SUMMARY REPORT OF THE 1986

EFFLUENT MONITORING PROGRAM

SUPERVISORY COORDINATING COMMITTEE

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PREFACE

On April 1, 1986, a five-year agreement was concluded between the Fraser River Harbour Commission (FRHC) and the B.C. Ministry of Environment (MOE). The agreement related to carrying out water quality monitoring in the Fraser River Estuary area.

Monitoring during 1986/1987 was directed towards major operations identified as potentially impacting the Fraser River. As a result, 12 confidential reports of a technical nature were prepared. The technical reports are titled as follows:

Report No.	1	Titan Steel
	2	Noranda
	3	Tree Island
	4	Western Canada
	5	Annacis STP
	6	Lulu STP
	7	Belkin
	8	Scott Paper
	9	Lafarge Cement
	10	Chatterton Chemicals
	11	Iona STP
	12	Doman

Each of the technical reports contains conclusions and recommendations based on the technical investigation of the operation, including investigating the process and performing monitoring. The recommendations do not necessarily reflect the policy of the FRHC or the B.C. Ministry of Environment and Parks.

To bring this work together, the Supervisory Coordinating Committee has published this summary report. This document summarizes the technical reports, analyses their main findings and presents final recommendations. Some of the recommendations from the technical 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 will be available at the Water Management Branch (Victoria), Waste Management (Surrey), and Fraser River Harbour Commission offices.

ACKNOWLEDGEMENTS

The cooperation of personnel from all operations discussed in this report was greatly appreciated. Staff from Waste Management, Surrey were invaluable in providing background information on each operation visited. Of particular value was the coordination provided by Dr. D. Walton of the Supervisory Coordinating Committee with both Waste Management, Surrey and each operation.

The Fraser River and North Fraser Harbour Commissions provided use of water craft to sample upstream and downstream from discharges, as well as secretarial support for several drafts of this report and the background technical reports.

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1. INTRODUCTION

This report summarizes twelve background technical reports for operations investigated during 1986-87. The purpose of this monitoring program was to examine major discharges for contaminants of concern which may not have been previously identified as entering the estuary.

These industrial and municipal operations were identified previously by an interagency Committee in a 1984 report titled Fraser River Estuary Monitoring, A Recommended Approach, as having the greatest potential for discharging large quantities of contaminants of concern to the Fraser River Estuary. Additional operations were identified by staff of Waste Management, B.C. Ministry of Environment and Parks, Surrey. Locations of operations in the study area are shown on Figure 1.

During the 1986-87 fiscal year, the B.C. Ministry of Environment and Parks (MOEP), through the Fraser River Harbour Commission (FRHC), and with cooperation from Environmental Protection, conducted the first year of the monitoring program largely as outlined in the 1984 report. The program was conducted by contract using about 11 person months of an experienced professional engineer and 6 person months of a technician. Assistance was also provided by MOEP and FRHC personnel. Twelve sites were investigated with detailed assessments at 8 industrial sites and somewhat less detailed assessments at 3 sewage treatment plants and a wood treatment plant. General guidelines for this work are included in Appendices A to C.

Monitoring certain categories of effluent was carried out according to procedures established in the appendices to this report, for each industrial sector. Ambient samples were collected on outgoing tides.

The purpose of this summary report is to identify the location of major sources of some contaminants so that future ambient monitoring programs can take this knowledge into account.

2. TITAN STEEL AND WIRE CO. LTD.
(11041 Elevator Road , Surrey)

This summary is based on investigations and sampling carried out between June and October 1986.

Titan Steel is a metal finishing plant. High - and low - carbon steel rod is acid cleaned and drawn into wire of various gauges. The drawn wire is sold as such or further processed into nails, stranded wire, and galvanized or patented wire. The nails are sold as either bright or vinyl coated. From 70 types of rod, Titan Steel produces 7,000 finished products.

Titan Steel uses only city water (22,500 m^3/week) for their production needs. More than half is used for cooling purposes (wire drawing and stranders). The rest of the water is used in the rod cleaning operation, galvanizing and patenting processes.

The sulphuric acid used for rod cleaning is used in a closed loop system. The waste acid is continuously recovered (purified and concentrated). The by-product of the acid-recovery process is $FeSO_4.7H_2O$ which is sold as an ingredient in fertilizers, herbicides (moss killer), and other products.

The wastewater from the rod cleaning, wire galvanizing, and wire patenting processes is neutralized with NaOH in the effluent neutralization system. The neutralized wastewater is sent to a clarifier unit.

Titan Steel has three main waste streams:

1. Clarifier supernatant discharged to GVRD sewer.
2. Clarifier underflow discharged to the sludge lagoon.
3. Cooling water discharged to Gunderson Slough, via a ditch.

Stormwater is combined with the cooling water. Sanitary waste and boiler blowdown go to the GVRD sewer.

Recoverable solid waste, such as dross from Zn and Pb tanks is sold to a recycling company. The remainder of the solid waste is landfilled.

The Fraser River does not receive any direct discharge from Titan Steel. The only discharges to the environment are via the cooling water ditch and the sludge lagoon.

Groundwater contamination with B, Fe, Mn, and Zn by the sludge lagoons is a problem which was to be expected, as the lagoons are unlined. Since currently there is no viable alternative for the sludge disposal other than dispose of it on the plant property, control of the volume and pH of the clarifer underflow is a strict requirement of the wastewater treatment process.

The toxicity of the cooling water indicated that some contaminants were present at levels acutely toxic to fish. The slough water was not toxic and its composition was similar to that of the Fraser River. However, if the toxicity of the 14,700 m^3/week cooling water is not reduced, it could affect the slough water.

Weekly loadings to the slough calculated on the basis of the monitoring data are: 2.94 to 9.85 kg of Zn, 4.26 to 16.17 kg of Fe, 2.89 to 3.78 kg of P and up to 8.52 kg of B. Zn seems to be the source of toxicity of the cooling water. The cooling water chemistry showed a possible synergistic effect on toxicity created by low hardness of the city water and dissolved Zn levels of 0.17 to 0.51 ppm. Other potential sources of toxicity were identified in the drawing soaps and slimicides used for growth control in the cooling water system.

In early 1987, Titan Steel will undergo major modifications of their process (cleaning and galvanizing lines) and some changes to their actual waste treatment are expected. Titan Steel makes constant efforts to improve the quality and quantity of their waste streams. The company is presently evaluating the potential of using groundwater from a 200 foot depth as an alternative to city water for their cooling water needs. The high hardness of the groundwater may assist them in alleviating the cooling water toxicity problem.

3. NORANDA METAL INDUSTRIES LTD.
(920 Derwent Way, Annacis Island, North Delta)

This summary is based on investigations and sampling carried out between June and December, 1986.

Noranda Metal is a Cu and Cu alloy tubing manufacturer. Pure metals (Cu, Zn, Sn, and Ni), alloys and scrap metal from the mill and other off-site sources are charged in the furnaces where they are melted and cast into billets. The billets are extruded into shells and subjected to several drawing operations to reach the required dimensions. Pickling and annealing processes are part of the overall process. The plant is currently producing 7,000 tonnes of tubing per year and employs 175 people.

Noranda uses only city water for their production needs. For the past 5 years the average water consumption was 400,000 m^3/year, indicating an average weekly consumption of 8,300 m^3 (48 operating weeks/year).

The main consumption of water is for the cooling processes. There are six cooling towers in operation to economize water consumption by recirculating and cooling the water. It seems, however, that the cooling towers are underdesigned and in order to keep the cooling water at the required temperature, fresh water must be constantly supplied. This creates large volumes of overflow. A certain amount of water is lost to the atmosphere by evaporation.

The only discharge to the environment is the outfall to the river which contains all the wastewater and stormwater drained from the plant property. At present this discharge is not permitted. Its flow was estimated at 500-1000 m^3/d.

The wastewater originates from cooling towers overflows, overflow and dragouts from the quench tank, bright annealing and pickling tanks and cooling water from the process annealing.

No treatment of any kind is applied to any of the individual wastestreams prior to entering the discharge pipe. As a result, the outfall discharge contains all contaminants carried by each wastestream. Toxicity of the discharge was high with 96h LC_{50} values varying between 5.6 to 44.9%. Causes for toxicity were identified as low pH, Cu, Zn, and oil and grease content. Investigations and on-site monitoring indicated that, the main sources of low pH wastewater to the outfall were the pickling tanks waste and the process annealing wastewater; the main sources of oil and grease were the overflows coming from CT #2 and CT #5; and the main sources of metals (Zn, Cu and Fe) were the pickling tanks waste, overflow from CT #2 and roof runoff (19.5 mg/L Zn and 1.0 mg/L Cu was found in roof runoff from the furnaces'roof).

The emmissions from the foundry are exhausted to the atmosphere by two ceiling ventilators with no intermediate pollution abatement device. Fallout and metal vapours are therefore washed down by the rain or by water sprayed to cool the metal roof.

The river water quality was influenced by the oil and grease, and Cu input from the outfall. The downstream location was also influenced by a nearby discharge from Davis Wire.

At present, Noranda does not hold any water pollution permits. The plant was contacted by Waste Management with regard to a Waste Management permit application and has hired a consultant (B.C. Research) to help them improve the quality of the effluent.

Noranda's sanitary discharge is connected to the G.V.R.D. sewer system.

Recommendations for future monitoring include periodic sampling of the outfall, and upstream and downstream locations in order to evaluate the impact of the discharge on the river water quality and to determine any improvements on effluent characteristics. The Davis Wire (non-permitted) discharge should be also taken into consideration since its location is within the initial dilution zone of Noranda's outfall discharge.

4. TREE ISLAND STEEL CO. LTD.
(3933 Boundary Rd., Richmond)

Tree Island Steel is located on the northeast corner of Lulu Island bordering the Fraser River's north arm. Total production is 7,500 tons/month with the major product being nails and lesser amounts of mesh, rebar, coathangers, and various types of wire.

The raw material is imported steel rod. After HCl pickling to remove rust and scale, the rod is drawn through dies to reduce its diameter. This wire may then be sold as drawn wire, however, most is fabricated into nails, fencing wire, coat hangers, weld mesh, woven mesh, rebar, or springs. Product finishes include galvanizing (hot or electroplating), phosphating, or vinyling.

Spent hydrochloric acid from the rod cleaning line is stored on site prior to use at Brenda Mines and a number of sewage treatment plants for treatment of their effluents. Excepting the acid tanks, the cleaning line's tanks and tank washing from all of the tanks drain to an underlying pit and thence to an effluent treatment system. Similar pits underly the hot galvanizing, electrogalvanizing, and phosphatizing lines. Effluents from these pits are collected and then discharged to the treatment system. In this system caustic soda raises the effluent pH to 9.5 - 10 and insoluble metal hydroxides formed (largely Zn and Fe) precipitate. The effluent is agitated to maintain the suspension, then pumped to a system of four lagoons connected roughly in series. This discharge is one of two discharges authorized under Permit (PE 3190) by Waste Management, Provincial Ministry of Environment and Parks.

The second permitted discharge is at the north outfall from which cooling water and stormwater enter the Fraser River.

The lagoon discharge, monitored on two occasions, has high total zinc (203,214 mg/L), low dissolved zinc (0.31, 0.59 mg/L), and high but variable nitrogen levels (NH_3 - 23, 29 mg/L; NO_2 - 117, 5 mg/L; NO_3 - 20, 1 mg/L). As the lagoons are constructed of sand, the discharge infiltrates to the groundwater. In this situation the theory is that by maintaining a high pH, the metals will be retained as insoluble precipitated hydroxides. pH of the perimeter groundwater, however, is considerably lower (5.6 to 9.1) than the pH of the discharged effluent. The lowest pH (5.6) was noted in the well adjacent to the first lagoon. Correspondingly high levels of dissolved zinc (5.2, 3.0, 0.8 mg/L) were noted in the groundwater from this well. This may signal an escape of hence generally elevated metal levels in the neighbouring Blind Channel. A direct impact is not clear, however, as fish bioassays conducted using river water collected from the area overlying the Blind Channels sediments near Well #1 did not indicate any toxic effects.

The north outfall discharging directly to the Fraser River was monitored on four occasions. This discharge occasionally exhibited slightly toxic effects to rainbow trout probably a result of dissolved metal concentrations primarily zinc.

The Company has an ongoing program to improve the quality of the north outfall discharge. The groundwater around the lagoons though should be further studied to determine why the pH in the groundwater and possibly the first lagoon appears to be decreasing resulting in the mobilization of the precipitated metal hydroxides.

5. WESTERN CANADA STEEL LTD.
(Mitchell Island, Richmond)

This summary is based on investigations and sampling carried out between July and November, 1986.

Western Canada Steel's Mitchell Island operation has a steel foundry and a rolling mill which produce steel construction products from scrap metal.

In addition to the materials used directly in the steel making process (i.e. scrap metal, lime rock, alloys, carbon), a large quantity of refractory materials are consumed during the melting and casting processes (150 tonnes/month).

Western Canada Steel uses only city water to meet their production needs. Water consumption is highly dependent on the production level and outside temperature since the water is mainly used for cooling. City water consumption fluctuates between 4,250 and 14,000 m^3/week.

There are 4 cooling systems in the melt and cast shops and 3 cooling systems in the rolling mill. The melt and cast shops use about 35% of the city water. Most of the remainder is used in the rolling mill's reheat furnace cooling system.

Cooling water is recirculated within the various cooling systems. Two of the cooling systems (primary cooling water system in the cast shop and cooling water system in the rolling mill) are provided with settling tanks which assist in removing the solids and oil and grease from the water. The cooling water pond, which is part of the recirculation system for the rolling mill, is characterized as a recirculation/sedimentation/exfiltration pond. Average water circulation through the pond is 20,700 m^3/d. It's estimated that more than 1,000 kg/d of Fe (as mill scale) settle each day at the bottom of the pond, while 13 kg/d of Fe reach the river by exfiltration and 6 kg/d of Fe enter the river via the pond overflow.

The wastewater generated by Western Canada Steel consists of overflows from the cooling water systems and stormwater (leachate and surface runoff).

Western Canada Steel has four wastewater streams:

1. Overflow from the cooling systems in the cast and melt shops which drain to a closed pond on the island.

2. Overflow from the cooling water pond and miscellaneous drainage which discharge to a drainage ditch and enter the north branch of the North Arm of the Fraser River via the north flood gate.

3. Miscellaneous drainage from the south part of the property which enters the south branch of the North Arm of the Fraser River via the south flood gate.

4. Leachate and surface runoff from the landfill area which enters the North Arm of the Fraser River as a non-point discharge.

Domestic waste is treated in a package treatment plant and the effluent is discharged to the river via a submerged outfall.

Western Canada Steel has a Waste Management permit authorizing a landfill operation. The slag (in excess of 400 tonnes/month) and the scrapped refractories are landfilled on the property. Domestic refuse and sludges from the settling tanks are trucked away. Most of the mill scale is either recycled to the melt shop or sold to a cement plant.

The monitoring data indicated that the main source of contamination to the environment was the landfill area under wet conditions. In order to estimate the environmental loadings more sampling under wet weather conditions is recommended.

Levels of dissolved Zn (0.24 mg/L) and Pb (0.5 mg/L) in the south drain indicated that the south outfall may occasionally be toxic.

The north outfall discharge was not toxic. It contained moderate levels of Fe, Mn, Al, Zn and oil and grease. The oil and grease levels (3 to 14 mg/L) did not influence the river water quality outside the dilution zone. However, a consistent increase of Fe and Al concentrations was noted between upstream and downstream locations. Main contributors to this increase seemed to be leachate and surface runoff from the landfill area. Some iron was contributed by the north outfall, exfiltration from the cooling water pond and miscellaneous drainage.

The cooling water pond overflow is not a permitted discharge and is a major contributor to the north outfall (estimated at 1,700 m^3/week). The cooling water overflow may contain contaminants such as alkaline detergents (from on-line cleaning of the equipment) and ethylene glycol (from broken lines in the hydraulic systems.)

Recommendations for future monitoring include sampling from the south outfall and sampling both the river water and sediment from several sites on the south branch of the North Arm and downstream from the west end of Mitchell Island.

6. ANNACIS ISLAND SEWAGE TREATMENT PLANT
(Operated by the Greater Vancouver Sewerage and Drainage District)

This summary is based on investigations and sampling carried out between June and November, 1986.

The Annacis Island STP provides primary treatment of sewage from eleven municipalities in the Lower Mainland, with an estimated combined population of 486,000. Storm and sanitary sewer lines from New Westminster and parts of Burnaby are combined; all other lines are separate.

The treatment involves prechlorination, mechanical screening, preaeration, grit removal, sedimentation, scum removal, sludge thickening, digestion, drying and storage, and effluent post-chlorination and dechlorination from May through September.

The plant design assumes a 60% reduction in suspended solids and a 35% reduction in BOD_5. The Waste Management permit (PE 387) requires that the Annacis effluent contain less than 100 mg/L suspended solids and 130 mg/L BOD.

The effluent is discharged into the Main Arm of the Fraser River through an outfall with 18 diffuser pipes at least three metres below the extreme low water level.

The digested sludge is discharged to lagoons on the plant property for storage and drying.

The technical investigation of the process was limited to a general description of the plant operation and the regular monitoring programs conducted by the Greater Vancouver Regional District and Ministry of Environment and Parks.

The sampling program was restricted to three effluent samples and one digested sludge sample. The effluent samples were flow proportional, weekly composites. The sludge sample was a five-day composite.

Seventeen target compounds or groups of compounds were quantified. One effluent sample and the sludge sample were subjected to confirmatory GC-MS analysis and to full scanning peak identification. Confirmatory work was in full agreement with the quantitative analysis with one exception (presence of tetrachlorophenols in sludge was not confirmed). Sixty-nine additional peaks were identified in the effluent and 71 in the sludge.

The data were used to calculate daily environmental loadings. The average effluent flow was 300,000 m^3/d and led to environmental loadings ranging from 73 g/d for dichlorobenzene to 9,074 g/d for nonylphenol. Nonyphenol levels in effluent were one to two orders of magnitude higher than the other compounds.

The average sludge discharge was 847 m^3/d and led to environmental loadings ranging from 24 to 402 g/d. The highest level in the sludge was found for diethylhexylphthalate. The heavier organic molecules were predominant in the sludge composition.

The concentrations of organics in the sludge solids were three orders of magnitude higher than in the effluent, but the environmental loadings from the sludge were smaller due to the considerably smaller discharge of sludge than effluent.

PCBs, DDE, pentachlorophenol and hexachlorobenzene were not found in either the effluent samples or the sludge sample.

The levels of the target compounds in the effluent did not appear to be influenced by the chlorination/dechlorination of the sewage.

Future monitoring of an extended list of organics was recommended. Sampling should include the effluent, sludge, biota and sediments.

7. LULU ISLAND SEWAGE TREATMENT PLANT

(Operated by the Greater Vancouver Sewerage and Drainage District)

This summary is based on investigations and sampling carried out between June and November, 1986.

The Lulu Island STP provides primary treatment of sewage from the Municipality of Richmond (1985 population 102,000).

Richmond has separate storm and sanitary sewers. The treatment process includes prechlorination, screening, preaeration, grit dewatering and removal, sedimentation, scum removal, sludge removal, sludge thickening, centrifugation and incineration, post-chlorination and dechlorination (May through September).

The effluent is discharged into the Main Arm of the Fraser River via an outfall pipe with diffusers at least two m below the extreme low water level. The ash from the sludge incineration is removed to a landfill south of the plant area fence.

The design data assume a 60% reduction in suspended solids and 35% reduction in BOD_5. The Waste Management permit (PE 233) requires that the Lulu Island STP effluent contain less than 128 mg/L suspended solids and 169 mg/L BOD.

The technical investigation of the process was limited to a general description of the plant operation and the routine monitoring programs conducted by the GVRD and Ministry of Environment and Parks.

The sampling program was restricted to six effluent samples. The samples were flow proportional, weekly composites. Sludge was not sampled because it is currently incinerated.

Seventeen target compounds or groups of compounds were quantified. Two effluent samples were subjected to confirmatory GC-MS analysis and to full scanning peak identification. Confirmatory work proved the quantitative work satisfactory.

Sixty-one additional peaks were identified in one of the samples.

The data were used to calculate daily environmental loadings. The average effluent flow was about 42,000 m^3/d and led to environmental loading from < 1g/d for DDE to 670 g/d for nonylphenol. Nonylphenol loadings were one to two orders of magnitude higher than the other target compounds.

The levels of the target compounds did not seem to be influenced by the chlorination/dechlorination of the sewage.

Phthalates were found in all the six samples. Their environmental loadings were higher than the PAHs' loadings.

With only one exception, all the other target compounds were at equal or lower levels than in the Annacis STP effluent. The exception was dichlorobenzene which was detected in 4 of the 6 samples, at levels as high as 2.34 ug/L.

PCBs, trimethylphenanthrenes, hexachlorobenzene and pentachlorophenol were not detected.

Further monitoring is recommended to evaluate the variation and composition of the organic load to the environment. Sampling should include effluent, biota and sediments from the outfall area.

8. IONA ISLAND SEWAGE TREATMENT PLANT
(Operated by the Greater Vancouver Sewerage and Drainage District)

This summary is based on investigations and sampling carried out in October, 1986.

The Iona Island STP provides primary treatment of sewage from the City of Vancouver, the University of British Columbia, Vancouver International Airport and part of Burnaby. Storm and sanitary sewers are combined, however some are currently being separated.

The treatment process includes prechlorination, screening, grit removal, preaeration, sedimentation, scum removal, sludge thickening, digestion, drying and storage, and effluent chlorination (from May through September). There is no effluent dechlorination, as the chlorine residual is desirable through the summer when public beaches are in use.

The current outfall discharges effluent through an open channel to the Strait of Georgia. A deep sea outfall, which will discharge effluent 2000 m into the Strait and 100 m below the water surface, is under construction and is expected to be completed in December, 1987. The sludge is discharged to a lagoon on plant property for storage and drying.

The plant design assumes a 60% reduction in suspended solids and a 35% reduction in BOD_5. The Waste Management permit (PE-23) requires that the Iona effluent contain less than 130 mg/L of BOD_5 and 100 mg/L of suspended solids.

The technical investigation of the process was limited to a general description of the plant operation and the monitoring programs conducted by the Greater Vancouver Regional District and Ministry of Environment and Parks. The sampling program was restricted to one sludge sample. The effluent was not sampled since the GVRD itself was monitoring the effluent for the same parameters as those being tested at other sewage treatment plants by this program.

Seventeen target compounds or groups of compounds were quantified in the sludge. The results were subjected to confirmatory GC-MS analysis using the Single Ion Monitoring mode. Confirmatory work was in full agreement to the quantitative analysis, except for tetrachlorophenols. GC/MS full scanning was used for other peaks' identification and 75 additional peaks were identified in the sludge.

The data were used to calculate the environmental loadings. The 544 m^3 of digested sludge discharged to the lagoon led to total contaminant inputs to the environment ranging from 19 to 3210 g/d.

Phenanthrenes were found at the highest concentrations in the Iona sludge. Dimethylphenanthrenes at 260 ug/g, dry weight, were the most abundant of the target compounds. Most of the other quantified compounds were present at about 20 ug/g (dry weight), with the exception of naphthalene and tetrachlorophenols which were present at lower concentrations.

All of the target compounds were found at higher concentrations in the Iona STP sludge than in the sludge from Annacis STP. The greatest increases were noticed for methylated naphthalenes and methylated phenanthrenes which were one order of magnitude higher.

No PCBs, DDE, pentachlorophenol, hexachlorobenzene or trimethylnaphthalene were detected in the Iona sludge. The same compounds were absent from the Annacis sludge.

The sludge composition from the two sewage plants was similar qualitatively but very different quantitatively. The quantitative differences could be explained by differences in the influent characteristics and by different operational parameters at the two plants.

9. BELKIN PAPERBOARD
(A Division of Belkin Packaging Ltd., 8255 Wiggins, Burnaby)

This summary is based on investigations and sampling carried out between December 1986 and February 1987.

Belkin Paperboard is located on the north shore of the North Arm of the Fraser River, downstream of Queensborough Bridge and upstream of Mitchell Island.

The plant produces paperboard from a variety of waste paper and wood materials. The main raw materials are: old corrugated cardboard containers, old newspapers, mixed paper waste, and boxboard cuttings. Numerous other waste materials are used in smaller quantities (wood shavings, groundwood pulp, bleached and unbleached Kraft pulp, computer printouts, etc.).

There are three paper machines at Belkin which produce roofing felt, uncoated and coated boxboards, gypsum wallboards, core stock, liner and medium for corrugated box manufacturers, etc.

The paper machines are interconnected in terms of stock preparation and feed, whitewater collection and recycle, and wastewater collection, treatment and discharge.

The process of making paper is highly water consumptive. It is estimated that Belkin uses about 30 m^3 of water per one tonne of paper product. The plant uses river water, recycled whitewater, and city water to satisfy their production requirements.

River water is pumped from the Fraser River at about 12,000 m^3/d and treated before it is used in the process. The treatment consists of chemical additions of alum, Na aluminate (Han Floc) and chlorine. Some of this water is lost by evaporation and some is contained in the paper products, but the largest amount is discharged as effluent to the river.

City water is used in much smaller quantities as make-up water for the boilers, chemical solutions, and in the lunch and washroom facilities.

A great deal of water is recirculated within the process or from the effluent treatment unit back to the process. The water circulation rate within the mill is about 60,000 m^3/d and about 30,000 m^3/d is passed through the effluent treatment unit (clarifier).

Treatment of the effluent consists of removal of the bulk of the fibre and other materials by screening and clarification processes. The screened material and the skimmings from the clarifier surface are landfilled. The bottom clarifier sludge is returned to the process. The effluent from the clarifier is either discharged directly to the river (about 12,000 m^3/d) or recycled to the process via an Albany strainer.

Waste streams from Belkin are of two types: liquid and solid. The major liquid waste stream is the treated mill effluent which is discharged to the river via a 3'diameter submerged outfall. The mill effluent contains besides the process effluent, boiler blowdown, cooling water from the steam plant, roof and yard drainages. Sanitary discharge from a sewage package treatment plant which treats the plant's domestic waste joins the treated effluent line before discharging to the river. Another liquid waste stream consists of surface runoff collected in the landfill perimeter ditch and is discharged to the river via an open ditch and a concrete culvert. There are four other pipes discharging to the river which contain yard drainage or return water from the river water treatment plant.

The solid waste is landfilled on the property site and consists of rejects from the stock preparation process, paper making process and skimming from the effluent treatment facility.

It is expected that residuals from all the chemicals used in the process or contained in the raw material could be found at various levels in the mill effluent or landfilled material.

The mill wastewater is treated (screening and clarification processes) prior to being discharged to the river. The treated mill effluent was found to be toxic, with 96h LC50 values from 70 to 75%. The cause of toxicity was not determined.

pH and BOD levels in the effluent were variable in time, with values from 5.1 to 8 and 252 to 461 mg/L, respectively. COD levels were much higher than BOD levels, ranging from 660 to 1620 mg/L.

GC/MS analyses identified the presence of various phthalates in the mill effluent and in the landfill leachate. Estimated environmental loadings were as high as 765 g/d (diethylphthalate in the effluent).

Chlorophenols (mono, di, tri, tetra and penta) were found in the mill effluent. Penta and tetrachlorophenol appeared to be persistent at levels of 0.6 to 1.7 ppb and 0.3 to 0.5 ppb, respectively. Polychlorinated biphenyls were not detected.

Al and Zn found in the mill effluent contributed to an estimated daily metal loading to the river of 26.9 to 42.6 kg of Al and 1.71 to 3.19 kg of Zn. Fe was the major metal contaminant in the landfill leachate. The input of metals did not affect the river water quality outside the dilution zone.

Recommendations for further monitoring include determining the cause for toxicity of the effluent; residual chlorine tests at time of sampling of the effluent; GC/MS analyses to further evaluate the environmental input of phthalates and chlorophenols; continued monitoring of Al, Zn and coliforms to further assess their impact on the river water quality.

10. SCOTT PAPER LTD.
(New Westminster)

This summary is based on investigations and sampling carried out between September 1986 and February 1987.

Scott's paper mill in New Westminster is the only tissue mill in British Columbia. The main finished products are bathroom and commercial tissue and towels.

Scott's process can be divided in three basic operations: pulping, paper making and converting. About 30% of the required pulp is produced at Scott (groundwood pulp) and about 70% is purchased (mainly Kraft pulp). The plant does not use secondary fibres.

Scott's process of making paper require a large volume of water (about 50 m^3 per each tonne of paper produced).

The water requirements are met by using clarified Fraser River water, purchased city water, and recycled process water.

Fraser River water is pumped from the river at 18,000 m^3/d and treated (chemical flocculation, clarification, filtration, and disinfection) before use in the process. Ten percent of it is used in the pulping process, 80% in the paper making process, and 10% is returned to the river from the treatment unit.

About 400,000 m^3/d of whitewater is recirculated in the process of paper making.

City water consumption varies seasonally. The peak consumption is during winter (2,500 m^3/d) and the lowest consumption is during the summer (750 m^3/d). City water is used to supplement the filtered river water, as boiler make-up water, and as cooling or sealing water in the groundwood pulping operation.

Wastewater from the paper making process is treated to recover fibres. There are two separate fibre reclaim systems, each consisting of collection sumps, screens, filtrate and fibre tanks, and flotation cells. One system serves paper machine #4 and one system serves paper machines # 1, 2, and 3. A sludge dewatering press serves both fibre reclaim systems.

Scott has two permitted discharges to the river: one from the paper mill and one from the groundwood mill.

The paper mill discharge is composed of many waste streams which are collected in a large effluent basin (partitioned from the wharf lagoon) and it enters the river via a submerged outfall. Paper mill discharge components are: combined paper machines' effluent and filter plant discharges. The combined paper machines' effluent is, at its turn, composed of clarified effluents and overflows pumped from the wharf lagoon (they discharge to the effluent sump via the effluent weir). The filter plant discharges are the filter backwash water and the clarifier bottom return (they discharge to the effluent sump via the filter plant pipe).

The groundwood mill discharge to the river consists of fibre-free city water used in the pressure and vacuum systems. It is collected in a sump and discharges through an outfall.

The main sanitary sump is located at the groundwood mill and it receives excess whitewater from the groundwood pulping process and sanitary discharges from the paper and groundwood mills. Its contents are pumped to the main GVRD sewer trunk on Stewardson Way.

Solid waste generated from the pulping process, paper making process and fibre reclaim systems (dewatered sludge) are landfilled. Off-grade paper is routinely reprocessed. Fibres recovered from the air emissions by the scrubbing units are landfilled.

The investigation concluded that the major source of contaminants to the environment is the paper mill effluent.

Environmental loadings were estimated for COD, BOD, SS, Al, Fe and chlorophenols. As the paper mill effluent is a multicomponent waste stream, contaminants were contributed in various proportions by the individual components.

BOD and COD were contributed to the overall effluent mainly by the paper machines' effluent. COD loadings were about 5 times higher than BOD loadings.

Suspended solids were contributed to the overall effluent by the combined paper machines' effluent (mostly non - or slow - biodegradable suspended organic matter) and by the filter plant discharges (mostly suspended inorganic matter).

The filter plant discharges had a major contribution to the Al and Fe environmental loadings from Scott's discharge, which were estimated at 73.52 kg Al/d and 29.05 kg Fe/d.

Chlorophenols were found at part per trillion levels.

Occasional toxicity was exhibited by various components of the overall paper mill effluent, which was, however, never found toxic. The analytical data did not point out the exact cause for individual component's toxicity.

Recommendations proposed include the monitoring of COD, Al and Fe impact on the river water and sediment quality. Further investigation of the causes for occasional toxicity of the combined paper machines' effluent was also recommended.

11. DOMAN FOREST PRODUCTS LTD.
(New Westminster Mill)

This summary is based on investigations in November 1986 and January 1987.

Doman Forest Products Limited operates a sawmill on the north shore of the Fraser River in New Westminster. The mill was monitored to determine concentrations of chlorophenols released to the environment during rainfall events.

After passing through the planer mill, lumber is treated with a chlorophenol-containing wood preservative using a spray box system. The brand of wood preservative used was Chapco C-1 concentrate. Following treatment, lumber passes through the sorting chain and is stored in loose form, then is strapped and end-sealed and stored on a paved lot for various periods of time (to a maximum of three months).

Composite samples for chlorophenol analyses were collected from a storm drain adjacent to the planer mill, from the outfall draining the storage yard and discharging to the Fraser River, and from beneath lumber stacks in the yard. Monitoring was conducted over three rainfall events. Field measurements of flow, specific conductivity, dissolved oxygen, pH and temperature were taken during each event. In addition, samples for other water quality characteristics were collected at the planer mill storm drain site on one occasion.

The highest levels of chlorophenols on the site were found adjacent to the planer mill. This was also the source of the greatest loading of chlorophenols to the environment. Pentachlorophenol (PCP) levels ranged from a low of 4,420 ppb to 12,200 ppb in half-hour composites and were even higher in composite samples of longer duration (up to 107,000 ppb). Tetrachlorophenol levels ranged from a low of 146 ppb to 485 ppb in half hour composites. Trichlorophenol levels ranged from 11.8 ppb to 95.0 ppb. Chlorophenol levels were found to be higher during rainfall events of longer duration.

PCP levels measured in stormwater at the planer mill increased from the beginning to the end of the storm, whereas at the outfall PCP and other chlorophenols were released within one hour after rain began to fall, likely a residue from past storms. The average PCP concentration at the outfall was 160 ppb.

Chlorophenols leaching through lumber stacks in the yard were recorded at levels of approximately one-third of the levels in samples taken at the planer mill. This indicates that leaching or runoff of chlorophenols from freshly treated lumber poses a greater threat to the environment than does leaching from stored lumber.

PCP levels at the planer mill, the storage yard and the outfall were significantly above acutely toxic levels for biota. As chlorophenols are resistant to degradation and accumulate in the environment, monitoring of the Fraser River water, sediment and biota is recommended.

12. CANADA CEMENT LAFARGE LTD.
(#9 Road, Richmond)

This summary is based on investigations and sampling carried out between October 1986 and January 1987.

Lafarge Cement Richmond plant is one of the numerous manufacturing plants Canada Cement Lafarge has in Canada. It is located on the north shore of the Main Arm of the Fraser River, just downstream from Annacis Island. The Richmond plant produces portland cement of various types and has a maximum annual production capacity of 545,000 tonnes. In the past several years it has been operating at 55% capacity due to depressed cement markets.

The main ingredients in portland cement are lime, silica, alumina and iron. A variety of raw materials containing these ingredients are used at Lafarge which relies on the "wet process" to manufacture cement. Raw materials are ground with water and fed to the kiln in a slurry. Fuel for the kiln may be coal, coke, coal tailings, or natural or landfill gas. Coal and coke are also fed to the kiln as a slurry. At the kiln temperature the water is evaporated and the raw materials reach a point of incipient fusion forming the clinker which is further ground to make cement.

Lafarge uses Fraser River and city water to meet their production requirements.

Fraser River water is pumped from the river at about 4,900 m^3/d (147,000 m^3/month) and used without any prior treatment as process water, cooling water or wash water for truck washing. More water is used for cooling than for process purposes. There is little recirculation of the cooling water.

City water is used to a smaller extent (9,200 m^3/month in 1985). Its main use is as back-up cooling water, in a few cooling systems, washrooms, cafeteria, laboratory, air conditioning and fire protection systems.

There are three wastewater streams resulting from Lafarge operation: two discharge to the Main Arm of the Fraser River and one discharges to Nelson Road ditch. The river discharges are mainly process and cooling water, laboratory wastewater and surface runoff. They enter the river via two separate outfalls, which are exposed at low tide. The Nelson Road ditch discharge is intermittent and of low volume. It is made of waste wash water from the truck washing facility.

The process water used for making raw material and coal slurries is evaporated in the process of making clinker and it leaves the kiln together with combustion gases.

There is virtually no rejected cement since the quality checks at the grinding and kilning stages allow for corrections in the formulations before the final cement grinding.

Rejected raw materials and any other solid waste are landfilled. Washroom facilities discharge to sanitary holding tanks that are pumped out by septic tank trucks and contents taken to a disposal site.

The monitoring data showed that the Lafarge effluents, discharged to the river, were not toxic and exhibited characteristics similar to the river water with two exceptions: turbidity and oil and grease content.

Turbidity increases above the river background were not drastic and did not seem to influence the river water quality.

Oil and grease content, however, did have a definite impact on the water quality nearby Lafarge: 5 mg/L of oil and grease was found outside the 100 m initial dilution zone at both downstream and upstream locations. A marina located upstream from Lafarge and the river traffic may have contributed to the oil and grease level in the river in that area.

Metals present in Lafarge effluents and Fraser River water were largely associated with particulate matter.

Surface runoff from the raw material storage area did not exhibit higher metal levels than the other water samples. Dissolved Al was found at a higher ratio to total Al than in river water or effluent samples taken under dry conditions (0.22 mg/L dissolved Al in surface runoff as compared to 0.03 - 0.07 mg/L dissolved Al in other samples for total Al concentrations of 0.50 - 0.70 mg/L). Surface runoff pH was 11 but it did not influence the river water pH which was at the same level (7.6) as the dry weather river pH.

Recommendations for further monitoring include sampling of the surface runoff from the raw material storage area, to confirm its low contaminant input to the environment.

Oil and grease contributions to the river from Lafarge effluents are believed to be an ongoing, localized pollution problem.

13. CHATTERTON PETROCHEMICAL CORP.
(7900 River Road, Ladner)

This summary is based on investigations and sampling carried out between August 1986 and January, 1987.

Chatterton Petrochemical Corporation is a newly formed company (1984) which purchased an old Dow Chemical plant and property on the south shore of the Main Arm of the Fraser River.

The plant currently produces: benzoic acid, phenol, benzaldehyde, sodium and potassium benzoate, benzene, and meta-toluic acid. A series of other products is under consideration for future production. Chatterton's production requires a variety of utilities: compressed air, steam, hot oil, cooling water, and electric power.

Chatterton uses Fraser River water and city water to meet their water requirements. The volume of river or city water used is directly dependent on the production volume.

River water is pumped from the river at a rate of 18-26 m^3/min and is used, untreated, as cooling water. After use it is returned, uncontaminated, to the river, with the exception of 1 m^3/min which is diverted to a worm farm (experiment which will end in spring 1987), from where it eventually enters Tilbury Slough. River water is also used in the fire suppression system.

City water is mainly (75%) used for steam production. During the past year, city water consumption fluctuated from 23,000 m^3 to 31,000 m^3 per 3 months. City water used in the chemical processes is recycled, evaporated or discarded as contaminated process water to the process sewer. The process sewer collects all waste process water, stormwater and housekeeping water, boiler blowdown, cooling water bleed, spills and overflows. From the main process sump the wastewater is pumped to the equalization lagoon, which acts as a feed and surge tank for the biox plant where the wastewater is treated. The equalization lagoon also receives acetic acid waste and overflow from a septic tank.

There are two waste streams resulting from the biological treatment of the wastewater: clarifier supernatant going to the river at a rate of about 180 L/min and clarifier underflow going to the sludge lagoon at 10 L/min. The clarifier supernatant is the major discharge. It combines with the cooling water return line in a 30" pipe and submerged outfall.

The clarifier supernatant and cooling water return are combined at a ratio of 1:100.

Other minor effluents are the clarifier underflow going to the sludge lagoon and the cooling water diversion to the worm farm.

The solid waste is composed of process wastes and rejected products. The process wastes such as raffinate and reactor mass are burned in boilers, and fly ash from the baghouse is drummed and stored on the property. The rejected products are either reprocessed or disposed of in the biox system.

The monitoring data showed that the combined effluent discharged to the Fraser River was non toxic at all times: 0% fish mortality in 96h.

One of its components, the clarifier supernatant, was acutely toxic to fish but its toxicity was annihilated by the dilution achieved by the cooling water return, the other component.

The GC/MS analysis of the equalization lagoon (untreated wastewater) and clarifier supernatant (treated wastewater) showed the high efficiency of the biological treatment in removal of the organics. During phenol production, acetic acid was reduced from 1900 ppm to < 1 ppm, benzoic acid from 12,000 ppm to < 0.05 ppm, phenol from 160 ppm to < 0.0015 ppm.

During meta-toluic acid production, the biological treatment efficiency was somewhat lower (acetic acid was still present in the clarifier supernatant at 38 ppm). Copper and cobalt (components of catalysts used in the chemical processes) were also detected at higher levels in the clarifier supernatant during the meta-toluic acid production. High Co concentration (10.8 mg/L in the clarifier supernatant and 16.1 mg/L in the equalization lagoon) had visible effects on the colour of the wastewater which was deep red. Environmental loading for Co was 2.18 kg/day for that sampling period.

Hypothetical environmental loadings were calculated for the event of absolute failure of the biological treatment. If the untreated wastewater is discharged to the river under these conditions, as much as 34.67 kg/d of benzoic acid, 470 kg/d of acetic acid, and 39.6 kg/d of phenol could reach the river. Such loadings are unlikely to result in contaminant concentrations which are acutely toxic to aquatic life beyond the initial dilution zone in the river.

Any upset conditions of the biox system historically have been corrected without discharging untreated wastewater to the river. These discharges are prevented by the monitoring system combined with ample storage.

Recommendations proposed include that monitoring of the biological treatment efficiency should be carried out under changed production parameters (new raw materials, new products and new by-products) and that the impact of the equalization and sludge lagoons on soil, air, biota and vegetation should be assessed. Monitoring of the old Dow dump sites and of the groundwater should be continued.

14. CONCLUSIONS

The four metal finishing operations had on occasion, effluents which exhibited acute toxicity. The most significant toxicity was associated with the discharge from Noranda Metals which provided no wastewater treatment. However, this should improve once the company treats its effluent discharge and this is authorized by a Waste Management permit. Toxicity at Noranda Metals was associated with low pH and elevated copper, zinc, and oil and grease concentrations. The occasional slight toxicity at Titan Steel was speculated to be attributable to the drawing soaps and slimicides used. At Tree Island Steel, the acute toxicity was speculated to be attributable to dissolved zinc while the cause at Western Canada Steel could not be identified.

Impacts downstream from the metal finishing operations could only be quantified at Noranda Metals and Western Canada Steel. At distances of 100 metres downstream from the discharges, increases in copper and oil and grease concentrations could be measured at Noranda Metals. At Western Canada Steel, measured increases were found for iron and aluminum.

Organic compounds were measured in the effluents from the Annacis and Lulu Island Sewage Treatment Plants (STP) and in the sludge from the Annacis and Iona Island STP's. Nonylphenol was at concentrations of one to two orders of magnitude higher than any other organic compound in both the Lulu and Annacis effluents. Levels of most organic compounds were generally lower at Lulu than at Annacis. Organic compounds which could not be detected included PCB's, PCP, and hexachlorobenzene in both effluents and DDE in the Annacis effluent (just above detection at Lulu STP). Trimethylphenanthrenes were not detected in the effluent from the Lulu STP.

All target compounds were higher in the sludge from the Iona STP than from the Annacis STP. In the sludge from both sewage treatment plants, PCB's, PCP, DDE and hexachlorobenzene could not be detected.

Effluents from Belkin Packaging were found to be acutely toxic while those from Scott Paper were occasionally toxic. The causes of the toxicity was not determined. The effluent from Belkin Packaging had a high oxygen demand and contained quantities of mono-, di-, tri-, tetra-, and penta-chlorophenols.

At Doman, tri-, tetra-, and penta-chlorophenols were measured. Chlorophenol concentrations were found at higher levels in storms of longer duration. As well, leaching from freshly treated lumber was a greater threat than from stored lumber. The average concentration of chlorophenols at the outfall was 0.16 mg/L.

The effluents from LaFarge Cement and Chatterton Chemicals were found to be non-acutely toxic. No impacts on the river were noted at Chatterton, however, oil and grease concentrations at LaFarge increased by 5 mg/L, 100 m downstream.

Since many processes and chemicals used change at industrial sites with time, it is recommended that a similar audit program be undertaken in about 1991 to determine if effluent quality from these discharges has changed.

Other recommendations from the 1986 program are:

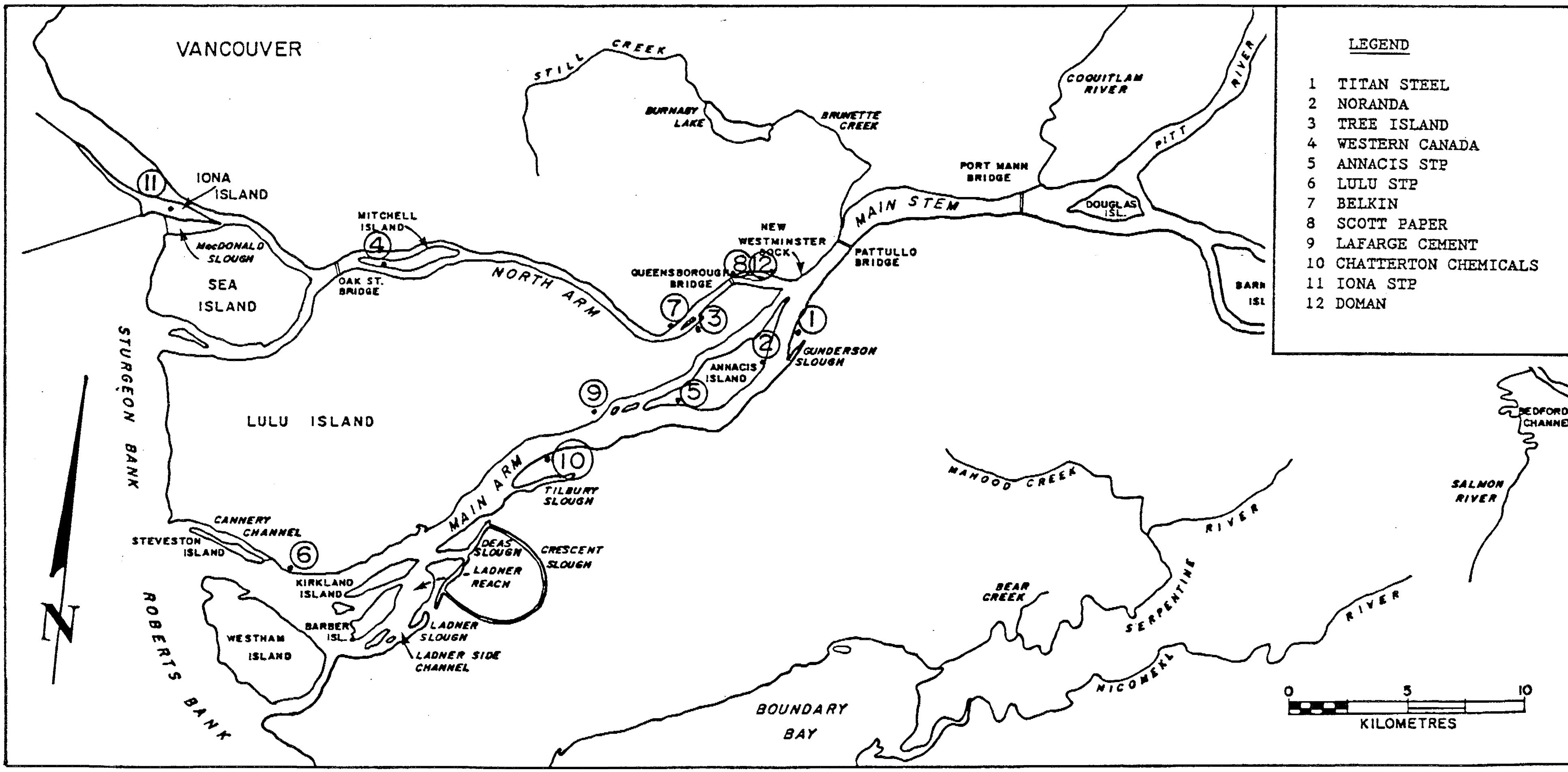
a) it would be desirable to perform GC/MS analyses on composite effluents samples collected at all operations at least once versus only at those operations where these types of analyses were recommended after studying the operation's processes.

b) the turn-around time of laboratory results makes it realistic to only sample at each operation on a maximum of 3 occasions.

c) the program's budget should include a vehicle for conducting the field work/sample collection.

d) joint sampling programs with other agencies or individuals should only be undertaken after careful consideration of all details in order to keep the program as autonomous as possible and to avoid misunderstandings.

e) prior to hiring staff for the program the Supervisory Coordinating Committee which oversees the monitoring work being done at the FRHC should carefully review the range of operations to be investigated in that year and thereby hire staff whose knowledge and experience best accommodates the perceived needs of the decided program.



LOCATION MAP

APPENDIX A

Monitoring at Municipal Sewage Treatment Plants

Introduction

The work undertaken at the sewage treatment plants will differ from the other investigative/monitoring programs. The treatment processes at Annacis, Lulu, and Iona do not have to be researched extensively, nor inputs to these systems evaluated. The internal processes at each of the sewage treatment plants is well understood, and inputs to the plants are subject of source-control work by the GVS & DD.

Course of Action

Work at the plants should be coordinated through Mr. Bob Jones of the GVS & DD. Samples should only be collected when the effluent is chlorinated. The expected output from this sector will consist of information as follows:

1. Name and location of STP.
2. Contact.
3. Dates of inspections, sample collections.
4. Flow records. Actual flows are required for the period effluent samples were collected.
5. Copy of plant layout, with design figures.
6. Indicate on the site plan where samples were collected.
7. Results of samples.
8. Estimated loadings, based on samples.
9. Projected impact on receiving water.
10. Any recommended future ambient sampling.
11. Provide effluent summary for 1986 from GVS & DD for each plant. Quarterly reports are sent to Waste Management in Surrey.

Investigatory Process

1. Contact B. Jones (432-6429) of GVS & DD to arrange initial visits to each operation and to obtain site plans and design criteria. These may also be available from E. Lawson (584-8822) of Waste Management. Mr. Lawson or one of his appointed technicians should accompany you on the first visit to each STP.
2. Contact the contractor who will perform the laboratory analyses to obtain information on correct procedures and containers for submission of the samples.
3. Prepare monitoring reports (to as full an extent as possible) for each plant providing information required under Section titled "Course of Action". These should be completed immediately after samples are collected from each site.
4. It is likely arrangements for the collection of composite samples can be made through the GVS & DD.
5. Submit samples to contractor for analysis.

APPENDIX B

Monitoring at Wood Preservation Sites (Using Chlorophenols)

Introduction

This industrial sector has had a great deal of work carried out in it, particularly by EPS, in the last few years. An inventory and questionnaire have been completed for the entire Province, and EPS have compiled a priorized listing of individual operations.

In the lower Fraser River (below Kanaka Creek), there are about thirty operations which use chlorophenol-type products. These would enter the river with stormwater which could leach them from stockpiled treated supplies or from drippings from treated supplies.

Course of Action

A priorized list of sites is being prepared by the Environmental Protection Service (EPS). This will be the basis for the work. One location near Mitchell Island in the North Arm should be assessed, since Westwater Research have found some interestingly high chlorophenol results in the ambient water near there. Four other sites with the highest priority should also be investigated.

The expected output for this industrial sector will consist of information as follows:

1. Name and location of operation.
2. Contact.
3. Dates of inspections, sample collections.
4. Quantities of chlorophenols used per year and wood processed.
5. How are these chlorophenols applied.
6. Likely paths of entry of chlorophenols, from stockpile or other location via stormwater runoff, groundwater contamination or some other path.
7. Copy of the site plan and simplified flow sheet showing inputs, outputs, and main processes, including any effluent treatment. An attempt should be made to draw up a water balance for the plant.
8. Indicate on site plan where samples were collected.
9. Results of samples.
10. Estimated stormwater flows i.e. m^3/sec/ha/mm.
11. Estimated loading based on samples.
12. Ranking of this operation compared to others in terms of potential impact on the ambient environment (in terms of loading?).
13. Recommended future ambient sampling.

This will require that samples be collected at a designated point during rainfall events. The first time that samples are collected at the Mitchell

Island operation, discrete samples should be collected manually every 15 minutes for a maximum period of three hours.

In subsequent storms, and at the other locations, occasional discrete samples may be collected. Some of those operations with the highest priority may have as many as three sets of samples collected at the 15-minute interval spacing. This will be at the discretion of the Supervisory Committee.

Investigatory Process

1. Use priorized list of sites prepared by EPS and modified by the Supervisory Committee.
2. Contact Stanley Liu (666-2104) or other appointed EPS contact to arrange initial visits to each operation, to obtain information from inventory for each site, to obtain the site plan, etc.
3. Contact the Laboratory to obtain correct procedures for submission of chlorophenol samples (and possibly some metals).
4. Prepare monitoring reports (to as full an extent as possible) for each operation providing information required under section titled "Course of Action". These should be completed immediately after samples are collected from each site.
5. Collect samples, as is possible, during rainfall events. This may have to be done during evening hours. However, permission must be obtained from the plant contact in order to gain access.
6. Submit samples to Laboratory for analysis.

APPENDIX C

Monitoring at Other Forest Operations, Metal Finishing and Fabricating, Concrete and Miscellaneous Operations

Introduction

The six forest industry operations to be investigated are Belkin Paper, Scott Paper, BCFP Hammond, C.Z. Fraser Mills, M.B. New Westminster and M.B.Canadian White Pine. The Forest Industry operations have the highest priority. Process effluents from any industrial sector which can have a direct impact on the river, or contaminated surface runoff, are of most importance.

Course of Action

The expected output for these industrial sectors will consist of information as follows:

1. Name and location of operation.
2. Contact.
3. Dates of inspections, sample collections.
4. Process description including quantities and types of chemicals used on a yearly basis, where and how these are introduced in the system, how they react in the system, and whether they or some derivative would enter the effluent. A water balance should also be drawn up.
5. Likely paths of entry of chemicals, from product stockpiles or other location with stormwater runoff, groundwater contamination or some other path.
6. Copy of the site plan and simplified flow diagrams of process description, as per #4 above.
7. Indicate on site plan where samples were collected, including concurrent ambient samples.
8. Results of samples.
9. Estimated stormwater flows i.e. $m^3/s/ha/mm$.
10. Estimated or measured effluent flow rates.
11. Estimated loading based on samples.
11. Ranking of this operation compared to others in terms of potential impact on the ambient environment (in terms of loading?).
13. Recommended future ambient monitoring.
14. For each operation, a report should be prepared following the general outline contained in Chapter 2 of Kootenay Air and Water Quality Study Phase 1, Water Quality in Region 8, the Lower Columbia River Basin (Ministry of Environment, August 1977).

Investigatory Process

1. Use priorized list of sites prepared by Supervisory Committee.
2. Contact P. Khare (584-8822) of Waste Management in Surrey to obtain available background information on each operation and to arrange initial visits to each operation. This visit will result in obtaining up-to-date information on quantities, process modifications, site

plan, etc. The first visit to each operation should be in the company of P. Khare or other delegated Waste Management Branch staff.

3. Contact Laboratory to obtain correct procedures for submission of samples.
4. Advise the Supervisory Coordinating Committee of recommended characteristics for monitoring. The Supervisory Coordinating Committee will then authorize sampling, as appropriate.
5. Prepare monitoring reports (to as full an extent as possible) for each operation providing information required under section titles "Course of Action". These should be completed immediately after samples are collected from each site.
6. Collect effluent samples and initial dilution zone samples when plant is in normal mode of operation and when tide is at ebb, just before flood tide. This should be noted in the write-up.
7. Submit samples to Laboratory for analysis.