Water Quality Branch

Ambient Water Quality Objectives For Pender Harbour

Overview Report

Water Management Division
Ministry Of Environment, Lands And Parks

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SUMMARY
This report assesses the marine water quality of Pender Harbour, including Bargain Bay, on the Sechelt Peninsula. Water quality objectives are set to protect aquatic life, wildlife, primary-contact recreation and shellfish harvesting for human consumption. All objectives are provisional pending collection of additional data. A monitoring program is recommended to check whether water quality objectives are being achieved, to finalize provisional objectives that have been proposed and to increase our understanding of environmental understanding of environmental quality in Pender Harbour.

The main water quality concerns in Pender Harbour relate to leachate from septic tile fields and agricultural runoff, as well as sewage effluent and other contaminants originating from boats. These sources have caused elevated fecal coliform levels that have resulted in shellfish harvesting closures but primary-contact recreation is not currently at risk. The extent to which the waters and sediments are impacted by other contaminants such as heavy metals is largely unknown until additional monitoring can be conducted. Nutrient enrichment is not considered to be a significant threat in Pender Harbour.

FIGURES

FIGURE 1. Location of Pender Harbour

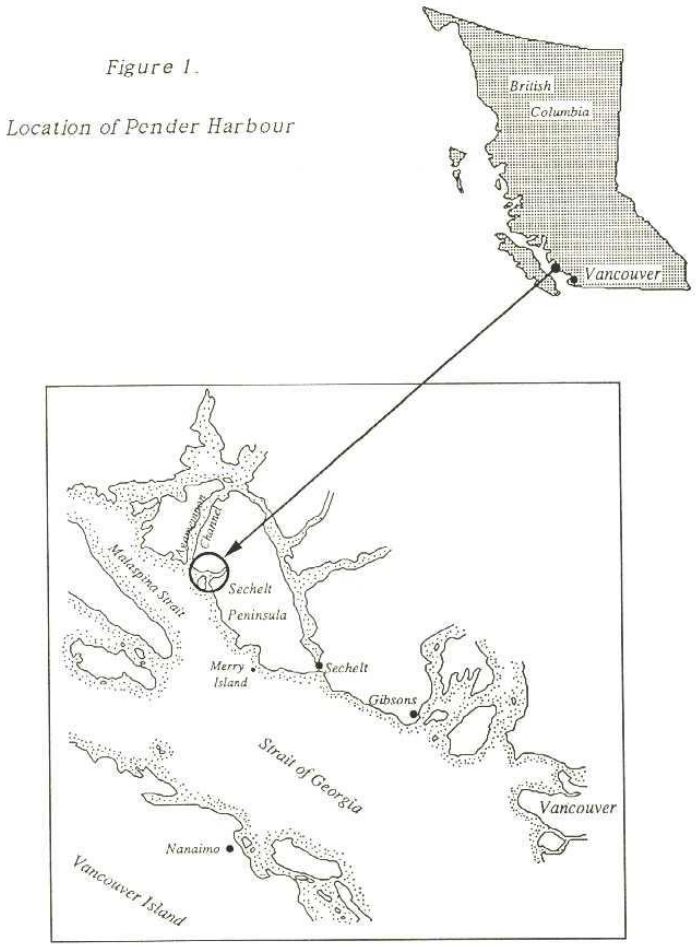


FIGURE 2. Pender Harbour Study Area

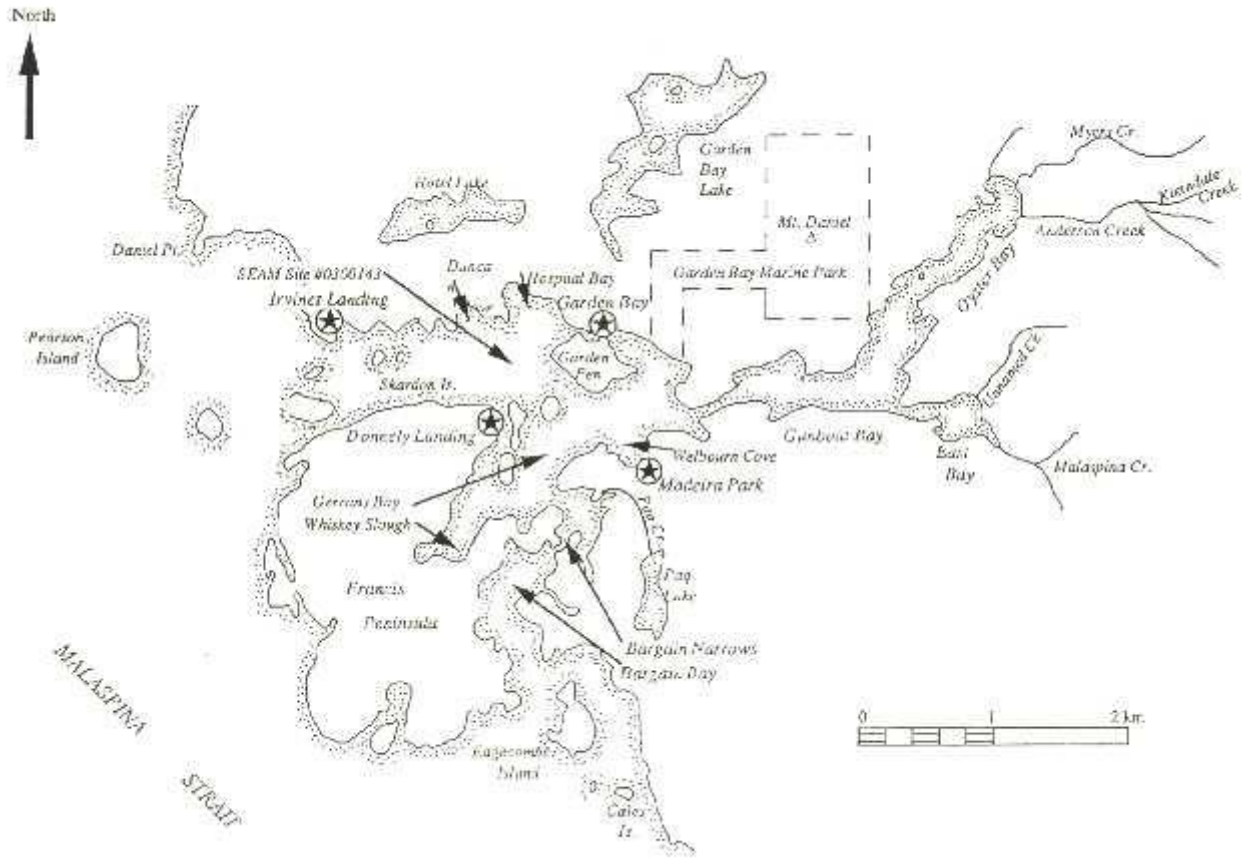
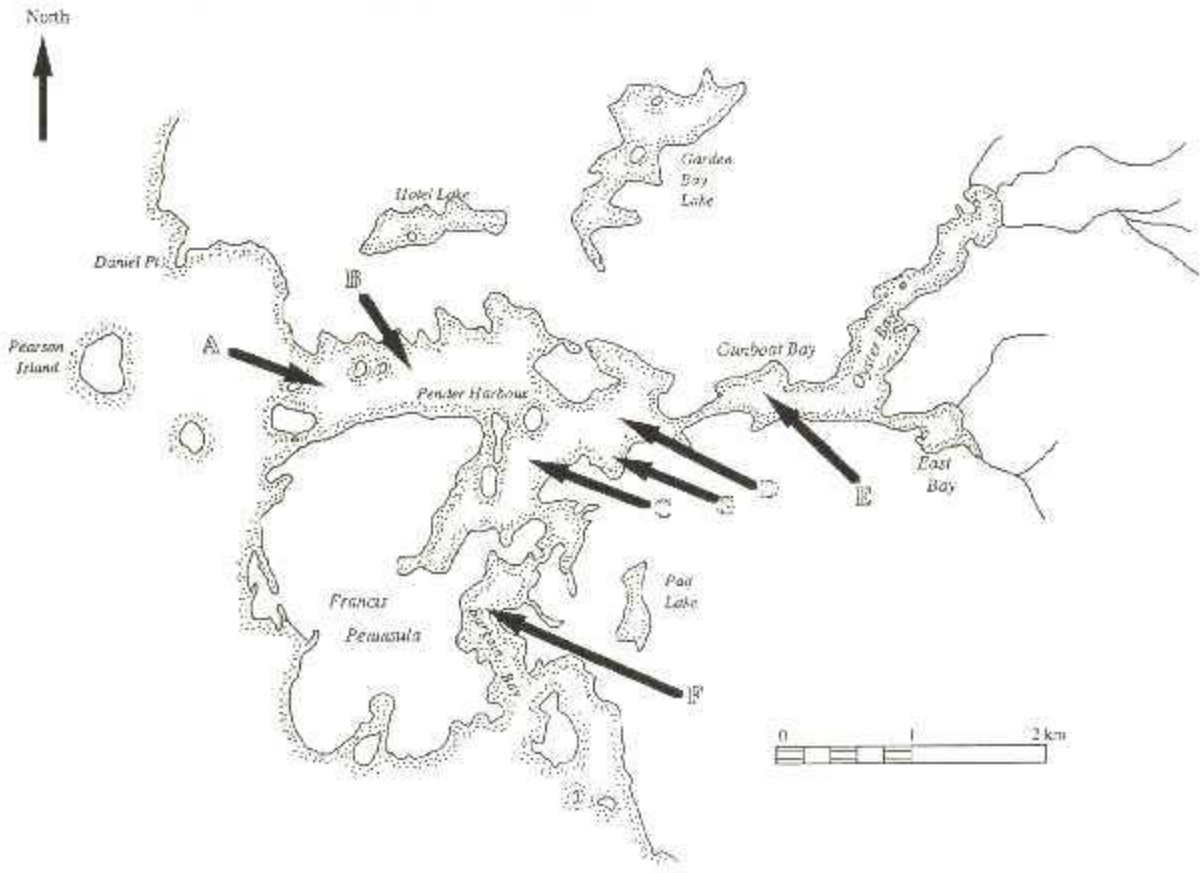


FIGURE 3. Pender Harbour Sampling Sites



PREFACE

Purpose of Water Quality Objectives

Water quality objectives are prepared for specific bodies of fresh, estuarine and coastal marine surface waters of British Columbia as part of the Ministry of Environment, Lands and Parks' mandate to manage water quality. Objectives are prepared only for those waterbodies and water quality characteristics that may be affected by human activity now or in the near future.

How Objectives Are Determined

Water quality objectives are based the BC approved and working criteria as well as national water quality guidelines. Water quality criteria and guidelines are safe limits of the physical, chemical, or biological characteristics of water, biota (plant and animal life) or sediment which protect water use. Objectives are

established in British Columbia for waterbodies on a site-specific basis. They are derived from the criteria by considering local water quality, water uses, water movement, waste discharges, and socio-economic factors.

Water quality objectives are set to protect the most sensitive designated water use at a specific location. A designated water use is one that is protected in a given location and is one of the following:

- raw drinking water, public water supply, and food processing
- aquatic life and wildlife
- agriculture (livestock watering and irrigation)
- recreation and aesthetics
- industrial water supplies.

Each objective for a location may be based on the protection of a different water use, depending on the uses that are most sensitive to the physical, chemical or biological characteristics affecting that waterbody.

How Objectives Are Used

Water quality objectives routinely provide policy direction for resource managers for the protection of water uses in specific waterbodies. Objectives guide the evaluation of water quality, the issuing of permits, licences and orders, and the management of fisheries and the province's land base. They also provide a reference against which the state of water quality in a particular waterbody can be checked, and help to determine whether basin-wide water quality studies should be initiated.

Water quality objectives are also a standard for assessing the Ministry's performance in protecting water uses. While water quality objectives have no legal standing and are not directly enforced, these objectives become legally enforceable when included as a requirement of a permit, licence, order, or regulation, such as the Forest Practices Code Act, Water Act regulations or Waste Management Act regulations.

Objectives and Monitoring

Water quality objectives are established to protect all uses which may take place in a waterbody. Monitoring (sometimes called sampling) is undertaken to determine if all the designated water uses are being protected. The monitoring usually takes place at a critical time when a water quality specialist has determined that the water quality objectives may not be met. It is assumed that if all designated water uses are protected at the critical time, then they also will be protected at other times when the threat is less.

The monitoring usually takes place during a five week period, which allows the specialists to measure the worst, as well as the average condition in the water.

For some waterbodies, the monitoring period and frequency may vary, depending upon the nature of the problem, severity of threats to designated water uses, and the way the objectives are expressed (*i.e.*, mean value, maximum value).

INTRODUCTION

Pender Harbour is a small coastal inlet on the Sechelt Peninsula, approximately 80 km northwest of Vancouver Figure 1 and Figure 2. The protected and picturesque nature of the harbour is attracting an expanding resident population and supports an increasing tourist trade. This growth has resulted in escalating pressures on the marine waters of Pender Harbour. Increased nutrient and bacterial loading to the harbour along with intense boating, fishing and other recreational activities have led to concerns over the possibility of deteriorating water quality. These concerns have been given substance by shellfish harvesting closures which have expanded to encompass the entire harbour.

The purpose of this report is to assess the current water quality of Pender Harbour and to develop water quality objectives for use by resource managers. A detailed technical appendix was prepared and forms the basis for the conclusions presented in this report.

HYDROLOGY and OCEANOGRAPHY

In an embayment such as Pender Harbour that has no large riverine input, the dynamics of water circulation, mixing and exchange will be driven principally by tidal movement. A tidal mixing model predicts that the median flushing time for Pender Harbour should be approximately three days. However, since both entrances to Pender Harbour are characterized by shallow depths, deeper waters of the harbour may under some circumstances remain isolated from overlying water and consequently be subject to slower flushing rates.

During months of heavy rain, flushing in Pender Harbour is accelerated due to the entrainment of saltwater by outflowing freshwater (known as "estuarine-type circulation"). The watershed area for the harbour is 58 km^2 and the months of November through March have the heaviest rainfalls, with monthly freshwater inputs averaging in excess of 7×10^6 m^3/month. This is a significant volume in comparison with the total volume of the harbour of approximately 35×10^6 m^3. Estuarine-type circulation models predict that such inputs can result in a flushing time of 6 days or less. Combining this with the predicted tidal flushing time of 3 days results in a combined median flushing time of 2 days or less duing the winter months.

WATER USES

Water-based recreational use of Pender Harbour is high with boating and sport fishing being the dominant activities. The harbour has a total of 21 marina-type facilities with a combined capacity in excess of 750 boats. In addition, there are more than 200 small, private docks spread throughout the harbour. Swimmers also use the water inspite of an absence of good quality beaches.

The fisheries resources of Pender Harbour are diverse and encompass important recreational and commercial fish stocks. Several streams entering the head of the inlet support spawning populations of coho and chum salmon as well as cutthroat and rainbow trout. Chinook salmon, rockfish, perch and herring are all known to frequent the harbour and crabs constitute a well-used recreational fishery. Clams and oysters are abundant in several areas, although these shellfish are currently subject to a harvesting closure due to excessive fecal coliform levels.

Waterfowl are also important users of Pender Harbour with a variety of species overwintering in the surrounding area. A number of locations in the harbour serve as feeding areas for these birds.

Pender Harbour supports very little industrial/commercial activity in the harbour other than the marinas catering to boat-owners and sport fishermen. There is only one waterfront fish processing plant currently in operation, although a number of commercial fishing vessels continue to utilize the harbour's mooring facilities. There is also one active oyster lease in Pender Harbour.

WASTE DISCHARGES

There are three permitted point sources discharging effluent into Pender Harbour, but their combined discharge volumes are low and water quality impacts are negligible. Non-point sources such as septic tank/tile field leachate, agricultural inputs and boats are more likely to influence water quality in the harbour.

Although most homes and businesses around Pender Harbour are serviced by septic tanks with tile fields, local soils are generally poorly suited for the renovation of septic tank effluents. As a result, some effluent leachate reaches the harbour and contributes to nutrient and bacterial loading. Small agricultural enterprises at the eastern end of the harbour are also a source of fecal contamination.

Boats are a significant source of bacterial loading to the harbour. Their sewage discharges tend to be concentrated and, since most boats tend to moor or anchor in relatively shallow water, localized areas of elevated coliform levels can be expected to occur. Boats are also a potential source of a number of metals and fuel-related contaminants. It is expected that these materials may exist at elevated concentrations, particularly in the sediments surrounding large docks or marina facilities.

WATER QUALITY

Most areas of Pender Harbour routinely experience levels of fecal coliforms in excess of current criteria for growing harvestable shellfish. In the eastern portion of the harbour (Gunboat Bay, Oyster Bay and East Bay) these elevated concentrations are attributed primarily to livestock sources. In the main basin of the harbour, high coliform concentrations are probably due partly to land-based septic tank/tile field systems and partly due to boating discharges. In both cases, however, concentrations are normally well within allowable limits for primary-contact recreation.

Septic field leachate, agricultural runoff and boat discharges are also sources of nutrient (nitrogen and phosphorus) loading to the harbour. Background variability is so great and the receiving volume of the harbour is so large, that nutrient inputs are not anticipated to significantly impact water quality in the harbour. The possibility does exist that deeper waters in the harbour may trap and concentrate nutrients over a period of time, and this may cause brief pulses of enrichment during periods of complete mixing of the harbour.

Bargain Bay, which forms a southern appendage to Pender Harbour, has generally superior water quality due to better flushing. Only very localized areas of this bay surpass shellfish growing criteria and at no time is primary-contact recreation compromised. Nutrient enrichment problems are not expected in this bay.

Non-bacteriological water quality data for Pender Harbour are extremely sparse, but there is slight evidence of possible heavy metal contamination, particularly of the sediments. This is consistent with other reports of metal contamination in association with large numbers of boats. Metals of concern include copper, zinc, lead and iron. There are currently insufficient data to draw any firm conclusions related to these metals in Pender Harbour. Although no ambient data are available, tributyl tin and polycyclic aromatic hydrocarbons are also of some concern in the harbour because of their known linkage with boats.

Dissolved oxygen levels are somewhat depressed in Pender Harbour, but this is expected in an enclosed bay with restricted flushing.

WATER QUALITY OBJECTIVES

Water quality objectives proposed for Pender Harbour are summarized in Table 1. The objectives are based on working and approved criteria for water quality and on available data on ambient water quality, waste discharges, water uses and flushing rates. Many objectives are provisional and will require review when adequate data become available or when approved water quality criteria for the characteristics of concern are developed.

Water quality objectives have no legal standing and are not directly enforceable. They can be considered as policy guidelines for resource managers to protect water uses in the specified water bodies. They will guide the evaluation of water quality, the issuing of permits, orders and licences and the management of the fisheries and of the Province's land base. They will also provide a baseline reference against which localized water quality can be compared and decisions for basin-wide water quality studies assessed.

Depending on the circumstances, water quality objectives may already be met in a water body, or may describe water quality conditions which can be met in the future. To limit the scope of the work, objectives are only being prepared for water bodies and for water quality characteristics which may be affected by man's activity now and in the foreseeable future.

The designated water uses for Pender Harbour are for the protection of aquatic life, harvesting of shellfish (in Bargain Bay only), and primary-contact recreation. Water and/or sediment objectives have been proposed for the following characteristics of concern: microbiological indicators, nitrogen, copper,

zinc, lead, iron, tributyl tin, polycyclic aromatic hydrocarbons and dissolved oxygen. Oil and grease films are recognized as nuisance conditions that should be minimized to the greatest extent possible.

Most objectives correspond to approved or working provincial criteria for water quality. Exceptions include the objective for microbiological indicators which has been modified to conform to the new Health and Welfare Canada criteria to protect primary-contact recreation (geometric mean of less than or equal to 350 enterococci/L). Sediment objectives as given in Table 1 for copper, zinc, lead and polycyclic aromatic hydrocarbons are based on objectives developed for Burrard Inlet, since Provincial sediment criteria are not available. There are also no Provincial criteria for tributyl tin, so this objective has been set at a maximum of less than or equal to 0.001 micrograms/L in accordance with the Canadian Water Quality Guidelines.

MONITORING RECOMMENDATIONS

A summary of recommended water quality monitoring is given in Table 5. Quality assurance (QA) for the monitoring program should be maintained by adequate sample replication and testing of field blanks and reference samples in accordance with the Ambient Water Quality Monitoring Program. The recommended monitoring program provides the minimum requirements to evaluate whether objectives are being achieved, to finalize provisional objectives that have been proposed and to increase understanding of environmental quality in Pender Harbour.

The recommended monitoring program is based on technical considerations. Regional priorities and considerations may limit or expand this program

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TABLES

Table 1. Water Quality Objectives for Pender Harbour

Water Body	**Pender Harbour excluding Bargain Bay**	**Bargain Bay**
Designated Water Uses	**Aquatic life, wildlife, primary contact recreation, fish consumption**	**Aquatic life, wildlife, primary contact recreation, shellfish harvesting, fish consumption**
enterococci	**less than or equal to 350/L geometric mean**	

fecal coliforms	**not applicable**	**less than or equal to 14/100 mL (median) less than or equal to 43/100 mL (90th percentile)**
total ammonia nitrogen	**AMMONIA TABLES**	
dissolved oxygen	**6.75 mg/L minimum**	
total copper in water column	**3 micrograms/L maximum less than or equal to 2 micrograms/L as a 30-day mean**	
dissolved zinc in water column	**15 micrograms/L maximum**	
total lead in water column	**140 micrograms/L maximum less than or equal to 2 micrograms/L as a 30-day mean less than or equal to 3 micrograms/L 80th percentile**	
dissolved zinc in sediment	**150 micrograms/g maximum**	
total copper in sediment	**100 micrograms/g maximum**	
total lead in sediment	**30 micrograms/g maximum**	
total lead in edible portions of fish and shellfish	**0.8 micrograms/g maximum wet weight**	
total iron in water column	**0.05 mg/L maximum**	
tributyl tin in water column	**0.001 micrograms/L maximum**	
polycyclic aromatic hydrocarbons	**see Table 4**	

The objectives apply to distinct samples from all parts of the waterbody except from initial

dilution zones of fixed effluent dischargess. These excluded initial dilution zones may theoretically extend up to 100 m in all directions around the point of discharge, although in practice thay will usually be much smaller.
1. For fecal coliforms, enterococci and total copper and lead the geometric means, medians, averages and percentiles are calculated from at least 5 weekly samples taken in a 30-day period. For values recorded as less than the detection limit the detection limit itself should be used to calculate the statistic.
2. For total copper and lead and dissolved zinc the sediment concentrations are on a dry weight basis.
3. The dissolved zinc objective also applies to the total zinc fraction if suspended solids are negligible or absent.

Table 4. Polycyclic Aromatic Hydrocarbon (PAH) Sediment Objectives for Pender Harbour (micrograms/gram dry weight)

low molecular weight PAH's	objectives	high molecular weight PAH's	objectives
sum of all LMW PAH's	0.5	sum of all HMW PAH's	1.2
naphthalene	0.2	fluoranthene	0.17
acenaphthylene	0.06	pyrene	0.26
acenaphthene	0.05	benzo(a)anthracene	0.13
fluorene	0.05	chrysene	0.14
phenanthrene	0.15	benzofluoranthenes	0.32
anthracene	0.10	benzo(a)pyrene	0.16
...	...	ideno(1,2,3-cd)pyrene	0.06
...	...	dibenzo(a,h)anthracene	0.06

...	...	benzo(g,h,i)perylene	0.07

Table 5. Recommended Water Quality Monitoring for Pender Harbour

Sites	Frequency and Timing	Characteristics to be Measured
Several sample sites, 10 are suggested, should be selected in areas most likely to experience recreational use (*i.e.* wharves, beaches, etc.). In Bargain Bay some sites should be chosen in areas supporting shellfish populations	A minimum of 5 samples taken in a 30-day period. Sampling should be in July and August	fecal coliforms and enterococci
Sites A through F, see Figure 3	A minimum of once/month for 1 year	temperature, salinity and dissolved oxygen. Samples to be collected at 0,2,4,6,8 and 10 m and then every 5 m to the bottom
Site B at the deepest point in the harbour, see Figure 3	A minimum of 5 samples taken in a 30-day period in late summer	temperature, salinity, dissolved oxygen, pH, nitrate, nitrite and ammonia. Samples to be collected at the surface, near the surface, at mid-depth and near the bottom
Site G (Madeira Park Government Wharf) and Site F (center of Bargain Bay), sediments, see Figure 3	A minimum of 5 samples taken in a 30-day period in late summer	copper, lead, zinc and tributyl tin

Site G (Madeira Park Government Wharf) and Site F (center of Bargain Bay), water column, seeFigure 3	**A minimum of 5 samples taken in a 30-day period in late summer**	**total and dissolved copper, lead, zinc and iron, as well as tributyl tin, to be sampled in surface and near-bottom waters**
one shellfish site in each of Oyster Bay and Bargain Bay.	**A minimum of 3 shellfish edible tissue samples taken in late summer**	**total lead content of edible tissues**
one site adjacent to a fuel dock	**A minimum of 3 replicate sediment samples taken in late summer**	**polycyclic aromatic hydrocarbons**

Membrane filtration is the recommended analytical technique for fecal coliforms and enterococci.

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