Fraser River Estuary Study Water Quality

Industrial Effluents

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ABSTRACT

A review of industrial wastewater effluents discharged directly to the Fraser and Serpentine Rivers within the Fraser River Estuary study area, over the period 1970 to 1978, was undertaken. Each industrial sector was addressed from the viewpoint of relevant guidelines, objectives, or regulations and applicable wastewater treatment technology. Individual operations within an industrial sector were assessed according to their pollution control permits, monitoring data related to their discharges, and the relationship between individual discharges in the same industrial sector. Many of the assessments were made on the basis of very few data.

Operations within the forest and food industries, exclusive of fish processing operations, are generally required to meet level "A" objectives of the Pollution Control Board. Suspended solids loadings to the study area from the food industry could be reduced between 60% and 90% if effluents from fish processing operations met level "A" of the objectives.

Domestic sewage discharges from industry and small operations are required to meet level "AA" of the objectives. Many metal finishing and fabricating operations do not meet level "C" of the objectives. Some metal loadings from metal finishing and fabricating operations could be reduced by 95% if level "C" of the objectives was met.

Bioassay monitoring is required for effluents from the forest, food, metal finishing and fabricating, and concrete industries, as well as from certain other specified operations. This monitoring should include adequate background chemical analyses. Other required monitoring programs include mercury analyses of effluents at the forest, food, and metal finishing and fabricating industries; nutrient analyses of effluents from all forest and food operations; analyses of all effluents from the concrete industry and some specified forest industry operations for certain heavy metals; as well as analyses of effluents from forest industry and wood preservation operations for chlorinated phenolic compounds. A special study has been recommended to determine any improvements in ground and surface waters if pH is controlled in exfiltration ponds at metal finishing operations.

PREFACE

The Fraser River Estuary Study was set up by the Federal and Provincial Governments to develop a management plan for the area.

The area under study is the Fraser River downstream from Kanaka Creek to Roberts Bank and Sturgeon Bank. The Banks are included between Point Grey and the U.S. Border. Boundary Bay and Semiahmoo Bay are also included but Burrard Inlet is not in the study area.

The study examined land use, recreation, habitat and water quality, and reports were issued on each of these subjects.

Since the water quality report was preliminary, a more detailed analysis of the information was undertaken by members of the water quality work group. As a result, eleven background technical reports, of which this report is one, are being published. The background reports are entitled as follows:

- Municipal Effluents.
- Industrial Effluents.
- Storm Water Discharges.
- Impact of Landfills.
- Acute Toxicity of Effluents.
- Trace Organic Constituents in Discharges.
- Toxic Organic Contaminants.
- Water Chemistry; 1970-1978.
- Microbial Water Quality; 1970-1977.
- Aquatic Biota and Sediments.
- Boundary Bay.

Each of the background reports contains conclusions and recommendations based on the technical findings in the report. The recommendations do not necessarily reflect the policy of government agencies funding the work. Copies of these reports will be available at all main branches of the public libraries in the lower mainland.

Five auxiliary reports are also being published in further support of the study. These cover the following subjects:

- Site registry of storm water outfalls.
- Dry weather storm sewer discharges.
- Data report on water quality.
- Survey of fecal coliforms in 1978.
- Survey of dissolved oxgyen in 1978.

Copies of these reports are available from the Ministry of Environment, Parliament Buildings, Victoria, British Columbia.

To bring this work together the water quality work group has published a summary report. This document summarizes the background reports, analyzes their main findings and presents final recommendations. Some of the recommendations from the background reports may be omitted or modified in the summary report, due to the effect of integrating conclusions on related topics. Copies of the summary report are in public libraries, and extra copies are available to interested parties from the Ministry of Environment in Victoria.

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1. INTRODUCTION

The discharge of wastewater by industry can cause degradation to receiving water quality. Industry can reduce this degradation by improving effluent quality through the use of in-plant controls and wastewater treatment.

Industry, in British Columbia, discharges effluents to surface waters following conditions of a pollution control permit. These permits were issued under the authority of the Director of Pollution Control who administers the Pollution Control Act. The Pollution Control Branch (PCB), and since late 1979 the Waste Management Branch (WMB), administers enforcement of the permits.

The permits contain limits on effluent flow, contaminant concentrations, and requirements for wastewater monitoring. It is the responsibility of industry to meet the prescribed limits and monitoring requirements. These limits and monitoring requirements are usually based upon provincial objectives which have been issued by the Pollution Control Board for a particular industrial sector. Input by other government agencies to the WMB prior to the issuance of a permit is required, while input from Federal agencies is encouraged.

The Pollution Control Board issues objectives after holding public hearings. The objectives are based upon input from the hearings. The objectives assume an initial 20:1 dilution in the receiving water, and assess what concentrations of contaminants in effluents are needed to maintain water quality in the receiving water. Initially the objectives outline three levels of treatment; levels "A" and "AA" being the highest, level "C" being an immediate requirement and levels "B" and "BB" being intermediate levels. Currently the trend is towards setting a range of values from which permit conditions can be set, based upon site specific needs.

Objectives listed as level "C" for food processing operations and the chemical and petroleum industries, as well as those listed as level "BB" for municipal-type waste discharges and level "B" for the forest products industry, generally were to be met by existing operations at the time the objectives were issued. The limits established for the various levels were based upon concentrations which could be attained with wastewater treatment technology existing at the time.

Level "A" or level "AA" objectives were to be met at some undefined time in the future. They were based upon concentrations attainable in effluents using the equivalent of approximately best practicable technology (this implies that it is both technically and economically feasible). For some contaminants, a best practicable technology may not exist, thereby necessitating that no discharge occur. Level "A" or "AA" objectives were to be met by all new operations and eventually, all operations.

The Federal Government has issued national baseline guidelines and regulations for limiting pollutants from wastewater discharges for certain industries. The limits in the federal guidelines and regulations may differ from those in provincial objectives. However, they are relevant to a discussion of industry since Federal limits are designed to be met using best practicable technology. General provisions of the Fisheries Act may also be used to control discharges.

Included in the discussion of industrial wastewater discharges will be a review of some industrial stormwater discharges as well as some domestic sewage discharges. Domestic sewage discharges considered in this report originate from hotels, motels, marinas and industrial complexes, while discharges from the major sewage treatment plants are covered in another report in this series[7]. Industrial wastewater discharges to soil disposal systems and to municipal sewerage systems are not discussed. Only industrial wastewaters discharged directly to the study area are considered. Not included are effluents such as leachates from most industrial landfills, runoff from most industrial complexes, accidental spills, or effluents not covered by a pollution control permit.

For ease of presentation, industrial wastewater discharges have been classified into seven sectors. These sectors include forest, food, concrete, metal finishing and fabricating, domestic sewage and uncontaminated cooling water. The seventh sector includes wastewater discharges from miscellaneous industries. An operation may have wastewater discharges belonging to more than one sector.

Operations in each sector are subdivided according to which section of the river their wastewater is discharged. The Fraser River has been divided into three sections; the Main Stem, North Arm and Main Arm.

The principal data base used in this report covers the period of January 1965 to December 1977. Data generated in 1978 and 1979 have been examined, and any significant changes from the 1965-1977 period have been noted in the discussion.

However, the description of wastewater flows is generally based upon the situation as it existed in December 1977, since wastewater flows change as new industries start up, and old industries expand, close, or discontinue their wastewater discharges to the river.

The data have been extracted from the files of the WMB, or from the computerized data storage and retrieval system (EQUIS) operated by the Ministry of Environment. These data likely indicate normal discharge situations and not instances of accidental spills. Not necessarily all chemical parameters analyzed at an operation have been included in this report. Data included are those which the author has decided can help in an overall appreciation of the river water quality. Individual operations were not contacted directly for monitoring data related to their wastewater discharges, as this was beyond the scope of the report.

Some information in this report may vary slightly from that presented in other background reports or the summary report for this study. This is due to overlapping stages of preparation of the data for the different reports, however the overall content and conclusions are not affected.

2. THE FOREST INDUSTRY

2.1 Introduction

Discharges within the study area from the forest industry originate from sawmill operations, pulp and paper mills, packaging plants, plywood, shingle and hardboard plants, and wood preservation plants. Operations belonging to this sector are indicated in Figure 1.

2.1.1 Guidelines/Objectives/Regulations

The Pollution Control Board issued revised objectives for the forest industry in 1977[37]. These objectives deal with discharges to air, land and water. Objectives related to the quality of the receiving water, usually requiring negligible or no degradation in the characteristics of the receiving water, are also outlined. Only those objectives related to wastewater discharges will be discussed, and are included in Table 1.

Special problems associated with log handling and storage in water are addressed by recommendations outlined in the objectives. These recommendations are:

(1) construct new facilities so as to minimize problems associated with log handling and storage in water.
(2) manage existing water storage and transportation to minimize deleterious effects.
(3) provide leadership for clean-up of existing wood and debris in natural waters.

The federal government enacted the Pulp and Paper Effluent Regulations on November 2, 1971[38]. These regulations are the only federal environmental regulations specifically applicable to the forest industry. They limit the deposit of suspended solids, and the deposit of substances exerting a five day biochemcial oxygen demand (BOD_5), or substances which cause acute toxicity to fish. Limits related to BOD_5 and suspended solids are included in Table 2. According to these documents, wastewater is considered acutely toxic if at least eighty percent of fish tested over 96 hours do not survive in water containing sixty-five percent wastewater, using a continuous flow bioassay technique. Section 33(3) of the Fisheries Act is also specifically applicable to this industrial sector.

A general comparison of the provincial and federal requirements for BOD_5 and suspended solids for pulp and paper operations is not practical since numerous variations in plants can exist. Also toxicity requirements cannot be readily compared since the provincial requirements are in terms of a 96-hour LC_{50} (the concentration of wastewater acutely toxic to fifty percent of the test population over 96 hours). However, it has been indicated that the Provincial objectives are slightly more stringent than the Federal requirements[(45)].

2.1.2 Sources of Contaminants

Certain components of wood are soluble in many solvents including water. Although species dependent, soluble components include tannins, resins, fats, oils, terpenes, flavanoids, quinones, carbohydrates, glycosides and alkaloids. The insoluble components are cellulose, hemi-celluloses, and lignins. Bark contains a higher portion of soluble components than the rest of the log. The leaching rate of the soluble components does not, according to Karau, differ greatly between saline and fresh water[(1)].

(a) Wood Floatage

Wood floatage is the term used for the water transportation of logs from the forest to the mill, and/or log storage in water until use. The dominant method of wood transportation on water in British Columbia is by barging and rafting[(1)]. The deposition of bark as a result of wood floatage can cause the smothering of fish eggs, the destruction of invertebrate bottom fauna, and the formation of hydrogen sulphide with subsequently reduced dissolved oxygen concentrations.

(b) Pulp and Paper Mills

Wastewaters occur in all steps in the manufacture of paper and groundwood pulp. Many of the wastewaters, such as flume water, bleach wastes, whitewater from the paper machine, hydraulic and wet debarker effluents, as well as condensates from evaporators and heat exchangers can be recycled within the plant with little or no treatment. Debarker effluents can be eliminated entirely through the use of mechanical debarkers.

(c) Veneer and Plywood Plants

The major sources of contaminants in veneer and plywood plants, other than from log storage and debarking, are from veneer dryers and glue washwaters. For ease of peeling, logs are conditioned in either a steam or hot water vat. Discharges contain water soluble fractions and wood particles as suspended solids.

Conditioning of logs is expected to become more widespread in the Lower Mainland(49). A summary of six steam vat discharges from different plants in the United States indicated suspended solids concentrations from 74 to 2 940 mg/L, BOD_5 concentrations from 470 to 3 117 mg/L, phenolic compound concentrations from 0.2 to 0.69 mg/L, total Kjeldahl nitrogen concentrations from 1.9 to 56.8 mg/L, and ortho-phosphate P concentrations from 0.2 to 5.7 mg/L(3). A summary of five hot water vat discharges indicated a suspended solids concentration of 72 to 2 520 mg/L, a BOD_5 concentration from 326 to 4 740 mg/L, phenolic concentrations to 0.4 mg/L, and concentrations of total Kjeldahl nitrogen ranging from 16.2 to 26.4 mg/L(3).

Veneer dryers are used to reduce the moisture content of the veneer to ensure proper glueing. The dryers accumulate wood particles and organic deposits which are mainly condensed volatile hydrocarbons. These organic deposits are cleaned out of the dryers with a high pH detergent. Wastewater from dryers in British Columbia can typically have average concentrations of BOD_5 of 667 mg/L, suspended solids of 660 mg/L, chemical oxygen demand (COD) of 3102 mg/L, phenolics of 0.23 mg/L, resin acids of 76 mg/L, pH of 8.7 and a 96-hour LC_{50} of 1.87%(49).

In the glueing operation, washwaters can originate from adhesive mixtures, storage tanks, transfer lines and application equipment. Three types of glue can be used in glueing operations; protein, phenol-formaldehyde, or urea formaldehyde. Urea based glues exert the largest BOD_5 (9 750 mg/kg), and contain the largest amount of total phosphate (37.8 mg/kg) and Kjeldahl nitrogen (1 065 mg/kg) of the three glue types(3). Phenolic glues exert the largest amount COD (32 650 mg/kg), and contain the largest amount of suspended solids (15 250 mg/kg)(3). Protein based glue contained 90.5 mg/kg of phenolics(3). This is the largest quantity of phenolics in any of the glue types. Glue spreader washwater in British Columbia can typically have average concentrations for BOD_5 of 135 mg/L, suspended solids of 1 071 mg/L, COD of 4 850 mg/L, phenolics of 1.4 mg/L, resin acids of 1.4 mg/L, a pH of 10.5, and a 96-hour LC_{50} of 8.4%(49).

d) Wood Preservers

When pentachlorophenol, or creosote mixed with pentachlorophenol, is used in the treatment of wood, condensate from steam conditioning can contain from 25 to 150 mg/L of pentachlorophenol and 100 to 350 mg/L of phenol(3). These condensates also contain from 3 000 to 60 000 mg/L of COD and 1 500 to 25 000 mg/L of BOD_5. Arsenic has been identified in water based salt type preservatives in concentrations from 10 to 50 mg/L(3). Copper (0.05 to 1.1 mg/L), hexavalent chromium (0.23 to 1.5 mg/L), ammonia (80 to 200 mg/L), and phosphate (15.15 mg/L as PO_4) have also been identified(3).

Cooling waters used with barometric condensers and wet-type vacuum pumps, as well as the vacuum water itself, can become contaminated with preservative. Boiler blowdown water can be contaminated with chemicals such as chromates and phosphates.

2.1.3 Wastewater Treatment Methods

Suspended solids and BOD_5 are usually removed using physical sedimentation and biological treatment in aerated lagoons(2). These techniques are usually implemented in conjunction with programs of in-plant water recycling, and the pretreatment of individual wastewater streams. Pretreatment can include grit and debris removal, wastewater neutralization, or the provision of an emergency spill facility.

Wood preservation operations using only water-borne preservatives eliminate wastewaters by recycling. Lime precipitation of metals followed by treatment in lagoons is a common treatment method when oil-based preservatives are used in conjunction with water-based preservatives. Oil-borne preservatives used alone are treated for bulk oil recovery. When this is followed by the breaking of emulsions, the COD can be reduced by 50% to 70%(3).

Suspended solids and BOD_5 due to wood floatage can be reduced through modifications in the storage and transportation of logs. These modifications can include debarking pulpwood at the woodlands operation, sorting and storing logs on dry land, and eliminating water transportation where possible.

2.2 Operations Discharging to the Main Stem

These operations are presented in descending order of magnitude of the flow of process water at existing operations. Operations which have discontinued direct discharges to the river are then presented.

2.2.1 Crown Zellerbach Canada Ltd., Fraser Mills, (PE 412)

This operation, originally constructed in 1890, consists of a sawmill, plywood plant, boiler plant and barker plant. Mechanically debarked logs are used to manufacture plywood and lumber. Dry usable wastes are chipped and sold for pulp manufacturing, while bark and sawdust are burned in boilers or landfilled.

The wastewater consists of boiler blowdown, boiler condensate, compresssor cooling water, and fly ash effluent. The fly ash effluent consists of water which is used to sluice fly ash from the bottoms of the cyclones of the high pressure boilers. This water subsequently passes through two parallel settling basins designed to provide approximately 2.5 minutes retention at a flow of 1 468 cubic metres per day (m^3/d). It is believed that the design retention time is exceeded since 1 766 m^3/d of fly ash water passes through the basins. As well, the buildup of fly ash in the settling basins would reduce the actual retention time. The WMB indicated, in assessing this operation, that approximately fifty percent of the ash would settle at the design overflow rate, and that the remainder would be discharged.

Prior to December 1972, domestic sewage was discharged to the Fraser River either untreated or after having passed from the operation through a septic tank. After that date, sewage flows were diverted to the municipal sewage system.

The wastewater characteristics prescribed by pollution control permit PE 412, as well as a summary of analytical data on wastewater quality, are included as Table 3. The limits in PE 412 are more restrictive than level "A" of the objectives. The data, although limited, indicate that the limits of PE 412 were generally met, except for suspended solids. Based upon the permitted incremental concentration of suspended solids above background concentrations at the permitted discharge rate, a suspended solids loading of 1 870 kilograms per day (kg/d) may be permitted. Based upon the actual annual median concentration of suspended solids and the permitted flow, the annual median suspended solids loading was 2 300 kg/d.

Cain et al.[8], in reporting on a trace organic contaminant survey carried out in 1978 on selected wastewaters, revealed that 1.3 µg/L of pentachlorophenol and 3.0 µg/L of 2.3,4,6-tetrachlorophenol were detected in this wastewater. These levels could be related to wood preservation facilities at the plant. The levels of these contaminants in associated waste streams, prior to their dilution, could be significant.

The EPS[50], through consultants, carried out a survey in 1978 at eleven sites where wood protection facilities existed. The results of this survey indicated that tissue samples collected adjacent to this plant were among those least contaminated, when compared to tissue samples analyzed at the other ten sites. Surface water samples collected adjacent to the plant in the Fraser River contained both penta- and tetrachlorophenol[50].

Singleton[4] reported on four bioassays conducted in the early 1970's by the Environmental Protection Service (EPS) using coho salmon. These tests revealed an intermittent toxicity coincident with boiler clean out, although the final combined effluent met the Federal Guidelines.

2.2.2 B.C. Forest Products Ltd., Hammond, (PE 2756)

This sawmill and shingle mill discharges hydraulic debarker effluent, boiler blowdown, gangsaw water, and compressor and turbine cooling water. The company installed a debarker effluent recycle system in May 1975 which eliminated most of the hydraulic debarker and gangsaw water. According to information provided by the company, this measure would reduce the wastewater discharge rate by 5 000 m^3/d. The suspended solids concentration associated with this discharge was estimated at 1 200 mg/L. The elimination of this discharge represents a loading reduction of 6 000 kg/d suspended solids.

The requirements for wastewater quality outlined in pollution control permit PE 2756, and a summary of monitoring data, are presented in Table 4. The effluent quality complied with the limits of PE 2756 although the effluent quantity exceeded the permitted discharge rate of 42 400 m^3/d by 3 400 m^3/d. The loading is estimated to be about 460 kg/d of BOD_5, and 3 390 kg/d of suspended solids, based upon the median annual concentrations and the median annual flow rate.

A survey of trace organics in selected wastewater discharges in 1978 indicated 0.2 μg/L pentachlorophenol and 0.7 μg/L 2,3,4,6-tetrachlorophenol in this wastewater[8]. These levels could be related to wood preservation facilities at the plant.

Bioassays were carried out on the wastewater using rainbow trout[4]. One test was performed in 1974 prior to the recycling of the debarker and gangsaw effluent. One test was also carried out in each of 1976 and 1977. All tests indicated that the wastewater was not lethal at 100 percent concentration.

2.2.3 Weldwood of Canada Ltd., T-Ply and Timberland, Surrey, (PE 3434)

This operation is a sawmill and plywood plant which utilizes mechanical debarkers. Cooling water (discussed in Section 8.2.2) and domestic sewage (discussed in Section 6.2.1) are discharged separately from the process wastewater. The process wastewater consists of boiler blowdown, dryer humidifying, and fire deluge water which is discharged to an exfiltration pond. Wastewaters which enter such ponds are not discharged directly to the river, but exfiltrate into the surrounding soil and groundwater. The groundwater thus becomes contaminated, and when in close proximity to the river, can enter the river carrying the contaminant load. Soil micro-organisms can have some effect in reducing the contaminant load entering the river.

Levels of specific contaminants allowed pursuant to pollution control permit PE 3434 and a summary of effluent monitoring data are included in Table 4. The levels specified are equal to or more restrictive than level A of the objectives. No data on flow are available. Loadings of total nitrogen and total phosphorus, based upon the permitted wastewater flow rate, were about 16 kg/d and 2 kg/d respectively.

The pH exceeded that permitted on at least one occasion between 1975 and 1977. As well, values indicating acidity in the effluent were noted. This may be significant since Drinnan and Clark[5] recorded low pH values in the river adjacent to this operation.

2.2.4 Canadian Forest Products Ltd., New Westminster, (CE 1656)

This plywood/hardboard plant discharged process wastewater to the river until August 1, 1976. At that time, the flow was diverted to the municipal sewer system, and the wastewater is now treated at the Annacis Sewage Treatment Plant.

In their permit application to the WMB, the company indicated that the 6 800 m^3/d discharged to the river had a suspended solids concentration of 515 mg/L (19.5 kg/tonne), a BOD_5 concentration of 1 420 mg/L (53.5 kg/tonne), a pH in the range of 6.5-8.5, and a concentration of phenols of 1.9 mg/L (kg/tonne represent kilograms per air dried metric tonne). Based upon these concentrations, the loading of BOD_5 and suspended solids would have been 9 650 kg/d and 3 500 kg/d respectively.

Six bioassays conducted by the company between August 21, 1975 and June 25, 1976 indicated that the 96-hour LC_{50} in all the tests was less than 5%. In total, between 1974 and 1976, fourteen bioassays were conducted on coho salmon and rainbow trout using 24-hour composite samples[4]. In all of these tests, the 96-hour LC_{50} ranged from 3% to 12%, indicating a toxic effluent. Singleton indicates that work carried out by Rogers et al. identified the major toxic fractions as resin acids and neutral compounds[4].

2.2.5 Lamford Cedar Ltd., New Westminster, (PE-414)

This sawmill operation discharges boiler blowdown to the Brunette River, approximately 100 metres above the confluence with the Fraser River. The blowdown has been the only wastewater discharged since 1971. At that time, domestic sewage was diverted to a holding tank.

The limits of pollution control permit PE 414, as well as a summary of the monitoring data, are included in Table 4. The monitoring data for temperature indicate compliance with the limits of PE 414, although pH was out of compliance with the range of 6.5 to 8.0.

Five analyses of blowdown between 1965 and 1974 indicated a median phosphorus concentration of 0.6 mg/L (range 0.03 to 1.82 mg/L). Four analyses for true colour between 1965 and 1974 indicated a median true colour of 1 500 units. No analyses for chromates or bioassays to measure acute toxicity were carried out. However, the permitted effluent flow rate of 0.13 m^3/d suggests this effluent will have little effect on the Fraser River.

2.3 Operations Discharging to the North Arm

These operations are presented in descending order of magnitude of the loading of suspended solids at existing operations. Operations which have discontinued direct discharges to the river are then presented.

2.3.1 Belkin Packaging Ltd., Burnaby, (PE 17)

This paperboard mill discharges process effluent and domestic sewage (discussed in Section 6.3.2). The process effluent has been treated using clarifiers since 1976.

The limits of pollution control permit PE 17, as amended in February 1980, as well as a summary of monitoring data, have been included in Table 5. The limits meet or exceed level "A" for kraft, sulphite, and mechanical mills. The pH, flow rate, suspended solids, and BOD_5 loadings to 1978 have not met the permitted levels. The loadings of suspended solids and BOD_5 per unit of production increased yearly between 1974 and 1977, even though the clarifier was added in 1976 to treat the wastewater. In fact, the clarifier was barely able to keep pace with the increased production rates.

The trend of discharging acidic effluents from this operation has continued through to the end of 1979. The median pH in 1978 was 6.3, while it was only 5.8 in 1979. Median pH values since 1974 have been as low as 5.0.

In August 1979, the use of a flocculating agent in the clarifier began on a continuous basis. As well, the recycling of underflow from the clarifier and the use of this material in stock preparation, reached complete utilization in September 1979. These two measures reduced the loading of suspended solids to the river for the period of September 1979 to the end of January 1980, to 16 000 kg/d, or 45% of the loading recorded from January 1979 to August 1979. The January 1980 loading of suspended solids (41 kg/tonne of product) compared favourably to the 1976 median suspended solids loading per tonne of finished product.

The mean BOD_5 loading to the river for the period of May 1979 to January 1980 was 7 100 kg/d. However, the modifications to the operation of the clarifier in August and September 1979 also affected the BOD_5 loadings. The mean BOD_5 loading of 8 900 kg/d in the period of May 1979 to August 1979, was reduced to 5 500 kg/d, in the period of September 1979 to, and including, January 1980.

The median loadings to the river of suspended solids and BOD_5 for the period 1974 to 1977 were obtained by averaging available median annual loadings per tonne of production and then multiplying by the average available median annual production for the same time period. This lead to loadings of about 3 600 kg/d of BOD_5 and 11 100 kg/d of suspended solids. Based upon the median concentrations between 1965 and 1973, loadings of 53.2 kg/d of zinc, 37.7 kg/d of nitrogen, 15.7 kg/d of iron, 2.5 kg/d of phosphorus, 1.8 kg/d of lead, 0.9 kg/d of copper and 0.3 kg/d of nickel occurred. The fact that these loadings may still be discharged to the North Arm of the river is a possible cause for concern due to the reduced flow in that section of the river[5]. However, the mill has stopped using zinc as a slimicide.

High values of resin acids, tannin and lignin, COD, and phenolic compounds were recorded occasionally in the wastewater between 1965 and 1973. Cain et al.[8], in a survey conducted in 1978, recorded trace amounts of 2,4,5-trichlorophenol and 2,4,6-trichlorophenol, as well as 5.4 µg/L of pentachlorophenol and 7.2 µg/L of 2,3,4,6-tetrachlorophenol. These compounds may result from the presence of a phenolic-based slimicide.

The effluent was analyzed on four occasions during April and May of 1979, for the presence of polychlorinated biphenyls. The results of the testing indicated a mean concentration of 2.37 µg/L, for a range from 0.074 µg/L to 4.6 µg/L. The mean loading of polychlorinated biphenyls to the river in April and May of 1979 was 0.06 kg/d, based on these data. Analyses of the sludge, which has been completely recycled within the plant since September 1979, indicated a mean polychlorinated biphenyl concentration of 26 650 µg/kg, with a range from 3 400 µg/kg to 68 500 µg/kg.

The 1980 amendment to PE 17 restricted the average monthly discharge of polychlorinated biphenyls to 0.11 kg/d. In addition, the company is required by PE 17 to carry out studies to determine methods of reducing the polychlorinated biphenyl loading to the river to below 0.11 kg/d.

Singleton[4] has indicated that the wastewater is acutely toxic. In twelve tests on rainbow trout between 1976 and 1977, the mean 96-hour LC_{50} was 52%. The range was from 30% to 87%.

The company engaged a consultant to formulate methods of reducing wastewater toxicity. The consultant reported in early 1979 that wastewater toxicity could be reduced by internally recycling aggressive wastewater streams and improving clarification with polymer addition[35]. As indicated earlier, many of these improvements were undertaken in August and September of 1979.

2.3.2 Rayonier Canada Ltd., New Westminster, (PE-4959)

This operation discharges cooling water (discussed in Section 8.3.9) and wastewater from a hydraulic debarker. The hydraulic debarker is to be replaced by the end of 1980 with a mechanical debarker. This discharge is not covered by a permit for that reason. The company has indicated that the quality of this wastewater would be such that the concentration of suspended solids would be approximately 1 075 mg/L, the concentration of BOD_5 would be 50 mg/L, and the daily flow would be approximately 8 200 m^3/d. This screened effluent would therefore contribute 8 815 kg/d of suspended solids and 410 kg/d of BOD_5.

2.3.3 Rayonier Canada Ltd., Vancouver, (PE 4960)

This sawmill/planermill operation discharges three wastewaters. One of these is cooling water (discussed in Section 8.3.10), one is wastewater from an hydraulic debarker, and the third is from a sawdust recovery system associated with occasional log bucking. Pollution control permit PE 4960, did not impose limits on the effluent quality from the hydraulic debarker since it is to be replaced by the end of 1981. The company has indicated that this wastewater, after screening, has a suspended solids concentration of 820 mg/L, a BOD_5 concentration of 10 mg/L, and a flow rate of 4 550 m^3/d. This represents a loading to the river of about 3 730 kg/d of suspended solids and 45 kg/d of BOD_5.

Pollution control permit PE 4960 restricts the wastewater flow from the sawdust recovery system to 140 m^3/d.

2.3.4 Scott Paper Ltd., New Westminster, (PE 335)

This groundwood pulp and paper mill was originally built in 1926. Since 1970, logs have been mechanically debarked, and bark, screenings and sawdust have been used as landfill.

Three separate discharges from the paper mill were combined into one discharge in April 1971. A second wastewater is discharged from the groundwood operation.

The wastewater from the paper mill has been treated since 1971 using screens, a flocculation system, a flotation tank, and a clarifier. The wastewater from the groundwood operation was diverted to the municipal sewage system in August 1977. This was an alternative to providing treatment for the removal of suspended solids and BOD_5, and reducing the toxicity of the wastewater. Fibre-free effluent from the groundwood pulping area and cooling water are discharged separately, and are discussed in Section 8.3.1. Domestic sewage, which was discharged raw to the river, has been diverted to the municipal sewage system.

Monitoring data on the groundwood mill wastewater is included in Table 6(b). It is estimated that this wastewater contributed a loading of about 485 kg/d of BOD_5 and 440 kg/d of suspended solids. These estimates are based upon the means of the median values in Table 6(b).

Levels of contaminants in the wastewater from the paper mill, allowed by pollution control permit PE 335, as well as a summary of the monitoring data, have been included in Table 6(a). The levels permitted by PE 335 are at least equal to level "A" of the objectives, based upon the 1977 ninety percentile production rate. The loading of suspended solids was about 2 600 kg/d and of BOD_5 was 1 100 kg/d, based upon the median concentrations and the median wastewater discharge rate for the period to December 1977. Thereafter, the loadings of both BOD_5 and suspended solids were approximately 1 000 kg/d each in 1978 and 1979.

One analysis for true colour in 1977 indicated 30 colour units in the paper mill wastewater. This value rose to 100 colour units in 1979. The median pH was 6.6 pH units, although the range of values was from 3.0 to 10.5 for the period to December 1977. Drinnan and Clark[5] have indicated a concern for high pH discharges to the river. Results for pH indicated that the maximum value in 1978 was 7.3, while it was 7.7 in 1979.

Cain et al.,[8] reported on a survey of trace organics in selected wastewaters in 1978. The wastewater from this operation contained 5.4 μg/L of 2, 4, 6-trichlorophenol, 0.2 μg/L of pentachlorophenol, and 0.2 μg/L of 2, 3, 4, 6-tetrachlorophenol. These phenolic compounds may originate in a slimicide used in the operation.

Three bioassays carried out in 1975 using coho salmon indicated that the groundwood mill wastewater had a 96-hour LC_{50} greater than 90%[4]. Nineteen bioassays carried out on paper mill wastewater between 1975 and 1977 using coho salmon and rainbow trout indicated the same result. A slight toxicity was noted in four of the nineteen tests.[4]

2.3.5 Canadian Forest Products Ltd., Eburne Sawmill Division, Vancouver, (PE 2115)

This operation consists of three sawmills, a planermill, and a shingle mill. The wastewater is discharged from three outfalls, two of which discharge steam condensate. The third discharges condenser cooling water and a small quantity of boiler blowdown water, and is discussed in Section 8.3.5.

A major rebuilding of the operation was begun in 1973. Prior to that time, wastewater originated from fourteen sources. This number was reduced through a series of steps. These steps included diverting domestic sewage to the municipal system in 1977, combining or recycling steam condensates and cooling waters, and replacing two hydraulic debarkers in 1974 and 1975 with mechanical debarkers.

Analyses of the hydraulic debarker effluent, between March and December 1975, indicated a mean suspended solids concentration of 2 413 mg/L and a mean BOD_5 concentration of 148 mg/L. The use of mechanical debarkers reduced the wastewater volume by 6 800 m^3/d. Thus, the replacement of the hydraulic debarkers reduced the loadings to the river by 16 400 kg/d for suspended solids and 1 000 kg/d for BOD_5.

Pollution control permit PE 2115 restricted the temperature of both sources of steam condensate to 35^oC, and the flow rates to 22.7 m^3/d and 13.6 m^3/d. Monitoring data for temperature and flows at both of these outfalls, identified as 2115-01 and 2115-02, are included in Table 38. The pH of one of these discharges, not recorded in Table 38, has ranged from 4.5 to 7.6 between 1975 and 1978. No other data on pH in these wastewaters were received.

Eleven bioassays were performed in 1972, prior to the hydraulic debarkers being replaced with mechanical debarkers. Although the species of fish tested is not known, it has been indicated that the mean 96-hour LC_{50} was 13.3%[4]. The range of 96-hour LC_{50} values was from less than 5% to 60%. Eighty percent of the 96-hour LC_{50} results were less than 10%. There are no bioassay data available on the remaining discharges.

2.3.6 Crown Zellerbach Canada Ltd., Richmond, (PE 3264)

This lumber mill cuts cedar into rough boards. The wastewater from this operation consists of return water from the log bucking sawdust recovery system. Also discharged from this operation is compressor cooling water, discussed in Section 8.3.8, and domestic sewage, discussed in Section 6.3.7.

Approximately 2 600 m^3/d of screened hydraulic debarker effluent ceased being discharged to the river in July 1974. At that time, the company began to recycle this wastewater completely. As well, approximately twenty percent of the return water from the log bucking sawdust recovery system is used as make-up water for the debarker system.

No data are available on the quality of the debarker effluent prior to its being recycled. However, the EPS[6] cited the work of Glasser and Reed who found that in a survey of eight screened hydraulic debarker effluents, the suspended solids ranged from 521 to 2 362 mg/L and the BOD_5 ranged from 56 to 250 mg/L. Using the midpoints of these ranges as the approximate concentrations in the discharge, it is estimated that the loadings to the river after July 1974 were reduced by 3 750 kg/d for suspended solids and 400 kg/d for BOD_5.

The flow of return water from the log bucking sawdust recovery system is restricted by pollution control permit PE 3264 to 2 227.5 m^3/d. A summary of data from 1975-1977 has been included in Table 4. The loading of suspended solids to the river, based upon the median concentration and flow rate for the period of record, is 48.5 kg/d.

2.3.7 MacMillan Bloedel Ltd., New Westminster, (PE 1664)

This sawmill operation discharges three separate wastewaters. One of these is a mixture of cooling water and washdown water. This is discharged into a municipal stormwater ditch. Other wastewaters consist of boiler blowdown and steam condensate.

The hydraulic debarker was replaced with a mechanical unit in 1974. Information provided by the company indicated that this would reduce the flow by 3 300 m^3/d, and the suspended solids loading by 1 056 kg/d.

Limits prescribed by pollution control permit PE 1664, as well as a summary of the monitoring data, are included in Tables 7(a) and 7(b). The data for the steam condensate indicate general compliance with the pH and flow limits. Oil and grease limits however, were exceeded. The levels of contaminants in the boiler blowdown usually met the limits of PE 1664 for all parameters except pH. The pH of the boiler blowdown ranged from 1.2 to 9.3.

Cain et al.,[8] reported on analyses of both the steam condensate and the cooling water and washdown water for phenolic compounds. None were detected in the steam condensate discharged. The cooling water and washdown water contained 6 µg/L of 2, 3, 4, 6-tetrachlorophenol, 1.2 µg/L of pentachlorophenol, and a trace of 2, 4, 6-trichlorophenol. These levels could result from wood preservation facilities at the operation.

2.3.8 MacMillan Bloedel Ltd., Canadian White Pine Division, Vancouver, (PE 1666)

This sawmill operation discharges wastewater from three outfalls, although at one time the number of outfalls was eight. One measure which reduced the number of wastewater outfalls was the replacement of hydraulic debarkers with mechanical debarkers. This occurred in 1977.

One of the wastewaters discharged is uncontaminated cooling water, discussed in Section 8.3.15. A second is contaminated cooling water, while the third is return water from the log bucking recovery system.

Pollution control permit PE 1666 limited the discharge of return water from the log bucking recovery system to 1 370 m^3/d. Wastewater monitoring was not required except for cooling water, and no monitoring data are recorded within EQUIS.

The largest wastewater volume discharged is contaminated cooling water (73 000 m^3/d-permit level). A median oil and grease concentration of 1.5 mg/L was recorded in each of 1978 and 1979, for a range of values from 0.9 mg/L to 3.3 mg/L. The pH ranged from 6.8 to 7.7, while recorded flows have ranged from 49 000 m^3/d to 54 500 m^3/d. These data have not been tabulated elsewhere in this report.

The wastewater volume was reduced by 26 800 m^3/d when the hydraulic debarkers were replaced. The company also indicated that the suspended solids concentration was 110 mg/L. Thus the suspended solids loading to the river was reduced by 2 950 kg/d.

The EPS[50], through consultants, carried out a survey in 1978 of eleven sites where wood protection facilities existed. The results of this survey indicated that tissue samples collected adjacent to the plant were among those most contaminated, when compared to tissue samples analyzed at the other ten sites. Surface water samples collected adjacent to the plant in the Fraser River contained both penta- and tetrachlorophenol[50].

One bioassay using coho salmon was carried out in 1972.[4] It revealed that the wastewater (source unknown) was not lethal at 100% concentration.

2.3.9 Rayonier Canada Ltd., Silvichemical Division Rayflo Plant, Vancouver, (PE 3087)

This operation, which closed in April 1976, extracted wood chemicals from wet hemlock bark. The extract was used to produce concentrated polyphenols for use as drilling mud additives, boiler feedwater additives, and metal chelating compounds. Wastewater was generated at the extraction plant and the evaporation plant.

The wastewaters from both sources were analyzed once in December 1974. The data, included in Table 8, indicate the presence of phenols, sulphides, tannin and lignin, and resin acid soaps. It is also expected that the wastewater would have contained certain heavy metals, specifically copper, chromium, iron and zinc.

Bioassays conducted on the two wastewaters in November and December 1973 indicated that the effluent associated with the evaporation plant was not lethal. The 96-hour LC_{50} for wastewater from the extraction plant ranged from 16.5% to greater than 55%. Singleton[4] indicated that, based upon one test during 1974 on each of the effluents, the 96-hour LC_{50} of the extraction plant effluent was 45% while the 96-hour LC_{50} of the evaporator plant effluent was 75%.

2.3.10 MacMillan Bloedel Packaging Ltd., New Westminster, (PE 108)

This corrugated container plant began operation in 1954. The processes involved at the plant include the manufacture of corrugated board, and the subsequent cutting, printing, folding, and binding of cardboard boxes.

An extensive program of wastewater recycling within the operation, completed in 1974, eliminated nearly seventy-five percent of the flow which had been discharged to the river. Sources of contaminants which were eliminated as a result of this program included starch adhesive wash-up, flexographic printer wash-up, and lithographic printer ink wash-up. The starch adhesive contained borax, caustic soda and formaldehyde resin, while the flexographic inks contained waxes, and organic solvents such as ketone, and isopropanol. A part of this program included the installation of an oil separator to recover lubricating oil.

The wastewater is discharged to the river from two outfalls. One carries uncontaminated cooling water (discussed in Section 8.3.22). The second discharge consists of boiler blowdown water and at times, treated contaminated plant wastewater.

An historical data summary, as well as levels of contaminants allowed by pollution control permit PE 108, are included in Table 9. Temperature, measured on one occasion, was the only parameter which met the specified limits. Data were to be submitted only when discharges occurred. The WMB, based upon site inspections and the lack of data since 1974, does not believe discharges have occurred from this operation since 1974.

The true colour averaged 40 units on two occasions between 1965 and 1974. Although some significant concentrations of several contaminants such as zinc, lead, copper, phenols, oil and grease, and COD were recorded prior to 1974, the discharge rate is such that the loadings of these contaminants is small. However, localized toxicity within the receiving water may occur due to this discharge.

One toxicity test performed by the company, prior to the implementation of the wastewater recycle program, indicated a 96-hour LC_{50} of 40%. The lack of monitoring data since 1974 does not permit conclusions on the effect of the wastewater recycle program on effluent quality.

2.4 Operations Discharging to the Main Arm

Both operations in this section now discharge to the municipal sewer system.

2.4.1 MacMillan Bloedel Ltd., Island Paper Mills Division, (PE 35)

This non-integrated single machine fine grade paper mill uses purchased pulp to produce approximately 200 grades of paper. The wastewater, which consists of domestic sewage and process wastewater, was discharged to the river until October 31, 1978. On that date, these flows were diverted to the municipal sewer system.

No external wastewater treatment was used. However, certain in-plant controls were utilized. These were generally in place by the end of 1974, and involved the recycling of water within the plant.

Levels prescribed by pollution control permit PE 35, as well as a summary of monitoring data, have been included in Table 10. The levels prescribed were approximately equal to level "B" of the objectives. Data obtained from the WMB files, but not tabulated in this report, indicated average monthly suspended solids loadings from 6 to 11kg/tonne and BOD_5 loadings from 5 to 8.25 kg/tonne during 1976. Based upon the median flow rate and concentrations, the BOD_5 loading to the river was 530 kg/d and the suspended solids loading was 440 kg/d.

Singleton[4] has indicated that eighteen of twenty-four bioassays using rainbow trout during 1976 and 1977 had a 96-hour LC_{50} greater than or equal to 90%, with a mean 96-hour LC_{50} of 90.3%, and a range of 96-hour LC_{50} values from 45.5% to greater than 100%. This would indicate that the toxicity limit specified in PE 35 was generally met.

2.4.2 Crown Zellerbach Canada Ltd., Richmond Paper Products (PE 3265)

The company manufactures boxes, bags, and wrapping paper at this operation. The wastewater consists of uncontaminated vacuum pump seal water, domestic sewage, starch adhesive wash-up and compressor cooling water. The vacuum pump seal water is discussed in Section 8.4.2. The domestic sewage, the starch adhesive wash-up and compressor cooling water were diverted to the municipal sewer system in March 1975.

The company estimated the average flow of starch adhesive wash-up and compressor cooling water to be 125 m^3/d, with a suspended solids concentration of 900 mg/L and a BOD_5 concentration of 360 mg/L. This would have resulted in approximate loadings of 110 kg/d for suspended solids and 45 kg/d for BOD_5.

2.5 Discussion of the Forest Industry

A summary of flow rates and BOD_5 and suspended solids loadings has been presented in Table 11. These parameters are also presented graphically in Figures 2, 3 and 4 to show how they have changed in the period 1970 to 1978, and how they are expected to change by approximately 1981.

The forest industry has concentrated the largest number of operations along the North Arm of the river. Since this river section carries only fifteen percent of the river flow(5), it is less able to absorb as significant a loading as the other sections of the river.

By the end of 1981, the forest industry is expected to reduce the effluent flows discharged to the river by 37% compared to 1971. Associated with this flow reduction will be a suspended solids loading reduction of 70% (approximately 35 000 kg/d) and a BOD_5 loading reduction of over 30% (approximately 2 400 kg/d). These reductions will be generally brought about through the replacement of hydraulic debarkers with mechanical debarkers at six operations.

The single largest BOD_5 and suspended solids loading reduction to the North Arm occurred in 1975 when the Canadian Forest Products Eburne Sawmill (PE 2115) replaced its hydraulic debarkers. The largest flow reduction occurred in 1977 when an estimated 26 800 m^3/d was eliminated with the replacement of the hydraulic debarkers at the MacMillan Bloedel sawmill in New Westminster (PE 1666).

Drinnan and Clark(5) have indicated that 15% of the river flow in the Main Stem of the Fraser River, as measured at the Pattullo Bridge, enters the North Arm of the river. They have further noted low flows for the river of 900 m^3/s Based upon these values, the suspended solids loading reduction could have lowered suspended solids concentrations at low flows in the North Arm of the river by 3 mg/L.

The largest single source of suspended solids and BOD_5 to the North Arm of the river is Belkin Packaging (PE 17). It is estimated that this operation discharged 3 600 kg/d of BOD_5 and 11 100 kg/d of suspended solids. Based upon analytical data obtained prior to 1974, it is estimated that the company also discharged 37.7 kg/d of total nitrogen, 15.7 kg/d or iron, 2.5 kg/d of total phosphorus, 1.8 kg/d of lead, and 0.9 kg/d of copper.

An amendment to Belkin Packaging's (PE 17) pollution control permit in February 1980 required that the company investigate methods of reducing polychlorinated biphenyls in its effluent. Data obtained in 1979 indicated an average loading of 0.06 kg/d of polychlorinated biphenyls in the effluent, approximately one half of the loading allowed by the permit.

Belkin Packaging effluent (PE 17) had a tannin and lignin content of 20.4 mg/L. The Rayonier Silvichemical Plant, which closed in 1976, had a tannin and lignin concentration in the extraction plant wastewater of 15.8 mg/L.

Although the flow rate and the suspended solids and BOD_5 loadings from Scott Paper (PE 335) have been reduced, the flow from the groundwood section of the plant has not been eliminated from the Fraser River since the effluent has been diverted to the municipal sewerage system (through the Annacis STP). The Annacis STP, which utilizes primary treatment in the form of sedimentation, removes approximately 35% of the BOD_5 loading and 60% of the suspended solids[(7)].

Both Island Paper Mills (PE 35) and Richmond Paper Products (PE 3265) discharged directly to the Main Arm of the river until the end of 1978 when their flows were diverted to the Annacis STP. Three operations (PE 412, PE 2756, PE 3434) located along the Main Stem of the river continue to discharge wastewater directly to the river. Effluent flows from the forest industry to the Main Stem of the river have only been reduced by ten percent. This occurred through the diversion of the Canadian Forest Products' wastewater (CE 1656) to the municipal sewer system, and the replacement of a hydraulic debarker at B.C. Forest Products (PE 2756).

Canadian Forest Products (CE 1656), indicated in their permit application that their wastewater had a phenol concentration of 1.9 mg/L. Phenols have also been recorded in the MacMillan Bloedel Packaging New Westminster plant wastewater (PE 108) at a median concentration of 0.04 mg/L, in the effluent from both the extraction plant

(0.85 mg/L) and evaporator plant (1.4 mg/L) at the Rayonier Canada Ltd., Silvichemical operation (PE 3087), and in the wastewater from Belkin Packaging (PE 17) at a concentration of 0.093 mg/L.

Cain et al.[8] indicated that from a preliminary survey carried out in 1978, which was based upon one grab sample from most effluents, measurable levels of pentachlorophenol, 2,3,4,6-tetrachlorophenol, and on occasion 2,4,6-trichlorophenol and 2,4,5-trichlorophenol were found in forest industry wastewaters. These levels could be related to wood preservation or use of slimicides. These wastewaters included cooling water from the MacMillan Bloedel sawmill (PE 1664) and process water from Scott Paper (PE 335), MacMillan Bloedel Finepaper Mill (PE 135), B.C. Forest Products Hammond (PE 2756), Crown Zellerbach (PE 412), and Belkin Packaging (PE 17). The highest levels of pentachlorophenol (5.4 µg/L) and 2, 3, 4, 6-tetrachlorophenol (7.2 µg/L) at any forest industry operation were recorded at Belkin Packaging (PE 17). The Scott Paper operation recorded the highest level of 2, 4, 6-trichlorophenol (5.4 µg/L). Cain et al.[8] also indicate that other phenolic compounds may be present at similar levels but were not recorded because these compounds have higher analytical detection levels.

The 1978 EPS survey[50] found that surface water samples in the river, adjacent to both the McMillan Bloedel Canadian White Pine operation (PE 1666) and the Crown Zellerbach Fraser Mills operation (PE 412), contained quantities of pentachlorophenol and tetrachlorophenol. Tissue samples at Canadian White Pine (PE 1666) were among the most highly contaminated, while those from Fraser Mills (PE 412) were among the least contaminated in the survey.

Bioassay results have indicated that, on at least one occasion, the wastewaters from Scott Paper (PE 412), Canadian Forest Products (PE 1656), Belkin Packaging (PE 17), Canadian Forest Products (PE 2115), Rayonier Silvichemical Division (PE 3087), MacMillan Bloedel Island Paper Mills (PE 35), and MacMillan Bloedel Packaging (PE 108) were acutely toxic to salmonids. Rayonier Silvichemical Division (PE 3087) closed in April, 1976, while Canadian Forest Products (PE 1656) and MacMillan Bloedel Island Paper Mills (PE 35) now discharge to the municipal sewer system. The remaining wastewaters cited by Singleton[4] continue to be discharged directly to the Fraser.

The process wastewaters from the forest industry, for those operations which continue to discharge into the river within the study area, usually are treated by proven treatment methods. At operations where limits are not met, there are indications that the wastewater treatment facilities are undersized for the loadings applied. The pollution control permits usually require that limits for level "A" of the objectives be met at operations which continue to discharge to the river.

2.6 Conclusions and Recommendations

The wastewater which continues to be discharged to the river usually has pollution control permit levels equal to, or more stringent than, level "A" of the objectives. These levels have not always been met at Belkin Packaging (PE 17) or Scott Paper (PE 335) according to the available monitoring data. Steps should be taken to verify the data and if necessary, upgrade the quality of these effluents in order to meet these limits.

The elimination of approximately 35 000 kg/d of mostly organic suspended solids to the North Arm between 1971 and 1981 could reduce the incremental concentration of suspended solids in the North Arm by an estimated 3 mg/L at low flows. This, as well as the implementation of increased dry land log storage, should improve the river water quality. (*)

The discharge of chlorophenols above the levels recommended by EPA for the freshwater environment is of concern due to their high toxicities, persistence, and the possibility of tainting of fish flesh. Chlorinated phenolic compounds should therefore be investigated more fully in all wastewater discharges to the river associated with this industrial sector. Other substances which should be investigated more fully include resin acids, terpenes, and other trace organics. Garrett has discussed elsewhere[46] environmental levels and relative toxicities of trace organics.

3. THE FOOD INDUSTRY

3.1 Introduction

Fruit canning, meat processing, vegetable packaging, and fish processing operations discharge wastewater into the Fraser River within the study area. Except for meat processing, these processes are operated on a seasonal basis. The locations of these operations are indicated in Figure 5.

3.1.1 Guidelines/Objectives/Regulations

The Pollution Control Board issued objectives for discharges from food processing operations in January 1975[9]. Objectives applicable to operations within the study area have been included in Tables 12(a) to 12(c). Level "A" objectives are limits which all new operations should meet. Level "C" objectives were to be met by all operations in existence when the objectives were proclaimed. Existing operations were then expected to upgrade wastewater quality so that it could meet level "B" and later level "A" objectives. No time frames were referenced for these changes to take place.

The EPS has issued regulations and/or guidelines for fish processing operations (May 1975)[47], potato processing operations (June 1977)[40], and meat and poultry operations (June 1977)[39]. The federal guidelines for fish processing operations do not prescribe limits for contaminants in wastewater. The guidelines prohibit the discharge of stickwater, press liquor, or bloodwater to a receiving stream. The guidelines also require operations to install solids removal facilities equivalent to a 25 mesh screening device. The intent of this was to prevent sludge build-up near the outfall[10].

Levels for specified contaminants outlined in the federal meat plant regulations and guidelines are included in Tables 13(a) and 13(b). A comparison of these levels with the provincial objectives is approximate since the federal requirements are expressed in terms of "dressed weight" while the objectives are in terms of "live weight". The provincial and federal requirements have been compared in Table 14.

The federal potato processing regulations and guidelines are included in Tables 15(a) and 15(b), and can be compared to the provincial objectives in Table 12(c).

Generally, for the different food industry operations, the federal and provincial requirements are similar, although one or the other may be more restrictive.

3.1.2 Sources of Contaminants

(a) Fish Processing

Wastewaters generated by fish operations usually contribute significant loadings of organics in the form of BOD_5 and suspended solids, as well as ether soluble oils. Many species of fish are processed differently in order to produce a saleable product.

The processing of salmon generates two wastewaters. Salmon are commonly unloaded hydraulically, and the water used in this process is recycled until this operation is completed. It is then discharged. Villamere[13] has indicated that this process utilizes approximately 10 m^3 of water per standard catch, with a BOD_5 of 3 470 mg/L and a suspended solids concentration of 937 mg/L.

The other process wastewaters are generated from preparing the salmon for freezing or canning, and include washwater, retort water and cooling water. The mechanical processing of the salmon has, at some plants, been shown to use approximately seventy percent less water than handprocessing and to reduce the BOD_5 loading by about six percent[13]. However, it increases the suspended solids loading by thirty-five percent and the soluble oil loading by over ninety percent.

In herring roe production, the major sources of wastewater are pumpout water, and water used in the cutting process for roe removal. The BOD_5 loading from the overall wastewater is in the range of 14 to 26 kg/t of raw fish with the pumpout water contributing 11 kg/t[13]. The suspended solids loading is in the range of 9 to 29 kg/t with the pumpout water contributing 7 kg/t. Water usage ranges from 3 to 10 m^3/t.

Fish reduction plants have significantly higher concentrations of BOD_5, suspended solids, and ether soluble oils than other fish processes. Villamere[13] had indicated BOD_5 concentrations in bloodwater and stickwater from 80 000 to 100 000 mg/L, and in evaporator condensates and deodorizer water from 100 to 500 mg/L; suspended solids concentrations in bloodwater and stickwater from 15 000 to 20 000 mg/L, and in evaporator condensates and deodorizer waters from 50 to 200 mg/L; and ether soluble oils concentrations in bloodwater from 1 000 to 2 500 mg/L, in stickwater from 1 500 to 2 500 mg/L, and up to 100 mg/L in evaporator condensates and deodorizer water.

Different species of groundfish can produce wastewaters with significantly different characteristics. The BOD_5 concentrations[14] can be as high as 150 mg/L for halibut, 195 mg/L for sole, and 540 mg/L for ocean perch. The suspended solids concentrations[14] can be as high as 110 mg/L for halibut, 85 mg/L for sole, and 1 395 mg/L for ocean perch.

(b) Fruit and Vegetable Processing

Contaminants are generally introduced in the washing, rinsing, peeling and blanching processes. Large volumes of water, used in washing and rinsing, leach biodegradable, soluble organic compounds such as sugars, acids and starches and can contain quantities of pesticides.

Peeling can be carried out using mechanical cutting, heated air, steam or hot water, or through the use of caustic soda in the form of a lye solution. Caustic peeling can also be accompanied by two removal techniques. One of these is dry removal which mechanically peels the product. The other is by wet removal where high pressure water sprays remove the product's skin.

Blanching is carried out prior to canning, freezing, or dehydration to inactivate enzymes and destroy micro-organisms. Blanching can be carried out using steam which is injected into a steel tank, or by using hot water through which the product is passed. Plant clean-up also generates contaminated wastewater.

A literature[17] review of the major commodity groups indicated that the major sources of contamination are evenly divided among the washing, peeling, blanching, and clean-up processes. The major contaminant sources are commodity dependent. Data in the literature indicated that of any commodity, beets have the highest BOD_5 loading (4 900 kg/d) in its raw wastewater[17]. Tomatoes generate the largest suspended solids loading (5 050 kg/d) in raw wastewaters. Among commodity groups, flows can range from 178 to 6 780 m^3/d, BOD_5 concentrations can range from 363 to 3 710 mg/L, and suspended solids concentrations can range from 70 to 1 350 mg/L.

(c) Meat Processing

The major steps in slaughterhouse operations are the killing of the animal with subsequent hide removal (cattle) or scalding and dehairing (hogs), eviscerating, washing and cooling of the carcasses.

Blood has a BOD_5 of between 150 000 mg/L and 200 000 mg/L[19]. Depending upon whether blood is collected during the killing operation, blood can account for BOD_5 loadings between 3 kg/t and 15 kg/t. Paunch manure can account for a BOD_5 loading of 1.5 kg/t, hog scald tank water for a BOD_5 loading of 0.25 kg/t, and dehairing machine water for a BOD_5 loading of 0.4 kg/t[19].

Meat specialty operations generate wastewater loadings during blending processes, filling, cooking and plant clean-up. It is estimated, based upon the amount of finished product, that loadings from these types of operations could be approximately 9.5 kg/t of BOD_5, 6.1 kg/t of suspended solids, 0.1 kg/t of total phosphorus, 0.6 kg/t Kjeldahl nitrogen, and 4 kg/t of oil and grease. The associated wastewater flow would be approximately 10 m^3/t[19].

3.1.3 Wastewater Treatment Methods

(a) Fish Processing Operations

Wastewater quality can be improved through in-plant control measures as well as more conventional wastewater treatment methods. Vacuum systems can be used to reduce water quantities used for unloading. Claggett[15] indicated that Environment Canada studies on the adoption of dry fish handling techniques used throughout a groundfish operation have shown that the BOD_5 and suspended solids loadings "can be reduced by at least fifty percent". He also describes other measures which have only a minimal impact.

The conventional wastewater treatment method for fish operations is screening. Screens can remove coarse solids, but fine screens have not been successful because raw protein and fish oil can plug small screen openings (less than 0.25 inch square). Fine screens equipped with cleaning devices, or self-cleaning fine screens, can operate trouble-free. In order to remove soluble solids and additional quantities of suspended solids, chemical treatment using aluminum sulphate (alum), sodium hydroxide, and a polyelectrolyte are utilized. This produces a floc which can be separated using dissolved air flotation.

Work carried out by Claggett[16] on dissolved air flotation systems showed suspended solids removals of 86% for salmon canning wastewater, 95% for groundfish wastewater, and 74% for herring roe wastewater; soluble solids removals of 30% for salmon canning wastewater, 34% for groundfish wastewater, and 24% for herring roe wastewater; and C.O.D. removals of 84% for salmon canning wastewater, 58% for groundfish wastewater, and 66% for herring roe wastewater. These would be maximum removals under ideal operating conditions and constant operator attention. The Canadian Department of Agriculture has apparently approved the use of sludge from this type of treatment process as poultry feed[16]. However, sludge disposal from this type of treatment has been a problem due to a concern of feeders about additives in the sludge.

(b) Fruit and Vegetable Processing Operations

Wastewater loadings can be reduced within processing plants by modifying the process or operation. A pilot scale demonstration plant for cleaning of tomatoes without water has shown that water usage can be reduced by approximately 80%[17]. Dry caustic peeling can reduce water usage by 80% to 90%. Steam blanching can reduce water usage by approximately 50%. High pressure-low volume clean-up can reduce water usage by about 25%.

External wastewater treatment methods can utilize proven biological treatment. However, a neutral pH is required before treatment. Biological treatment is normally preceded in the flow sequence by physical solids-separation. This can be accomplished using screens, gravity clarifiers, dissolved air flotation, or chemical precipitation.

Effective biological treatment requires a BOD_5:N:P ratio of between 100:6:1 and 100:3:1[18]. This ratio is seldom found in fruit and vegetable wastewaters[17], necessitating the addition of nutrients. As well, the organic nature of the nitrogen in these wastewaters means that the nitrogen is not readily available to support the growth of micro-organisms.

(c) Meat Processing Operations

In-plant controls can be instituted to reduce the loadings in wastewater streams. The most significant reduction can be made by ensuring that blood is almost totally collected in a blood collection system. Associated with this process would be the cleaning without water of floors and walls, followed by a minimum quantity of first wash water being directed to the blood collection system. Mechanical dumping of paunch contents, as well as the collection, treatment and reuse of scald tank water can reduce wastewater volumes.

Similar wastewater treatment systems to those utilized in fruit and vegetable processing operations, but without neutralization or nutrient addition, are also used as external wastewater treatment methods in meat processing operations.

3.2 Operations Discharging to the Main Stem

The one operation which continues to discharge to this section of the river is discussed first, followed by discussion of an operation which has closed.

3.2.1 Berryland Canning Company Ltd., Maple Ridge, (PE 260)

This fruit and vegetable canning operation generates three liquid effluents, two of which are cooling water (discussed in Section 8.5.1) and one composed of process water and domestic sewage. The process water and domestic sewage are treated using screens, a settling tank, and a holding reservoir. Additional screens, a surface aeration basin, a clarifier, and facilities for pH adjustment are to be built as part of a plant expansion, the first stage of which was to have been completed in July 1980. Ultimately, construction should be completed in July, 1982.

Levels of specified substances allowed in the wastewater pursuant to pollution control permit PE 260, as well as a summary of monitoring data, have been included in Table 16. The pH in the wastewater has ranged from 2.3 to 12.3. In general, acidic or alkaline conditions can be equally detrimental to various aquatic forms in the receiving stream. However, Drinnan and Clark[5] have indicated that the Fraser River has minimal buffering capacity for alkaline discharges.

The proposed limits for BOD_5 and suspended solids were met on less than fifty percent of the occasions when the effluent was sampled. However, this situation should improve when the new wastewater treatment facilities are constructed. The loadings of these contaminants, based upon their median concentrations and the median discharge rate to the end of 1977, were 800 kg/d of BOD_5 and 100 kg/d of suspended solids. The

BOD_5 loading rose to 1 650 kg/d during 1978, while the suspended solids concentration rose to 130 kg/d. Data obtained on one occasion in 1978 for Kjeldahl nitrogen and total phosphorus, indicated loadings to the river of 19 kg/d of nitrogen and 24 kg/d of phosphorus.

Singleton[4] has indicated that one bioassay was carried out in 1973 on coho salmon, using liquid from the settling tank when peaches were being processed. It had a 96-hour LC_{50} of 42% v/v.

3.2.2 Clappison Packers Ltd., Haney, (PE 100) (PE 3743)

This slaughterhouse closed in 1977. Wastewater discharges consisted of process wastewater and domestic sewage. These wastewater sources were eventually separated. The discharge of domestic sewage was authorized by pollution control permit PE 3743 and is discussed in Section 6.2.8.

It is believed that the volume of wastewater discharged was approximately 65 m^3/d, that the concentration of suspended solids ranged from 100 mg/L to 1 066 mg/L, and the concentration of BOD_5 ranged from 153 mg/L to 579 mg/L. Using mean concentrations, the loadings to the river would have been 40 kg/d of suspended solids and 25 kg/d of BOD_5.

One bioassay conducted using coho salmon in 1972 indicated that the wastewater had a 96-hour LC_{50} greater than 100%[4].

3.3 Operations Discharging to the North Arm

The two largest continuous contaminant sources to this section of the river are discussed initially. Discussion then follows of an operation which now sends its wastewater to a municipal sewer, as well as an operation which discharges intermittently.

3.3.1 Puritan Canners, Richmond, (PE 36)

Puritan Canners (PE 36) produces convenience foods primarily with a meat base. The operation consists of placing the contents into cans which are subsequently closed, washed, cooked for sterility, chilled, labelled and placed into cartons for shipping.

Pollution control permit PE 36 was amended in 1973. The amendment eliminated limits on pH, suspended solids, BOD_5, and coliform concentrations in the wastewater. The basis for this amendment was that only cooling water would be discharged to the river after July 1, 1974. Process washwater and domestic sewage were to be diverted to the municipal sewage system at that time. This diversion did not occur until August 1979.

Domestic sewage was treated in a septic tank while the process washwater was treated in a four-stage catch basin. These wastes are now being pretreated in an aerated lagoon prior to discharge to the municipal sewage system.

A summary of monitoring data, as well as the pre-1974 limits outlined in PE 36, is included in Table 16. The BOD_5 loading, based upon one analysis, was 315 kg/d. The suspended solids loading, based upon nine analyses, was 5 kg/d.

3.3.2 Richmond Packers, Richmond, (PE 90)

This abattoir discharges process wastewater which has passed through screens, settling tanks, and coal treatment beds. The WMB has indicated in a technical assessment of the operation that the coal bed acts as an anaerobic filter which converts organics to carbon dioxide, methane and water.

A summary of monitoring data, as well as limits allowed pursuant to pollution control permit PE 90, are included in Table 16. The limits outlined are equivalent to level "A" of the objectives.

Oil and grease levels were always less than permitted. Suspended solids and BOD_5 concentrations met the limits on approximately fifty percent of the analyses. It is doubtful if this wastewater quality will improve since no further wastewater treatment works have been initiated.

Loadings of suspended solids and BOD_5, based upon their median concentrations to December 1977, and the maximum permitted flow rate, were 3 kg/d for both contaminants. Loadings of total phosphorus and total nitrogen were 0.5 kg/d and 1.9 kg/d, respectively. Analytical results for 1978 and 1979 indicated that the suspended solids loading was 250 kg/d, the BOD_5 loading was 190 kg/d, the Kjeldahl nitrogen loading was 340 kg/d, while the total phosphorus loading was 80 kg/d.

The median fecal coliform content was 3 900 MPN/100 mL (MPN is the most probable number) between 1974 and 1977. Churchland[20] has indicated that the geometric mean fecal coliform level in the reach of the river nearest to this discharge ranged from approximately 200 MPN/100 mL in 1977 to 2 200 MPN/100 mL in 1974.

Bioassays of the wastewater in 1974 and 1975 using coho salmon indicated that the 96-hour LC_{50} was greater than 100%.

3.3.3 Standard Brands Canada Ltd., Richmond, (PE 2063)

This pet food cannery discharged process water, boiler blowdown, and domestic sewage until January 16, 1975. At that time, this wastewater was discharged to the municipal sewer system. Cooling water is still discharged to the river, and is discussed in Section 8.3.3.

Pollution control permit PE 2063 was issued to the company on March 13, 1974. Since the company had agreed prior to the issuance of PE 2063 to discharge all wastewater except cooling water to the municipal sewer system, no limits were imposed on contaminants which might be found in process water, boiler blowdown, or domestic sewage.

In their permit application, the company had indicated that the wastewater discharge rate would be 500 m^3/d with a BOD_5 concentration of 1 400 mg/L and a suspended solids concentration of 700 mg/L. This would have represented loadings to the river of 700 kg/d and 350 kg/d respectively.

One bioassay in 1974 using coho salmon indicated that the wastewater had a 96-hour LC_{50} of 24.5%[4].

3.3.4 B.C. Coast Vegetable Co-operative Association, Richmond, (PE 4505)

This company washes and packs a variety of vegetables. The wastewater consists of vegetable wash water, and is heavily laden with settleable solids. A settling ditch used to collect solids was to be expanded to provide increased retention time for the wastewater, thereby improving solids removals.

A summary of monitoring data, as well as the limits imposed by pollution control permit PE 4505, is included in Table 16. The limits for BOD_5 and suspended solids are more restrictive than level "A" of the objectives. Based upon the maximum allowable discharge and the median concentrations of BOD_5 and suspended solids, the loadings to the river were 30 kg/d and 450 kg/d respectively.

3.4 Operations Discharging to the Main Arm

These operations are presented in descending order of magnitude of the BOD_5 loading to this section of the river.

3.4.1 The Canadian Fishing Company Ltd., Gulf of Georgia Plant, Steveston, (PE 1814)

This herring and salmon reduction plant processes herring offal trucked in from roe operations. It discharges effluent to Steveston (Cannery) Channel. The plant was operated during the 1960's and was reactivated in 1973. The wastewater consists of condenser water and domestic sewage. The condenser water is untreated while the domestic sewage passes through a septic tank.

Limits of specified contaminants allowed pursuant to pollution control permit PE 1814, as well as a summary of the monitoring data, have been included in Table 17. The limits in the permit are approximately equal to level "A" of the objectives, although there are no objectives specific to reduction plant effluents. It is not known if the BOD_5 and suspended solids met these limits since the quantity of raw feed used in the reduction plant has not been recorded in EQUIS. It is estimated, using the median concentrations and the permitted flow, that the loading of BOD_5 would be 13 700 kg/d and of suspended solids 1 550 kg/d.

3.4.2 Cassiar Packing Company Ltd., Richmond Fish Processing Plant, (PE 1975)

This facility has been expanded from the original 1974 salmon canning operation. Herring, shrimp, and other fresh and frozen fish products are now processed. The wastewater is made up of process water, cooling water, and domestic sewage. All of this wastewater is discharged through one outfall. The domestic sewage is treated in a septic tank and the process water passes through coarse and fine screens. The cooling water is uncontaminated.

The monitoring data for this operation have been summarized in Table 17, together with the limits of pollution control permit PE 1975. The prescribed limits are those of level "B" of the objectives. The paucity of data makes an evaluation of the wastewater and its compliance with permit levels difficult.

Based upon the maximum flow allowed pursuant to PE 1975, and the median concentrations of BOD_5 and suspended solids, the loadings from this operation were 1 950 kg/d of BOD_5 and 915 kg/d of suspended solids.

Singleton[4] has indicated that in one bioassay in 1973, using coho salmon, the wastewater had a 96-hour LC_{50} of 13.5%.

3.4.3 British Columbia Packers Ltd., Imperial Plant, Steveston, (PE 1830)

This is one of the largest integrated fish processing plants in British Columbia, discharging effluent to Steveston (Cannery) Channel. The operation consists of salmon canning, salmon and halibut dressing, halibut and groundfish filleting, salmon and herring roe processing, and offal and herring reduction.

Three separate discharges of wastewater have originated from this operation. The discharge to the river of domestic sewage was discontinued in late 1975 when it was conveyed to the municipal sewage system. A second wastewater discharge consists of refrigeration condenser water and smaller quantities of boiler blowdown water. This discharge is discussed in Section 8.4.1. The other discharge consists of process water, retort cooling water, and barometer condenser cooling water.

Wastewater treatment facilities for the process water consist of coarse and fine screens. Stickwater evaporation facilities are also present on-site, as are experimental air flotation devices, which treated approximately one half of the contaminated discharge from 1971 until 1978. Chemicals are added to the wastewater to improve flotation. As cited in Section 3.1.3, the presence of these chemicals in resultant sludges has created a sludge disposal problem. The sludge is presently discharged to the river.

Pollution control permit PE 1830 required that the air flotation device be fully operational by December 31, 1980. Although an air flotation device capable of treating the total plant effluent is installed, operating difficulties and sludge disposal problems have hampered its use. The permit also requires that the BOD_5, suspended solids, and oil and grease discharged are to be less than the quantities prescribed by level "B" of the objectives. Limits approximately equal to level "A" objectives were to have been met in January 1981.

A summary of the wastewater monitoring data has been included in Table 17. Compliance of BOD_5, suspended solids, and oil and grease with the permit limits cannot be determined since production figures have not been recorded. Based upon the median flow and the median concentrations, the loading of BOD_5 was 1 600 kg/d; the loading of suspended solids was 760 kg/d; the loading of total nitrogen 250 kg/d; and the loading of total phosphorus was 4 kg/d.

Prior to the implementation of full treatment, wastewater was bioassayed in 1973 using coho salmon. The test results indicated the 96-hour LC_{50} was 56%[4].

3.4.4 British Columbia Packers Ltd., (The Canadian Fishing Company Ltd.), Phoenix Plant, Steveston, (PE 1811)

This plant operated between 1972 and 1974. The wastewater consisted of process water and domestic sewage and was discharged to Steveston (Cannery) Channel. Although pollution control permit PE 1811 was issued October 23, 1973, the wastewater treatment facilities authorized were never installed.

In the permit application, the company indicated that the concentration of BOD_5 would be 2 100 mg/L and the concentration of suspended solids would be 1 300 mg/L. At the permitted discharge rate indicated in Table 17, the resultant loading would have been 1 150 kg/d of BOD_5 and 710 kg/d of suspended solids. The actual loadings may have been higher than these since the concentrations listed in the permit application were those anticipated after wastewater treatment.

3.4.5 British Columbia Packers Ltd., Paramont, Steveston, (PE 1824)

This fish canning operation uses a dry conveying system. Contaminated wastewater arises from the washdown of the process area and is discharged to Steveston (Cannery) Channel. Pollution control permit PE 1824 allowed an average flow of 91 m^3/d, a loading of suspended solids of 10 kg/t, and a BOD_5 loading of 25 kg/t. These loadings are more restrictive than level "B" of the objectives.

The wastewater passes through screens prior to discharge. No monitoring data exist for this operation. It is believed the loading to the river, based upon a suspended solids concentration of 400 mg/L and a BOD_5 concentration of 950 mg/L, would be 35 kg/d of suspended solids and 85 kg/d of BOD_5.

3.4.6 J. Griffin and Company Ltd., Delta, (PE 5480)

This fish processing operation came into production in April 1979. Wastewater consists of process wastewater and domestic sewage. The discharge of domestic sewage was formerly covered by pollution control permit PE 1914, and is discussed in Section 6.4.5. The limits of pollution control permit PE 5480 are given in Table 17. These limits are similar or equal to level "B" of the objectives, and are to remain as such until the company is advised by the WMB to upgrade effluent quality to meet level "A" objectives.

The process wastewater is treated using screens, and is generated in the handling of shrimp, groundfish, herring, herring roe, and dressed salmon. The average flow rate, according to information provided by the company in its permit application, was to be 230 m^3/d although flows of 2 750 m^3/d would be realized. It is expected that the average daily loading would be about 320 kg/d of suspended solids and 400 kg/d of BOD_5.

3.4.7 Long Beach Shellfish Co. Ltd., Delta, (PE 3139)

This salmon processing operation was constructed during 1974. Process wastewater is discharged after passing through screens. It is believed that the company may be planning further expansion to include herring and halibut.

Levels of contaminants specified by pollution control permit PE 3139, as well as a summary of monitoring data, are included in Table 17. Based upon the maximum allowable daily flow and the median concentrations of BOD_5 and suspended solids, the loadings from this operation were about 15 kg/d and 5 kg/d respectively.

3.4.8 Pisces Trading Co. Ltd., (Searich Industries Ltd.), Delta, (PE 3474) (PE 5483)

This plant, established in 1974, consists of herring and salmon unloading with a minor amount of salmon dressing. This operation is being expanded and the new operation (PE 5483) will be processing herring for roe and dressing salmon.

The wastewater consists of process water which is screened and domestic sewage which is treated in a secondary package treatment plant. The discharge of both effluents is through a common discharge pipe.

Pollution control permit PE 3474 was superceeded on July 13, 1979, by PE 5483. This permit imposed level "B" limits on the process water, restricted its flow to 45 m^3/d and increased the permitted concentrations in the domestic sewage from 45 mg/L of BOD_5 and 60 mg/L of suspended solids to 130 mg/L for each parameter (level "AA" of objectives).

3.4.9 Western Canada Seafoods Ltd., Delta, (PE 5111)

This is a fish unloading dock. Wastewater consists of washdown water which passes through coarse and fine screens prior to being discharged. Wastewater was first discharged during 1978. Pollution control permit PE 5111 restricts the flow to 9.1 m^3/d.

3.4.10 East Side Holdings Ltd., Delta, (PE 5174)

This facility, proposed during 1978, was to be a salmon dressing and herring processing operation. Although the facility has never been operational, the possibility exists that it could become so in the future. Plans for the operation had called for secondary treatment of domestic sewage and coarse and fine screening of process wastewater.

Pollution control permit PE 5174, issued July 13, 1978, permitted a maximum flow of 136 m^3/d, level "B" objectives for the process water, and level "AA" objectives for the domestic sewage effluent.

3.4.11 Matsuo, S. and Son Ltd., Richmond, (PE 3461)

This salmon roe processing plant discharges wastewater generated from the washing and processing area as well as brine solution. Wastewater treatment facilities available include fine screens and air flotation devices. The effluent was to be discharged to Steveston (Cannery) Channel. However, due to the costs of operating these facilities, the wastewater has been hauled away by tanker truck since 1974. This operation has been included in this report since they hold a valid pollution control permit (PE 3461) allowing the discharge of wastewater to the river.

3.5 Discussion of the Food Industry

The wastewater flows discharged by each operation, as well as the loadings of suspended solids and BOD_5, are summarized in Table 18. These values are also plotted in Figures 6, 7 and 8 to show how they have changed between 1971 and 1978.

The Main Arm of the Fraser receives the largest number of food industry effluents. In 1971, the flows, and loadings of BOD_5 and suspended solids to the Main Arm and the North Arm were approximately equal. However, yearly thereafter to 1974, the Main Arm received significantly higher flows and loadings. This was due to the opening of a number of fish processing operations. After 1974, the flows and loadings to the Main Arm have remained unchanged.

Wastewater discharges to both the Main Stem and the North Arm have remained nearly unchanged over the period of record. The most significant change in discharges to the North Arm occurred when the wastewater from Standard Brands (PE 2063) was diverted to the municipal sewer system in 1974. A minor reduction in flows and loadings to the Main Stem of the river occurred in 1977 when Clappison Packers (PE 3743) closed.

The source of the largest loading of nitrogen to the river is the British Columbia Packers Imperial operation (PE 1830). This integrated fish processing plant discharges 250 kg/d of total nitrogen and 4 kg/d of total phosphorus to the Main Arm. The only other measurable nitrogen and phosphorous loading recorded from the food industry in the study area originated from Richmond Packers (PE 90). This operation discharges 1.9 kg/d of total nitrogen and 0.5 kg/d of total phosphorus to the North Arm. However, data for 1978 and 1979 indicate the Kjeldahl nitrogen loading to be 340 kg/d, and the total phosphorus loading to be 80 kg/d.

The source of the largest organic loading to the river is the Canadian Fish Company Gulf of Georgia Plant (PE 1814). This plant discharges 13 700 kg/d of BOD_5. This quantity represents 80% of the organic loading discharged directly by the food industry to the river.

Five fish processing operations are allowed by their pollution control permit to discharge to Steveston (Cannery) Channel. Both the Canadian Fish Company Gulf of Georgia Plant (PE 1814) and the British Columbia Packers Imperial operation (PE 1830) discharge large loadings of BOD_5. These discharges can cause localized depressions in dissolved oxygen concentrations due to the large quantities of organic matter. Dissolved oxygen concentrations in Steveston Channel have ranged from 2.7 mg/L to 13.6 mg/L[5].

Bioassays of wastewaters from Richmond Packers (PE 90) and Clappison Packers (PE 3743) indicated that the wastewaters were non-lethal when tested. However, Standard Brands (PE 2063), Cassiar Packing (PE 1975), B.C. Packers Imperial Plant (PE 1830), and Berryland Canning (PE 260) have all had acute toxicity tests performed in which the 96-hour LC_{50} was less than 100%. This indicates that an acute toxicity problem was associated with the wastewaters at the time they were tested.

The intent of the EPS guidelines for fish processing plants would appear to be met at all plants in the study area. All fish processing plants discharging process wastewater passed the wastewater through screens prior to being discharged. As well, two operations (PE 1830, PE 3461) have air flotation wastewater treatment equipment, although the equipment is not being operated.

Berryland Canning (PE 260), the one fruit and vegetable operation discharging both acidic and alkaline wastewaters in the study area, is installing equipment for pH control. As well, biological treatment is to be installed for wastewater treatment.

All operations discharging to the river are required by their pollution control permits to meet level "B" objectives. Several operations, including Puritan Canners (PE 90), B.C. Coast Vegetable Co-operative (PE 4505), and the Canadian Fish Company Gulf of Georgia plant (PE 1814) are restricted to level "A" objectives. Berryland Canning (PE 260), due to the wide variety of products processed, has not been issued limits which conform to the format of the objectives.

3.6 Conclusions and Recommendations

The general lack of monitoring data on numerous operations of the food industry makes a precise evaluation of effluent quality impossible. As well, this paucity of data usually does not allow one to determine permit compliance. The data base must be improved upon. Particular emphasis should be placed on updating monitoring at fish processing operations.

Fish processing operations are generally required to meet level "B" objectives. The implementation of level "A" objectives could potentially reduce BOD_5 and suspended solids loadings between 60% and 90%. No major reductions in these loadings have been realized over the period of record. Such reductions would help significantly in preventing localized lowering of dissolved oxygen concentrations in Cannery Channel. For this reason, consideration should be given to implementing level "A" objectives at fish processing plants, or alternatively, to moving their outfalls into the main river channel. Level "A" objectives are generally applied at the other food industry operations within the study area.

4. THE METAL FINISHING AND FABRICATING INDUSTRY

4.1 Introduction

Wastewater discharges from this industrial sector originate at lead recovery operations, battery manufacturers, steel foundries, steel melting and rolling mills, and metal finishing operations. Those operations discharging to the river in the study area are indicated in Figure 9. Wastewaters from this industrial sector usually contain significant quantities of heavy metals.

4.1.1 Guidelines/Objectives/Regulations

The Pollution Control Board issued objectives for this industrial sector in 1975[9]. The objectives relating to discharges to water have been included in Table 19. The EPS has issued guidelines for wastewater generated from the metal finishing industry[41]. The guidelines have been included in Table 20.

A comparison of the guidelines and objectives indicates that the objectives are equal to or more stringent than the guidelines. However, the objectives do not address oxidizable cyanide. Oxidizable cyanide, also known as cyanide amenable to chlorination, is of interest since it is the form of cyanide which can, through wastewater treatment, be readily removed.

4.1.2 Sources of Contaminants

(a) Metal Finishing Plants

Contaminated wastewaters from the electroplating and metal finishing industries originate from rinse waters, discharges of concentrated baths from electroplating, washwaters, vent scrubber waters, and regenerants from ion exchange units. Untreated wastewaters from the major metal finishing processes can have concentrations of copper from 5 to 50 mg/L; nickel from 2 to 15 mg/L; hexavalent chromium from 10 to 120 mg/L (trivalent chromium less than 1 mg/L); zinc and cadmium from 10 to 50 mg/L; cyanide from 1 to 50 mg/L; and up to 20 mg/L of tin[21].

(b) Foundries

Foundry wastewaters can contain suspended solids (mostly sand) from 2 500 to 5 000 mg/L[21]. As well, water sprays used to reduce stack emissions can contain iron particles, oils, and phenolic compounds[22].

(c) Steel Mills

Wastewaters from steel mills which utilize scrap material are generated in two processes. These are the casting of billets from melted scrap material and the following transformation of the billets into usable engineering members. The largest percentage of wastewater is used to quench either the billets or the finished products, and can contain large quantities of scale in the form of suspended solids. The wastewater can also contain quantities of oil and iron and be of low pH.

4.1.3 Wastewater Treatment Methods

(a) Metal Finishing Plants

Many steps can be undertaken within these operations to reduce wastewater contaminant loadings. Some of these steps can include the substitution of chemicals containing deleterious substances with others which are less harmful; the reduction of rinse water requirements by improving and changing the types of rinsing techniques; the control of spills and leaks; minimizing drag-out; the regeneration of process electrolyte baths; and the use of solutions at the lowest effective concentration.

The most common wastewater treatment technology applicable to metal finishing wastewaters is chemical treatment of the effluent[24]. Utilizing this treatment method requires that cyanide streams be treated separately to destroy oxidizable cyanide. Waste streams containing hexavalent chromium are treated to reduce the hexavalent chromium to trivalent chromium. Once this has been accomplished, metals are precipitated and subsequent suspended solids separated.

(b) Foundries

Primary settling of the wastewaters from these types of operations has reduced suspended solids contents by 90%[22]. Additional precipitation and sedimentation can increase this removal to a total of 99.2%. The subsequent use of dissolved air flotation can bring the total suspended solids reduction to 99.7%. Dissolved air flotation can remove emulsified oil, and small particles of free and suspended oil not removed by gravity separation.

(c) Steel Mills

The nature of wastewater from some steel mills permits the employment of basic wastewater treatment technology. Oils can be separated using gravity separators, suspended solids can be removed by sedimentation, acidity can be neutralized, and dissolved iron and other metals can be removed with lime precipitation.

4.2 Operations Discharging to the Main Stem

No operations within this sector discharge to this section of the river.

4.3 Operations Discharging to the North Arm

The operations discussed in this section are presented in random order.

4.3.1 Western Canada Steel Ltd., Mitchell Island, (PE 2087)

This steel melting and rolling mill uses scrap material to produce steel construction products. Wastewater originates from four sources. One of these is domestic sewage and is discussed in Section 6.3.3. Two others are composed of miscellaneous drainage. The fourth consists of rolling mill cooling water and effluent from the wet scrubber. This wastewater is discharged to an exfiltration/recycle/ sedimentation pond, which due to its location, likely allows the wastewater to seep to the Fraser River.

A summary of monitoring data, and the limits permitted by pollution control permit PE 2087, are included in Table 22. The limits are equal to or more stringent than level "A" of the objectives. The median concentrations of contaminants in the rolling mill cooling water have met the limits. However, these limits have been exceeded by the maximum recorded concentrations of copper, iron, suspended solids, and oil and grease in the rolling mill cooling water entering the pond.

The rolling mill cooling water contributes a loading of 1.2 kg/d of copper, 6.9 kg/d of iron, 0.24 kg/d of lead, 0.5 kg/d of zinc, and 880 kg/d of suspended solids to the pond. These loadings were based upon the median recorded concentrations and the permitted flow of 23 775 m^3/d. The dissolved fraction of these metals is likely to enter the river through seepage.

4.3.2 Tree Island Steel Co. Ltd., Richmond, (PE 131), (PE 3190)

This metal finishing operation and proposed associated rolling mill discharges two wastewater streams. One is contaminated cooling water while the second is process wastewater and domestic sewage. Although the process wastewater and domestic sewage are discharged to an exfiltration lagoon, the close proximity of the lagoon to the river (approximately 15 metres) and the fact that it is in sandy soil makes it highly probable that some wastes are exfiltrating to the river (Blind Channel). The EPS have indicated that there was a direct surface discharge of effluent to the river during March, April and May of 1980[48]. The process wastewater is composed of spent liquor from the acid bath and acid rinse waters from the pickling operation and galvanizing line. The cooling water is discharged through a separate outfall to the river.

The company was required by a 1976 amendment to pollution control permit PE 3190 to install monitoring wells to permit monitoring by the WMB. Analyses of the groundwater quality have not been carried out.

The limits for contaminants in the wastewater allowed by pollution control permit PE 3190, as well as a summary of monitoring data, have been included in Table 23. The cooling water is required to meet level "A" of the objectives, while the process water is required to meet level "C". Both the cooling water and the process water were heavily laden with iron, zinc and lead. The loadings of these metals from both sources to the river based upon median recorded values are 98 kg/d, 89 kg/d, and 4.5 kg/d respectively, assuming 100% breakthrough to the river. Phosphorus in the cooling water contributes a loading of 0.8 kg/d to the river. The median pH value in the process water has been raised from 2.2 in 1976 to 1977, to 7.5 in the period 1977 to 1980. The quality of the cooling water, according to a 1979 assessment of the operation by the WMB, has met level "A" of the objectives since August 1978. The quality of the process water has not changed significantly.

Singleton[4] has indicated that toxicity tests performed on process water in the exfiltration lagoon in 1976 gave a 96-hour LC_{50} of 4.2%. This is to be expected since the concentrations of lead, zinc and iron seldom met the permitted levels under PE 3190. As well, the pH of the process water seldom met the limits.

4.3.3 Metalex Products Ltd., Richmond, (PE 2311)

This operation reclaims lead from lead acid batteries. The wastewater was discharged to the river until August 1976. At that time, it was diverted to the municipal sewer system. The wastewater, prior to being discharged to the river, had passed through four settling tanks and was then neutralized.

In its permit application, the company had indicated that the maximum discharge rate would be 13 m^3/d. Based upon one wastewater analysis, it was also indicated that the concentration of total lead was 13.5 mg/L, the concentration of dissolved lead was 2.24 mg/L, the concentration of sulphate was 13 750 mg/L, the concentration of sodium was 6 250 mg/L, and the concentration of suspended solids was 20 810 mg/L.

Wastewater analyses between May 1972 and July 1973 revealed a median pH of 2.7 (Range of 1.72 to 6.5), a median dissolved lead concentration of 3.9 mg/L (Range of 2.5 to 8.0 mg/L), total lead as high as 88 mg/L, dissolved iron as high as 84 mg/L, and a dissolved copper concentration of 2.2 mg/L.

Five toxicity tests were performed on the wastewater[4] using coho salmon during 1972 and 1973. Although the 96-hour LC_{50} values ranged from 0.23% to 6.15%, eighty percent of the values were less than 0.5%. The mean 96-hour LC_{50} value was 1.5%.

4.3.4 Varta Batteries Ltd., Richmond, (AE 4661)

This battery manufacturing operation discharged domestic sewage, cooling water, and washwater from a paste machine and paste mixer until January 1978. By that time, the domestic sewage was diverted to the municipal sewer system, the cooling water was discharged to a municipal ditch, and the washwater was eliminated through the implementation of a recycling system.

A pollution control permit was never issued for this operation, and no monitoring data exist related to the wastewater quality. However, Singleton[4] reported a 96-hour LC_{50} of 2.4% for one bioassay in 1972 using coho salmon.

4.3.5 Alcan Canada Products, Richmond, (AE 2509)

This aluminum fabricating and anodizing plant discharged wastewater until late 1974, at which time the wastewater was diverted to the municipal sanitary sewerage system. Wastewater consisted of process wastewater and uncontaminated cooling water (discussed in Section 8.3.18).

A study of the wastewater, conducted for the company by a consultant, indicated that the process wastewater was discharged at an average rate of 135 m^3/d (Range - 90 m^3/d to 180 m^3/d). Analyses of the process wastewater indicated the pH to be in the range of 3.0 to 4.2, the concentration of aluminum to range from 14.5 to 24.0 mg/L, and the concentration of copper to be 0.1 mg/L.

4.4 Operations Discharging to the Main Arm

Only one operation discharges to this section of the river.

4.4.1 Titan Steel and Wire Company Ltd., Surrey, (PE 161)

This metal finishing plant is a steel rod cleaning, zinc galvanizing, lead patenting (heat treating and coating of wire with lead), and drawing operation. It finishes approximately 2 250 tonnes per month, half of which is pickled in sulphuric acid, and the remainder in sulphuric acid and hydrochloric acid. Wastewater discharges consist of cooling water (discussed in Section 8.4.3) and rinse water from pickling, lead patenting, and zinc galvanizing. The rinse water is treated using lime precipitation, clarification, and pH neutralization.

Levels of specified contaminants allowed pursuant to pollution control permit PE 161, as well as a summary of the monitoring data, have been included in Table 24. The limits prescribed by PE 161 are those outlined as level "C" of the objectives, although the pH is more lenient. The latter characteristic is of concern since Drinnan and Clark[5] have indicated that alkaline discharges should be controlled. The data indicate that since 1975 the median concentrations of iron, lead, and zinc have been less than those permitted under PE 161. Nonetheless, some extremely high values have been recorded for these contaminants since 1975. During the same period, the concentrations of both suspended solids and sulphate were reduced. In 1977, the sulphate concentration met the limit on over fifty percent of the sampling dates. The pH of the wastewater has not improved consistently over the period of record.

Toxicity tests were performed during 1976 and 1977 on six occasions using rainbow trout[4]. Four ~~percent~~ of the tests indicated that the effluent was non-toxic (96-hour LC_{50} greater than 100%), while the other two tests had 96-hour LC_{50}'s of 0.14% and 1.7%.

Based upon the permitted flow rate of 455 m^3/d and the median concentrations, the loadings to the river were about 30 kg/d of suspended solids, 125 kg/d of total iron, and 0.4 kg/d each of total lead and total zinc. The loadings of dissolved metals were significantly less than those of total metals.

4.5 Operation Discharging to the Serpentine River

Only one operation discharges to the Serpentine River.

4.5.1 Associated Foundry Ltd., Surrey, (PE 1529)

This foundry melts scrap iron to produce plumbing pipe. The wastewater is treated by being passed through an oil separator and a series of catch basins.

Limits on specified contaminants allowed by pollution control permit PE 1529, and a summary of monitoring data, are included in Table 21. The limits prescribed by PE 1529 are equivalent to level "C" of the objectives. The data indicate that flows were usually three to five times those permitted, and that pH was usually not in compliance with the permit levels. The suspended solids concentrations met the permitted level approximately fifty percent of the time. High levels of oil and grease were also recorded.

4.6 Operations Discharging to the Coquitlam River

The one operation which continues to discharge to the river is discussed. The second operation discontinued direct discharges to the river in 1979.

4.6.1 Kennametal Inc., Port Coquitlam, (PE 2350)

This manufacturing operation produces carbides of titanium, tantalum, tungsten and niobium. Wastewater which is discharged consists of uncontaminated cooling water, discussed in Section 8.9.1, and process wastewater. The process wastewater originates as spent acid solution from the leaching process to reduce impurities, the washing of settled metal carbides, and water from two centrifuges used to reclaim carbides. The process wastewater is discharged to an exfiltration pond. This results in an indirect discharge to the river.

Several analyses of groundwater, between March and July 1975, indicated the following median values: pH, 3.7 (Range 3.5-5.7); dissolved aluminum, 242 mg/L (Range 0.6-260 mg/L); dissolved nickel, 20.6 mg/L (Range <0.01-26.1 mg/L); dissolved cobalt, 66.2 mg/L (Range 0.104-134 mg/L); and dissolved iron, 425 mg/L (Range 0.1-711 mg/L). It was expected that these values would be modified by the addition of neutralization facilities in 1977. However, data for the period 1977 to 1980 indicate that there has been no significant improvement in these values in the groundwater.

Analyses of water in a ditch adjacent to the area indicated that the pH had been lowered from 7.8 to 4.1, the sulphate concentration raised from 47.8 to 313 mg/L, the dissolved aluminum concentration raised from less than 0.5 mg/L to 28 mg/L, the dissolved iron concentration raised from 0.2 to 62.2 mg/L, the dissolved nickel concentration raised from 0.03 to 3.8 mg/L, and the dissolved cobalt concentration raised from 0.2 to 12.5 mg/L. Since flow rates in the ditch were not recorded, loadings to the Coquitlam River cannot be determined. However, the smallest monthly average flow on record[36] (2 m^3/sec) for the Coquitlam would likely render the impact of these loadings on the Fraser River insignificant.

It is apparent that both the ground and surface waters are contaminated with heavy metals. The actual loadings to the river cannot be determined since data are not available which would indicate an average flow rate of surface water, or an average seepage rate of the groundwater, to the river.

Limits of pollution control permit PE 2350 as they relate to the wastewater quality being discharged to the exfiltration pond, as well as a summary of the monitoring data, have been included in Table 21. The limits for some contaminants meet level "A" of the objectives, while others do not even meet level "C". The data indicate non compliance on most sampling dates for all regulated parameters. Of most concern is the pH which never exceeded 2.8. These low pH values would result in the presence of large concentrations of dissolved metals.

A toxicity test conducted by the EPS in July 1974 using coho salmon revealed that the wastewater entering the exfiltration pond had a 96-hour LC_{50} of 2.4%. An analysis of this same wastewater indicated a phenolic concentration of 1.9 mg/L, a sulphide concentration of 2 794 mg/L, and a suspended solids concentration of 4 300 mg/L.

4.6.2 Esco Ltd., Coquitlam, (PE 2505)

This steel foundry uses nickel, chromium, manganese, and molybdenum in the manufacture of products. The wastewater consists of cooling water from the quench tank, the furnace and the air compressor. The wastewater was diverted to the City of Port Coquitlam storm sewers in 1979.

Limits prescribed by pollution control permit PE 2505, and a summary of monitoring data, have been included in Table 21. The limits are approximately equal to those of level "A" of the objectives, although iron was equal to level "C". The limited data indicate little contamination of the wastewater by nickel, chromium, manganese, or molybdenum.

4.7 Discussion of the Metal Finishing and Fabricating Industry

Details of the metal finishing and fabricating industry related to loadings and flows are included in Table 25.

Evidence of contamination of both surface and groundwater exists at Kennametal Inc. (PE 2350). The wastewater at this operation is discharged to an exfiltration pond. The limits in the pollution control permit, which are not met, range from those of level "A" to less stringent than level "C" of the objectives.

Implementation of wastewater treatment utilizing pH control and metals precipitation at Titan Steel (PE 161) has reduced the concentrations of dissolved metals below those concentrations found in the wastewater in 1974. Although the permit specifies level "C" objectives, values at times are significantly higher than level "C". The data for 1977 would seem to indicate a possible improvement in wastewater quality with respect to pH control.

The other metal finishing plant in the study area is Tree Island Steel (PE 3190). This operation discharges the largest measured loading of metals of any operation in this sector, not directly, but to an exfiltration pond. This pond has, on occasion, overflowed to the river. This loading amounts to 92% of the iron loading, 95% of the lead loading, and 99% of the zinc loading to the North Arm. It is not known how much of these loadings reach the river. The cooling water has limits equivalent to level "A" of the objectives. There is an indication that the cooling water has met these limits since August 1978. The process water, with limits equivalent to level "C", continues not to meet these limits.

Western Canada Steel (PE 2087) has limits on its wastewater quality equivalent to level "A" of the objectives. These limits are usually met.

The Associated Foundry (PE 1529) discharges to the Serpentine River. The discharge permit specifies limits equivalent to level "C" of the objectives. Oil and grease concentrations exceed these limits, even though an oil separator is used. The pH of the wastewater is also usually not in compliance with permit limits.

Bioassays conducted on wastewaters from Titan Steel (PE 161) and Tree Island Steel (PE 3190) have indicated that these wastewaters are acutely toxic.

If the quality of the wastewaters from Tree Island Steel (PE 3190) and Titan Steel (PE 160) met level "C" of the objectives, zinc and iron loadings at Tree Island Steel (PE 3190) could each be reduced to 0.66 kg/d, and at Titan Steel (PE 161) they could be reduced to 0.46 kg/d. Thus, level "C" represents loading reductions of over 95% compared to present loadings. Similarly, the loading of lead at Tree Island Steel (PE 3190) could be reduced by 92% to 0.33 kg/d. Level "A" objectives for these metals would additionally reduce loadings over level "C" objectives by factors of between 2 and 3.3.

The EPS guidelines for the metal finishing industry are based upon the levels of contaminants which can be obtained through the implementation of proven wastewater treatment technology. If this was utilized at Tree Island Steel (PE 3190) and the levels outlined in the guidelines were obtained, the present lead loading could be reduced from 4.6 kg/d to 2.5 kg/d. The zinc loading could be reduced from 89 kg/d to 3.3 kg/d.

The use of exfiltration ponds does not appear to be consistently reducing dissolved metal concentrations at Tree Island Steel (PE 3190) or Kennametal (PE 2350). Analyses of groundwater at the Kennametal carbide operation reveal severe groundwater and surface water contamination. Exfiltration ponds, built in such a manner as to prevent excessive outward seepage are practical in arid areas where evaporation can reduce wastewater quantities. However, such is not the case in the study area. The exfiltration ponds allow the discharge of the dissolved metals in the wastewater to enter the river indirectly, since good pH control is not maintained to depress metal solubility and the ponds are situated in porous soils at very small distances from the river. Tree Island Steel, however, has improved pH control in their pond between 1977 and 1980 to the point where the median pH has been raised from 2.2 to 7.5.

4.8 Conclusions and Recommendations

The data available indicate that the loadings of the metals to the river are significant. The loadings presently going to the river could be reduced through the use of proven wastewater treatment technology. Such technology would require the reduction of hexavalent chrominum to trivalent chromium in individual wastewater streams prior to attempting further treatment in the form of metal precipitation and pH control. Within the study area, only Titan Steel (PE 161) and Kennametal (PE 2350) utilize any of these wastewater treatment methods.

Associated Foundry (PE 1529) does not meet pH or oil and grease limits consistently. This operation should install pH control facilities, and either upgrade or replace its existing oil separator.

The limits in PE 2350 for the Kennametal operation are not consistent with level "A" or level "C" of the objectives. A review of this permit should be undertaken with a view to bringing these limits into line with limits at similar operations. As well, steps should be taken to ensure that level "C" objectives are met immediately and level "A" objectives in the near future.

Both Titan Steel (PE 161) and Tree Island Steel (PE 3190) do not consistently meet limits equivalent to level "C". Meeting this level could reduce effluent loadings of zinc, iron, and lead by a minimum of 90%. Steps should be taken to ensure that the quality of these wastewaters meet level "C". Once level "C" objectives are consistently met, the meeting of level "A" objectives could further reduce loadings.

The fact that the wastewater from operations in this sector is acutely toxic is not surprising considering the pH and metals values recorded to date. The upgrading of the wastewater quality so that it consistently meets at least level "C", but preferably level "A", should reduce this toxicity. However, additional in-plant controls may be required should the wastewater remain acutely toxic.

The use of exfiltration ponds as a method of wastewater disposal in the study area without pH control does little to reduce wastewater contaminant levels. The exfiltrates from these ponds has contaminated groundwater supplies and surface water, but this situation could be eliminated by maintaining the pH at about 10.0.

5. THE CONCRETE INDUSTRY

5.1 Introduction

Operations in this industrial sector within the study area (see Figure 10) consist of ready mix plants, a precast concrete plant, a cement manufacturing plant, and a roofing material plant. No attempt has been made to indicate sites of indiscriminate dumping from trucks of washwater or excess concrete.

5.1.1 Guidelines/Objectives/Regulations

Wastewater quality from concrete batch plants and cement manufacturing plants is controlled by objectives issued by the Pollution Control Board(9). These objectives outline limits on the pH and the quantity of suspended solids in wastewater discharges. The objectives have been included in Table 26.

No federal water pollution control regulations or guidelines exist for this industrial sector.

5.1.2 Sources of Contaminants

The dearth of literature related to this industrial sector does not permit a detailed examination of all of the operations within this sector. However, ready-mix operations will be looked at more closely.

Ready-mix operations are oriented towards material handling, in that raw materials are drawn from storage areas for concrete manufacture. Other than in cases of spillage of some of these materials, there is virtually no waste generated in the preparation and batching. The major waste source is trucks returning to the plant. The trucks are washed on two occasions: at the end of the day and if they return with a partial load. Trucks which return empty are washed on the outside with up to 0.5 m^3, and on the inside with up to 1.5 m^3 of acidified water(25). The 1.5 m^3 used inside the truck can be increased to 4.5 m^3 should a significant amount of concrete remain within the truck.

Wastewater from truck washing can have a suspended solids concentration ranging from 280 to 156 000 mg/L, a BOD_5 of 3 to 5 mg/L, a pH from 10.9 to 11.2 and a turbidity from 110 to 70 000 J.T.U. (Jackson Turbidity Units)[25]. Numerous chemical additives used in concrete manufacture makes the wastewater more toxic.

5.1.3 Wastewater Treatment Methods

Morrow et al.[25] have indicated that the successful recovery of aggregate, sand, and water was practiced in an area where these commodities were in short supply. Water can be recycled for truck washing or for use in the ready-mix.

Wastewater can be treated by using mechanical screening, sedimentation basins, and/or tube settlers. This type of treatment has produced an effluent with a BOD_5 concentration ranging from 1 to 3 mg/L, an alkalinity concentration ranging from 73 to 2 683 mg/L, and a suspended solids concentration ranging from 18 to 523 mg/L[25]. Wastewater would be highly alkaline and would require neutralization.

5.2 Operations Discharging to the Main Stem

No operations belonging to this sector discharge to this section of the river.

5.3 Operations Discharging to the North Arm

The one operation which continues to discharge to this section of the river is discussed first, followed by a discussion of an operation which has closed.

5.3.1 Globe West Products Inc. (Canadian Gypsum Company), Vancouver, (PE 2071)

This operation manufactures asphaltic roofing materials by saturating heavy paper with asphalt, covering the top of the material with colour slate granules, and the bottom with sand. The wastewater from this operation consists of cooling water which is sprayed on the product surface. The wastewater is treated in a settling tank followed in sequence by a settling ditch.

Pollution control permit PE 2071 restricted the suspended solids concentration to 50 mg/L at a flow of 318 m^3/d. The data for this operation, summarized in Table 27, indicate that the median suspended solids concentration was 6 mg/L and the median flow rate was 295 m^3/d.

The pH of the wastewater ranged from 6.2 to 9.4. Drinnan and Clark[5] have indicated a concern for wastewater discharged with high pH values.

5.3.2 Ocean Construction Supplies Ltd., New Westminster, (PE 2302)

This ready-mix concrete plant, through a program of recycling completed in 1974, eliminated seven of nine wastewater discharges to the river. The two remaining wastewater discharges were storm water from the plant area. The WMB was advised in late 1979 that the plant had closed and the equipment had been dismantled.

The limits for specified contaminants in the wastewater allowed by pollution control permit PE 2302, and a summary of the monitoring data, are included in Table 27. From the small amount of monitoring data available for the post 1974 period, it is estimated that the loading of suspended solids to the river was 100 kg/d. This is less than the 800 kg/d loading discharged prior to 1975 according to information provided to the WMB in the pollution control permit application submitted by the company.

The pH of the wastewater was as high as 10.7. A concern for alkaline discharges has been expressed by Drinnan and Clark[5]. This plant was demolished in May 1980[48].

5.3.3 LaFarge Concrete Ltd., Kent Street, Vancouver, (PE 3432)

This ready-mix plant began operations in late 1974. Wastewater is generated from washing the trucks, both inside and outside.

Wastewater discharges during the first year of operation were to a settling pond, approximately 120 metres from the high water level of the Fraser River. The pond overflowed to the river. This system was replaced in late 1975 by two concrete-lined ponds, which operated in series. Each pond had a capacity of 165 m^3. Effluent from the second pond was returned for use in washing trucks, or in the concrete mix. This system eliminated discharges to the river.

Pollution control permit PE 3432 restricted the discharge to a volume of 91 m^3/d. There are no monitoring data related to this operation.

5.3.4 Allied Ready Mix, Mitchell Island, (PE 5325)

This ready-mix plant, in existence since approximately 1965, was taken over by LaFarge Concrete in May 1977. Wastewater is generated as washwater from the trucks.

A trench of approximately 6 m^3 capacity is used as an exfiltration pond. Solids from the pond were to be removed daily, and transported to Richmond Landfill as necessary.

Pollution control permit PE 5325 restricted the flow of washwater to 6.8 m^3/d. There are no monitoring data related to this operation.

5.4 Operations Discharging to the Main Arm

Operations discussed in this section are presented in random order.

5.4.1 LaFarge Cement, Richmond, (PE 42)

This cement plant discharges wastewater from a dust leaching installation. The limits for specified contaminants in the wastewater allowed by pollution control permit PE 42, as well as a summary of the monitoring data, are included in Table 28. The pH limit is more restrictive than that outlined in the objectives.

The data in Table 28 indicate that the median suspended solids level consistently met the permitted value. However, the maximum suspended solids level, which occurred frequently, exceeded the permit level of 2 000 mg/L listed in PE 42. The suspended solids loading, based upon the median concentration and discharge rate, was 1 515 kg/d. The wastewater tended to be alkaline, with the maximum yearly pH ranging between 10.3 and 13. Drinnan and Clark[(5)] have expressed a concern about high pH wastewaters entering the Fraser. Although data for 1978 indicated that eighty percent of the pH data was in the range of 7 to 9, pH values as high as 12 or as low as 6 were recorded.

The median mercury value in the effluent was 0.05 µg/L (0.06 kg/d). This concentration is the upper limit designated as safe for freshwater aquatic life in ambient waters by the EPA[(26)]. Measurable loadings were also recorded for iron (6.4 kg/d), lead (0.4 kg/d), zinc (0.2 kg/d), and copper (0.1 kg/d).

The company applied for an amendment on May 23, 1980 to increase the metals levels in the permit. The application indicated that the suspended solids would be reduced to 1280 mg/L, but that the concentration of cyanide would be raised to 0.5 mg/L, lead to 0.5 mg/L, zinc to 0.3 mg/L and chromium to 0.15 mg/L. The permitted concentration of mercury would be reduced to 0.005 mg/L from the 0.090 mg/L presently allowed.

Singleton[4] has reported that nineteen acute bioassays of the wastewater were conducted between 1971 and 1977 using coho salmon and rainbow trout. Sixty-five percent of these tests gave a 96-hour LC_{50} greater than 100%. The lowest 96-hour LC_{50} was 56%.

5.4.2 LaFarge Concrete, Richmond (PE 2439)

This is a ready-mix operation which eliminated all wastewater discharges to the river except steam condensate and boiler blowdown by the end of 1974. The wastewater is limited to a discharge rate of 1.6 m^3/d. No monitoring data exist on the quality of this effluent.

Prior to 1974, wash water from the mixer truck and the batch plant was discharged to the river. The wash water is now recycled. From the information supplied by the company at the time of permit application, the flow rate of this effluent was 65 m^3/d with an associated suspended solids loading of 27 kg/d. The pH was in the range of 10.2 to 10.8.

5.4.3 Con-Force Products Ltd., Richmond (PE 2976)

This operation manufactures precast concrete members and ready-mix cement. The wastewater generated consists of domestic sewage, discussed in Section 6.4.1, washdown water from the cement mixer, and boiler blowdown and steam condensate. The cement mixer washdown water has been discharged to three concrete-lined settling basins since after 1973 (identified as "01"). The boiler blowdown and steam condensate (identified as "02") is discharged to a storm drain leading to a ditch.

Limits of pollution control permit PE 2976, and a summary of the monitoring data, are included in Table 27. The limit for pH for the boiler blowdown and steam condensate allowed under PE 2976 are 6.5 to 8.5, as outlined in the objectives. The pH of the boiler blowdown and steam condensate was generally high and usually outside the range of 6.5 to 8.5. The median suspended solids concentration was less than the 50 mg/L permitted.

5.4.4 Tri-Mac Concrete Ltd., Delta (PE 2273)

This ready-mix truck washing operation provided no treatment to the truck washwater until early 1974 when an exfiltration pond was installed. The pond is of approximately 150 m^3 volume, and is located approximately 40 metres from the Fraser River.

Pollution control permit PE 2273 restricted the daily quantity of flow to the pond to 46 m^3/d. The average flow between 1974 and 1978 was 22 m^3/d, for a range of values from 4.5 m^3/d to 45.5 m^3/d.

5.5 Discussion of the Concrete Industry

The pH of wastewaters from this sector is usually high. The concern of Drinnan and Clark[5] for high pH discharges should not be ignored. Globe West Products Inc. (Canadian Gypsum) (PE 2071) do not have restrictions on pH in their pollution control permit. Ocean Construction (PE 2302) and LaFarge Cement (PE 42) do not meet the pH limits contained in their permits.

The LaFarge Concrete operation (PE 2439) eliminated its wastewater discharges to the river in 1974 by recycling the water. The pH of this wastewater ranged from 10.2 to 10.8. The LaFarge Cement operation (PE 42) recorded a median mercury level of 0.05 μg/L.

5.6 Conclusions and Recommendations

LaFarge Concrete (PE 2439) has taken steps, through recycling, to eliminate one alkaline wastewater discharge to the river. Globe West Products Inc. (Canadian Gypsum) (PE 2071), Ocean Construction (PE 2302) and LaFarge Cement (PE 42) should take steps to either recycle their alkaline wastewaters or to implement pH control measures. In the case of Ocean Construction (PE 2302), this may include steps to control storm water discharges.

The permit held by Canadian Gypsum (PE 2071) is being reviewed by the WMB. The pH range of 6.5 to 8.5 specified in the objectives should be imposed in any new permit issued.

6. DOMESTIC SEWAGE DISCHARGES

6.1 Introduction

Discharges of domestic sewage, which enter the river directly from industry and small miscellaneous operations instead of being conveyed to a municipal sewer system, are discussed in this chapter. The domestic sewage is generated at private residences, hotel/motel complexes, restaurants, and commercial and industrial mill sites. The locations of such discharges are indicated in Figure 11. Domestic sewage discharges from municipal treatment plants are not described here but are dealt with elsewhere[7].

6.1.1 Guidelines/Objectives/Regulations

Objectives dealing with discharges of domestic sewage have been published by the Pollution Control Board and are included in Tables 30 and 31[42]. Specific requirements for each operation are dependent upon the wastewater discharge rate, the dilution provided by the receiving water, the type of receiving water the wastewater is discharged to, and whether the operation is new or existing.

The Federal Government has outlined guidelines for domestic sewage discharges from federal establishments. These are included in Table 32[43]. These limits could be expected to be met at a properly designed and operated conventional secondary treatment plant. These guidelines generally are more restrictive than the provincial objectives.

6.1.2 Wastewater Treatment Methods

For many years, domestic sewage from small installations was treated in septic tanks prior to discharge. Septic tanks are intended to effect the physical separation of settleable solids and floating material but the normal effluent is of inferior quality to that of primary treatment plants. Septic tanks, however, have the distinct advantage over physical sedimentation of producing significantly less sludge[28]. This is accomplished through the partial liquefaction of the sludge by the septic action of bacteria and other microscopic biota. The effluent from septic tanks can occasionally contain sludge and can then be of poorer quality than the influent to the tank.

To obtain treatment efficiencies equivalent to secondary treatment at small installations, the activated sludge process or variations thereof are now being utilized. The activated sludge process "uses micro-organisms in suspension to oxidize soluble and colloidal organics in the presence of molecular oxygen"[29]. More precise details of the specifics relating to this process are found elsewhere[29].

Manufacturers now make available "package plants" which utilize the activated sludge process (normally extended aeration). These can be purchased in many sizes and with several options, such as flow equalization chambers, comminutors, and chlorine contact tanks.

6.2 Operations Discharging to the Main Stem

The operations in this section are presented in a random order.

6.2.1 Weldwood of Canada Ltd., T-Ply and Timberland, Surrey, (PE 3434)

The wastewater from this operation consists of domestic sewage, process water (discussed in Section 2.2.3), and cooling water (discussed in Section 8.2.2). A summary of monitoring data, and the limits outlined in pollution control permit PE 3434, are included in Table 33. The prescribed limits are more stringent than those outlined for level "AA" of the objectives. The domestic sewage is treated in a package plant, with a design capacity of 77.3 m^3/d.

Although chlorination equipment is part of the package plant, the company has never used it due to a stated concern for the effect of residual chlorine on the receiving environment. This concern could be eliminated by adding dechlorination equipment, or by replacing the chlorination equipment with other means of disinfection.

The monitoring data for this operation indicate that the BOD_5 seldom met the limit of 45 mg/L. However, the concentration of suspended solids during the same period usually met the limit of 60 mg/L. The loading of total phosphorus from this operation was 0.5 kg/d, and of total nitrogen was 3.8 kg/d. These loadings were based upon the permitted flow rate of 65 m^3/d, and the median concentrations for these parameters.

6.2.2 Evergreen Trailer Park, Port Coquitlam, (PE 1508)

This 87 unit trailer park discharges domestic sewage through two septic tanks, an aeration tank, an oxidation ditch, and a two-stage settling basin prior to chlorination. The limits for specific contaminants allowed in the wastewater by pollution control permit PE 1508, as well as a summary of the monitoring data, are included in Table 33.

The limits of PE 1508 are more stringent than level "AA" of the objectives. The monitoring data for this operation indicate that the median BOD_5 and suspended solids concentrations exceeded the permit levels.

6.2.3 Mill and Timber Products, Surrey, (PE 328)

This operation discharges domestic sewage from the sawmill and office facilities. The sewage is treated in an extended aeration plant and is post-chlorinated.

A summary of monitoring data and permitted levels of specified contaminants pursuant to pollution control permit PE 328 are included in Table 33. The limits of PE 328 are more stringent than level "AA" of the objectives. The available data indicate that the concentrations of BOD_5 and suspended solids generally met the limits of PE 328.

Chlorination of the effluent, according to fecal coliform data available, did not appear to be particularly effective. The median fecal coliform content was approximately 8 000 MPN/100 mL, while the maximum fecal coliform content was 160 000 MPN/100 mL, although the chlorine residual was as high as 2.4 mg/L. Assuming that the bacteriological samples were taken at the same time as the chlorine residuals were measured, it can be speculated that the chlorine contact period was insufficient to provide adequate disinfection.

The total nitrogen loading from this discharge was 0.1 kg/d, based upon one recorded value and the permitted discharge rate of 13.5 m^3/d.

6.2.4 10014 Allard Crescent, Langley, (PE 1536)

The domestic sewage is generated and discharged from a multiple bedroom private residence. Treatment is provided by an activated sludge plant followed by chlorination. Limits for specified contaminants allowed pursuant to pollution control permit PE 1536, as well as a summary of the monitoring data, are included in Table 33. The levels of PE 1536 are more stringent than level "AA" of the objectives. The data indicate general compliance with the limits of PE 1536.

6.2.5 Big "B" Burgers Ltd., Surrey, (PE 2975)

Domestic sewage from this drive-in restaurant is treated utilizing a grease trap, a septic tank for primary clarification, a package treatment plant, and chlorination. This wastewater flow was diverted to the municipal sewer system in April 1978. Limits for specific contaminants allowed pursuant to PE 2975, as well as a summary of the monitoring data, are included in Table 33. The limits of PE 2975 are more stringent than level "AA" of the objectives. The BOD_5 and suspended solids concentrations met the limits of PE 2975 on more than fifty percent of the occasions sampling occurred.

6.2.6 Swiftsure Towing Company Ltd., Surrey, (PE 3154)

This operation discharges domestic sewage generated from 15 people. Treatment is provided by a package treatment plant. Facilities to provide ultraviolet sterilization of the effluent are available.

The limits of pollution control permit PE 3154, as well as a summary of the monitoring data, are included in Table 33. The limits of PE 3154 are more stringent than level "AA" of the objectives. The small amount of monitoring data available indicate that the limits were not met.

6.2.7 Rolyn Mills Ltd., Port Hammond, (PE 3712)

The domestic sewage from sawmill washrooms is treated in an extended aeration plant with post chlorination.

Pollution control permit PE 3712 allows a flow of 2.3 m^3/d with an associated BOD_5 concentration of 45 mg/L and suspended solids concentration of 60 mg/L. These limits are more stringent than level "AA" of the objectives. No monitoring data are available.

6.2.8 Clappison Packers Ltd., Haney, (PE 100) (PE 3743)

This slaughterhouse operation is discussed in Section 3.2.2. Domestic sewage was discharged independently of process wastewater during the period 1974 to 1977. Domestic sewage was to be treated in two septic tanks but no monitoring data are available.

Pollution control permit PE 3743 limited this discharge to a flow of 9.1 m^3/d. The concentration of BOD_5 was limited to 45 mg/L, and the suspended solids to 60 mg/L. These limits are more stringent than level "AA" of the objectives.

6.3 Operations Discharging to the North Arm

The operations in this section are presented in a random order.

6.3.1 Koppers International Canada Ltd., Burnaby, (PE 1804)

Two wastewaters are generated at this operation, one being cooling water (Section 8.3.4), and one domestic sewage. The domestic sewage from this operation is treated in an extended aeration package plant with chlorination equipment. The wastewater is limited by pollution control permit PE 1804 to a flow of 1.8 m^3/d, a BOD_5 concentration of 45 mg/L, and a suspended solids concentration of 60 mg/L. These limits are more stringent than level "AA" of the objectives.

A summary of the monitoring data has been included in Table 33. Flow data have never been recorded. The BOD_5 and suspended solids concentrations do not usually meet the permitted levels.

6.3.2 Belkin Packaging Ltd., Burnaby, (PE 17)

Process wastewater, discussed in Section 2.3.1, and domestic sewage are discharged from this operation. The domestic sewage is treated in an extended aeration activated sludge plant. Limits for specified contaminants allowed by pollution control permit PE 17, as well as a summary of monitoring data, are included in Table 33. The limits are more stringent than level "AA" of the objectives. The small amount of data indicates compliance with the specified levels.

6.3.3 Western Canada Steel Ltd., Mitchell Island, (PE 2087)

Wastewater discharged from this operation consists of process wastewater, discussed in Section 4.3.1, and domestic sewage. In late 1975, a package plant was installed.

A summary of monitoring data, as well as the levels permitted by pollution control permit PE 2087, are included in Table 33. The limits are more stringent than level "AA" of the objectives. The data generally indicate compliance with the limits of PE 2087. The loading of phosphorus to the river was 0.1 kg/d, and the loading of nitrogen was 0.5 kg/d. These loadings were based upon the permitted flow rate of 45.5 m^3/d and the median recorded concentrations for these parameters.

6.3.4 Cumberland Development Corporation Ltd., Mitchell Island, (PE 52)

This furnace manufacturing plant discharges cooling water (discussed in Section 8.3.16) and domestic sewage. The domestic sewage is treated in a septic tank, and then filtered through sand prior to discharge.

A summary of the monitoring data, and the limits pursuant to pollution control permit PE 52, are included in Table 33. The limits are more stringent than level "AA" of the objectives. The limits for BOD_5 and suspended solids in PE 52 were met.

6.3.5 Tree Island Steel Company Ltd., Richmond, (PE 139) (PE 3190)

This operation discharged domestic sewage to the river through two septic tanks in parallel from 1971 to 1979. Prior to 1971, acid pickling wastes were discharged with the domestic sewage. In 1979, the domestic sewage was diverted to an exfiltration lagoon.

Pollution control permit PE 139 restricted the domestic sewage discharge to 4.5 m^3/d. The monitoring data, included in Table 33, indicate that the suspended solids were usually less than 30 mg/L. Although there were few monitoring data on BOD_5 concentrations, they indicated a BOD_5 of less than 30 mg/L.

6.3.6 Terminal Sawmills, Richmond, (PE 3950)

The wastewater from this operation consists of cooling water and domestic sewage. The sewage is generated in the sawmill and office building. It is then treated in a package treatment plant.

Limits for specified contaminants in the wastewater pursuant to pollution control permit PE 3950, as well as a summary of the monitoring data, are included in Table 33. The limits are more stringent than level "AA" of the objectives. The small amount of data collected indicates that the limit for the concentration of suspended solids was never met. The BOD_5 limit was met on one occasion.

6.3.7 Crown Zellerbach, Richmond Lumber Mill, (PE 3377)

Wastewater from this operation consists of process wastewater, discussed in Section 2.3.6, cooling water, discussed in Section 8.3.8, and domestic sewage. The domestic sewage is generated from approximately 135 people. It has been treated in a package plant since 1975. Before 1975, the sewage was treated in a septic tank.

Limits for specified contaminants in the wastewater pursuant to pollution control permit PE 3377, as well as a summary of the monitoring data, are included in Table 33. The limits of PE 3377 are more stringent than level "AA" of the objectives. The data indicte that the suspended solids limit has never been met. Over fifty percent of the BOD_5 analyses were in excess of the permit level.

6.3.8 Crestwood Kitchens Ltd., Richmond, (PE 341)

This factory discharged domestic sewage, treated in an extended aeration plant, until approximately 1974. At that time, the flow was diverted to the municipal sewer system.

Pollution control permit PE 341 allowed the company to discharge 36.4 m^3/d of wastewater. The suspended solids concentration was limited to 60 mg/L, the BOD_5 concentration to 30 mg/L, and the pH to the range of 6.5 and 7.5. No monitoring data are available on the quality of the wastewater prior to 1974.

6.4 Operations Discharging to the Main Arm

The operations in this section are presented in a random order.

6.4.1 Con-Force Products Ltd., Richmond, (PE 2976)

Wastewater discharged from this operation consists of process wastewater, discussed in Section 5.4.3, and domestic sewage. The domestic sewage was treated in a septic tank until July 1975. At that time, a package plant of 22.7 m^3/d capacity was installed.

The limits for specified contaminants allowed in the wastewater by pollution control permit PE 2976, as well as a summary of the monitoring data, are presented in Table 33. The limits of PE 2976 are more stringent than level "AA" of the objectives. The data indicate that the wastewater quality did not normally meet the permit levels for BOD_5 or suspended solids. As well, the bacteriological data indicate that fecal coliform contamination (as high as 92 000 MPN/100 mL in the wastewater) was occurring.

6.4.2 St. George Holdings, Richmond, (PE 2)

This is a 30-room hotel which also has a 300-seat beverage room and 75-seat dining room and coffee shop. The domestic sewage is treated in a secondary package treatment plant of 45.5 m^3/d capacity. The effluent from the plant is chlorinated and twenty minutes contact time is provided at design flow.

A summary of the monitoring data, and the limits for specified contaminants allowed by pollution control permit PE 2, are included in Table 33. The limits of PE 2 are more stringent than level "AA" of the objectives. The data indicate general compliance of suspended solids, and slightly more than fifty percent compliance of BOD_5 concentrations. The loadings of total phosphorus and total nitrogen were 0.1 kg/d and 1.1 kg/d, respectively. These loadings were based upon the permitted discharge rate of 45.5 m^3/d and the median recorded concentrations for these parameters.

6.4.3 Wawryk Holdings, Delta, (PE 2722)

The domestic sewage from this operation originates in a 20-unit motel and a 100-seat beverage room. The sewage is treated using primary clarification, secondary treatment in the form of activated sludge, and post chlorination. The discharge of effluent is to Crescent Slough. A summary of monitoring data and levels of specified contaminants allowed by pollution control permit PE 2722, are included in Table 33.

The limits of PE 2722 are more stringent than level "AA" of the objectives. The data indicate compliance of the BOD_5 with the permitted concentration of 30 mg/L. The suspended solids concentration met the permitted concentration of 35 mg/L on more than fifty percent of the sampling occasions. The fecal coliform level was generally low, with the maximum recorded being 490 MPN/100 mL.

6.4.4 Satellite Developments Ltd., Richmond, (PE 2969)

The domestic sewage originates from an office building with approximately 105 people. The sewage is treated in a septic tank. Pollution control permit PE 2969 requires that the sewage be discharged to the municipal sewer system, or treated so that the concentration of BOD_5 is 45 mg/L and the concentration of suspended solids is 60 mg/L. These limits are more stringent than level "AA" of the objectives. No monitoring data exist for this operation.

6.4.5 J. Griffin and Company Ltd., Delta, (PE 1914) (PE 5480)

This fish processing operation started up operations in April 1979. The process wastewater is discussed in Section 3.4.6. The premises were used until 1977 by a boat manufacturer who discharged domestic sewage.

A summary of monitoring data and limits for specified contaminants allowed pursuant to former pollution control permit PE 1914 are included in Table 33. The limits of PE 1914 were more stringent than level "AA" of the objectives. The data indicate that the limits for BOD_5 and suspended solids were exceeded on over fifty percent of the samplings. As well, fecal coliform concentrations greater than 24 000 MPN/100 mL were measured.

6.4.6 Grosvenor Laing, Annacis Island, (PE 182)

Domestic sewage from this complex was treated in a septic tank prior to discharge. In 1978, the sewage was diverted to the municipal sewer system.

Limits for specified contaminants in the wastewater, as well as a summary of the monitoring data, have been included in Table 33. There are insufficient data for comment.

6.5 Discussion of Domestic Sewage Discharges

A summary of flow rates and of BOD_5 and suspended solids loadings is included in Table 34. The three major sewage treatment plants within the study area (Lulu, Iona, Annacis) discharged 31 300 kg/d of suspended solids and 58 100 kg/d of BOD_5 in 1977[7]. These quantities compare to discharges during 1977 of approximately 20 kg/d of BOD_5 and 20 kg/d of suspended solids for all of the operations discussed in this chapter. The loadings from the operations discussed in this chapter have an insignficant impact on the water chemistry of the Fraser River compared to loadings from the three major sewage treatment plants, although localized effects may occur. Most of these operations improved their wastewater treatment systems to the level of conventional treatment.

The limits for BOD_5 and suspended solids outlined in pollution control permits for operations which continue to discharge to the river are more stringent than level "AA" of the objectives. The permit limits for suspended solids range from 35 mg/L to 75 mg/L. The permit limits for BOD_5 range from 30 mg/L to 75 mg/L. These limits are applicable to secondary treatment plants, and can be met at these types of plants when they are properly designed and operated. Several of these operations are not meeting the limits in their pollution control permits.

One hundred percent compliance with suspended solids limits was accomplished at only 29.4% of the operations. Compliance on at least fifty percent of the sampling occasions occurred at 36% of the operations.

One hundred percent compliance with BOD_5 limits was accomplished at only 17.6% of the operations. Compliance on at least fifty percent of the sampling occasions occurred at 41.2% of the operations.

No general trends of improving effluent quality were noted from the limited data.

6.6 Conclusions

Loadings of BOD_5 and suspended solids from direct discharges of domestic sewage are insignificant compared to similar discharges from municipal operations.

The limits for BOD_5 and suspended solids outlined in the pollution control permits are more stringent than level "AA" of the objectives. However, these limits can be easily attained with the types of treatment being utilized at these operations.

There has been significant non-compliance with levels specified in pollution control permits. The fact that there would appear to be no trend of improving wastewater quality so that these levels are met is probably not a design problem, but an operating problem.

7. MISCELLANEOUS INDUSTRIES

7.1 Introduction

Operations discussed in this chapter include a phenol plant; a phenol-formaldehyde plant; a car dewaxing operation; a film and flexible packaging operation; an oxygen, nitrogen, and acetylene manufacturing operation; a winch manufacturing operation; a peat moss extraction operation; a rope and twine manufacturing operation; and two oil tank farms. The location of these operations are indicated in Figure 12.

7.1.1 Guidelines/Objectives/Regulations

No federal regulations or guidelines exist applicable to the aforementioned operations. Objectives for wastewater quality have been issued by the Pollution Control Board for wastewaters from phenol manufacturing operations and acetylene plants[44]. The applicable objectives are included as Table 35. These objectives are discussed and related to specific operations.

7.1.2 Wastewater Treatment Methods

It has been indicated that "biological treatment methods have afforded the most economical secondary treatment processes for pollution abatement" in the petroleum industry[30]. Pretreatment of the wastes can reduce costs of treatment. In the case of the petrochemical industry, problems arise due to process changes, poor plant management and spills.

Wastewater from acetylene plants can be treated utilizing physical sedimentation.

7.2 Operations Discharging to the Main Stem

No miscellaneous operations discharge directly to the Main Stem of the Fraser River within the study area. However, the effluents from two operations enter the Brunette River upstream from its confluence with the Fraser River. These operations are discussed in Sections 7.5.1 and 7.5.2.

7.3 Operations Discharging to the North Arm

The operations in this section are presented in a random order.

7.3.1 Borden Company Ltd., Vancouver, (PE 1549)

This plant manufactures formaldehyde as an intermediate product and a phenol-formaldehyde type of resin as a final product. The formaldehyde is manufactured by oxidation of methyl alcohol with air at high temperatures over a catalyst. The formaldehyde formed is absorbed by water. The phenol-formaldehyde resin is formed after the distillation of formaldehyde and unreacted methyl alcohol and the subsequent condensation of formaldehyde with phenol to form a resin.

The plant discharges cooling water, discussed in Section 8.3.19, and surface runoff. This surface runoff was eliminated by the company in 1975 by utilizing some of it within the process while directing the overflow to the municipal sewage system.

Five analyses of the surface runoff between January 1973 and March 1973 indicated phenolic concentrations ranging from 7 mg/L to 25 mg/L. A summary of analyses of the cooling water indicates a slight phenolic contamination (0.016 mg/L) at times, as well as a measurable oil and grease concentration.

7.3.2 Liquid Carbonic Canada Ltd., Mitchell Island, (PE 3555)

This oxygen, nitrogen, and acetylene manufacturing plant consists of two distinct operations: the production of acetylene and the production of oxygen and nitrogen.

Acetylene is produced by reacting calcium carbide with water. This reaction produces acetylene and carbide lime. The carbide lime is settled out in a sedimentation basin, and the resulting sludge is trucked away and used on farmland. The supernatant drawn off from the sedimentation tank is reused in the reactor. Water used in spray cooling acetylene bottles is also recycled.

Oxygen and nitrogen are produced through a four-stage compression and liquefaction of air. Water is condensed by indirect cooling. The indirect cooling water is discharged to a ditch which flows to the Fraser River. Carbon dioxide is removed by caustic scrubbing. The spent caustic from scrubbing of the carbon dioxide is trucked away and sold.

Pollution control permit PE 3555 restricts the discharge rate of the cooling water to 705 m^3/d at a maximum temperature of 30^oC. Three wastewater samples taken between 1975 and 1977, contained oil and grease from less than 0.1 mg/L to 2.2 mg/L (median 1.1 mg/L).

7.4 Operations Discharging to the Main Arm

The operations in this section are presented in a random order.

7.4.1 Fraser Wharves Ltd., Richmond, (PE 1621)

This is a car dewaxing operation. New cars are passed through a sequence of kerosene and hot water sprays. The wastewater is treated using sedimentation, coagulation, and air flotation to remove wax and kerosene. As well, some of the wastewater is recycled while waste kerosene and sludge are transported to an oil refinery. The buildup in concentrations of certain substances in the wastewater prevents continual recycling of all of the wastewater.

A summary of monitoring data, and limits allowed pursuant to pollution control permit PE 1621, are included in Table 36. The limits are equal to or more stringent than the level "A" objectives. The data indicate non-compliance of pH, but compliance with permit levels on at least fifty percent of the sampling dates for suspended solids, total organic carbon and flow.

Singleton(4) reported that single bioassays, using rainbow trout in 1973 and 1975, gave 96-hour LC_{50}'s of 21% and 43%, respectively.

7.4.2 Dow Chemical of Canada, Delta, (PE 41)

This plant produces phenol by the oxidation of toluene. Wastewater consists of cooling water and phenol contaminated process water. The phenol contaminated process water originates from condensate, washwater, surface runoff, and domestic sewage and is biologically treated after fifty days retention in a lagoon. The biological treatment consists of a fast trickle tower, aeration chamber, and settling tank. Ammonia is used to raise the pH of the lagoon effluent.

Limits for specified contaminants in the process water, as well as a summary of the monitoring data, have been included in Table 36. All of the limits, except temperature, are related to the process wastewater. The limits for all contaminants except suspended solids are equivalent to, or more stringent than level "B" of the objectives. The data indicate that the pH and the wastewater temperature were in the range authorized by the permit. The loadings of total phosphorus, ammonia, suspended solids, and total organic carbon could not be calculated since no flow data were available. Therefore compliance with the permit limits could not be determined.

The loading of total phosphorus was estimated to be 5.3 kg/d, while the total nitrogen loading was 17.8 kg/d. The suspended solids loading was about 3 100 kg/d, while the BOD_5 loading was about 2 700 kg/d. These loadings were based upon the permitted flow rate of about 66 000 m^3/d and the median concentrations for these parameters.

Phenol concentrations in the combined effluent as high as 0.19 mg/L were recorded, although the median concentration was 0.01 mg/L. A report by Cain et al[8] indicated that trace quantities were found in the wastewater of pentachlorophenol (1.4 µg/L) and 2,3,4,6-tetrachlorophenol (0.2 µg/L). A trace of 2,4,6-trichlorophenol was also encountered.

Acute toxicity tests were carried out on eight samples of process effluent between 1974 and 1976 using coho salmon and rainbow trout. The range of values for the 96-hour LC_{50} was from 8.5% to greater than 100%, with five of the samples not being acutely toxic[4].

Dow applied for an amendment to their permit in February 1980. The company requested that the permitted suspended solids loading in the process water be increased from 10 kg/d to 32.7 kg/d. It was indicated in the amendment request that the permitted loading had to be increased since wastewater volumes had increased with increased production. The company also indicated that high strength wastes had resulted from unspecified in-plant controls which were implemented to reduce water consumption.

7.4.3 Western Peat Moss Ltd., Delta, (PE 4382)

This peat moss mining plant discharged washwater to the river until June 1976. At that time, the company diverted these flows to an old mine cavity in the peat bog which was defined as an exfiltration pond. Although no discharge from this pond was supposed to take place, personnel from the WMB noted that discharges occurred on several occasions when field inspections were carried out.

These overflows discontinued in early 1979 when the drying plant was moved adjacent to the mining area and dykes were built around the exfiltration pond. Peat is now pumped in a slurry to the drying plant, the peat is removed, the water is screened to recover peat fines, and it is then returned to the exfiltration pond.

Pollution control permit PE 4382 restricted the flow rate to 5 500 m^3/d. In 1978, this value was raised to 17 275 m^3/d. The EPS tested the wash and press effluent prior to its entry into the exfiltration pond. The 1978 EPS data indicated a pH of 4.1, a COD concentration of 6 150 mg/L, a TOC concentration of 1 832 mg/L, and a suspended solids concentration of 3 770 mg/L. The EPS also performed an acute toxicity test on the wash and press effluent. The 96-hour LC_{50} was 36%.

7.4.4 Imperial Oil Ltd., Steveston, (PE 4649)

This is a fuel storage depot which discharges spills and/or rain water runoff. Pollution control permit PE 4649 restricted the flow to 54.5 m^3/d and the oil and grease concentration to 5 mg/L. No monitoring data exist for this operation.

7.5 Operations Discharging to the Brunette River

The operations in this section are presented in a random order.

7.5.1 Canada Western Cordage Co. Ltd., New Westminster, (PE 2069)

This rope and twine manufacturing company discharged cooling water, process wastewater, and domestic sewage. The domestic sewage was diverted to the municipal sewer system in July 1975. Pollution control permit PE 2069 restricted the daily discharge of process and cooling water to 36.4 m^3/d at a maximum temperature of 23.9°C. The plant closed in 1978.

Most of the wastewater consisted of cooling water from the quench tanks which was used in the extrusion of the polypropylene fibres. On a monthly basis, 0.1 m^3 of organic dyes and 0.2 m^3 of wastewater from the batch stabilizing tanks in the nylon process were also discharged.

Monitoring data for the wastewater quality are included in Table 36 for the period of 1974 to 1977. One analysis of the wastewater in 1973 indicated an oil and grease concentration of 1 897 mg/L, a BOD_5 concentration of 660 mg/L, and a suspended solids concentration of 1 911 mg/L. However, the limited data for later years revealed significantly lower values for all of these parameters. This may have resulted from improved wastewater treatment methods, or from the 1973 values reflecting the presence of an intermittent monthly discharge of one of the aforementioned process wastewaters.

7.5.2 Shell Canada Ltd., Burnaby, (PE 3138)

This tank farm operation discharges stormwater after it has passed through a stormwater retention pond. Pollution control permit PE 3138 limited the discharge to 273 m^3/d with an oil and grease concentration of 5 mg/L. Monitoring data are summarized in Table 36.

The oil and grease concentration met the permit level on over fifty percent of the sampling dates. Phenol was detected in the stormwater at concentrations as high as 0.3 mg/L. The median concentration was 0.002 mg/L.

Analytical data for cyanide, sulphite and metals are not included in this report, however, concentrations were not high.

7.6 Operations Discharging to the Serpentine River

The operations in this section are presented in a random order.

7.6.1 Gearmatic Company Ltd., Surrey, (PE 2361)

This operation manufactures winches. It discharges wastewater which originates from water fountains, air compressors, the deburring machine and the flame hardening unit.

Pollution control permit PE 2361 restricts the flow of wastewater to 29.6 m^3/d at a maximum temperature of 24°C. Twelve analyses of the wastewater between 1974 and 1979 indicated a median oil and grease concentration of 2.7 mg/L (maximum 15.5 mg/L).

7.6.2 Capital Plastics Ltd., Surrey, (PE 2645)

This film and flexible packaging manufacturing plant discharges wastewater which is made up of cooling water and bleedoff from the polyethylene reclaim machine. This wastewater passes through a sedimentation sump prior to being discharged to Bear Creek through a ditch.

Pollution control permit PE 2645 restricts the flow to 54.6 m^3/d at a temperature of 32.2°C. The monitoring data have been summarized in Table 36. They indicate that the pH ranged from 6.3 to 6.8, the median flow rate was 32.7 m^3/d, while the median recorded temperature was 26.7°C.

7.7 Discussion of Miscellaneous Industries

The smallest number of operations have been grouped into this industrial classification. The diverse nature of the operations makes comparison among them difficult. However, there is one group of operations which can be compared.

This grouping consists of two tank farm operations. Both operations have permit limits for allowable oil and grease concentrations. However, there are no monitoring data for the Imperial Oil operation (PE 4649). The data for the Shell Canada operation (PE 3138) indicate that the oil and grease concentration in the wastewater met the permit level of 5 mg/L on over fifty percent of the sampling dates.

Two operations in the study area either handle or manufacture phenolic substances, Borden Company (PE 1549) and Dow Chemical (PE 41). The Borden operation discharged phenolic compounds in its surface runoff until 1975. Concentrations of phenol as high as 25 mg/L were recorded. This direct discharge was eliminated by using some of the stormwater within the process, while discharging the remainder to the municipal sewer system. This may have implications in any source control program undertaken[31]. According to the data contained within EQUIS, the phenol concentration in the Dow

Chemical discharge (cooling water and process water) was as high as 0.19 mg/L, although the median concentration was only 0.01 mg/L. The flow at Dow was approximately 66 000 m^3/d.

Acute toxicity tests were carried out on wastewaters from only two operations: Fraser Wharves (PE 1621) and Dow Chemical (PE 41). The Fraser Wharves operation is a car dewaxing operation. The 96-hour LC_{50} results at Fraser Wharves were 21% and 43%, the tests having been carried out in 1973 and 1975. Improvements in the wastewater treatment system may have been made since these tests were carried out. The acute toxicity tests carried out on the wastewater from Dow Chemical indicated that the wastewater was non toxic in five of eight tests.

A summary of loadings and flows for miscellaneous operations is included in Table 37. A significant intermittent suspended solids loading from Western Peat Moss Ltd. (PE 4382), of approximately 21 000 kg/d, was discontinued after 1978 when flows were diverted to an exfiltration pond.

7.8 Conclusions and Recommendations

The phenolic concentrations measured at Borden Chemical (PE 1549) make investigations of this discharge for phenolics an important aspect of any source control program undertaken since the effluent is discharged to the municipal sewer system.

Additional facilities may have to be installed at Fraser Wharves (PE 1621) to control the pH within the range outlined in the permit.

8. UNCONTAMINATED COOLING WATER

8.1 Introduction

The discharge of wastewater into a receiving stream at a higher temperature than the ambient temperature of that receiving stream can be harmful to some aquatic life[32]. Although most environmental studies of thermal discharges have been related to the electrical generation industry, the effects of thermal discharges and the need to regulate them are independent of the source of the thermal discharge. Cooling water discharges within the study area are indicated in Figure 13. The cooling water discharges may have anti-fouling agents added to them.

8.1.1 Guidelines/Objectives/Regulations

No federal guidelines or regulations exist for either the maximum temperature of any discharge or the maximum temperature rise in any stream. Receiving water quality objectives in British Columbia permit a $1^{o}C$ temperature rise due to effluents from the forest industry[37], and a $2^{o}F$ temperature rise due to effluents from the chemical and petroleum industry[44].

Instead of regulating temperature rises in receiving streams, maximum effluent temperatures have been regulated for some industries in British Columbia. Table 1 indicates that the maximum temperature of effluents from pulping processes, or from saw, planer, shingle, wood preserving, veneer, and plywood mills should be $35^{o}C$. Table 35, which relates to chemical industries other than petroleum refineries, indicates the maximum effluent temperature should be $90^{o}F$ ($32.2^{o}C$).

8.1.2 Wastewater Treatment Methods

Water used for cooling is either used once and classified "once-through" or is continuously recycled. Continuously recycled cooling waters are classified "closed-cycle" or "recirculating". Recirculating systems employ means such as cooling towers, and control make-up and blowdown. The recirculating systems control pH, use corrosion inhibitors, and exercise slime control using chlorine or other chemicals.

The temperature of the effluent discharged from once-through systems can be reduced through the use of cooling towers, cooling ponds or spray ponds. The mixing of the heated wastewater with the receiving water can also be improved by discharging wastewater through a diffuser pipe near the bottom of the waterway.

8.2 Operations Discharging to the Main Stem

The operations in this section are presented in a random order.

8.2.1 Domtar Ltd., Northwest Wood Preservers, New Westminster (PE 3410)

Wastewater from this wood preserving operation consisted of domestic sewage, contaminated process water, and uncontaminated cooling water. The domestic sewage which was treated in a septic tank was diverted to the municipal sewer system in 1977. The contaminated process water was burned by a liquid incinerator, and was to be subsequently discharged to the sewer in 1977 or recycled.

The cooling water consisted of indirect condenser cooling water and condensate from retort steam coils. It is believed, from the permit application, that the cooling water contained approximately 1.0 mg/L of phenolic compounds as a result of past spills. Cain et al.[8] analyzed what is believed to have been cooling water, in a ditch near the plant. No phenolic compounds were measured.

The EPS[50], through consultants, carried out a survey in 1978 where wood protection facilities existed. The results of the survey indicated that tissue samples collected adjacent to the plant were among those most contaminated, when compared to tissue samples analyzed from ten other sites. Chlorobenzenes and pentachlorophenols were found in sediments from the river. Surface water samples collected adjacent to the plant in the Fraser River contained both pentachlorophenol and tetrachlorophenol[50].

An acute toxicity test of the cooling water in 1974, using coho salmon indicated that the cooling water was non-lethal (96-hour LC_{50} greater than 100%).

Pollution control permit PE 3410 restricted the flow to 35 m^3/d at a maximum temperature of 35^{o}C. The monitoring data included in Table 38 indicate that the permitted flow was always exceeded. The temperature criterion was exceeded less than fifty percent of the time.

8.2.2 Weldwood of Canada Ltd., T-Ply and Timberland, Surrey, (PE 3434)

This operation is also discussed in Section 2.2.3 and Section 6.2.1 of this report. Three cooling water discharges occur. One is from the boiler feed pump, a second from the mechanical debarker, and a third from an air compressor. Pollution control permit PE 3434 restricts the flows to 12.7 m^3/d, 32.7 m^3/d, and 84.1 m^3/d, respectively. The temperature of all of these discharges is restricted to a maximum of 21.1^oC. No monitoring data are available.

8.2.3 Fraser Gourmet Food Products Ltd. (Valley Custom Packers Ltd.), Maple Ridge, (PE 4577) (PE 5019)

The wastewater discharged to the river from this meat packing plant consists solely of uncontaminated cooling water. Process water and domestic sewage are now trucked to the Maple Ridge sewage treatment facility.

Pollution control permit PE 4577 restricts the flow of uncontaminated cooling water to 4.6 m^3/d, with a maximum rate of 6.8 m^3/d, at a maximum temperature of 32.2^oC. The cooling water is stored in a tank in an effort to reduce its temperature prior to discharge. There are no monitoring data for this operation.

8.3 Operations Discharging to the North Arm

The operations in this section are presented in a random order.

8.3.1 Scott Paper Ltd., New Westminster, (PE 335)

This operation is discussed in Section 2.3.4. Cooling water and fibre-free effluent are discharged from the groundwood pulping area. Pollution control permit PE 335 restricts the average flow to 910 m^3/d and the maximum flow to 1 150 m^3/d. The maximum permitted temperature of the cooling water is 35^oC.

The monitoring data, presented in Table 38, indicate that the cooling water temperature met permit conditions on the two occasions it was measured.

8.3.2 Puritan Canners, Richmond, (PE 36)

This operation is discussed in Section 3.3.1. Cooling water originates from two sources within the plant: the cooling canal and the batch retort. The cooling canal is a continuous operation where batch loads of cooked cans are passed through flowing water. The batch retort is the cooling process by which retorts are opened following steam cooking of cans, and are flooded with water.

Pollution control permit PE 36 restricts the maximum temperature of the cooling water to 21°C, at a flow rate of 373 m^3/d. The data in Table 38 indicate that the temperature requirement was seldom met.

8.3.3 Standard Brands Canada Ltd., Richmond, (PE 2063)

This operation has been discussed in Section 3.3.3. The cooling water originates from steam condensate in the retorts and the cooling canal. Pollution control permit PE 2063 restricted the cooling water to a maximum temperature of 29.5°C, at a maximum flow of 340 m^3/d.

The monitoring data have been summarized in Table 38. The data indicate that the temperature of the cooling water was less than that permitted on over fifty percent of the samplings.

8.3.4 Koppers International Ltd., Burnaby, (PE 1804)

This wood preserving operation boils wood in creosote or pentachlorophenol under vacuum. The wastewater consists of domestic sewage, discussed in Section 6.3.1, and cooling water (with a small amount of steam condensate). Pollution control permit PE 1804 restricts the maximum temperature of the cooling water to 21°C, the maximum flow to 1 400 m^3/d, and the average flow to 1 060 m^3/d.

A summary of the monitoring data, included in Table 38, indicate that the temperature of the cooling water met the permit limit.

8.3.5 Canadian Forest Products Ltd., Eburne Sawmill Division, Vancouver, (PE 2115)

This sawmill operation, discussed in Section 2.3.5, discharges mostly condenser cooling water. Pollution control permit PE 2115 allows the discharge of 27 275 m^3/d at a maximum temperature of 35°C.

The monitoring data, summarized in Table 38 (identified as 2115-02), indicate that these limits were not exceeded during 1978.

8.3.6 Weldwood of Canada Ltd., Vancouver, (PE 2155)

This veneer and plywood mill operated until 1978 when it was dismantled and sold. There were three sources of cooling water discharged, all requiring a maximum temperature of 35^{o}C, and discharge rates of 36.4 m^3/d, 68.2 m^3/d, and 36.4 m^3/d. Prior to December 1974, wastewater consisting of boiler blowdown water, veneer dryer wastewater, and domestic sewage was also discharged. At that time, the washwater and domestic sewage were diverted to the municipal sewer system. No data on the quality of these discharges are available.

The data for the cooling water have been summarized in Table 38 (identified as 2155-01). The data indicate that the permit limits were met.

8.3.7 Weldwood of Canada Ltd., Kent Ave., Vancouver, (PE 2154)

This veneer and plywood plant has, since 1975, discharged only cooling water and steam condensate. This was brought about by recycling glue washdown from the presses and spreaders in 1972, and by diverting all contaminated process water and domestic sewage to the municipal sewage system in 1975.

Pollution control permit PE 2154 restricted the flow of cooling water from four outfalls to 390 m^3/d at a maximum temperature of 35^{o}C. No data are available for this operation.

8.3.8 Crown Zellerbach Canada Ltd., Richmond, (PE 3264)

This operation is also discussed in Sections 2.3.6 and 6.3.7. The cooling water from the compressor system is restricted by pollution control permit PE 3264 to a flow rate of 98.2 m^3/d at a maximum temperature of 35^{o}C. The data for this operation have been summarized in Table 38. The temperature criterion has been exceeded on less than 50% of the analyses.

8.3.9 Rayonier Canada Ltd., New Westminster, (PE 4959)

This operation is also discussed in Section 2.3.2. It discharges cooling water used in a pump. Pollution control permit PE 4959 allows a maximum temperature of 35^{o}C. The flow is restricted to 23 m^3/d. No monitoring data are available since the permit was issued November 9, 1978.

8.3.10 Rayonier Canada Ltd., Vancouver, (PE 4960)

This operation is also discussed in Section 2.3.3. Cooling water is used for the hydraulic debarker compressor. The discharge will cease by the end of 1981 when the hydraulic debarker is replaced.

Pollution control permit PE 4960, issued November 23, 1978, restricts the maximum temperature of the cooling water to $35^{o}C$, at a flow of 45 m^3/d.

8.3.11 MacMillan Bloedel Ltd., S. Burnaby, (PE 4962)

This operation discharges cooling water from the compressor and the starch process. Pollution control permit PE 4962 restricted the flow to 13.4 m^3/d, with an associated maximum temperature of $35^{o}C$. No monitoring data exist for this operation.

8.3.12 Somerville Belkin Industries Ltd., Carton Converting Plant, Burnaby, (PE 4963)

Cooling water at this operation is associated with compressors and carton converter chill rollers. Pollution control permit PE 4963, issued September 15, 1978, restricts the flow to 73 m^3/d and the maximum temperature to $35^{o}C$.

8.3.13 MacMillan Bloedel Ltd., Specialty Board Division, Vancouver, (PE 4248)

MacMillan Bloedel applied to discharge 131 m^3/d of cooling water at a maximum temperature of $35^{o}C$. The application was withdrawn so that this flow could be considered with wastewater flows from the company's Vancouver Plywood Division. Further discussion is found in Section 8.3.21.

8.3.14 MacMillan Bloedel Ltd., Wooden Pole Plant, New Westminster, (PE 4249)

All wastewater is recycled at this plant except for cooling water. Pollution control permit PE 4249 restricts the flow of cooling water to 4.1 m^3/d, at a maximum temperature of $35^{o}C$. No monitoring data are available on this effluent.

8.3.15 MacMillan Bloedel Ltd., Canadian White Pine Division, Vancouver, (PE 1666)

This sawmill is also discussed in Section 2.3.8. Pollution control permit PE 1666 requires that the discharge of planer guide cooling water be less than 3 m^3/d at a maximum temperature of 35°C. No monitoring data on this cooling water are available.

8.3.16 Cumberland Development Corporation Ltd., Mitchell Island, (PE 52)

This furnace manufacturing firm, discussed in Section 6.3.4, discharges cooling water used with electrowelding tips. Pollution control permit PE 52 allowed the discharge of 84 m^3/d from this operation. No monitoring data have been recorded for this discharge.

8.3.17 Inmont Canada Ltd., Richmond, (PE 2181)

This printing ink manufacturing plant uses cooling water to cool rollers. Pollution control permit PE 2181 allowed for the discharge of 25.5 m^3/d. The maximum permitted temperature rise of the cooling water was 20°F. No monitoring data are available..

8.3.18 Alcan Canada Products, Richmond, (AE 2509)

This operation discharged cooling water until sometime in 1974 when the existing cooling towers were increased in capacity to permit a "closed-cycle" type system. The flow of cooling water was approximately 450 m^3/d. This operation is also discussed in Section 4.3.5.

8.3.19 Borden Company Ltd., Vancouver, (PE 1549)

This operation, also discussed in Section 7.3.1, discharged cooling water from two sources after 1972. One source of cooling water was from the formaldehyde plant. The second was from the synthetic resin manufacturing plant, although it was later eliminated by putting in place a "closed-cycle". The discharge rate allowed by pollution control permit PE 1549 was decreased from 3 928 m^3/d to 182 m^3/d. The maximum temperature permitted remained at 24°C.

The summarized monitoring data in Table 38 indicate that the maximum permitted temperature was met on less than fifty percent of the test dates.

8.3.20 Domtar Construction Materials Ltd., Fibre Products Division, Burnaby, (PE 3735)

This asphalt roofing plant discharges cooling water used for the press tools. Pollution control permit PE 3735 restricts the flow to 940 m^3/d, and the temperature to 32^oC.

The datum in Table 38 indicates this temperature was met.

8.3.21 MacMillan Bloedel Ltd., Plywood Division, Vancouver, (PE 5475)

This operation has eliminated domestic sewage, glue spreader washup overflow, and solvent and paint waste discharges. It now discharges only cooling water. Pollution control permit PE 5475, issued in 1979, allows the discharge of 760 m^3/d of cooling water at a temperature of 35^oC.

8.3.22 MacMillan Bloedel Packaging Ltd., New Westminster, (PE 108)

This corrugated container plant is discussed in Section 2.3.10. The uncontaminated cooling water is pumped to the roof in order to maintain a back pressure to keep the cooling chamber full of liquid.

Pollution control permit PE 108 requires the flow of cooling water to be less than 23 m^3/d and the temperature to be less than 35^oC. No flow data were available. One temperature measurement indicated a temperature of 18.5^oC.

8.4 Operations Discharging to the Main Arm

The operations in this section are presented in a random order.

8.4.1 British Columbia Packers Ltd., Imperial Plant, Steveston, (PE 1830)

This operation is also discussed in Section 3.4.3. Effluent is made up of refrigeration condenser water and small quantities of boiler blowdown water. Pollution control permit PE 1830 restricts the flow of cooling water to 455 m^3/d and the flow of boiler blowdown water to 0.23 m^3/d.

8.4.2 Crown Zellerbach Canada Ltd., Richmond Paper Products, (PE 3265)

This operation is discussed in Section 2.4.2. The discharge of uncontaminated vacuum pump seal water is limited by pollution control permit PE 3265 to a flow of 90.9 m^3/d. The maximum permitted temperature is 35^oC. The summarized monitoring data in Table 38 indicate that the temperature limit was met.

8.4.3 Titan Steel and Wire Company Ltd., Surrey, (PE 161)

This operation is also discussed in Section 4.4.1. Pollution control permit PE 161 restricted the temperature of the cooling water to 24^oC. The flow was restricted to 3 637 m^3/d. The monitoring data, summarized in Table 38, indicate that the temperature limit was met on more than fifty percent of the dates of sampling.

8.4.4 Fraser Surrey Docks Ltd., Surrey, (PE 5024)

This wood chips terminal discharges cooling water from the radiator which cools lubricating oil. Pollution control permit PE 5024 restricts the discharge to 2.75 m^3/d, at a temperature of 32.5^oC. No monitoring data are available for this effluent.

8.4.5 Genstar Ltd., Delta, (PE 4513)

This cement manufacturing plant utilizes dry processing and handling of materials. It became operational in 1978, the only wastewater being cooling water from various process areas. Pollution control permit PE 4513 allowed the discharge of 6 546 m^3/d of cooling water with a temperature rise of 10^oC. In June 1978, the permit was amended to allow the discharge of 18 200 m^3/d. This increase in volume was necessary to maintain the cooling water within the 10^oC temperature rise range.

Surveys in the Fraser River which were carried out by the WMB during low tide conditions on March 3, 1978 and March 17 1978 indicated that the discharge had no measurable temperature effect at distances greater than 50 metres downstream from the discharge.

Acute toxicity tests were carried out by B.C. Research for the company in early 1978. The 96-hour LC_{50} tests indicated that yearling coho salmon could survive a temperature rise of $10^{o}C$ when acclimatized to a river temperature of $5^{o}C$. However, when the fish were acclimatized to temperature of $18^{o}C$, they could only survive a temperature rise of $5^{o}C$.

8.5 Operations Discharging to Kanaka Creek

Only one operation discharges to Kanaka Creek.

8.5.1 Berryland Canning Company Ltd., Maple Ridge, (PE 260)

This operation is also discussed in Section 3.2.1 of this report. The cooling water originates from retort cooling and is discharged to a roadside ditch. Pollution control permit PE 260 restricts the flow to 260 m^3/d and the temperature to $25^{o}C$. No monitoring data are available for this discharge.

The ditch into which the cooling water is discharged leads to a tributary of Kanaka Creek. The creek is reported to be a fish bearing stream. Monitoring of the temperature of the ditch water, 200 metres downstream from the plant, has indicated that the temperature was $32^{o}C$, according to information in the WMB files.

8.6 Operations Discharging to the Brunette River

Only one operation discharges to the Brunette River.

8.6.1 Continental Can of Canada Ltd., Burnaby, (PE 2642)

This metal container manufacturing operation discharges cooling water which originates from three compressors and two vacuum pumps. Pollution control permit PE 2642 restricts the discharge to 105 m^3/d at a maximum temperature of $32^{o}C$.

A review of the monitoring data, included in Table 38, indicates that the permitted flow was exceeded on over fifty percent of the sampling dates. The temperature limit was never exceeded.

8.7 Operations Discharging to the Serpentine River

The operations in this section are presented in a random order.

8.7.1 Reliance Foundry Co. Ltd., Surrey, (PE 2549)

The cooling water is once-through cooling water which passes through closed jackets. Pollution control permit PE 2549 restricts the flow to 113.6 m^3/d at a temperature of 23.9^oC. The summarized monitoring data in Table 38 indicate that these limits were met.

8.7.2 Stowe Woodward, Surrey, (PE 2624)

The cooling water is used to cool the compressor and rubber rollers manufactured at the plant. The cooling water was discharged to Mahood Creek until 1976. At that time it was discharged to the municipal sewer system. Pollution control permit PE 2642 restricted the flow to 227 m^3/d at a temperature of 21.1^oC. The summarized monitoring data in Table 38 indicate that the temperature limit was met on over fifty percent of the samplings.

8.7.3 Ferro Enamels Ltd., Surrey, (PE 2208)

This paint manufacturing company discharges uncontaminated cooling water to Mahood Creek. Pollution control permit PE 2208 restricts the flow to 2 m^3/d at a maximum temperature of 26.7^oC. There are no monitoring data for this discharge.

8.8 Operations Discharging to the Pitt River

Only one operation discharges to the Pitt River.

8.8.1 Shane Food Products Ltd., Port Coquitlam, (PE 2195)

This candy and cookie manufacturing company generates cooling water from the peanut brittle cooling table. Pollution control permit PE 2195 formerly pertained to cooling water, washwater and domestic sewage. The washwater and domestic sewage were treated in a septic tank prior to soil disposal. It is believed that the tile fields overflowed on occasion. Presently only uncontaminated cooling water is discharged.

PE 2195 restricts the cooling water to a flow of 3.6 m^3/d with a maximum temperature of 30°C. No monitoring data are available.

8.9 Operations Discharging to the Coquitlam River

Only one operation discharges to the Coquitlam River.

8.9.1 Kennametal Inc., Port Coquitlam, (PE 2350)

This operation is also discussed in Section 4.6.1. Uncontaminated cooling water originates from the cooling jackets of vacuum dryers, pumps and condensers. Pollution control permit PE 2350 restricts the flow to 114 m^3/d at a maximum temperature of 24°C. Monitoring data in Table 38 indicate compliance with this temperature requirement.

8.10 Discussion of Cooling Water Discharges

The flow data for cooling water discharges have been summarized in Table 39. An estimated total flow of 41 000 m^3/d of cooling water is discharged to the river.

The largest number of cooling water discharges enter the North Arm of the Fraser River. The twenty cooling water sources discharge approximately 18 100 m^3/d of cooling water. Drinnan and Clark[5] reported that the minimum flow in the North Arm is approximately 11 664 000 m^3/d. At this flow rate, cooling water discharges represent approximately a maximum 0.2% of the river flow. (✗)

Five sources are responsible for the discharge of 22 400 m^3/d of cooling water to the Main Arm. This flow represents only 0.03% of the river flow at low flow conditions.

The largest source of cooling water is Genstar Ltd. (PE 4513). This operation discharges 18 200 m^3/d of cooling water to the Main Arm of the river. Canadian Forest Products (PE 2115) discharges 9 250 m^3/d to the North Arm, while the Borden Company (PE 1549) discharges 3 928 m^3/d. Titan Steel and Wire (PE 161) discharges 3 637 m^3/d to the Main Arm. Koppers International (PE 1804) discharges 1 060 m^3/d to the North Arm. The remaining twenty-five sources of cooling water discharge less than 1 000 m^3/d each. In total, these twenty-five sources discharge approximately 4 800 m^3/d of cooling water.

Cooling water discharges discussed in this section are free of contaminants, other than possibly small quantities of algicides and the presence of heat. The fact that large volumes of dilution water are available to these discharges renders their effect, if any, localized.

A paucity of monitoring data exists within EQUIS on cooling waters. The data generally indicate compliance with levels in pollution control permits.

8.11 Conclusions

The cooling water discharges represent only a very small percentage of the flow which is carried by the Fraser at low flow conditions. The nature of these discharges is such that, given the great dilution afforded by the river flows, only very small localized areas near cooling water outfalls may be affected.

9. MONITORING OF INDUSTRIAL DISCHARGES

9.1 Introduction

Monitoring of industrial wastewater can be related to three factors. These are: frequency of sampling carried out by the industry, the type of sample collected (grab, composite or continuous), and the contaminant being measured. Each of these factors is to a degree, site specific.

The Pollution Control Board has outlined suggested monitoring frequencies in its Pollution Control Objectives. These are used as guidelines in the issuing of permits by the WMB. The Federal Government also outlines frequencies for monitoring programs in its regulations and guidelines. As well, the EPS is contacted by the WMB as a matter of policy when operations are being assessed for the issuance of permits. The EPS has the opportunity to recommend that monitoring frequencies which are outlined in federal regulations and guidelines be incorporated into subsequent permits. In general, operators are required by permits to analyze effluents for contaminants outlined in applicable pollution control objectives.

The type of sample to be collected is outlined in the objectives. The sample type is usually dependent upon the industrial process carried out by the operation. However, the type of sample collected by individual operations may differ from the objectives. In general, a grab sample is an adequate monitoring tool where wastewater quality remains constant. Composite samples are preferable to grab samples where fluctuations in wastewater quality occur, but where cost or technology does not allow continuous sampling and analysis.

Continuous sampling requires equipment that can instantaneously measure and record contaminant levels. Temperature and pH are the only parameters outlined in some of the objectives which are to be measured on a continuous basis.

The United States EPA has outlined wastewater parameters which can be of significance for selected industrial classifications[34]. This outline has been divided into two groups. One group lists parameters for which effluent limits will often be set. The second group lists parameters which can be of concern. Both of these groupings are of interest when establishing monitoring programs for industrial operations.

9.2 The Forest Industry

9.2.1 Discussion

The objectives for all operations in this industrial sector, outlined in Table 1, address suspended solids, BOD_5, temperature, pH and toxicity. Certain operations can also be required to monitor for the presence of oil, dissolved oxygen and zinc.

The objectives require that daily composite samples be taken at a specified frequency and analyzed for BOD_5 and suspended solids. Operations utilizing pulping processes are required to analyze pH continuously, while mills are required to take only a grab sample for pH. Failure to pass a 96-hour LC_{50} static acute toxicity test on salmonid species would require that a wastewater be tested for acute toxicity every second week. Otherwise, wastewater from pulp processes is to be tested for acute toxicity monthly, while wastewater from mills is to be tested once every three months. The temperature in wastewater from mills, other than pulp mills, is to be tested weekly. A daily composite for oil is to be taken once every week at all mills, except for paper mills, where no sample is required. Dissolved oxygen is to be measured daily where pulp processes utilize secondary wastewater treatment. Zinc is to be analyzed at mechanical pulp processes only.

The EPA have specified parameters of concern for only the pulp and paper industry. These parameters, excluding those outlined in the objectives, are chemical oxygen demand (COD), total organic carbon (TOC), colour, unspecified heavy metals, turbidity, ammonia, phenols, sulphite, oil and grease, total and fecal coliforms, total nitrogen, total phosphorus, and total dissolved solids.

Significant gaps in data have occurred at some operations which continue to discharge to the river. The Weldwood of Canada T-Ply and Timberland (PE 3434) sawmill and plywood plant was to sample for BOD_5 and suspended solids monthly according to its letter of transmittal dated October 20, 1975. Five values for each constituent were recorded during 1976 and 1977. All other operations appeared to comply with the intent of their monitoring requirements.

A general lack of recent wastewater monitoring for acute toxicity is evident. Frequencies of monitoring for acute toxicity, as outlined in the objectives, are not being followed.

The preliminary study into trace organics in wastewaters identified five operations in the forest industry which discharged over 1 μg/L of trichlorophenol, pentachlorophenol, and/or tetrachlorophenol. As well, polychlorinated biphenyls have been recorded in the wastewaters from Belkin Packaging (PE 17).

Zinc has been recorded in the wastewater from Belkin Packaging (PE 17) prior to 1974 at concentrations as high as 3.5 mg/L although the source of the zinc has since been eliminated. This wastewater also contained 0.12 mg/L of lead. Mean loadings of polychlorinated biphenyls of 0.06 kg/d were also recorded in the effluent. Prior to 1974, MacMillan Bloedel Packaging (PE 108) recorded copper concentrations as high as 0.8 mg/L, lead concentrations as high as 0.7 mg/L, and zinc concentrations as high as 0.96 mg/L. The United States EPA has indicated a possible concern for heavy metals from pulp and paper operations.

The Weldwood T-Ply and Timberland (PE 3434) operation contributed 15.8 kg/d of nitrogen and 2 kg/d of phosphorus. There is a general lack of information on these parameters at other forest industry operations. The EPA has indicated that these parameters may be of concern. Also, a monitoring program establishing the nutrient loading entering the study area has been proposed[31].

Any information on sulphites and colour is usually limited and not recent. As well, no data have been recorded related to mercury levels in wastewater discharges.

9.2.2 Recommendations

The general lack of recent toxicity data on wastewater quality warrants the measurement of acute toxicity as required by the objectives, as a minimum. Certain situations may warrant different test methods and/or frequencies. This is particularly important at Belkin Packaging (PE 17) where a consultant has recommended steps which the company can take to reduce wastewater toxicity. The progress of any program undertaken by Belkin should be monitored closely.

The fact that at least five operations were documented as discharging chlorinated phenolic compounds at levels which may be of concern warrants expansion of the program to measure chlorinated phenolics. This expanded program should be initially of one year's duration and should be carried out four times during that period. All forest industry wastewaters should be included. As was the case with toxicity, this is particularly important at Belkin Packaging (PE 17). The wastewater from Belkin contained the largest concentration of pentachlorophenol (5.4 µg/L) and 2,3,4,6-tetrachlorophenol (7.2 µg/L) of any forest industry operation sampled. The presence of contaminated fish near Domtar (PE 3410) and Canadian White Pine (PE 1666) requires that closer surveillance of effluents and stormwater runoff from these sites be carried out.

The presence of metals in wastewaters of some industries requires that monitoring programs for copper, lead, nickel and zinc be undertaken at Belkin Packaging (PE 17), Scott Paper (PE 335), and MacMillan Bloedel Packaging (PE 108). These monitoring programs should be undertaken on a weekly basis for a period of one month. The results could then be reviewed to determine the need for further monitoring.

Several facts necessitate that phosphorus and nitrogen monitoring be undertaken monthly at all forest industry operations. One of these is that the nutrients have been recorded at significant levels at the Weldwood T-Ply and Timberland (PE 3434) operation. Another is that few nutrient monitoring data are available at other forest industry operations. As well, a program to determine the nutrient loading entering the study area has been proposed, and EPA has indicated that these nutrients can be of concern within the forest industry.

9.3 The Food Industry

9.3.1 Discussion

The provincial objectives for monitoring of wastewater from this industrial sector are included in Table 12. Suspended solids and BOD_5 are to be monitored at fish processing plants, meat manufacturing plants, and fruit and vegetable processing plants. As well, pH is to be monitored at fruit and vegetable processing plants, grease is to be monitored at meat manufacturing plants, and ether soluble oils at fish processing plants.

Suspended solids and BOD_5 are to be monitored weekly at all plants except fresh and frozen fish plants carrying out dressing only. At these plants, monitoring is only required twice a month. The pH at fruit and vegetable processing plants is to be measured weekly, as is grease at meat manufacturing plants. Ether soluble oils are to be monitored weekly at fish processing plants.

The United States EPA has designated significant parameters for fruit and vegetable processing and meat processing operations. In addition to pH, BOD_5, and suspended solids, the EPA designated COD, colour, fecal coliform, total phosphorus, temperature, TOC, and total dissolved solids as being significant in fruit and vegetable processing operations. Significant parameters for meat processing operations were BOD_5, pH, suspended solids, settleable solids, oil and grease, total coliforms, toxic materials, ammonia, turbidity, total dissolved solids, phosphate, and colour.

The Canadian Fishing Company Gulf of Georgia (PE 1814) herring and salmon reduction plant was to sample for BOD_5, suspended solids, and ether soluble oils every second week during production. Only two BOD_5 and suspended solids, and three oil and grease samples, have been taken since 1974. The Cassiar Packing Company Richmond (PE 1975) salmon, herring, and shrimp canning operation also was to sample for the same parameters at the same frequency as the Gulf of Georgia plant. Since 1974, three BOD_5, four suspended solids, and two oil and grease analyses have been carried out. The Long Beach Shellfish Company (PE 3139) salmon processing operation was to analyze for BOD_5, suspended solids, and ether soluble oils on a monthly basis. One analysis during each of 1977 and 1978 for each parameter has been performed. Searich Industries (PE 3474) and the B.C. Packers Paramont operation (PE 1824) were to analyze for BOD_5, suspended solids, pH, and ether soluble oils monthly during the operating seasons. No monitoring data are available from these operations.

The B.C. Packers Imperial operation (PE 1830) has recorded a total nitrogen value of 244 mg/L and a total phosphorus value of 2.3 mg/L. Cassiar Packing (PE 1975) has discharged total nitrogen as high as 46.1 mg/L and total phosphorus as high as 12.3 mg/L. Richmond Packers (PE 90) has had concentrations as high as 45 mg/L of total phosphorus and 161 mg/L of total nitrogen. There is a general lack of information on these parameters at other food industry operations. The EPA has indicated that these parameters may be of concern from food processing operations. As well, a monitoring program establishing the nutrient loading entering the study area has been proposed[31].

The lack of recent wastewater monitoring for acute toxicity is evident. The guideline of two to four bioassay tests being carried out over two years, has been considered in establishing monitoring requirements.

Berryland Canning (PE 260) and the B.C. Packers Imperial plant (PE 1830) are upgrading their wastewater treatment systems. In the case of B.C. Packers, air flotation devices were to be operational before December 31, 1980. No testing of full scale air flotation devices in the fishing industry has been undertaken in British Columbia to date.

9.3.2 Recommendations

Data which are required by pollution control permits should be collected at the Canadian Fishing Company Gulf of Georgia (PE 1814) plant, the Cassiar Packing Company Richmond (PE 1975) operation, the Long Beach Shellfish Company (PE 3139) operation, Searich Industries (PE 3474), and B.C. Packers Paramont operation (PE 1824). Sampling frequencies at these operations will depend upon the product being handled and the period of operation.

Several facts necessitate that phosphorus and nitrogen monitoring be undertaken monthly at all food industry operations. One of these is that nutrients have been recorded at significant levels at some operations. Another is that few nutrient monitoring data are available at food industry operations. As well, a program to determine the nutrient loading to the Strait of Georgia[31] has been proposed, and EPA has indicated that nutrients can be of concern in food industry wastewaters.

The fact that relatively few acute toxicity data have been collected on food operations in recent years suggests that further monitoring for acute toxicity would be useful. The frequency of two to four bioassays in two years outlined in the objectives seems to be a realistic approach to assessing the acute toxicities of food industry wastewaters. Adequate chemical analyses should be performed in order to provide background information on the acute toxicity tests.

The first full scale air flotation device is to be operational at the B.C. Packers Imperial plant (PE 1830) by December 31, 1980. The existence of a good data bank for this operation will allow a proper assessment of the device to be made.

9.4 The Metal Finishing and Fabricating Industry

9.4.1 Discussion

The provincial objectives for this industrial sector are indicated in Table 19. The table indicates frequencies of monitoring for several metals, as well as for cyanide, nitrate and nitrite, oil and grease, phenols, pH, phosphate, sulphate, and suspended solids. The suggested monitoring frequency is twice per month.

The EPA does not recommend any additional parameters which might be significant above those listed in Table 19. The operations which continue to discharge to the river meet the intent of the monitoring programs, required by permit.

Kennametal Inc. (PE 2350) and Tree Island Steel (PE 3190) both utilize exfiltration lagoons to treat their wastewaters. Acute toxicity tests on the influents to these lagoons have indicated 96-hour LC_{50} results of 2.4% and 4.2%, respectively. Recent acute toxicity tests on Titan Steel (PE 161) generally indicated 96-hour LC_{50} values of greater than 100%. However, two of the 96-hour LC_{50} values were 0.14% and 1.7%.

9.4.2 Recommendations

Increased monitoring of effluents for concentrations of copper and zinc above the frequency prescribed by present permit conditions does not seem warranted.

The need for continuing acute toxicity tests at operations in this industrial sector is borne out by the results obtained at Titan Steel (PE 161). A regular acute toxicity monitoring program as outlined in the objectives at a frequency of twice per year should be instituted. Chemical analyses should be performed in order to provide adequate background information on the acute toxicity tests.

It has been recommended in Section 4.7 that when exfiltration ponds are used within the study area, the pH should be maintained at about 10.0. Once this has been accomplished, monitoring of the ground and surface waters in the immediate vicinity of the ponds may be desirable to determine the rate of improvement in both ground and surface water quality.

9.5 The Cement Industry

9.5.1 Discussion

The provincial objectives for monitoring of this industrial sector are included in Table 26. The table indicates that the pH, suspended solids, and total solids are to be analyzed four times per year.

The EPA lists as significant parameters for this industrial sector COD, pH, suspended solids, temperature, alkalinity, chromates, phosphates, zinc, sulphite, and total dissolved solids.

The operations which continue to discharge wastewater to the river meet the intent of their required monitoring programs.

Measurements of a wide variety of contaminants have been made at the LaFarge Cement operation. Chromium concentrations as high as 0.25 mg/L and zinc concentrations as high as 0.43 mg/L have been recorded. As well, mercury levels as high as 0.30 µg/L have been measured.

There are no acute toxicity data for any operations discussed in Chapter 5, except LaFarge Cement (PE 42).

9.5.2 Recommendations

Metals such as chromium, zinc, mercury, lead, and copper should be measured in a one year initial monitoring program for all wastewaters discharged from this sector. The frequency of sampling outlined in the objectives is satisfactory. A similar program can be undertaken to determine phosphorus concentrations.

A program to measure acute toxicity of the wastewaters from this industrial sector should be undertaken. The minimum suggested frequency outlined in the objectives, of two tests per year, should be satisfactory for an initial one year program. Chemical analyses should be performed in order to provide adequate background information on the acute toxicity tests.

9.6 Domestic Sewage Discharges

9.6.1 Discussion

The provincial objectives for monitoring programs for domestic sewage discharges are included in Table 40. Wastewater discharges considered in this sector were all less than 455 m^3/d. For discharges of this volume, the objectives indicate that BOD_5 is to be monitored every three months, suspended solids weekly, coliforms every three months, total phosphorus monthly, and toxicity and other selected parameters annually.

Thirteen of twenty-one (61.9%) wastewater discharges are less than 10 m^3/d in quantity, while all but one is less than 50 m^3/d. It is presumed that for this reason, the WMB has not required that monitoring be carried out as frequently as suggested by the objectives. It would appear that BOD_5 and suspended solids are monitored on an equal number of occasions at each operation.

Operations met the intent of monitoring requirements in their permits with some exceptions. Swiftsure Towing (PE 3154) have only monitored their wastewater twice, although required by permit to monitor four times per year. Terminal Sawmills (PE 3950) did no monitoring in 1977 although required to analyze wastewater quality twice per year.

9.6.2 Recommendations

An effort should be made to ensure that all operations meet the monitoring requirements outlined in the permits.

9.7 Miscellaneous Industries

9.7.1 Discussion

The only provincial objectives related to these industries are for phenol manufacturing and acetylene plants[44]. The objectives, included in Table 35, are too lengthy to describe here. Sampling frequencies can vary from once per week to once per month for composite samples, continuous measuring of chlorine residual, temperature, and pH, quarterly analysis for toxicity, and weekly grab samples of phenols, sulphides and cyanides.

The operations classified as miscellaneous appear to meet the intent of permit monitoring requirements.

Acute toxicity tests have been performed at Fraser Wharves (PE 1621) and Dow Chemical (PE 41). The 96-hour LC_{50} values ranged from 21% to 43% at Fraser Wharves and from 8.5% to greater than 100% at Dow Chemical. The most recent tests were carried out in 1975 and 1976.

Cain et al.[8], in an initial survey of organic contaminants, found 1.4 μg/L of pentachlorophenol, 0.2 μg/L of 2,3,4,6-tetrachlorophenol, and a trace of 2,4,6-trichlorophenol at Dow Chemical.

No actual monitoring data related to the Western Peat Moss (PE 4382) operation exist to verify suspected intermittent suspended solids loadings from the exfiltration pond.

9.7.2 Recommendations

Acute toxicity tests should be undertaken at Fraser Wharves (PE 1621) to determine if improvements in the wastewater treatment system have reduced wastewater toxicity. As well, continued testing for acute toxicity at Dow Chemical (PE 41) should be carried out. Chemical analyses should be performed in order to provide adequate background information on the acute toxicity tests.

9.8 Cooling Water Discharges

9.8.1 Discussion

The provincial objectives require different monitoring frequencies for different thermal discharges. For example, cooling waters from pulping processes are to be monitored daily (Table 1), while cooling waters from chemical industries are to be monitored continuously.

Because measurements of temperature in wastewater are generally required fairly frequently, but are of limited historical value, they have not been recorded in EQUIS on a consistent basis. Thus, it is not certain whether data gaps exist due to lack of monitoring or lack of recording of data.

Puritan Canners (PE 36) were to record the cooling water temperature weekly. Only four temperature values are recorded in the period of 1965 to 1978. Scott Paper (PE 335) has recorded only two temperature values during 1977 and 1978. Koppers International (PE 1804) were to record effluent temperature every three months. Only three values have been recorded. Kennametal Inc. (PE 2350) recorded only four temperature values during 1974 and 1975 when weekly monitoring was required. Domtar Construction Materials Ltd. (PE 3735) recorded only one temperature measurement during 1975. Weekly temperature monitoring was required.

Pentachlorophenol is used as a wood preservative by Koppers International (PE 1804) and Northwest Wood Preservers (PE 3410) in their oil-based preservation treatment techniques. Cain et al.[8], found pentachlorophenol and 2,3,4,6-tetrachlorophenol in ditches adjacent to Northwest Wood Preservers.

9.8.2 Recommendations

The presence of pentachlorophenol and 2,3,4,6-tetrachlorophenol near Northwest Wood Preservers makes investigation of levels of trace organics in the cooling waters and stormwaters from Koppers International (PE 1804) and Northwest Wood Preservers (PE 3410), desirable. An initial program could be carried out yearly over a five year period.

It is essential that monitoring data for temperatures of cooling waters be both recorded and gathered at frequencies compatible with the provincial objectives.

10. INDUSTRIAL WASTEWATER DISCHARGES - AN OVERVIEW

A discussion of specific operations within each industrial sector has been presented in each section of this report. The discussion which follows will attempt to interrelate the industrial discharges.

A summary of loadings of BOD_5, suspended solids, phosphorus, nitrogen, copper, iron, lead, nickel, and zinc has been included in Table 41. It should be noted that these loadings have been determined in some cases on the basis of one or two measurements. Extrapolations using these values are therefore highly speculative and subject to error. A future priority will be to get better loading estimates.

10.1 Suspended Solids

Suspended solids entering a receiving water are not only important when in suspension, but also as potential components of the sediments. These solids are generally of a different origin and nature than the other sediment solids, which have been derived from channel erosion.

An estimated 60 000 kg/d of suspended solids enters the river directly from industry. This is 45% higher than the loadings from the three major sewage plants[7]. The characteristics of these solids, which come mainly from the forest industry,are different from solids discharged from sewage plants. Loadings to the Main Arm and North Arm make up 91% of the total suspended solids loadings from industry with the loading to the Main Arm comprising 49%. However, the 42% of the loading which is discharged to the North Arm has the potential to be more detrimental, since river flows in the North Arm are only 15% of the total Main Stem flow. At low flow conditions, this loading can represent a suspended solids increase over background values in the North Arm of 2.2 mg/L. At similar low flow conditions, the suspended solids loading to the Main Arm would increase the concentration in the Main Arm by only 0.4 mg/L.

The largest industrial source of suspended solids to the North Arm is attributable to the forest industry, which discharges 93% of the suspended solids from industry. The forest industry has reduced the loading to the North Arm by approximately 50% compared to the loading discharged in 1971. It is anticipated that this reduction will reach 70% by the end of 1981. This reduction has generally been brought about through the elimination of hydraulic debarkers.

The second largest loading (4.5%) to the North Arm is generated by the metal finishing and fabricating industries. The largest percentage of these solids originates at Western Canada Steel (PE 2087), a steel rolling mill. The suspended solids generated by this industrial sector are inorganic in nature and not readily degraded. The nature of these suspended solids is dissimilar to the organic solids discharged by the forest and food industries.

The food industry discharges only 2% of the loading to the North Arm. The largest percentage of these solids originates from B.C. Coast Vegetable Co-operative (PE 4505).

The largest loading to the Main Arm originates from miscellaneous industries, which discharge 82% of the direct industrial loading to that portion of the Fraser. The loading before 1979 was generally attributable to the intermittent discharge from Western Canada Peat Moss operation (PE 4382). Dow Chemical (PE 41), a phenol production plant, presently discharges the largest loading.

The second largest loading (6%) to the Main Arm comes from the food industry. Three fish processing plants in that industrial sector discharge most of the suspended solids. Approximately one percent of the loading originates from the metal finishing and fabricating industry, at Titan Steel (PE 161).

Only 9% of the total suspended solids loading to the river is discharged to the Main Stem. Over 95% of this small percentage is discharged by the forest industry. Two operations, B.C. Forest Products (PE 2756) and Crown Zellerbach Fraser Mills (PE 412) are the main sources of this loading.

Suspended solids which enter the river, but are not recorded as being generated by industrial sources, arise from wood floatage. These solids are generally settleable, and can form a mat which can smother fish eggs and destroy invertebrate bottom fauna. As has been discussed in Chapter 2, a large percentage of these solids can be eliminated through dry land storage of logs. This loading would occur along any reach of the river where logs are transported or stored.

10.2 Biochemical Oxygen Demand

The BOD_5 loading to the river from direct industrial discharges is estimated to be 23 900 kg/d. Nearly 75% of this loading is discharged to the Main Arm, 22% to the

North Arm, and the remainder to the Main Stem. The loading to the river is 41% of that discharged by the three major sewage treatment plants[7].

The food industry contributes 99.8% of the industrial BOD_5 loading to the Main Arm. Most of this originates at the Canadian Fish Company Gulf of Georgia Plant (PE 1814). This company discharges 77% of the BOD_5 loading to the Main Arm. The loading from this plant during periods when it is operating, and based on only two measurements, would appear to be approximately equal to the BOD_5 loading generated at the Annacis Island Sewage Treatment Plant in 1977[7].

The forest industry contributes 93% of the industrial BOD_5 loading to the North Arm. This loading has been reduced by an estimated 27.5% of the 1971 loading. It is expected that this reduction will increase to 34% by the end of 1981. These reductions will be accomplished by the replacement of hydraulic debarkers with mechanical debarkers.

The food industry discharges 6.5% of the industrial BOD_5 loading to the North Arm of the river. Puritan Canners (PE 36) was the largest single source, contributing 91% of the total loading from the food industry to the North Arm. However, this loading is only approximately one third of that which entered the North Arm of the river before 1975. The direct BOD_5 loadings to the river from the food industry were reduced to the present levels when Standard Brands (PE 2063) and Puritan Canners (PE 36) diverted their wastewater to the municipal sewage system.

Only 3.5% of the BOD_5 loading discharged by industry in the study area enters the Main Stem of the river. The majority of this loading (95.5%) originates from the food industry, and in particular, from Berryland Canning (PE 260). The loading from this operation can vary significantly, depending upon which produce is being processed.

10.3 Total Nitrogen

An estimated 270 kg/d of nitrogen is discharged directly by industry to the river in the study area. The loading to the Main Arm is 78%, to the North Arm 15%, and the remaining 7% is to the Main Stem. However, this total loading is only 3% of the 10 000 kg/d discharged by the three major sewage treatment plants in the study area during 1977[7].

The food industry contributes nearly 91% of the industrial loading of nitrogen to the Main Arm. Approximately two-thirds of this loading originates at the B.C. Packers Imperial plant (PE 1830). The remainder comes from the Cassiar Packing operation (PE 1975). The largest potential, but unrecorded source of nitrogen, is the Canadian Fish Company Gulf of Georgia (PE 1814) plant. No data were available for nitrogen concentrations in the effluent. However, based upon the respective BOD_5 and suspended solids loadings, it is estimated that the Gulf of Georgia operation might contribute as much nitrogen as that already recorded for the rest of the food industry.

The miscellaneous industries contributed 8% of nitrogen discharged to the Main Arm. The nitrogen originates from Dow Chemical (PE 41). However, the estimated loading is based on only two measurements.

The forest industry contributes 94% of the nitrogen loading to the North Arm, through Belkin Packaging (PE 17). This industrial sector also contributes 78% of the loading to the Main Stem. Nitrogen values were only measured at the Weldwood of Canada T-Ply and Timberland (PE 3434) operation. It is anticipated that other operations in this industrial sector contribute enough nitrogen to the river to double the recorded loadings.

10.4 Total Phosphorus

Industry discharges approximately 30 kg/d of phosphorus directly to the river, 77% to the Main Arm, 13.5% to the North Arm, and 9% to the Main Stem. However, this loading is less than 2% of the total phosphorus discharged by the three major sewage treatment plants during 1977[7].

Cassiar Packing (PE 1975) contributes 88% of the phosphorus loading from the food industry to the Main Arm. The B.C. Packers Imperial plant (PE 1830) has the only other measured phosphorus concentration in the food industry. In total, the food industry contributes 75% of the phosphorus loading from industry in the Main Arm. Dow Chemical (PE 41) contributes 24% of the phosphorus loading to the Main Arm.

The forest industry contributes 64% of the phosphorus discharged directly by industry to the North Arm, and 77% of that discharged to the Main Stem. These loadings occur from Belkin Packaging (PE 17) and Weldwood of Canada T-Ply and Timberland (PE 3434).

It is anticipated that other phosphorus loadings from the food and forest industry have gone unmeasured.

10.5 Metals

Metals have been measured in wastewaters entering the Main and North Arms. Except for iron, over 95% of all metals entering the river from industry are discharged into the North Arm.

An estimated 140 kg/d of zinc enters the North Arm directly from industrial discharges. This is 61% more zinc than was discharged by the three main sewage treatment plants during 1977[7]. Also, the discharges from the sewage treatment plants entered receiving waters at points in the study area (Main Arm and Sturgeon Banks) which provide significantly more dilution to the effluents than does the North Arm. Dilution of these measured zinc loadings in the industrial discharges could raise the zinc concentration in the North Arm of the river by 0.01 mg/L. This theoretical concentration is based upon all the zinc being in the dissolved state, and low flow conditions existing in the North Arm, as cited in Section 10.1.

Tree Island Steel (PE 3190) discharges 63% of the zinc which enters the North Arm. Belkin Packaging (PE 17), according to data recorded prior to 1974, discharges the remaining quantity of zinc to the river.

Industry discharges an estimated 7 kg/d of total lead and 2.2 kg/d of copper. This represents 21% of the lead, but only 2% of the copper discharged by the three major sewage treatment plants in 1977[7]. Copper and lead loadings originate in the wastewaters of Belkin Packaging (PE 17) and Western Canada Steel (PE 2087), although lead is also found in the wastewater of Tree Island Steel (PE 3190). Nickel has only been measured in the wastewater from Belkin Packaging (PE 17).

Industry discharges an estimated 250 kg/d of iron to the river. This represents 40% of the iron discharged by the three major sewage treatment plants during 1977[7]. Approximately equal loadings of iron are discharged to the North and Main Arms by industry. Titan Steel (PE 161) contributes 95% of the iron discharged to the Main Arm. Tree Island Steel (PE 3190) discharges 81% of the iron discharged to the North Arm. Other wastewaters with appreciable iron loadings are Belkin Packaging (PE 17) which contributes 13% of the iron loading and Western Canada Steel (PE 2087) which contributes 6%.

The paucity of data on mercury in industrial effluents prevents an analysis being made of the source of this metal.

10.6 Toxicity

Acute toxicity tests of effluents discharging into the study area have been summarized by Singleton[4]. Tests were performed on different fish species, and were generally 96-hour LC_{50} tests.

The largest number of acute toxicity tests were performed on industries discharging to the North Arm. A total of eleven operations along the North Arm have had their effluents tested for acute toxicity. Fifty-nine individual tests have been conducted. Fifty-five of the tests gave results showing that the effluents were toxic.

The largest number of acute toxicity tests was carried out on wastewater from the forest industry. Ninety-five individual acute toxicity tests were performed on wastewaters from the forest industry. Five operations in the forest industry discharged acutely toxic wastewaters. Four of these, Belkin Packaging (PE 17), Canadian Forest Products Ltd. Eburne Division (PE 2115), Rayonier Canada Silvichemical Division (PE 3087) (now closed), and Scott Paper (PE 335) discharged acutely toxic wastewater to the North Arm. Canadian Forest Products New Westminster operation (PE 1656) discharged acutely toxic wastewater to the Main Stem. Toxicity tests were not performed on the process effluent from the Crown Zellerbach Fraser Mills operation (PE 412), although four acute toxicity tests indicated the boiler blowdown discharge was lethal at 65% concentration.

Seven individual acute toxicity tests were carried out on wastewaters from six operations in the food industry. The tests performed on the B.C. Packers Imperial's wastewater (PE 1830) and the Cassiar Packing's wastewater (PE 1975) indicated the wastewaters were acutely toxic prior to entering the Main Arm. The Berryland Canning's effluent (PE 260) was also acutely toxic prior to entering the Main Stem, as was Standard Brand's effluent (PE 2063) prior to entering the North Arm.

The wastewaters from Metalex Industries (PE 2311), (now discharged to municipal sewer), Varta Batteries (PE 4661) (now recycled), and Tree Island Steel (PE 3190) were all acutely toxic. All of these wastewaters, before entering the North Arm, had 96-hour LC_{50} values of less than five percent. The one metal finishing and fabricating operation discharging to the Main Arm, Titan Steel and Wire (PE 161), also had wastewater which had a slight acute toxicity (average 96-hour LC_{50} of 93.2% based upon nineteen tests). Other operations which discharged acutely toxic wastewater to the Main Arm were Dow Chemical (PE 41), Canada LaFarge Cement (PE 42), and Fraser Wharves (PE 1621).

10.7 Trace Organics

Cain et al.[8] carried out some preliminary work on chlorinated phenolics from selected industries discharging to the Fraser River within the study area. A total of ten samples were collected from industrial wastewaters discharged to the river.

Eight samples were collected from forest industry operations. All but one of these samples contained pentachlorophenol and 2,3,4,6-tetrachlorophenol. The concentrations of these compounds ranged as high as 7.2 μg/L. Trace levels of 2,4,5-trichlorophenol (in two samples) and of 2,4,6-trichlorophenol (five samples) were recorded. The wastewater with the largest phenol content was discharged from Belkin Paper (PE 17). This wastewater contained 5.4 μg/L of pentachlorophenol, 7.2 μg/L of 2,3,4,6-tetrachlorophenol, and trace quantities of 2,4,5- and 2,4,6-trichlorophenol[8].

Dow Chemical (PE 41) was the only non-forest industry effluent which contained measurable quantities of chlorinated phenolic compounds. An analysis of its wastewater indicated the presence of 1.4 μg/L of pentachlorophenol, 0.2 μg/L of 2,3,4,6-tetrachlorophenol, and trace quantities of 2,4,6-trichlorophenol. No measurable quantities of phenolic compounds were found in cooling water from Domtar Wood Preservers (PE 3410)[8].

Four analyses of effluent from Belkin Packaging Ltd. (PE 17) indicated a mean polychlorinated biphenyl concentration of 2.37 μg/L, or a loading of 0.06 kg/d.

10.8 Flows

Nearly 330 000 m^3/d is discharged by industry to the river. This quantity has been determined from those industries discharging on December 31, 1977. Fifty-one percent of this flow is discharged to the North Arm, 32% to the Main Arm, and 17% to the Main Stem.

The three major sewage treatment plants in the study area discharged an average of 570 000 m^3/d of effluent during 1977[7]. However, only 190 000 m^3/d was discharged directly to the river (380 000 m^3/d to Sturgeon Banks).

The forest industry discharges 55% of all flows entering the river from industry. Miscellaneous industries are the second largest discharger at 22%. Cooling water discharges account for 12% of the total, while metal finishing and fabricating operations account for 8% of the flow. All other industrial sectors account for less than 3% of the flow.

The forest industry discharges 72% of the flows entering the North Arm, while the metal finishing and fabricating industry discharges 15.5% of the flow, and cooling water discharges contribute 11% of the flows. Miscellaneous discharges account for 69% of the flow to the Main Arm, while cooling water discharges make up 21.5%. The forest industry discharges 97.5% of the flows to the Main Stem.

11. SUMMARY OF MAJOR RECOMMENDATIONS

The following recommendations are based upon factors such as the present quantity and quality of wastewater discharged within the study area, the relationship of these data with Provincial Objectives and pollution control permits dealing with the discharges, and other knowledge related to certain specific discharges. These recommendations may be modified when related to discussions and recommendations made in other background reports prepared by the Water Quality Work Group. The integration of the background reports has already taken place in the final Summary Report of the Water Quality Work Group(31).

1) Steps should be taken to investigate further the wastewater quality at Scott Paper (PE 335) and Belkin Packaging (PE 17) and if necessary to upgrade these discharges to meet limits of level "A" of the objectives.

2) Consideration should be given to upgrading wastewater discharges at fish processing operations which discharge directly to Cannery Channel so that they meet level "A" of the objectives. Alternatively, the outfalls from operations discharging to Cannery Channel could be put into the main river channel.

3) All operations in the metal finishing and fabricating industry should, as a minimum, be required to meet level "C" objectives immediately.

4) Wastewater treatment facilities should be planned and designed for operations in the metal finishing and fabricating industry in order that level "A" of the objectives might be met in the future. As one step towards this end, the use of exfiltration ponds as a wastewater management technique at metal finishing and fabricating operations must be in conjunction with pH control of effluents.

5) All pollution control permits should require that the pH of the final effluent discharged directly to the river fall within the range of 6.5 to 8.5.

6) Operations in the cement and concrete industries, discharging alkaline wastewaters with a pH outside of the range of 6.5 to 8.5, should either recycle this wastewater, or treat it so that the pH is within the range of 6.5 to 8.5.

7) New and amended pollution control permits should reflect the concerns, where warranted, for toxic organic contaminants in discharges, and should express these concerns both in establishing limits and requiring monitoring for these contaminants.

√ 8) In general, industrial discharges to the river should be monitored more regularly.

9) The following monitoring programs, in addition to those already being conducted pursuant to pollution control permits, are suggested:

(a) Acute toxicity testing for all process wastewaters discharged to the study area from the forest, food, concrete, and metal finishing and fabrication industries, as well as at Fraser Wharves (PE 1621) and Dow Chemical (PE 41). A minimum of four tests over a two year period should be conducted. The requirement for further testing would be established at the conclusion of the two year period. The results of this program may lead to further investigations related to acutely toxic materials in these effluents. This testing should be accompanied by adequate chemical analyses to provide background information on the acute toxicity.

(b) Mercury levels in wastewaters discharged by the metal finishing and fabricating industries should be determined. This program should include monitoring twice per month for three months. The requirement for further testing would be considered on the basis of this program.

(c) Phosphorus levels in concrete industry wastewaters, and nitrogen and phosphorus levels in food and forest industry operations, should be determined. This program should include monthly monitoring for one year.

(d) Heavy metals levels should be determined in all concrete industry operations and in wastewaters from Belkin Packaging (PE 17), Scott Paper (PE 335), and MacMillan Bloedel Packaging (PE 108). This program is particularly important for operations discharging zinc to the North Arm of the river, and should initially include monthly monitoring for one year.

(e) Chlorophenolic compounds (as analyzed by Cain _et al_[8]) in wastewaters discharged to the study area from all forest industry operations, as well as at Koppers International (PE 1804), Northwest Wood Preservers (PE 3410), and Borden Chemical (PE 1549), should be determined yearly for a two year period. An overall survey of chlorophenolic compounds from these industries should include stormwater runoff from the plants, and should thus be integrated with rainfall.

10) Studies should be undertaken to determine the rate at which ground and surface waters improve, when metal operations within the study area maintain the pH in exfiltration ponds at about pH 10.0.

REFERENCES CITED

1) J. Karau, Environmental Protection Service; EPS 3-WP-75-3; Water Transportation of Wood: The Current Situation; October 1975.

2) A.J. Bruley, Environmental Protection Service; EPS 6-WP-74-3; The Basic Technology of the Pulp and Paper Industry and its Waste Reduction Practices; August 1974.

3) Environmental Protection Service; EPS 3-WP-77-2; Literature Review of Wastewater Characteristics and Abatement Technology in the Wood and Timber Processing Industry; February 1977.

4) H.J. Singleton; Acute Toxicity of Effluents; Fraser River Estuary Study; Water Quality; Ministry of Environment; Victoria, B.C.; 1980.

5) R.W. Drinnan, M.J.R. Clark; Water Chemistry, 1970-1978; Fraser River Estuary Study; Water Quality; Ministry of Environment; Victoria, B.C.; 1980.

6) Environmental Protection Service; EPS 3-WP-78-3; Technical, Economic and Environmental Aspects of Wet and Dry Debarking; March 1978.

7) R.T. Cain, L.G. Swain; Municipal Effluents; Fraser River Estuary Study; Water Quality; Ministry of Environment; Victoria, B.C.; 1980.

8) R.T. Cain, M.J.R. Clark, N.R. Zorkin; Trace Organic Constituents in Discharges; Fraser River Estuary Study; Water Quality Work Group; Ministry of Environment; Victoria, B.C.; 1980.

9) Pollution Control Board, Province of British Columbia; Pollution Control Objectives for Food-Processing, Agriculturally Orientated, and Other Miscellaneous Industries of British Columbia; 1975.

10) Environmental Protection Service; Report No. EPS 3-WP-74-1; Characterization and Treatment of Fish Processing Plant Effluents in Canada; January 1974.

11) Toronto Dominion Bank; TD Farm-Pac.

12) Personal Communication; Mr. Don Rugg; B.C. Department of Agriculture; to Mr. L.G. Swain, B.C. Ministry of Environment; November 8, 1979.

13) J. Villamere; Environmental Protection Service; EPS 3-WP-75-1; The Characteristics of Wastewater from British Columbia Fish Processing Plant; Seminar on Fish Processing Plant Effluent Treatment and Guidelines; February 1975.

14) M.J. Riddle and K. Shikaze; Environmental Protection Service; EPS 3-WP-74-1; Characterization and Treatment of Fish Processing Plant Effluents in Canada; June 1973.

15) F. Claggett; Environmental Protection Service; EPS 3-WP-75-1; In-Plant Design and Changes for Minimizing Water Use; Seminar on Fish Processing Plant Effluent Treatment and Guidelines; February 1975.

16) F. Claggett; Environmental Protection Service; EPS 3-WP-75-1; Treatment Technology in Canada -Chemical Treatment and Air Flotation; Seminar on Fish Processing Plant Effluent Treatment and Guidelines; February 1975.

17) Environmental Protection Service; EPS 3-WP-77-5; Review of Treatment Technology in the Fruit and Vegetable Processing Industry in Canada; March 1977.

18) R.E. Bantlett; Design in Metric - Wastewater Treatment; Applied Science Publishers Ltd.; 1971.

19) Environmental Protection Agency; Red Meat Processing; February 1974.

20) L.M. Churchland; Microbial Water Quality 1970-1977; Fraser River Estuary Study; Water Quality; Inland Waters Directorate, Environment Canada; Vancouver, B.C.; January, 1980.

21) Environmental Protection Service; EPS 3-WP-75-2; Review of the Canadian Metal Finishing Industry; March 1975.

22) N.L. Nemerow; Liquid Waste of Industry; Theories, Practices, and Treatment; Addison-Wesley Publishing Co.; 1971.

23) A.R. Balden, P.R. Erickson; The Treatment of Industrial Wastewater for Reuse-Chrysler Indianapolis Foundry; The Proceedings - 25th Industrial Waste Conference; Purdue University; 1970.

24) Environmental Protection Service; EPS 3-WP-76-10; Wastewater and Sludge Control in the Canadian Metal Finishing Industry; December 1976.

25) J.W. Morrow, et al., Characteristics and Treatment of Ready-Mix Concrete Waste for Free Discharge; 28th Industrial Waste Conference; Purdue University; 1973.

26) Environmental Protection Agency; Quality Criteria for Water; July 1976.

27) Environmental Protection Agency, Handbook for Monitoring Industrial Wastewater; August 1973.

28) Babbitt and Baumann; Sewerage and Sewage Treatment; Eighth Edition; 1958.

29) Environmental Protection Agency; EPA-625/1-77-009; Wastewater Treatment Facilities for Sewered Small Communities; October 1977.

30) H.R. Jones, Pollution Control in the Petroleum Industry; Noyes Data Corporation; 1973.

31) Summary Report of the Water Quality Work Group, Fraser River Estuary Study, Water Quality; December 1979.

32) H.W. Gehm, and J. Bregman; Water Resources and Pollution Control; 1976.

33) Environmental Protection Service; EPS 3-WP-77-13; Heated Discharge Control and Management Alternatives; October 1977.

34) Environmental Protection Agency; Handbook for Monitoring Industrial Wastewater; August 1973.

35) E.V.S. Consultants Ltd.; Treatability and Bioassay Studies of Belkin Paper-Board Effluent; December 1978.

36) Inland Waters Directorate, Water Resources Branch, Water Survey of Canada; Historical Streamflow Summary - British Columbia - to 1976; 1977.

37) Pollution Control Board, Province of British Columbia; Pollution Control Objectives for the Forest Products Industry of British Columbia; 1977.

38) Pulp and Paper Effluent Regulations, Fisheries Act; SOR/71-578, Canada Gazette Part II, Vol. 105, No. 22; November, 1971.

39) Environmental Protection Service; EPS 1-WP-77-2; Meat and Poultry Products Plant Liquid Effluent Regulations and Guidelines; July 1977.

40) Environmental Protection Service; EPS 1-WP-77-4; Potato Processing Plant Liquid Effluent Regulations and Guidelines; November 1977.

41) Environmental Protection Service; EPS 1-WP-77-5; Metal Finishing Liquid Effluent Guidelines; November 1977.

42) Pollution Control Board, Province of British Columbia; Pollution Control Objectives for Municipal Type Waste Discharges in British Columbia; 1975.

43) Environmental Protection Service, EPS 1-EC-76-1; Guidelines for Effluent Quality and Wastewater Treatment at Federal Establishments; April 1976.

44) Pollution Control Board, Province of British Columbia; Pollution Control Objectives for the Chemical and Petroleum Industries of British Columbia; 1974.

45) C. Walden, et al; Comparing Bioassay Procedures for Pulp and Paper Effluents, Pulp and Paper Canada, Vol. 76, No. 4; April 1975.

46) C.L. Garrett; Toxic Organic Contaminants; Fraser River Estuary Study; Water Quality; Environmental Protection Service, Environmental Canada; Vancouver, B.C.; March 1, 1980.

47) Environmental Protection Service; EPS 1-WP-75-1; Fish Processing Operations Liquid Effluent Guidelines; June 1975.

48) Personal Communication; Mr. O.E. Langer; Environmental Protection Service, Environment Canada; to Mr. L.G. Swain, B.C. Ministry of Envionment; July 28, 1980.

49) Environmental Protection Service, EPS 3-WP-78-7; Wastewater Generation and Disposal in Veneer and Plywood Plants in British Columbia; June 1978.

50) Environmental Protection Service, Pacific and Yukon Regon, Regional Program Report 79-24; Monitoring Environmental Contamination From Chlorophenol Contaminated Wastes Generated in the Wood Preservation Industry; April 1979.

FIGURE I.
FOREST INDUSTRY OPERATIONS, 1970-1978.

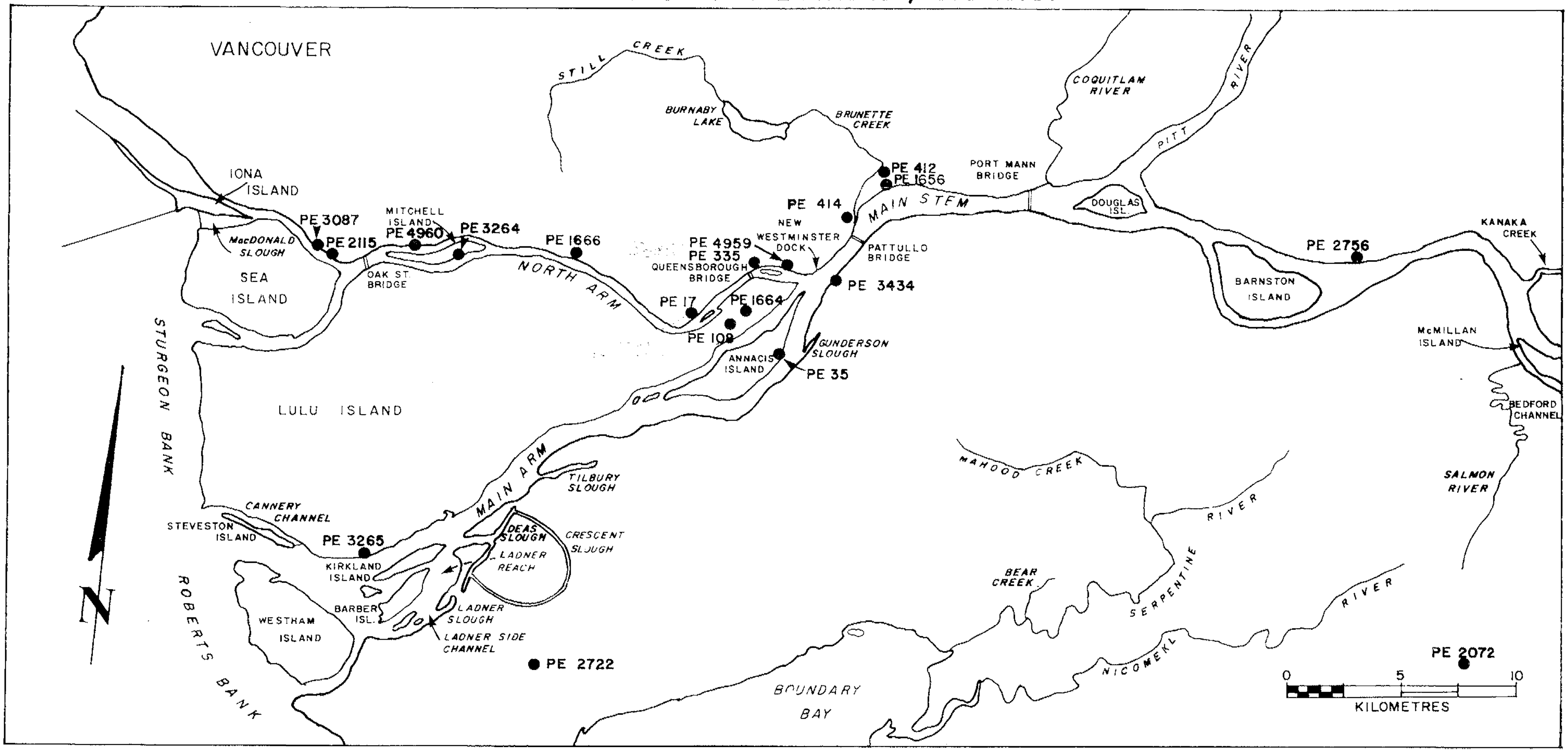

FIGURE 2. FOREST INDUSTRY.
DAILY EFFLUENT FLOW DATA, 1971-1981.

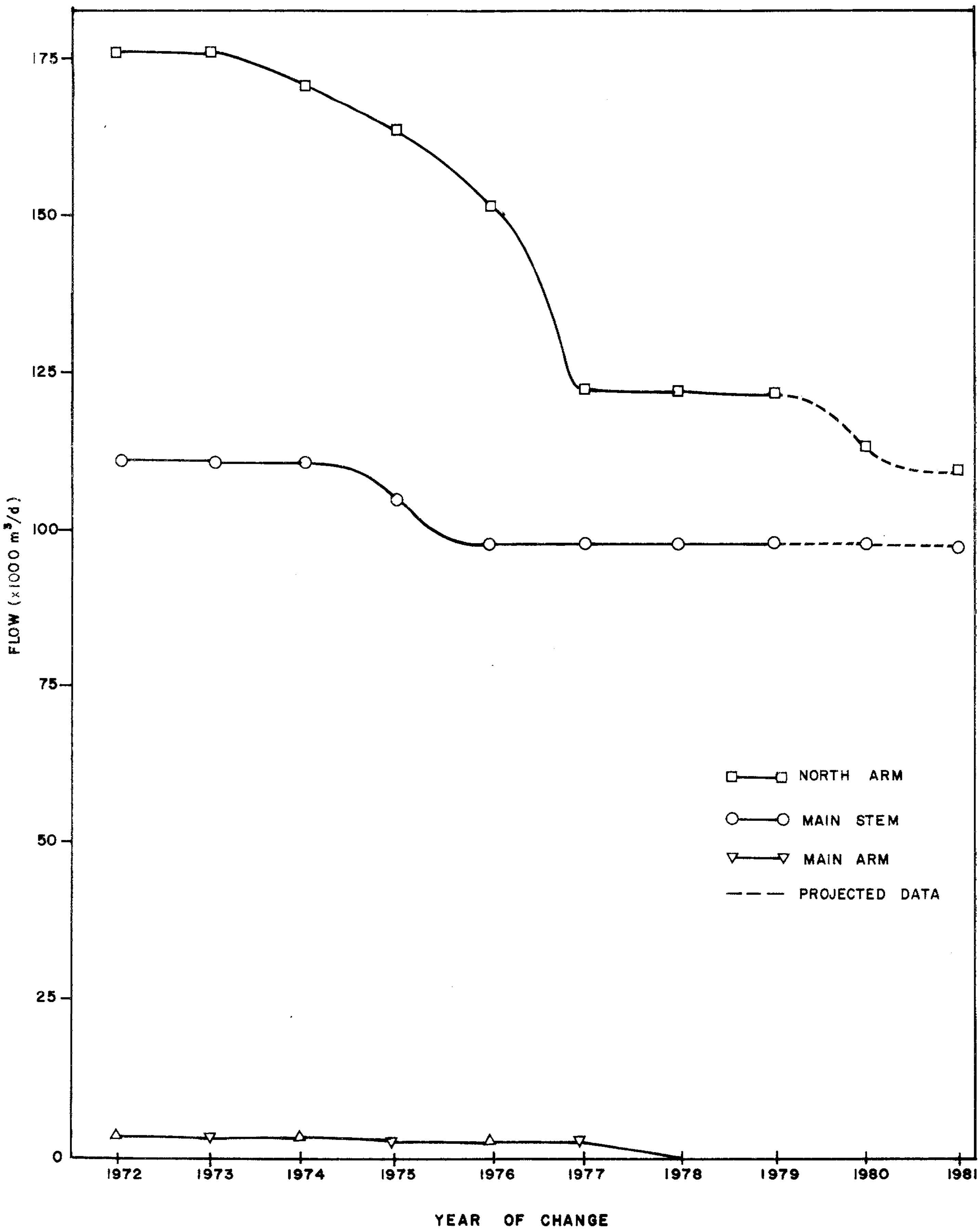

FIGURE 3. FOREST INDUSTRY.
DAILY LOADINGS OF SUSPENDED SOLIDS, 1971-1981

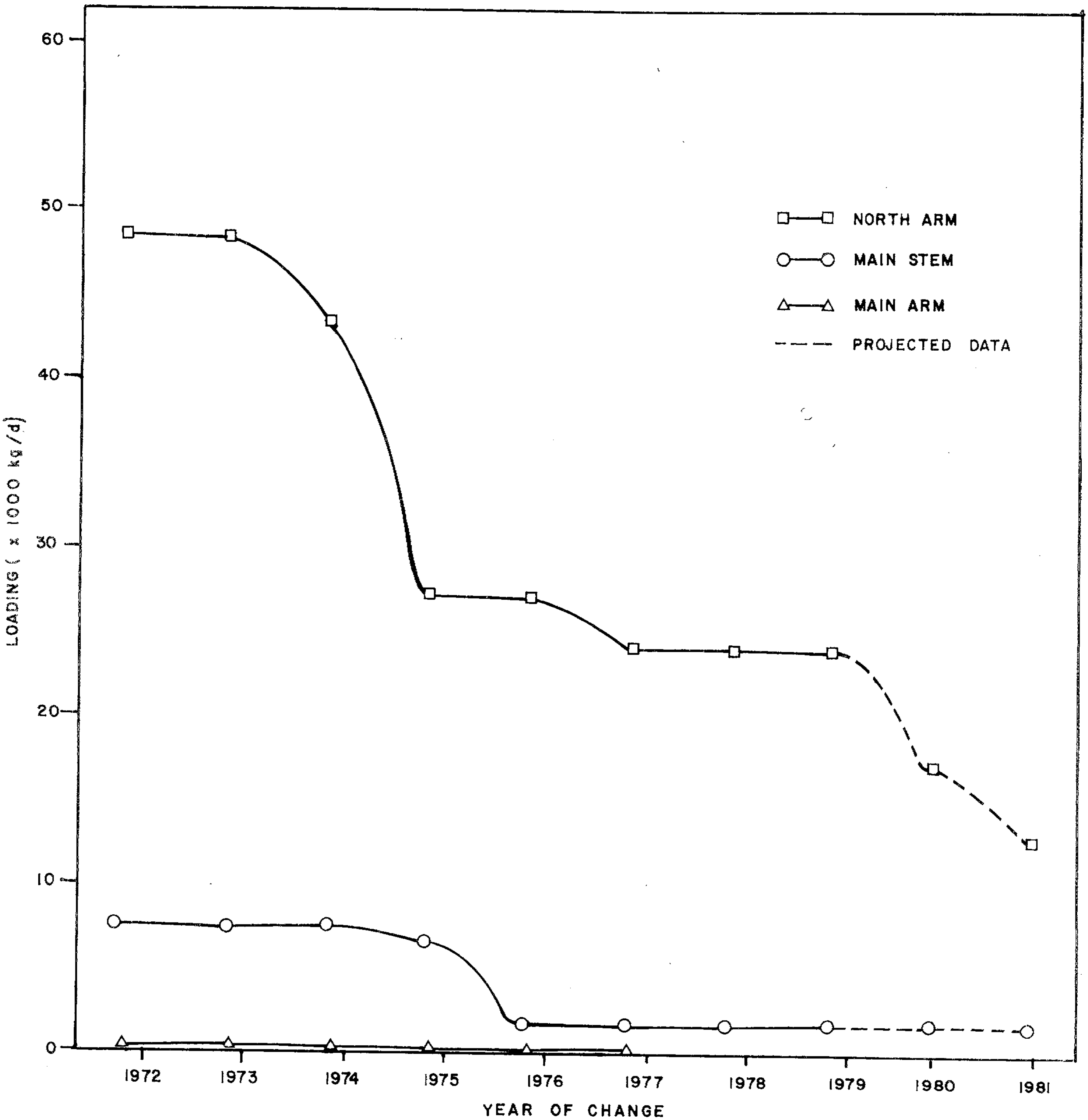

FIGURE 4. FOREST INDUSTRY.
DAILY LOADINGS OF BOD_5, 1972-1981

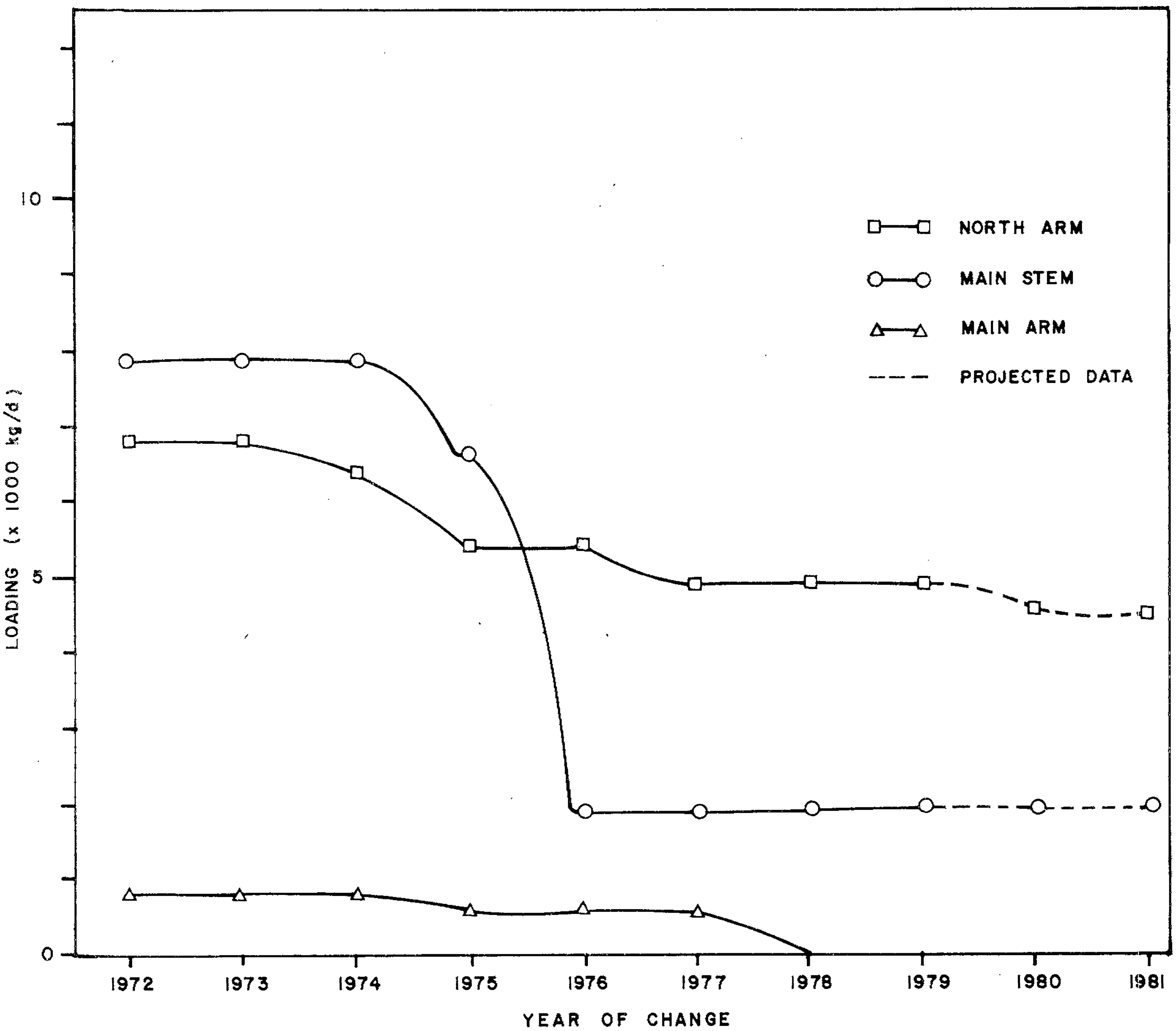

FIGURE 5.
FOOD PROCESSING OPERATIONS, 1970-1978.

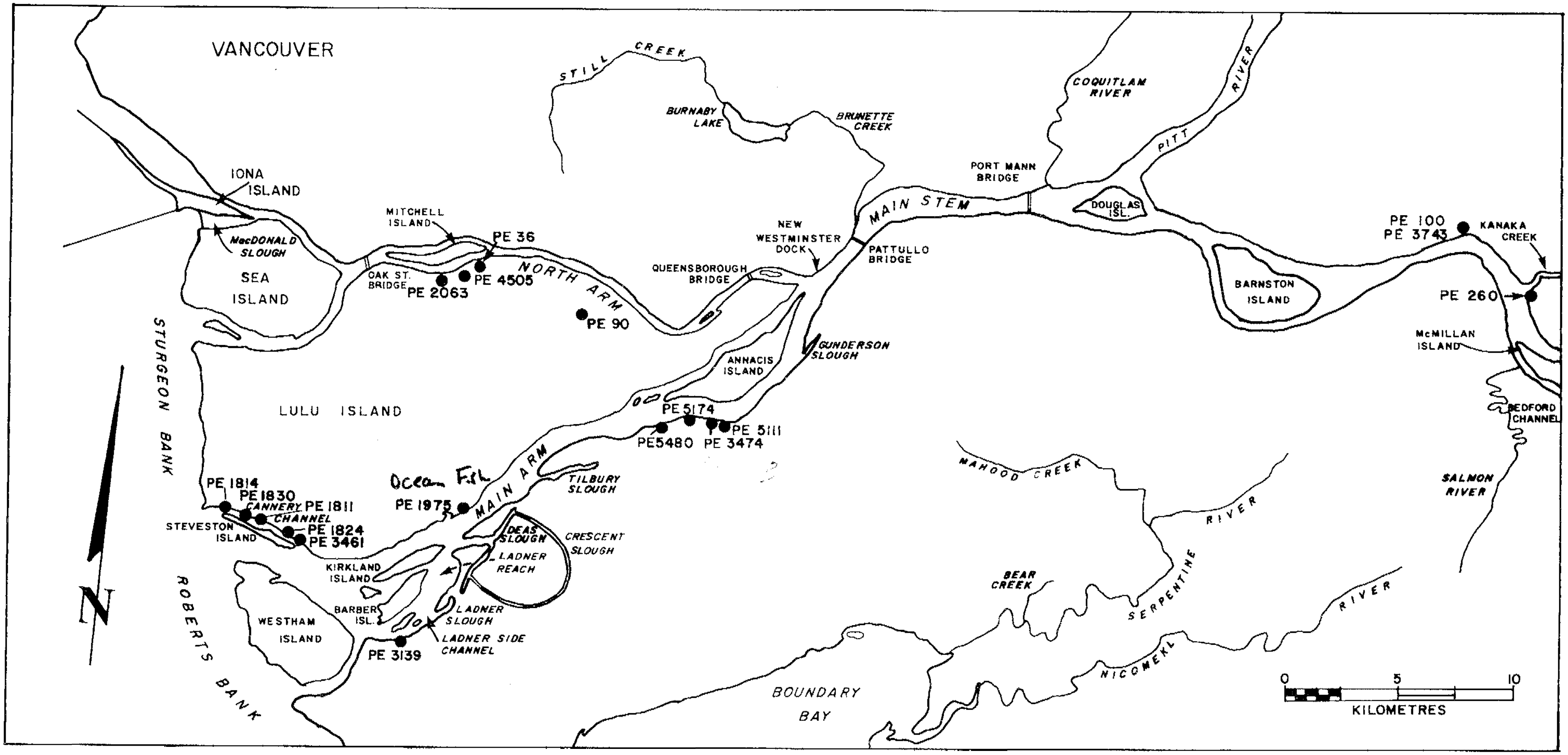

FIGURE 6. FOOD INDUSTRY.
DAILY EFFLUENT FLOW DATA, 1971-1978.

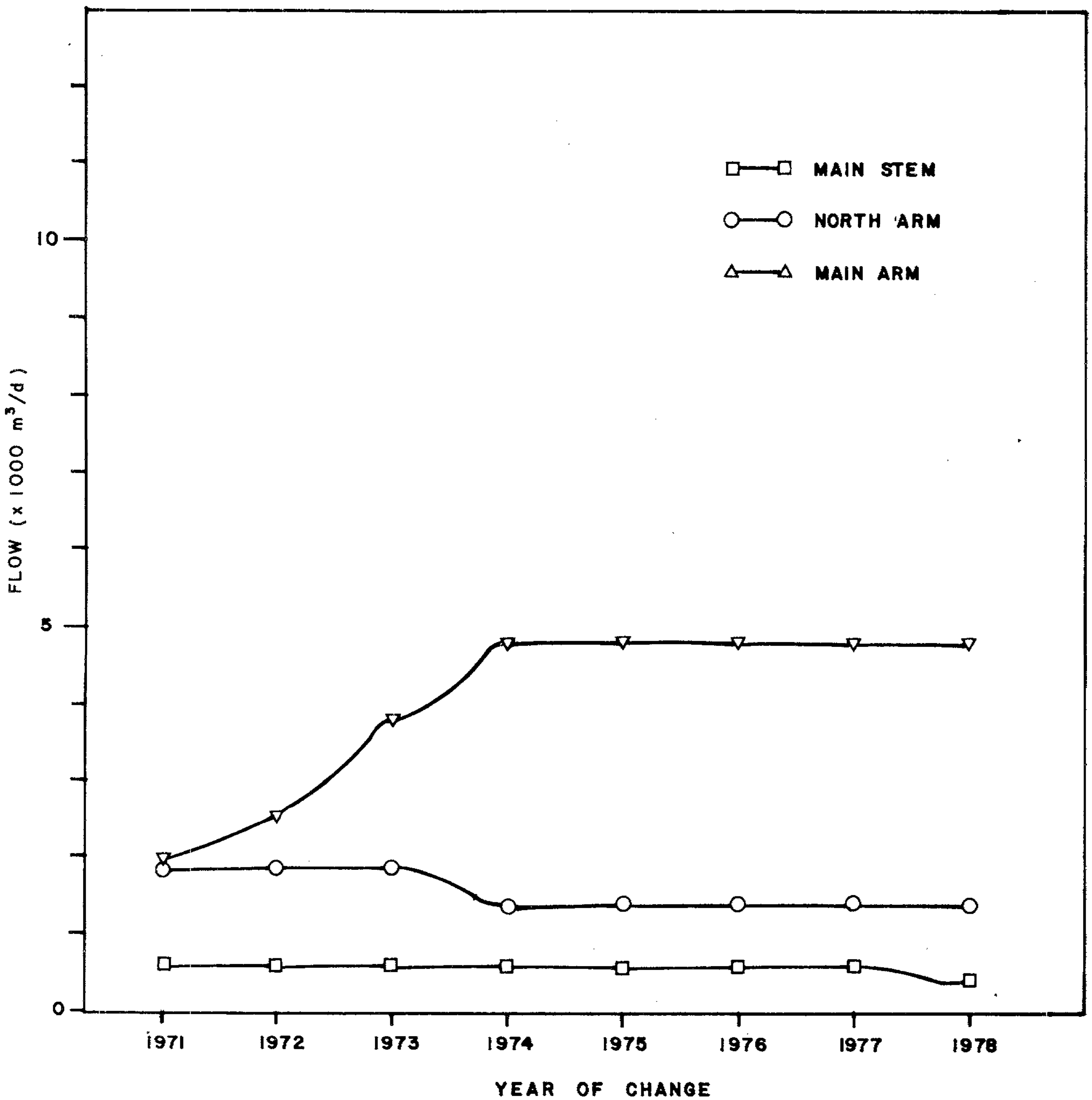

FIGURE 7. FOOD INDUSTRY.
DAILY LOADINGS OF BOD_5, 1971-1978.

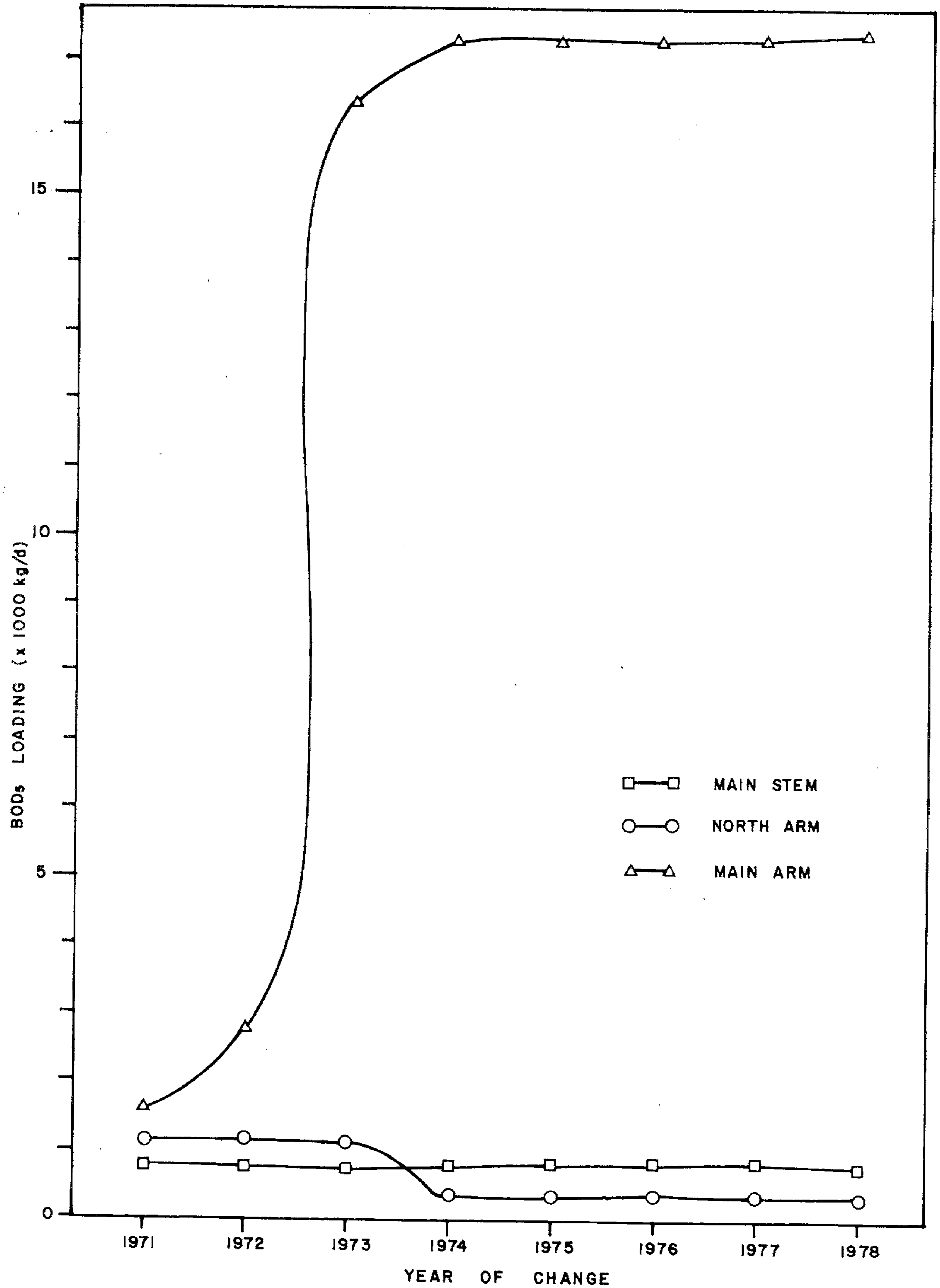

FIGURE 8. FOOD INDUSTRY.
DAILY LOADINGS OF SUSPENDED SOLIDS,
1971-1978

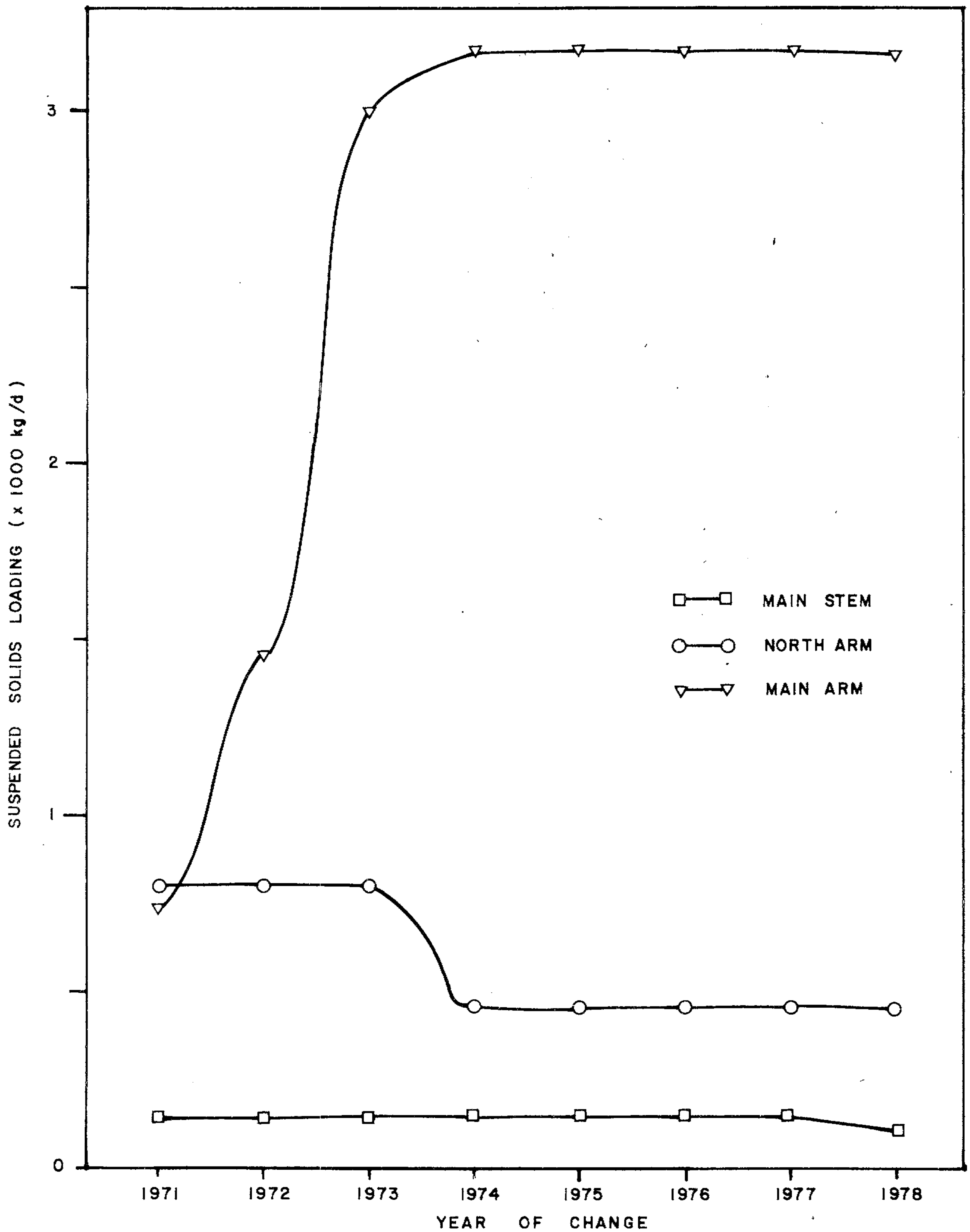

FIGURE 9.
METAL FINISHING AND FABRICATING OPERATIONS, 1970-1978.

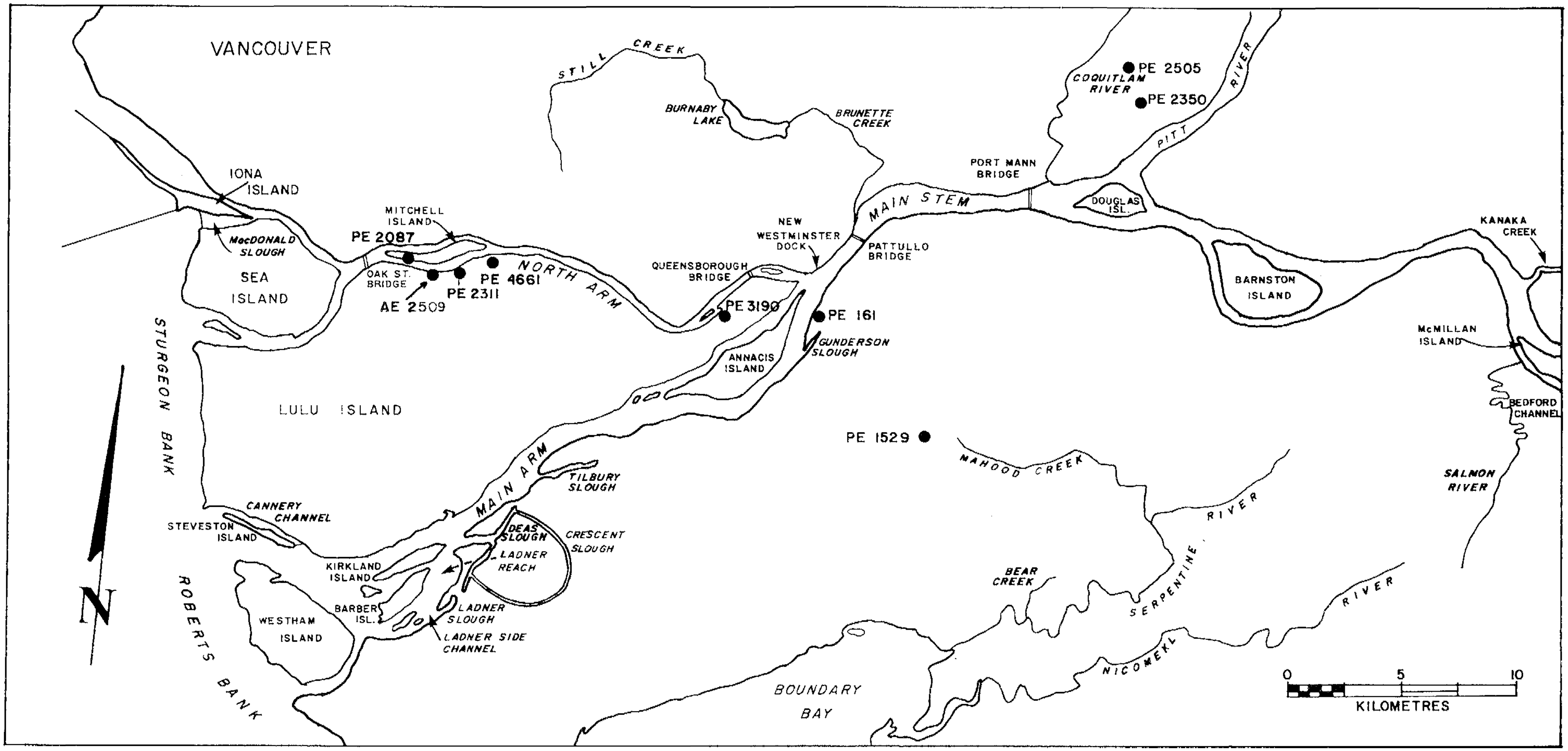

FIGURE 10.
CONCRETE INDUSTRY OPERATIONS, 1970-1978.

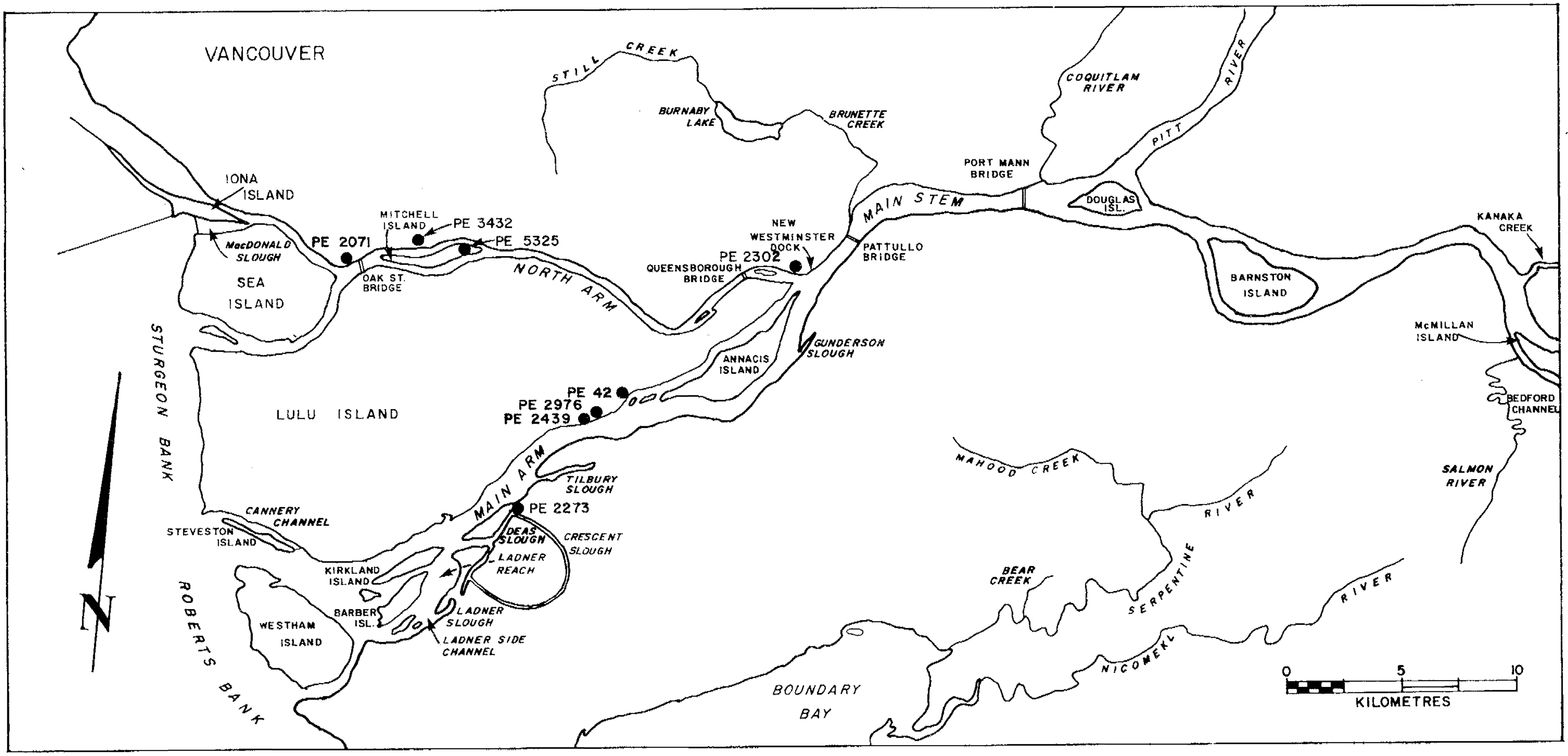

FIGURE 11.
DOMESTIC SEWAGE DISCHARGES, 1970-1978.

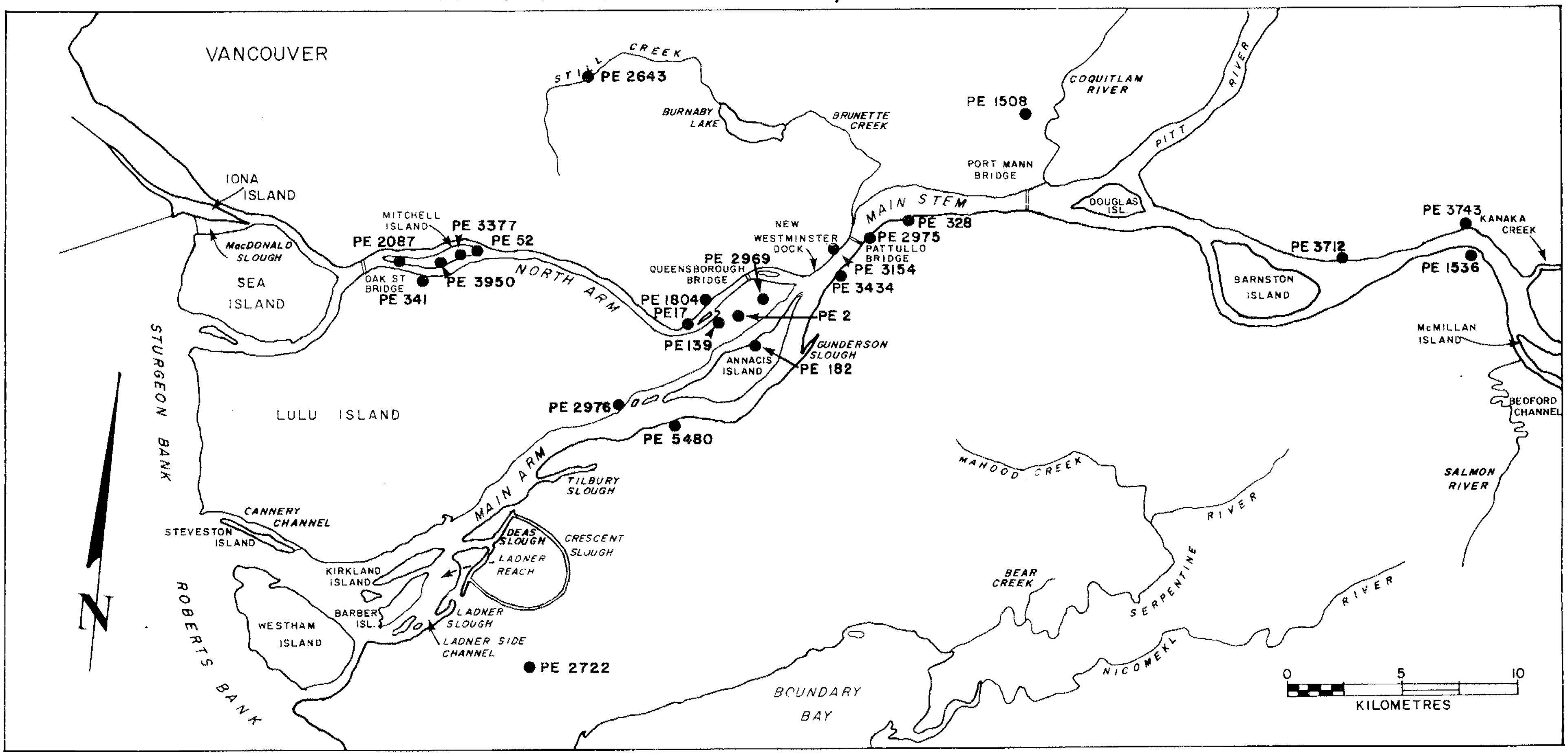

FIGURE 12.
MISCELLANEOUS OPERATIONS, 1970-1978.

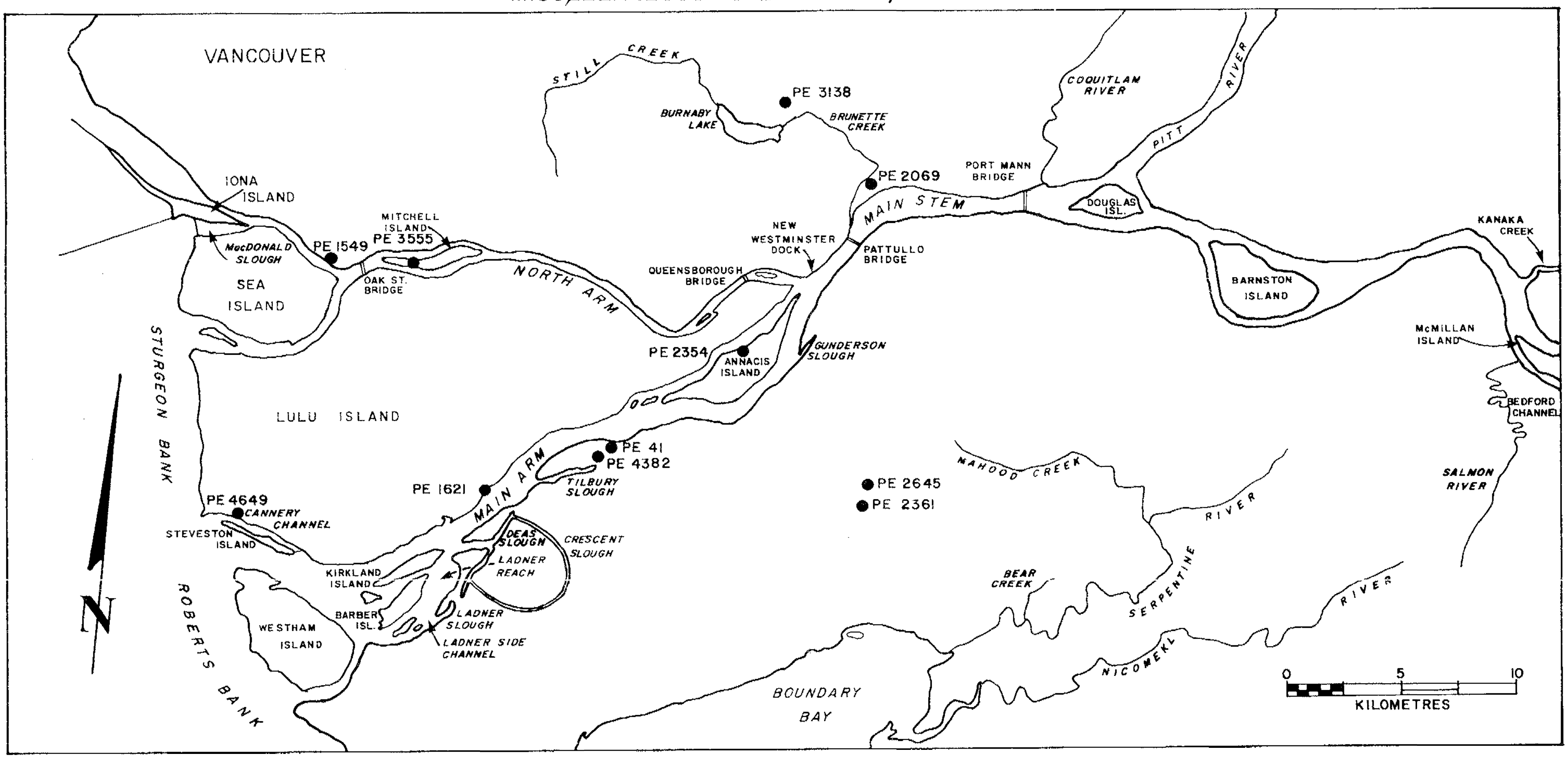

FIGURE 13.
COOLING WATER DISCHARGES, 1970-1978.

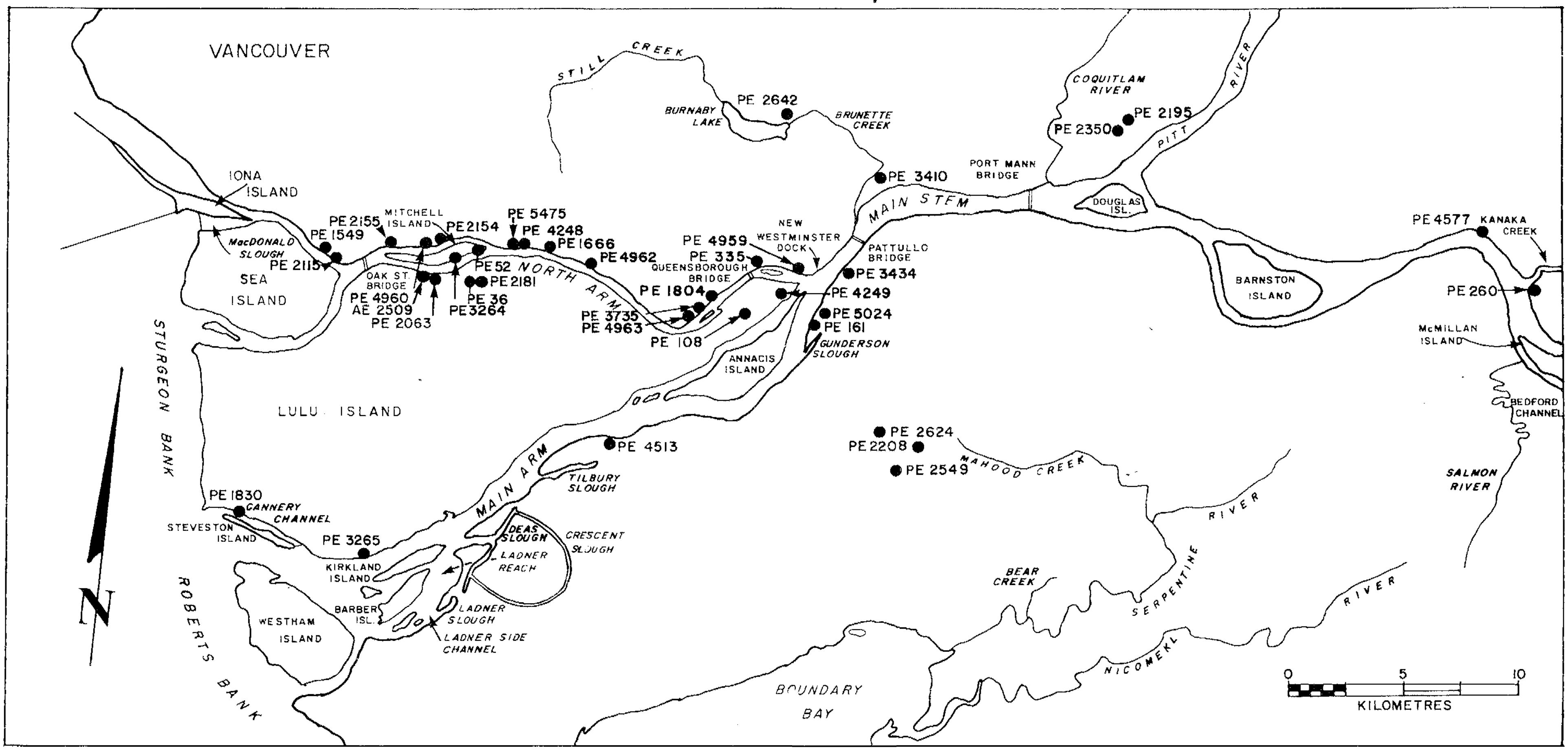

TABLE 1

POLLUTION CONTROL BOARD OBJECTIVES[37]

THE FOREST PRODUCTS INDUSTRY

EFFLUENT QUALITY OBJECTIVES

Characteristic	Unit	Level A	Level B	Suggested Monitoring Frequency
A. HYDRAULIC DEBARKER				
Total Suspended Solids	kg/m^3 (lb./cunit)	0.24 (1.5)	0.64 (4.0)	Daily composite three times per week.
BOD_5	kg/m^3 (lb./cunit)	0.18 (1.1)	0.64 (4.0)	Daily composite once per week.
pH Range[1]	-	6.5-8.0	6.5-8.0	Continuous.
Toxicity[4]	% effluent volume	100	30	Quarterly.
B. SAW, PLANER, SHINGLE, WOOD PRESERVING, VENEER, AND PLYWOOD MILLS				
Total Suspended Solids	mg/L	60	-	Daily composite once per week.
BOD_5	mg/L	50	-	Daily composite once per week.
Oil[5]	mg/L	10	-	Daily composite once per week.
Temperature	°C	35	-	Grab sample once per week.
pH Range[1]	-	6.5-8.5	-	Grab sample once per week.
Toxicity[4]	% effluent volume	100	-	Quarterly[5].

TABLE 1 (CONTINUED)

POLLUTION CONTROL BOARD OBJECTIVES[37]

THE FOREST PRODUCTS INDUSTRY

C. PULPING PROCESSES (KRAFT, SULPHITE, AND MECHANICAL)

Characteristic	Unit	Level		Suggested Monitoring Frequency
		A	B	
Total Suspended Solids	kg/t (lb./ADT)	10 (20)	17.5 (35)	Daily composite three times per week.
BOD_5				
Kraft	kg/t (lb./ADT)	7.5 (15)	30 (60)	Daily composite once per week.
Sulphite:				
Paper Grades	kg/t (lb./ADT)	50 (100)	113 (225)	Daily composite once per week.
Dissolving Grades	kg/t (lb./ADT)	75 (150)	175 (350)	Daily composite once per week.
Mechanical	kg/t (lb./ADT)	7.5 (15)	20 (40)	Daily composite once per week.
Temperature	°C	35	35	Daily.
pH Range[1]	-	6.5-8.0	6.5-8.0	Continuous.
Dissolved Oxygen[2]	mg/L	2.0	-	Daily.
Zinc (Mechanical Only)	kg/t (lb./ADT)	-	1 (2)	Once per week.
Toxicity[3] [4]	% effluent volume	100	30	Monthly[5].

GENERAL NOTES TO TABLE

1 Applicable only to fresh waters. Where background pH of receiving water is outside the designated range, effluent pH shall not differ from background by more than ± 0.2 pH units.

2 Applicable to effluents after secondary treatment.

3 In the case of bleached kraft mills the tabled values are based on water usage of 150 m^3/ADT (30 000 gal/ADT.) The Director may adjust the tabled objectives for mills using more or less than 150 m^3/ADT (30 000 gal/ADT.)

4 96 hour TL_m static bioassay on salmonid species giving 50 per cent survival over 96 hours. Tabled values are effluent dilutions (by volume) in which tests are to be conducted. For marine discharges, toxicity tests are to be carried out on neutralized samples.

5 if failure detected, frequency to be every two weeks until objective met.

TABLE 2

PULP AND PAPER REGULATIONS[38]

SPECIFIED LIMITS

PERMITTED DEPOSITS OF TOTAL SUSPENDED SOLIDS IN THE EFFLUENT OF MILLS IN KILOGRAMS PER TONNE*

Component Process Category	Existing Kraft Sulphite or Semi-chemical Mill	New, Expanded or Altered Kraft Sulphite or Semi-chemical Mill	Existing Mechanical Mill	New Expanded or Altered Mechanical Mill
1. Wood Rewashing	2.5	2.5	2.5	2.5
2. Debarking-Hydraulic Process	2.5	2.5	2.5	2.5
3. Debarking-Wet Drum Process	5	4	5	4
4. Pulping	3.5	2.5	6.5	5
5. Bleaching	3	2	1	1
6. Pulp Sheet Formation	1	0.5	2.5	2
7. Integrated, Single Product Paper Making	1.5	1	2.5	2
8. Integrated, Speciality Single-Product Paper Making	3	2	5	4
9. Tissue Paper Making	7.5	5	10	7.5
10. Fine and Speciality Multi-Product Paper Making	12.5	10	12.5	10
11. Cylinder Paper or Paperboard Manufacture	7.5	6	7.5	6
12. Neutral Sulphite Semi-Chemical Corrugating Medium	3.5	3.5		

* "Tonne" means, in respect of a component process category in

(a) Items 1 to 3, an oven-dry tonne of wood processed without the bark,

(b) Items 4 to 6, an air dry tonne of product, and

(c) Items 7 to 12, a tonne of product as produced.

TABLE 3

MONITORING DATA SUMMARY
CROWN ZELLERBACH
FRASER MILLS
PE 412

Parameter	Permitted Level	Monitoring Data				
		Period of Record	No. of Values	Max.	Median	Min.
pH	6.5-8.0	1965-1973	3	8.1	7.7	7.5
		1974	4	7.8	7.55	7.3
		1975	5	7.8	7.5	6.9
		1976	2	8.0	-	7.5
		1977	2	7.9	-	7.8
		1965-1977	16	8.1	7.7	6.9
Suspended Solids (mg/L)	35 mg/L (Above background level in Fraser River)	1965-1973	2	59	-	19.2
		1974	4	109	72.5	37
		1975	5	99	24	20
		1976	1	293	-	-
		1977	2	61	-	27
		1965-1977	14	293	42.5	19.2
Temperature (^{o}C)	26.1	1965-1973	2	26	21.5	17
		1974	2	20	-	18
		1975	2	25	-	15
		1976	1	19	-	-
		1977	2	32	-	20
BOD_5 - (mg/L)	<2.0	1965-1973	3	<10	<10	<10
		1974	4	<10	<10	<10
		1975	5	<10	<10	<10
		1976	2	<10	-	<10
		1977	2	<10	-	<10
		1965-1977	16	<10	<10	<10
Flow (m^3/d)	53 442	-	-	-	-	-
Toxicity	Non Toxic	1971-1973	4	Final Combined Effluent Non-Toxic at 65% Conc.		

TABLE 4

MONITORING DATA SUMMARY

MISCELLANEOUS FOREST INDUSTRY OPERATIONS

Parameter	Permit No. PE	Permitted Level	Monitoring Data				
			Period of Record	No. of Values	Max.	Median	Min.
pH	414	6.5-8.0	1965-1973	22	11.1	9.3	6.4
	2756	6.5-8.0	1975-1977	19	7.9	7.0	6.6
	3434	6.5-8.0	1975-1977	6	10.1	6.95	6.8
Suspended Solids (mg/L)	414	-	1965-1977	19	879	241	8
	2756	*	1975-1977	8	1 236	74	21
	3264	-	1975-1977	23	113	38	7
	3434	60.	1976-1977	5	21	16	11
Temperature (°C)	414	35.	1965-1977	6	33.3	27	8.3
	2756	35.	1975-1977	16	26	19.5	17
BOD_5 (mg/L)	414	-	1965-1977	20	269	123	3
	2756	**	1975-1977	8	116	10	1.0
	3434	45.	1976-1977	5	29	10	<10
Flow (m^3/d)	414	0.13	1974	1	0.2	-	-
	2756	42 400	1975-1977	14	45 823	45 823	45 823
	3264	-	1975-1977	75	2 226	1 276.5	0
	3434	272.2	-	-	-	-	-
Total Phosphorus (mg/L)	414	-	1965-1974	5	1.82	0.60	0.03
	3434	-	1976-1977	2	9.85	-	4.78
Total Nitrogen (mg/L)	414	-	1965-1974	2	72.2	-	32.7
	3434	-	1977	2	61	-	55.2
Colour-True	414	-	1965-1974	4	1 600	1 500	1 000

* Permitted Level 57 kg/d above background.

** " " 7 kg/d " "

LEGEND

PE 414 - Lamford Cedar
PE 2756 - B.C. Forest Products - Eburne
PE 3264 - Crown Zellerbach
PE 3434 - Weldwood of Canada - TPly and Timberland

TABLE 5

MONITORING DATA SUMMARY

BELKIN PACKAGING LTD.

PE 17

Parameter	Permitted Level	Monitoring Data				
		Period of Record	No. of Values	Max.	Median	Min.
Dissolved Oxygen (mg/L)	>2.0	1974 1975 1976 1977	29 27 24 10	8.3 8.3 8.5 8.9	7.2 6.8 7.2 6.1	5.7 5.6 2.4 5.5
Flow - (m^3/d)	11 400	1974 1975 1976 1977 1974-1977	30 33 41 46 150	15 488 16 365 22 875 30 039 30 039	13 840 13 700 16 290 20 975 15 213	11 424 13 10 397 13 640 13
pH	6.5-8.0	1974 1975 1976 1977	32 36 43 48	7.2 6.6 7.7 6.9	5.0 5.1 6.0 6.0	4.5 4.7 4.7 4.6
Suspended Solids (kg/t)	7.5*	1974 1975 1976 1977	29 30 40 45	65 65 135.5 202	36 32.6 40.8 54	19.6 16.5 18.6 23.9
Suspended Solids (mg/L)	-	1965-1977	7	220	125	52
BOD_5 - (kg/t)	7.5**	1974 1975 1976 1977	27 29 27 11	19.1 32.2 25.2 25.3	10.3 12.6 14.9 15.2	5 6.7 10.4 11
BOD_5 - (mg/L)	-	1965-1977	19	436	162	60
Production (Tonnes)	-	1974 1975 1976 1977	30 33 41 46	265 267.7 401.4 528.4	222.8 228.6 248.7 388.4	179.3 70.7 138 158.8
Settleable Solids (mL/L)	0.5	1974 1975 1976 1977	23 34 37 41	155 159 510 1 520	73 86 100 172	38 12 52 72

*4 840 kg/d (effective April 20, 1978)
**3 630 kg/d (Effective April 20, 1978)

TABLE 5 (CONTINUED)

MONITORING DATA SUMMARY

BELKIN PACKAGING LTD.

PE 17

Parameter	Permitted Level	Monitoring Data				
		Period of Record	No. of Values	Max.	Median	Min.
Colour - True	-	1965-1977	11	50	20	5
Tannin and Lignin (mg/L)	-	1965-1973	3	30.4	20.4	14
Resin Acids (mg/L)	-	1965-1973	2	4	-	<0.5
Phenols	-	1965-1973	1	0.093	-	-
Total Phosphorus (mg/L)	-	1965-1973	1	0.16	-	-
Total Nitrogen (mg/L)	-	1965-1973	1	2.23	-	-
COD - (mg/L)	-	1965-1973	2	627	-	498
Total Copper (mg/L)	-	1965-1973	3	0.06	0.06	0.04
Total Iron-(mg/L)	-	1965-1973	3	1.72	1.03	0.54
Total Lead-(mg/L)	-	1965-1973	3	0.16	0.116	0.105
Total Nickel-(mg/L)	-	1965-1973	1	0.02	-	-
Total Zinc-(mg/L)	-	1975-1973	3	3.6	3.5	0.92
Acute Toxicity	96-hr LC_{50} 90% conc.	1976-1977	12	>87%	52%*	30%
PCB 1242-(mg/L)	0.11 kg/d	1978	1	0.031	-	-
PCB 1254-(mg/L)		1978	1	< 0.0004	-	-
PCB 1260-(mg/L)		1978	1	< 0.0004	-	-

* Mean

TABLE 6(a)

MONITORING DATA SUMMARY

SCOTT PAPER

PE 335

PAPER MILL WASTEWATER

Parameter	Permitted Level	Monitoring Data				
		Period of Record	No. of Values	Max.	Median	Min.
pH	6.5-8.0**	1972-1977	1 036	10.5	6.6	3.0
Suspended Solids (mg/L)	*	1972-1977	1 035	1 297	285	10
Temperature (^{o}C)	35	1972-1977	276	35	26	15
Flow - (m^3/d)	11 500 Max. 9 100 Avg.	1974 1975 1976 1977 1974-1977	261 264 268 225 1 018	12 233 12 982 13 092 10 801 13 092	9 805 9 091 8 819 9 091 9 091	7 136 3 273 4 523 4 615 3 273
BOD_5 - (mg/L)	*	1965-1977 1974 1975 1976 1977 1965-1977	7 9 13 11 22 62	194 190 226 390 190 390	110 108 125 180 112 117.5	53 42 62 80 60 42
Dissolved Oxygen (mg/L)	>2.0	1965-1977	48	9.7	8.1	4.3
Toxicity (96 hour LC_{50})	50% Survival in 90% Effluent	1975-1977	19	>100%	>100%	>100%
Colour-True	-	1977	1	30	-	-
Production (Tonnes)	-	1977	10	162.8	152.8	141.7

* 1 250 kg/day.

** This limit was changed in a July 31, 1978 ammendment to 6.0 to 8.0 pH units.

TABLE 6(b)

MONITORING DATA SUMMARY

SCOTT PAPER

PE 335

GROUNDWOOD MILL WASTEWATER*

Parameter	Monitoring Data				
	Period of Record	No. of Values	Max.	Median	Min.
pH	1974 1975 1976	243 271 174	9.2 10.8 11.6	7.2 7.2 7.3	6.0 6.4 6.5
Suspended Solids (mg/L)	1974 1975 1976	245 270 174	870 890 738	250 250 200	100 60 50
Flow (m^3/d)	1974 1975 1976	243 267 172	3 593 3 662 3 647	1 933 1 819 1 946	966 346 841
BOD_5 (mg/L)	1974 1975 1976	10 13 8	360 350 420	233.5 233.5 300	126 102 100
Toxicity (96 hr LC_{50})	1975	3	>100%	>100%	>100%

Direct Discharge to the River

* Discontinued in 1977 (Sent to Annacis STP).

TABLE 7(a)

MONITORING DATA SUMMARY

MACMILLAN BLOEDEL SAWMILL - NEW WESTMINSTER

PE 1664

Boiler Blowdown

Parameter	Permitted Level	Monitoring Data				
		Period of Record	No. of Values	Max.	Median	Min.
Oil and Grease (mg/L)	5	1975 1976 1977	6 5 5	<1 5.3 1.9	1 1 1	0.9 <0.5 <1
pH	6.5-8.0	1975 1976 1977	45 41 50	9.3 7.2 7.7	7.2 6.8 6.9	6.2 6.5 1.2
Temperature (°C)	35	1975 1976 1977	39 39 51	35 32.2 48	25.6 20 17.8	13.3 11.7 5.6
Flow (m^3/d)	16.8	1975 1976 1977	39 39 48	28.6 15.9 13.6	17.1 8.7 1.8	8 5.2 0.7

TABLE 7(b)

MONITORING DATA SUMMARY
MACMILLAN BLOEDEL SAWMILL
NEW WESTMINSTER
PE 1664

Steam Condensate

Parameter	Permitted Level	Monitoring Data				
		Period of Record	No. of Values	Max.	Median	Min.
Oil and Grease (mg/L)	5	1975 1976 1977	5 4 7	10.8 6 39.2	2.5 4.3 4.0	2.3 4 <1
pH	-	1975 1977	2 1	6.7 7.7	- -	6.6
Temperature ($^{\circ}C$)	35	1975 1976 1977	43 39 51	31.1 33.3 37.5	24.4 25.6 27.2	8.9 17.8 13.8
Flow (m^3/d)	145.5	1975 1976 1977	29 39 48	167 132 147	107 103 91	58 70 44

TABLE 8

MONITORING DATA SUMMARY

RAYONIER CANADA (B.C.) LTD.

SILVICHEMICAL DIVISION

PE 3087

	Extraction Plant		Evaporation Plant	
	Permitted Level	Data Dec. 2/74	Permitted Level	Data Dec. 2/74
Oil and Grease	-	<1	-	3.9
BOD_5	-	44	45	45
Suspended Solids	-	11	60	40
Sulphides	-	10	0.5	16
Tannin and Lignin	-	15.8	-	3.4
Resin Acid Soaps	-	<0.5	-	1.4
pH	6.5-8.0	3.7	6.5-9.0	10.8
Phenols	-	0.85	-	1.4
Flow (m^3/d)	6 819	-	5 455	-
Temperature (^oC)	35	-	35	-

All units are mg/L except for pH and where otherwise noted.

TABLE 9

MONITORING DATA SUMMARY

MACMILLAN BLOEDEL PACKAGING

PE 108

Parameter	Permitted Level	Monitoring Data				
		Period of Record	No. of Values	Max.	Median	Min.
pH	6.5-8.0	1965-1974	6	10.1	7.9	6.5
Suspended Solids (mg/L)	60	1974	6	16 680	933	45
Temperature (^{o}C)	35	1974	1	18.5	-	-
BOD_5 (mg/L)	45	1965-1974	5	1 539	800	40
Flow (m^3/d)	6.8	-	-	-	-	-
Oil and Grease (mg/L)	15	1965-1974	4	800	551	126
COD (mg/L)	-	1965-1974	4	7 898	1 299	68
Phenols (mg/L)	-	1965-1974	4	0.055	0.04	0.011
Tannin and Lignin (mg/L)	-	1974	1	0.9	-	-
Total Copper (mg/L)	-	1965-1974	3	0.8	0.08	0.04
Total Iron (mg/L)	-	1965-1974	3	4.2	2.7	1.6
Total Lead (mg/L)	-	1965-1974	2	0.7	-	0.5
Total Zinc (mg/L)	-	1965-1974	3	0.96	0.43	0.17
True Colour (Rel Units)	-	1965-1974	2	50	-	30
Toxicity (96 h LC_{50})	*	1974	1	40%	-	-

* 50% survival in 90% effluent concentration over 96 hour period.

TABLE 10

MONITORING DATA SUMMARY

MACMILLAN BLOEDEL

ISLAND PAPER MILLS

PE 35

Parameter	Permitted Levels	Monitoring Data				
		Period of Record	No. of Values	Max.	Median	Min.
pH	6.5-8.5	1965-1973	95	7.4	6.7	4.6
		1974	304	9.6	6.9	5.3
		1975	309	11	7	6
		1976	317	11.2	6.9	5.8
		1977	328	9.4	7	5.7
		1965-1977	1 353	11.2	6.9	4.6
Suspended Solids (mg/L)	*	1965-1973	94	1 004	138	40
		1974	303	1 062	164	34
		1975	310	866	134	26
		1976	315	1 005	174	0
		1977	329	1 030	128	22
		1965-1977	1 351	1 062	144	0
Flow (m^3/d)	4 546	1965-1973	90	4 046	3 091	456
		1974	298	4 319	2 955	591
		1975	305	3 864	2 955	1 500
		1976	319	4 046	3 091	591
		1977	330	4 228	3 182	864
		1965-1977	1 342	4 319	3 046	546
Settleable Solids (mg/L)		1965-1973	59	7	7.5	2
		1974	248	15	6.5	1.5
		1975	212	10	6.5	1
		1976	227	80	9	0
		1977	235	392	5	0
		1965-1977	981	392	7	0
BOD_5 (mg/L)	**	1965-1977	13	270	84	35
		1974	50	312	153	33
		1975	43	305	147	72
		1976	46	343	195	92
		1977	42	288	187	68
		1965-1977	194	343	174.5	33

TABLE 10 (CONTINUED)

MONITORING DATA SUMMARY

MACMILLAN BLOEDEL

ISLAND PAPER MILLS

PE 35

Parameter	Permitted Levels	Monitoring Data				
		Period of Record	No. of Values	Max.	Median	Min.
Colour-True (Rel Units)	-	1965-1977	5	75	5	0.5
Temperature ($^{\circ}C$)	35	1965-1973	63	65	25.6	15.6
		1974	210	35	28.3	17.2
		1975	214	27.8	21.1	10
		1976	229	32.2	23.3	5.6
		1977	237	36.7	25	4.4
		1965-1977	953	65	24.4	4.4
96 hour LC_{50}	***	1976-1977	24	>100%	90.3%†	45.5%

* 15 kg/ADT

** 20 kg/ADT

*** 50% survival over 96 hours in 50% effluent.

† Mean

TABLE 11

SUMMARY

MAIN FOREST INDUSTRY LOADINGS AND FLOWS

Operation	Permit No.	River Reach	Flow m^3/d	Loading (kg/d)		Comments
				BOD_5	Suspended Solids	
Crown Zellerbach Fraser Mills	412	Main Stem	53 442*		1 870*	
Canadian Forest Products	1656	Main Stem	6 800*D	9 650*D	3 500D*	-Flows to municipal sewer system Aug. 1, 1976 -Phenolics 1.9 mg/L (permit application) -Estimated 96 hour LC_{50} < 5%
B.C. Forest Products	2756	Main Stem	5 000D 45 823	 458*	4 589*D 3 389*	Flow reduced by 5 000 m^3/d May 1975 when hydraulic debarker effluent recycled
Weldwood of Canada T-Ply and Timberland	3434	Main Stem	272*	2.7	4.4	Total Nitrogen - 15.8 kg/d Total Phosphorus - 2.0 kg/d
Belkin Packaging	17	North Arm	15 200*	3 605*	11 115*	Median: Tannin and Lignin - 20.4 mg/L (1965-1973) Total Zinc - 3.5 mg/L PCB-0.03 mg/L
MacMillan Bloedel Packaging Ltd.	108	North Arm	6.8*	4	4	
Scott Paper Ltd. New Westminster	335	North Arm	9 091 1 900*D	1 100 485*D	2 600 440*D	Groundwood effluent to municipal system August 1977
MacMillan Bloedel -Sawmill New Westminster	1664	North Arm	3 300*D		1 056*D	Hydraulic debarker replaced late 1974

TABLE 11 (CONTINUED)

SUMMARY

MAIN FOREST INDUSTRY LOADINGS AND FLOWS

Operation	Permit No.	River Reach	Flow m^3/d	Loading (kg/d)		Comments
				BOD_5	Suspended Solids	
MacMillan Bloedel -Sawmill New Westminster	1666	North Arm	73 000* 1 370* 26 800*D		2 950*D	Hydraulic debarkers replaced late 1977
Canadian Forest Products Eburne Sawmill Div.	2115	North Arm	6 800*D 9 090*	1 000*D	16 400*D	Hydraulic debarkers replaced by late 1975
Rayonier Silvi-chemical	3087	North Arm	6 819D 5 455D			EXT. PLT.: Sulphide - 10 mg/L Tannin and Lignin - 15.8 mg/L pH - 3.7 EVAP. PLT.: Sulphide - 16 mg/L Tannin and Lignin - 3.4 mg/L Resin Acid Soap - 1.4 mg/L pH - 10.8 CLOSED April 1976
Crown Zellerbach -Lumbermill	3264	North Arm	2 600*D 2 228*	400*D	3 750*D 49	Hydraulic debarker replaced July 1974
Rayonier Can. Ltd. -Sawmill	4959	North Arm	8 200*	410*	8 815*	Hydraulic debarker to be replaced by end of 1980
Rayonier Can. Ltd. -Sawmill	4960	North Arm	4 550* 140*	45*	3 730*	Hydraulic debarker to be replaced by end of 1981
MacMillan Bloedel Island Paper Mills	35	Main Arm	3 050D	530D	440D	Flows to municipal sewer system Nov. 1/78

TABLE 11 (CONTINUED)

SUMMARY

MAIN FOREST INDUSTRY LOADINGS AND FLOWS

Operation	Permit No.	River Reach	Flow m^3/d	Loading (kg/d)		Comments
				BOD_5	Suspended Solids	
Crown Zellerbach Richmond Paper Prod.	3265	Main Arm	125*D	45*D	110*D	Flows to municipal sewer system March 1975

D = Discontinued.

Note: Values are based upon median recorded levels, unless otherwise noted.

* See specific industrial write-up for source of estimate.

TABLE 12(a)

PROVINCIAL POLLUTION CONTROL BOARD

POLLUTION CONTROL OBJECTIVES

OBJECTIVES FOR THE DISCHARGE OF EFFLUENT TO MARINE WATERS FROM FISH-PROCESSING PLANTS[9]

Operation	Level / Parameter	A	B	C	Monitoring Frequency
Salmon cannery and reduction plant	BOD_5, kg/tonne product Suspended solids, kg/tonne product Ether soluble oils, kg/tonne product	7 2.6 0.8	32 13 10	40 22 10	Weekly Weekly Monthly
Fresh and frozen fish plants carrying out dressing only	BOD_5, kg/tonne product Suspended solids, kg/tonne product	1.4 1	1.4 1	1.8 1.6	Twice a month Twice a month
Fresh and frozen fish plants carrying out filleting, and reduction plants	BOD_5, kg/tonne product Suspended solids, kg/tonne product Ether soluble oils, kg/tonne product	4 1.5 0.8	10 6 4	30 15 20	Weekly Weekly Monthly
Herring-processing plants	BOD_5, kg/tonne raw fish Suspended solids, kg/tonne raw fish Ether soluble oils, kg/tonne raw fish	1.2 0.9 0.5	4 3.5 3.5	14 10 3.5	Weekly Weekly Weekly

TABLE 12(b)

PROVINCIAL POLLUTION CONTROL BOARD

POLLUTION CONTROL OBJECTIVES

OBJECTIVES FOR THE DISCHARGE OF EFFLUENT TO MARINE AND FRESH WATERS FROM MEAT-MANUFACTURING PROCESSES[9]

Operation	Level / Parameter	A	B	C	Monitoring Frequency
Slaughterhouse	BOD_5, kg/tonne live weight killed	0.30	1.8	6	Weekly
	Suspended solids, kg/tonne live weight killed	0.45	1.4	4.5	Weekly
	Grease, kg/tonne live weight killed	0.20	0.8	1.9	Weekly
Meat-processing plant	BOD_5, kg/tonne product	0.40	1.8	6	Weekly
	Suspended solids, kg/tonne product	0.30	0.57	1.9	Weekly
	Grease, kg/tonne product	0.30	0.53	1.5	Weekly
Meat-rendering plant	BOD_5, kg/tonne raw material	0.20	1.1	3.8	Weekly
	Suspended solids, kg/tonne raw material	0.30	0.84	2.8	Weekly
	Grease, kg/tonne raw material	0.20	0.28	0.80	Weekly
Packing house (integrated house)	BOD_5, kg/tonne live weight killed	0.50	3	10	Weekly
	Suspended solids, kg/tonne live weight killed	0.50	1.5	5	Weekly
	Grease, kg/tonne live weight killed	0.20	0.80	2	Weekly

TABLE 12(c)

PROVINCIAL POLLUTION CONTROL BOARD

POLLUTION CONTROL OBJECTIVES

OBJECTIVES FOR THE DISCHARGE OF EFFLUENT TO MARINE AND FRESH WATERS FROM FRUIT- AND VEGETABLE-PROCESSING PLANTS[9]

Material Processed	Level / Parameter	A	B	C	Monitoring Frequency
Asparagus, green beans, sauerkraut, spinach, tomatoes	BOD_5, kg/tonne raw material	0.60	3.5	7.5	Weekly
	Suspended solids, kg/tonne raw material	0.5	1.1	1.8	Weekly
	pH range	6.5-8.5	6.5-8.5	6.5-8.5	Weekly
Apples, carrots, corn, pears, pumpkin, squash, white potatoes	BOD_5, kg/tonne raw material	1.1	6.5	14	Weekly
	Suspended solids, kg/tonne raw material	1	2.6	4.1	Weekly
	pH range	6.5-8.5	6.5-8.5	6.5-8.5	Weekly
Apricots, peaches, peas, sweet potatoes	BOD_5, kg/tonne raw material	1.8	10.9	23.7	Weekly
	Suspended solids, kg/tonne raw material	1.1	2.8	4.5	Weekly
	pH range	6.5-8.5	6.5-8.5	6.5-8.5	Weekly

TABLE 13(a)

FEDERAL MEAT PRODUCTS REGULATIONS AND GUIDELINES[39]

REGULATIONS

NEW AND EXPANDED PLANTS

SCHEDULE 1

AUTHORIZED DEPOSITS OF DELETERIOUS SUBSTANCES

Class of Plant	Deleterious Substance	Authorized Actual Daily Deposit	Authorized Average Daily Deposit
Red Meat Integrated Plant	Biochemical Oxygen Demanding Matter	1.0 kg/tonne of finished product	0.5 kg/tonne of finished product
	Total Suspended Matter	1.2 kg/tonne of finished product	0.6 kg/tonne of finished product
	Grease	1.6 kg/tonne of finished product	0.8 kg/tonne of finished product
Processing Plant	Biochemical Oxygen Demanding Matter	0.7 kg/tonne of finished product	0.35 kg/tonne of finished product
	Total Suspended Matter	0.5 kg/tonne of finished product	0.25 kg/tonne of finished product
	Grease	0.8 kg/tonne of finished product	0.4 kg/tonne of finished product
Rendering Plant	Biochemical Oxygen Demanding Matter	0.4 kg/tonne of raw material	0.2 kg/tonne of raw material
	Total Suspended Matter	0.4 kg/tonne of raw material	0.2 kg/tonne of raw material
	Grease	0.3 kg/tonne of raw material	0.15 kg/tonne of raw material

TABLE 13(b)

FEDERAL MEAT PRODUCTS REGULATIONS AND GUIDELINES[39]

GUIDELINES

EXISTING OPERATIONS

SCHEDULE 1

MAXIMUM DEPOSITS OF SUBSTANCES CONSIDERED IN PARAGRAPH 4(a), (b) AND (c) OF THE GUIDELINES

Class of Plant	Deleterious Substance	Authorized Actual Daily Deposit	Authorized Average Daily Deposit
Red Meat Integrated Plant	Biochemical Oxygen Demanding Matter	3.0 kg/tonne of finished product	1.5 kg/tonne of finished product
	Total Suspended Matter	3.0 kg/tonne of finished product	1.5 kg/tonne of finished product
	Grease	2.6 kg/tonne of finished product	1.3 kg/tonne of finished product
Processing Plant	Biochemical Oxygen Demanding Matter	1.4 kg/tonne of finished product	0.7 kg/tonne of finished product
	Total Suspended Matter	1.0 kg/tonne of finished product	0.5 kg/tonne of finished product
	Grease	0.8 kg/tonne of finished product	0.4 kg/tonne of finished product
Rendering Plant	Biochemical Oxygen Demanding Matter	1.8 kg/tonne of raw material	0.9 kg/tonne of raw material
	Total Suspended Matter	1.8 kg/tonne of raw material	0.9 kg/tonne of raw material
	Grease	1.2 kg/tonne of raw material	0.6 kg/tonne of raw material

TABLE 14

COMPARISON

FEDERAL AND PROVINCIAL EFFLUENT REQUIREMENTS

MEAT PLANTS

New Operations								
Type of Plant	Substance	Federal Limits						B.C. Objective (kg/t Live Wt.)
		kg/t Dressed Wt.		With Factors Applied (kg/t Live Wt.)				
				Hogs(11)		Beef(12)		
		Max.	Avg.	Max.	Avg.	Max.	Avg.	
Red Meat Integrated Plant	BOD_5	1.0	0.5	1.3	0.65	1.82	0.91	0.5
	Suspended Solids	1.2	0.6	1.58	0.79	2.18	1.09	0.5
	Grease	1.6	0.8	2.1	1.05	2.9	1.45	0.2
Processing Plant	BOD_5	0.7	0.35	0.92	0.46	1.27	0.64	0.4
	Suspended Solids	0.5	0.25	0.66	0.33	0.9	0.45	0.3
	Grease	0.8	0.4	1.05	0.53	1.45	0.73	0.3

Existing Operations									
Type of Plant	Substance	Federal Limits						B.C. Objective (kg/t Live Wt.)	
		kg/t Dressed Wt.		With Factors Applied (kg/t Live Wt.)					
				Hogs(11)		Beef(12)			
		Max.	Avg.	Max.	Avg.	Max.	Avg.	Level "B"	Level "C"
Red Meat Integrated Plant	BOD_5	3.0	1.5	3.9	1.45	5.45	2.73	3.0	10.0
	Suspended Solids	3.0	1.5	3.9	1.45	5.45	2.73	1.5	5.0
	Grease	2.6	1.3	3.42	1.71	4.73	2.37	0.8	2.0
Processing Plant	BOD_5	1.4	0.7	1.84	0.92	2.55	1.28	1.8	6.0
	Suspended Solids	1.0	0.5	1.32	0.66	1.82	0.91	0.57	1.9
	Grease	0.8	0.4	1.05	0.53	1.45	0.73	0.53	1.5

Ratio of dressed weight of hogs to live weight ≃ 0.76(11).
" cattle " ≃ 0.55(12).

TABLE 15(a)

FEDERAL POTATO PROCESSING PLANT REGULATIONS AND GUIDELINES[40]

REGULATIONS

NEW AND EXPANDED PLANTS

AUTHORIZED DEPOSITS OF DELETERIOUS SUBSTANCES

Class of Plant	Deleterious Substance	Authorized Actual Daily Deposit	Authorized Average Daily Deposit
Potato Chip Plant	Biochemical Oxygen Demanding Matter	1.5 kg/tonne of raw potatoes processed	0.5 kg/tonne of raw potatoes processed
	Total Suspended Matter	2.1 kg/tonne of raw potatoes processed	0.7 kg/tonne of raw potatoes processed
Other Potato Products Plants*	Biochemical Oxygen Demanding Matter	2.7 kg/tonne of raw potatoes processed	0.9 kg/tonne of raw potatoes processed
	Total Suspended Matter	2.4 kg/tonne of raw potatoes processed	0.8 kg/tonne of raw potatoes processed

*Note: Other Potato Products Plants include plants that produce canned potato products, dehydrated potato products, frozen potato products and potato starch.

TABLE 15(b)

FEDERAL POTATO PROCESSING PLANT REGULATIONS AND GUIDELINES[40]

GUIDELINES

EXISTING OPERATIONS

MAXIMUM DEPOSITS OF SUBSTANCES CONSIDERED IN PARAGRAPHS 4(a) AND (b) OF THE GUIDELINES

Class of Plant	Deleterious Substance	Authorized Actual Daily Deposit	Authorized Average Daily Deposit
Potato Chip	Biochemical Oxygen Demanding Matter	3.0 kg/tonne of raw potatoes processed	1.0 kg/tonne of raw potatoes processed
	Total Suspended Matter	4.2 kg/tonne of raw potatoes processed	1.4 kg/tonne of raw potatoes processed
Other Potato Products Plants*	Biochemical Oxygen Demanding Matter	5.4 kg/tonne of raw potatoes processed	1.8 kg/tonne of raw potatoes processed
	Total Suspended Matter	4.8 kg/tonne of raw potatoes potatoes	1.6 kg/tonne of raw potatoes processed

*Note: Other Potato Products Plants include plants which produce canned potato products, dehydrated potato products, frozen potato products and potato starch.

TABLE 16

MONITORING DATA SUMMARY

MISCELLANEOUS FOOD INDUSTRY OPERATIONS

Parameter	Permit No. PE	Permitted Level	Monitoring Data				
			Period of Record	No. of Values	Max.	Median	Min.
Oil and Grease (mg/L)	36	-	1965-1977	10	392	8.6	<1.0
	90	35^{++}	1974-1977	20	18.3	6.5	1.0
	2063	-	1974-1977	14	523	5.65	0.0
pH	36	$6.5-7.5^{+}$	1965-1977	11	7.5	6.4	5.0
	90	-	1974-1977	19	7.8	7.5	6.3
	260	$6.5-8.5^{+}$	1965-1977	71	12.3	6.8	2.3
	2063	-	1974-1977	14	7.1	6.3	5.8
	4505	-	1978	2	7.5	-	6.4
Suspended Solids (mg/L)	36	180^{+}	1965-1977	9	3 543	25	0
	90	$60(78^{++})$	1965-1977	31	230	61	2
	260	(120^{**})	1965-1977	71	2 958	220	15
	2063	-	1974-1977	12	97	1.9	0
	4505	0.5 kg/t	1977	3	1 580	410	264
Temperature (°C)	260	-	1974-1977	20	28.3	16.1	10
	2063	-	1974-1977	179	32.2	22.2	6.7
BOD_5 - (mg/L)	36	130^{+}	1965-1973	1	1 473	-	-
	90	$40(52^{++})$	1965-1977	30	438	64	3.6
	260	(500*)	1965-1977	70	30 000	1 785	26
	2063	-	1974-1977	14	21	10	0
	4505	0.3 kg/t	1977	3	29	26	20
Flow - (m^3/d)	36	-	1977	3	225.3	214.8	206.6
	90	45.5	-	-	-	-	-
	260	-	1974-1977	689	1 283	460.8	16.5
	2063	-	1975-1977	179	287.3	91.2	0
	4505	1 090	-	-	-	-	-
Total Coliform (MPN/100 mL)	90	$5M^{+}$	1974-1976	6	>2.4M	0.13M	1 700
Fecal Coliform (MPN/100 mL)	90	-	1974-1977	14	>2.4M	3 900	2
Total Phosphorus (mg/L)	90	-	1974-1977	14	45	11.85	4.7
Total Nitrogen (mg/L)	90	-	1975-1977	8	161	41.3	19.4

* effective July 1, 1980
** effective July 1, 1982
M = million
\+ terminated May 8, 1973
++ effective January 19, 1979

LEGEND

PE 36 - Puritan Canners
PE 90 - Richmond Packers
PE 260 - Berryland Canning
PE 2063 - Standard Brands
PE 4505 - B.C. Vegetable Co-op.

TABLE 17

MONITORING DATA SUMMARY

MISCELLANEOUS FISH PROCESSING OPERATIONS

Parameter	Permit No. PE	Permitted Level	Monitoring Data				
			Period of Record	No. of Values	Max.	Median	Min.
Oil and Grease (mg/L)	1814	-	1974-1976	3	4 400	1 230	1.9
	1830	*	1974-1977	46	485	126.1	13
	1975	*	1975-1978	2	278	-	27.7
	3139	-	1978	2	21.3	-	6
pH	1814	-	1974-1976	2	7.5	-	6.6
	1830	-	1974-1977	7	7.3	6.6	5.9
	1975	-	1975-1978	5	7.3	5.7	4.1
	3139	-	1978	1	6.7	-	-
Suspended Solids (mg/L)	1814	(1)	1974-1975	2	2 180	-	94
	1830	*	1974-1977	47	1 500	426.7	34
	1975	*	1974-1978	4	1 255	654	176
	3139	(2)	1977-1978	2	156	-	93
Flow - (m^3/d)	1811	546	-	-	-	-	-
	1814	1 364	1975	1	138	-	-
	1830	5 200	1975-1977	11	3 591	1 773	1 227
	1975	1 400	-	-	-	-	-
	3139	45.5	-	-	-	-	-
BOD_5 - (mg/L)	1814	(3)	1975-1976	2	11 940	-	8 160
	1830	*	1974-1977	47	3 102	900	25
	1975	*	1975-1978	3	2 194	1 392	741
	3139	(4)	1977-1978	2	360	-	257
Total Phosphorus (mg/L)	1830	-	1974	1	2.3	-	-
	1975	-	1974-1975	2	12.3	-	8.8
Total Nitrogen (mg/L)	1830	-	1975-1976	2	244.02	-	39.1
	1975	-	1975	1	46.1	-	-

* See Permit Details in Addendum to Table.

(1) 0.2 kg/tonne product

(2) 1 kg/tonne product

(3) 0.3 kg/tonne product

(4) 1.4 kg/tonne product

LEGEND

PE 1811 - Can. Fish Co. Phoenix
PE 1814 - Can. Fish Co. Gulf of Georgia
PE 1830 - B.C. Packers - Imperial
PE 1975 - Cassiar Packing
PE 3139 - Longbeach Shellfish

ADDENDUM TO TABLE 17

Permit Details

Permit Number	Process	Suspended Solids (kg/t)	BOD_5 (kg/t)	Ether Soluble Oils (kg/t)
1811	Herring Roe Processing	4	3	-
	Herring Unloading	1.5	1	-
	Reduction Plant	0.2	0.3	-
	Fresh & Frozen	10	6	-
1830	Salmon Canning	4	14	1
	Fresh & Frozen Dressing	1	1.4	-
	Fresh & Frozen Filleting	6	10	4
	Herring Roe Processing	1.9	2.6	0.7
1975	Salmon Canning	13	32	10
	Fresh & Frozen Dressing	1	1.4	-
	Fresh & Frozen Filleting	6	10	4
	Herring	3.5	4	3.5
	Shrimp Processing	32	96	32
3461	Salmon Roe	4	10	-
5174	Fresh & Frozen Dressing	1	1.4	-
	Herring Roe Processing	3.5	4	3.5
5480	Fresh & Frozen Dressing	1	1.4	-
	Fresh & Frozen Filleting	1.5	4	0.8
	Herring Roe Processing	1.9	2.6	0.7
	Shrimp Processing	10	5.8	5

TABLE 18

SUMMARY OF MAIN

FOOD INDUSTRY LOADINGS AND FLOWS

Operation	Permit No.	River Reach	Flow (m^3/d)	Loading (kg/d)		Comments
				BOD_5	Suspended Solids	
Berryland Canning	260	Main Stem	460	800	100	
Clappison Packers	3743	Main Stem	65D	25D	40D	Closed 1977
Puritan Canners	36	North Arm	215	315	5	
Richmond Packers	90	North Arm	46	3	3	
Standard Brands	2063	North Arm	500D	700D	350D	No limits issued-to municipal sewer 1974
B.C. Coast Veg. Co-op	4505	North Arm	1 090	30	450	
B.C. Packers - Imperial	1830	Main Arm	1 775	1 600	760	Total Nitrogen-250 kg/d Total Phosphorus-4 kg/d
B.C. Packers - Paramont	1824	Main Arm	91*	-	-	
Can. Fish. Co. Gulf of Georgia	1814	Main Arm	1 364*	13 700	1 500	Reactivated 1973

TABLE 18 (CONTINUED)

SUMMARY OF MAIN

FOOD INDUSTRY LOADINGS AND FLOWS

Operation	Permit No.	River Reach	Flow (m^3/d)	Loading (kg/d)		Comments
				BOD_5	Suspended Solids	
Can. Fish. Co.-Phoenix	1811	Main Arm	546*D	1 150	710D	Operated 1972, 1973
Cassiar Packing-Richmond	1975	Main Arm	1 400*	1 950	915	Started 1974
Long Beach Shellfish	3139	Main Arm	46*	15	5	Started 1974
Searich Ind. Ltd.	3474	Main Arm	45*	Not Estimated		
Western Can. Seafoods	5111	Main Arm	9*	Insufficient Data		Startup 1978
East Side Holdings	5174	Main Arm	136*	New Operation		Proposed during 1978
J. Griffin & Co. Ltd.	5480	Main Arm	230**	400*	320*	Scheduled startup April 1979

D = Discharge eliminated

* See writeup

** On line April 1979 - estimated values

TABLE 19

PROVINCIAL POLLUTION CONTROL BOARD

POLLUTION CONTROL OBJECTIVES

OBJECTIVES FOR THE DISCHARGE OF EFFLUENT TO MARINE AND FRESH WATERS FROM METAL FINISHING PLANTS AND INDUSTRIES DISCHARGING HEAVY METALS(9)

Level / Parameter		A	B[1]	C	Monitoring Frequency
Aluminum	Dissolved mg/L Al	0.2	-	0.50	Twice a month
Ammonia	Dissolved mg/L N	1	-	2	Twice a month
Antimony	Dissolved mg/L Sb	5	-	5	Twice a month
Arsenic	Dissolved mg/L As	1	-	1	Twice a month
Cadmium	Dissolved mg/L Cd	0.02	-	0.10	Twice a month
Chromium, hexavalent and trivalent	Dissolved mg/L Cr	0.15	-	0.60	Twice a month
Cobalt	Dissolved mg/L Co	1	-	2	Twice a month
Copper	Dissolved mg/L Cu	0.10	-	1	Twice a month
Cyanide	Total mg/L CN	0.50	-	1	Twice a month
Fluoride	Dissolved mg/L F	5	-	15	Twice a month
Iron	Dissolved mg/L Fe	0.5	-	1	Twice a month
Lead	Dissolved mg/L Pb	0.20	-	0.50	Twice a month
Manganese	Dissolved mg/L Mn	1	-	1	Twice a month
Mercury	Dissolved mg/L Hg	0.005	-	0.005	Twice a month
Molybdenum	Dissolved mg/L Mo	10	-	10	Twice a month
Nickel	Dissolved mg/L Ni	1	-	2	Twice a month
Nitrate and Nitrite	Dissolved mg/L N	10	-	25	Twice a month
Oil and Grease	Total mg/L	10	-	15	Twice a month
Phenols	Dissolved mg/L Phenol	0.20	-	0.50	Twice a month
pH Range		6.5-8.5	-	6.5-8.5	Twice a month
Phosphate	Total mg/L P	2	-	5	Twice a month
Selenium	Dissolved mg/L Se	0.20	-	1	Twice a month
Silver	Dissolved mg/L Ag	0.05	-	0.10	Twice a month
Sulphate[2]	Dissolved mg/L SO_4	100	-	250	Twice a month
Nonfilterable Residue	mg/L	50	-	100	Twice a month
Tin	Dissolved mg/L Sn	2	-	4	Twice a month
Zinc	Dissolved mg/L Zn	0.3	-	1	Twice a month

1 No intermediate level of treatment is suggested.

2 Objectives for sulphate are not applicable to discharges to marine water.

TABLE 20

FEDERAL GUIDELINES
METAL FINISHING INDUSTRY[41]

Item	Substance	Max. Total Concentration in mg/L
1.	Total Suspended Matter	30
2.	Cadmium	1.5
3.	Chromium (Total)	1
4.	Copper	1
5.	Lead	1.5
6.	Zinc	2
7.	Nickel	2
8.	Cyanide (Oxidizable)	0.1
9.	Cyanide (Total)	3

Characteristic	Range
pH	6.0-9.5

TABLE 21

MONITORING DATA SUMMARY

MISCELLANEOUS METAL FINISHING AND FABRICATING OPERATIONS

Parameter	Permit No.	Monitoring Data					
		Permitted Level	Period of Record	No. of Values	Max.	Median	Min.
Oil and Grease (mg/L)	1529 2505	15 10	1965-1977 1975-1977	101 9	100 12.4	2.6 1.5	0.06 <1
pH	1529 2350 2505	6.5-8.5 8.5-10.5 6.0-8.5	1965-1977 1974-1977 1975-1977	102 19 11	11.4 2.8 8.2	6.95 2.4 7.3	4.6 1.9 6.05
Suspended Solids (mg/L)	1529 2350 2505	30 - -	1965-1977 1975-1977 1975-1977	102 8 8	238 186 91.3	31.3 - 3.1	2.3 7 1
Flow - (m^3/d)	1529 2350 2505	19 45 131	1965-1977 - -	137 - -	83 - -	57 - -	0 - -
Aluminum, Diss. (mg/L)	2350	-	1975-1977	10	39.9	4.8	1.5
Chromium, Total (mg/L)	2505	-	1973	1	<0.005	-	-
Cobalt, Diss. (mg/L)	2350	1	1974-1977	12	805	66.4	0.8
Fluoride, Diss. (mg/L)	2350	10	-	-	-	-	-
Iron, Diss. (mg/L)	2350	5	1974-1977	13	1 660	683	15.5
Iron, Total (mg/L)	2505	1	1975-1977	9	5	0.5	0.12
Lead, Total (mg/L)	2505	-	1975-1977	1	0.01	-	-
Manganese, Diss. (mg/L)	2350 2505	1.5 -	1975-1977 1973	12 1	7.21 0.24	4 -	0.61 -
Molybdenum, Total (mg/L)	2505	-	1973	1	0.0083	-	-
Nickel, Diss. (mg/L)	2350 2505	1 -	1974-1977 1973	13 1	380 0.2	22.5 -	3.7 -
Temperature (°C)	2505	24	-	-	-	-	-

PE 1529 - Associated Foundry PE 2350 - Kennametal PE 2505 - Esco Ltd.

TABLE 22

MONITORING DATA SUMMARY

WESTERN CANADA STEEL

PE 2087

Parameter	Outfall No.	Permitted Level	Monitoring Data				
			Period of Record	No. of Values	Max.	Median	Min.
Oil and Grease (mg/L)	01 02 03	5 5 5	1965-1977 1976-1977 1975-1977	15 6 17	31.2 5.7 9.8	7.2 1.5 1.9	<1 <1 0.4
pH	01 02 03	6.5-8.5 6.5-8.5 6.5-8.5	1975-1977 1976-1977 1975-1977	16 6 18	7.9 9.2 7.4	6.9 7.7 7.15	6.0 7.4 6.4
Suspended Solids (mg/L)	01 02 03	50 50 50	1975-1977 1976-1977 1975-1977	15 5 14	123 36 121	16 15 37	11 7.2 10
Copper, Diss. (mg/L)	01 02 03	0.05 0.05 0.05	1975-1977 1976-1977 1975-1977	16 6 17	0.14 0.05 0.1	0.065 0.03 0.05	0.03 0.008 0.02
Iron, Diss. (mg/L)	01 02 03	0.3 0.3 0.3	1975-1977 1976-1977 1975-1977	16 6 17	2 0.14 1.2	0.265 0.095 0.29	0.02 0.04 0.06
Lead, Diss. (mg/L)	01 02 03	0.05 0.05 0.05	1975-1977 1976-1977 1975-1977	16 6 17	0.16 0.08 0.03	0.01 0.025 0.01	0.006 0.01 <0.001
Zinc, Diss. (mg/L)	01 02 03	0.3 0.3 0.3	1975-1977 1976-1977 1975-1977	16 6 17	0.36 0.5 0.11	0.15 0.135 0.02	0.05 0.07 0.005
Flow - (m^3/d)	01 02 03	271 45.5 23 775	- - -	- - -	- - -	- - -	- - -

01; 02 = miscellaneous drainage

03 = rolling mill cooling water

TABLE 23

MONITORING DATA SUMMARY

TREE ISLAND STEEL

PE 3190

Parameter	Wastewater Source	Permitted Level	Monitoring Data				
			Period of Record	No. of Values	Max.	Median	Min.
pH	P.W.* P.W. C.W.	- 8.0-9.5 6.5-8.5**	1975-1977 1976-1977 1976-1977	8 38 5	12.1 12.2 7.1	4.9 2.2 6.9	1.9 1.7 5.9
Chromium, Diss. (mg/L)	P.W. C.W.	0.6 -	1976-1977 1976-1977	49 2	0.45 <0.005	0.1 -	<0.01 <0.005
Copper, Total (mg/L)	P.W. C.W.	- -	- -	1 1	0.03 0.006	- -	- -
Iron, Diss. (mg/L)	P.W.* P.W. C.W.	- 1 0.5**	1965-1977 1976-1977 1977	5 49 2	910 706 0.4	11 148 -	<0.1 <0.05 <0.1
Lead, Diss. (mg/L)	P.W.* P.W. C.W.	- 0.5 0.2**	1965-1977 1976-1977 1977	5 49 2	19.6 53 0.025	0.008 7 -	<0.001 <0.01 <0.001
Nickel, Total (mg/L)	P.W. C.W.	- -	- -	1 1	0.1 <0.01	- -	- -
Zinc, Diss. (mg/L)	P.W.* P.W. C.W.	- 1 0.3**	1965-1977 1976-1977 1977	5 49 2	64.4 156 82.7	1.4 38 -	0.02 0.007 47
Total Phosphorus (mg/L)	P.W. C.W.	- -	- -	44 3	1.6 27	0.15 0.68	<0.003 0.5
Flow - (m^3/d)	P.W. C.W.	1 000 1 500	1974-1977 1974-1977	265 271	1 002 1 698	662*** 984***	52 478

P.W. = Process Water

C.W. = Cooling Water

* Majority of values are pre 1976

** Effective April 30, 1979

*** Mean Value

TABLE 24

MONITORING DATA SUMMARY

TITAN STEEL AND WIRE

PE 161

Parameter	Permitted Level	Monitoring Data				
		Period of Record	No. of Values	Max.	Median	Min.
pH	6-9	1965-1973	6	12.2	6.3	4.8
		1974	3	7.6	7.6	2.4
		1975	12	12.1	11.6	2.5
		1976	17	12.2	5.2	1.6
		1977	6	8.8	5.6	4.1
		1965-1977	44	12.2	7.05	1.6
Suspended Solids (mg/L)	50	1965-1973	6	1 993	107	39
		1974	3	7 449	2 056	17
		1975	10	4 620	41.3	9.1
		1976	49	4 960	111	2.7
		1977	47	6 000	25	3
		1965-1977	115	7 449	64.2	2.7
Sulphate (mg/L)	250	1965-1973	3	1 851	1 352	1 155
		1974	2	3 489	2 683	1 877
		1976	47	11 100	2 000	480
		1977	47	2 900	1 440	470
		1965-1973	99	11 100	1 640	470
Chromium, Diss. (mg/L)	-	1965-1977	6	0.19	0.008	<0.005
Copper, Diss. (mg/L)	-	1965-1977	7	0.16	0.04	0.02
Iron, Diss. (mg/L)	1	1974	2	1 200	885	570
		1975	10	1 300	0.1	0.04
		1976	47	4 050	0.21	<0.01
		1977	47	850	0.07	0.01
		1974-1977	106	4 050	0.115	<0.01
Iron, Total (mg/L)	-	1965-1973	6	2 000	294.5	3.6
		1974	1	1 570	-	-
		1976	14	1 730	615	3.9
		1977	13	925	30.5	0.8
		1978	4	320	83	23.6
		1965-1977	34	2 000	277.5	0.8

TABLE 24 (CONTINUED)

MONITORING DATA SUMMARY

TITAN STEEL AND WIRE

PE 161

Parameter	Permitted Level	Monitoring Data				
		Period of Record	No. of Values	Max.	Median	Min.
Lead, Diss. (mg/L)	0.5	1974 1975 1976 1977 1974-1977	2 9 47 47 105	5.1 5 18.4 0.2 18.4	2.7 0.08 0.16 0.05 0.05	0.3 <0.001 <0.01 <0.01 <0.001
Lead, Total (mg/L)	-	1965-1973 1974 1976 1977 1978 1965-1977	6 1 14 13 4 34	1.7 27.4 20.8 10.4 0.3 27.4	0.53 - 2.2 0.2 0.18 0.78	0.11 - <0.05 0.02 <0.02 <0.02
Zinc, Diss. (mg/L)	1	1974 1975 1976 1977 1974-1977	2 10 47 46 105	7.01 13.7 42.4 2.5 42.4	4 0.15 0.07 0.03 0.04	0.98 0.019 <0.01 <0.01 <0.01
Zinc, Total (mg/L)	-	1965-1973 1974 1976 1977 1978 1965-1977	6 1 14 13 4 34	3 6.02 11.6 121 3.9 121	0.41 - 3.11 0.21 0.97 0.73	0.03 - 0.1 0.06 0.28 0.03
Phosphorus, Total (mg/L)	-	-	1	0.17	-	-
Flow - (m^3/d)	454.5	-	-	-	-	-

TABLE 25

SUMMARY FOR MAIN
METAL FINISHING AND FABRICATING INDUSTRIES
LOADINGS AND FLOWS

Operation	Permit No.	River Reach	Flow (m^3/d)	Loadings (kg/d)						
				Suspended Solids	Copper	Iron	Lead	Zinc	Total Phosphorus	Total Nitrogen
Western Canada Steel	2087	North Arm	24 000*	880*	1.2	6.9	0.24	0.5	0.9	5.3
Tree Island Steel	3190	North Arm	662* 984*	- -	- -	98.1 -	4.6 -	25 64	0.8 -	- -
Metalex Products	2311	North Arm	13D	270	-	1.1	-	-	-	-
Varta Batteries	4661	North Arm	-	-	-	-	-	-	-	-
Alcan Canada	2509	North Arm	135D	-	-	-	-	-	-	-
Titan Steel	161	Main Arm	455	29*	-	125*	0.4	0.4	-	-

D = discontinued.

* See specific industrial write-up for source of estimate.

<u>Notes</u>:

(1) Metals are "dissolved" except for Titan Steel which are "total".

(2) Values are based upon median recorded values unless otherwise noted.

TABLE 26

POLLUTION CONTROL BOARD OBJECTIVES

OBJECTIVES FOR THE DISCHARGE OF EFFLUENT TO MARINE AND FRESH WATERS FROM CEMENT-MANUFACTURING AND READY-MIX CONCRETE BATCH PLANTS[(9)]

Operation	Level / Parameter	A	B	C	Monitoring Frequency
Cement-Manufacturing Plants	Suspended solids, kg/tonne of cement produced	0.035	0.25	0.9	Four times a year
	Total solids[1], kg/tonne of cement produced	1.15	1.6	3.4	As above
	pH range	6.5-8.5	6.5-8.5	6.5-8.5	As above
	Suspended solids, kg/100 m^3	0.36	2.5	9.8	As above
Ready-Mix Concrete Batch Plants	Total solids[1], kg/100 m^3 produce	12.5	17.2	36.8	As above
	pH range	6.5-8.5	6.5-8.5	6.5-8.5	As above

[1] Not applicable to discharges to marine water.

TABLE 27

MONITORING DATA SUMMARY

MISCELLANEOUS CONCRETE INDUSTRY OPERATIONS

Parameter	Permit No.	Monitoring Data					
		Permitted Level	Period of Record	No. of Values	Max.	Median	Min.
pH	2071	-	1973-1977	19	9.4	7.6	6.2
	2302-01	-	1975-1977	5	10.7	7.7	7.2
	2302-02	-	1976-1977	2	8.9	-	8.15
	2976-01	6.5-8.5	1975-1977	34	10.9	8.8	6.8
	2976-02	6.5-8.5	1975-1977	33	11.7	9.5	6.9
Suspended Solids (mg/L)	2071	50	1973-1977	17	37	6	1.5
	2302-01	50	1975-1977	5	330	100	4
	2302-02	170	1975-1976	2	391	-	153
	2976-01	50	1975-1977	12	166	26	6
	2976-02	50	1975-1977	10	118	47.5	2.4
Flow - (m^3/d)	2071	318	1973-1977	607	491	295	0
	2302-01	-	1975-1977	2	485	-	409
	2302-02	-	1975-1976	1	215	-	-
	2976-01	6.4	1975	40	0.6	0.6	0.3
	2976-02	2.3	1975	40	3	2.8	2.6
Temperature (^oC)	2071	-	1973-1977	8	33	25	15

TABLE 28

MONITORING DATA SUMMARY

LAFARGE CEMENT

PE 42

Parameter	Permitted Level	Monitoring Data				
		Period of Record	No. of Values	Max.	Median	Min.
pH	6.7-8.5	1965-1973 1974 1975 1976 1977	191 331 361 250 82	11.6 10.3 12.1 11.5 13	8.1 8 8.1 7.5 7.3	6 6 6.5 6.4 6.4
Suspended Solids (mg/L)	2 000	1965-1973 1974 1975 1976 1977 1965-1977	34 53 54 28 38 207	9 146 4 100 5 104 4 716 6 040 9 146	1 251 1 597 1 437 843 352 1 190	159 250 380 157 10 10
Flow - (m^3/d)	1 365	1965-1973 1974 1975 1976 1977 1965-1977	184 325 365 247 80 1 201	1 365 1 386 1 409 1 409 1 341 1 409	1 365 1 250 1 273 1 250 1 227 1 273	1 227 1 091 341 1 136 1 114 341
Cyanide - (mg/L)	0.16	1965-1977	18	0.03	0.01	<0.01
BOD_5 - (mg/L)	0.6	1965-1977	13	65	22	<10
Chromium, Total (mg/L)	0.1	1965-1977	18	0.25	0.0195	<0.005
Copper, Total (mg/L)	0.2	1965-1977	79	0.66	0.069	0.005
Iron, Total (mg/L)	-	1965-1977	7	10.2	5	2.68
Lead, Total (mg/L)	0.1	1965-1977	79	2.2	0.32	0.003
Mercury, Total (µg/L)	90	1965-1977	15	0.3	0.05	<0.05
Zinc, Total (mg/L)	0.4	1965-1977	79	0.43	0.12	0.01
Potassium (mg/L)	-	1965-1977	188	2 180	786	20

TABLE 29

SUMMARY FOR MAIN CONCRETE
INDUSTRIES LOADINGS AND FLOWS

Operation	Permit No.	River Reach	Flow m^3/D	Loading (kg/D)		Comments
				BOD_5	Suspended Solids	
Can. Gypsum	2071	North Arm	295	-	-	-
Ocean Construction	2302	North Arm	700D	-	800*D	Loading after 1974 was 100 kg/d Plant Dismantled - May 1980
LaFarge, Kent St.	3432	North Arm	91D	-	-	Complete recycle
Allied Ready Mix	5325	North Arm	6.8	-	-	To exfiltration pond
LaFarge Cement, Richmond	42	Main Arm	1 273	26	1 515	Hg 0.05 µg/L
LaFarge Concrete, Richmond	2439	Main Arm	65D	-	27D	Discharge eliminated 1974 with recycle pH was 10.2-10.8
Con Force	2976	Main Arm	3.4	-	-	-
Tri-Mac Concrete	2273	Main Arm	46	-	-	To exfiltration pond

* See specific industrial write-up for source of estimate.

D = Discontinued.

Notes: Values are based upon median recorded levels unless otherwise noted.

TABLE 30

POLLUTION CONTROL BOARD OBJECTIVES

MUNICIPAL-TYPE WASTE DISCHARGES

EFFLUENT QUALITY OBJECTIVES - DISCHARGES TO RECEIVING WATERS

(INCLUDING STORM OVERFLOWS)*[42]

Portion of Effluent Being Discharged		Receiving Waters: Streams, Rivers & Estuaries — Dilution(b)			Lakes	Marine(a)		Parameter (Numerical Values in mg/L)
		≥20:1 <200:1(c)	≥200:1 <2 000:1	≥2 000:1		Open	Embayed	
	Level	AVERAGE DWF ≥ 45 m^3/d						
Effluent Quality Required For All Flows Up To 3 Times AVG.DWF	AA	30	45	100	30	130	45	BOD_5
		40	60	100	40	130	60	SS
		Yes	Yes	Yes	Yes	Yes	Yes	Disinfection
		Yes	No	No	No(d)	No	No	Dechlorination**
		<0.05	0.5-1.0	0.5-3.0	0.5-1.0	0.5-1.0	0.5-1.0	Chlorine Residual**
		1.5(e)	1.5(e)	-	1.5(e)	-	1.5(e)	Total Phosphorus
	BB	45	130	130	45	130	130	BOD_5
		60	130	130	60	130	130	SS
		Yes	Yes	Yes	Yes	No	Yes	Disinfection
		No	No	No	No	-	No	Dechlorination**
		0.5-1.0	0.5-1.0	0.5-3.0	0.5-1.0	-	0.5-1.0	Chlorine Residual**

TABLE 30 (CONTINUED)

POLLUTION CONTROL BOARD OBJECTIVES

MUNICIPAL-TYPE WASTE DISCHARGES

EFFLUENT QUALITY OBJECTIVES - DISCHARGES TO RECEIVING WATERS (INCLUDING STORM OVERFLOWS)*[42]

Portion of Effluent Being Discharged		Receiving Waters						Parameter (Numerical Values im mg/L)
		Streams, Rivers & Estuaries			Lakes	Marine(a)		
		Dilution(b)				Open	Embayed	
		$\geq$20:1 <200:1(c)	$\geq$200:1 <2 000:1	$\geq$2 000:1				
	Level	AVERAGE DWF $\geq$ 45 m^3/d						
Require-ments For All Flows Greater Than The Multiple of Avg. DWF Shown	AA	Screening 8	Screening 6	Screening 3	Screening 8	None 3	Screening 6	Treatment of Overflow Multiple of Avg. DWF
	BB	Screening 6	None 3	None 3	Screening 6	None 3	None 3	Treatment of Overflow Multiple of Avg. DWF
Effluent Quality Required for Interme-diate DWF Mul-tiples(f)	AA	45 60 Yes 0.1-1.0	130 130 No -	- - - -	45 60 Yes 0.1-1.0	- - - -	130 130 Yes 0.1-1.0	BOD_5 SS Disinfection Chlorine Residual**
	BB	130 130	- -	- -	130 130	- -	- -	BOD_5 SS

TABLE 30 (CONTINUED)

POLLUTION CONTROL BOARD OBJECTIVES

MUNICIPAL-TYPE WASTE DISCHARGES

EFFLUENT QUALITY OBJECTIVES - DISCHARGES TO RECEIVING WATERS

(INCLUDING STORM OVERFLOWS)*[42]

Portion of Effluent Being Discharged		Receiving Waters						Parameter (Numerical Values) im mg/L)
		Streams, Rivers & Estuaries			Lakes	Marine(a)		
		Dilution(b)				Open	Embayed	
		$\geq$20:1 <200:1(c)	$\geq$200:1 <2 000:1	$\geq$ 2 000:1				
	Level	AVERAGE DWF $\geq$ 45 m^3/d						
All Flows	AA	45 60 Yes(h) 0.2-0.5	130 130 Yes(i) 0.2-1.0	130(g) 130 Yes(i) 0.5-3.0	45 60 Yes(i) 0.2-1.0	Typical Septic Tank Effluent (j)	45 60 Yes 0.2-1.0	BOD_5 SS Disinfection Chlorine Residual**
	BB	45 60	Typical Septic Tank Effluent (j)	Typical Septic Tank Effluent (j)	45 60	Typical Septic Tank Effluent (j)	Typical Septic Tank Effluent (j)	BOD_5 SS

DWF refers to Dry Weather Flow

* Bracketed letters refer to Appendix 1 to Table 30 which follows.

$\geq$ Means equal to or greater than.

< Means less than.

** "Dechlorination" and "Chlorine Residual" designations apply where disinfection is by chlorination. Values shown are for total Chlorine Residual based on amperometric procedures.

APPENDIX 1 TO TABLE 30

EXPLANATORY NOTES

(a) The effluent quality objectives for marine discharges for flows up to 3 times avg. DWF are based on outfall depth-distance combinations given in the Objectives[42]. Alternatively, where outfalls are extended on the basis of maintaining receiving water quality as in Table 5-3, a lower effluent quality for flows up to 3 times avg. DWF may be accepted, but not less than comminution. Visual evidence of the discharge should normally not be noticeable. Approval for such an alternative will normally be given only where provision is made for space to house an appropriate treatment plant in the future. Where quality better than the tabulated values is provided and for any portion of flow exceeding 3 times avg. DWF, outfall lengths may be reduced.

(b) Stated dilution ratios are based on the lowest week's stream flow anticipated during the discharge period in an average year and the highest estimated hourly effluent discharge rate (both flows expressed in the same units). For estuaries, the stream flow is to be based on the fresh water content.

(c) If the receiving stream is used for recreation or domestic water extraction, discharge will be prohibited within this dilution range, unless there is no feasible alternate solution. Dilutions less than 20:1 will normally not be permitted, but where there is no alternative, discharge may be permissible with higher discharge standards required.

(d) Dechlorination may be required if it is anticipated that a significant portion of any fish-bearing lake will be affected by the residual chlorine. Alternatively, it may be possible to reduce the chlorination requirements instead, if phosphorus removal facilities are included, and if they are found to be helpful in reducing coliform concentrations.

(e) The total phosphorus requirement for effluents may be waived if it can be reasonably shown from a site-specific study that the receiving waters would not be subject to an undesirable degree of increased biological activity because of the nutrient input.

(f) Where intermediate DWF multiples are passed through the treatment plant, the overall effluent quality objective shall be the flow-weighted average of the value shown and the value for the under 3 DWF portion of the flow. Chlorination and dechlorination shall be provided as required for the "up to 3 DWF" portion of the flow.

(g) Where effluent volume is less than 1 000 gpd and dilution is greater than 50 000:1 and no water extraction is practised in the vicinity, typical septic tank effluent quality may be permitted.

(h) Dechlorination may be required if a significant fish resource exists.

(i) The chlorination requirement may be dropped where no domestic water extraction occurs in the vicinity.

(j) Septic tanks must have a hydraulic capacity of at least two times the design average daily flow for the effluent to meet Level AA requirements. Lesser capacities may be permitted for Level BB.

TABLE 31

POLLUTION CONTROL BOARD OBJECTIVES

MUNICIPAL-TYPE WASTE DISCHARGES

LIMITS FOR EFFLUENT PARAMETERS THAT MAY BE OF CONCERN

IN SPECIFIC DISCHARGES[a]*[42]

Parameter	Maximum Concentrations[b,e] mg/L (Except pH and TL_m)	
	Level AA	Level BB
Methylene Blue Active Substances	5	-
Oil and Grease	15	30
pH	6.5-8.5	6.5-8.5
Phenol	0.2	0.4
TL_m (96 Hour)[c]	100%	75%
Aluminum, Total	2	4
Arsenic, Total	0.05	0.25
Barium, Dissolved	1	1
Boron, Dissolved	5	5
Cadmium, Dissolved	0.005	0.01
Chromium, Total	0.1	0.3
Cobalt, Dissolved	0.1	0.5
Copper, Dissolved	0.2	0.5
Cyanide, Total	0.1	0.5
Fluoride, Dissolved	5	-
Iron, Dissolved	0.3	1
Lead, Total	0.05	0.1
Manganese, Dissolved	0.05	0.5
Mercury, Total	0.0006	0.002
Molybdenum, Total	0.2	0.5
Nickel, Dissolved	0.3	0.5
Nitrogen[d]	-	-
Resin Acid Soaps	5	-
Selenium, Total	0.05	0.1
Silver, Total	0.1	1
Sulphate, Dissolved[e]	50	250
Sulphide, Dissolved	0.5	1
Tin, Total	5	10
Zinc, Total	0.5	5

* Bracketed letters refer to Appendix to Table 31 which follows.

APPENDIX TO TABLE 31

EXPLANATORY NOTES

(a) The limits apply to discharges to all receiving waters and to ground unless otherwise noted. However, a limit will only be shown on a permit were investigations indicate this is needed.

(b) Levels may be adjusted to take account of background levels in the water supply. Other parameters may be added at the discretion of the Director.

(c) TL_m (96 hr.) samples to be prior to chlorination.

(d) A limitation on nitrogen may be required where site-specific studies indicate nitrogen to be a controlling factor for eutrophication or where the nitrogen level of the effluent is considered to be abnormally high.

(e) Applies to freshwater only.

TABLE 32

GUIDELINES FOR
EFFLUENT QUALITY AT
FEDERAL ESTABLISHMENTS[43]

GENERAL

Effluents from Federal establishments should be treated before being discharged to receiving waters so that they are:

1) Free from materials and heat in quantities, concentrations or combinations which are toxic or harmful to human, animal, waterfowl or aquatic life;

2) Free from anything that will settle in receiving waters forming putrescent or otherwise objectionable sludge deposits, or that will adversely affect aquatic life or waterfowl;

3) Free from floating debris, oil, scum and other materials in amounts sufficient to be noticeable in receiving waters;

4) Free from materials and heat that alone, or in combination with other materials will produce color, turbidity, taste or odour in sufficient concentration to create a nuisance or adversely affect aquatic life or waterfowl in receiving waters;

5) Free from nutrients in concentrations that create nuisance growths of aquatic weeds or algae in the receiving waters.

SPECIFIC LIMITS

Effluents discharged to receiving waters should receive treatment such that an effluent of the following minimum quality is achieved:

5 Day Biochemical Oxygen Demand	20 mg/L
Suspended Solids	25 mg/L
Fecal Coliforms (MF Method)	400 per 100 mL (after disinfection)
*Chlorine Residual	0.50 mg/L minimum after 30 minutes contact time[a] 1 mg/L maximum
pH	6 to 9
Phenols	20 μg/L
Oil and Greases	15 mg/L
Phosphorus (Total P.)	1 mg/L[b]

Temperature - not to alter the ambient water temperature by more than[c] one degree Centigrade ($1^{o}C$).

(a) Applicable where chlorination is used for disinfection purposes;
(b) Applicable where phosphorus removal is required;
(c) Applicable at perimeters of mixing zone.

APPENDIX TO TABLE 32

EXPLANATORY NOTES

(a) For discharges to shellfish waters, greater frequency of effluent monitoring may be required.

(b) The parameters which shall be sampled for any effluent discharge are:

(i) those on which quality limitations have been imposed;

(ii) coliforms (normally fecal) unless discharging to exfiltration basins or sub-surface disposal fields; and,

(iii) other parameters where there may be concern as to possibility of environmental effects but no quality limit is imposed.

Additionally, where disinfection of effluent by chlorination is required, regular testing of chlorine residual should be made at intervals throughout each day and any necessary adjustment to chlorine dosage implemented.

(c) BOD_5 to be run more frequently if analysis of SS is not satisfactory.

(d) Parameters to be specified on an individual basis by the Director.

TABLE 33

MONITORING DATA SUMMARY

MISCELLANEOUS DOMESTIC SEWAGE DISCHARGES

Parameter	Permit No.	Permitted Level	Period of Record	No. of Values	Max.	Median	Min.
Suspended Solids (mg/L)	2	60	1965-1977	25	66	32	13
	17	60	1977-1978	2	41	-	14
	52	50	1965-1977	14	21	5	<1
	182	100	1965-1976	3	116	40	37
	328	75	1965-1977	16	64	22	9
	1508	50	1965-1977	37	191	31	2
	1536	60	1965-1977	10	49	23	7
	1804	60	1974-1977	13	225	79	21
	1914	60	1974-1977	9	224	67	38
	2087	60	1974-1977	17	51	19	2
	2722	35	1974-1977	16	149	24.5	1.7
	2975	40	1974-1977	7	148	4	<1
	2976	60	1975-1977	5	153	92	58
	3154	60	1975-1977	2	148	104.5	61
	3190	-	1974-1977	5	31	18	6
	3377	60	1975-1977	9	296	195	72
	3434	60	1976-1977	8	65	33	21
	3950	60	1976	2	345	302	259
BOD_5 - (mg/L)	2	45	1965-1977	25	116	36	12
	17	45	1977-1978	2	14	-	<10
	52	50	1965-1977	14	36	10	<10
	182	100	1965-1976	3	>191	49	37
	328	75	1965-1977	16	83	22	<10
	1508	45	1965-1977	39	438	36	8.7
	1536	45	1965-1977	10	59	20	<5
	1804	45	1974-1977	14	95	51.5	<5
	1914	45	1974-1977	9	157	80	36
	2087	45	1974-1977	16	62	10	1
	2722	30	1974-1977	16	30	15.6	9.8
	2975	30	1975-1977	7	302	10	<1
	2976	45	1975-1977	5	120	65	2.8
	3154	45	1977	1	115	-	-
	3190	-	1976	1	<10	-	-
	3377	45	1975-1977	10	599	135	32
	3434	45	1976-1977	8	109	59	19
	3950	45	1976	3	380	134	38
Flow - (m^3/d)	2	45.5	-	-	-	-	-
	17	21	-	-	-	-	-
	52	6.8	-	-	-	-	-
	182	135	-	-	-	-	-
	328	13.5	-	-	-	-	-
	1508	64	1974-1975	11	54.6	28.2	15.1

TABLE 33 (CONTINUED)

MONITORING DATA SUMMARY

MISCELLANEOUS DOMESTIC SEWAGE DISCHARGES

Parameter	Permit No.	Permitted Level	Period of Record	No. of Values	Max.	Median	Min.
Flow - (m^3/d)	1536	4.1	1974-1976	11	54.6	28.2	15.1
	1804	1.8	-	-	-	-	-
	1914	1	1974-1977	2	1	1	1
	2087	45.5	-	-	-	-	-
	2722	25	1974-1977	84	6.1	3.2	0.5
	2975	6.8	-	-	-	-	-
	2976	13.2	1975	42	11.7	11.7	2.9
	3154	1.1	-	-	-	-	-
	3190	4.5	-	-	-	-	-
	3377	5.1	1975-1977	77	3.6	0.7	0.4
	3434	65	-	-	-	-	-
	3950	7.4	-	-	-	-	-
Fecal Coliform (MPN/100 mL)	2	-	1975-1977	10	220 000	20	<1
	52	-	1977	2	270	-	<200
	131	-	1975	1	<20	-	-
	328	-	1975-1977	6	160 000	8 010	<20
	1508	-	1974-1977	32	2 200 000	20	<2
	1536	-	1975	1	2 400	-	-
	1804	-	1974-1977	10	>240 000	145	<20
	1914	-	1974-1977	5	>240 000	>24 000	>24 000
	2722	-	1974-1977	10	490	200	<1
	2975	-	1975-1976	5	1 100	20	<2
	2976	-	1975-1977	4	92 000	7 700	2
	3377	-	1975-1977	7	>240 000	51 000	24 000
	3950	-	1976	1	1 600 000	-	-
Chlorine Residual (mg/L)	2	-	1965-1977	13	>3	1.2	0.1
	328	0.1-1.0	1965-1977	7	2.4	0.9	0
	1508	-	1974-1977	40	>3	0.2	0
	1536	-	1965-1977	57	>3	0.4	0
	2722	-	1974-1977	11	2.7	0.6	<0.1
	2975	-	1975-1976	3	0.3	0	0
	2976	-	1977-1978	5	>3	0.1	0
Total Phosphorus (mg/L)	2	-	1965-1973	2	3.4	2.6	1.7
	328	-	1965-1973	1	1.03	-	-
	1508	-	1974-1977	3	4.2	4	3.66
	1804	-	1974	1	6.25	-	-
	2087	-	1976-1977	3	2.16	1.96	1.28
	2722	-	1977	1	2.9	-	-
	3434	-	1976-1977	3	9.85	7.1	4.78

TABLE 33 (CONTINUED)

MONITORING DATA SUMMARY

MISCELLANEOUS DOMESTIC SEWAGE DISCHARGES

Parameter	Permit No.	Permitted Level	Period of Record	No. of Values	Max.	Median	Min.
Total Nitrogen (mg/L)	2	-	1965-1973	1	25.2	-	-
	328	-	1965-1973	1	8.5	-	-
	1508	-	1975-1977	5	36.1	16.1	12.1
	1804	-	1974	1	69.1	-	-
	2087	-	1976-1977	2	12.6	11.7	10.8
	2722	-	1977	1	28.2	-	-
	3377	-	1976	1	89	-	-
	3434	-	1977	2	61	58	55

TABLE 34

SUMMARY OF MAIN
DOMESTIC SEWAGE DISCHARGES

Operation	Permit No.	River Reach	Flow m^3/D	Loading (kg/d)		Comments
				BOD_5	Suspended Solids	
Weldwood	3434	Main Stem	65	4.6	2.6	No disinfection
Mill & Timber Products	328	Main Stem	14	0.3	0.3	
Evergreen Trailer Park	1508	Main Stem	28	0.9	0.9	
10014 Allard Cresc.	1536	Main Stem	2	-	-	
Whonock Elementary	2012	Main Stem	5	-	-	
Big "B" Burgers	2975	Main Stem	7	-	-	
Swiftsure Towing	3154	Main Stem	1	-	-	
Rolyn Mills	3712	Main Stem	2	-	-	
Clappison Packers	3743	Main Stem	9D	0.4D	0.5D	Operation closed 1977
Koppers Int.	1804	North Arm	2	-	-	
Belkin Packaging	17	North Arm	21	0.1	0.1	
Western Canada Steel	2087	North Arm	46	0.5	0.2	
Cumberland Dev. Corp.	52	North Arm	7	-	-	
Tree Island Steel	139	North Arm	5	-	-	

TABLE 34 (CONTINUED)

SUMMARY OF MAIN

DOMESTIC SEWAGE DISCHARGES

Operation	Permit No.	River Reach	Flow m^3/D	Loading (kg/d)		Comments
				BOD_5	Suspended Solids	
Terminal Sawmills	3950	North Arm	7	0.9	2.1	
Crestwood Kitchens	341	North Arm	36D	1.1	2.2	To Municipal Sewer 1974
Crown Zell. Richmond	3377	North Arm	5	0.7	1.0	
Con-Force Products	2976	Main Arm	12	0.9	1.2	
St. George Holding	2	Main Arm	46*	1.6	1.6	
Wawryk Holdings	2722	Main Arm	3	0.4	0.6	
Satellite Develop.	2969	Main Arm	7*	0.3	0.4	
J. Griffin & Co.	1914 5480	Main Arm	1*	-	-	
Grosvenor Laing	182	Main Arm	135*	6.6	5.4	

* See specific industrial write-up for source of estimate.

D = Discontinued.

Notes: Values are based upon median recorded levels unless otherwise noted.

TABLE 35

POLLUTION CONTROL BOARD OBJECTIVES

EFFLUENT-QUALITY OBJECTIVES FOR CHEMICAL INDUSTRIES OTHER THAN PETROLEUM REFINERIES[44]

	Discharge to Marine Waters			Discharges to Fresh Waters			Monitoring
	Level A	Level B	Level C	Level A	Level B	Level C	
Oil, Nonvolatile, mg/L (a)	-	10	15	-	10	15	Daily composite, once per week(b)
Oil, Total, mg/L	10	-	-	5	-	-	Daily composite, once per week
BOD, Five Day, 20°C, mg/L	20	45	130	20	45	130	COD or TOC once per week, BOD checked quarterly
Ammonia, as N, mg/L	10	15	15	10	15	15	Daily composite, once per week
Nitrates, as N, mg/L	10	50	50	10	50	50	Daily composite, once per week
Total Nitrogen, mg/L (Kjeldahl)	15	25	25	15	25	25	Daily composite, once per week
Chlorate, mg/L	75	150	150	50	100	100	Daily composite, once per week
Chloride Ion, mg/L (c)	-	-	-	-	-	-	Daily composite, once per week
Chlorine, Residual, mg/L	0.2	0.5	1	0.2	0.5	1	Continuous
Fluoride, mg/L	2.5	10	15	2.5	10	15	Daily composite, once per week
Formaldehyde, mg/L	5	5	10	5	5	10	Daily composite, once per week
Metals (Total) -							
Arsenic, Trivalent, mg/L	0.05	0.05	0.08	0.05	0.05	0.05	Daily composite, once per month
Barium, mg/L	1	1	1.5	1	1	1	Daily composite, once per month
Boron, mg/L	15	15	15	10	10	10	Daily composite, once per month
Chromium, mg/L	0.2	0.2	0.2	0.2	0.2	0.2	Daily composite, once per month
Copper, mg/L	0.1	0.1	0.1	0.1	0.1	0.1	Daily composite, once per month
Lead, mg/L	0.2	0.2	0.2	0.2	0.2	0.2	Daily composite, once per month
Mercury, mg/L	0.002	0.050	0.050	0.002	0.050	0.050	Daily composite, once per month
Nickel, mg/L	0.2	0.2	0.2	0.2	0.2	0.2	Daily composite, once per month
Zinc, mg/L	0.2	0.2	0.3	0.2	0.2	0.2	Daily composite, once per month
Phenols, mg/L	0.2	0.3	1	0.2	0.3	1	Weekly grab
Phosphate, as P, mg/L	-	-	-	1	10	30	Daily composite, once per week
Sulphate, mg/L (c)	-	-	-	-	-	-	Daily composite, once per week
Urea, mg/L	2	2	2	1	1	1	Daily composite, once per week

TABLE 35 (CONTINUED)

POLLUTION CONTROL BOARD OBJECTIVES

EFFLUENT-QUALITY OBJECTIVES FOR CHEMICAL INDUSTRIES OTHER THAN PETROLEUM REFINERIES[44]

	Discharge to Marine Waters			Discharges to Fresh Waters			Monitoring
	Level A	Level B	Level C	Level A	Level B	Level C	
Sulphides, mg/L	0.10	0.10	1	0.10	0.10	1	Weekly grab
Cyanide, mg/L	0.10	0.10	0.20	0.10	0.10	0.20	Weekly grab
Suspended Solids, mg/L (d)	20	20	30	20	20	30	Daily composite, once per week
Settleable Solids, mg/L (d)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	Daily composite, once per week
Floatable Solids	(e)	(e)	(e)	(e)	(e)	(e)	Daily observation
Total Solids, mg/L (f)	3 000	3 000	3 000	1 500	1 500	1 500	Daily composite, once per week
Colour, Pt-Co Units at pH 7	20	20	30	15	15	20	
Turbidity, JTU	15	15	25	10	10	15	
Temperature, °F Maximum	90	90	90	90	90	90	Continuous
pH	6.5-8.5	6.5-9.0	6.5-9.0	6.5-8.5	6.5-8.5	6.5-9.0	Continuous
Toxicity (g)	50	45	25	100	90	50	Quarterly

(a) For discharge of once-through cooling water used for indirect cooling (heat exchangers, bearings, etc.) the maximum permissible oil concentration is 2 mg/L above background.
(b) See Table VIII, footnote (c).
(c) While the importance of these characteristics is recognized, no limits have been established at this time.
(d) Not applicable to discharges to exfiltration ponds.
(e) Negligible.
(f) Depends upon the nature of solids other than normal marine composition.
(g) 96 hour TL_m bioassay on salmonid species, expressed as per cent by volume of effluent in receiving-water which is required to give 50 per cent survival over 96 hours.

TABLE 36

MONITORING DATA SUMMARY

MISCELLANEOUS OPERATIONS

Parameter	Permit No.	Permitted Level	Period of Record	No. of Values	Max.	Median	Min.
Oil and Grease (mg/L)	1621	-	1965-1977	31	28.4	10.1	2.8
	2069	-	1975-1977	5	2	1	<1
	3138	5	1974-1977	53	10.6	2.3	0.1
pH	41	6.5-8.5	1965-1977	100	8.2	7.4	6.6
	1621	6.5-8.5	1965-1977	45	9.2	6.7	4.8
	2069	-	1975-1977	7	7.3	6.6	5.9
	2645	-	1975-1977	6	6.8	6.7	6.3
	3138	-	1974-1977	53	8.1	7.2	5.9
Suspended Solids (mg/L)	41	*	1965-1977	71	660	47	11
	1621	13	1965-1977	43	20	4	1
	2069	-	1975-1977	7	9	2	1
	2645	-	1975-1977	19	5.6	2	<1
	3138	-	1974-1977	30	24	6	0.5
COD - (mg/L)	41	-	1965-1977	48	613	98	<10
BOD_5 - (mg/L)	41	-	1965-1973	42	130	40.5	12
	2069		1976	2	10	-	<5
Total Organic Carbon (mg/L)	41	*	1965-1977	7	13	7	2
	1621	25	1965-1977	37	40	16	6
Total Phosphorus (mg/L)	41	*	1965-1977	8	0.24	0.08	0.008
Ortho Phosphorus (mg/L)	41	-	1965-1977	68	26.1	12.1	5.9
Total Nitrogen (mg/L)	41	-	1965-1977	2	0.39	0.27	0.15
Ammonia - (mg/L)	41	*	1965-1977	72	<1	<1	<0.005
Phenol - (mg/L)	41	-	1965-1977	97	0.19	0.01	0.007
	3138	-	1974-1977	29	0.3	0.002	0.0
Flow - (m^3/d)	41	164 PW 66 082 CW	-	-	-	-	-
	1621	38	1974-1976	68	26.7	19	6.4
	2645	54.6	1975-1977	549	54.6	32.7	0

TABLE 36 (CONTINUED)

MONITORING DATA SUMMARY

MISCELLAENEOUS OPERATIONS

Parameter	Permit No.	Permitted Level	Period of Record	No. of Values	Max.	Median	Min.
Temperature - (°C)	41 1621 2645	32 32 32.2	1965-1977 1974-1976 1975-1977	98 2 88	30 36 43.3	20 33.5 26.7	7.2 31 5.6

CW - cooling water
PW - process water

* 10 Kg/d of suspended solids

32.7 Kg/d of T.O.C.

1.6 Kg/d of NH_3

1.6 Kg/d of total phosphorus

TABLE 37

SUMMARY OF MAIN
MISCELLANEOUS INDUSTRIES
LOADINGS AND FLOWS

Operation	Permit No.	River Reach	Flow m^3/d	Loading (kg/D)		Comments
				BOD_5	Suspended Solids	
Borden Co. of Canada	1549	North Arm	D	-	-	To Municipal Storm Sewer Phenolics: 7 mg/L - 25 mg/L
Liquid Carbonic	3555	North Arm	705*	-	-	
Fraser Wharves	1621	Main Arm	19	-	-	pH 4.8 - 6.8 Median - 6.7
Dow Chemical	41	Main Arm	66 082	-	3 100	Phenols Median 0.01, High 0.19
Western Peat Moss	4582	Main Arm	5 500*	-	20 725*	pH 3.5 - 5.0
Imperial Oil	4649	Main Arm	55*	-	-	

* See specific industrial write-up for source of estimate.
D = Discontinued.

<u>Notes:</u> Values are based upon median recorded levels unless otherwise noted.

TABLE 38

MONITORING DATA SUMMARY

COOLING WATER DISCHARGES

Permit No.	Flow (m^3/d)					Temperature (^{o}C)				
	Period of Record	No. of Values	Max.	Median	Min.	Period of Record	No. of Values	Max.	Median	Min.
36	1965-1978	4	225	215	207	1965-1978	4	25	25	18
161	-	-	-	-	-	1977	40	29	21	9
335	-	-	-	-	-	1977-1978	2	34	29	24
1549	1965-1977	78	3 810	1 811	560	1965-1977	709	43.3	26.7	7.8
1804	1977	1	188	-	-	1974	3	15	15	12.3
2063	1975-1978	200	287.3	91.2	0	1975-1978	202	32.2	22.2	6.7
2115-01	1978	63	13.8	6.5	6.5	1978	63	20	14.4	10
2115-02	1978	63	9 087	9 087	9 087	1978	63	23.7	22.8	19.4
2115-03	1978	63	157	157	157	1978	63	18.3	13.3	3.9
2155-01	1975-1976	13	15.5	13.2	10.9	1975-1976	14	26.7	24.7	13
2155-01	1975-1976	26	0.2	0.1	0.1	1975-1976	28	32	26.5	13
2350	-	-	-	-	-	1974-1975	4	24	19	5
2549	1974	12	109	62	14	1974-1977	54	23	11	1
2624	1974	1	107	-	-	1975-1976	17	25	20	13
2642	1975	19	163.7	130.9	65.5	1975-1977	21	22.8	19.4	14
3264	1975-1977	75	1 785	84.1	54.6	1975-1977	79	38.7	22.8	13.3
3265	1975-1977	52	61.4	0	0	1975-1977	53	25.6	23.3	5
3410	1977	12	280	153	98	1977	13	50	32.2	15
3735	-	-	-	-	-	1975	1	10	-	-

TABLE 39

SUMMARY OF MAIN COOLING WATER FLOWS

Operation	Permit No.	River Reach	Flow (m^3/d)
Domtar	3410	Main Stem	153
Weldwood	3434		130*
Valley Packers	4577		5*
Scott Paper	335	North Arm	910*
Puritan Canners	36		373*
Standard Brands	2063		91
Koppers Int.	1804		1 060
Can. Forest Prod.	2115		9 250
Weldwood of Canada	2155		13
Weldwood of Canada	2154		390*
Crown Zellerbach	3264		84
Rayonier Canada	4959		23*
Rayonier Canada	4960		45*
MacMillan Bloedel	4962		13*
Somerville Belkin	4963		73*
MacMillan Bloedel	4248		131D
MacMillan Bloedel	4249		4*
MacMillan Bloedel	1666		3*
Cumberland Devel.	52		84*
Inmont Canada	2181		26*
Alcan Canada	2509		450D
Borden Co.	1549		3 928*
Domtar	3735		940*
MacMillan Bloedel	5475		760
MacMillan Bloedel	108		23*
B.C. Packers	1830	Main Arm	455*
Crown Zellerbach	3265		91*
Titan Steel	161		3 637*
Fraser Surrey Docks	5024		3*
Genstar Ltd.	4513		18 200*

* Permit Level.

D = Discontinued.

TABLE 40

PROVINCIAL OBJECTIVES

INITIAL MONITORING FREQUENCY FOR MUNICIPAL TYPE EFFLUENT DISCHARGES[42]

Frequency of Sampling and Type of Sample										
	Discharge to Receiving Waters								Discharge to Ground	
Parameter Where Applicable	<455 m^3/d		≥455<4 550 m^3/d		>4 550≤22 750 m^3/d		≥22 750 m^3/d		All Flows	
	Frequency	Type	Frequency	Type	Frequency	Type	Frequency	Type	Frequency	Type
BOD_5	Q	C_1	W	C_1	T/W	C_2	D	C_3	Q	C_1
SS	W	C_1	W	C_1	T/W	C_2	D	C_3	T/W	C_1
Coliforms	Q	G	M	G	M	G	W	G	Q	G
Total Phosphorus	M	C_1	W	C_1	T/W	C_2	D	C_3	M	C_1
Other Selected Parameters From Table 31	A	C_1	S/A	C_1	Q	C_2	M	C_3	A	C_1
Toxicity (96 Hr. TL_m)	A	G	S/A	G	Q	G	M	G	A	G

Q = Quarterly
W = Weekly
M = Monthly
D = Daily
T/W = Twice Weekly
S/A = Semi-Annually
A = Annually

G = Grab Sample
C_1 = Sample composited from 4 grab samples over 2 hours at maximum flow
C_2 = Sample composited in proportion to flow over 8 hours in daytime
C_3 = Sample composited in proportion to flow over 24 hours

* Bracketed letters refer to explanatory notes.

TABLE 41

LOADING SUMMARIES (kg/d)
FOR ALL INDUSTRIAL SECTORS

Industrial Sector	Suspended Solids			BOD_5		
	Main Stem	North Arm	Main Arm	Main Stem	North Arm	Main Arm
Forest	5 263	23 700	-	7	4 972	-
Food	98	455	3 550	796	347	17 667
Metal	-	1 150	292	-	-	-
Cement	-	100	1 515	-	-	26
Domestic Sewage	4	6	9	6	3	10
Miscellaneous	67	-	23 831	24	-	-
	5 432	25 411	29 197	833	5 322	17 703
		Total	60 040		Total	23 858

Industrial Sector	Total Phosphorus			Total Nitrogen		
	Main Stem	North Arm	Main Arm	Main Stem	North Arm	Main Arm
Forest	2	2.5	-	15.8	38.2	-
Food	-	0.5	16.8	-	1.9	191.9
Metal	-	0.8	-	-	0.5	-
Cement	-	-	-	-	-	-
Domestic Sewage	0.6	0.1	0.2	4.4	0.1	1.8
Miscellaneous	-	-	5.3	-	-	17.8
	2.6	3.9	22.3	20.2	40.7	211.5
		Total	28.8		Total	272.4

Industrial Sector	Total Copper	Total Iron	Total Lead	Total Nickel	Total Zinc
Forest Metal	0.9 1.2*	15.7 105*	1.8 4.8*	0.3 -	53.2 89.5*
Total-North Arm	2.1	120.7	6.6	0.3	142.7
Metal-Main Arm	0.1	132.5	0.4	-	0.2
Total	2.2	253.2	7	0.3	142.9

* Dissolved