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**OCEAN DISPOSAL ACTIVITIES SUMMARY
1998
PACIFIC AND YUKON REGION**

**ENVIRONMENT CANADA
ENVIRONMENTAL PROTECTION BRANCH**

PACIFIC AND YUKON REGION



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Regional Program Report: 1999-27

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**ENVIRONMENT CANADA
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PACIFIC AND YUKON REGION

Report No. 99-27

Regional Program Report by:

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ABSTRACT

Environment Canada's administration of ocean disposal activities undertaken in the Pacific and Yukon Region from 01 January 1998 to 31 December 1998 under the authority of the *Canadian Environmental Protection Act* (CEPA), Part VI, is summarized in this report. Ocean disposal sites in this Region are used primarily for the disposal of dredged and excavated spoils. This report includes information on ten disposal sites that were active in 1998 and seven disposal site monitoring programs.

This report is a continuation of a series of reports documenting ocean disposal activities from 1975 to 1997 and includes Ward and Sullivan (1980), Sullivan (1987), Kim and Sullivan (1993), Kim et al. (1997), Sullivan et al. (1997), Schnider and Sullivan (1997a), Schnider and Sullivan (1997b), Kim et al. (1999). These reports and other information are available on our website at <http://www.pyr.ec.gc.ca/ep/ocean-disposal/index.htm>.

RÉSUMÉ

Ce rapport résume les activités d'Environnement Canada en matière d'application de la partie VI de la Loi canadienne sur la protection de l'environnement (LCPA) (dépôts de déchets en mer) du 1^{er} janvier 1998 au 31 décembre 1998. Plus spécifiquement, il contient de l'information sur les activités de 10 sites de dépôt dans la région du Pacifique et du Yukon au cours de l'année 1998 et les données fournies concernent les contrôles effectués dans 7 de ces sites. Les sites de cette région servent principalement au dépôt des matériaux de dragage et d'excavation.

Ce rapport s'inscrit dans une série de rapports préparés pour la période comprise entre 1975 et 1996: Ward et Sullivan (1980), Sullivan (1987), Kim et Sullivan (1993), Kim et al. (1997), Sullivan et al. (1997), Schnider et Sullivan (1997a), Schnider et Sullivan (1997b) et Kim et al. (1999). Ces rapports sont disponibles sur notre adresse internet au <http://www.pyr.ec.gc.ca/ep/ocean-disposal/index.htm>.

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1.0 INTRODUCTION

Environment Canada has administered the requirements for ocean disposal of wastes since 1975 under authority of the *Ocean Dumping Control Act* (ODCA). In 1988 this legislation was replaced by the *Canadian Environmental Protection Act* (CEPA), Part VI. Material destined for ocean disposal requires a permit issued by Environment Canada. To ensure compliance with the conditions of the permit, inspections are routinely conducted by Environment Canada, Enforcement and Emergencies Division.

Within Canada, ocean disposal sites are divided into four geographical regions: Atlantic, Prairie and Northern, Quebec, and Pacific and Yukon. This report describes all ocean disposal activities conducted in 1998 in the Pacific and Yukon Region (Figure 1). There are thirty-five designated sites in Southern British Columbia. In 1998, ten of these disposal sites were used and seven were monitored (Table 1).

2.0 ADMINISTRATION

2.1 APPLICATION AND REVIEW PROCESS

Under the authority of CEPA Part VI, material destined for ocean disposal or loaded for the purpose of ocean disposal requires an Ocean Disposal Permit. Permit applications are reviewed by Environment Canada (EC) with advice from the Regional Ocean Disposal Advisory Committee (RODAC). This committee includes representation from Environment Canada, the Department of Fisheries and Oceans (DFO) and the British Columbia Ministry of Environment, Lands and Parks. Information on the application process can be obtained from Environment Canada, 224 West Esplanade, North Vancouver, B.C., V7M 3H7 or online at <http://www.pyr.ec.gc.ca/ep/ocean-disposal/index.htm>. Figure 2 shows the complete permitting process.

The public is advised of the application via a Notice of Intent that is published in a newspaper local to the area of the proposed activity by the applicant. The public can address their comments to Environment Canada throughout the application review process. All environmental screenings can be viewed by the public at the *Canadian Environmental Assessment Act* (CEAA) Public Registry at 224 West Esplanade, North Vancouver, B.C., V7M 3H7. Environmental screenings can also be viewed online at the CEAA website: <http://ea-ee.ncr.ec.gc.ca/glea/index.asp>.

Based on the initial review of an application, inspection and sampling by EC personnel may be required to assess the proposed loadsite. Following the application review process, only material which has been rigorously tested and found to meet the criteria outlined in the Interim Contaminant Testing Guidelines for Ocean Disposal (ICTG), Pacific and Yukon Region (Appendix I), is approved for ocean disposal. All ocean disposal permits and amendments must be published in the Canada Gazette before they are issued. Permits are valid for a one year period.

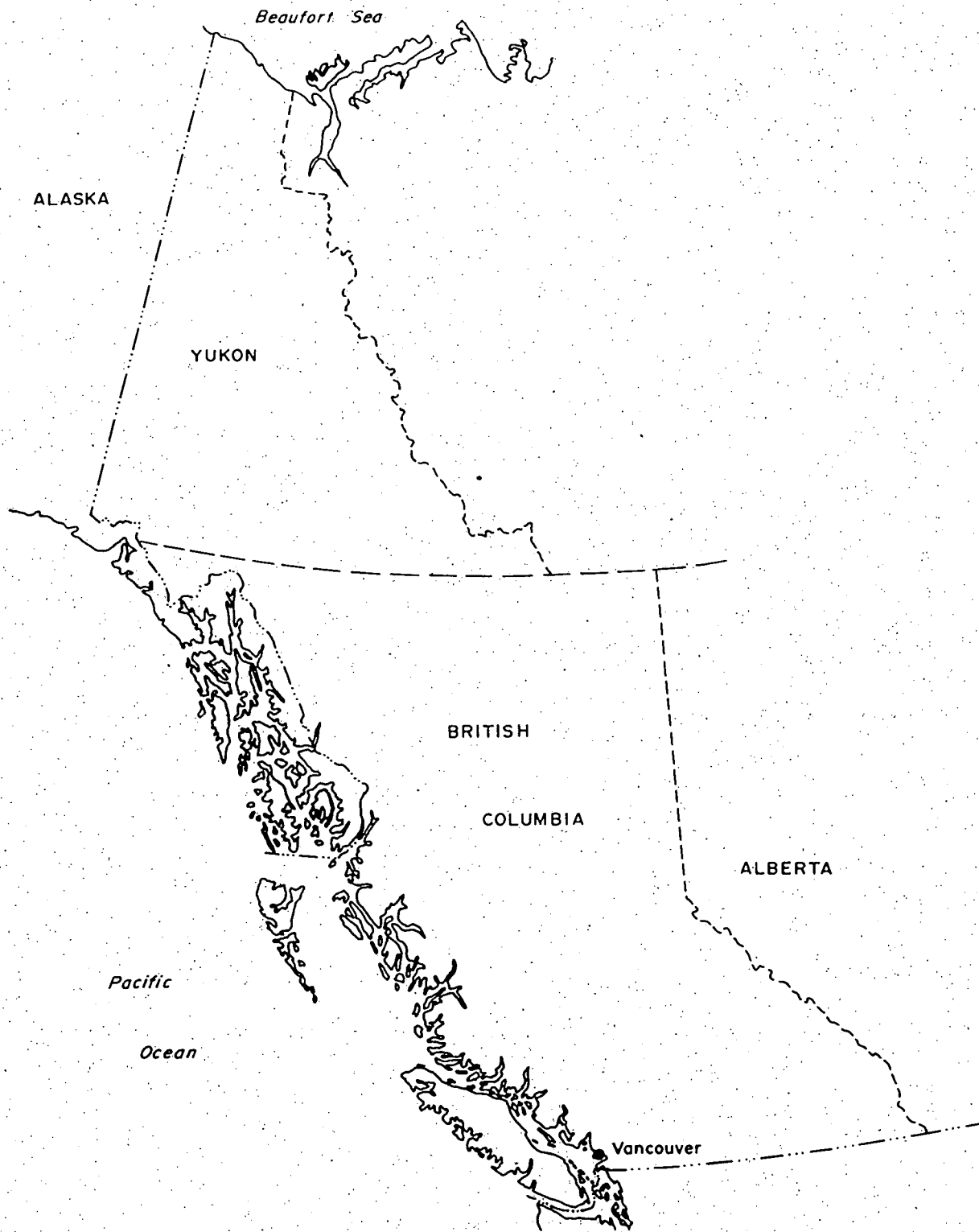


Figure 1. Location map.

Table 1. Active ocean disposal sites.

Number	Disposal Site	Depth (m)	Co-ordinates	Volume Disposed in 1998
* 1	Point Grey	210	49°15.40'N; 123°22.10'W	500 027 m ³
9	Sand Heads	70	49°06.00'N; 123°19.50'W	61 839 m ³
32	Porlier Pass	200	49°00.20'N; 123°29.80'W	10 150 m ³
* 40	Five-Finger Island	280	49°15.20'N; 123°54.60'W	3 207 m ³
48	Comox (Cape Lazo)	190	49°41.70'N; 124°44.50'W	11 800 m ³
49	Malaspina Strait	320	49°45.00'N; 124°27.00'W	26 507 m ³
64	Thornbrough Channel	220	49°31.00'N; 123°28.30'W	3 000 m ³
* 78	Quatsino	99	50°28.50'N; 127°50.00'W	0 m ³
116	Cape Mudge	200	49°57.70'N; 125°05.00'W	8 000 m ³
* 119	Johnstone Strait - Hickey Point	270	50°27.80'N; 126°04.80'W	0 m ³
* 120	Johnstone Strait - Hanson Island	350	50°33.50'N; 126°48.00'W	4 000 m ³
* 121	Malcolm Island	180	50°42.00'N; 127°06.00'W	0 m ³
* 140	Queen Charlotte Strait	390	50°46.40'N; 127°22.60'W	0 m ³
185	Zeballos	200	49°56.06'N; 126°48.04'W	40 tonnes
Total:				628 530 m ³ 40 tonnes

* Monitoring studies were conducted at these disposal sites in 1998.



RODAC Agencies

EC -	Pollution Prevention and Assessment Division
DFO -	Science and Research
DFO -	Habitat Management
MELP -	Pollution Prevention and Remediation Branch

Legend

EC -	Environment Canada
RODAC -	Regional Ocean Disposal Advisory Committee
MELP -	Ministry of Environment, Lands and Parks
DFO -	Fisheries and Oceans Canada
CEAA -	Canadian Environmental Assessment Act

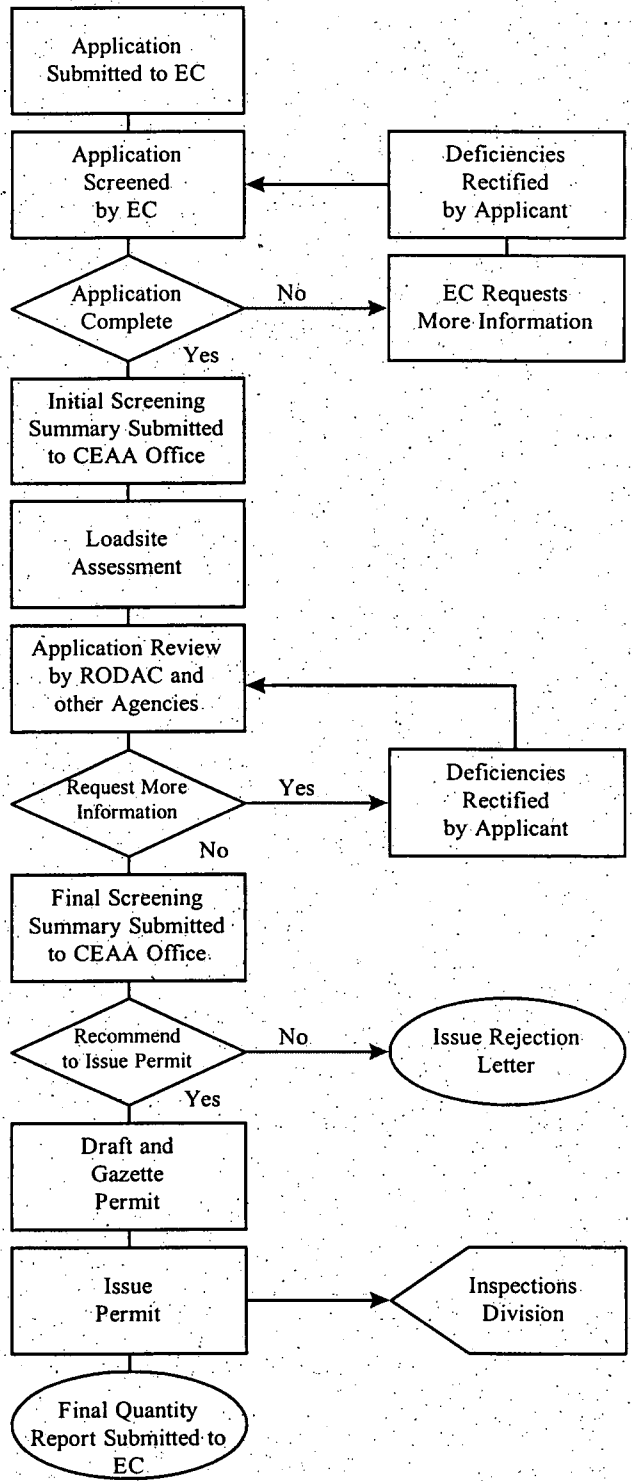


Figure 2. Ocean disposal permitting process.

Maintenance dredging activities involving less than 4 000 cubic metres of dredged material, or excavation projects involving clean native till may be undertaken under the terms and conditions of a general ocean disposal permit. New dredging projects or maintenance activities involving volumes in excess of 4 000 cubic metres require a site-specific permit.

2.2 OCEAN DISPOSAL RESTRICTIONS

Under Schedule III, Parts I and II, certain substances are prohibited or restricted from ocean disposal. In addition, the ICTG further outline the criteria for polycyclic aromatic hydrocarbons, polychlorinated biphenyls, chlorophenols and dioxins/furans.

The substances listed in Part I are generally prohibited when present at dry weight concentrations in excess of those specified below unless, in the opinion of the Minister, the substance will be rapidly rendered harmless by physical, chemical or biological processes of the sea at the specified disposal site:

- a) Organohalogen compounds
 - Chlorophenols (PCP and TCP) 1.0 µg/g
 - Polychlorinated biphenyls (PCB) 0.1 µg/g
 - Polycyclic aromatic hydrocarbons (PAH) 2.5 µg/g
 - Dioxin (2,3,7,8 TCDD) Quantifiable
- b) mercury and mercury compounds in a solid phase of a waste (0.75 µg/g), and in the liquid phase of a waste (1.5 µg/g);
- c) cadmium and cadmium compounds in the solid phase of a waste (0.6 µg/g), and in the liquid phase of waste (3.0 µg/g);
- d) persistent plastics and other persistent synthetic materials (four percent by volume), in a suitably comminuted form;
- e) crude oil and its wastes, refined petroleum products, petroleum distillate residues and any mixtures containing any of those substances (any quantity that yields more than 10.0 µg/g of n-hexane soluble substances);
- f) radioactive wastes and other radioactive matter;
- g) substances in whatever form produced for biological and chemical warfare; and
- h) industrial waste, namely, material that comes from manufacturing or processing operations and is waste, other than:
 - dredged material;

- fish waste or other organic matter that comes from industrial fish processing operations;
- ships, platforms or other anthropogenic structures at sea, provided that material capable of creating floating debris or otherwise polluting the marine environment has been removed;
- uncontaminated inert geological material; and
- uncontaminated organic matter of natural origin.

Under Part II, the following substances are restricted when present in significant amounts. In dredged material, lead is considered to be present in significant amounts when contained in wastes at concentrations of 0.05 percent or more by weight (500 µg/g) and arsenic, copper, zinc, beryllium, chromium, nickel and vanadium when present at concentrations of 0.1 percent (1000 µg/g). Pacific RODAC considers these levels as general guidelines only and may impose more stringent limits.

- a) arsenic and its compounds;
- b) lead and its compounds;
- c) copper and its compounds;
- d) zinc and its compounds;
- e) organosilicon and its compounds;
- f) cyanides;
- g) fluorides;
- h) pesticides and their by-products not included in the List of Prohibited Substances in Part I;
- i) beryllium and its compounds;
- j) chromium and its compounds;
- k) nickel and its compounds;
- l) vanadium and its compounds;
- m) containers and scrap metal;
- n) substances that by reason of their bulk would interfere with fishing; and
- o) substances that, though of a non-toxic nature, may become harmful due to the quantities in which they are dumped, or that are liable to seriously reduce amenities.

In order to protect fisheries resources, spawning areas, and juvenile and adult migratory areas, Fisheries and Oceans Canada (DFO) requires that dredging and/or ocean disposal activities be conducted within time frames specified by district Habitat Management Units. Proponents are directed to contact the appropriate DFO units prior to commencing any projects for timing restrictions relevant to the area of proposed activities. For example, the Fraser River dredging guidelines for operations within navigation channels specify periods when clamshell or suction dredging is allowed. Dredging outside navigation channels is reviewed on a site-specific basis.

2.3 COMPLIANCE AND ENFORCEMENT

Environment Canada, Pollution Prevention and Assessment Division, conducts pre-load inspections to verify sampling program design and that samples are collected as required. Enforcement of the terms and conditions of permits under CEPA, Part VI, is the responsibility of the Inspections Section, Enforcement and Emergencies Division. CEPA inspectors routinely conduct compliance and surveillance inspections of dredging/loading and disposal operations. Vessel Traffic Management Centres monitor disposal sites to ensure disposal activities occur at the authorised locations. Any contravention of permit conditions are dealt with under authority of CEPA, Part VI or Section 36 (3) of the *Fisheries Act*.

3.0 DISPOSAL SITE MONITORING

Disposal site monitoring procedures are outlined in the Interim Monitoring Guidelines for Ocean Disposal (1993). Physical monitoring is the first stage of the monitoring approach. Of key importance is the collection of geological information to determine the area of deposition, delineation of the disposal site boundaries, the accumulation of material within the boundaries and evidence of sediment transport off the disposal site.

Chemical assessment of a disposal site is aimed at measuring chemical concentrations of sediment from within the disposal site boundary and from one or more nearby reference stations removed from ocean disposal activity. Environment Canada uses the results to determine whether disposal activities are altering the chemical composition of sediments within the disposal site.

Biological testing is focused primarily on laboratory toxicity testing and benthic community studies. Biological testing protocols were completed in 1992 and continue to be evaluated for use in disposal site assessment. In addition, Environment Canada has published "Guidance Document on the Collection and Preparation of Sediment for Physiochemical Characterization and Biological Testing" (1994).

All available information from physical, chemical and biological monitoring is considered in the overall assessment of a disposal site.

4.0 OCEAN DISPOSAL ACTIVITIES

4.1 NUMBER OF PERMITS

In 1998, thirty ocean disposal permit applications were received and thirty permits were issued (Table 2): six for excavated material, twenty-three for dredged material and one for vessel disposal.

Under general permits for dredged and excavated materials, 89 projects were assessed and approved in 1998. Twenty-three approvals were issued for excavation projects in the lower mainland and 66 approvals were issued for maintenance projects involving less than 4 000 cubic metres of dredged material.

Table 2. Number of permits issued in the Pacific and Yukon Region - 1987 to 1998.

Permit Type	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Dredge	33	41	28	25	23	20	21	18	20	15	14	23
Excavation	2	5	5	4	4	5	3	2	4	6	6	6
Vessel	0	0	1	0	2	2	0	0	1	2	1	1
Others	2	2	2	2	1	0	1	0	0	0	0	0
Total	37	48	36	31	30	27	25	20	25	23	21	30

4.2 VOLUME OF MATERIAL OCEAN DISPOSED

In 1998, approximately 629 000 cubic metres of material was disposed of at various disposal sites in the Pacific and Yukon Region. The Point Grey and Sand Heads disposal sites received approximately 90% of all materials.

Dredged material accounted for approximately 60% of the material sent to disposal sites while excavation projects in the lower mainland accounted for the remainder.

In 1998, approximately 52 000 cubic metres of sand from the Fraser River Channel maintenance dredging was disposed at the Sand Heads ocean disposal site. Sand recovery and sales for construction projects has greatly reduced the need for ocean disposal of sediment resulting from channel maintenance.

4.3 MONITORING

Routine monitoring of ocean disposal sites is carried out by Environment Canada to assess physical, chemical and biological effects of disposal operations. At each designated ocean disposal site, a grid of sediment sampling stations has been established to allow repetitive surveys.

Environment Canada undertook three monitoring surveys in 1998 at seven designated disposal sites: Point Grey, Five Finger Island, Quatsino, Johnstone Strait-Hickey Point, Johnstone Strait-Hanson Island, Malcolm Island, and Queen Charlotte Strait. All sediments collected were analysed for trace metals and particle size distribution. Sediment samples collected at Five Finger Island, Quatsino, Johnstone Strait-Hickey Point, Malcolm Island and Queen Charlotte Strait, and composite samples from Point Grey disposal sites were analysed for concentrations of total polycyclic aromatic hydrocarbons (TPAH) and total organic carbon (TOC). Sediment samples collected at

Quatsino disposal site were tested for additional substances: ammonia, sulphide, acid volatile sulphides (AVS), and simultaneously extracted metals (SEM).

Sediment toxicity tests are conducted to determine and monitor effects of ocean disposed sediments on the receiving environment. Sediment samples from Quatsino disposal site were tested for acute toxicity using the marine amphipods *Eohaustorius washingtonianus* and *Rhepoxynius abronius*. Quatsino sediment samples were further analysed using the solid phase and liquid phase Microtox[®] tests.

Sidescan sonar mosaics of the Point Grey disposal site and surrounding area were generated from a survey conducted in November 1997 in co-operation with the Natural Resources Canada, Pacific Geoscience Centre. Results of this survey are included in Section 5.1.

In September 1998, video images of Point Grey disposal site were recorded using a remotely operated submersible (ROPOS II) owned by Fisheries and Oceans Canada and operated by the Canadian Scientific Submersible Facility. Predetermined transect lines were followed across the disposal site to examine bottom conditions and evidence of ocean disposal activities. Discussion of the physical monitoring conducted at Point Grey is presented in Section 5.1 and selected video images are located in Appendix III.

5.0 ACTIVE DISPOSAL SITE INFORMATION

The total quantity of materials found under disposal site headings in the following section is the total quantity disposed of under permit/approval since 1976. Information on specific permits and approvals in 1998 at each disposal site can be found in the disposal site summaries located in Appendix II.

Where trace metal concentrations are reported in the following sections, results are expressed as dry weight total metals.

5.1 POINT GREY

Disposal Site:	Point Grey
Number:	1
Co-ordinates:	49°15.40'N; 123°22.10'W
Depth:	210 metres
Total Quantity Disposed Since 1976:	9 082 300 cubic metres + 390 tonnes

Comments

DFO requests that Vancouver Harbour and the Fraser River Dredging Guidelines be applied to any dredging project, subject to approval by the appropriate Habitat Management Unit.

Loadsite Information

Over 264 000 cubic metres of dredged material was sent to the Point Grey disposal site in 1998. This material resulted from maintenance dredging operations at various locations in Vancouver Harbour and the Fraser River. In addition, over 235 000 cubic metres of excavated native till from Greater Vancouver was taken to the disposal site.

Monitoring Information

In November 1997, the second phase of a sidescan sonar survey was completed in conjunction with the Pacific Geoscience Centre. The survey included the disposal site and surrounding area, covering approximately 36 square nautical miles. A mosaic image of the disposal site was produced by the Pacific Geoscience Centre (Figures 3 and 4). Evidence of disposal activity can be seen on the mosaic. Dredged woodwaste and river sediment is normally removed from the barges by front-end loaders leaving clearly defined "strings of black pearls" on the sidescan mosaic. Excavation material is normally transported to the site in split-hull barges and the disposal, which occurs in a matter of minutes, leaves large black "splotches" on the mosaic. Initial observations indicate that material sent for disposal is being deposited within the disposal site boundaries.

In September 1998, ROPOS II was deployed at the Point Grey disposal site. As part of a physical monitoring program, the remotely operated vehicle (ROV) is used to observe the benthic condition of the disposal site and surrounding area. In addition, information on the area of deposition of materials, and physical characteristics of sediment in and around the disposal site boundary can be gathered from ROPOS video. Predetermined track lines were plotted over the disposal site and continuous video images were recorded. Computer-captured still images (transferred to slide and CD ROM) were also collected. A selection of these images is presented in Appendix III.

In April 1998, surface sediment samples were collected from 41 stations at the disposal site and the surrounding area (Table 3). The samples were analysed for trace metal concentrations and particle size distribution. Trace metal and particle size results for stations 25-41 are the averages values of three grab samples per station. PAH and TOC were analyzed on a single grab from each station. No PAH and TOC results were obtained for station 40 as the sample jar was broken before the chemical analyses could be performed. Results are presented in Table 3. No chemical concentrations exceeded the ICTG screening limits.

In September 1998, surface sediment samples were taken from stations 25-41 at the Point Grey disposal site. Results of chemical and particle size analyses are presented in Table 4. No chemical concentrations exceeded the ICTG screening limits.

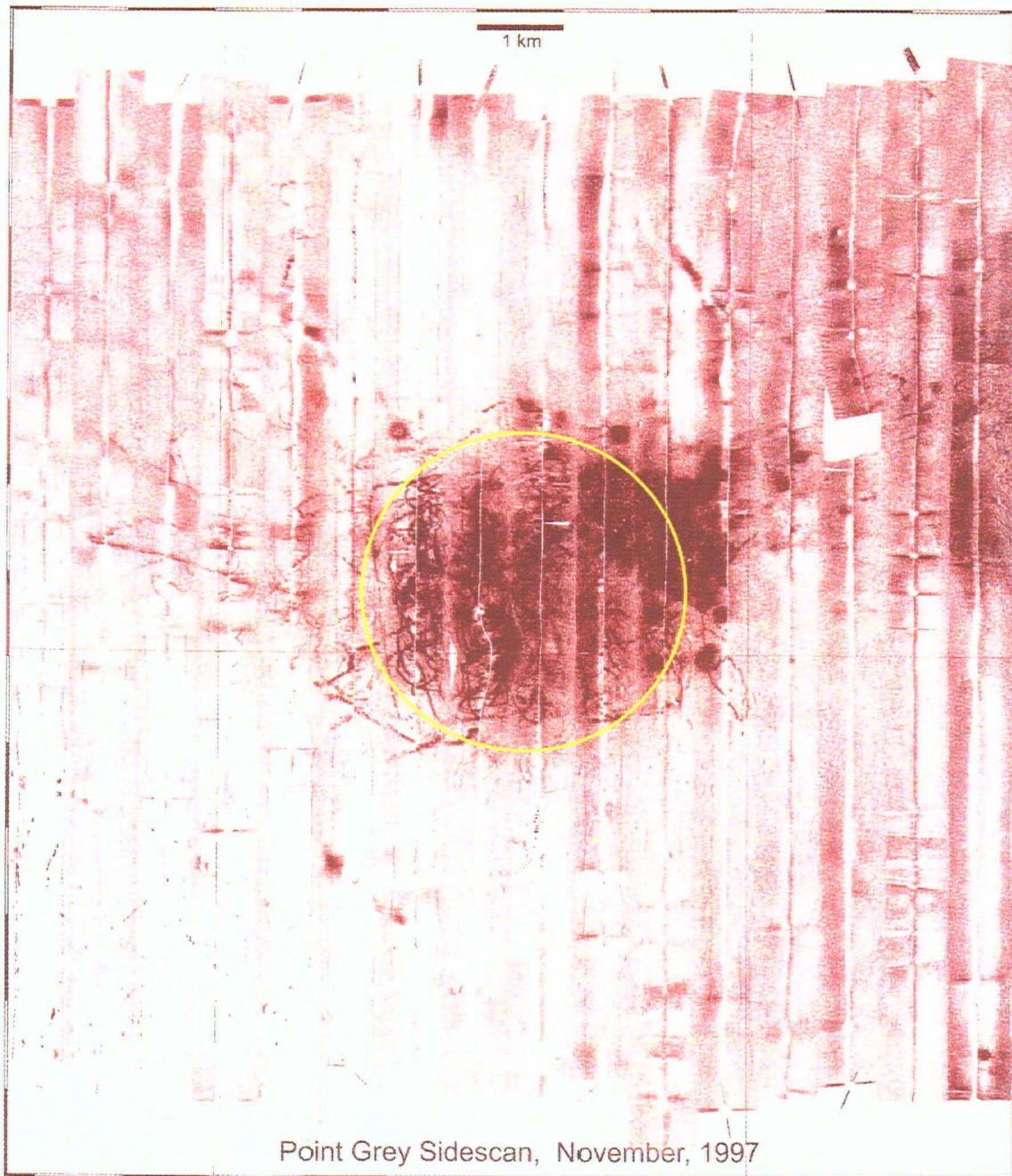


Figure 3. Sidescan sonar mosaic of Point Grey disposal site and surrounding area - November 1997. The image is centered at 49°15.40'N; 123°22.10'W. The area within the circle represents the designated disposal area. Note the characteristic patterns of disposal by front-end loaders and split-hull barges (see page 10).

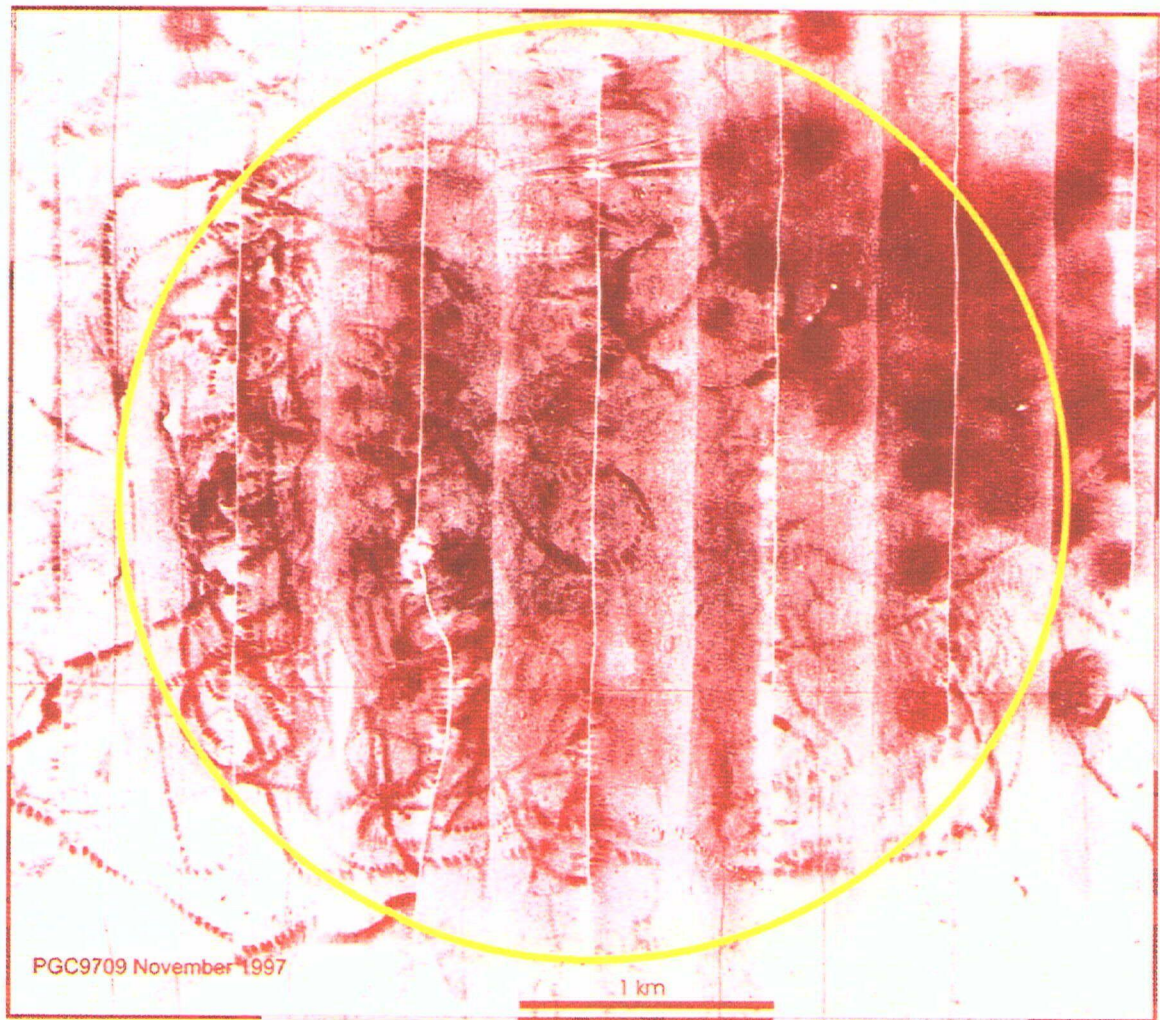


Figure 4. Sidescan sonar mosaic of Point Grey disposal site - November 1997. The image is centered at $49^{\circ}15.40'N$; $123^{\circ}22.10'W$. The area within the circle represents the designated disposal area. Note the characteristic pattern of disposal by front-end loaders and split-hull barges (see page 10).

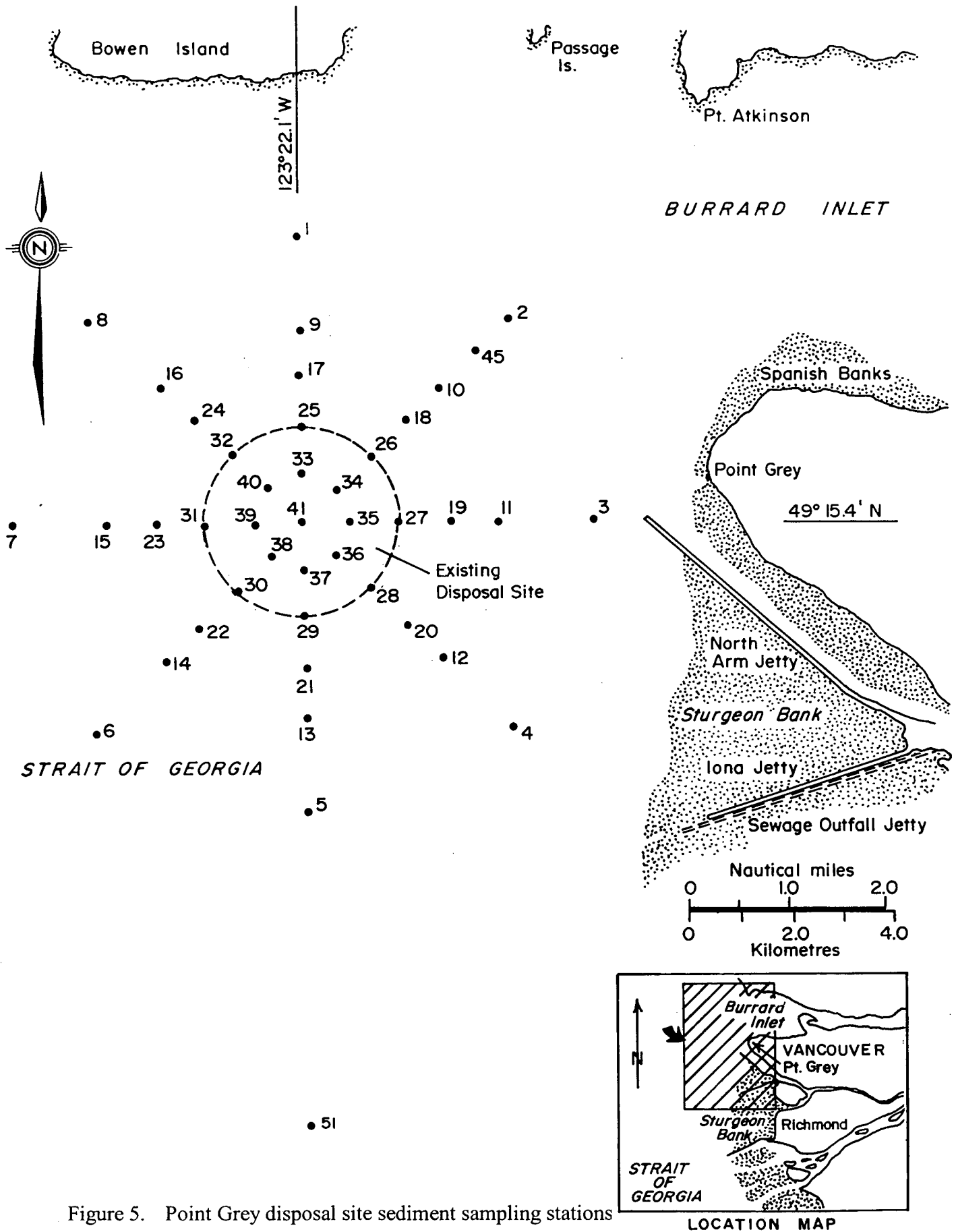


Figure 5. Point Grey disposal site sediment sampling stations

Table 3. Point Grey sediment chemistry and particle size data - April 1998 survey.

Station	Sediment Chemistry ¹						% Particle Size				
	Cd µg/g	Hg µg/g	Cu µg/g	Pb µg/g	Zn µg/g	TPAH µg/g	TOC %	Gravel > 2.0 mm	Sand 2 - 0.063 mm	Silt 0.063 - 0.004 mm	Clay < 0.004 mm
1	0.20	0.09	45.8	22.0	94.6			0.00	3.66	75.46	20.88
2	0.27	0.09	52.7	27.0	92.0			0.00	2.78	78.01	19.22
3	0.20	0.07	37.3	18.0	68.7			0.00	35.53	57.19	7.27
4	0.10	0.08	46.8	17.0	91.5			0.00	3.33	78.96	17.71
5	0.19	0.08	38.0	8.0	78.2			0.00	3.53	78.26	18.21
6	0.20	0.08	44.9	21.0	91.9			0.00	2.72	79.73	17.57
7	0.16	0.09	45.0	32.0	96.4			0.00	1.60	76.47	21.92
8	0.19	0.10	50.9	28.0	98.4			0.00	4.12	72.43	23.46
9	0.22	0.08	42.4	20.0	93.4			0.00	6.62	73.64	19.73
10	0.59	0.08	44.4	23.0	85.4			0.00	2.86	77.49	19.64
11	0.10	0.09	48.6	22.0	93.0			0.00	2.51	77.99	19.51
12	0.10	0.08	46.4	26.0	95.1			0.00	2.16	79.30	18.50
13	0.17	0.08	43.5	10.0	88.0			0.00	3.62	78.67	17.69
14	0.24	0.08	43.0	18.0	87.2			0.00	2.11	78.39	19.49
15	0.10	0.10	45.0	24.0	91.6			0.00	1.42	75.44	23.12
16	0.18	0.11	51.5	33.0	101.0			0.00	1.36	77.82	20.81
17	0.24	0.07	42.3	20.0	90.0			0.00	7.26	73.07	19.66
18	0.36	0.09	49.7	24.0	93.8			0.00	2.56	76.63	20.83
19	0.20	0.08	45.0	22.0	91.4			0.00	1.15	78.45	20.40
20	0.09	0.08	41.4	24.0	87.4			0.00	3.26	77.97	18.77
21	0.20	0.08	43.9	17.0	89.8			0.00	4.68	76.58	18.73
22	0.24	0.08	39.2	10.0	83.1			0.00	2.89	76.76	20.35
23	0.21	0.09	45.3	22.0	92.0			0.00	2.72	74.31	22.98
24	0.10	0.10	48.0	32.0	94.6			0.00	6.34	71.14	22.50
25	0.21	0.07	40.6	17.0	80.0	0.48	1.31	0.00	17.80	65.80	16.50
26	0.31	0.04	30.3	18.0	60.0	1.54	0.79	0.00	47.20	44.60	8.10
27	0.07	0.05	32.1	22.0	62.0	1.35	0.90	0.00	28.50	57.70	13.90
28	0.27	0.07	42.4	25.0	86.0	0.45	1.22	0.00	7.10	75.40	17.50
29	0.21	0.07	41.9	21.0	85.0	0.38	1.73	0.00	6.80	75.80	17.40
30	0.19	0.08	37.8	6.0	75.0	0.54	1.09	0.00	5.50	75.40	19.10
31	0.10	0.08	43.7	21.0	84.0	0.70	1.38	0.00	4.90	74.30	20.70
32	0.19	0.08	40.9	21.0	81.0	0.54	1.23	0.00	5.80	74.40	19.80
33	0.18	0.05	36.3	13.0	69.0	0.70	1.06	0.00	22.30	63.90	13.80
34	0.27	0.05	34.4	22.0	68.0	0.56	0.88	0.00	33.00	55.40	11.60
35	0.12	0.04	27.9	10.0	57.0	0.52	0.66	0.00	30.30	56.60	13.10
36	0.31	0.05	32.6	15.0	63.0	0.29	0.59	0.00	48.10	44.10	7.80
37	0.19	0.05	36.5	12.0	70.0	0.56	0.69	0.00	38.40	51.80	9.80
38	0.18	0.06	35.4	11.0	65.0	0.38	1.37	0.00	25.30	60.60	14.00
39	0.10	0.06	35.0	16.0	70.0	0.44	4.36	0.00	23.80	61.50	14.80
40	0.16	0.05	32.4	18.0	64.0			0.00	22.20	62.60	15.30
41	0.19	0.05	27.5	18.0	64.0	1.97	1.44	0.00	44.00	48.40	7.60

¹ Trace metals results are expressed in dry weight

Table 4. Point Grey sediment chemistry and particle size data - September 1998 survey.

Station	Sediment Chemistry ¹					Particle Size (%)			
	Cd µg/g	Hg µg/g	Cu µg/g	Pb µg/g	Zn µg/g	Gravel > 2.0 mm	Sand 2 - 0.063 mm	Silt 0.063 - 0.004 mm	Clay < 0.004 mm
25	0.21	0.07	40.3	9.3	83.1	2.64	24.55	38.56	34.25
26	0.09	0.02	21.3	3.9	43.0	9.17	65.42	16.46	8.96
27	0.20	0.07	39.7	9.7	84.6	0.88	28.07	40.50	30.55
28	0.18	0.07	40.8	9.4	81.9	0.58	13.67	45.77	39.98
29	0.21	0.09	41.8	10.0	89.2	0.08	8.71	46.89	44.31
30	0.20	0.09	43.0	12.0	92.2	0.09	9.63	43.37	46.90
31	0.22	0.09	43.8	13.0	91.8	3.26	11.81	39.12	45.81
32	0.19	0.08	42.5	10.0	84.0	24.36	18.13	27.85	29.66
33	0.20	0.07	33.5	7.4	70.1	4.25	37.26	37.49	21.00
34	0.10	0.03	33.3	6.6	51.3	11.14	49.71	25.87	13.28
35	0.10	0.05	26.9	8.3	64.4	3.31	49.01	31.25	16.43
36	0.22	0.06	37.6	7.2	66.9	9.12	31.37	35.87	23.64
37	0.17	0.06	35.3	8.2	74.9	0.34	38.69	36.81	24.16
38	0.20	0.06	33.7	9.3	72.7	3.09	37.64	32.84	26.43
39	0.18	0.06	37.1	8.1	70.1	10.19	34.14	29.19	26.48
40	0.20	0.04	34.4	6.7	63.9	24.92	33.54	24.94	16.60
41	0.10	0.04	31.0	6.0	60.9	3.35	53.56	27.80	15.29

¹ Trace metals results are expressed in dry weight.

5.2 SAND HEADS

Disposal Site:	Sand Heads
Number:	9
Co-ordinates:	49°06.00'N; 123°19.50'W
Depth:	70 metres
Total Quantity disposed Since 1976:	10 847 721 cubic metres

Comments

The Fraser River Dredging Guidelines apply to all projects. Clamshell dredging may be conducted throughout the year, subject to site specific approval. Suction dredging may be conducted from March 1 to June 1 but the dredge must be operated at a five metre depth at low tide. In even-numbered years, suction dredging is prohibited from April 15 to May 15 during the downstream pink salmon migration.

The DFO Habitat Management Unit in New Westminister should be contacted for specific timing restrictions on dredging.

Loadsite Information

Only clean sand, silt and gravel, (no woodwastes) are approved for disposal at the Sand Heads disposal site. The majority of material disposed of at this site originates from Fraser River channel maintenance projects. In 1998, approximately 52 000 cubic metres of material were disposed of at Sand Heads. Other material sent to Sand Heads typically results from maintenance dredging at load ramps for construction aggregate facilities on the Fraser River.

5.3 PORLIER PASS

Disposal Site:	Porlier Pass
Number:	32
Co-ordinates:	49°00.20'N; 123°29.80'W
Depth:	200 metres
Total Quantity Disposed Since 1976:	177 025 cubic metres

Comments

The DFO Habitat Management Unit in Nanaimo (South Coast Division) should be contacted for specific timing restrictions on dredging.

Loadsite Information

In 1998, 10 150 cubic metres of material were sent to the Porlier Pass disposal site resulting from maintenance dredging activities at forest industry operations in Chemainus and Ladysmith.

5.4 FIVE FINGER ISLAND

Disposal Site:	Five Finger Island
Number:	40
Co-ordinates:	49°15.20'N; 123°54.60'W
Depth:	280 metres
Total Quantity Disposed Since 1976:	216 129 cubic metres

Comments

For timing restrictions on dredging, proponents should contact the DFO Habitat Management Unit in Nanaimo (South Coast Division).

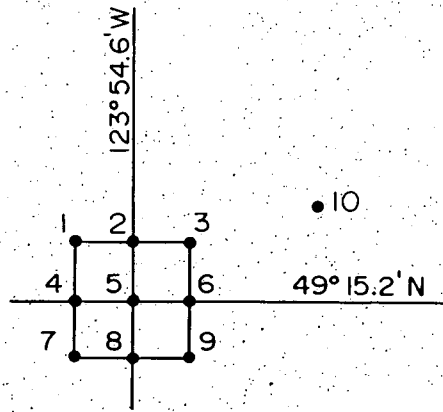
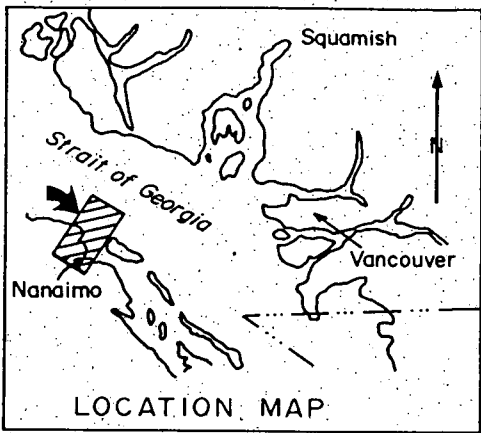
Loadsite Information

In 1998, 3 207 cubic metres of material resulting from forest related industry operations in Nanaimo and Ladysmith were sent to the Five Finger Island disposal site.

Monitoring Information

In April 1998, surface sediment samples were collected from the Five Finger Island disposal site and at five reference locations in the vicinity of the disposal site (stations 10-14).

Chemical and particle size data are presented in Table 5. There were no trace metal concentrations above the ICTG limits. Total PAH concentration at station 9 and reference station 13 marginally exceeded the ICTG limit.



STRAIT OF GEORGIA

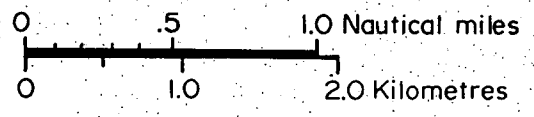
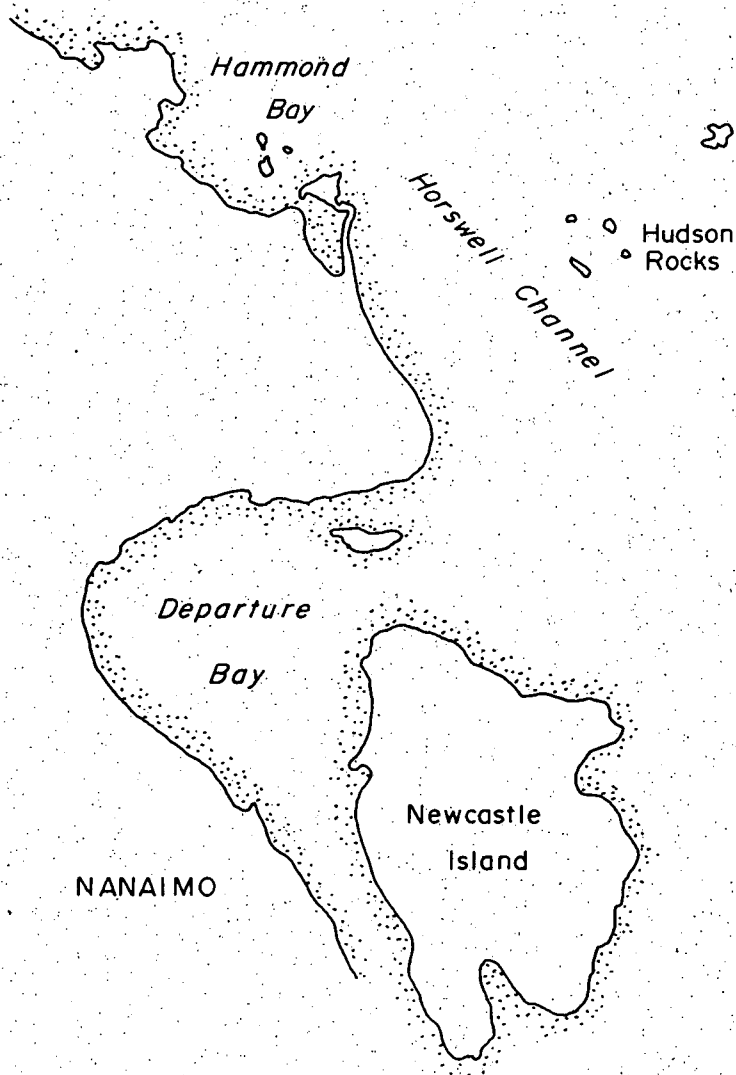


Figure 6. Five Finger Island disposal site sediment sampling stations.

Table 5. Five Finger Island sediment chemistry and particle size data - April 1998 survey.

Station	Sediment Chemistry ¹							% Particle Size			
	Cd µg/g	Hg µg/g	Cu µg/g	Pb µg/g	Zn µg/g	TPAH µg/g	TOC %	Gravel > 2.0 mm	Sand 2 - 0.063 mm	Silt 0.063 - 0.004 mm	Clay < 0.004 mm
1	0.45	0.13	58.1	40.0	131.0	1.35	2.26	0.00	6.48	74.74	18.76
2	0.48	0.13	58.3	35.0	131.0	1.20	3.36	0.00	2.12	77.38	20.49
3	0.20	0.07	55.0	-8.0	130.0	0.65	1.49	0.00	24.24	59.23	16.55
4	0.30	0.10	43.9	25.0	106.0			0.00	8.55	74.56	16.90
5	0.50	0.12	58.9	38.0	128.0	1.51	3.99	0.00	9.48	75.15	15.35
6	0.53	0.13	57.1	31.0	124.0	1.62	2.91	0.00	6.66	73.79	19.58
7	0.27	0.13	54.2	32.0	129.0			0.00	7.80	74.71	17.48
8	0.54	0.13	59.0	35.0	130.0	1.81	2.59	0.00	16.32	69.02	14.64
9	0.53	0.13	49.2	21.0	101.0	* 3.74	5.47	0.00	16.69	68.62	14.68
10	0.23	0.13	56.4	38.0	126.0	1.33	1.79	0.00	4.09	75.73	20.19
11	0.32	0.14	62.7	42.0	145.0	0.98	1.52	0.00	2.13	72.80	25.09
12	0.36	0.13	59.4	32.0	132.0	1.37	1.78	0.00	3.68	78.83	17.48
13	0.25	0.13	47.0	27.0	89.1	* 2.97	3.45	0.00	18.70	68.34	12.98
14	0.09	0.08	59.0	-8.0	100.0	1.28	1.60	0.00	26.19	58.70	15.09

¹ Trace metals results are expressed in dry weight.

* Indicates sample exceeded ICTG limit.

5.5 COMOX (CAPE LAZO)

Disposal Site:	Comox (Cape Lazo)
Number:	48
Co-ordinates:	49°41.70'N; 124°44.50'W
Depth:	190 metres
Total Quantity Disposed Since 1976:	31 917 cubic metres

Comments

For specific timing restrictions on dredging, contact the DFO Habitat Management Unit in Nanaimo (South Coast Division).

Loadsite Information

In 1998, 11 800 cubic metres of material were disposed of at the Comox disposal site. This material originated from maintenance dredge activities in the Courtenay River and the Baynes Sound area.

5.6 MALASPINA STRAIT

Disposal Site:	Malaspina Strait
Number:	49
Co-ordinates:	49°45.00'N; 124°27.00'W
Depth:	320 metres
Total Quantity Disposed Since 1976:	550 475 cubic metres + 6 000 tonnes

Comments

For timing restrictions on dredging, contact the DFO Habitat Management Unit in Nanaimo (South Coast Division).

Loadsite Information

In 1998, 13 500 cubic metres of material resulting from maintenance dredging activities outside the Stillwater Bay Dry Land Sort and at the MacMillan Bloedel (Pacifica Papers) mill in Powell River were sent to the Malaspina Strait disposal site. In addition, 13 007 cubic metres of excavated native till from Jervis Inlet were disposed at Malaspina Strait disposal site.

5.7 THORNBROUGH CHANNEL

Disposal Site:	Thornbrough Channel
Number:	64
Co-ordinates:	49°31.00'N; 123°28.30'W
Depth:	220 metres
Total Quantity Disposed Since 1976:	73 861 cubic metres

Comments

For complete timing restrictions on dredging, contact the DFO Habitat Management Unit in New Westminster.

Loadsite Information

In 1998, maintenance dredging at forest industry operations in Howe Sound resulted in 3 000 cubic metres of material sent to the Thornbrough Channel disposal site.

5.8 QUATSINO

Disposal site:	Quatsino
Number:	78
Co-ordinates:	50°28.50'N; 127°50.00'W
Depth:	99 metres
Total Quantity Disposed Since 1976:	382 cubic metres

Comments

For complete timing restrictions on dredging, contact DFO Habitat Management Unit in Nanaimo (South Coast Division).

Loadsite Information

The Quatsino disposal site was last used in 1977.

Monitoring Information

In November 1998, surface sediment samples were collected from the Quatsino disposal site and one reference station (station 10) in the vicinity of the disposal site. A single core sample from the centre of the disposal site (station 5) was also taken.

Results of chemical (sediment metals, PAH, TOC) and particle size analyses are presented in Table 6. Cadmium concentrations at the composited reference location and at all depths in the station 5 core sample marginally exceeded the ICTG limit of 0.6 µg/g.

Composite samples from the disposal site sampling grid and the reference site were submitted for additional chemical (sediment sulphide, ammonia, AVS and SEM) analyses and subjected to biological testing using the amphipod acute lethality test using marine and estuarine amphipods *Eohaustarius washingtonianus* and *E. estuarius*; and the Microtox[®] solid phase test using the bioluminescent bacterium *Vibrio fischeri*. Test results are presented in Table 7 and 8, respectively. Survival in test sediments with *E. washingtonianus* was very poor although the series with *E. estuarius* exhibited no toxic response. Toxic responses were also obtained in the solid phase Microtox[®] test for three of the composite samples.

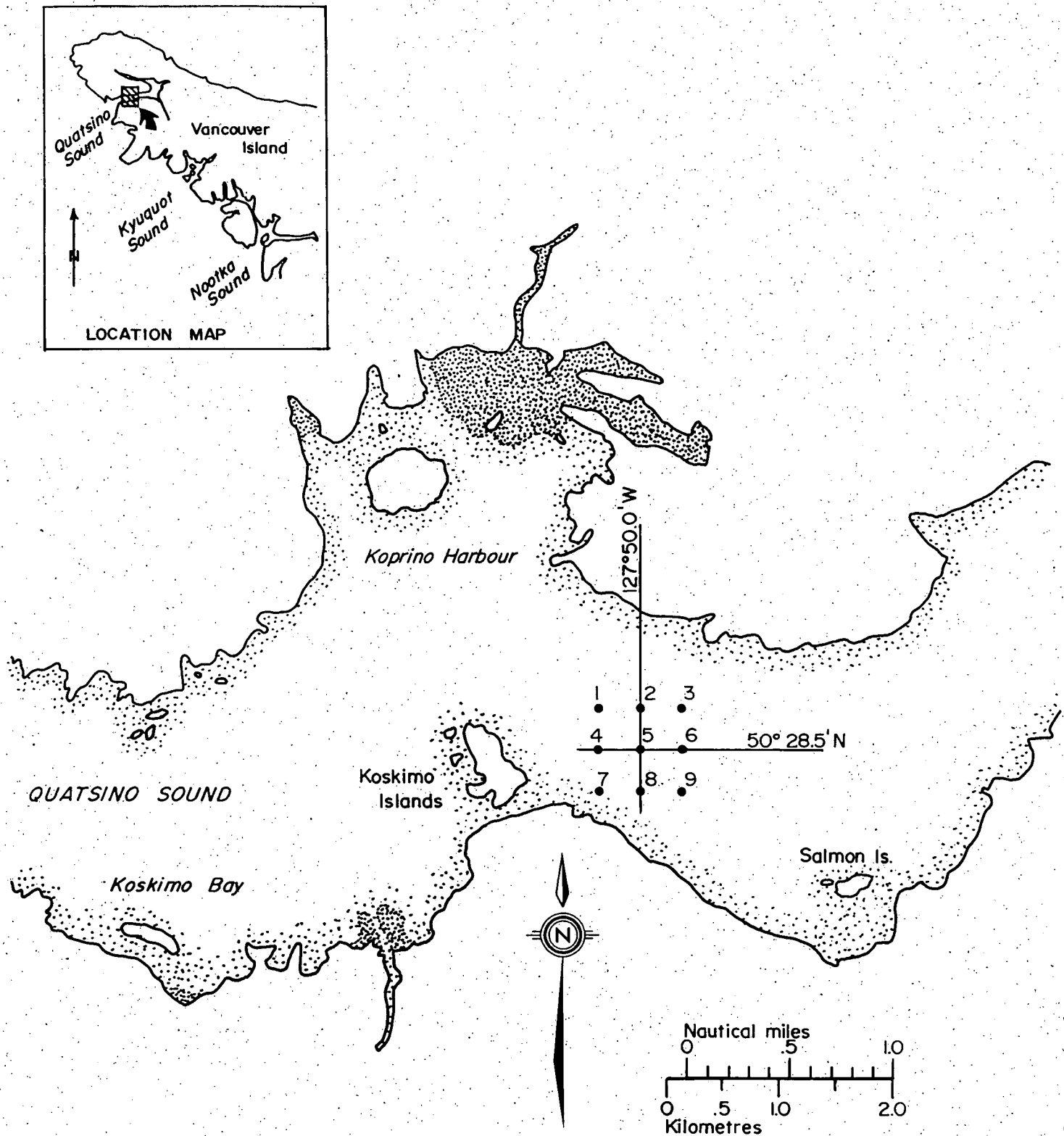


Figure 7. Quatsino disposal site sediment sampling stations.

Table 6. Quatsino sediment chemistry and particle size data - November 1998.

Station	Sediment Chemistry ¹							% Particle Size			
	Cd µg/g	Hg µg/g	Cu µg/g	Pb µg/g	Zn µg/g	TPAH µg/g	TOC %	Gravel > 2.0 mm	Sand 2 - 0.063 mm	Silt 0.063 - 0.004 mm	Clay < 0.004 mm
1	0.43	0.07	43.3	6.1	69.5	0.20	0.90	0.23	66.60	13.81	19.59
2	0.35	0.11	78.5	11.0	87.7	0.46	2.43	0.15	8.07	36.27	55.66
3	0.31	0.09	79.6	11.0	87.7	0.38	2.13	0.00	8.03	37.41	54.57
4	0.49	0.11	69.3	9.8	77.9	0.37	3.35	0.87	20.10	33.52	46.38
5	0.43	0.09	74.0	10.0	83.7	0.43	2.86	0.11	18.01	35.45	46.54
Station 5 core											
0-5 cm	* 1.00	0.06	38.0	3.4	67.4			0.45	20.39	35.10	44.50
10-20 cm	* 1.10	0.07	34.0	3.6	66.8			0.26	14.55	36.32	49.12
30-40 cm	* 1.10	0.06	34.2	3.5	63.3			0.66	25.35	36.27	38.38
60-70 cm	* 1.20	0.06	38.0	3.7	69.8			0.75	16.67	36.18	47.15
90-100 cm	* 1.10	0.07	39.6	4.0	69.6			0.24	19.03	34.90	46.07
6	0.47	0.08	71.3	10.0	83.8	0.47	2.81	0.84	13.05	36.99	49.95
8	0.31	0.08	68.4	9.7	80.3	0.41	2.60	3.40	25.38	30.92	43.70
9	0.33	0.10	80.1	11.0	84.6	0.47	2.93	0.00	6.64	62.80	30.56
10	0.30	0.09	98.7	12.0	86.8	0.47	3.01	0.00	2.44	40.84	56.72
Composite (1,2,3)	0.43	0.08	66.5	8.8	77.7	0.36	2.27	1.35	33.49	27.96	38.55
Composite (4,5,6)	0.55	0.08	70.8	9.8	81.1	0.43	2.68	0.60	16.86	34.93	48.21
Composite (8,9)	0.42	0.09	72.6	10.0	81.3	0.47	2.80	0.78	16.30	33.85	49.85
Reference	* 1.00	0.06	38.0	3.4	67.4	0.48	2.87	0.14	3.75	37.80	58.45

¹ Total metals results are expressed in dry weight

* Indicates sample exceeded ICTG limit.

Table 7. Quatsino additional sediment chemistry data - November 1998.

Station	Sulphide µg/g	Ammonia µg/g	AVS µmol/g	SEM µmol/g	Ratio AVS/SEM
Composite (1,2,3)	<0.1	2.92	1.3	0.54	* 2.4
Composite (4,5,6)	<0.1	3.72	0.3	0.84	0.36
Composite (8,9)	0.1	7.18	0.5	0.58	0.86
Reference (10)	<0.1	4.46	2.8	0.86	* 3.25

"<" values indicate concentrations below the method detection limit.

* AVS/SEM > 1 indicates SEM metals may be bioavailable

Table 8. Quatsino Toxicity Test Results - November 1998

Station	Amphipod <i>E. washingtonianus</i> % survival	Amphipod <i>E. estuarius</i> % survival	Microtox® ⁺ solid phase IC50 % effect (corrected)
Control	88.0 ± 2.7	100.0 ± 0	
Composite (1,2,3)	*31.0 ± 13.0	89.0 ± 7.0	* 0.055
Composite (4,5,6)	*25.0 ± 11.0	89.0 ± 11.0	* 0.076
Composite (8,9)	*16.0 ± 8.0	100.0 ± 0.0	0.10
Reference (10)	*20.0 ± 6.0	97.0 ± 3.0	* 0.038

* Toxic response

+ Microtox® results have been moisture corrected.

5.9 CAPE MUDGE

Disposal Site:	Cape Mudge
Number:	116
Co-ordinates:	49°57.70'N; 125°05.00'W
Depth:	200 metres
Total Quantity Disposed Since 1976:	153 853 cubic metres

Comments

DFO generally prohibits dredging/loading activities during December 1 to March 15 in the Campbell River area to protect salmon stocks and to minimize disruption of the local sport fishery.

For specific dredging and disposal timing restrictions, contact the DFO Habitat Management Unit in Nanaimo.

Loadsite Information

In 1998, 8000 cubic metres of dredged material was disposed of at the Cape Mudge disposal site. This material originated from MacMillan Bloedel operations in Campbell River, Menzies Bay, and Gowland Harbour.

5.10 JOHNSTONE STRAIT - HICKEY POINT

Disposal Site:	Johnstone Strait - Hickey Point
Number:	119
Co-ordinates:	50°27.80'N; 126°04.80'W
Depth:	270 metres
Total Quantity Disposed Since 1976:	160 187 cubic metres + 40 tonnes

Comments

For specific timing restrictions on dredging, contact the DFO Habitat Management Unit in Nanaimo (South Coast Division).

Loadsite Information

This disposal site was last used in 1997.

Monitoring Information

Surface sediment samples were collected from the Johnston Strait - Hickey Point disposal site and one reference site (station 10) in November 1998. Chemical and particle size data are presented in Table 9. All trace metal concentrations in surface sediment were within ICTG limits.

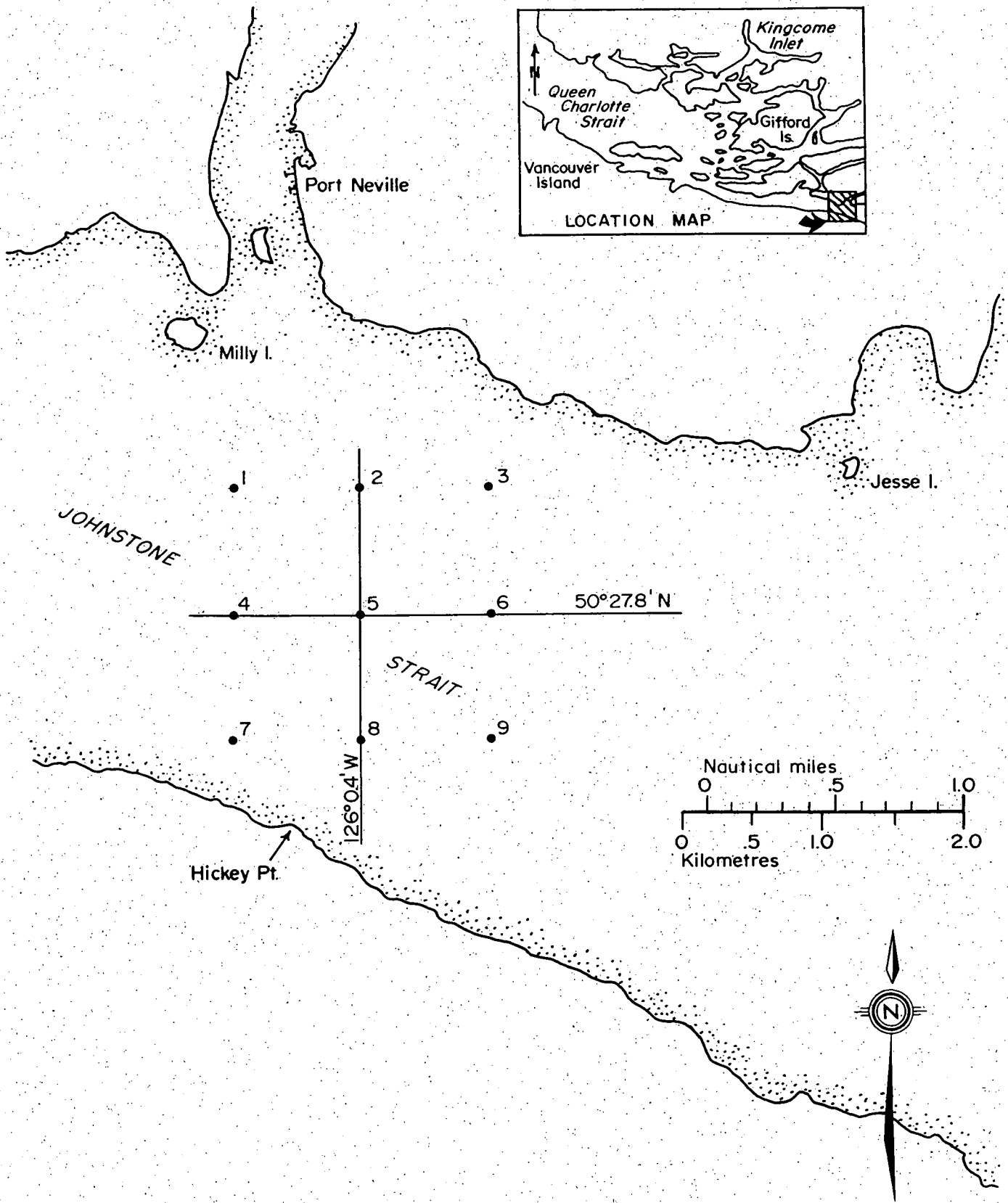


Figure 8. Johnson Strait - Hickey Point disposal site sediment sampling stations.

Table 9. Johnson Strait - Hickey Point sediment chemistry and particle size data - November 1998.

Station	Sediment Chemistry ¹						% Particle Size				
	Cd µg/g	Hg µg/g	Cu µg/g	Pb µg/g	Zn µg/g	TPAH µg/g	TOC %	Gravel > 2.0 mm	Sand 2 - 0.063 mm	Silt 0.063 - 0.004 mm	Clay < 0.004 mm
1	0.10	0.03	50.5	4.2	52.1	0.10	0.50	19.39	47.24	16.09	17.28
2	0.20	0.02	37.4	3.5	39.3	0.04	0.58	14.43	76.84	4.13	4.61
3	0.10	0.02	47.9	3.1	39.9	0.07	0.62	26.99	64.16	3.87	4.98
4	0.10	0.02	37.9	3.7	37.6	0.04	0.45	49.62	42.73	3.73	3.93
5	0.19	0.03	34.3	4.5	41.2	0.06	0.40	19.40	65.75	6.20	8.65
6	0.09	0.02	40.5	3.9	44.1	0.06	0.50	24.43	64.59	4.47	6.51
7	0.10	0.03	44.9	4.6	44.7	0.08	0.78	68.77	24.75	2.80	3.68
8	0.09	0.02	38.7	4.0	39.5	0.05	0.44	21.80	62.81	6.16	9.23
9	0.07	0.02	45.9	3.6	43.8	0.03	0.34	17.01	76.80	2.57	3.61
10	0.04	<0.01	38.1	2.2	37.5	0.01	0.14	0.04	96.47	1.73	1.75

¹ Total metals results are presented in dry weight
 “<” values indicate concentrations below the method detection limit

5.11 JOHNSTONE STRAIT - HANSON ISLAND

Disposal site:	Johnstone Strait - Hanson Island
Number:	120
Co-ordinates:	50°33.50'N; 126°48.00'W
Depth:	350 metres
Total Quantity Disposed Since 1976:	196 156 cubic metres

Comments

For specific timing restrictions on dredging, contact the DFO Habitat Management Unit in Nanaimo (South Coast Division).

Loadsite Information

In 1998, 4 000 cubic metres of dredged material was disposed at the Hanson Island disposal site. This material originated from forest industry operations in Kelsey Bay.

Monitoring Information

Surface sediment samples were collected from a reference station at the Johnston Strait - Hanson Island disposal site. Attempts to sample on the disposal site were made but adequate grab samples from the disposal site could not be collected for testing purposes due to the composition of the sediments. Sediments on the disposal site consisted predominately of rocks, gravel and coarse sand. The results of chemical and particle size analyses for the reference station are presented in Table 10. No chemical concentrations exceeded the ICTG limits at the reference site.

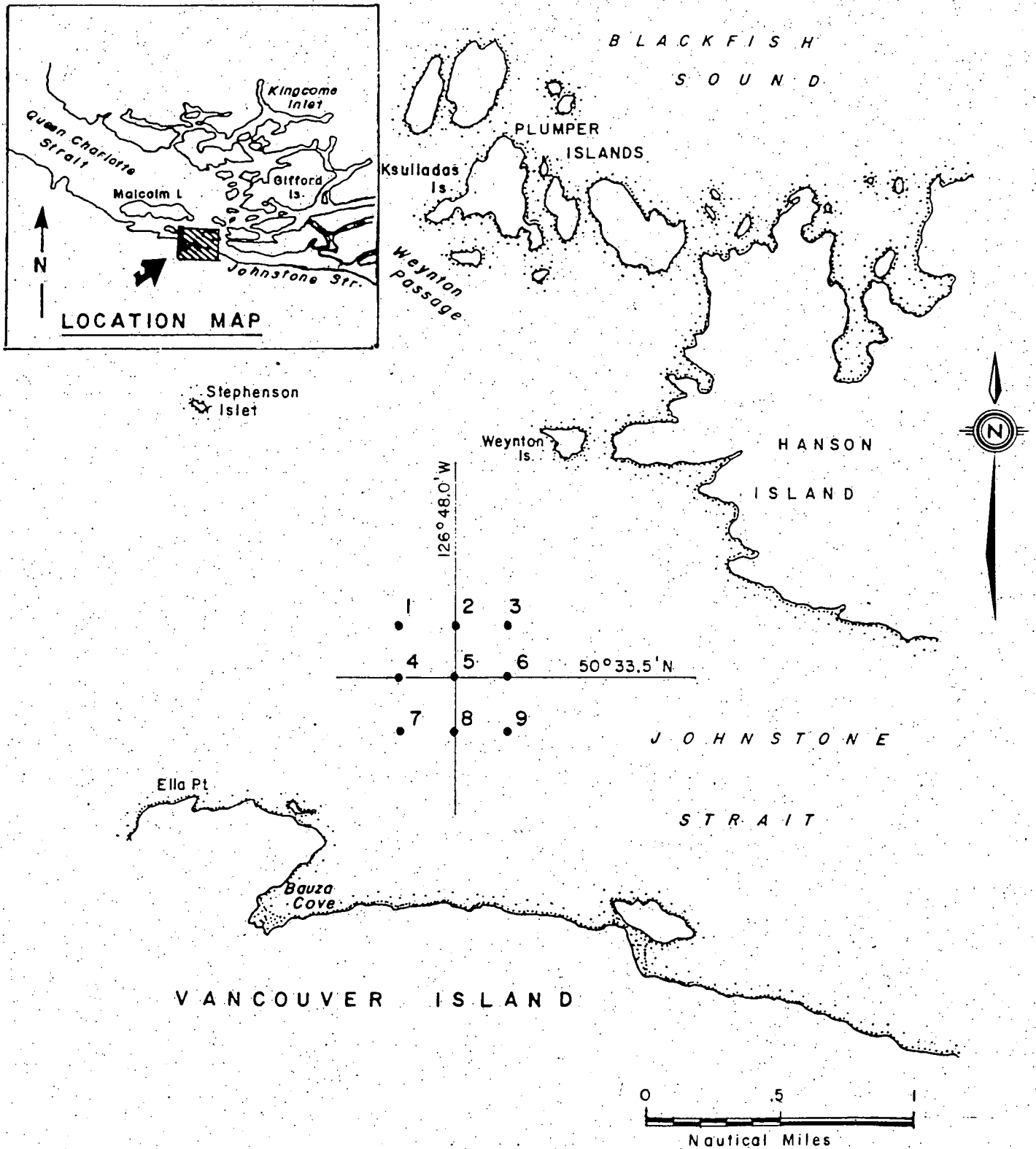


Figure 9. Johnstone Strait - Hanson Island disposal site sediment sampling stations.

Table 10. Johnstone Strait - Hanson Island sediment chemistry and particle size data - November 1998 survey.

Station	Sediment Chemistry ¹					% Particle Size			
	Cd μg/g	Hg μg/g	Cu μg/g	Pb μg/g	Zn μg/g	Gravel > 2.0 mm	Sand 2 - 0.063 mm	Silt 0.063 - 0.004 mm	Clay < 0.004 mm
Reference (10)	0.04	-0.01	31.2	1.7	26.4	16.46	80.37	1.24	1.93

¹Trace metals results are expressed in dry weight

5.12 MALCOLM ISLAND

Disposal site:	Malcolm Island
Number:	121
Co-ordinates:	50°42.00'N; 127°06.00'W
Depth:	180 metres
Total Quantity Disposed Since 1976:	102 960 cubic metres

Comments

For timing restrictions on dredging, contact DFO Habitat Management Unit in Nanaimo (South Coast Division).

Loadsite Information

The Malcolm Island disposal site was last used in 1992.

Monitoring Information

Surface sediment samples were collected from stations 1-9 at the Malcolm Island disposal site and from a reference location (station 10) in the vicinity of the site. A single core sample was taken in the centre of the disposal site (station 5). Chemical and particle size analyses are presented in Table 11. Total cadmium concentration at station 9 exceeded the ICTG limit.

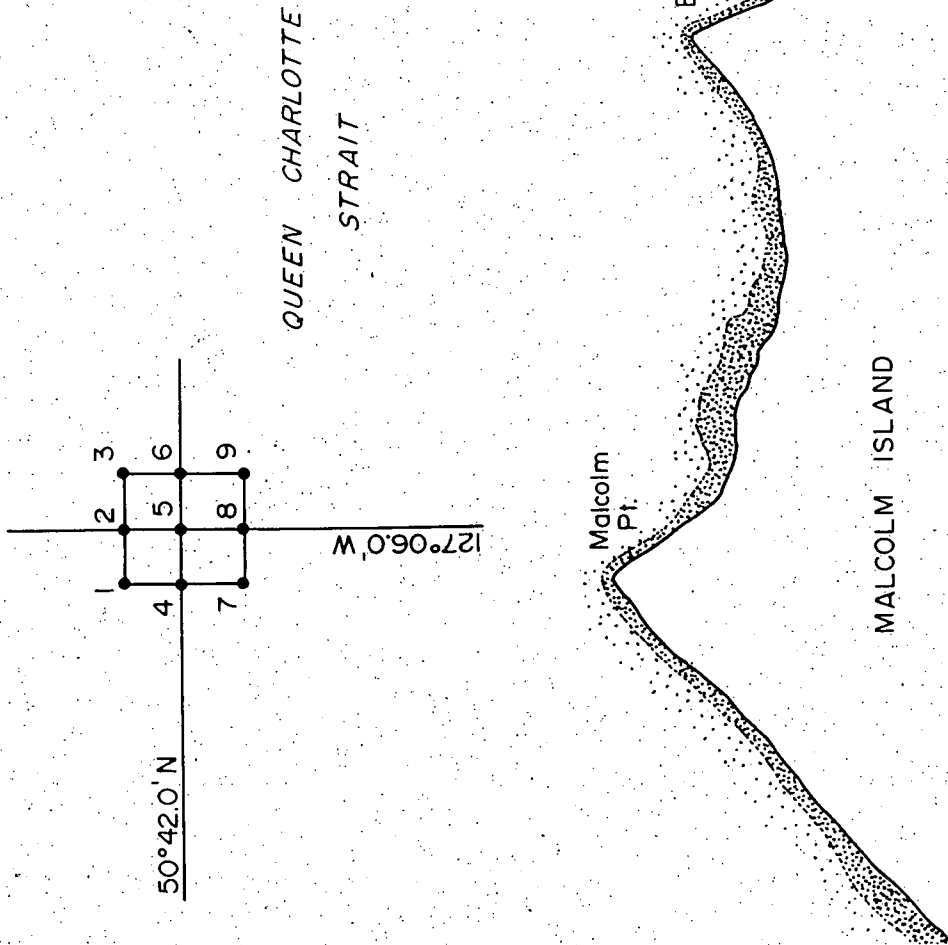
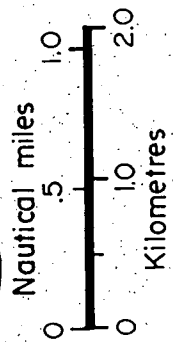
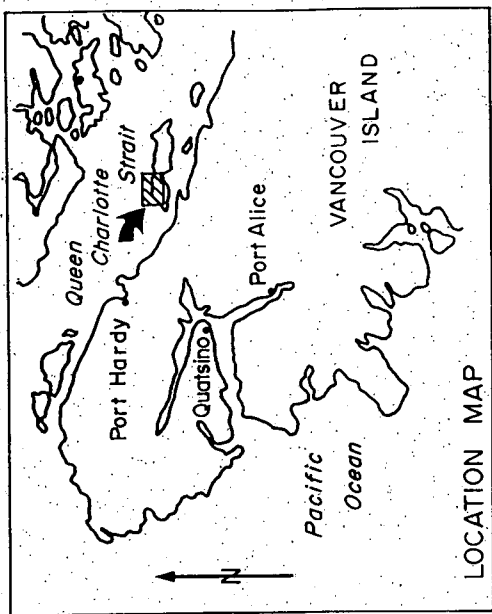


Figure 10. Malcolms Island disposal site sediment sampling stations.

Table 11. Malcolm Island sediment chemistry and particle size data - November 1998 survey.

Station	Sediment Chemistry ¹							% Particle Size			
	Cd μg/g	Hg μg/g	Cu μg/g	Pb μg/g	Zn μg/g	TPAH μg/g	TOC %	Gravel >2.0 mm	Sand 2 - 0.063 mm	Silt 0.063 - 0.004 mm	Clay < 0.004 mm
1	0.40	0.07	29.3	7.9	59.7	0.22	1.39	0.26	35.92	28.36	35.47
2	0.42	0.06	29.6	7.9	54.2	0.23	1.50	5.14	44.46	23.40	27.00
3	0.28	0.06	33.3	8.8	63.3	0.38	1.87	0.25	25.37	27.94	46.44
4	0.45	0.05	26.4	5.8	48.0	0.15	1.24	0.51	59.44	17.08	22.97
5	0.29	0.05	25.4	5.3	49.0	0.17	1.03	0.41	47.53	24.42	27.63
0-5 cm	0.44	0.04	25.1	3.8	46.2			0.43	54.05	21.33	24.19
10-20 cm	0.58	0.03	30.4	2.2	51.9			0.00	13.42	46.32	40.26
30-40 cm	0.25	0.03	31.4	2.1	47.8			0.93	19.01	40.45	39.61
60-70 cm	0.23	0.03	29.4	2.1	48.5			0.00	13.28	50.72	36.00
90-100 cm	0.28	0.03	31.6	2.2	49.2			0.11	9.32	53.90	36.67
6	0.27	0.06	35.0	7.6	70.3	0.36	1.37	0.40	24.51	26.45	48.63
7	0.44	0.06	29.4	7.8	55.3	0.20	1.36	0.20	44.32	26.21	29.27
8	0.46	0.04	21.4	4.7	43.6	0.11	0.91	0.13	74.37	11.08	14.41
9	* 1.10	0.05	34.6	7.6	64.4	0.17	1.42	0.66	19.77	26.52	53.05
10	0.43	0.07	33.2	7.8	65.2	0.32	1.84	0.76	18.82	33.83	46.59

¹ Trace metals are expressed in dry weight.

* Indicates sample exceeded ICTG limit.

5.13 QUEEN CHARLOTTE STRAIT

Disposal site:	Queen Charlotte Strait
Number:	140
Co-ordinates:	50°46.40'N; 127°22.60'W
Depth:	390 metres
Total Quantity Disposed Since 1976:	20 613 cubic metres

Comments

For specific timing restrictions on dredging, contact the DFO Habitat Management Unit in Nanaimo (South Coast Division).

Loadsite Information

The Queen Charlotte Strait disposal site was last used in 1993.

Monitoring Information

Surface sediment samples were collected from stations 1-9 and a reference station (station 10) at the Queen Charlotte Strait disposal site. In addition, a single core sample was taken at the centre of the disposal site (station 5).

Chemical and particle size data are presented in Table 12. Trace metal concentrations in sediment were within ICTG limits, with the exception of marginally elevated cadmium concentrations at reference station 10 and the station 5 core sample at depths of 10-20cm, 60-70cm, and 90-100cm.

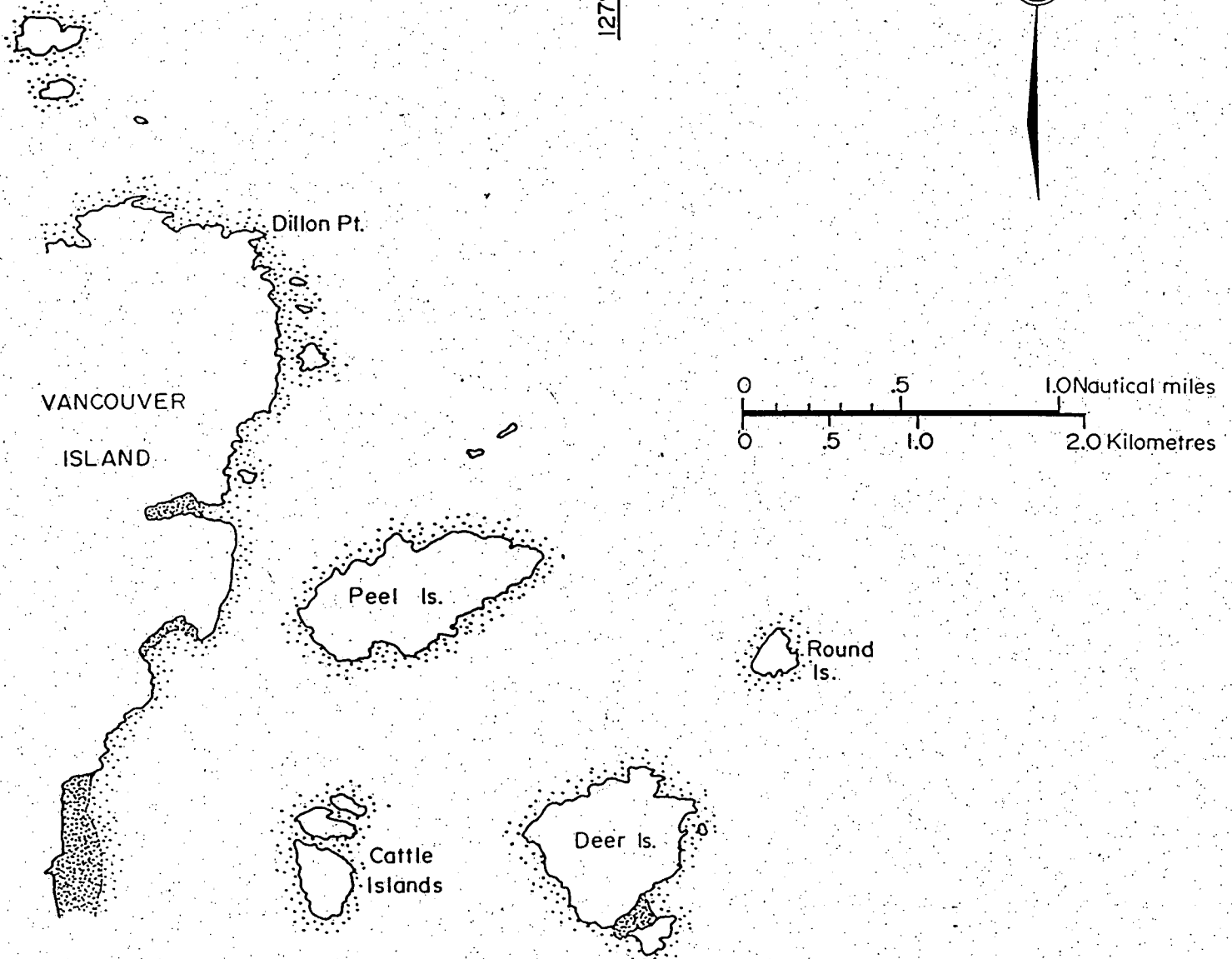
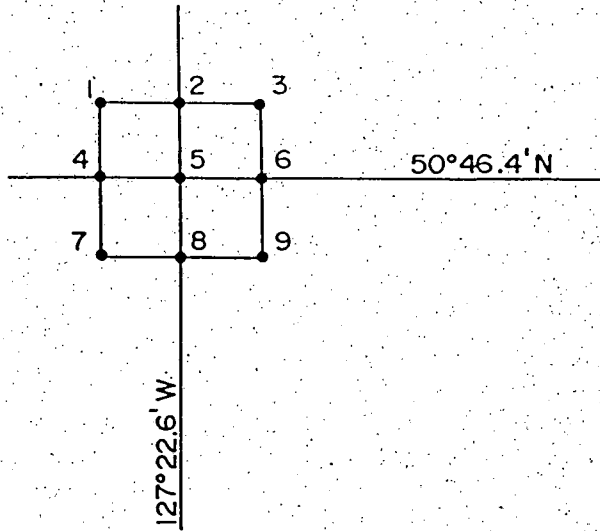
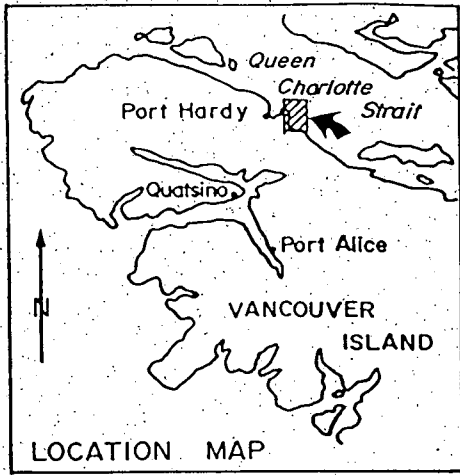


Figure 11. Queen Charlotte Island disposal site sediment sampling stations.

Table 12. Queen Charlotte Strait sediment chemistry and particle size data - November 1998.

Station	Sediment Chemistry ¹						% Particle Size				
	Cd µg/g	Hg µg/g	Cu µg/g	Pb µg/g	Zn µg/g	TPAH µg/g	TOC %	Gravel > 2.0 mm	Sand 2 - 0.063 mm	Silt 0.063 - 0.004 mm	Clay < 0.004 mm
2	0.44	0.07	34.5	6.3	51.2	0.21	1.51	1.12	44.51	19.28	35.09
3	0.43	0.04	35.5	4.5	40.3	0.13	0.81	5.43	64.64	11.06	18.87
4	0.50	0.06	37.7	7.0	56.8	0.20	1.63	1.36	40.39	21.95	37.67
5	0.49	0.06	30.9	7.5	55.9	0.26	1.50	2.07	39.89	22.23	37.88
0-5 cm	0.54	0.07	32.5	8.1	58.9			2.90	37.02	21.01	39.06
10-20 cm	* 0.68	0.07	29.9	7.0	58.5			0.00	37.38	22.65	39.97
30-40 cm	0.58	0.06	29.1	5.6	53.0			0.00	42.13	21.49	36.38
60-70 cm	* 0.66	0.05	35.5	4.0	47.4			0.25	33.81	24.07	41.87
90-100 cm	* 1.10	0.04	26.7	2.4	48.2			1.98	49.25	17.79	30.97
6	0.47	0.15	29.9	7.1	54.6	0.20	1.41	0.10	50.85	18.14	31.01
7	0.50	0.07	37.5	8.1	66.6	0.29	1.98	0.83	15.45	29.43	55.12
8	0.51	0.06	34.8	7.6	61.8	0.35	1.76	3.01	28.68	25.43	45.89
9	0.48	0.06	37.5	6.6	55.7	0.25	1.40	2.81	47.25	19.90	32.85
10	* 0.76	0.07	28.0	6.5	55.3	0.16	1.28	0.47	53.53	17.56	28.91

¹ Trace metals are expressed in dry weight.

* Indicates sample exceeded ICTG limit.

5.14 ZEBALLOS

Disposal site:	Zeballos
Number:	185
Co-ordinates:	49°56.06'N; 126°48.04'W
Depth:	200 metres
Total Quantity Disposed Since 1976:	40 tonnes

Comments

This disposal site was designated in 1998 for the disposal of a vessel. This disposal site is near the historic Zeballos Inlet disposal site (82). There have been no other disposal activities at this site.

Loadsite Information

A derelict barge was sunk near Zeballos in June 1998. All floatables, fuel, oil, hydraulic fluids, lubricants and other petroleum-based products were removed from the barge and the barge was inspected prior to sinking.

6.0 REFERENCES

Publications

- Environment Canada. 1993. Interim monitoring guidelines for ocean disposal. Environment Canada, Conservation and Protection.
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- Kim, K., C. Schnider and D.L. Sullivan. 1999. Ocean disposal activities summary 1997 Pacific and Yukon region. Environment Canada, Environmental Protection Branch, Pacific and Yukon Region. Regional Program Report: 99-02.
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- Kim, K., D.L. Sullivan, D.E. Brothers and C. Schnider. 1997. Ocean disposal activities summary for Pacific and Yukon Region 1993. Environment Canada, Conservation and Protection, Pacific and Yukon Region. Regional Program Report: 97-01.
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Ward, A.B. and D.L. Sullivan. 1980. A review of existing and historical ocean dumpsites in the Pacific Region. Environment Canada, Environmental Protection Service, Pacific Region. Regional Program Report: 80-5.

Websites

<http://www.pgc.nrcan.gc.ca/marine/georgia2.htm>

<http://www.pyr.ec.gc.ca/ep/ocean-disposal/index.htm>

<http://ea-ee.ncr.ec.gc.ca/glea/index.asp>

APPENDICES

APPENDIX I

Interim Contaminant Testing Guidelines for Ocean Disposal Pacific and Yukon Region (1997 March)

INTERIM CONTAMINANT TESTING GUIDELINES FOR OCEAN DISPOSAL Pacific and Yukon Region (1997 March)

In response to growing concern over the biological implications of contaminants in marine sediments along the Canadian coastline, Environment Canada (EC), Pacific and Yukon Region, in consultation with the Regional Ocean Disposal Advisory Committee (RODAC), has developed the following guidelines for sampling, analysis and reporting associated with proposed ocean disposal activities.

Under Schedule III, Part III of the *Canadian Environmental Protection Act* (CEPA), EC must consider the availability of practical alternative disposal options. To satisfy this requirement the applicant must provide a written record of the decision making process used in selecting ocean disposal as the alternative of choice for disposal of materials. Disposal at sea is only permitted for materials where it is the environmentally preferable and practical alternative.

To assess the potential for environmental impacts of ocean disposal, EC will require chemical analyses to be performed on any material where there is a lack of chemical data, or a reason to believe that contaminants such as selected trace metals or organics are present. The minimum number of samples and the analyses required is specified in the following tables; the number of samples and the analyses required may be increased by EC in some instances. A proposed sampling program should be developed by the applicant, based on information provided in the following tables, and submitted to EC for approval prior to commencement of loading/ocean disposal activities.

Materials found to contain substances of concern at or higher than the regulated or guideline concentrations identified in the following tables may be considered for ocean disposal under section 71(3) of CEPA if they pass a series of biological tests. A tiered assessment approach using biological testing is used for this determination. The procedures for these tests are described in the document entitled "Interim Guidance for Application of Rapidly Rendered Harmless (RRH) and Trace Contaminants", which is available upon request from EC. Ocean disposal options such as capping, containment, and side-casting, suggested by an applicant, will be considered by EC, but their acceptance will be conditional on compliance with RRH protocols.

SAMPLING AND ANALYSIS REQUIREMENTS

The following pages identify the minimum sampling and analytical requirements for dredged and excavated materials based on the size of the project, as well as rejection/screening limits currently used by EC. Sampling requirements will be tailored on a site specific basis at the discretion of EC and analysis of other parameters may be requested when there is reason to believe that other contaminants are present.

MINIMUM REQUIREMENTS FOR DREDGED MATERIALS

SAMPLING REQUIREMENTS

All samples are analysed for minimum requirements.

Project Quantity (m ³)	Permit Type	Minimum # of Samples	Type of Sampling
0 - 4,000	General *	3 (1) **	<ul style="list-style-type: none"> • surface sampling prior to loading
0 - 10,000	Site-Specific	3 (1)	<ul style="list-style-type: none"> • surface sampling prior to loading
10,000 - 30,000	Site-Specific	3 (1) 3 (1) or 6 (2)	<ul style="list-style-type: none"> • surface sampling prior to loading • sampling to depth prior to loading • surface sampling prior to loading • may require additional sampling during dredging
30,000 - 60,000	Site-Specific	4 (2) 4 (2)	<ul style="list-style-type: none"> • surface sampling prior to loading • sampling to depth prior to loading
>60,000	Site-Specific	<ul style="list-style-type: none"> • sampling requirements to be determined on a project specific basis 	

* General Permits are multi-loadsite permits issued to applicants, and are specific to disposal from maintenance dredging projects of less than 4 000 cubic metres.

** The brackets indicate the number of *composite* samples to be analysed initially for dioxins/furans, if requested by EC.

MINIMUM ANALYSIS REQUIREMENTS

	Parameter	Limit of Detection
Trace Metals	Mercury (Hg)	0.2 µg/g
	Cadmium (Cd)	0.2 µg/g
Organics	TPAH	0.1 µg/g
Other	TOC	
	Particle Size	

For PAH, the analytical methodology and quality assurance protocol must conform to that outlined in the 'Interim Quality Assurance Guidelines for Determination of Polynuclear Aromatic Hydrocarbons in Marine Sediments for Ocean Disposal', a copy of which is available from EC.

Should the site history reveal cause for environmental concern, an increased number of samples and/or analysis of other metals and/or organics may be requested. Additional parameters may include the following:

	Parameter	Limit of Detection
Trace Metals	Copper (Cu)	10 µg/g
	Zinc (Zn)	10 µg/g
	Arsenic (As)	10 µg/g
	Chromium (Cr)	10 µg/g
	Nickel (Ni)	10 µg/g
	Lead (Pb)	10 µg/g
Organics	PCB	0.05 µg/g
	PCP	0.05 µg/g
	Dioxins/furans	10 pg/g for T ₄ CDD

The analysis results are to be reported on a dry weight basis with detection limits less than or equal to those stated above. The precision of the test method should be indicated by reporting analyses on five replicate sub-samples on 10% of the trace metal samples, and two replicate sub-samples on 20% of the organics samples, with a minimum of one replicated sample. Sub-sampling should be done following homogenizing but prior to digestion of the sample and the replicates should not be run consecutively. The accuracy of the test method should be indicated by reporting the results of certified reference materials analysed at the same time as the test samples.

For dioxin/furan, the analytical methodology and quality assurance protocol must conform to that outlined in the 'Internal Quality Assurance Requirements for Analysis of Dioxins in Environmental Samples', a copy of which is available from EC.

MINIMUM REQUIREMENTS FOR EXCAVATION MATERIALS*

* "General" Permits for excavation spoils are restricted to the loading and ocean disposal of *undisturbed, native material*. For other excavated materials, a site specific permit will be required.

SAMPLING REQUIREMENTS

Project Quantity (m ³)	Minimum Number of Samples	Type of Sampling
0 - 10,000	3	• composite of surface native material to one metre depth
10,000 - 30,000	6	• composite of surface native material to one metre depth
30,000 - 60,000	8	• composite of surface native material to one metre depth
> 60,000	sampling requirements to be determined on a project specific basis	

MINIMUM ANALYSIS REQUIREMENTS

	Parameter	Limit of Detection
Trace Metals	Mercury (Hg)	0.2 µg/g
	Cadmium (Cd)	0.2 µg/g
	Lead (Pb)	10 µg/g
	Copper (Cu)	10 µg/g
	Zinc (Zn)	10 µg/g
	Arsenic (As)	10 µg/g
	Chromium (Cr)	10 µg/g
	Nickel (Ni)	10 µg/g
Organics	TPAH	0.1 µg/g
Other	TOC	
	Particle Size	

Should the site history reveal cause for environmental concern, an increased number of samples and/or analysis of other metals and/or organics may be requested.

The analysis results are to be reported as stipulated under "Minimum requirements for dredged materials".

REJECTION/SCREENING LIMITS

Parameter	Rejection/Screening Limit ($\mu\text{g/g}$ dry weight)
Cadmium	0.6 $\mu\text{g/g}$
Mercury	0.75 $\mu\text{g/g}$
Arsenic	* 0.1 % or more by weight or 1000 $\mu\text{g/g}$
Copper Zinc	
Beryllium	
Chromium	
Nickel	
Vanadium	
Lead	
Chlorophenols (PCP) (penta and tetra isomers)	1.0 $\mu\text{g/g}$
Polychlorinated biphenyls (PCB)	0.1 $\mu\text{g/g}$
PAH (total)	2.5 $\mu\text{g/g}$
Dioxin/Furan	"quantifiable" 2,3,7,8 TCDD

* These levels are defined as "significant amounts" as agreed to by Canada as a signatory to the London Convention (LC); if exceeded, special care measures are required for disposal. *EC considers these levels as general guidelines only and may impose more stringent limits.*

STEPS REQUIRED FOR COLLECTING SAMPLES AND SUBMITTING ANALYTICAL DATA

Prepare the following information:

- 1) a location map for the dredge/excavation site with the the street address of the proposed excavation or dredge site,
- 2) a site map showing the proposed excavation or dredge site relative to known landmarks and/or streets,
- 3) a list of any known possible contaminant input sources in the vicinity of the proposed works,
- 4) a written record of the decision making process used in selecting ocean disposal as the preferred materials disposal option, explaining why other disposal methods are not being used,
- 5) a site use history for the site from which the material destined for ocean disposal will originate, and
- 6) a proposed sampling plan of the site showing the proposed sampling locations, and a list of proposed analyses. The proposed sampling plan should be developed based on information presented in this document. Assistance in designing a sampling program can be provided by EC, Pacific and Yukon Region. *The sampling program must be approved prior to taking the samples.*

The information identified above should be sent to EC. If the project does not qualify for completion under the terms and conditions of a "General" permit, this information should be submitted with a completed ocean disposal application form. For information on how to apply, please contact EC.

If the project qualifies for completion under a "General" ocean disposal permit, this information must be submitted to EC with a covering letter describing the proposed activities in detail, and the proposed schedule for the work. Upon completion of the sampling and analyses program, the test data, together with all QA/QC data as identified in the foregoing information, must be sent to EC.

No work may proceed under a "General" permit until written approval for the specific site has been received from EC, and a copy of the approval letter is posted at the work site.

For further information on this document, or any other matter relating to ocean disposal, please contact the following:

Dixie Sullivan (604) 666-2730

GENERAL GUIDE TO SOIL AND SEDIMENT SAMPLE COLLECTION

Containers for the samples should be obtained from the laboratory contracted to conduct the required analyses. Avoid unnecessary contact with clean glassware and utensils. A clean stainless steel or teflon spoon or scoop is ideal for transferring samples. Handle containers by the outsides only. Do not touch the inside of the jar, or teflon (or foil) liners, and use spoons or scoops by the handles only. When removing a foil or teflon liner and lid from a jar, remove as one piece and put down on a piece of foil or other clean surface while filling the jar.

If using a grab sampler, remove the water from the surface of the grab, taking care not to disturb the contents if possible. Use the clean scoop to remove a portion of the sediment from the middle of the sampler down to the depth of the material caught in the grab. The material in the sample jar should be representative of the material to be loaded for ocean disposal.

Alternatively, the sample may be taken by removing the lid, holding the jar by the sides and scooping the sample from the sediment without the use of other utensils. The threads of the jar may then be wiped with a paper towel before replacing the lid. Do not fill the jar more than about 3/4 full, allowing plenty of room for mixing/stirring, and expansion during freezing.

When the sample is in the jar, replace the teflon/foil liner and lid, and label the jar with project identification, the sampling site number, and the date.

To clean the sampling spoon or grab in-between samples, wipe with a paper towel to remove any solids, then rinse with water. Clean the tray in this manner as required.

If three samples are required for analysis, three small jars of sediment should be taken for *each* sampling station, for a total of nine jars. The three jars per sample will be composited by the analytical lab by taking equal aliquots of sample from each jar for a single analysis of most parameters of concern. The samples may be further composited for other testing as required but would otherwise be maintained as discrete samples.

Keep the samples in a refrigerator or on ice for short term storage (1-2 days); freeze the sample as soon as possible or store over dry ice for long term storage. The laboratory responsible for the analyses should be asked to freeze the samples after removal of sufficient material to complete the required analyses. These samples should remain frozen until the permit, or approval under a general permit, has been issued by EC.

APPENDIX II
Ocean Disposal Site Summaries

Disposal Site History Report

For Disposal Activities Between 1998/01/01 and 1998/12/31

Disposal Site Point Grey
 Number 1
 Latitude 49°15.40'N
 Longitude 123°22.10'W
 Depth (m) 210

Permit Type	Permit	Loadsite	Dump Start Date	Quantity
Dredge	3114	FR-LULU IS-SOUTH DYKE ROAD	12-Mar-98	727 m3
	3171	FR-MAINTENANCE	18-Mar-98	50,000 m3
	3171	FRNA-COWARD'S COVE	07-Apr-98	16,000 m3
	3174	FR-ACORN-PRIMEX	24-Jan-98	2,000 m3
	3174	FRNA-WEST COAST CELLUFIBRE	23-Apr-98	2,000 m3
	3174	FR-NAMU FOREST PRODUCTS	30-Apr-98	2,000 m3
	3176	FR-ESTUARY	02-Feb-98	1,500 m3
	3176	FR-DELTA CEDAR	14-Feb-98	1,000 m3
	3176	FRNA-TREE ISLAND STEEL	15-Feb-98	1,400 m3
	3176	FRNA-TERMINAL SAWMILL	07-Mar-98	3,000 m3
	3176	FR-CIPA LUMBER	29-Mar-98	1,000 m3
	3176	FRNA-GOLDWOOD IND	08-Apr-98	1,500 m3
	3176	FRNA-MAINLAND SAWMILL	25-Apr-98	545 m3
	3176	FR-DELTA CEDAR	26-Apr-98	1,000 m3
	3176	FR-DOMANS-NW	22-May-98	4,000 m3
	3179	FRNA-MB-NW	11-May-98	5,400 m3
	3181	FR-LULU IS-SOUTH DYKE ROAD	17-Feb-98	3,316 m3
	3181	FR-COAST MOUNTAIN HARDWOODS	20-May-98	4,310 m3
	3187	FR-MILL & TIMBER	02-Jan-98	10,500 m3
	3188	FR-WESTVIEW DREDGING	05-Feb-98	1,500 m3
	3193	FRNA-WESTCOAST PLYWOOD	08-Jun-98	11,659 m3
	3195	FR-ACORN-PRIMEX	21-Jun-98	1,600 m3
	3195	FRNA-WEST COAST CELLUFIBRE - EAST	25-Aug-98	3,000 m3
	3195	FRNA-WEST COAST CELLUFIBRE - WEST	25-Aug-98	1,000 m3
	3195	FR-MACKENZIE MILLS	05-Sep-98	1,000 m3
	3195	FR-ACORN-PRIMEX	11-Oct-98	1,250 m3
	3195	FRNA-WEST COAST CELLUFIBRE - WEST	29-Nov-98	1,500 m3
	3195	FR-MACKENZIE MILLS	29-Nov-98	3,000 m3
	3195	FRNA-WEST COAST CELLUFIBRE - WEST	24-Dec-98	1,000 m3
	3198	FR-DELTA CEDAR	30-Jun-98	3,000 m3
	3198	FR-FRASER MILLS	11-Jul-98	3,000 m3
	3198	FR-BELL POLE	23-Jul-98	1,500 m3
	3198	FRNA-SILVERTREE SAWMILLS	17-Aug-98	4,000 m3
	3198	FRNA-RICHMOND PLYWOOD	12-Sep-98	2,500 m3
	3198	FR-DELTA CEDAR	13-Sep-98	750 m3

3198	FR-COLUMBIA BITULITHIC	16-Sep-98	1,500 m3
3198	VAN HBR-FLAVELLE CEDAR	19-Sep-98	750 m3
3198	FR-FRASER CEDAR	19-Sep-98	2,000 m3
3198	FR-MAPLE LEAF SHAKE & SHINGLE	20-Sep-98	1,000 m3
3198	FR-FRASER MILLS	26-Sep-98	1,500 m3
3198	FR-CIPA LUMBER	10-Oct-98	1,500 m3
3198	FRNA-WESTERN WHITEWOOD	15-Oct-98	1,500 m3
3198	FR-COLUMBIA BITULITHIC	16-Oct-98	700 m3
3198	FR-FRASER PULP CHIP	06-Nov-98	2,700 m3
3198	FR-DELTA CEDAR	21-Nov-98	700 m3
3198	FRNA-CONAG-DUCK ISLAND	14-Dec-98	1,800 m3
3198	FRNA-CONAG-MITCHELL ISLAND	15-Dec-98	1,700 m3
3200	FR-S&R SAWMILLS	08-Sep-98	47,000 m3
3201	FRNA-MB-NW	01-Jul-98	5,700 m3
3201	FRNA-CANADIAN WHITE PINE	01-Jul-98	7,750 m3
3206	FRNA-FLETCHER CHALLENGE	28-Sep-98	34,517 m3

Total Dredge Quantity: 264,774 m3

Excavation	3177	LOWER MAINLAND-BEL	01-Jan-98	9,230 m3
	3177	LOWER MAINLAND-BEL	01-Feb-98	7,586 m3
	3177	LOWER MAINLAND-BEL	01-Mar-98	8,736 m3
	3177	LOWER MAINLAND-BEL	01-Apr-98	6,454 m3
	3177	LOWER MAINLAND-BEL	01-May-98	23,302 m3
	3177	LOWER MAINLAND-BEL	01-Jun-98	33,047 m3
	3177	LOWER MAINLAND-BEL	01-Jul-98	2,249 m3
	3191	LOWER MAINLAND-CONAG-NORTH	01-Jan-98	4,500 m3
	3191	LOWER MAINLAND-CONAG-NORTH	01-Mar-98	7,500 m3
	3191	LOWER MAINLAND-CONAG-NORTH	01-May-98	10,700 m3
	3191	LOWER MAINLAND-CONAG-NORTH	01-Jun-98	8,568 m3
	3191	LOWER MAINLAND-CONAG-NORTH	01-Jul-98	7,441 m3
	3199	LOWER MAINLAND-BEL	03-Jul-98	27,053 m3
	3199	LOWER MAINLAND-BEL	01-Aug-98	46,604 m3
	3199	LOWER MAINLAND-BEL	01-Sep-98	16,814 m3
	3199	LOWER MAINLAND-BEL	01-Oct-98	5,139 m3
3199	LOWER MAINLAND-BEL	01-Nov-98	7,454 m3	
3199	LOWER MAINLAND-BEL	01-Dec-98	2,876 m3	

Total Excavation Quantity: 235,253 m3

Disposal Site History

For Disposal Activities Between 1998/01/01 and 1998/12/31

Disposal Site Sand Heads
Number 9
Latitude 49°06.00'N
Longitude 123°19.50'W
Depth (m) 70

Permit Type	Permit	Loadsite	Dump Start Date	Quantity
Dredge	3114	FR-LULU IS-SOUTH DYKE ROAD	23-Feb-98	1,405 m3
	3176	FR-WESTMINSTER TERMINALS	30-Mar-98	500 m3
	3198	FR-GENSTAR-TILBURY ISLAND	26-Oct-98	4,000 m3
	3198	FR-TILBURY CEMENT	10-Nov-98	4,000 m3
	3205	FR-MAINTENANCE	12-Jul-98	51,934 m3

Total Dredge Quantity: 61,839 m3

Disposal Site History

For Disposal Activities Between 1998/01/01 and 1998/12/31

Disposal Site Porlier Pass
Number 32
Latitude 49°00.20'N
Longitude 123°29.80'W
Depth (m) 200

Permit Type	Permit	Loadsite	Dump Start Date	Quantity
Dredge	3175	VAN IS-LADYSMITH-WESTERN	03-Jan-98	1,500 m3
	3188	VAN IS-CHEMAINUS-SAWMILL	25-Jul-98	1,800 m3
	3188	VAN IS-CHEMAINUS-DRYSORT	01-Aug-98	1,350 m3
	3197	VAN IS-LADYSMITH-DOMANS	04-Jul-98	1,100 m3
	3197	VAN IS-LADYSMITH-WESTERN	11-Jul-98	400 m3
	3197	VAN IS-BURLEITH ARM-CPFP	13-Jul-98	4,000 m3

Total Dredge Quantity: 10,150 m3

Disposal Site History

For Disposal Activities Between 1998/01/01 and 1998/12/31

Disposal Site Five Finger Island
Number 40
Latitude 49°15.20'N
Longitude 123°54.60'W
Depth (m) 280

Permit Type	Permit	Loadsite	Dump Start Date	Quantity
Dredge	3184	VAN IS-PACIFIC BIOLOGICAL STATION	21-Oct-98	1,107 m3
	3197	VAN IS-DOMANS-DUKE PT-LOG	02-Jul-98	800 m3
	3197	VAN IS-LADYSMITH-WESTERN	25-Jul-98	400 m3
	3197	VAN IS-DOMANS-DUKE PT-SAWMILL	04-Aug-98	900 m3

Total Dredge Quantity: 3,207 m3

Disposal Site History

For Disposal Activities Between 1998/01/01 and 1998/12/31

Disposal Site Comox (Cape Lazo)
Number 48
Latitude 49°41.70'N
Longitude 124°44.50'W
Depth (m) 190

Permit Type	Permit	Loadsite	Dump Start Date	Quantity
Dredge	3190	VAN IS-PRIMEX-FJELD SAWMILLS	31-Jul-98	10,000 m3
	3198	VAN IS-COMOX TIMBER	08-Aug-98	1,800 m3
Total Dredge Quantity:				11,800 m3

Disposal Site History

For Disposal Activities Between 1998/01/01 and 1998/12/31

Disposal Site Malaspina Strait
Number 49
Latitude 49°45.00'N
Longitude 124°26.95'W
Depth (m) 320

Permit Type	Permit	Loadsite	Dump Start Date	Quantity
Dredge	3189	STILLWATER	23-May-98	900 m3
	3208	POWELL RIVER	29-Sep-98	1,400 m3
	3208	POWELL RIVER	01-Oct-98	11,200 m3
Total Dredge Quantity:				13,500 m3
Excavation	3186	JERVIS INLET	28-Sep-98	13,007 m3
Total Excavation Quantity:				13,007 m3

Disposal Site History

For Disposal Activities Between 1998/01/01 and 1998/12/31

Disposal Site Thornbrough Channel
Number 64
Latitude 49°31.00'N
Longitude 123°28.30'W
Depth (m) 220

Permit Type	Permit	Loadsite	Dump Start Date	Quantity
Dredge	3176	HOWE SD-AVALON DRYLAND LOG SORT	09-Mar-98	3,000 m3

Total Dredge Quantity: 3,000 m3

Disposal Site History

For Disposal Activities Between 1998/01/01 and 1998/12/31

Disposal Site Cape Mudge
Number 116
Latitude 49°57.70'N
Longitude 125°05.00'W
Depth (m) 200

Permit Type	Permit	Loadsite	Dump Start Date	Quantity
Dredge	3189	VAN IS-TIMBERWEST-GOWLAND	02-Feb-98	4,000 m3
	3210	VAN IS-MENZIES BAY	15-Dec-98	1,000 m3
	3210	VAN IS-PAINTERS LODGE	19-Dec-98	3,000 m3

Total Dredge Quantity: 8,000 m3

Disposal Site History

For Disposal Activities Between 1998/01/01 and 1998/12/31

Disposal Site Johnstone Strait-Hanson Island
Number 120
Latitude 50°33.50'N
Longitude 126°48.00'W
Depth (m) 350

Permit Type	Permit	Loadsite	Dump Start Date	Quantity
Dredge	3210	VAN IS-KELSEY BAY-MB	07-Jan-98	4,000 m3

Total Dredge Quantity: 4,000 m3

Disposal Site History

For Disposal Activities Between 1998/01/01 and 1998/12/31

Disposal Site Zeballos
Number 185
Latitude 49°56.06'N
Longitude 126°48.04'W
Depth (m) 200

Permit Type	Permit	Loadsite	Dump Start Date	Quantity
Vessel	3204	ZEBALLOS	07-Jun-98	40 tonnes

Total Vessel Quantity: 40 tonnes

APPENDIX III

Images Obtained by ROPOS II

Point Grey Disposal Site - September 1998

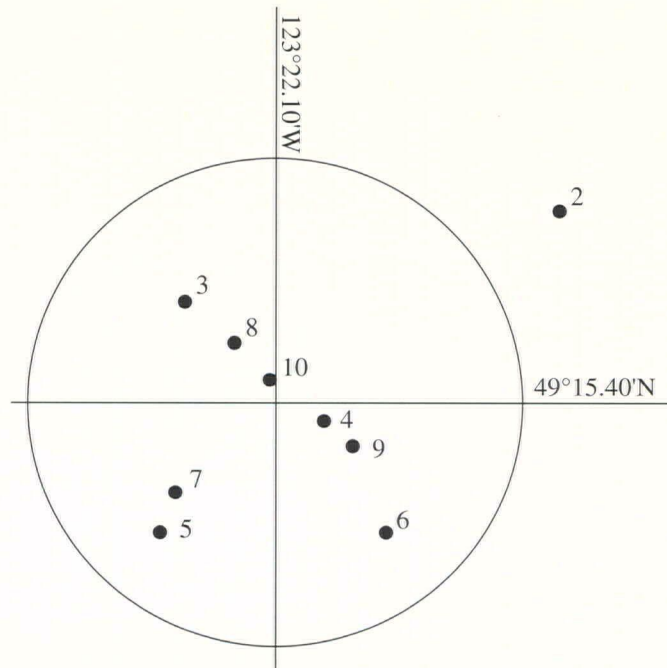


Figure 1. Point Grey disposal site boundary and locations of ROPOS images.



Figure 2. Sea anemones on the silty bottom outside the disposal site boundary.



Figure 3. Typical disposed materials include dredged sediments and woodwaste.

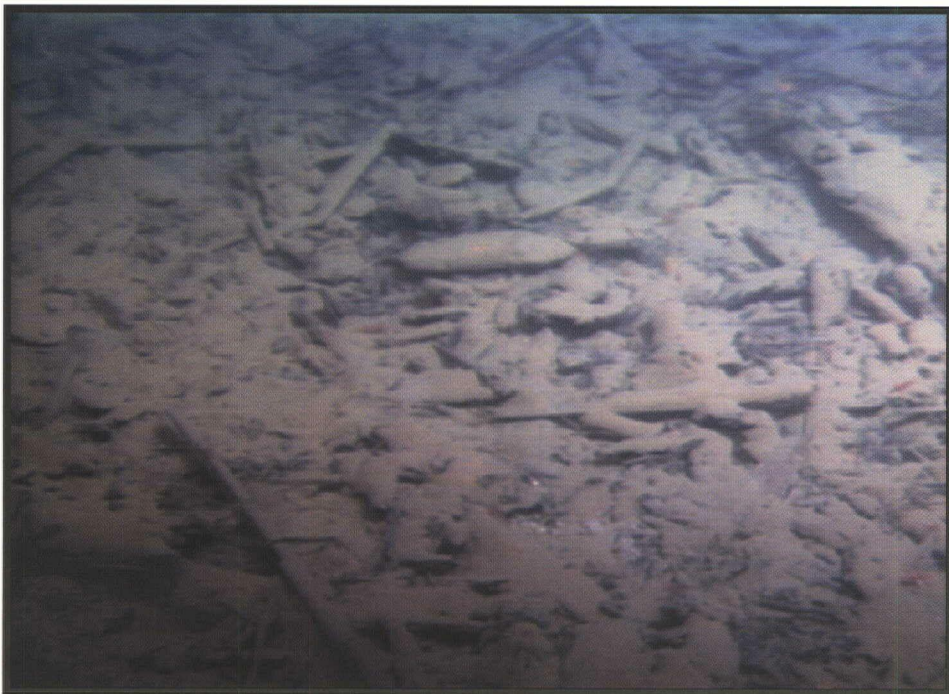


Figure 4. Small pieces of woodwaste with covering of fine material from natural sedimentation.

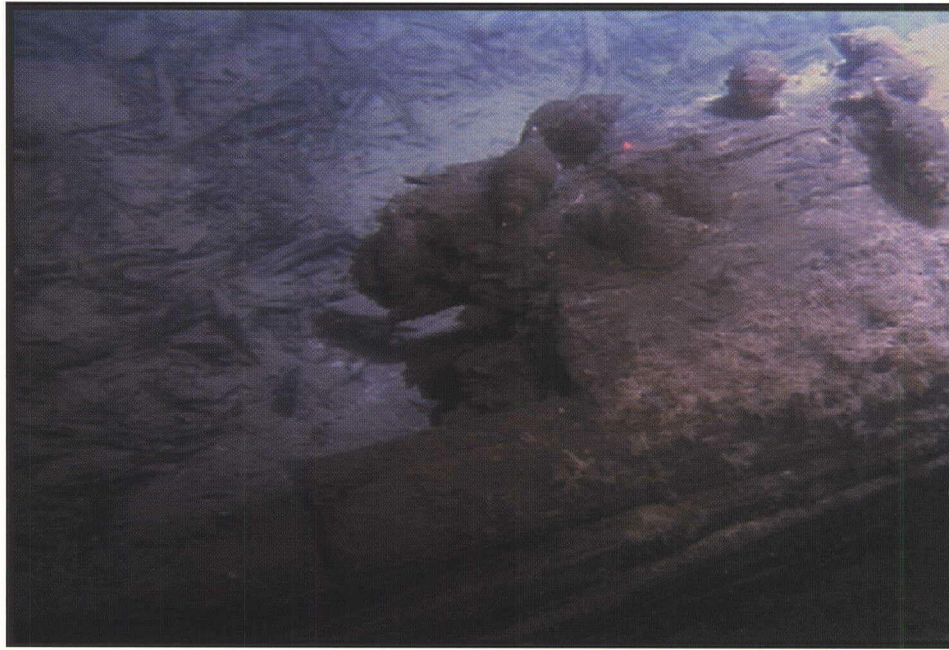


Figure 5. Molluscs (*Neptunea sp.*) are common on wood debris at the disposal site.

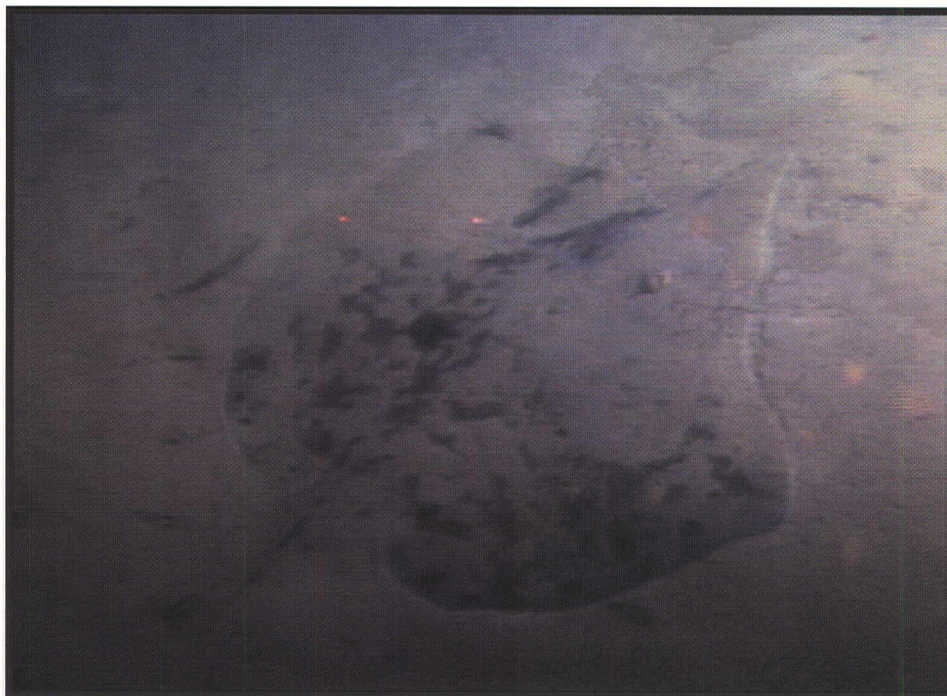


Figure 6. A skate (*Raja sp.*) on the silty mud bottom.



Figure 7. Woodwaste at the disposal site.



Figure 8. Disposed materials provide habitat for molluscs, seastars and crabs.



Figure 9. Woodwaste surrounding a small mound of excavation spoil.



Figure 10. Squat lobsters (*Munida quadrispina*) and rockfish (*Sebastes sp.*) are common.