'	26-31
	Station 2	49° 17.293'	123° 04.696'	14-22
BI-26	Canada Place			
	Station 1	49° 17.378'	123° 06.583'	17
	Station 2	49° 17.365'	123° 06.634'	18-20
COAL HARBOUR				
CH-1	Bayshore Inn Marina			
	Station 1	49° 17.580'	123° 07.575'	3
	Station 3	49° 17.597'	123° 07.614'	2
	Station 4	49° 17.613'	123° 07.649'	6
CH-3	Royal Vancouver Yacht Club Marina			
	Station 4	49° 17.719'	123° 07.587'	6
	Station 5	49° 17.685'	123° 07.563'	6
	Station 6	49° 17.709'	123° 07.638'	5

APPENDIX 2.1 **Sampling Station Co-ordinates cont.**

Sediment Samples:

Site No.	Location	Latitude	Longitude	Depth (m)
VICTORIA HARBOUR				
The Gorge:				
VH-1	Station SW-7; storm drains across from Aaron Point	48° 26.658'	123° 23.811'	3
VH-2	Station SW-8; off Gorge Park	48° 26.852'	123° 24.341'	1.5
Selkirk Waters:				
VH-4	Station SW-2; off old BCFP/ Fletcher Challenge sawmill, west side	48° 26.415'	123° 22.725'	2
VH-5	Station SW-3; off old BCFP/ Fletcher Challenge sawmill, southwest side	48° 26.355'	123° 22.734'	4.5
VH-6	Station SW-4; trawl site, midchannel	48° 26.278'	123° 22.728'	4.5
VH-7	Station SW-5; south end of old BCFP/Fletcher Challenge sawmill; off location of old dip tanks	48° 26.329'	123° 22.613'	3
VH-8	Station SW-6; off storm drain south of sawmill site	48° 26.351'	123° 22.534'	3-4
Upper Harbour:				
VH-9	Station UH-1; Victoria Machinery Depot	48° 26.030'	123° 22.531'	7
VH-10	Station UH-2; Rock Bay	48° 26.131'	123° 22.131'	4

APPENDIX 2.1 **Sampling Station Co-ordinates cont.**

Sediment Samples:

Site No.	Location	Latitude	Longitude	Depth (m)
VICTORIA HARBOUR				
VH-11	Station UH-3; head of Rock Bay	48° 26.053'	123° 22.060'	4
VH-12	Station UH-4; midchannel trawl site	48° 26.030'	123° 22.313'	7
VH-13	Station UH-5; off Point Ellice (old Smith Cedar Products)	48° 25.951'	123° 22.552'	5
VH-14	Station UH-6; Site 1	48° 25.899'	123° 22.496'	4.5
VH-15	Station UH-7; Hope Pt/Standard Oil	48° 25.812'	123° 22.331'	6.5
VH-16	Station UH-8; Garbage Depot/ Standard Oil	48° 25.787'	123° 22.222'	2.5
VH-17	Station UH-9; Boat Building Facilities	48° 25.940'	123° 22.208'	7.5
Inner Harbour:				
VH-18	Station IH-1; off Songhees	48° 25.575'	123° 22.416'	3
VH-19	Station IH-2; West Coast Air	48° 25.521'	123° 22.343'	6.5
VH-20	Station IH-3; commercial dock at entrance to James Bay	48° 25.385'	123° 22.157'	7
VH-21	Station IH-4; Undersea Gardens	48° 25.307'	123° 22.119'	2
VH-22	Station IH-5; BC Steamships	48° 25.305'	123° 22.184'	7
VH-23	Station IH-6; bay beside BC Steamships	48° 25.395'	123° 22.446'	6.5
VH-24	Station IH-8; Trotac Marine	48° 25.384'	123° 22.655'	5

APPENDIX 2.1 **Sampling Station Co-ordinates cont.**

Sediment Samples:

Site No.	Location	Latitude	Longitude	Depth (m)
VICTORIA HARBOUR cont.				
VH-25	Station IH-9; Raymur Pt/ Fisherman's Wharf	48° 25.372'	123° 22.802'	1.5
VH-26	Station IH-10; between Shoal Pt and Fisherman's Wharf	48° 25.442'	123° 23.123'	7
VH-27	Station IH-11; Centre Channel trawl site	48° 25.493'	123° 22.708'	8
VH-28	Station IH-12; south side of Songhees/old Seaspan site	48° 25.577'	123° 22.764'	7
VH-29	Station IH-13; south side of Songhees/old Shell Oil site	48° 25.556'	123° 22.637'	8
VH-30	Station IH-14; West Bay	48° 25.679'	123° 23.523'	9-13
Outer Harbour:				
VH-31	Station OH-2; Ogden Point Wharves	48° 24.962'	123° 23.281'	13-18
ESQUIMALT HARBOUR				
EH-1	Upper Harbour Station 1	48° 27.380'	123° 27.109'	1.5
	Plumper Bay:			
EH-2	Station PB-1; off old wood products facility	48° 26.844'	123° 26.044'	3
EH-3	Station PB-2; off site of old diptank	48° 26.648'	123° 25.833'	4

APPENDIX 2.1 **Sampling Station Co-ordinates cont.**

Sediment Samples:

Site No.	Location	Latitude	Longitude	Depth (m)
ESQUIMALT HARBOUR cont.				
EH-4	Trawl Site PBT-1	48° 26.797'	123° 26.209'	9
EH-5	Dunn's Nook;	48° 26.456'	123° 26.856'	10
EH-6	Fort Rodd	48° 25.787'	123° 26.909'	10
	Constance Cove:			
EH-7	Station 1	48° 26.143'	123° 25.703'	12
EH-9	Station 2	48° 26.018'	123° 25.214'	9
EH-10	Station 3	48° 26.014'	123° 25.420'	8
EH-11	Station 4	48° 25.914'	123° 25.550'	10
EH-12	Station 5	48° 26.008'	123° 25.862'	11.5
EH-13	Station 6	48° 26.014'	123° 26.206'	12
EH-14	Trawl Site	48° 26.032'	123° 25.641'	13
VI-14	***Ladysmith Harbour*** Site #29 Site #30 Site #31 Site #32 Site #33 Site #37	49°	123°	

APPENDIX 2.1 **Sampling Station Co-ordinates cont.**

Sediment Samples:

Site No.	Location	Latitude	Longitude	Depth (m)
Reference Sites				
RF-1	Crescent Beach Station 1	49° 03.358'	122° 03.199'	1
	Queen Charlotte Islands:			
RF-9	Delkatla Slough	54°	132°	
RF-11	Tow Hill	54°	131°	

APPENDIX 2.2 **Sampling Station Co-ordinates cont.**

Biota Samples:

Site No.	Location		Latitude	Longitude
FALSE CREEK				
FC-1	Marina at Market			
	Station 3		49° 16.310'	123° 08.178'
	Station 4		49° 16.280'	123° 08.178'
	Station 5		49° 16.255'	123° 08.166'
FCT-1	East Basin Trawl	start	49° 16.187	123° 07.205'
		stop	49° 16.296	123° 06.888'
FCT-2	Monk McQueen's Trawl			
		start	49° 16.159'	123° 07.413'
		stop	49° 16.273'	123° 06.992'
BURRARD INLET				
BI-2	Vancouver Wharves			
	Station M1		49° 18.528'	123° 06.891'
	Station M2		49° 18.497'	123° 06.810'
BI-3	L&K Lumber			
	Station M1		49° 18.667'	123° 06.564'
BI-5	Versatile Pacific (was Burrard Yarrows)			
	Station M2		49° 18.451'	123° 04.460'
BI-9	Seaboard Terminals			
	Station M2		49° 18.079'	123° 02.653'
BI-10	Lynnterm			
	Station M2		49° 17.824'	123° 01.706'
BI-26	Canada Place			
	Station M1		49° 17.308'	123° 06.840'

APPENDIX 2.2 **Sampling Station Co-ordinates cont.**

Biota Samples:

Site No.	Location		Latitude	Longitude
COAL HARBOUR				
CH-1	Bayshore Marina			
	Station 5		49° 17.603'	123° 07.821'
	Station 8		49° 17.608'	123° 07.649'
	Station 10		49° 17.588'	123° 07.587'
	Station 11		49° 17.573'	123° 07.579'
CH-3	Royal Vancouver Yacht Club			
	Station 1		49° 17.765'	123° 07.587'
	Station 2		49° 17.732'	123° 07.581'
	Station 3		49° 17.726'	123° 07.596'
	Station 8		49° 17.728'	123° 07.521'
VICTORIA HARBOUR				
Selkirk Waters:				
SW-C1	Station C1		48° 26.398'	123° 22.899'
SWT-3	Trawl SWT-3	start	48° 26.349'	123° 22.843'
		stop	48° 26.192'	123° 22.652'
SW-SS1	Station SS1 (off old sawmill site)		48° 26.551'	123° 22.784'
SW-SS2	Station SS2 (beach at Bamfield Park)		48° 26.290'	123° 23.129'
Upper Harbour:				
UH-C2	Station C2		48° 26.051'	123° 22.617'
UHT-1	Trawl UHT-1	start	48° 26.012'	123° 22.546'
		stop	48° 25.781'	123° 22.260'
Inner Harbour:				
IH-C3	Station C3		48° 25.409'	123°22.811'
IHT-1	Trawl IHT-1	start	48° 26.012'	123° 22.546'
		stop	48° 25.781'	123° 22.260'

APPENDIX 2.2 **Sampling Station Co-ordinates cont.**

Biota Samples:

Site No.	Location		Latitude	Longitude
VICTORIA HARBOUR				
Inner Harbour:				
IH-SS3	Station SS3		48° 25.391'	123° 22.443'
West Bay:				
IH-C4	Station C4		48° 25.585'	123° 23.505'
IH-SS4	Station SS4 (Hidden Harbour Marina)		48° 25.716'	123° 23.708'
ESQUIMALT HARBOUR				
Constance Cove:				
CC-C1	Station C1		48° 26.067'	123° 26.150'
CC-M2	Station M1		48° 26.014'	123° 26.097'
CCT-1	Trawl CCT-1	start	48° 26.147'	123° 25.997'
		stop	48° 26.112'	123° 25.476'
Plumper Bay:				
PBT-1	Trawl PBT-1	start	48° 27.103'	123° 26.762'
		stop	48° 26.930'	123° 26.403'
PBT-2	Trawl PBT-2	start	48° 26.930'	123° 26.268'
		stop	48° 26.641'	123° 26.250'
PBT-3	Trawl PBT-3	start	48° 27.060'	123° 26.886'
		stop	48° 26.633'	123° 26.432'
PB-SS5	Station SS5		48° 26.821'	123° 25.991'
PB-M2	Station M2		48° 26.864'	123° 25.985'
PB-M3	Station M3		48° 26.809'	123° 26.027'

APPENDIX 2.2 **Sampling Station Co-ordinates cont.**

Biota Samples:

Site No.	Location	Latitude	Longitude
ESQUIMALT HARBOUR			
Dallas Bank:			
PB-SS6	Station SS6	48° 26.743'	123° 25.985'
VI-14	***Ladysmith Harbour***	49°	123°
	Site #29		
	Site #30		
	Site #31		
	Site #32		
	Site #33		
	Site #38		
REFERENCE SITES			
RF-1	Crescent Beach		
	Station 1	49° 03.358'	122° 53.199'
RF-8	Rivers Inlet		
	Station 1	51° 39	127° 26

APPENDIX 3

SAMPLE INFORMATION

APPENDIX 3.1 SEDIMENT CHARACTERISTICS

SITE NO.	LOCATION	DATE	MEDIAN PARTICLE SIZE	CLAY AND SILT (%)				SAND (%)					GRANULES (%)	SFR	SVR
				Clay (%)		Silt (%)		Very Fine Sand (%)	Fine Sand (%)	Medium Sand (%)	Coarse Sand (%)	Very Coarse Sand (%)			
	FRASER RIVER														
FR-16	**Kopper's International**	26-Sep-90													
	Station 1		clay	62.2	30.7	5.6	1	0.3	0.2	0	0	0		980000	20400
	Station 2		clay	63.2	29.4	5.9	1.3	0.2	0	0	0	0		977000	23300
	Station 3		clay	71.3	20.6	6.1	1.8	0.2	0	0	0	0		967000	32500
	Station 4		clay	73.9	17.1	7.8	0.9	0.3	0	0	0	0		964000	36400
FR-17	**Domtar Wood Preservers**	24-Sep-90													
	Station 1		clay	80	11.3	5.5	0.9	0.3	0	0	0	0		970000	29600
	Station 2		clay	75.6	14.7	6.3	3.1	0.2	0	0	0	0		971000	28900
	Station 3		clay	62.8	23.9	9.2	3.9	0.2	0	0	0	0		973000	27100
	Station 4		clay	57.1	17.4	7.8	4.9	2.2	1.9	1.6	3	0.1		973000	26600
FR-18	**Domtar/Liverpool Site**	26-Sep-90													
	Station 1		clay	74.8	14.2	6.7	3.3	0.4	0	0	0	0		696000	31500
	Station 2		clay	64.7	28.4	5.5	0.8	0.4	0.2	0	0	0		977000	23400
	Station 3		clay	65.9	28.7	4.9	1.2	0.2	0	0	0	0		978000	22400
	Station 4		very fine sand	2.1	19.5	76.6	1	0.1	0.2	0.3	0.2	0		992000	7710
FR-19	**Princeton Wood Preservers**	25-Sep-90													
	Station 1		clay	86.4	8.8	2.3	2.3	0.2	0	0	0	0		965000	35100
	Station 2		clay	91.3	6.6	1.6	0.5	0	0	0	0	0		962000	38300
	Station 3		clay	76.4	7	13.7	2.8	0.1	0	0	0	0		961000	38800
	Station 4		clay	71.1	21.2	6.4	0.3	0	0	0	0	0		970000	30200
FR-20	**B.C. Cleanwood Preservers**	25-Sep-90													
	Station 1		silt	19.9	40.2	37.9	1.6	0.2	0.2	0	0	0		983000	17000
	Station 2		silt	44.2	31.7	21	2.7	0.4	0	0	0	0		974000	26100
	Station 3		very fine sand	18.9	29.9	23.8	36.1	7.6	3.7	0.3	0.2	0		906000	93700
	Station 4		clay	83.7	4.3	7	2.7	0.3	0	0	0	0		940000	60100
	FALSE CREEK														
FC-1	**Marina at Market**														
	Station 3,4,5 (composite)	25-Mar-91	silt	21.4	8.9	37.9		2.1	2.5	4.34	4.8	6.1	19.2	919000	80600
FC-4	**Outer creek - midchannel**														
	Station 1	4-Jun-91	medium sand	5.5	2	8.5		6.5	18.2	36.9	18.1	3.1	0.51	964000	36200
FC-5	**At Granville Ferries**														
	Station 1	4-Jun-91	silt	24.8	11.3	49.8		9	2.9	1.6	0.6	0.14	0	944000	55600
		16-Nov-94	clay and silt	[	62.9	]		11.6	10.9	10.9	3.2	0.5	<0.1	931000	68900
FC-6	**Off Granville Island Hotel**														
	Station 1	4-Jun-91	silt	26.8	9.4	43.5		11.6	6	1.8	0.62	0.27	0.41	942000	57900

APPENDIX 3.1 SEDIMENT CHARACTERISTICS

SITE NO.	LOCATION	DATE	MEDIAN PARTICLE SIZE	CLAY AND SILT (%)			SAND (%)					GRANULES (%)	SFR	SVR
				Clay (%)		Silt (%)	Very Fine Sand (%)	Fine Sand (%)	Medium Sand (%)	Coarse Sand (%)	Very Coarse Sand (%)			
	FALSE CREEK cont.													
FC-7	**Off Marina at Monk McQueen's**													
	Station 1	4-Jun-91	silt	17.7	7.3	31.6	4.6	8.6	10.7	11.1	5.01	5.04	930000	70200
	(Lab duplicate)						NO INFORMATION						927000	72600
		16-Nov-94	clay and silt	[	72	]	6.7	8.1	7.3	3.4	2.5	<0.1	919000	81300
FC-8	**Off Monk McQueen's; near Cambie Bridge**													
	Station 1	4-Jun-91	silt	19.3	10.2	42.8	5.1	7.7	7.6	4.4	1.8	1.9	921000	78800
		16-Nov-94	clay and silt	[	74.3	]	6.8	8.8	8	1.4	0.6	0.1	928000	72000
FC-9	**Inside Cambie Bridge off dumpsite**													
	Station 1	4-Jun-91	silt	19.8	11.6	48.6	3.8	2.8	3.3	3.1	2.6	8.6	918000	82000
	(Lab duplicate)						NO INFORMATION						926000	73700
FC-10	**Northeast corner**													
	Station 1	4-Jun-91	clay and silt	19.7	12.2	47.2	4.4	5.6	5.5	2.9	1.8	1.5	914000	86200
	(Lab duplicate)						NO INFORMATION						910000	90000
	BURRARD INLET													
BI-1	**Vancouver Outer Harbour (Pacific Environment Institute)**													
	Station 2	9-Sep-91	silt	32	10.4	54.5	2.4	0.67	0.11	0.04	0.01	0	949000	51000
	(Lab duplicate)						NO INFORMATION						949000	50800
BI-2	**Vancouver Wharves**													
	Station 4	12-Sep-91	medium sand	[	1.1	]	1.2	14.4	44.6	19.6	8.5	10.6	759000	241000
	(Repeat analysis)						NO INFORMATION						938000	62300
BI-3	**L & K Lumber**													
	Station 2a	12-Sep-91	very fine sand	[	40.8	]	15.9	19.6	16.7	4.8	1.1	1.1	929000	71300
	(Repeat analysis)		clay and silt	[	80.2	]	8.5	5.1	3.7	2.5	0.9	0.1	NA	NA
BI-4	**Vancouver Shipyards/Seaspan**													
	Station 4	12-Sep-91	coarse sand	1.73	0.44	2.7	0.99	5.5	27	40	16.2	5.6	941000	58900
BI-5	**Versatile Pacific (was Burrard Yarrows)**													
	Station 5	12-Sep-91	very fine sand	15.5	4.8	27.2	19.2	26.2	3.8	1.8	0.69	1.4	950000	49700

APPENDIX 3.1 SEDIMENT CHARACTERISTICS

SITE NO.	LOCATION	DATE	MEDIAN PARTICLE SIZE	CLAY AND SILT (%)			SAND (%)					GRANULES (%)	SFR	SVR
				Clay (%)		Silt (%)	Very Fine Sand (%)	Fine Sand (%)	Medium Sand (%)	Coarse Sand (%)	Very Coarse Sand (%)			
	BURRARD INLET cont.													
BI-7	**Saskatchewan Wheat Pool**													
	Station 1	12-Sep-91	very fine sand	10.2	2.4	22.3	31.5	26.6	4.3	0.6	0.2	2.6	967000	32900
BI-8	**Neptune Terminals**													
	Station 2a	12-Sep-91	very fine sand	[	25.2	]	24.7	28.6	17.1	3.4	1	<0.1	953000	47000
	(Lab duplicate)						NO INFORMATION						949000	50900
	(Repeat analysis)		very fine sand	9.2	2.5	21.3	21.9	29.3	13.6	1.9	0.3	0	NA	NA
BI-9	**Seaboard Terminals**													
	Station 1x	12-Sep-91	medium sand	[	8.8	]	9.3	16.4	21.5	12.4	9.2	22.4	960000	40400
	(Repeat analysis)		medium sand	2.7	1.6	10.2	8.5	18.5	20.2	11.7	7.5	21.2	NA	NA
BI-10	**Lynnterm**													
	Station 4	11-Sep-91	fine sand	3.3	1.4	7.1	8.3	44.5	27	4.4	1	3.2	963000	37200
BI-14	**Boulder Rock**													
	Station 1	11-Sep-91	silt	18.9	4.7	41.7	28.2	6.24	0.18	0.04	0	0	948000	51800
	(Lab duplicate)						NO INFORMATION						953000	46700
BI-15	**IOCO**													
	Station 1	10-Sep-91	medium sand	[	30	]	6	10	12	14	23	5	894000	106000
BI-17	**Port Moody**													
	Station1	11-Sep-91					NO INFORMATION						912000	87700
	(Blind duplicate)						NO INFORMATION						920000	79700
BI-18	**Alberta Wheat Pool**													
	Station 1	11-Sep-91	silt	12.5	10.3	52	2.4	5.1	9.1	5	2.4	2.54	988000	11800
	(Blind duplicate)												986000	14200
BI-19	**Central Harbour**													
	Station 1	12-Sep-91	silt	20.2	6.5	34.1	15.8	16.7	2.8	0.21	0.05	5.8	951000	48900
BI-23	**Vanterm**													
	Station 2	12-Sep-91	coarse sand	5.7	2.4	13.5	4.6	8	14.3	15.8	16.1	22.8	939000	61500
	(Lab duplicate)						NO INFORMATION						938000	62200
	(Blind duplicate)						NO INFORMATION						949000	50800
BI-24	**United Grain Growers**													
	Station 1	12-Sep-91	fine sand	[	31.8	]	15.4	15.9	12.7	7.7	3.9	12.6	943000	57100
BI-25	**Centerm**													
	Station 1	12-Sep-91	fine sand	12.5	3.5	20.3	11.1	24	21.7	4	1.3	2	958000	42500

APPENDIX 3.1 SEDIMENT CHARACTERISTICS

SITE NO.	LOCATION	DATE	MEDIAN PARTICLE SIZE	CLAY AND SILT (%)			SAND (%)					GRANULES (%)	SFR	SVR
				Clay (%)		Silt (%)	Very Fine Sand (%)	Fine Sand (%)	Medium Sand (%)	Coarse Sand (%)	Very Coarse Sand (%)			
	BURRARD INLET cont.													
BI-26	**Canada Place (Pier BC; NHB)** Station 2 (Lab duplicate) (Blind duplicate)	12-Sep-91	silt	23.1	7.7	42.2	13.8	7.9	4.8	0.52	0.06	0	943000 942000 940000	57100 57800 60400
	COAL HARBOUR													
CH-1	**Bayshore Inn Marina** Station 1,3,4 (composite) (Lab duplicate)	25-Mar-91	silt	20.2	6.7	38.4	1.9	2.9	3.3	3.6	4.4	30.4	898000 898000	102000 102000
CH-3	**Royal Vancouver Yacht Club Marina (RVYC)** Station 4,5,6 (composite) (Blind duplicate)	25-Mar-91					NO INFORMATION						921000 915000	79500 85500
	VICTORIA HARBOUR													
	The Gorge:													
VH-1	Stn. SW-7; storm drains across from Aaron Point	11-Jul-90	fine sand	[	28.6	]	15.1	22	29.9	4.4	0	0	861000	139000
VH-2	Stn. SW-8; off Gorge Park	11-Jul-90	medium sand	[	13.1	]	13.7	22.3	34.3	14.9	1.7	0	868000	132000
	Selkirk Waters:													
VH-4	Stn. SW-2; off old BCFP/Fletcher Challenge sawmill, west side	11-Jul-90	very fine sand	[	40.5	]	18.6	19.7	16.9	4.3	0	0	881000	119000
VH-5	Stn. SW-3; off old BCFP/Fletcher Challenge sawmill; southwest side	11-Jul-90	very fine sand	[	30.5	]	19.9	20.7	20.7	7.2	0	0	893000	107000
VH-6	Stn. SW-4; trawl site, midchannel	11-Jul-90	fine sand	[	25.4	]	15.5	19.5	23.9	15.7	0	0	854000	146000
VH-7	Stn. SW-5; south end of old BCFI Fletcher Challenge sawmill; off location of old dip tanks	11-Jul-90	fine sand	[	25	]	17.7	21.7	26.8	8.3	0.3	0.2	865000	135000
VH-8	Stn. SW-6; off storm drain south c sawmill site	11-Jul-90	fine sand	[	24.1	]	14.8	22.4	34.6	4.1	0	0	856000	144000

APPENDIX 3.1 SEDIMENT CHARACTERISTICS

SITE NO.	LOCATION	DATE	MEDIAN PARTICLE SIZE	CLAY AND SILT (%)			SAND (%)					GRANULES (%)	SFR	SVR
				Clay (%)		Silt (%)	Very Fine Sand (%)	Fine Sand (%)	Medium Sand (%)	Coarse Sand (%)	Very Coarse Sand (%)			
	VICTORIA HARBOUR cont.													
	Upper Harbour:													
VH-9	Stn. UH-1; Victoria Machinery De	11-Jul-90	fine sand	[	37	]	17.4	20.2	22	2.3	1.1	0	885000	115000
VH-10	Stn. UH-2; Rock Bay	11-Jul-90	silt and clay	[	52.9	]	18.1	15.3	10.9	2.8	0	0	879000	121000
VH-11	Stn. UH-3; head of Rock Bay	11-Jul-90	very fine sand	[	45.6	]	21.3	19.5	10.9	2	0.7	0	875000	125000
VH-12	Stn. UH-4; midchannel trawl site	11-Jul-90	fine sand	[	29.9	]	15.7	20.3	21	10.9	2	0.2	883000	117000
VH-13	Stn. UH-5; Smith Cedar Products	11-Jul-90	fine sand	[	23.2	]	16	22.1	23.1	13.9	1.5	0.2	879000	121000
VH-14	Stn. UH-6; Site 1	11-Jul-90	coarse sand	[	1.9	]	1.9	6	22.2	41.8	24.2	0.8	902000	98200
VH-15	Stn. UH-7; Hope Point/Standard (	11-Jul-90	very fine sand	[	48.1	]	24	19.9	7.3	0.7	0	0	891000	109000
VH-16	Stn. UH-8; Garbage Depot/Standi Oil	11-Jul-90	very fine sand	[	43.4	]	21.7	18.2	15.3	0.4	0	0	881000	119000
VH-17	Stn. UH-9; Boatbuilding Facility	6-Mar-91					NO INFORMATION							
	Inner Harbour:													
VH-18	Stn. IH-1; Off Songhees	11-Jul-90	very fine sand	[	26.9	]	27.7	24.7	13.9	4.2	2.1	0.5	936000	64400
VH-19	Stn. IH-2; West Coast Air	11-Jul-90	very fine sand	[	35.6	]	19.5	19.2	16.8	1.8	1.8	1.3	949000	51400
VH-20	Stn. IH-3; commercial dock at entrance to James Bay	11-Jul-90	coarse sand	[	13.1	]	6.9	11.5	18.1	10.3	12.2	27.9	911000	89400
VH-21	Stn. IH-4; Undersea Gardens	11-Jul-90	very fine sand	[	32.5	]	24.4	22.2	12.9	4.4	0.2	3.6	939000	61000
VH-22	Stn. IH-5; B.C. Steamships	11-Jul-90	very fine sand	[	35.8	]	18.3	19	18.9	5	1.5	1.5	927000	72700
VH-23	Stn. IH-6; bay beside B.C. Steamships	11-Jul-90	very fine sand	[	32.2	]	24.7	25.2	12.8	4.9	0.1	0.1	915000	85000
VH-24	Stn. IH-8; Trotac Marine	11-Jul-90	very fine sand	[	35.1	]	17.3	18.9	23.6	4.3	0.4	0.4	877000	123000
VH-25	Stn. IH-9; Raymer Point/Fisherman's Wharf	11-Jul-90	fine sand	[	25.2	]	27.8	25.6	12.9	4.2	2.6	1.7	937000	63000
VH-26	Stn. IH-10; between Shoal Point and Fisherman's Wharf	11-Jul-90	fine sand	[	11.5	]	22.1	57.2	7.2	0.7	0.1	0.2	961000	38600

APPENDIX 3.1 SEDIMENT CHARACTERISTICS

SITE NO.	LOCATION	DATE	MEDIAN PARTICLE SIZE	CLAY AND SILT (%)			SAND (%)					GRANULES (%)	SFR	SVR
				Clay (%)		Silt (%)	Very Fine Sand (%)	Fine Sand (%)	Medium Sand (%)	Coarse Sand (%)	Very Coarse Sand (%)			
	VICTORIA HARBOUR cont.													
VH-27	Stn. IH-11; Centre Channel trawl :	11-Jul-90	medium sand	[	15.6	]	17.4	24.3	17.4	2.5	2.5	20.4	931000	69200
VH-28	Stn. IH-12; south side Songhees/old Seaspan site	11-Jul-90	medium sand	[	10.1	]	7.1	13	26.2	24.9	9.4	9.3	879000	121000
VH-29	Stn. IH-13; south side Songhees/old Shell Oil site	11-Jul-90	fine sand	[	25	]	20.3	27.5	17.9	5.9	3	0.4	899000	101000
VH-30	Stn. IH-14; West Bay	11-Jul-90	very fine sand	[	29	]	25.1	29.4	15.5	0.7	0.3	0	914000	85700
	Outer Harbour:													
VH-31	Stn. OH-2; Ogden Point Wharves	11-Jul-90	very fine sand	[	27.4	]	37.1	24.4	10.4	0.7	0	0	963000	37200
	ESQUIMALT HARBOUR													
EH-1	Upper Harbour	11-Jul-90	fine sand	[	14.7	]	28.6	32.9	20.3	2.7	0.8	0	981000	19500
	Plumper Bay:													
EH-2	Stn. PB-1; off old wood products facility	11-Jul-90	fine sand	[	11.1	]	20.8	26.5	27.9	13.7	0	0	810000	190000
EH-3	Stn. PB-2; off site of old dip tank	11-Jul-90	medium sand	[	26.2	]	12	16.9	32.9	8.9	1.8	1.1	863000	137000
EH-4	Trawl site	11-Jul-90	very fine sand	[	47.3	]	17.5	16.1	18.6	0.5	0	0	927000	72600
EH-5	Dunn's Nook	11-Jul-90	very fine sand	[	47.7	]	16	16.6	17.8	1.9	0	0	925000	75000
EH-6	Fort Rodd	11-Jul-90	fine sand	[	13	]	12.7	31.5	30.5	9	3.3	<0.1	964000	36000
	Constance Cove:													
EH-7	Station 1	11-Jul-90	medium sand	[	9.4	]	5.5	16.9	43.6	15.1	8.1	1.4	928000	71600
EH-8	Station 6a; B-jetty	11-Jul-85					NO INFORMATION						920000	80300
EH-9	Station 2	11-Jul-90	fine sand	[	28	]	12.2	18.4	25.5	12.5	3.4	<0.1	904000	95900
EH-10	Station 3	11-Jul-90	fine sand	[	27.8	]	15.2	27.2	24.2	4.2	0.6	0.8	926000	74200
EH-11	Station 4	11-Jul-90	very fine	[	41.7	]	12.3	11.5	13.7	8.6	2.3	9.9	928000	71600
EH-12	Station 5	11-Jul-90	clay and silt	[	59.7	]	17.7	11.9	10.3	0.4	<0.1	<0.1	950000	50000

APPENDIX 3.1 SEDIMENT CHARACTERISTICS

SITE NO.	LOCATION	DATE	MEDIAN PARTICLE SIZE	CLAY AND SILT (%)			SAND (%)					GRANULES (%)	SFR	SVR
				Clay (%)		Silt (%)	Very Fine Sand (%)	Fine Sand (%)	Medium Sand (%)	Coarse Sand (%)	Very Coarse Sand (%)			
	ESQUIMALT HARBOUR cont.													
EH-13	Station 6	11-Jul-90	clay and silt	[	50	]	14.7	12.7	13.7	5.7	3.2	<0.1	936000	63700
EH-14	Trawl site	11-Jul-90	clay and silt	[	52.8	]	13	15.3	17.3	0.5	0.3	0.8	928000	72300
	(Blind duplicate)		clay and silt	[	93.8	]	3	1.7	1.2	0.3	<0.1	<0.1	NA	NA
	REFERENCE AREAS													
RF-1	Crescent Beach Station 1	28-Jun-91	medium sand	[	1.6	]	13.4	32.6	37.2	8.7	2.9	3.7	988000	12300
RF-11	Tow Hill, Queen Charlotte Isl.	22-Jul-89	fine sand	[	14.2	]	42.3	24	6.3	4.9	4.2	4.1	NI	NI

Clay	<0.004 mm
Silt	0.004 - 0.063mm
Silt and clay	<0.063 mm
Very fine sand	0.063 - 0.125 mm
Fine sand	0.125 - 0.25 mm
Medium sand	0.25 - 0.50 mm
Coarse sand	0.50 - 1.00 mm
Very coarse sand	1.00 - 2.00 mm
Granules	>2.00 mm

APPENDIX 3.2 BIOTA SAMPLE INFORMATION

SITE NO.	LOCATION	DATE	SPECIES		TISSUE	NO.	SEX	AGE	LENGTH (cm)	WEIGHT (g)	MOISTURE CONTENT (%)	LIPID CONTENT (%)
	FALSE CREEK											
FC-1	**Marina at Market**											
	Station 3,4,5 (composite)	25-Mar-91	Mussels	(large)	Soft tissue	177	NI	NI	3.5-5.2	NI	87	1
FCT-1	**East Basin Trawl**	4-Jun-91	Dungeness crab		Muscle	7	M	NI	11.0-13.2	153.4-286.0	82/84	0.02
		4-Jun-91	Dungeness crab		Hepatopancreas	7	M	NI	11.0-13.2	153.4-286.0	71	12.9
		4-Jun-91	English sole		Whole body	9	NI	NI	14.8-19.0	32.6-54.0	80	2
FCT-2	**Monk McQueen's Trawl**	6-Jun-91	English sole		Whole body	10	NI	NI	18.5-26.0	57.2-154.0	78/80	1.7
	BURRARD INLET											
BI-2	**Vancouver Wharves**											
	Stations M1, M2 (composite)	29-Oct-91	Mussels	(mixed sizes)	Soft tissue	82	NI	NI	0.5-4.5	NI	84/86	0.7
BI-3	**L & K Lumber**											
	Station M1	29-Oct-91	Mussels	(small)	Soft tissue	56	NI	NI	1.5-4.0	NI	88	0.6/0.7
BI-5	**Versatile Pacific/Burrard Yarrows**											
	Station M2	29-Oct-91	Mussels	(small)	Soft tissue	98	NI	NI	0.2-2.0	NI	88	1.2
BI-9	**Seaboard Terminals**											
	Station M2	29-Oct-91	Mussels	(small)	Soft tissue	87	NI	NI	0.5-2.5	NI	85/86	0.8
BI-10	**Lynnterm**											
	Station M2	29-Oct-91	Mussels	(small)	Soft tissue	117	NI	NI	0.5-3.5	NI	86/84/85	1.4/1.4
BI-26	**Canada Place**											
	Station M1	29-Oct-91	Mussels	(mixed sizes)	Soft tissue	56	NI	NI	1.0-4.5	NI	85/87	1.5

APPENDIX 3.2 BIOTA SAMPLE INFORMATION

SITE NO.	LOCATION	DATE	SPECIES		TISSUE	NO.	SEX	AGE	LENGTH (cm)	WEIGHT (g)	MOISTURE CONTENT (%)	LIPID CONTENT (%)
	COAL HARBOUR											
CH-1	**Bayshore Inn Marina**											
	Stations 5,8,10,11 (composite)	25-Mar-91	Mussels	(large)	Soft tissue	128	NI	NI	3.6-6.3	NI	88	0.89
	Stations 5,8,10,11 (composite)	25-Mar-91	Mussels	(large)	Soft tissue	128	NI	NI	3.6-6.3	NI	87	0.92
CH-3	**Royal Vancouver Yacht Club (RVYC) Marina**											
	Stations 2,3,8 (composite)	25-Mar-91	Mussels	(large)	Soft tissue	83	NI	NI	4.0-6.2	NI	89/90	0.4
	VICTORIA HARBOUR											
	Selkirk Waters:											
SW-C1	Station C1	10-Jul-90	Dungeness crab		Muscle	8	8M	NI	16.0-19.0	408.4-750.0	81.9	0.01
		10-Jul-90	Dungeness crab		Hepatopancreas	8	8M	NI	16.0-19.0	408.4-750.0	81.7	8.4
SWT-3	Trawl SWT-3	10-Jul-90	English sole		Whole body	6	NI	NI	6.8-14.6	8.7-10.9	76.4	1.4
		10-Jul-90	Sidestripe Shrimp		Tail	97	NI	NI	7.2-10.6	3.0-10.2	74.9	0.3
SW-SS1	Stn. SS1 (off old sawmill site)	11-Jul-90	Bentnose clams		Soft tissue	20	NI	NI	2.0-5.5	NI	NI	0.4
SW-SS2	Stn. SS2 (beach at Bamfield Park)	13-Jul-90	Bentnose clams		Soft tissue	21	NI	NI	2.5-4.5	NI	NI	0.7
	Upper Harbour:											
UHT-1	Trawl UHT-1	10-Jul-90	English sole		Whole body	33	NI	NI	6.1-11.5	2.2-14.8	77.2	1.9
UH-C2	Station C2	11-Jul-90	Dungeness crab		Muscle	8	8M	NI	16.0-19.0	408.4-750.0	80.4	0.05
	Station C2	11-Jul-90	Dungeness crab		Hepatopancreas	8	8M	NI	16.0-19.0	408.4-750.0	77.2	12
	Inner Harbour:											
IH-C3/IHT-1	Station C3 and Trawl IHT-1	10-Jul-90	Dungeness crab		Muscle	4	4M	NI	15.0-18.0	441.8-497.0	80.3	0.02
		10-Jul-90	Dungeness crab		Hepatopancreas	4	4M	NI	15.0-18.0	441.8-497.0	73/72	14
IHT-1	Trawl IHT-1	10-Jul-90	English sole		Whole body	52	NI	NI	5.4-11.3	1.4-15.8	78.7	1.0
	Trawl IHT-1	10-Jul-90	Shrimp		Tail	148	NI	NI	5.4-11.3	1.4-11.8	75.5	0.5

APPENDIX 3.2 BIOTA SAMPLE INFORMATION

SITE NO.	LOCATION	DATE	SPECIES		TISSUE	NO.	SEX	AGE	LENGTH (cm)	WEIGHT (g)	MOISTURE CONTENT (%)	LIPID CONTENT (%)
	VICTORIA HARBOUR cont.											
	Inner Harbour cont.:											
IH-SS3	Station SS3 (Laurel Point)	11-Jul-90	Bentnose clams		Soft tissue	20	NI	NI	2.0-3.5	NI	NI	0.3
IH-C4	Station C4 (West Bay)	9-Jul-90	Dungeness crab		Hepatopancreas	5	2M;4F	NI	14.5-18.0	496.0-645.2	82.9	NI
IH-SS4	Station SS4 (Hidden Harbour Marina)	11-Jul-90	Bentnose clams		Soft tissue	58	NI	NI	2.5-6.0	NI	83.5	NI
	ESQUIMALT HARBOUR											
	Constance Cove:											
CC-C1	Station C1	9-Jul-90	Dungeness crab		Muscle	9	9M	NI	14.0-19.0	405.4-752.8	83	0.5
		9-Jul-90	Dungeness crab		Hepatopancreas	9	9M	NI	14.0-19.0	405.4-752.8	83.9	5.0
CC-M1	Station M2	9-Jul-90	Mussels	(mixed sizes)	Soft tissue	126	NI	NI	2.5-5.0	NI	84	1.2
CCT-1	Trawl CCT-1	9-Jul-90	English sole		Whole body	47	NI	NI	6.0-16.0	2.2-37.8	77.7	1.2
		9-Jul-90	Shrimp		Tail	152	NI	NI	4.5-9.5	0.6-7.0	75.6	0.3
	Plumper Bay:											
PBT-1,2,3	Trawl PB-1,2,3	12-Jul-90	English sole		Whole body	44	NI	NI	4.7-11.1	0.8-11.8	78.2	1.1
	Trawl PB-1,2,3	12-Jul-90	Shrimp		Tail	92	NI	NI	5.0-11.5	0.8-8.2	73.4	0.3
	Trawl PB-1,2,3	4-Mar-91	Dungeness crab		Muscle	12	11M;1F	NI	12.0-18.0	212.2-654.2	NI	0.1
		4-Mar-91	Dungeness crab		Hepatopancreas	12	11M;1F	NI	12.0-18.0	212.2-654.2	NI	NI
PB-M2,M3	Stns. M2,M3 (adjacent old sawmill site)	9-Jul-90	Mussels	(large)	Soft tissue	89	NI	NI	3.0-5.5	NI	86.3	0.9
PB-SS5	Station SS5	9-Jul-90	Macoma clams		Soft tissue	1	NI	NI	7.5	NI	NI	0.5
PB-SS6	**Dallas Bank**											
	Station SS6	9-Jul-90	Bentnose clams		Soft tissue	46	NI	NI	3.0-5.5	NI	80.7	0.6

APPENDIX 3.2 BIOTA SAMPLE INFORMATION

SITE NO.	LOCATION	DATE	SPECIES	TISSUE	NO.	SEX	AGE	LENGTH (cm)	WEIGHT (g)	MOISTURE CONTENT (%)	LIPID CONTENT (%)
VI-14	**Ladysmith Harbour:**										
	Site #29	20-Jan-92	Mussels	Soft tissue			NO	INFORMATION			0.3
	Site #30	20-Jan-92	Mussels	Soft tissue			NO	INFORMATION			2
	Site #31	20-Jan-92	Mussels	Soft tissue			NO	INFORMATION			1.4
	Site #32	20-Jan-92	Mussels	Soft tissue			NO	INFORMATION			2.3
	Site #33	20-Jan-92	Mussels	Soft tissue			NO	INFORMATION			1.6
	Site #38	20-Jan-92	Mussels	Soft tissue			NO	INFORMATION			1.6
	REFERENCE SITES										
RF-1	**Crescent Beach**										
	CBT-1	16-Jun-91	Rock sole	Whole body	17	NI	NI	8.5-12.5	5.0-16.8	75/76	2.0/2.1
RF-8	**Rivers Inlet**										
	Station 1	26-Oct-89	Pink shrimp	Tail	92	NI	NI	7.0-10.0	1.2-8.2	77	0.7

NI no information was available
N/A no I.D. number assigned

APPENDIX 4

QUALITY ASSURANCE AND QUALITY CONTROL

APPENDIX 4.1 QUALITY ASSURANCE AND QUALITY CONTROL - Sediment Samples

Sediment Procedural Blanks (ng/g dry weight):

	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS-(2-ETHYLHEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE
Batch 1171						
Blank #						
1	252	188	180	52	192	40
2	228	130	250	38	185	43
3	210	100	141	156	243	147
4	235	75	80	110	600	95
5	160	140	140	44	150	47
6	170	170	210	37	150	65
7	210	100	130	56	500	75
8	196	260	124	32	9200	48
9	180	84	124	36	220	32
10	212	127	705	56	1880	80
11	171	204	171	39	330	45
12	63	95	95	27	436	22
Mean	191	139	196	57	1174	62
Standard Deviation	49	56	167	38	2572	34
Batch 1187/2905+A67						
Blank #						
154	<250	<75	<45	<10	<150	<12
Batch 2820						
Blank #						
307	310	125	160	30	1100	90
309	80	135	1150	35	750	55
313	700	600	9000 *	36	4300	70
394i	90	160	355	19	280	28
395i	51	231	364	37	277	43
408	200	130	400	3100*	510	
409	67	75	169	55	255	51
412	370	161	312	69	116	69
413	512	203	420	79	144	40
416	338	286	567	41	275	39
513	34	96	200	31	600	16
603	53	85	322	26	571	26
612	47	58	584	32	4380	32
Mean	204	173	403	39	1360	79
Standard Deviation	210	140	260	19	1700	125
Reporting D.L. (ng/g for 5 g sample)	130	80	160	11	1000	75

* These results are considered to be anomalous and are not included in the statistical treatment of the data. The rejection of these data points is based on Q-tests and t-tests.

APPENDIX 4.1 QUALITY ASSURANCE AND QUALITY CONTROL - Sediment Samples

Reference Sediments (ng/g dry weight):

	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS-(2-ETHYLHEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE
Batch 1171/1187						
Reference Sediment HS-6:						
1	ND (150)	ND (170)	ND (500)	ND (110)	ND (7700)	ND (100)
2	ND (150)	ND (170)	ND (500)	ND (110)	ND (7700)	ND (100)
3	ND (150)	ND (170)	ND (500)	ND (110)	ND (7700)	ND (100)
4	ND (150)	ND (170)	ND (500)	ND (110)	ND (7700)	ND (100)
5	ND (150)	ND (170)	ND (500)	ND (110)	ND (7700)	110 (100)
6	ND (150)	ND (170)	ND (500)	ND (110)	ND (7700)	220 (100)
7	ND (150)	ND (170)	ND (500)	ND (110)	ND (7700)	120 (100)
8	ND (150)	ND (170)	ND (500)	ND (110)	ND (7700)	230 (100)
9	ND (150)	ND (170)	ND (500)	ND (110)	ND (7700)	130 (100)
10	ND (150)	ND (170)	ND (500)	ND (110)	ND (7700)	ND (100)
11	ND (150)	ND (170)	ND (500)	ND (110)	ND (7700)	ND (100)
12	ND(150)	ND(170)	ND(500)	ND(110)	ND(7700)	ND (100)

*HS6 is not certified for Phthalate Esters.
Detection limits are given in brackets.

NOTE: Data has been blank corrected.

APPENDIX 4.1 QUALITY ASSURANCE AND QUALITY CONTROL - Sediment Samples

Spiked Reference Sediments:

	Concentration (ng/g)		
Compound	**Determined**	**Expected**	**% Recovery**
Batch 1171:			
SPIKE #1171-1			
Dimethyl phthalate	1100	1340	82
Diethyl phthalate	2300	2380	97
Di-n-butyl phthalate	1500	1700	88
Benzyl butyl phthalate	1800	1940	93
Bis-(2-ethylhexyl) phthalate	2000	1560	128
Di-n-octyl phthalate	1200	1360	88
SPIKE #1171-2			
Dimethyl phthalate	6400	8920	72
Diethyl phthalate	14000	15900	88
Di-n-butyl phthalate	9800	11300	85
Benzyl butyl phthalate	11000	13000	85
Bis-(2-ethylhexyl) phthalate	7900	10400	76
Di-n-octyl phthalate	7800	9100	86
SPIKE # 1171-3			
Dimethyl phthalate	7900	9870	80
Diethyl phthalate	15000	17600	85
Di-n-butyl phthalate	11000	12500	88
Benzyl butyl phthalate	12000	14400	83
Bis-(2-ethylhexyl) phthalate	8600	11500	75
Di-n-octyl phthalate	8400	10100	83
Batch 2820:			
Spike SPM 82			
Dimethyl phthalate	4100	6000	68
Diethyl phthalate	8000	5200	150
Di-n-butyl phthalate	6200	5100	120
Benzyl butyl phthalate	6500	5600	120
Bis-(2-ethylhexyl) phthalate	4800	4900	98
Di-n-octyl phthalate	4600	6000	77
Spike SPM 158i			
Dimethyl phthalate	1900	2000	95
Diethyl phthalate	3800	3600	110
Di-n-butyl phthalate	2700	2600	100
Benzyl butyl phthalate	2900	3000	97
Bis-(2-ethylhexyl) phthalate	2200	2400	92
Di-n-octyl phthalate	2100	2100	100

APPENDIX 4.1 QUALITY ASSURANCE AND QUALITY CONTROL - Sediment Samples

	Concentration (ng/g)		
Compound	Determined	Expected	% Recovery
Batch 2820 cont.:			
Spike SPM 78			
Dimethyl phthalate	3900	4300	91
Diethyl phthalate	7100	7700	92
Di-n-butyl phthalate	4900	5500	89
Benzyl butyl phthalate	5600	6200	90
Bis-(2-ethylhexyl) phthalate	5700	5100	110
Di-n-octyl phthalate	4300	4500	96
Spike SPM 169			
Dimethyl phthalate	1800	2000	90
Diethyl phthalate	3600	3600	100
Di-n-butyl phthalate	2600	2600	100
Benzyl butyl phthalate	2900	3000	97
Bis-(2-ethylhexyl) phthalate	2200	2400	92
Di-n-octyl phthalate	2100	2100	100
Spike SPM 172			
Dimethyl phthalate	1800	2000	90
Diethyl phthalate	3500	3600	97
Di-n-butyl phthalate	2500	2600	96
Benzyl butyl phthalate	2800	3000	93
Bis-(2-ethylhexyl) phthalate	2100	2400	88
Di-n-octyl phthalate	2000	2100	95
Spike SPM 173			
Dimethyl phthalate	1700	2000	85
Diethyl phthalate	3400	3600	94
Di-n-butyl phthalate	2500	2600	96
Benzyl butyl phthalate	2900	3000	97
Bis-(2-ethylhexyl) phthalate	2100	2400	88
Di-n-octyl phthalate	2000	2100	95
Spike SPM 174			
Dimethyl phthalate	1800	2000	90
Diethyl phthalate	3500	3600	97
Di-n-butyl phthalate	2500	2600	96
Benzyl butyl phthalate	2800	3000	93
Bis-(2-ethylhexyl) phthalate	2100	2400	88
Di-n-octyl phthalate	2000	2100	95
Spike SPM 278 i			
Dimethyl phthalate	4300	3400	130
Diethyl phthalate	2400	2200	110
Di-n-butyl phthalate	2600	2200	120
Benzyl butyl phthalate	3600	3600	100
Bis-(2-ethylhexyl) phthalate	2000	1900	110
Di-n-octyl phthalate	2600	3000	87

APPENDIX 4.1 QUALITY ASSURANCE AND QUALITY CONTROL - Sediment Samples

	Concentration (ng/g)		
Compound	Determined	Expected	% Recovery
Batch 2820 cont.:			
Spike SPM 249			
Dimethyl phthalate	3200	3400	94
Diethyl phthalate	2100	2200	95
Di-n-butyl phthalate	2100	2200	95
Benzyl butyl phthalate	3600	3600	100
Bis-(2-ethylhexyl) phthalate	1800	1900	95
Di-n-octyl phthalate	2400	2300	100

APPENDIX 4.1 QUALITY ASSURANCE AND QUALITY CONTROL - Sediment Samples

Internal Laboratory and External Audits (ng/g dry weight)

		DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE
Internal Laboratory Duplicates							
Batch 1171							
Sample 1:	a.)	<30	<34	<100	110	<1500	<20
	b.)	<30	<34	<100	100	<1500	<20
Sample 2:	a.)	<30	<34	<100	280	20000	840
	b.)	<30	<34	<100	370	23000	900
Sample 3:	a.)	93	<34	<100	56	<1500	<20
	b.)	77	<34	<100	73	<1500	<20
Sample 4:	a.)	<30	<34	<100	<22	<1500	<20
	b.)	<30	<34	<100	<22	<1500	<20
Sample 5:	a.)	89	<34	2100	76	<1500	<20
	b.)	110	<34	4000	55	<1500	<20
Sample 6:	a.)	<30	<34	645	<22	6200	NDR(86)
	b.)	<30	<34	NDR(610)	<22	6000	NDR(120)
Sample 7:	a.)	<30	<34	<100	<22	<1500	<20
	b.)	<30	<34	<100	<22	<1500	<20
Sample 8:	a.)	<30	<34	<100	<22	<1500	<20
	b.)	<30	<34	<100	<22	<1500	<20
Sample 9:	a.)	<30	<34	<100	<22	<1500	<20
	b.)	<30	<34	<100	<22	<1500	<20
Sample 10:	a.)	<30	5000	640	<22	9500	<20
	b.)	<30	5500	470	<22	7000	<20
Sample 11	a.)	150	<34	<100	<22	2000	<20
	b.)	43	<34	<100	<22	2100	<20
Sample 12	a.)	<30	<34	1300	<22	<1500	<20
	b.)	<30	<34	960	<22	<1500	<20
Sample 13	a.)	38	100	<100	<22	<1500	<20
	b.)	28	74	<100	<22	<1500	<20
Sample 14	a.)	<30	<34	<100	<22	<1500	<20
	b.)	<30	<34	<100	<22	<1500	28
Batch 1187/2905							
Sample 1:	a.)	<30	NDR (36)	<100	<22	<1500	<20
	b.)	<30	NDR (80)	<100	<22	<1500	<20

APPENDIX 4.1 QUALITY ASSURANCE AND QUALITY CONTROL - Sediment Samples

Internal Laboratory and External Audits (ng/g dry weight)

		DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE
Internal Laboratory Duplicates (cont.):							
Batch 2820							
Sample 1	a.)	<100	<35	150	<23	2100	<10
	b.)	<270	<95	160	<24	2700	<15
Sample 2	a.)	<100	110	<130	<10	<850	<63
	b.)	<120	88	<140	<10	<940	<69
Sample 3	a.)	<30	<34	1300	<22	<1500	<20
	b.)	<30	<34	960	<22	<1500	<20
Sample 4	a.)	38	110	<100	<22	<1500	<20
	b.)	28	<34	<100	<22	<1500	<20
Sample 5	a.)	<30	<34	<100	<22	<1500	<20
	b.)	<30	<34	<100	<22	<1500	<20
Sample 6	a.)	<110	<70	<130	<9	<870	<64
	b.)	<100	<67	290	<9	<820	<60
Sample 7	a.)	<130	94	<2000	23	<1100	<80
	b.)	<130	94	<2000	20	<1100	<80
Sample 8	a.)	<110	<72	<140	36	<890	<65
	b.)	<200	<130	<250	59	<1600	<120
Sample 9	a.)	<100	<68	<130	<9	<840	<62
	b.)	<100	<65	<120	<9	<800	<59
Sample 10	a.)	<350	<230	<430	<39	<2800	<210
	b.)	<200	<140	<260	<24	<1700	<120
Sample 11	a.)	<140	<94	<180	<13	<1200	<85
	b.)	<130	<80	<160	<11	<1000	<75
Sample 12	a.)	<140	<92	<170	15	1300	<84
	b.)	<130	<87	<160	22	1500	<79
Sample 13	a.)	<69	<45	<85	<7	<560	<41
	b.)	<72	<47	<88	<7	<580	<42
Sample 14	a.)	<68	<45	<84	<6	<550	<40
	b.)	<71	<47	<88	<6	<570	<42

APPENDIX 4.1 QUALITY ASSURANCE AND QUALITY CONTROL - Sediment Samples

Internal Laboratory and External Audits (ng/g dry weight)

		DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE
External Blind Duplicates:							
Batch 1171/1187:							
Sample 1	a.)	<30	<34	<100	<22	<1500	<20
	b.)	<30	<34	<100	<22	<1500	32
Batch 2820:							
Sample 1	a.)	<170	<110	1600	33	<1400	<100
	b.)	<130	94	<2000	23	<1100	<80
Sample 2	a.)	<120	<82	<152	<12	<230	<78
	b.)	<110	<75	<140	<10	<910	<67
Sample 3	a.)	<170	<110	<210	23	<1400	<100
	b.)	<130	<80	<160	<12	<1100	<75
Sample 4	a.)	<110	<73	<140	33	4000	<66
	b.)	<120	<80	1500	37	4000	<72

APPENDIX 4.1 QUALITY ASSURANCE AND QUALITY CONTROL - Sediment Samples

Surrogate Standard Recovery Percentages for Phthalate Ester Analysis

	DIMETHYL PHTHALATE D-4	DIETHYL PHTHALATE D-4	DI-N-BUTYL PHTHALATE D-4	BENZYL BUTYL PHTHALATE D-4	BIS(2-ETHYL HEXYL) PHTHALATE D-4	DI-N-OCTYL PHTHALATE D-4
Batch 1171/1187+A199						
Procedural Blanks						
Surrogate recovery information not provided by lab.						
Spiked Reference Sediments						
Spike #						
1	82	85	81	62	58	69
2	72	78	93	98	100	94
3	67	83	100	110	110	100
Samples						
False Creek						
FC-1	55	59	77	100	120	87
Coal Harbour						
CH-1	56	58	115	130	150	94
CH-3	52	84	85	79	74	66
(Lab duplicate)	45	80	95	83	81	76
Victoria Harbour Gorge:						
VH-1	58	69	78	70	83	66
VH-2	62	68	86	71	83	70
Selkirk Waters:						
VH-4	47	53	63	130	160	58
(Lab duplicate)	42	53	73	110	140	68
VH-5	11	17	31	48	130	56
VH-6	81	88	99	83	87	83
VH-7	24	33	53	86	160	59
VH-8	27	44	77	67	99	74
Upper Harbour:						
VH-9	26	36	48	45	88	58
VH-10	60	58	86	110	150	82
(Lab duplicate)	57	57	91	125	150	65
VH-11	84	90	115	87	98	93
VH-12	29	56	83	68	87	90
(Lab duplicate)	82	91	100	80	80	115
VH-13a	97	105	110	90	90	115
VH-14	69	79	87	87	100	79
(Lab duplicate)	23	39	62	59	87	65
VH-15	71	74	79	81	100	66
VH-16	82	93	100	82	87	87
(Lab duplicate)	72	82	94	78	80	76
VH-17	82	92	120	73	110	120
(Lab duplicate)	61	75	100	62	90	100

APPENDIX 4.1 QUALITY ASSURANCE AND QUALITY CONTROL - Sediment Samples

Surrogate Standard Recovery Percentages for Phthalate Ester Analysis

	DIMETHYL PHTHALATE D-4	DIETHYL PHTHALATE D-4	DI-N-BUTYL PHTHALATE D-4	BENZYL BUTYL PHTHALATE D-4	BIS(2-ETHYL HEXYL) PHTHALATE D-4	DI-N-OCTYL PHTHALATE D-4
Batch 1171 cont.						
Inner Harbour:						
VH-18	59	78	85	69	75	69
(Blind duplicate)	65	73	76	69	71	63
VH-19	51	56	64	68	85	57
(Lab duplicate)	55	61	69	72	87	63
VH-20	69	81	86	88	110	77
VH-21	78	82	88	81	98	72
VH-22	64	70	72	80	97	62
VH-23	69	78	96	93	100	77
VH-23a	91	100	100	90	85	82
VH-24	86	92	100	77	84	87
VH-25	18	21	38	53	92	53
VH-26	67	73	85	76	80	66
VH-27	10	10	11	10	43	21
VH-28	10	16	23	20	46	28
VH-29	19	32	46	38	68	49
VH-30	87	95	100	86	88	115
(Lab duplicate)	65	68	82	91	99	88
Outer Harbour:						
VH-31	81	100	120	88	80	96
Esquimalt Harbour						
EH-1	40	53	80	76	91	71
EH-6	99	97	110	90	85	92
(Lab duplicate)	63	88	96	85	88	110
Constance Cove:						
EH-7	31	39	67	62	105	110
EH-9	39	41	47	33	81	78
EH-10	50	58	80	75	92	60
(Lab duplicate)	29	53	83	80	90	60
EH-11	55	67	85	78	85	60
EH-12	28	39	67	64	100	73
EH-13	25	38	71	80	110	64
Plumper Bay:						
EH-2	40	48	69	100	120	61
EH-2	15	23	39	42	66	48
Ladysmith Harbour						
Station 29	71	74	94	85	72	91
Station 30	68	73	92	76	52	76
Station 31	68	83	95	92	67	80
Station 32	59	70	92	86	61	78
(Lab duplicate)	67	78	94	91	41	66
Station 33	74	81	92	85	89	90
Station 34	67	72	87	77	79	98
Station 36	70	78	92	85	90	98
Station 37	75	80	91	84	88	91

APPENDIX 4.1 QUALITY ASSURANCE AND QUALITY CONTROL - Sediment Samples

Surrogate Standard Recovery Percentages for Phthalate Ester Analysis

	DIMETHYL PHTHALATE D-4	DIETHYL PHTHALATE D-4	DI-N-BUTYL PHTHALATE D-4	BENZYL BUTYL PHTHALATE D-4	BIS(2-ETHYL HEXYL) PHTHALATE D-4	DI-N-OCTYL PHTHALATE D-4
Batch 2820						
Procedural Blanks						
Blank 551	35	34	39	32	36	23
Spiked Reference Sediments						
Spike # SSPM						
82	80	88	100	97	100	57
158i	62	76	93	93	87	92
78	93	110	120	140	140	57
169	92	87	96	92	100	98
172	83	86	100	100	77	80
173	72	73	93	89	94	98
174	93	92	100	100	110	93
278i	36	54	50	81	73	39
249	31	33	36	46	59	30
Samples						
False Creek						
FC-1	63	76	87	85	76	73
FC-4	92	93	110	100	120	57
(Lab duplicate)	91	100	120	110	120	63
FC-5	92	97	120	120	130	63
FC-6	85	94	120	120	130	62
(Blind duplicate)	92	98	110	120	120	58
(Lab duplicate)	100	100	100	120	120	57
FC-7	84	96	110	120	120	62
FC-8	91	100	110	120	120	60
FC-9	49	58	73	71	100	47
FC-10	120	120	120	130	130	64
Burrard Inlet						
BI-1	32	31	43	39	40	30
BI-2	40	41	52	78	100	61
BI-3	95	95	93	100	110	49
(Lab duplicate)	110	110	120	130	130	63
BI-4	74	95	97	110	110	53
BI-5	68	81	99	92	94	96
BI-7	58	65	110	110	99	86
BI-8	86	83	100	100	99	98
BI-9	63	65	91	94	95	86
(Lab duplicate)	73	76	98	97	93	89
BI-10	41	54	91	94	98	89
(Blind duplicate)	74	80	97	100	99	88
BI-14	36	40	63	32	32	35
BI-15	37	39	57	35	33	37
(Lab duplicate)	33	35	53	31	31	30
BI-17	42	41	53	25	27	26
BI-18	60	66	90	90	81	83
BI-19	42	44	65	39	37	36
BI-23	84	84	100	100	100	98
(Lab duplicate)	80	77	90	84	84	98
BI-24	84	84	110	87	83	99
BI-25	83	89	100	94	100	100
(Blind duplicate)	73	75	92	90	87	90
BI-26	89	86	100	90	90	96

APPENDIX 4.1 QUALITY ASSURANCE AND QUALITY CONTROL - Sediment Samples

Surrogate Standard Recovery Percentages for Phthalate Ester Analysis

	DIMETHYL PHTHALATE D-4	DIETHYL PHTHALATE D-4	DI-N-BUTYL PHTHALATE D-4	BENZYL BUTYL PHTHALATE D-4	BIS(2-ETHYL HEXYL) PHTHALATE D-4	DI-N-OCTYL PHTHALATE D-4
Batch 2820 cont.						
Coal Harbour						
CH-1	59	75	84	95	85	72
(Blind duplicate)	52	65	82	81	78	71
CH-3	61	72	86	81	78	79
(Lab duplicate)	58	68	86	79	74	74
Reference Sites						
RF-1	54	71	98	93	94	100
RF-9	58	65	89	87	88	94
(Lab duplicate)	69	72	93	87	92	95
RF-10	12	24	44	72	78	42
(Lab duplicate)	36	44	43	79	74	42

APPENDIX 4.2 QUALITY ASSURANCE AND QUALITY CONTROL - Biota Samples

Tissue Procedural Blanks (In ng)

	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BUTYL PHTHALATE	HEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE
Batch 1171/1187						
Blank #						
1	200	360	315	65	1950*	65
2	110	94	231	105	204	77
3	279	132	261	21	480	78
4	330	171	291	33	264	30
5	192	320	184	156	212	80
6	195	195	130	70	285	35
7	394	203	331	52	278	290
8	155	125	180	15	240	55
9	105	130	180	45	185	30
Mean	218	192	234	62	269	82
Standard Deviation	98	91	70	45	93	81
Reporting D.L. (ng/g for 5 g sample)	58	54	42	26	56	48

* Not used for calculations

Batch 2820						
Blank #						
307	310	125	160	30	1100	90
309	80	135	1150	35	750	55
313	700	600	9000*	36	4300	70
394i	90	160	355	19	280	28
395i	51	231	364	37	277	43
408	200	130	400	3100*	1400	510
409	67	75	169	55	255	51
412	370	161	312	69	116	69
413	512	203	420	79	144	40
416	338	286	567	41	275	39
513	34	96	200	31	600	16
560	11	80	240	15	4600	42
603	53	85	322	26	5712	26
612	47	58	584	32	4380	32
Mean	204	173	403	39	1360	79
Standard Deviation	210	140	260	19	1700	125
Reporting D.L. (ng/g for 5 g sample)	130	80	160	11	1000	75

APPENDIX 4.2 QUALITY ASSURANCE AND QUALITY CONTROL - Biota Samples

Spiked Reference Tissues

Compound	Concentration (ng/g) Determined	Expected	% Recovery
Batch 1171/1187			
SPIKE #1171/1187-1			
Dimethyl phthalate	4200	3800	110
Diethyl phthalate	7200	6900	104
Di-n-butyl phthalate	4300	4900	88
Benzyl butyl phthalate	5000	5600	89
Bis-(2-ethylhexyl) phthalate	4100	4500	91
Di-n-octyl phthalate	3300	3900	85
SPIKE #1171/1187-2			
Dimethyl phthalate	5600	5400	104
Diethyl phthalate	9800	9600	102
Di-n-butyl phthalate	6000	6900	90
Benzyl butyl phthalate	6600	7900	84
Bis-(2-ethylhexyl) phthalate	5500	6300	87
Di-n-octyl phthalate	4500	5500	82
SPIKE #1171/1187-3			
Dimethyl phthalate	3100	3300	94
Diethyl phthalate	6300	5900	107
Di-n-butyl phthalate	4000	4200	95
Benzyl butyl phthalate	4800	4800	100
Bis-(2-ethylhexyl) phthalate	5100	3800	134
Di-n-octyl phthalate	2900	3300	88
SPIKE #1171/1187-4			
Dimethyl phthalate	19000	20000	95
Diethyl phthalate	36000	36000	100
Di-n-butyl phthalate	24000	26000	92
Benzyl butyl phthalate	42000	30000	140
Bis-(2-ethylhexyl) phthalate	24000	24000	100
Di-n-octyl phthalate	22000	21000	105
SPIKE #1171/1187-5			
Dimethyl phthalate	24000	22000	110
Diethyl phthalate	43000	39000	110
Di-n-butyl phthalate	28000	28000	100
Benzyl butyl phthalate	43000	32000	130
Bis-(2-ethylhexyl) phthalate	26000	26000	100
Di-n-octyl phthalate	26000	23000	110

APPENDIX 4.2 QUALITY ASSURANCE AND QUALITY CONTROL - Biota Samples

Spiked Reference Tissues

Compound	Concentration (ng/g) Determined	Expected	% Recovery
SPIKE #1171/1187-6			
Dimethyl phthalate	22000	20000	110
Diethyl phthalate	42000	36000	117
Di-n-butyl phthalate	26000	26000	100
Benzyl butyl phthalate	36000	30000	120
Bis-(2-ethylhexyl) phthalate	22000	24000	92
Di-n-octyl phthalate	22000	21000	105
SPIKE #1171/1187-7			
Dimethyl phthalate	20000	20000	100
Diethyl phthalate	34000	36000	94
Di-n-butyl phthalate	28000	26000	108
Benzyl butyl phthalate	36000	30000	120
Bis-(2-ethylhexyl) phthalate	22000	24000	92
Di-n-octyl phthalate	20000	21000	95
SPIKE #1171/1187-8			
Dimethyl phthalate	19000	20000	95
Diethyl phthalate	34000	36000	94
Di-n-butyl phthalate	26000	26000	100
Benzyl butyl phthalate	36000	30000	120
Bis-(2-ethylhexyl) phthalate	22000	24000	92
Di-n-octyl phthalate	20000	21000	95
SPIKE #1171/1187-9			
Dimethyl phthalate	19000	20000	95
Diethyl phthalate	40000	36000	110
Di-n-butyl phthalate	26000	26000	100
Benzyl butyl phthalate	36000	30000	120
Bis-(2-ethylhexyl) phthalate	22000	24000	92
Di-n-octyl phthalate	20000	21000	95

APPENDIX 4.2 QUALITY ASSURANCE AND QUALITY CONTROL - Biota Samples

Spiked Reference Tissues

Compound	Concentration (ng/g) Determined	Expected	% Recovery
Batch 2820:			
SPIKE TSPM # 157i			
Dimethyl phthalate	1700	2000	85
Diethyl phthalate	3700	3600	100
Di-n-butyl phthalate	2800	2600	110
Benzyl butyl phthalate	2900	3000	97
Bis-(2-ethylhexyl) phthalate	2100	2400	88
Di-n-octyl phthalate	2000	2100	95
SPIKE TSPM # 168			
Dimethyl phthalate	1800	2000	90
Diethyl phthalate	3500	3600	97
Di-n-butyl phthalate	2500	2600	96
Benzyl butyl phthalate	2900	3000	97
Bis-(2-ethylhexyl) phthalate	2200	2400	92
Di-n-octyl phthalate	2000	2100	95
SPIKE TSPM # 283			
Dimethyl phthalate	3200	3400	94
Diethyl phthalate	2100	2200	95
Di-n-butyl phthalate	2100	2200	95
Benzyl butyl phthalate	3600	3600	100
Bis-(2-ethylhexyl) phthalate	150000	150000	100
Di-n-octyl phthalate	2200	2300	96

APPENDIX 4.2 QUALITY ASSURANCE AND QUALITY CONTROL - Biota Samples

Internal Laboratory and External Audits (ng/g dry weight)

		DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL PHTHALATE	DI-N-OCTYL PHTHALATE
Internal Laboratory Duplicates:							
Batch 1171/1187:							
Sample 1	a.)	<58	<54	<42	<26	140	<48
	b.)	<58	<54	<42	<26	120	<48
Sample 2	a.)	<58	<54	<42	<26	<56	<48
	b.)	<58	<54	<42	<26	<56	<48
Sample 3	a.)	150	<54	90	NDR(180)	<56	<48
	b.)	150	<54	100	<26	<56	<48
Sample 4	a.)	<58	<54	<42	NDR(3000)	NDR(1500)	<48
	b.)	<58	NDR(255)	NDR(3700)	NDR(18000)	NDR(6200)	<48
Sample 5	a.)	<58	<54	<42	<26	<56	<48
	b.)	<58	<54	<42	<26	<56	<48
Sample 6	a.)	<58	<54	<42	<26	<56	<48
	b.)	<58	<54	<42	<26	<56	<48
Sample 7	a.)	<58	<54	<42	<26	<56	<48
	b.)	<58	<54	<42	<26	<56	<48
Sample 8	a.)	<58	<54	NDR(380)	<26	NDR(88)	<48
	b.)	<58	<54	NDR(430)	<26	NDR(190)	<48
Sample 9	a.)	<58	<54	<42	<26	66	NDR(160)
	b.)	<58	<54	<42	<26	65	<48
Sample 10	a.)	<58	<54	<42	<26	<56	<48
	b.)	<58	<54	<42	<26	<56	<48
Batch 2820:							
Sample 1	a.)	<190	<130	<240	<17	<1600	<1100
	b.)	<210	<140	<260	<19	<1700	<120
Sample 2	a.)	<130	<80	<160	<590	<1000	<75
	b.)	<80	<53	190	<1200	930	200
Sample 3	a.)	<630	<420	<780	<100	<5100	<380
	b.)	<630	<420	<780	<100	<5100	<380
External Blind Duplicates:							
Batch 1171/1187:							
Sample 1:	a.)	<58	<54	<42	NDR(3000)	NDR(1500)	<48
	b.)	<58	NDR(255)	NDR(3700)	NDR(18000)	NDR(6200)	<48
Sample 2:	a.)	<58	<54	<42	<36	<56	<48
	b.)	<58	<54	<42	<36	<56	<48
Sample 3:	a.)	<58	<54	160	<26	95	<48
	b.)	<58	<54	720	<26	190	<48
Sample 4:	a.)	<58	<54	NDR(430)	<26	NDR(190)	<48
	b.)	<58	<54	<42	<26	66	NDR(160)

APPENDIX 4.2 QUALITY ASSURANCE AND QUALITY CONTROL - Biota Samples

Internal Laboratory and External Audits (ng/g dry weight)

		DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL PHTHALATE	DI-N-OCTYL PHTHALATE
External Blind Duplicates cont.:							
Batch 2820:							
Sample 1	a.)	<160	<100	NQ	NQ	5800	<94
	b.)	<88	<57	<110	150	<690	<51
Sample 2	a.)	<160	<100	<200	77	<1300	<94
	b.)	<300	<200	<370	<27	<2400	<180

APPENDIX 4.2 QUALITY ASSURANCE AND QUALITY CONTROL - Biota Samples

Surrogate Standard Recovery Percentages for Phthalate Ester Analysis

SAMPLE			DIMETHYL PHTHALATE D-4	DIETHYL PHTHALATE D-4	DI-N-BUTYL PHTHALATE D-4	BENZYL BUTYL PHTHALATE D-4	BIS(2-ETHYL HEXYL) PHTHALATE D-4	DI-N-OCTYL PHTHALATE D-4
Batch 1171/1187:								
Procedural Blanks:								
Surrogate recovery information not provided by lab.								
Spiked Reference Tissues:								
Spike #								
1			60	66	72	70	84	56
2			41	53	69	72	110	68
3			74	82	91	66	30	30
4			65	83	110	64	92	99
5			66	90	120	78	120	110
6			75	83	110	83	120	87
7			80	91	100	95	100	100
8			77	106	120	80	100	110
9			60	76	100	62	82	87
Samples:								
FC-1 Stn. 3,4,5 (composite)	Marina at Market Mussels (Sample 1)	soft tissue	93	120	120	95	120	120
CH-1 Stn. 5,8,10,11 (composite)	Bayshore Marina Mussels (Sample 1)	soft tissue	95	96	120	80	94	110
CH-3 Stn. 2,3,8 (composite)	Royal Vancouver Yacht Club Marina Mussels	soft tissue	88	96	110	81	93	110
	(Lab duplicate)		99	100	110	89	100	120
Station C1	Dungeness crab	hepatopancreas	100	100	100	100	100	100
		muscle	76	85	95	74	73	82
Trawl SWT-3	Shrimp	tail	68	83	120	82	82	89
Trawl SWT-3	English sole	whole body	93	100	95	77	81	84
Station SS1	Bentnose clams	soft tissue	50	59	100	66	65	100
Station SS2	Bentnose clams	soft tissue	64	69	100	74	100	83
	(Lab duplicate)		71	76	100	70	106	82
Station C2	Dungeness crab	hepatopancreas	87	94	120	72	108	95
		muscle	50	65	68	56	51	69
	(Lab duplicate)		55	65	77	61	60	73
Trawl UHT-1	English sole	whole body	72	76	105	105	92	98
	(Lab duplicate)		63	67	98	105	87	91
Station C3 and Trawl IHT-1	Dungeness crab	hepatopancreas	70	79	176	68	82	65
	(Blind duplicate)		74	77	115	120	120	91
	Dungeness crab	muscle	50	57	62	54	55	55

APPENDIX 4.2 QUALITY ASSURANCE AND QUALITY CONTROL - Biota Samples

Surrogate Standard Recovery Percentages for Phthalate Ester Analysis

SAMPLE			DIMETHYL PHTHALATE D-4	DIETHYL PHTHALATE D-4	DI-N-BUTYL PHTHALATE D-4	BENZYL BUTYL PHTHALATE D-4	BIS(2-ETHYL HEXYL) PHTHALATE D-4	DI-N-OCTYL PHTHALATE D-4
Samples:								
Trawl IHT-1	Shrimp	tail	69	80	120	83	80	76
	(Lab duplicate)		62	80	120	85	82	79
	(Blind duplicate)		69	89	90	78	84	93
Trawl IHT-1	English sole	whole body	86	97	102	69	58	81
	(Blind duplicate)		52	66	120	75	72	80
Station SS3	Bentnose clams	soft tissue	30	42	81	64	71	75
Station SS4	Bentnose clams	soft tissue	50	62	110	70	60	77
Station C1	Dungeness crab	hepatopancreas	87	120	120	120	120	120
	Dungeness crab	muscle	86	94	100	84	88	110
Station M2	Mussels	soft tissue	57	60	120	76	66	85
Trawl CCT-1	Shrimp	tail	43	56	95	84	84	86
	(Lab duplicate)		50	62	100	71	77	82
Trawl CCT-1	English sole	whole body	47	69	74	54	85	91
Trawl PB 1,2,3	Dungeness crab	hepatopancreas	80	98	120	96	110	100
	Dungeness crab	muscle	50	76	120	79	110	100
	(Lab duplicate)		54	76	110	70	110	92
Trawl PB 1,2,3	Shrimp	tail	48	56	99	72	75	79
Trawl PB 1,2,3	English sole	whole body	62	67	120	72	74	79
Station SS-5	Macoma clams	soft tissue	48	51	120	120	90	82
Station M2,M3	Mussels	soft tissue	43	47	81	120	110	81
	(Lab duplicate)		44	47	97	120	120	88
	(Blind duplicate)		86	91	97	77	81	92
	(Lab duplicate)		68	81	81	71	51	50
Station SS6	Macoma clams	soft tissue	47	51	110	120	110	90
VI-14	**Ladysmith Harbour**							
Station 29	Clams	soft tissue	79	81	87	110	120	83
Station 30	Clams	soft tissue	95	100	110	78	73	90
Station 31	Clams	soft tissue	79	84	98	93	95	100
Station 32	Clams	soft tissue	43	49	97	94	88	60
Station 33	Clams	soft tissue	67	75	108	120	77	44
(Lab duplicate)	Clams	soft tissue	44	52	100	89	80	50
Station 38	Clams	soft tissue	47	52	95	97	74	62

APPENDIX 4.2 QUALITY ASSURANCE AND QUALITY CONTROL - Biota Samples

Surrogate Standard Recovery Percentages for Phthalate Ester Analysis

SAMPLE			DIMETHYL PHTHALATE D-4	DIETHYL PHTHALATE D-4	DI-N-BUTYL PHTHALATE D-4	BENZYL BUTYL PHTHALATE D-4	BIS(2-ETHYL HEXYL) PHTHALATE D-4	DI-N-OCTYL PHTHALATE D-4
Batch 2820:								
Procedural Blanks:								
Surrogate recovery information not provided by lab.								
Spiked Reference Tissues:								
TSPM #								
157i			77	78	88	83	110	79
168			83	79	92	100	110	64
283			79	88	78	73	45	51
Samples:								
FC-1	Marina at Market							
Station 3,4,5 (composite)	Mussels (sample 2)	soft tissue	18	17	50	63	31	16
FCT-1	East Basin Trawl							
	Dungeness crab	muscle	49	59	59	66	64	53
		hepato.	50	50	50	50	50	50
	English sole	whole body	50	58	56	73	82	37
	(Lab duplicate)		42	51	55	76	84	38
FCT-2	Monk McQueen's Trawl							
	English sole	whole body	86	82	79	87	65	71
	(Blind duplicate)		67	60	58	93	96	23
CH-1	Bayshore Marina							
Stations 5,8,10,11 (composite)	Mussels (sample 2)		28	27	26	32	26	32
BI-9	Seaboard Terminals							
Station M2	Mussels	soft tissue	66	72	95	93	57	38
BI-26	Canada Place							
Station M1	Mussels	soft tissue	39	42	70	62	120	65
BI-2	Vancouver Wharves							
Station M1,M2 (composite)	Mussels	soft tissue	65	60	88	140	130	75
	(Lab duplicate)		61	56	78	140	130	68
BI-3	L & K Lumber							
Station M1	Mussels	soft tissue	71	74	88	110	98	64
BI-5	Versatile Pacific							
Station M2	Mussels	soft tissue	60	61	89	120	120	70
BI-10	Lynnterm							
Station M2	Mussels	soft tissue	47	48	53	78	80	24
	(Blind duplicate)		27	39	46	81	84	28
Station C4	West Bay							
	Dungeness crab	hepato.	47	34	65	120	120	82
	(Lab duplicate)		66	61	82	63	42	62
RF-1	**Crescent Beach**							
	Rock sole	whole body	160	140	120	120	98	85
RF-8	**River's Inlet**							
	Pink shrimp	tail	120	120	110	62	42	81

APPENDIX 5

ENVIRONMENTAL CONCENTRATIONS OF PHTHALATE ESTERS

APPENDIX 5.1 PHTHALATE ESTER CONCENTRATIONS IN SEDIMENTS (ng/g dry weight)

SITE NO.	LOCATION	DATE	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE	TOTAL PHTHALATE ESTERS	Batch No.
	Fraser River:									
FR-16	**Koppers International**									
	Site 1	26-Sep-90	<100	110	<130	<10	<850	<63	110	2820
	(Lab duplicate)		<120	88	<140	<10	<940	<69	88	2820
	Site 2	26-Sep-90	<98	<64	<120	<8	<790	<58	ND	2820
	Site 3	26-Sep-90	<110	<69	<130	<9	<850	<63	ND	2820
	Site 4	26-Sep-90	<120	<76	<140	<10	<930	<68	ND	2820
FR-17	**Domtar Wood Preservers**									
	Site 1	24-Sep-90	<30	<34	2900	<22	<1500	33	2933	1171
	Site 2	24-Sep-90	<32	<36	2200	23	<1600	<25	2223	1171
	Site 3	24-Sep-90	54	<31	1500	<20	<1400	<18	1554	1171
	Site 4	24-Sep-90	<26	<29	1300	<19	<1300	<17	1300	1171
	(Lab duplicate)		<28	<31	960	<21	<1400	<19	960	1171
FR-18	**Domtar/Liverpool Site**									
	Site 1	26-Sep-90	<30	<34	<101	<22	<1550	<20	ND	1171
	Site 2	26-Sep-90	<30	<34	<100	<22	<1550	<20	ND	1171
	Site 3	26-Sep-90	<30	<35	<102	<22	<1550	<20	ND	1171
	Site 4	26-Sep-90	<29	<32	95	<21	<1450	<19	ND	1171
	(Lab duplicate)		<21	<24	<70	<15	<1100	28	28	1171
FR-19	**Princeton Wood Preservers**									
	Site 1	25-Sep-90	40	<34	<99	35	<1500	<20	75	1171
	Site 2	25-Sep-90	<31	<35	<104	<23	<1600	<21	ND	1171
	Site 3	25-Sep-90	<35	<40	<117	<26	<1800	<23	ND	1171
	Site 4	25-Sep-90	38	100	<98	<21	<1500	<20	138	1171
	(Lab duplicate)		28	74	<93	<21	<1400	<19	102	1171
FR-20	**B.C. Cleanwood Preservers**									
	Site 1	25-Sep-90	33	<33	780	<22	<1500	<20	813	1171
	Site 2	25-Sep-90	<27	<31	<92	<20	<1400	<18	ND	1171
	Site 3	25-Sep-90	150	<40	<118	<26	2000	<24	2150	1171
	(Lab duplicate)		43	<41	<120	<26	2100	<24	2143	1171
	Site 4	25-Sep-90	150	<47	<140	<31	<2150	34	184	1171

APPENDIX 5.1 PHTHALATE ESTER CONCENTRATIONS IN SEDIMENTS (ng/g dry weight)

SITE NO.	LOCATION	DATE	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE	TOTAL PHTHALATE ESTERS	Batch No.
	False Creek:									
FC-1	Marina at Market									
	Sites 3,4,5 (Composite)	25-Mar-91	460	<41	1700	<26	3900	<24	6060	1171
	(Repeat analysis)		530	<77	460	31	3800	<69	4821	2820
FC-4	Outer creek - midchannel	4-Jun-91	<110	<70	<130	<9	<870	<64	ND	2820
	(Lab duplicate)		<100	<67	290	<9	<820	<60	290	2820
FC-5	At Granville Ferries	4-Jun-91	<160	<110	1000	NDR (33)	<1300	<96	1000	2820
FC-6	Off Granville Island Hotel									
	Station 1	4-Jun-91	<170	<110	1600	33	<1400	<100	1633	2820
	(Blind duplicate)		<130	94	<2000	23	<1100	<80	117	2820
	(Lab duplicate)		<130	94	<2000	20	<1100	<80	114	2820
FC-7	Off Marina by Monk McQueen's	4-Jun-91	<130	100	<2000	35	1400	<75	1535	2820
FC-8	Off Monk McQueen's; near Cambi Bridge	4-Jun-91	<130	100	<2400	NDR (64)	2600	<78	2700	2820
FC-9	Inside Cambie Bridge, off dumpsite	4-Jun-91	200	130	<2700	83	3400	<100	3813	2820
FC-10	Northeast corner	4-Jun-91	<140	<92	<2000	66	3300	<83	3366	2820
	Burrard Inlet:									
BI-1	Vancouver Outer Harbour (Pacific Environment Institute)	9-Sep-91	<160	<110	<200	<15	<1300	<100	ND	2820
BI-2	Vancouver Wharves									
	Station 4	12-Sep-91	<400	<260	<490	<35	<3200	<240	ND	2820
BI-3	L&K Lumber									
	Station 2a	12-Sep-91	<110	<72	<140	36	<890	<65	36	2820
	(Lab duplicate)		<200	<130	<250	59	<1600	<120	59	2820

APPENDIX 5.1 PHTHALATE ESTER CONCENTRATIONS IN SEDIMENTS (ng/g dry weight)

SITE NO.	LOCATION	DATE	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE	TOTAL PHTHALATE ESTERS	Batch No.
	Burrard Inlet cont.:									
BI-4	Vancouver Shipyards/Seaspan									
	Station 4	12-Sep-91	<79	<52	<98	<7	<640	<47	ND	2820
BI-5	Versatile Pacific (was Burrard Yarrows)									
	Station 5	12-Sep-91	<180	<120	<220	<16	<1500	<110	ND	2820
BI-7	Saskatchewan Wheat Pool									
	Station 1	12-Sep-91	<130	<80	<160	NDR (14)	<1000	<75	ND	2820
BI-8	Neptune Terminals									
	Station 2a	12-Sep-91	<130	<80	<160	<11	<1000	<75	ND	2820
BI-9	Seaboard Terminals									
	Station 1	12-Sep-91	<100	<68	<130	<9	<840	<62	ND	2820
	(Lab duplicate)		<100	<65	<120	<9	<800	<59	ND	2820
BI-10	Lynnterm									
	Station 4	11-Sep-91	<120	<82	<152	<12	<230	<78	ND	2820
	(Blind duplicate)		<110	<75	<140	<10	<910	<67	ND	2820
BI-14	Boulder Rock	11-Sep-91	<140	<91	<170	<23	<1100	<83	ND	2820
BI-15	IOCO	10-Sep-91	<350	<230	<430	<39	<2800	<210	ND	2820
	(Lab duplicate)		<200	<140	<260	<24	<1700	<120	ND	2820
BI-17	Port Moody	11-Sep-91	<160	<110	<200	<26	<1300	<100	ND	2820
BI-18	Alberta Wheat Pool	12-Sep-91	<97	<64	<120	<8	<780	<57	ND	2820
BI-19	Central Harbour	12-Sep-91	<130	<87	<160	<20	<1100	<78	ND	2820
BI-23	Vanterm									
	Station 2	12-Sep-91	<140	<94	<180	<13	<1200	<85	ND	2820
	(Lab duplicate)		<130	<80	<160	<11	<1000	<75		2820
BI-24	United Grain Growers									
	Station 1	12-Sep-91	<160	<110	<200	170	2600	NDR (180)	2770	2820
BI-25	Centerm									
	Station 1	12-Sep-91	<170	<110	<210	23	<1400	<100	23	2820
	(Blind duplicate)		<130	<80	<160	<12	<1100	<75	ND	2820
BI-26	Canada Place (Pier BC;NHB)									
	Station 2	12-Sep-91	<210	<140	<260	33	<1700	<130	33	2820

APPENDIX 5.1 PHTHALATE ESTER CONCENTRATIONS IN SEDIMENTS (ng/g dry weight)

SITE NO.	LOCATION	DATE	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE	TOTAL PHTHALATE ESTERS	Batch No.
	Burrard Inlet cont.:									
	Coal Harbour:									
CH-1	Bayshore Inn Marina									
	Stations 1,3,4 (composite)	25-Mar-91	93	<42	1300	<27	3000	43	4436	1171
	(Repeat analysis)		<110	<73	<140	33	4000	<66	4033	2820
	(Blind duplicate)		<120	<80	1500	37	4000	<72	5537	2820
CH-3	Royal Vancouver Yacht Club Marina									
	Stations 4,5,6 (composite)	25-Mar-91	<42	<48	<141	<31	<2150	<28	ND	1171
	(Lab duplicate)		<41	<46	<136	<30	<2100	<27	ND	1171
	(Repeat analysis)		<140	<92	<170	15	1300	<84	1315	2820
	(Lab duplicate)		<130	<87	<160	22	1500	<79	1522	2820
	Victoria Harbour:									
	The Gorge :									
VH-1	Station SW-7; storm drains across from Aaron Point	11-Jul-90	<60	1000	<198	58	<3050	<40	1058	1171
VH-2	Station SW-8; off Gorge Park	11-Jul-90	<55	130	<180	57	<2800	<36	187	1171
	Selkirk Waters :									
VH-4	Station SW-2; off old BCFP/Fletcher Challenge sawmill, west side	11-Jul-90	<73	<85	<240	110	<3700	<49	110	1171
	(Lab duplicate)		<71	<80	<236	100	<3600	<47	100	1171
VH-5	Station SW-3; off old BCFP/Fletcher Challenge sawmill, southwest side	11-Jul-90	<50	<57	<83	46	<2575	<33	46	1171
VH-6	Station SW-4 ; trawl site, midchannel	11-Jul-90	81	<79	4100	93	<3600	<47	4274	1171
VH-7	Station SW-5; south end of old BCFP/Fletcher Challenge sawmill; off location of old dip tanks	11-Jul-90	<42	<47	<140	66	<2150	62	128	1171
VH-8	Station SW-6; off storm drain south of sawmill site	11-Jul-90	67	<65	<190	200	5000	96	5363	1171

APPENDIX 5.1 PHTHALATE ESTER CONCENTRATIONS IN SEDIMENTS (ng/g dry weight)

SITE NO.	LOCATION	DATE	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE	TOTAL PHTHALATE ESTERS	Batch No.
	Victoria Harbour cont.:									
	Upper Harbour:									
VH-9	Station UH-1; Victoria Machinery Depot	11-Jul-90	67	<47	<139	57	<2150	<20	124	1171
VH-10	Station UH-2; Rock Bay	11-Jul-90	<61	<70	<200	280	20000	840	21120	1171
	(Lab duplicate)		<69	<79	<230	370	23000	900	24270	
VH-11	Station UH-3; head of Rock Bay	11-Jul-90	60	170	1500	330	15000	670	17730	1171
VH-12	Station UH-4 ; midchannel trawl site	11-Jul-90	93	<67	<200	56	<3050	<40	149	1171
	(Lab duplicate)		77	<69	<200	73	<3100	<40	150	1171
VH-13	Station UH-5b; off Point Ellice (old Smith Cedar Products site)	11-Jul-90	65	<67	240	<43	<3000	<39	305	1171
VH-14	Station UH-6; Site 1	11-Jul-90	<19	<22	<64	<14	<978	<13	ND	1171
	(Lab duplicate)		<17	<19	<56	<12	<869	<11	ND	1171
VH-15	Station UH-7b; Hope Pt/Standard Oil	11-Jul-90	<58	<66	<193	69	<2973	86	155	1171
VH-16	Station UH-8; Garbage Depot/ Standard Oil	11-Jul-90	89	<72	2100	76	<3277	<42	2265	1171
	(Lab duplicate)		110	<72	4000	55	<3250	<42	4165	1171
VH-17	Station UH-9; Boat Building Facilities	6-Mar-91	<58	<66	645	<42	6200	NDR(86)	6845	1171
	(Lab duplicate)		<54	<61	NDR(610)	<40	6000	NDR(120)	6000	1171
	Inner Harbour :									
VH-18	Station IH-1; off Songhees	11-Jul-90	<38	<43	<127	<28	<1954	<25	ND	1171
	(Blind duplicate)		<46	<52	<152	<33	<2340	32	32	1171
VH-19	Station IH-2; West Coast Air	11-Jul-90	<40	<45	<132	<29	<2042	<27	ND	1171
	(Lab duplicate)		<37	<42	<123	<27	<1897	<25	ND	1171
VH-20	Station IH-3; commercial dock at entrance to James Bay	11-Jul-90	<32	<36	<107	<24	<1652	<21	ND	1171
VH-21	Station IH-4 ; Undersea Gardens	11-Jul-90	<37	<42	<124	45	3000	<25	3045	1171
VH-22	Station IH5; B.C. Steamships	11-Jul-90	<26	470	<87	<19	<1334	<17	470	1171

APPENDIX 5.1 PHTHALATE ESTER CONCENTRATIONS IN SEDIMENTS (ng/g dry weight)

SITE NO.	LOCATION	DATE	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE	TOTAL PHTHALATE ESTERS	Batch No.
	Victoria Harbour cont.:									
	Inner Harbour cont.:									
VH-23	Station IH6; bay beside BC Steamships	11-Jul-90	<45	<51	170	43	<2300	<30	213	1171
VH-23a	Station IH-7 - west side of Laurel Point	11-Jul-90	<41	<46	<136	<30	<2092	<27	ND	1171
VH-24	Station IH-8b; Trotac Marine	11-Jul-90	380	<58	230	49	3300	<34	3959	1171
VH-25	Station IH-9; Raymur Pt/ Fisherman's Wharf	11-Jul-90	100	<36	2300	<23	2500	33	4933	1171
VH-26	Station IH-10; between Shoal Pt. and Fisherman's Wharf	11-Jul-90	<26	<29	<88	<19	<1350	<18	ND	1171
VH-27	Station IH-11; Centre Channel trawl site	11-Jul-90	670	930	<150	<33	<2320	<43	1600	1171
VH-28	Station IH-12; south side Songhees/ old Seaspan site	11-Jul-90	<37	<42	<123	<27	<1900	<25	ND	1171
VH-29	Station IH-13; south side Songhees/	11-Jul-90	59	600	<160	<35	<2460	<32	659	1171
VH-30	Station IH-14; West Bay	11-Jul-90	<49	<55	<163	<36	<2500	<33	ND	1171
	(Lab duplicate)		<44	<34	<147	<32	<2300	<29	ND	1171
	Outer Harbour :									
VH-31	Station OH-2; Ogden Point Wharves	11-Jul-90	<39	<44	<129	<28	<1980	<26	ND	1171
	Esquimalt Harbour:									
EH-1	Upper Harbour	9-Jul-90	<22	<25	<74	<16	<1136	<15	ND	1171
EH-5	Dunn's Nook	9-Jul-90	<88	<42	<50	<13	<380	<8	ND	2905
EH-6	Fort Rodd	9-Jul-90	<20	<23	<67	<15	<1030	<13	ND	1171
	(Lab duplicate)		<20	<28	<82	<18	<1260	<16	ND	1171

APPENDIX 5.1 PHTHALATE ESTER CONCENTRATIONS IN SEDIMENTS (ng/g dry weight)

SITE NO.	LOCATION	DATE	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE	TOTAL PHTHALATE ESTERS	Batch No.
	Esquimalt Harbour cont.:									
	Plumper Bay :									
EH-2	Station PB-1; off old wood products facility	9-Jul-90	<80	<91	<267	<59	<4100	<53	ND	1171
EH-3	Station PB-2; off site of old diptank	9-Jul-90	<91	160	<303	<67	<4700	77	237	1171
EH-4	Trawl site	9-Jul-90	<64	<39	<32	<9	<230	<14	ND	2905
	Constance Cove:									
EH-7	Station 1	9-Jul-90	<45	<51	<250	<33	<2300	<30	ND	1171
EH-9	Station 2	9-Jul-90	<65	<73	<216	<47	<2300	<43	ND	1171
EH-10	Station 3	9-Jul-90	<64	5000	640	<47	9500	<42	15140	1171
	(Lab duplicate)		<69	5500	470	<51	7000	<46	12970	1171
EH-11	Station 4	9-Jul-90	<46	2000	270	37	4300	<21	6607	1171
EH-12	Station 5	9-Jul-90	35	<36	660	<23	5500	<21	6195	1171
EH-13	Station 6	9-Jul-90	<36	<41	200	56	3900	46	4202	1171
EH-14	Station 7 (Trawl site)+B321	9-Jul-90	<100	<35	150	<23	2100	<10	2250	2905
	(Lab duplicate)		<270	<95	160	<34	2700	<15	2860	2905
VI-14	**Ladysmith Harbour**	20-Jan-92								
	Station 28		<20	<23	<68	<15	<1050	<14	ND	1187
	Station 30		<23	29	<75	<17	<1160	<15	29	1187
	Station 31		<20	NDR (51)	<68	<15	<1050	<14	ND	1187
	Station 32		<17	NDR (36)	<56	<12	<860	<11	ND	1187
	(Lab duplicate)		<16	NDR (80)	<54	<12	<828	<11	ND	1187
	Station 33		<24	<27	<81	<18	<1240	<16	ND	1187
	Station 34		<18	25	<60	<13	<930	<12	ND	1187
	Station 36		<16	23	<54	<12	<840	<11	ND	1187
	Station 37		<27	<30	<89	<20	<1375	<18	ND	1187

APPENDIX 5.1 PHTHALATE ESTER CONCENTRATIONS IN SEDIMENTS (ng/g dry weight)

SITE NO.	LOCATION	DATE	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS(2-ETHYL HEXYL) PHTHALATE	DI-N-OCTYL PHTHALATE	TOTAL PHTHALATE ESTERS	Batch No.
	Reference Sites:									
RF-1	Crescent Beach; Station 1	18-Jun-91	<80	<52	<980	<7	<640	<47	ND	2820
	Queen Charlotte Islands:									
RF-9	Delkatla Slough	25-Jul-89	<69	<45	<85	<7	<560	<41	ND	2820
	(Lab duplicate)		<72	<47	<88	<7	<580	<42	ND	2820
RF-11	Tow Hill	22-Jul-89	<68	<45	<84	<6	<550	<40	ND	2820
	(Lab duplicate)		<71	<47	<88	<6	<570	<42	ND	2820

NDR - A peak was detected but did not meet the quantification criteria. Maximum value given in brackets.

NOTE: The data has been blank corrected based on a statistical analysis of the procedural blank data. The detection limit has been defined as three times the standard deviation of the mean blank concentration. The sample data was blank corrected by subtracting the mean blank concentration from the concentration in the sample. The residual concentration was compared to the detection limit. When the residual was less than the detection limit, the analyte concentration was reported as less than (<) the detection limit.

APPENDIX 5.2 PHTHALATE ESTER CONCENTRATIONS IN BIOTA (ng/g wet weight)

SITE NO.	LOCATION	DATE	SPECIES		TISSUE	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS (2-ETHYL HEXYL PHTHALATE	DI-N-OCTYL PHTHALATE	TOTAL PHTHALATE ESTERS	BATCH NO.
	False Creek:												
FC-1	Marina at Market												
	Station 3,4,5 (composite)	25-Mar-91	Mussels (sample 1)	(mixed sizes)	Soft tissue	<60	<56	360	NDR(260)	<58	NDR(270)	360	1171
		25-Mar-91	(sample 2)	(mixed sizes)	Soft tissue	NDR(100)	75	NDR(270)	NDR(110)	<510	<38	75	2820
FCT-1	East Basin Trawl	4-Jun-91	Dungeness crab		muscle	<370	<240	<460	<33	<3000	<220	ND	2820
	Trawl EBT-1				hepatopancreas	<180	<120	<220	<16	<1400	<110	ND	2820
		6-Jun-91	English sole		whole body	<190	<130	<240	<17	<1600	<1100	ND	2820
			(Lab duplicate)			<210	<140	<260	<19	<1700	<120	ND	2820
FCT-2	Monk McQueen's Trawl	6-Jun-91	English sole		whole body	<160	<100	NQ	NQ	5800	<94	5800	2820
	Trawl MMT-1		(Blind duplicate)			<88	<57	<110	150	<690	<51	150	2820
	Burrard Inlet:												
BI-2	Vancouver Wharves												
	Station M1,M2 (composite)	29-Oct-91	Mussels	(mixed sizes)	Soft tissue	<130	<80	<160	<590	<1000	<75	ND	2820
			(Lab duplicate)			<80	<53	190	<1200	930	200	1320	2820
BI-3	L & K Lumber												
	Station M1	29-Oct-91	Mussels	(mixed sizes)	Soft tissue	<71	<47	<88	<350	<570	<42	ND	2820
BI-5	Versatile Pacific												
	Station M2	29-Oct-91	Mussels	(small)	Soft tissue	<77	<50	<95	<380	<620	<46	ND	2820
BI-9	Seaboard Terminals												
	Station M2	29-Oct-91	Mussels	(mixed sizes)	Soft tissue	<63	<40	<78	<310	<510	<37	ND	2820
BI-10	Lynnterm												
	Station M2	29-Oct-91	Mussels	(small)	Soft tissue	<160	<100	<200	77	<1300	<94	77	2820
			(Blind duplicate)			<300	<200	<370	<27	<2400	<180	ND	2820
BI-26	Canada Place												
	Station M1	29-Oct-91	Mussels	(mixed sizes)	Soft tissue	<70	<46	<87	<340	<570	<42	ND	2820
	Coal Harbour:												
CH-1	Bayshore Marina												
	Stations M5,8,10,11 (composite)	25-Mar-91	Mussels (sample 1)	(large)	Soft tissue	<54	<50	<39	<24	280	<44	280	1171
			(sample 2)	(large)	Soft tissue	<63	<42	<78	<10	<520	<38	ND	2820
CH-3	Royal Vancouver Yacht Club (RVYC)	25-Mar-91	Mussels (sample 1)	(large)	Soft tissue	<57	<53	<41	<25	140	<47	140	1171
	Stations M2,3,8 (composite)		(Lab duplicate)			<56	<52	<41	<25	120	<47	120	1171

APPENDIX 5.2 PHTHALATE ESTER CONCENTRATIONS IN BIOTA (ng/g wet weight)

SITE NO.	LOCATION	DATE	SPECIES	TISSUE	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS (2-ETHYL HEXYL PHTHALATE	DI-N-OCTYL PHTHALATE	TOTAL PHTHALATE ESTERS	BATCH NO.
	Victoria Harbour:											
	Selkirk Waters:											
SW-C1	Station C1	12-Jul-90	Dungeness crab	Hepatopancreas	<63	<59	<46	<28	260	<53	260	1171
		12-Jul-90		Muscle	<109	<101	120	<49	<106	<91	120	1171
SWT-3	Trawl SWT-3	12-Jul-90	Shrimp	Tail	<64	<59	<46	<29	<62	<53	ND	1171
		10-Jul-90	English sole	Whole body	<106	<99	100	580	<102	<88	680	1171
SW-SS1	Station SS1 (off old sawmill site)	11-Jul-90	Bentnose clams	Soft tissue	NDR(130)	270	NDR(100)	<26	390	<46	660	1171
SW-SS2	Station SS2 (beach at Bamfield Park)	13-Jul-90	Bentnose clams	Soft tissue	<55	<51	NDR(75)	<25	900	<46	900	1171
			(Lab duplicate)		<59	<55	NDR(90)	<26	940	<49	940	1171
	Upper Harbour:											
UH-C2	Station C2	10-Jul-90	Dungeness crab	Hepatopancreas	130	200	310	<29	770	140	1550	1171
		10-Jul-90		Muscle	<99	<92	<72	<45	<96	<82	ND	1171
			(Lab duplicate)		<101	<94	<73	<45	<98	<84	ND	1171
UHT-1	Trawl UHT-1	10-Jul-90	English sole	Whole body	150	<92	90	NDR(180)	<95	<82	240	1171
			(Lab duplicate)		150	<81	100	<39	<84	<72	250	1171
	Inner Harbour:											
IT-C3/IHT-1	Station C3 and Trawl IHT-1	10-Jul-90	Dungeness crab	Hepatopancreas	<102	<95	<74	NDR(3000)	NDR(1500)	<84	ND	1171
			(Blind duplicate)		<67	NDR(255)	NDR(3700)	NDR(18000)	NDR(6200)	<56	ND	1171
		10-Jul-90	Dungeness crab	Muscle	<117	<109	230	<52	3500	<97	3730	1171
IHT-1	Trawl IHT-1	10-Jul-90	Shrimp	Tail	<67	<63	<49	<30	<65	<56	ND	1171
			(Lab duplicate)		<56	<52	<40	<25	<54	<46	ND	1171
			(Blind duplicate)		<54	<50	<39	<24	<52	<45	ND	1171
		10-Jul-90	English sole	Whole body	<92	<86	160	<41	95	<76	255	1171
			(Blind duplicate)		<68	<64	720	<31	190	<56	910	1171
IH-SS3	Station SS3 (Laurel Point)	11-Jul-90	Bentnose clams	Soft tissue	<61	<57	NDR(70)	<27	250	<51	250	1171
	West Bay:											
IH-C4	Station C4	9-Jul-91	Dungeness crab	Hepatopancreas	<630	<420	<780	<100	<5100	<380	ND	2820
			(Lab duplicate)		<630	<420	<780	<100	<5100	<380	ND	2820
IH-SS4	Station SS4 (also called VI-4) (Hidden Harbour Marina)	10-Jul-90	Bentnose clams	Soft tissue	57	50	230	<17	145	<31	482	1171

APPENDIX 5.2 PHTHALATE ESTER CONCENTRATIONS IN BIOTA (ng/g wet weight)

SITE NO.	LOCATION	DATE	SPECIES	TISSUE	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS (2-ETHYL HEXYL PHTHALATE	DI-N-OCTYL PHTHALATE	TOTAL PHTHALATE ESTERS	BATCH NO.
	Esquimalt Harbour:											
	Constance Cove:											
CC-C1	Station C1	9-Jul-90	Dungeness crab	Hepatopancreas	NDR(164)	NDR(280)	NDR(1800)	NDR(14000)	NDR(1000)	NDR(130)	ND	1171
		9-Jul-90		Muscle	<55	<51	NDR(110)	<24	110	NDR(260)	110	1171
CC-M1	Station M1	9-Jul-90	Mussels	Soft tissue	<39	<37	NDR(450)	<18	100	<33	100	1171
CCT-1	Trawl CCT-1	9-Jul-90	Shrimp	Tail	<53	<49	<38	<24	<51	<44	ND	1171
			(Lab duplicate)		<54	<50	<39	<24	<56	<45	ND	1171
		9-Jul-90	English sole	Whole body	<50	<46	NDR(220)	<22	NDR(490)	NDR(110)	ND	1171
	Plumper Bay:											
PBT-1,2,3	Trawl PB-1,2,3	4-Mar-91	Dungeness crab	Hepatopancreas	<58	<54	<42	<26	<56	<53	ND	1171
		4-Mar-91		Muscle	<64	<60	<47	<29	<62	<48	ND	1171
			(Lab duplicate)		<63	<58	<45	<28	<61	<52	ND	1171
		12-Jul-90	Shrimp	Tail	<51	<48	<37	<23	<50	<42	ND	1171
			(Lab duplicate)		<58	<54	<42	<26	<56	<48	ND	1171
		12-Jul-90	English sole	Whole body	<68	<63	500	<30	<66	<56	500	1171
PB-SS5	Station SS5	9-Jul-90	Macoma clams	Soft tissue	<52	<48	NDR(490)	<23	<50	<43	ND	1171
PB-M2,M3	Station M2,M3 (adjacent old sawmill site)	9-Jul-90	Mussels	Soft tissue	<44	<41	NDR(380)	<20	NDR(88)	<37	ND	1171
			(Lab duplicate)		<44	<42	NDR(430)	<20	NDR(190)	<37	ND	1171
			(Blind duplicate)		<58	<54	<42	<26	66	NDR(160)	66	1171
			(Lab duplicate)		<56	<53	<41	<25	65	<47	65	1171
	Dallas Bank:											
PB-SS6	Station SS6	9-Jul-90	Macoma clams	Soft tissue	<56	<53	NDR(540)	<35	160	NDR(200)	160	1171
VI-14	**Ladysmith Harbour:**											
	Station 29	20-Jan-92	Clams	Soft tissue	<69	84	<50	<31	100	<57	184	1171
	Station 30	20-Jan-92	Clams	Soft tissue	<82	450	NDR(250)	1200	<79	<68	1650	1171
	Station 31	20-Jan-92	Clams	Soft tissue	<75	250	NDR(100)	<34	<73	<62	250	1171
	Station 32	20-Jan-92	Clams	Soft tissue	<58	<54	<42	<26	<56	<48	ND	1171
	Station 33	20-Jan-92	Clams	Soft tissue	<81	<75	<58	<36	<78	<67	ND	1171
			(Lab duplicate)		<83	<78	<60	<37	<81	<69	ND	1171
	Station 38	20-Jan-92	Clams	Soft tissue	<56	<52	65	<25	5600	<46	5665	1171

APPENDIX 5.2 PHTHALATE ESTER CONCENTRATIONS IN BIOTA (ng/g wet weight)

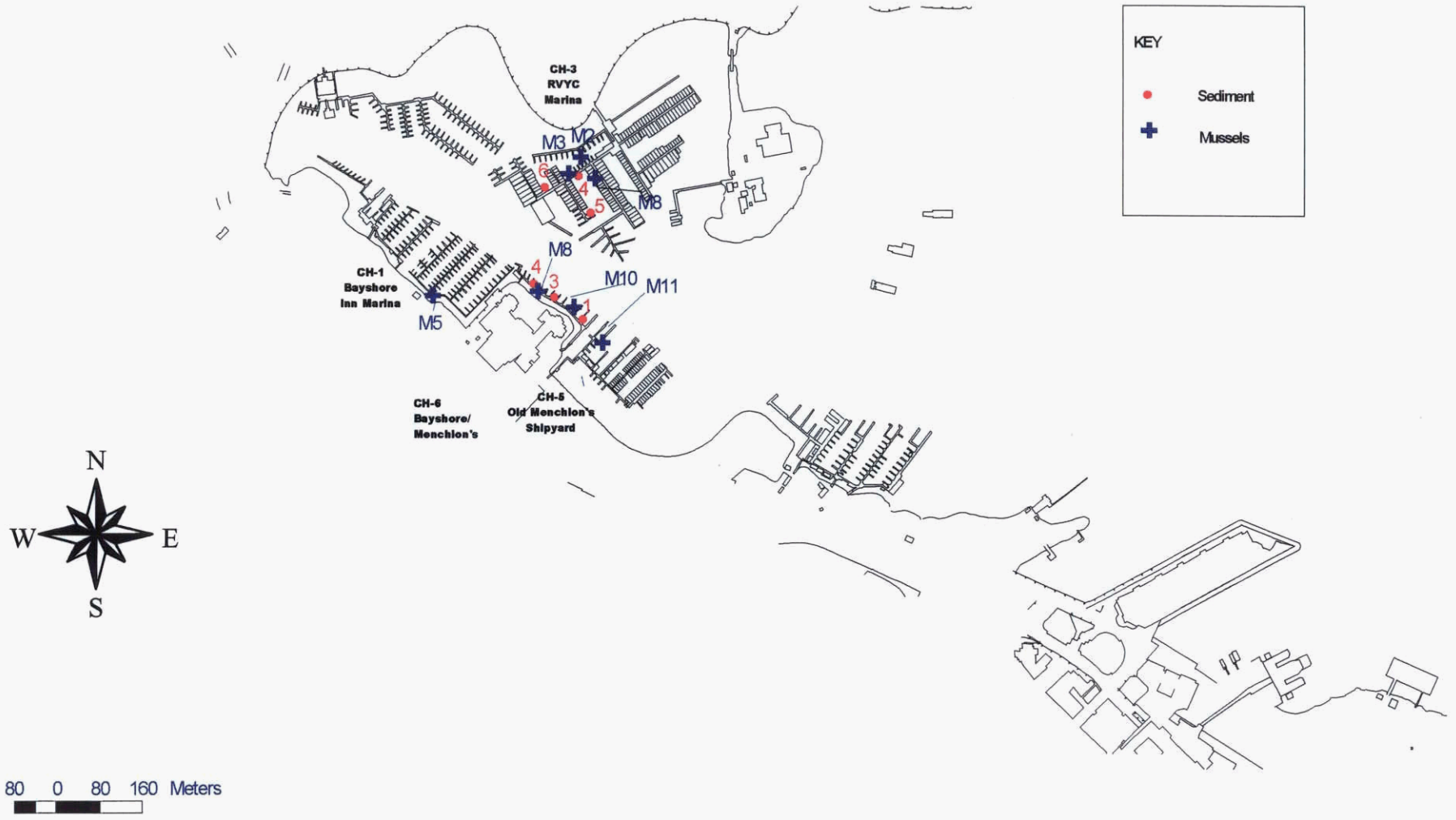
SITE NO.	LOCATION	DATE	SPECIES	TISSUE	DIMETHYL PHTHALATE	DIETHYL PHTHALATE	DI-N-BUTYL PHTHALATE	BENZYL BUTYL PHTHALATE	BIS (2-ETHYL HEXYL PHTHALATE	DI-N-OCTYL PHTHALATE	TOTAL PHTHALATE ESTERS	BATCH NO.
	Reference Sites:											
RF-1	Crescent Beach	18-Jun-91	Rock sole	Whole body	<180	<120	NQ	NQ	<1500	<110	ND	2820
RF-8	Rivers Inlet	26-Oct-89	Pink shrimp	Tail	<180	<120	<220	NDR(11000)	<24	NDR(2100)	ND	2820

Note: Data have been blank corrected where required

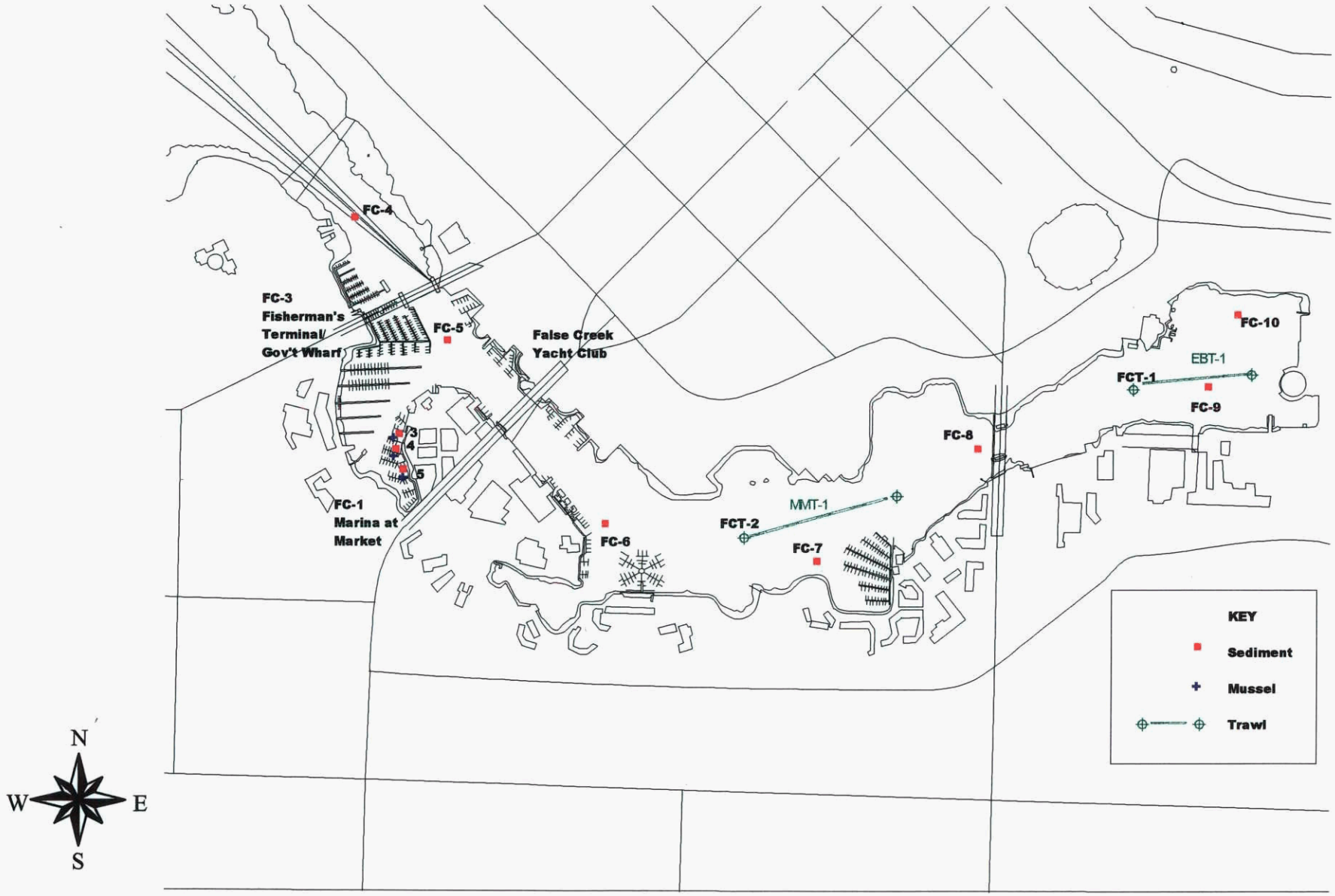
ND Not detected
NDR A peak was detected but did not meet quantification criteria. Maximum value given in brackets.
NQ Not quantified.

SITE LOCATION MAPS

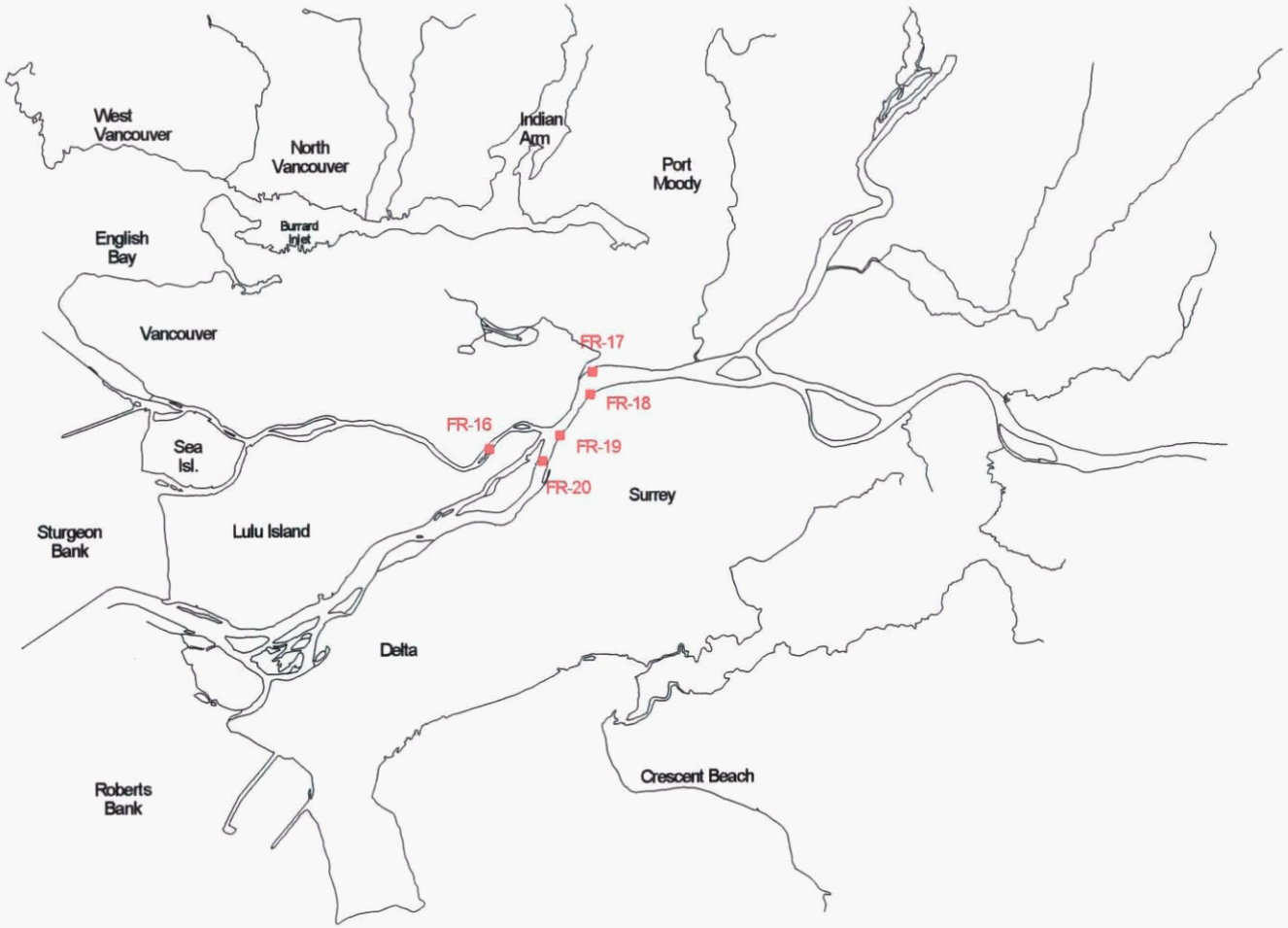
Map 1 : Coal Harbour Sampling Locations (CH-1-CH-3)

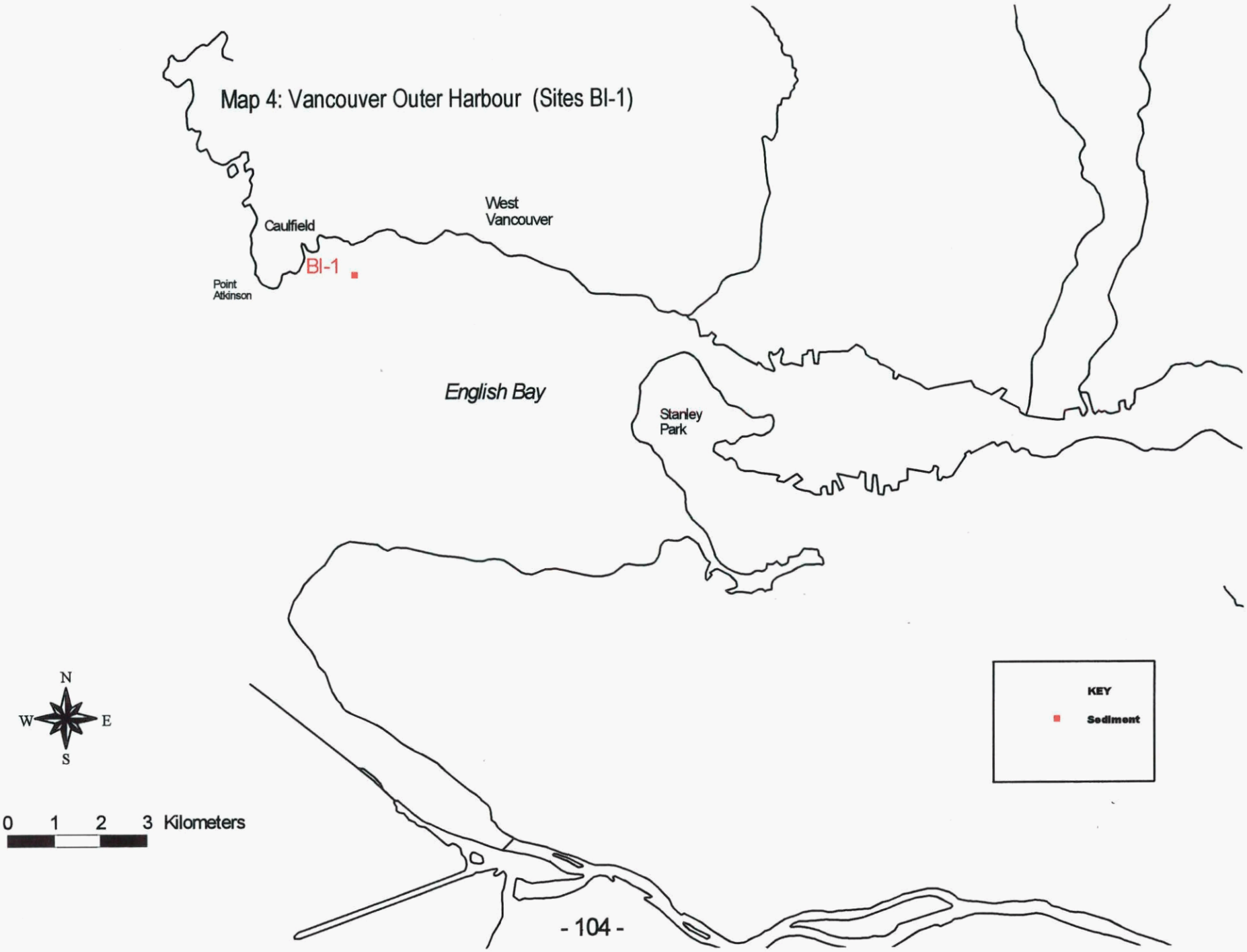


Map 2 : False Creek (FC-1 to FC-10)

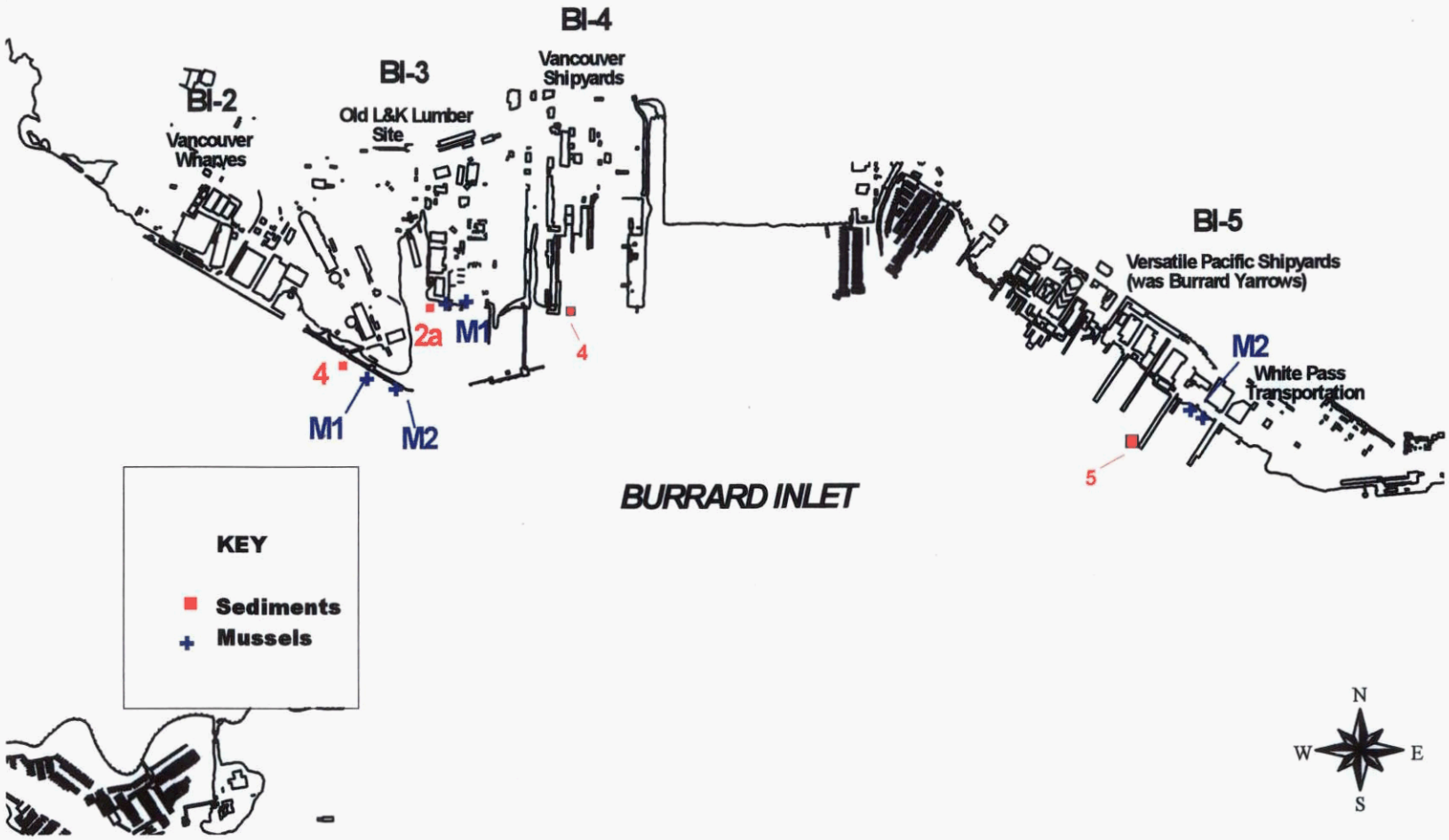


Map 3: Lower Fraser River (Sites FR-16 to 20)

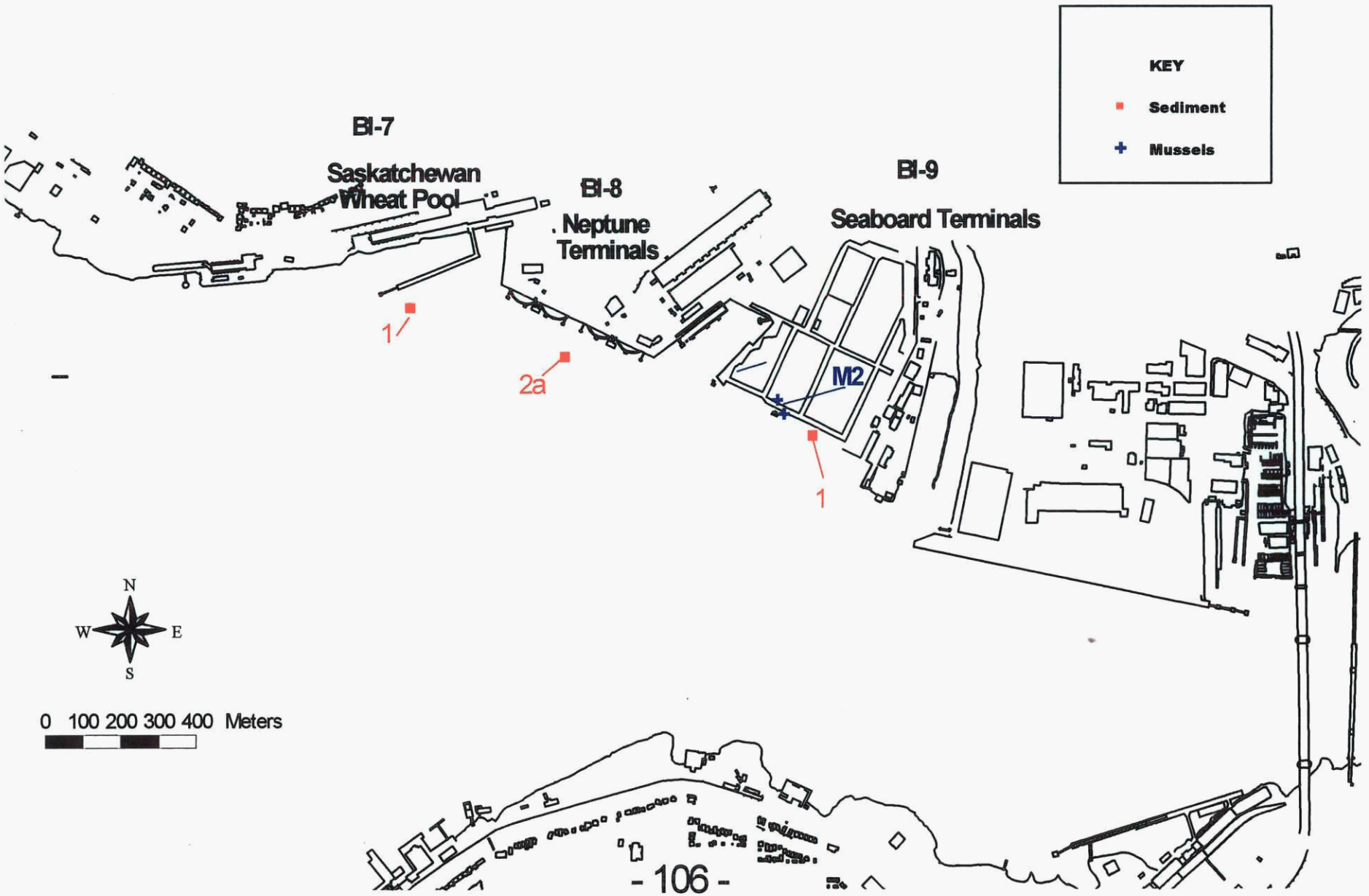



Map 4: Vancouver Outer Harbour (Sites BI-1)
West Vancouver
Caulfield
BI-1
Point Atkinson
English Bay
Stanley Park
N
W
E
S
0 1 2 3 Kilometers
KEY
Sediment

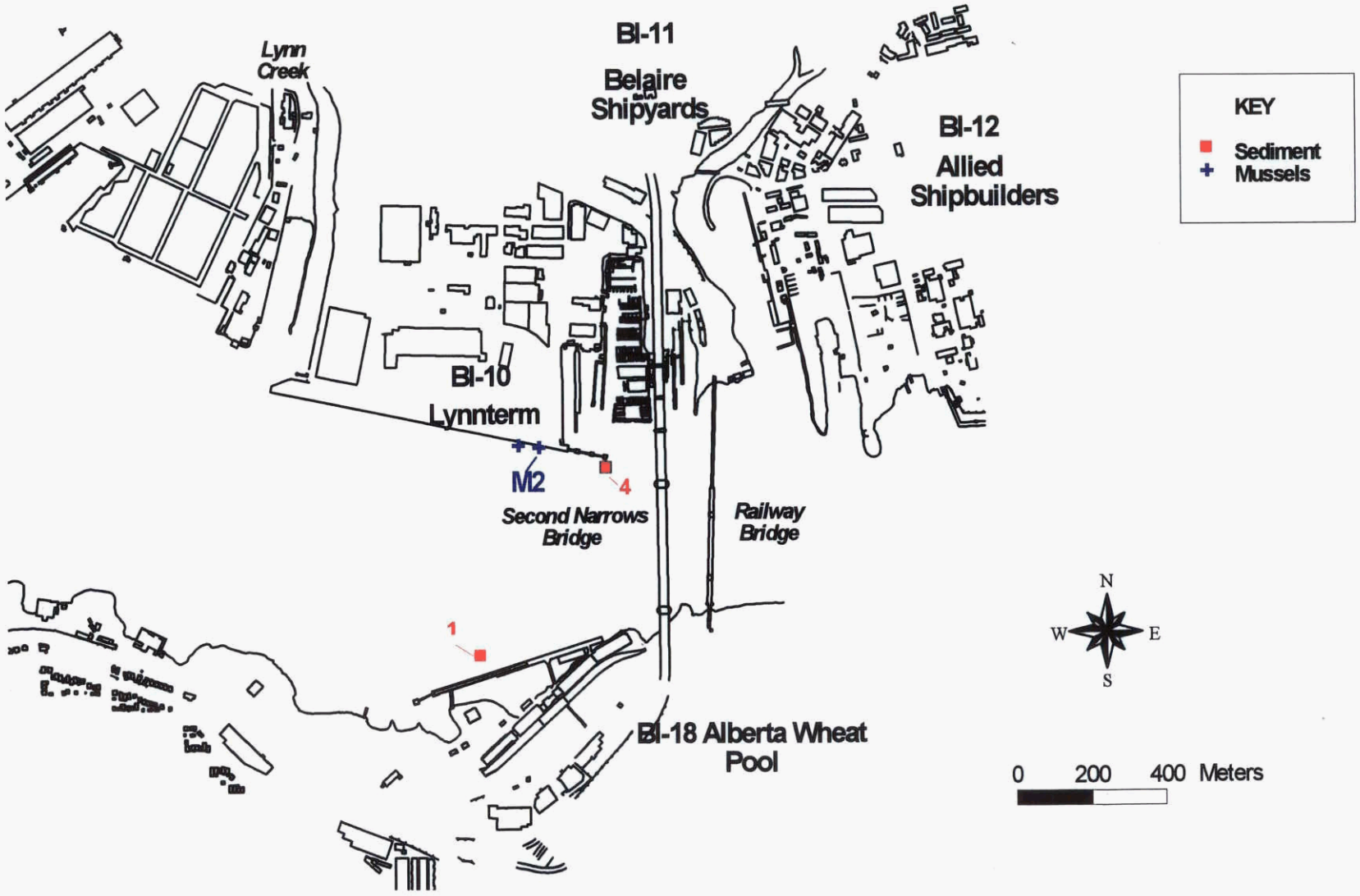
Map 5: Burrard Inlet (Sites BI-2 to BI-5)



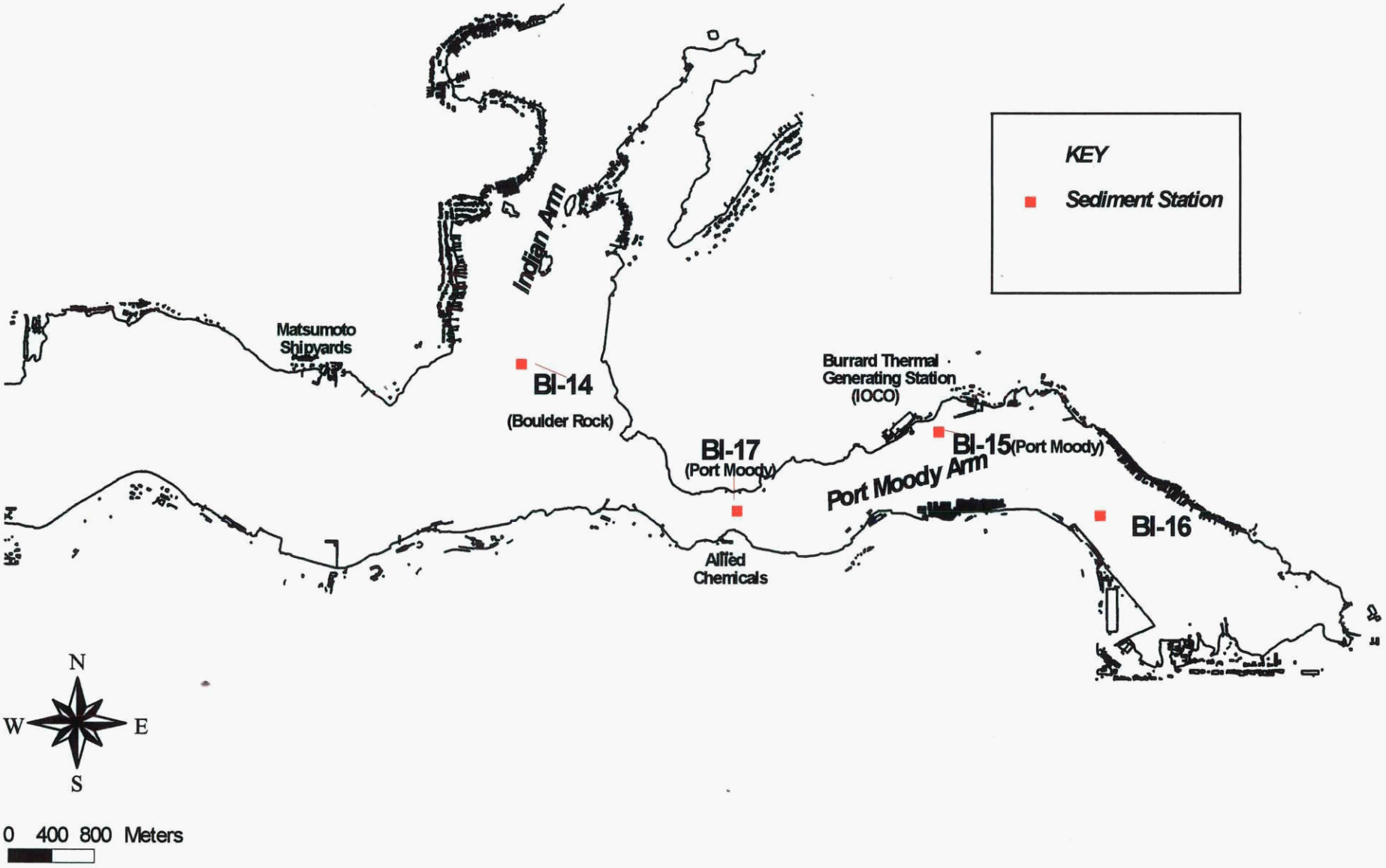
Map 6: Burrard Inlet (Sites BI-7, BI-8, and BI-9)



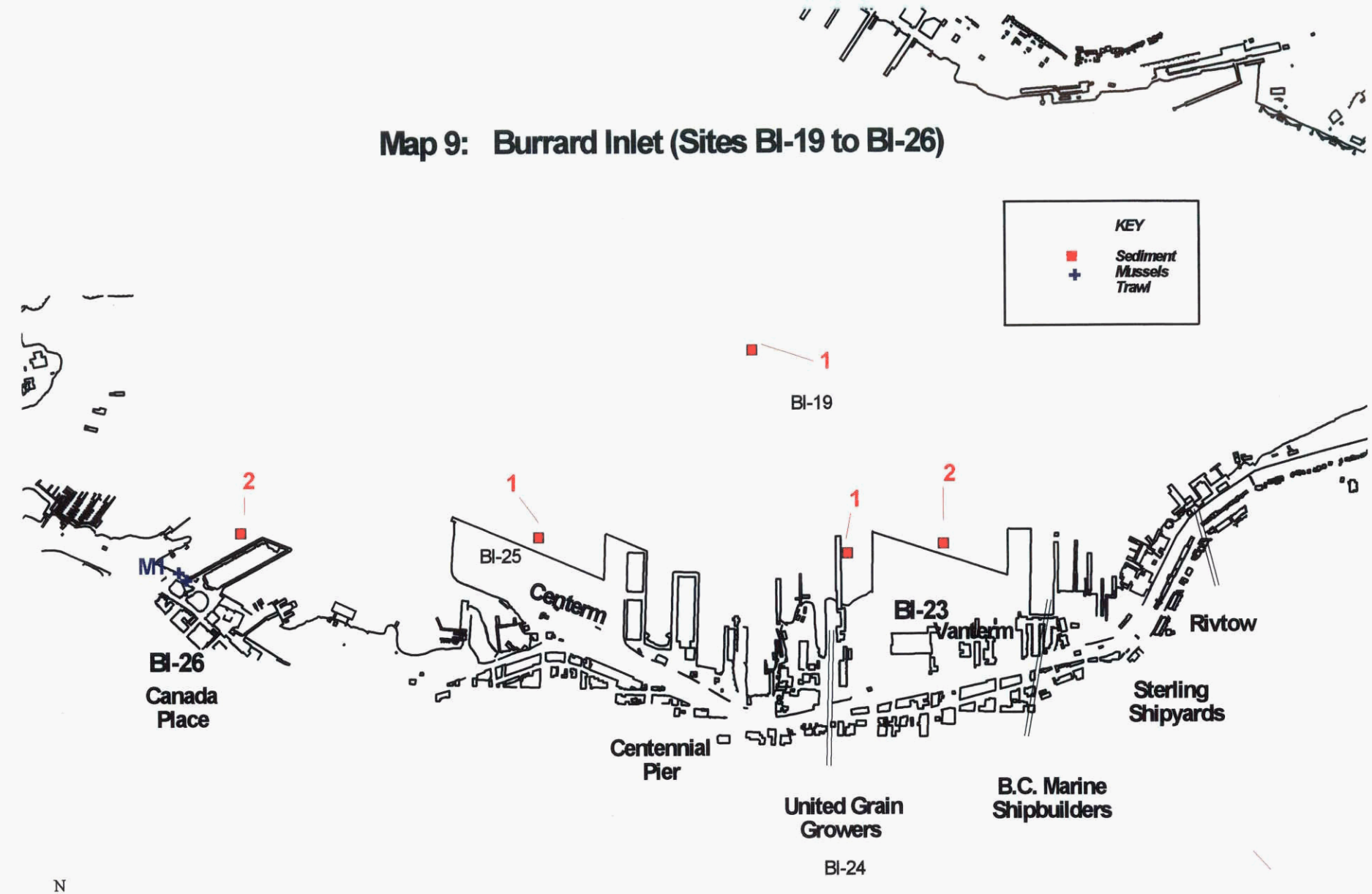
Map 7: Burrard Inlet (Sites BI-10 and 18)



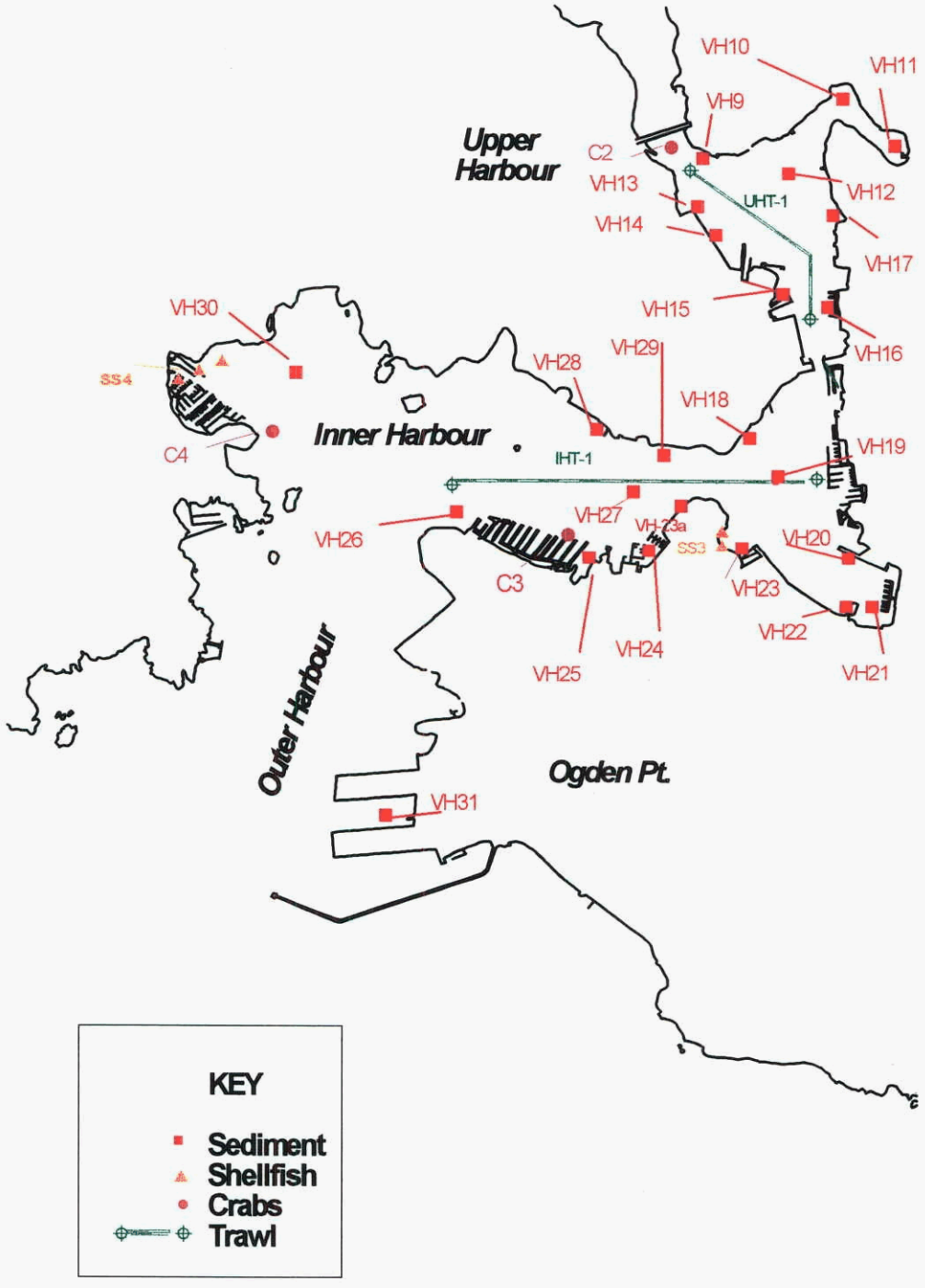
Map 8 : Burrard Inlet (Sites BI-14 to BI-17)



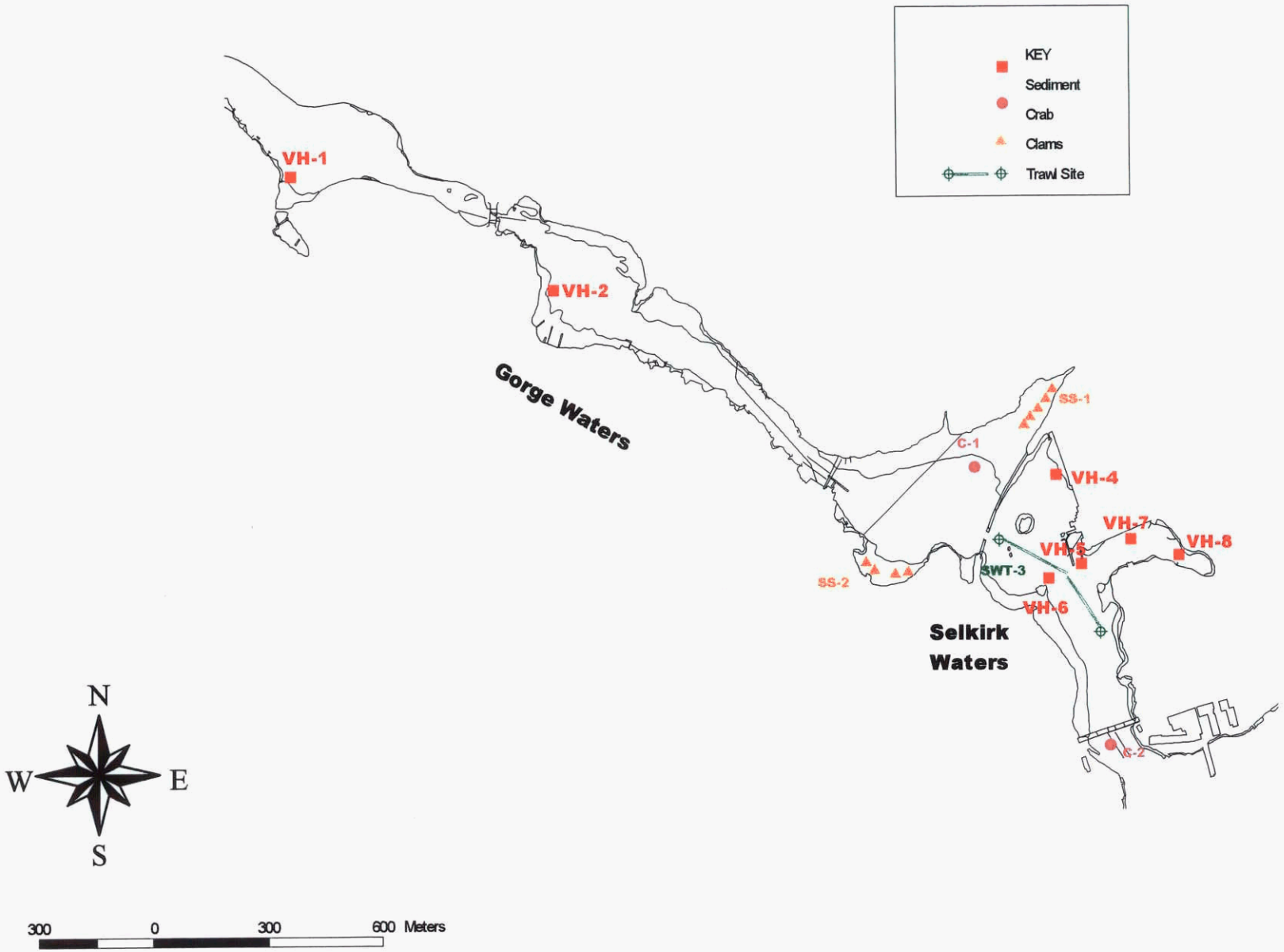
Map 9: Burrard Inlet (Sites BI-19 to BI-26)

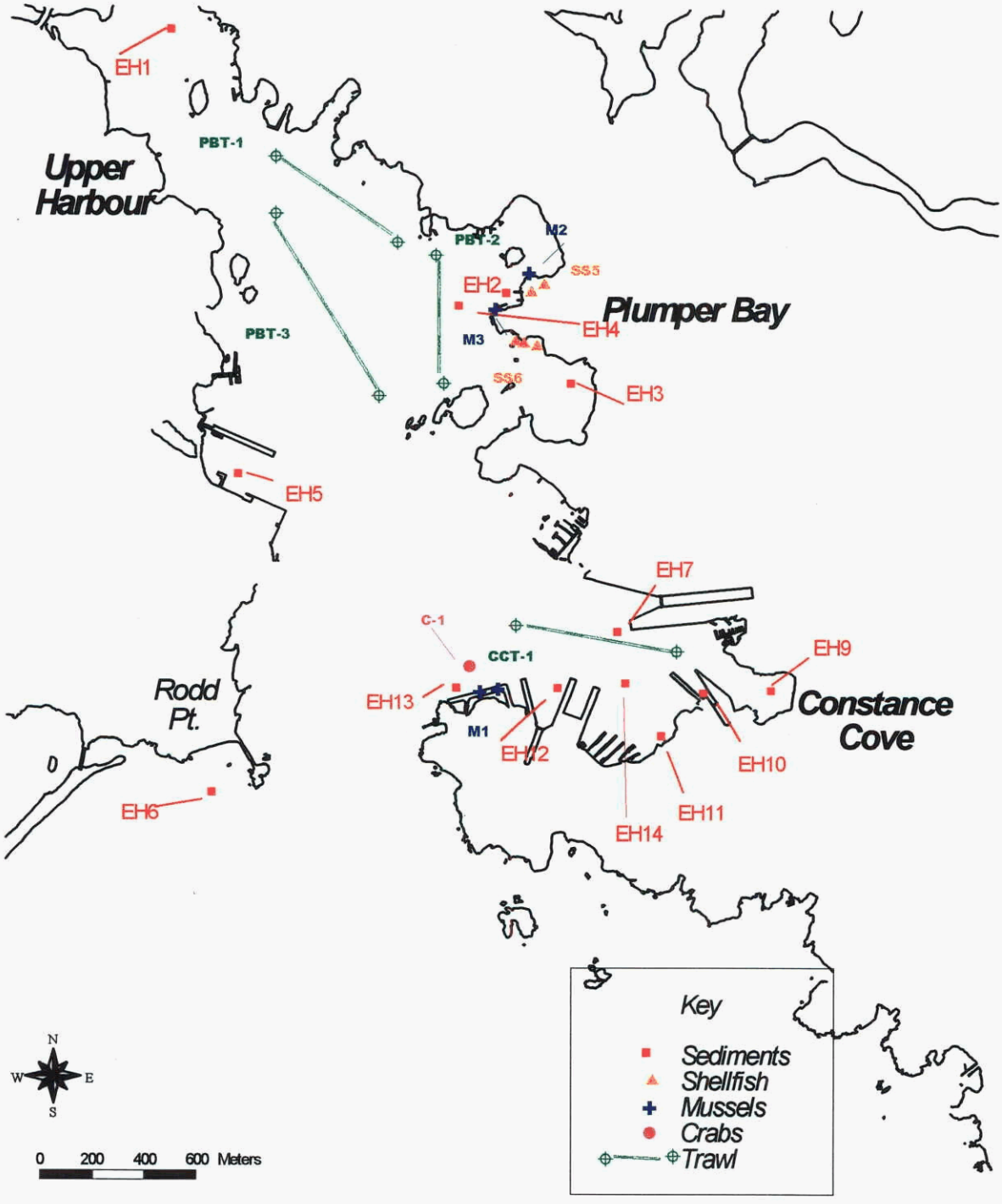


Map 10 : Victoria Harbour - Upper, Inner and Outer Harbour

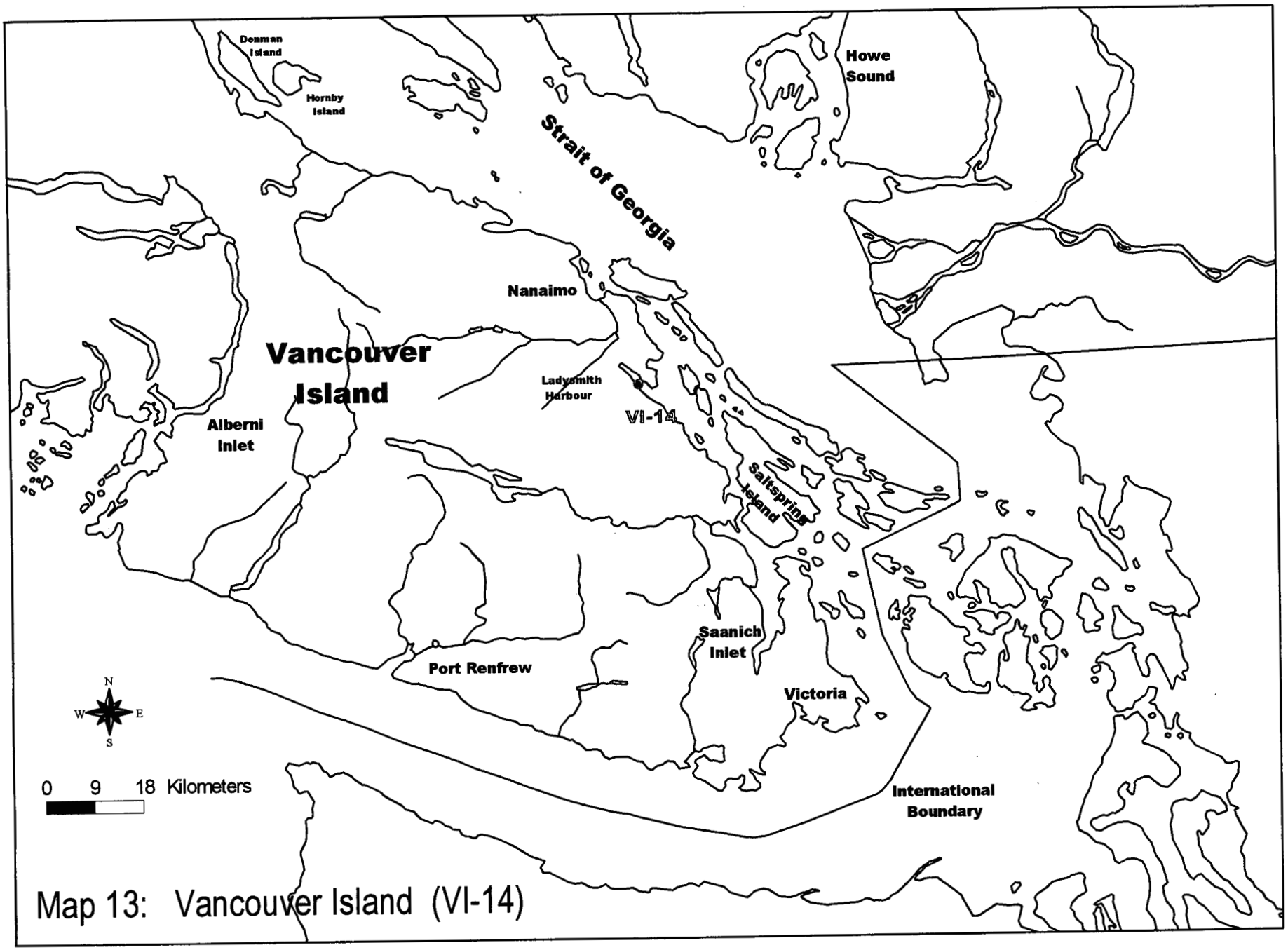


Map 11 : Victoria Harbour (Selkirk and Gorge Waters)



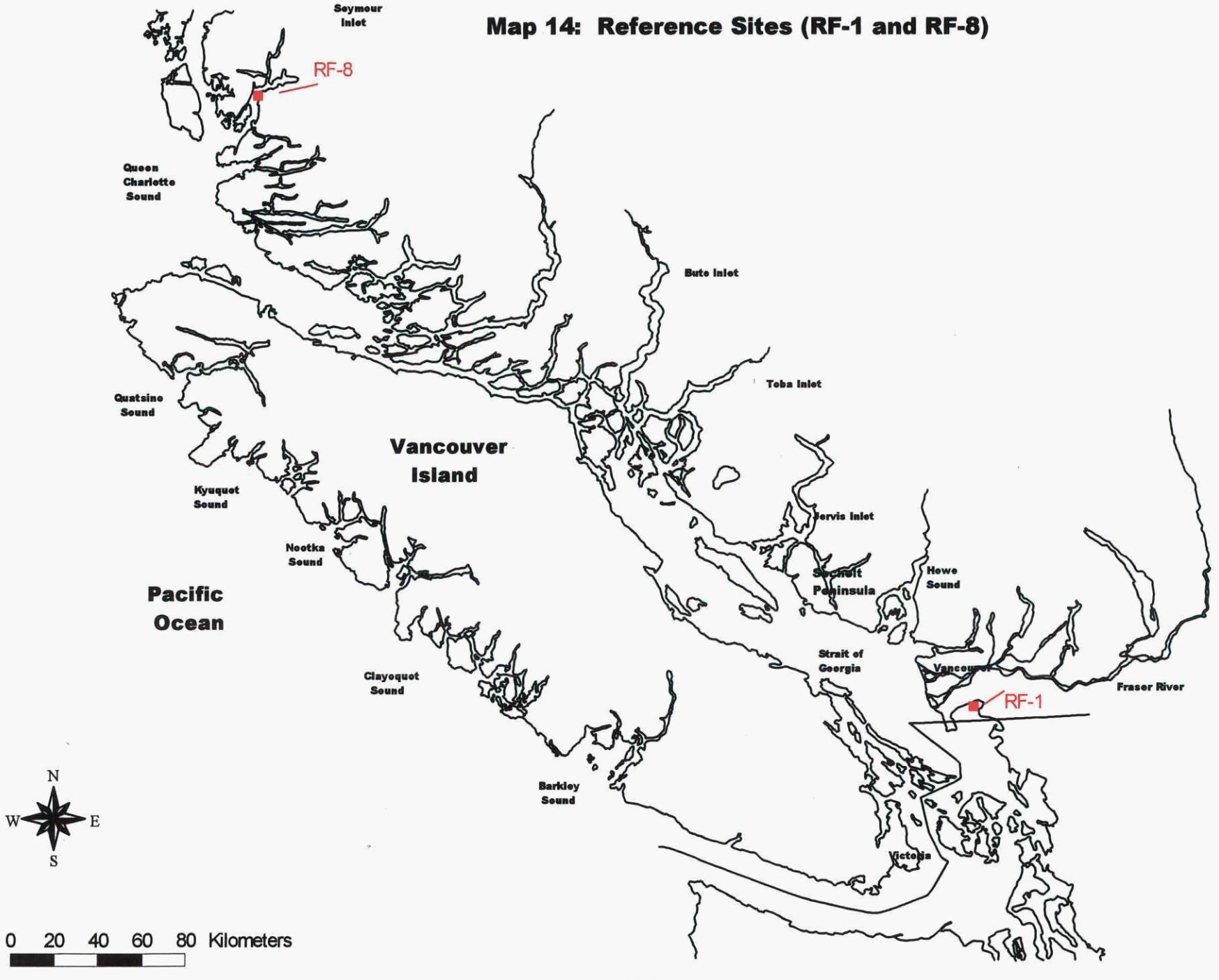


Map 12: Esquimalt Harbour



Map 13: Vancouver Island (VI-14)

Map 14: Reference Sites (RF-1 and RF-8)



Map 15 : Queen Charlotte Islands Reference Sites