T. W. BEAK CONSULTANTS LIMITED

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# BIOLOGICAL SURVEY OF THE ST. LAWRENCE RIVER 1972

VOLUME 1

A Report For

ENVIRONMENT CANADA

OTTAWA, ONTARIO

MAY 1973



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## SUMMARY

The Montreal Urban Community is planning the construction of sewage treatment facilities to serve Montreal Island. The design criteria for these facilities will depend on the present quality of the receiving waters rather than on effluent discharge standards.

T. W. Beak Consultants Limited was retained to investigate present water quality in the vicinity of Montreal and downstream on the St. Lawrence River to Lake St. Peter. In this investigation, analyses were conducted of bottom sediment (benthic) invertebrate animal communities, water chemistry, sediment chemistry, fecal coliform and streptococcus bacteria, rooted aquatic plants, and attached algal growths. The present report, Volume 1, presents the principal findings of this study together with relevant supportive data. Volume 2, which will be issued in July 1973, will include detailed biological analyses, and analyses of rooted aquatic plants and attached algae.

To facilitate the presentation and interpretation of data, the study area, from upstream of Lac St-Louis to downstream of Lake St. Peter, including Lac des Deux-Montagnes, has been divided into five major water masses differentiated by chemical characterization and water flow. The five water masses considered were: Riviere des Mille-Iles, Riviere des Prairies, St. Lawrence River north shore, St. Lawrence River mid-stream, and St. Lawrence River south shore. The

St. Lawrence River south shore flow includes samples taken near the mouths of the following tributaries: Riviere Chateauguay, Riviere St-Francois and Yamaska River, and Riviere Richelieu. Forty sampling stations were distributed throughout the study area.

Upstream control stations in both Lac St-Louis and Lac des Deux-Montagnes revealed evidence of eutrophic conditions. This enrichment, manifested by high nutrient levels and abundant growth of aquatic plants, was attributed to upstream municipal and industrial discharges in both the St. Lawrence and Ottawa Rivers. This assessment agreed with previously published reports on these areas.

In the Riviere des Mille-Iles, water quality deterioration was detected, to varying degrees, over the length of the river. Biological degradation of bottom faunal communities was noted from downstream of Laval-Ouest to Bois-des-Filion. Elevated bacterial levels were measured from Bois-des-Filion downstream past Terrebonne. Additional water and sediment data supported these findings.

The Riviere des Prairies contained good quality water downstream past Ile-Laval. Some biological degradation was in evidence at Chomedy (Cartierville Bridge). Near Montreal-Nord, gross organic pollution of bottom sediments was observed. Bottom sediments were characerized as sewage sludge, and contained high populations of sludgeworms. Little recovery from this condition had occurred before the confluence of this river and the St. Lawrence River. Elevated bacteria levels were noted from Montreal-Nord to Charlemagne.

The St. Lawrence River water quality along the north shore was affected by urban drainage near shore in Lac St-Louis. This condition was confirmed by biological and water chemistry results obtained near Dorval. In Montreal Harbour, the aquatic environment was severely degraded by organic depositions. This degradation extended downstream past Pointe-aux-Trembles, and recovery was still not complete at Repentigny. Possible toxic or deoxygenation effects were noted at Montreal-Est, where a less abundant benthic fauna was noted in an organic sediment type which at other locations had produced a massive abundance of sludgeworms.

The mid-stream St. Lawrence River stations indicated generally good quality water. Elevated bacteria levels were evident in surface waters in the vicinity of Montreal Harbour.

The St. Lawrence River south shore water quality was severely degraded biologically at Longueuil and downstream past Boucherville. At Longueuil, raw sewage and gasification of sediments (anaerobic decomposition) was observed. Recovery was in progress by Varennes. South shore water quality was not degraded over as long a distance as the north shore. This observation is compatible with smaller population and less industry along the south shore.

The communities of bottom organisms from Repentigny to Sorel appeared limited because of bottom erosion created by greater currents. Environmental conditions were not considered to be as good upstream of Lake St. Peter as they had been upstream of Lac St-Louis. Lake St. Peter was considered to be enriched by the effects of upstream discharges, especially in the upstream delta end. At the outlet of Lake St. Peter, the St. Lawrence River had apparently not yet completely assimilated waste loadings discharged from Montreal and downstream communities.

Tributary rivers revealed varying degrees of degradation. The Riviere St-

Francois, an enriched stream, had the poorest quality water of the three tributaries investigated.

The report concludes that the water quality parameters warranting reduction to establish quality compatible with future user requirements are; nutrients (nitrogen and phosphorus), organics (including suspended and dissolved volatiles), fecal bacteria, and possible toxic substances.

Industrial and municipal treatment facilities should be designed for suspended solids and nutrient removal followed by chlorination (for municipal).

Follow-up studies are recommended to accurately establish the extent of localized environmental degradation detected in the vicinity of Montreal-Nord, Montreal-Est and Montreal Harbour.

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ENVIRONMENT CANADA
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BIOLOGICAL SURVEY OF THE
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## INTRODUCTION

### Terms of Reference

The Montreal Urban Community is planning the construction of sewage treatment plants to alleviate the discharge of raw and partially-treated sewage into the waters surrounding the city and its suburbs. The degree of sewage treatment deemed necessary will be based on the present water quality of the receiving waters, and not on arbitrary levels of effluent quality.

T. W. Beak Consultants Limited was retained to furnish precise information on the present quality of water in the St. Lawrence River and its tributaries in the region of Montreal, and downstream to a point where recovery from the effects of Montreal area discharges might have occurred. BEAK's approach used the assessment of the benthic (bottom substrate) invertebrate animal fauna as the basis of determination. This evaluation is supported and strengthened by consideration of water chemistry characteristics, sediment chemistry characteristics, study of growths of attached algae and rooted aquatic plants, and documentation of fecal coliform and fecal streptococcus bacteria densities.

Literature pertinent to the study was sought out and consulted, and the main conclusions arrived at in these reports are presented below. Previous surveys conducted by BEAK for the Department of the Environment were also considered.

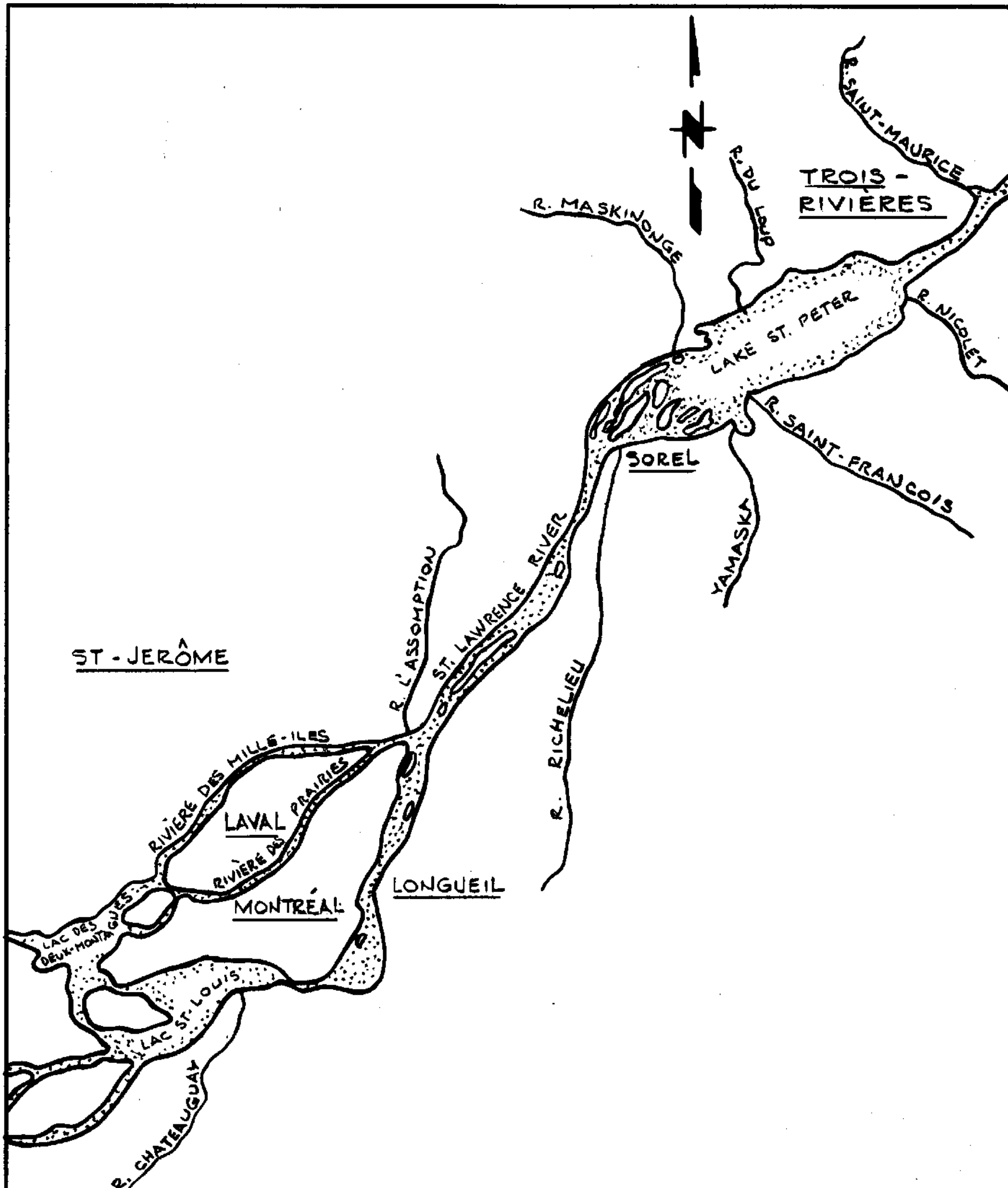
This report has been prepared in two volumes. Volume 1 (the present report) contains the general biological results, water chemistry results, sediment chemistry results, and bacteriological results. Volume 2 will contain the detailed benthological results, plus data on attached algae, and rooted aquatic plants. This division has been made to produce a basic report more comprehensible to the non-specialist (Volume 1). Major conclusions as discussed below may be amplified and detailed by the information available in Volume 2. However, the present report stands on its own as an account of the study findings.

Description of Study Area

The St. Lawrence River drains the entire great Lakes area of Canada and the United States of America. Figure A, which follows, shows the general study area. Upstream of Cornwall, Ontario, this drainage basin amounts to over 290,000 square miles. In the present study area, the drainage basin of the St. Lawrence River also includes the Ottawa River (56,000 square miles) and many major tributaries to the south shore, which drain the Eastern Townships area of Quebec and portions of the northern New England states. The major south shore tributary is the Riviere Richelieu, which drains Lake Champlain (drainage basin of 5,800 square miles), although the Riviere Chateauguay, the Yamaska River, the Riviere St-Francois and the Riviere Nicolet are also important streams. The north shore drainage does not contain any such large rivers downstream of the Riviere l'Assomption which enters the Riviere des Prairies just upstream of the St. Lawrence River. The Riviere Maskinonge and Riviere du Loup are major rivers of the north shore drainage.

The flow of the St. Lawrence River past La Salle, at the outlet from Lac St-Louis averaged approximately 335,000 cfs in 1972. Maximum average flow at this location reached 451,000 cfs, in May, 1972, and the minimum average flow of 221,500 cfs was recorded for January, 1972. During the twenty-two field days of the present study, river flow averaged 342,900 cfs. Approximately one-fourteenth of this water is derived from the Ottawa River basin, through the Dorion and St-Anne-de-Bellevue channels. A further contribution of Ottawa River water enters the St. Lawrence downstream of Montreal Island, from the Riviere des Mille-Iles and Riviere des Prairies (back rivers). This input averages approximately 30,000 cfs.

The St. Lawrence River in Ontario and Quebec drains an area of shales, lime-




## GENERAL STUDY AREA
## ST. LAWRENCE RIVER SURVEY
## SEPT.-OCT. 1972

12 0 12 24 MILES

MAP SCALE

| ENVIRONMENT CANADA<br>OTTAWA – ONTARIO | BEAK | BY B.G.<br>DWG. NO. A1155-16 | DATE 29-5-72 | FIG. A |
| --- | --- | --- | --- | --- |

TRANSLAR 003

stones and dolomites. The waters tributary to the St. Lawrence originate mainly from the Canadian Shield to the north, and the United States Appalachian region to the south. Smaller tributaries drain the St. Lawrence lowlands area, which flanks the river for most of its length. (Thomas, 1964)

Over one-third of Canada's population lives within the lower St. Lawrence River drainage basin (including the Ottawa River). Approximately three-quarters of Canada's total population resides in the whole Great Lakes-St. Lawrence drainage basin. Two major metropolitan areas, Toronto and Montreal, each have in excess of two million people. More than three-quarters of Canada's manufacturing is done in this area, and it is one of Canada's most important agricultural regions.

This relatively large concentration of human and associated industrial activity exerts a large demand on the water resources of the region. Water is taken from the system for municipal and industrial water supplies, cooling purposes, and crop irrigation. These waters are returned to the system with added process wastes and municipal sewage, which the river must assimilate. Runoff from urban and developed rural areas adds suspended and dissolved solids. Recreational pursuits include fishing, waterfowl hunting, boating, water-skiing, and swimming, as well as aesthetic enjoyment of scenery. Littoral areas of the river, especially in the lakes, are important wildfowl habitats and migration rest areas.

The St. Lawrence corridor has developed into Canada's principal transportation link. With the opening of the St. Lawrence Seaway in 1959, the volume of shipping increased, and use of the waterway extended past Montreal Harbour. This has increased the incidence of pollution by discharge of ship wastes, and by spillage during cargo handling, or accidents. Maintenance of the seaway channel necessitates dredging in many locales, involving re-suspension of fine sediments. Upstream of Montreal, several hydro-electric power structures regulate river flow.

The Montreal urban area has a population of approximately 2,500,000. The waste-water flow from this area has been estimated at 500,000,000 gallons per day. Of this total flow, approximately four percent receives treatment. Montreal Island itself, including the City of Montreal and the suburbs on the island, discharge approximately 300,000,000 gallons per day into the waters flowing around the island. Of this, about 150,000,000 gallons per day are discharged into the Riviere des Prairies through a large collector sewer emptying near Ile-de-la-Visitation. Storm sewer overflows from other sewers in this area may occur at peak periods. To the west, partially-treated sewage is derived from the communities of Roxboro, Ste-Genevieve, and Pierrefonds. To the east, there are about six major sewage outfalls in Montreal-Nord. The Riviere des Prairies also receives sewage from communities on Ile Jesus, although Laval has some sewage treatment facilities.

The St. Lawrence River receives the bulk of the effluent discharges. Raw sewage is discharged at Ste-Anne-de-Bellevue, Pointe Claire, Dorval, Lachine, Verdun, and La Salle, and primary treatment effluent is discharged at Beaconsfield. The City of Montreal has seventeen outlets along the harbour area, dumping 125,000,000 GPD into the St. Lawrence River. A population in excess of 200,000 discharge sewage to the south shore of the St. Lawrence, mainly near the Jacques Cartier Bridge, where a large south shore collector sewer, built in connection with the Seaway, is located.

In addition to the domestic waste flows, there is also a considerable burden of industrial wastes, both mixed with domestic sewage, and discharged independently to the river. It has been estimated by the Quebec Water Board that industry contributes 80% of the waste load to the St. Lawrence River, with an impact equivalent to a population of 20 million people.

Previous Research

The upper St. Lawrence River has been studied by several groups. Ontario Water Resources Commission (now Ministry of the Environment) conducted extensive biological surveys from Kingston to Cornwall during 1966-67 (Owen and Veal, 1968). They concluded that bottom fauna communities generally indicated water of good quality. Significant contamination was detected below all major population centres. Large abundances of aquatic plant growths, especially in Lake St. Francis, were linked both to the physical aspect of the environment, and the problem of nutrient inputs to the river. With the exception of nutrients, the overall quality of the river was concluded to be determined by that of Lake Ontario, and not by local drainage.

The International Joint Commission (I.J.C.) has conducted studies principally of the Great Lakes, but also extending into the international section of the St. Lawrence River (i.e. upstream of Cornwall). The latest report in this series appeared in 1969, based on data collected from 1963 to 1967. This report concluded that nutrient inputs to the lakes are a significant source of concern, that accelerated eutrophication is occurring in Lake Ontario and that the effects are being carried into the St. Lawrence River. Serious problems were noted in local waters and harbours, and the general quality of the water was felt to have deteriorated significantly. Algal and weed growths, changes in commercial fish catches, and bacterial contamination were cited as evidence for this conclusion.

BEAK has documented water quality for the Department of the Environment in the upper St. Lawrence River (upstream of Montreal) on two previous occasions (T. W. Beak Consultants Limited, 1968, 1973a). The conclusions reached in those reports agree with the evaluations discussed above. While the waters arriving in the Montreal region are not polluted, they are burdened with waste material, and produce a condition of eutrophy in Lac St-Louis.

A specific study of Lac St-Louis was made by Pageau, Gravel and Levesque (1971). They noted generally increased total dissolved solids levels as discussed by Beeton (1965) for the Great Lakes. They also documented a general increase of aquatic vegetation and large changes in fish populations. They concluded that Lac St-Louis was a complex, but highly eutrophic habitat.

Magnin (1970) has studied the littoral benthic fauna of Lac St-Louis. His study also revealed evidence of advanced eutrophication in Lac St-Louis considering especially the molluscan and crustacean macroinvertebrate fauna, and the rich flora of rooted aquatic plants. Dansereau (1958) has published several papers on the rooted aquatic plant communities of southern Quebec, including Lac St-Louis, and the St. Lawrence River.

Downstream of and around Montreal, only unpublished data of the Quebec Water Board is known. The Department of the Environment, Water Quality Branch, is currently collecting water quality data from I.H.D. (International Hydrological Decade) stations on the St. Lawrence River and its major tributaries. Nevertheless, in 1971, the Montreal Star quoted: "...it is not known to what extent the river is polluted. There has never been a scientific study to measure and classify the various pollutants freely dumped into the waterway" (Pascoe and Mailhot, 1971).

The Ottawa River has received more attention in recent years. Piche (1954), the Ontario Department of Health (1956), the Quebec Water Board (1966), and the Ontario Water Resources Commission/Quebec Water Board (1971), have all produced reports on the river. Major pollution sources have been identified in the Ottawa-Hull, and Carillon-Pointe Fortune sections of the river. The effect of these areas on water quality downstream in Lac des Deux-Montagnes has been to increase aquatic primary production and produce nuisance growths of aquatic plants. Nutrients, soluble organic compounds, suspended solids and bacterial contamination all add to the problem.

BEAK has documented water quality in the Ottawa River for the Department of the Environment (T. W. Beak Consultants Limited, 1968, 1973b). Based on analysis of benthic invertebrate communities, and water chemistry characteristics, it has been concluded that the Ottawa River is polluted upstream, and the effects of this degradation are expressed, in Lac des Deux-Montagnes, as increased eutrophication.

## SCOPE OF STUDY

### Description of Sampling Stations

Sampling stations were located in the St. Lawrence River from upstream of Lac St-Louis, to downstream of Lac St. Peter, including these two lakes.

In the Ottawa River system, stations were located in Lac des Deux-Montagnes, and in Riviere des Mille-Iles and Riviere des Prairies. Stations were also located at the mouth of the Riviere Chateauguay, Riviere Richelieu, and Riviere St-Francois.

A total of 40 stations was established.

St. Lawrence River stations were generally selected to provide transects of the river, giving an indication of the water quality close to each shore, and at certain mid-stream locations for reference and comparison. Stations located upstream of the Montreal urban area, in the St. Lawrence River, Lac St-Louis, Lac des Deux-Montagnes, the Riviere des Mille-Iles and Riviere des Prairies were intended to provide control data on the water quality as related to upstream pollution sources. Stations adjacent to the Montreal urban area were located as much as possible equidistantly over the length of river surveyed, and were not positioned with reference to specific waste discharges. In some areas access by boat was impossible. The project design, therefore, provides a general view of overall water quality, and outlines the major areas of concern which may warrant further, more detailed, study.

The section of the St. Lawrence River downstream of Montreal includes many communities of varying size, including: Repentigny, Lavaltrie, Lanoraie, Berthierville, and Louiseville on the north shore, and Boucherville, Varennes, Contrecoeur, Sorel, Nicolet, and Port St-Francois on the south shore. Wherever possible stations were located immediately upstream of these communities, in order that their contribution to the river's waste load should not be specifically isolated. In this way it was intended to provide a picture of the downstream water quality including the input from Montreal, and the additional collective burdens from downstream areas, and tributary streams. The choice of south shore tributaries reflected the larger drainage basins, denser populations and more heavily industrialized nature of the Eastern Townships region as compared to the St. Lawrence north shore.

Station locations were selected to be as similar in physical aspect as possible. Every effort was made to reduce variability due to differences in substrate type, current flows, and irregularity of depth profiles characteristic of such a large study area. In this way variations due to chemical characteristics should be more pronounced. Where possible, exact positions were fixed by triangulation with permanent landmarks using a hand bearing compass and a rangefinder. Station locations are briefly described in Table 1, and appear in Figures 1 and 3 on a map of the study area. Exact locations given as latitude and longitude will be appended to Volume 2 of this report.

## Procedures

A more detailed description of field and laboratory procedures is presented in Appendix 1 of this report.

### (a) Benthos

At each of the forty sampling stations six samples of bottom material were obtained for analysis of the population and community structure of macroinvertebrate animals. The basis of water quality assessment by this method is outlined in the General Discussion on page 14.

### (b) Water - Chemical and Physical Parameters

Surface water samples were obtained at each sampling location, from approximately one foot under the surface. Where water depth exceeded twelve feet, samples of water were also obtained from approximately one foot above the bottom. The collected samples were appropriately preserved for the following analyses: BOD5, total and suspended solids plus ash, phosphates and nitrates. Samples were trans-shipped the day of collection to the BEAK laboratory for immediate analysis.

In addition, in-situ measurements were taken of: Secchi disc transparency, temperature, dissolved oxygen, pH, and conductivity, using portable field equipment. These measurements were made on surface and, where applicable, bottom waters.

### (c) Sediments

At each sampling location, at least one core sample of bottom sediments was obtained. The top two inches of each core sample was kept for analysis of organic carbon and organic nitrogen content, and subsequent calculation of Organic Sediment Index (O.S.I.).

(d) Bacteria

At all water sampling locations, surface water samples were collected in sterilized containers for subsequent analysis of fecal coliform and fecal streptococcus bacteria. Samples were chilled and forwarded on the day of collection to the BEAK laboratory for immediate analysis.

(e) Periphyton

Seven stations were established for the collection of periphyton (attached algal growths). In the littoral area at each location, a suitable area of substrate was examined for attached algae, and photographed where possible. Samples of the growth were scraped from the substratum and preserved for subsequent analysis. Because of the highly variable nature of the bottom materials no attempt was made to obtain quantitative samples. The data will provide a qualitative evaluation of pollution effects on this flora. These analyses, including photographs, will be presented in Volume 2 of this report.

(f) Algae and Macrophytes

At each of the sampling sites, observations were made on the presence and abundance of algae and rooted aquatic plants. Particular attention was paid to possible nuisance species, such as the filamentous green alga Cladophora, and the vascular plants Elodea and Myriophyllum. At most locations, samples of the vegetation were collected and preserved for positive identification. The extent of distribution of plants in the immediate area of the sampling location was investigated and noted. The results of these observations and analyses will be presented in Volume 2 of this report.

## DISCUSSION

### General

Most natural waters support in and on their bottom sediments, diverse communities of aquatic animals, collectively known as benthos. These are organisms such as segmented worms, clams, snails, insect larvae, and various small crustaceans. They exhibit varying degrees of sensitivity to adverse changes in water quality and substrate characteristics. Because of this, and the fact that such communities are relatively stable in composition, they can be useful in assessing pollution.

Clean waters normally support a large number of species of benthos but no superabundance of any one. Partial biological degradation by chemical or physical influences may kill or drive out the most sensitive species, while more tolerant (facultative) forms may increase in numbers to occupy the vacated niches. Further impairment may result in a fauna restricted to high numbers of a few tolerant forms, such as the sludgeworms (certain aquatic oligochaetes). Total degradation results in elimination of even tolerant animals.

For convenience, these three tolerance groups are usually defined as, respectively, Group 3 (sensitive), Group 2 (facultative), and Group 1 (tolerant). As conditions improve, through dilution or natural recovery with increasing distance from the source, animals re-enter the environment in reverse order, the most sensitive last, until a normal balance in diversity and numbers is re-established.

In order to use the benthos to measure the impact of an effluent, it is preferable to document the animal communities prior to the onset of pollution. It is also desirable to establish controls in physically similar nearby or upstream areas, to monitor natural seasonal and yearly variations of diversity and abundance, and to account for unforeseeable natural occurrences.

## Discussion of Results

The results have been presented in the following format:

| | | |
|---|---|---|
| Station Locations | - | Table 1 and Figures 1 and 3. |
| Biological Results | - | Table 2 (complete) and Figures 1 (Summary Table) and 2 (graphical). |
| Water Chemistry | - | Table 3 (complete) and Figures 3 (Summary Table) 4 (pH graph), 5 ($BOD_5$ graph), 6 (Conductivity graph), 7 (total dissolved solids graph), 8 (total suspended solids graph), and 9 ($NO_3$ and $PO_4$ graph). |
| Sediment Chemistry | - | Table 4 (complete) and Figure 10 (graphical). |
| Bacteriology | - | Table 5 (complete). |

In the above-mentioned tables and graphs, the data have been grouped according to the different water masses involved.

Five basic water masses were considered:

(a) Riviere des Mille-Iles (including the control station in Lac des Deux-Montagnes, and the downstream confluence with Riviere des Prairies and the St. Lawrence River).

(b) Riviere des Prairies (including the control station in Lac des Deux-Montagnes and the downstream confluence with Riviere des Mille-Iles and the St. Lawrence River).

(c) St. Lawrence River north shore (including a control station upstream of Lac St-Louis, stations in Lac St-Louis, and stations in Lake St. Peter).

(d) St. Lawrence River mid-stream (including a control station near Beauharnois, and a station in Lake St. Peter).

(e) St. Lawrence River south shore (including a control station near Beauharnois, and stations in Lake St. Peter).

Tributary Rivers - Riviere Chateauguay, Riviere Richelieu, Riviere St-Francois, plus Yamaska River, and St. Lawrence River downstream of Riviere Nicolet. These four stations have been considered as part of the St. Lawrence River south shore.

In the following discussion of results, each of the above water masses has been discussed separately. Within each section, an evaluation has been made of the variations of each of the environmental parameters measured, and its contribution to water quality. Reference to the appropriate graph or map, as indicated, will aid in interpreting the environmental conditions described. Control and downstream station data which were common to more than one water mass were duplicated on the maps, graphs and tables involved to aid in continuity of discussion.

## Biological Results

### (a) Riviere des Mille-Iles

The data referred to in this discussion may be found in Table 2a, Figure 1 (map summary) and Figure 2a (graphical summary).

The source of water for this river is Lac des Deux-Montagnes, and it is, therefore, a continuation of the Ottawa River flow. Upstream environmental conditions at Station 2 have been monitored by the Quebec Water Board (OWRC/QWB, 1971) and by BEAK (T. W. Beak Consultants Ltd., 1973b). In the BEAK report it was concluded that Lac des Deux-Montagnes, in light of conditions upstream in the Ottawa River, was eutrophic. This conclusion expressed by BEAK in the study of the Ottawa River was borne out by the data from the present study.

Biologically sensitive taxa were collected in low relative abundance from Lac des Deux-Montagnes. Dominant forms were the clams. The oligochaete worms and chironomid (midge) larvae were also well represented. In total, 14 taxa were present in a total abundance of 163.7 per square foot.

Station 15, just downstream of Laval-Ouest in Riviere des Mille Iles, revealed a slightly altered biological picture. Total abundance and number of taxa were very similar to Station 2 (154.4/ft.$^2$ and 13 taxa) and most of the same groups were present. However, the sensitive forms were much less abundant, and the tolerant forms more abundant. The oligochaete worms were dominant numerically. These changes suggested that a change in water quality had occurred, possibly attributable to emissions from the Laval-Ouest and Deux-Montagnes area.

Station 16, at Ste-Rose, revealed that the degradation noted downstream of Laval-Ouest had apparently worsened. Both total abundance and number of taxa were low (99/ft.$^2$, 8 taxa), and the only groups present in any abundance were the clams, and the oligochaete worms. Only one animal considered pollution-sensitive was collected in six bottom samples.

Station 17, at Bois-des-Filion revealed some improvement of water quality from the upstream locations. No sensitive taxa were collected. However, both total abundance and number of taxa had increased (271.6/ft.$^2$, 11 taxa). Clams were still dominant, and snails and oligochaetes were also abundant.

Station 18, downstream of Terrebonne, showed a condition of apparent recovery. Sensitive taxa comprised nine percent of the fauna, and tolerant taxa, ten percent. The bulk of the forms collected were considered facultative and were dominated by the Amphipoda (scuds). Ephemeroptera (mayfly nymphs), clams, snails, chironomids, and oligochaetes, were all relatively abundant. The dominance of Amphipoda suggested a closer affinity between this station and those downstream rather than those upstream.

Station 23, below the confluence of the Riviere des Mille-Iles and Riviere des Prairies, revealed the influence of poor quality water from Riviere des Prairies. High abundances of a few taxa were noted, and no sensitive forms were collected. Tolerant oligochaetes dominated the assemblage.

(b) Riviere des Prairies

Data discussed in this section may be found in Table 2b, Figure 1 (Map summary), and Figure 2b (graphical summary).

Station 2, in Lac des Deux-Montagnes, provided control data for the Riviere des Prairies. As discussed above, water quality at this location was considered eutrophic, but not grossly polluted.

Station 19, at the upstream end of the river revealed a diverse and abundant fauna. Twelve taxa were collected, with a total abundance of 731.4 animals /ft.$^2$. Thirteen percent of these taxa were tolerant forms, and thirteen percent were considered sensitive, the bulk of these being caddisfly larvae (Trichoptera). The dominant form was the chironomid (midge) larvae, but clams, amphipods, caddisflies, and oligochaete worms were also abundant. This assemblage indicated relatively good water quality.

Biological conditions at Station 20, at Ile Laval, were very similar to those monitored upstream at Pierrefonds. There is a large input of water from Lac des Deux-Montagnes at this junction. Sensitive animals were not as abundant as upstream, but there were more sensitive taxa represented. Chironomids, amphipods, and oligochaete worms, were abundant. Total abundance and diversity were very similar to Station 19.

Station 21, at Cartierville Bridge (Chomedy), indicated slightly deteriorated water quality from Station 20, upstream. Total abundance and diversity were high, however the fauna was dominated by the oligochaete worms and fingernail clams, which together accounted for over three-quarters of the total numbers. Sensitive taxa were present in low abundance.

Biological conditions at Station 22, near Montreal-Nord, indicated gross pollution at this point. Only five taxa were collected in the six samples. The total abundance was very high (30,302.4) and 99% of the individuals were sludgeworms. Other forms encountered were clams, snails, aquatic sowbugs (isopods) and leeches. Some isopods are common in degraded environments. Leeches are known to thrive in the presence of large worm populations, on which they are predatory. Leeches were not abundant elsewhere in the river.

At Station 23, below the confluence of the Riviere des Mille-Iles, conditions had improved only slightly. The fauna was both more diverse (8 taxa) and less abundant (3603.3/$ft.^2$) than upstream, but 76% of the animals collected were oligochaete worms. Some of this improvement was probably due to mixing of better quality water from the Riviere des Mille-Iles.

Station 24, in the St. Lawrence River downstream of the Riviere des Prairies, revealed a similar but healthier fauna, due to the large dilution factor. This station will be described more thoroughly below in the section on the St. Lawrence River north shore.

(c) St. Lawrence River - North Shore

Results discussed below are presented in Table 2c, Figure 1 (map summary), and Figure 2c (graphical summary).

Station 1, in the St. Lawrence River just upstream of Lac St-Louis, served as a control point for the Great Lakes-St. Lawrence water mass passing Montreal. Biological results indicated generally clean but eutrophic water conditions. The St. Lawrence River upstream of this area has been described in a previous report to the Department of the Environment (T. W. Beak Consultants Ltd.,1973b), and has also been studied by the Ontario provincial government (Owen and Veal, 1968) and the International Joint Commission (I.J.C., 1969). These studies have all indicated that generally good water quality prevails in the upper St. Lawrence River, with significant contamination only below major population centres. One major concern was plant nutrients (N and P) and the eutrophy which has resulted from abundances of these elements in waste discharges. The problems of eutrophication in the Great Lakes, and subsequent effects on the St. Lawrence River, have been considered by Beeton (1965).

Station 3', off Pointe Claire in Lac St-Louis, was apparently in a zone of mixing of Ottawa and St. Lawrence River waters, and may be more or less affected by one or the other water mass. Biological conditions indicated eutrophic conditions, and water of a poorer quality to that at Station 1 upstream, possibly as a result of urban drainage from the north shore of Lac St-Louis. Almost 80% of the fauna was clams, both sphaeriids (fingernail clams) and the larger unionids. Sensitive forms were present in very low numbers. Lac St-Louis has been typified as highly eutrophic by Pageau, Gravel and Levesque (1971).

Station 3$^{o}$ was established close to shore at Lachine when no bottom samples could be obtained nearer mid-stream. The effects of urban wastewaters are apparent here when compared to either upstream or downstream stations. Seventy-four percent of the fauna was oligochaete worms, and no sensitive forms were encountered. Only seven taxa were collected. Clams, snails, chironomid larvae, and leeches, were also relatively abundant.

Station 5, in the LaPrairie basin off Verdun, had a rocky bottom, and the only sample obtained consisted of a composite of four core samples taken from between the large rocks. This qualitative sample indicated a basic similarity in benthic fauna to that found at Station 3'. Maintenance of water quality at this point is probably aided by the turbulence and mixing effect of the Lachine Rapids.

Station 8, in Montreal Harbour, was severely degraded by gross organic pollution. An extremely high abundance of animals (116,182.9/ft.$^2$) was 99.9% sludgeworms, and only five other taxa were recovered.

Station 11, downstream by the refineries at Montreal-Est, was degraded in much the same manner as Station 8. Total abundance was lower at Station 11, but the fauna was still 98% oligochaete worms. This lower abundance, in the presence of similarly highly organic sediments, may reflect toxic components in the wastewaters of this largely industrial area.

Station 14, near Bout-de-l'Ile, revealed very little recovery from the severe degradation present upstream. The fauna was slightly more diverse, and less abundant, but was still 98% sludgeworms.

Station 24, at Repentigny, was downstream of the input of the Riviere des Prairies. Considerable recovery was in evidence here from the severely degraded conditions upstream. Sensitive taxa reappeared for the first time since Station 5. The fauna was very diverse, with 15 taxa. However, 75% of the fauna was composed of oligochaetes and chironomid larvae, which indicated that conditions were far from fully recovered.

Station 26, offshore from Lavaltrie, did not reveal any further improvement in water quality from that monitored at Station 24. The community here was less diverse and abundant, but dominated by the same forms. An even more sparse fauna was collected at Station 29, at Lanoraie. It was possible that biological conditions in this section of the river are controlled largely by the strong current and scoured erosional nature of the bottom sediments, since there are apparently few sources of large wastewater inputs on the north shore.

Station 31 was located in a deep area among the islands which form a delta area in the upstream end of Lake St. Peter. An abundant, but not overly diverse fauna was collected (8,923.6/ft.$^2$, 9 taxa). Approximately two-thirds of this fauna was composed of oligochaetes and clams, while amphipods, snails, and polychaete worms were also abundant. This assemblage, associated with depositional sediments, indicated that the river was possibly still assimilating the burden of wastes from Montreal and downstream communities.

Station 32 was close to Station 31, but in the main stream channel of the St. Lawrence River. This station indicated water quality still inferior to that monitored upstream of Montreal. Clams dominated the fauna, but amphipods, snails, and oligochaete worms, were also well represented.

Station 38, in the downstream end of Lake St. Peter was located on a sandy bottom. As a result, the fauna was sparse ($101.2/ft.^2$) and not overly diverse (8 taxa). Community structure appeared to reflect the substrate conditions more than the water quality.

Station 39, in the St. Lawrence River downstream of Lake St. Peter, reflected a water quality still not as good as upstream of Montreal. Sensitive taxa were present but in low numbers, and 76% of the fauna was oligochaetes. This indicated that even in the passage through and mixing in Lake St. Peter, the total waste burden was not completely assimilated. Just downstream of this location, the river receives a large wastewater flow from the city of Trois-Rivieres, and the drainage of the Riviere St-Maurice, but the survey grid was not designed to measure conditions below this influx.

## (d) St. Lawrence River - Mid-Stream

Data discussed in this section may be found in Table 2d, Figure 1 (map summary), and Figure 2d (graphical summary).

The stations which were established in a mid-stream position helped to define a relatively unchanged flow of upper St. Lawrence River water past the Montreal area and downstream. The biological results revealed fairly stable conditions, which may be modified by strong current flow, and the subsequent erosional nature of the bottom. Samples could only be obtained near islands, since the main channel is scoured down to large boulders.

Above Lake St. Peter, there did not appear to be much mixing of mid-stream flow with the water nearer to the shorelines. In Lake St. Peter substantial mixing occurred, as shown by water chemistry parameters discussed later in this report.

## (e) St. Lawrence River - South Shore and Tributaries

Data discussed in this section is presented in Tables 2e and 2f, Figure 1 (map summary), and in Figures 2e and 2f (graphical summary).

Station 1, upstream of Lac St-Louis, served as a control point for south shore water flow. As discussed in section (c) above, the water quality here would be described as eutrophic.

Station 4 was located in the Riviere Chateauguay, a major tributary to the south shore of Lac St-Louis. Biological results indicated good water quality in the Riviere Chateauguay downstream of Chateauguay. Several types of sensitive taxa were collected, and the oligochaete worms were not overly abundant.

Dominant forms were snails, while clams, amphipods, chironomids, and isopods, were also relatively abundant. A total of 15 taxa was collected.

Station 7, in the LaPrairie basin, indicated that water quality remained relatively good below Lachine Rapids. Total abundance of macroinvertebrates was 619.5/ft.$^2$, in 12 taxa. Only ten percent of the fauna was tolerant worms, while 21 percent was sensitive caddisflies. The dominant forms were the snails. This situation was apparently similar to that measured across the La Prairie Basin near Ile des Soeurs at Station 5.

Water quality at Station 9, off Longueuil, was severely degraded. The fauna was over 99% sludgeworms, and only four other taxa were collected. Total abundance was low compared to Station 8, across the river, which indicated the possibility of severe deoxygenation of bottom waters, or toxic components in waste flow. It was noteworthy that fresh sewage was observed on the water surface and in bottom samples at this location. Gas bubbles rising from the bottom indicated anaerobic decomposition of bottom sediments. This raw sewage was probably from the large south shore collection sewer which empties upstream of this station.

Station 12, at Boucherville, revealed some degree of recovery from the gross pollution at Station 9. Sludgeworms still dominated the fauna, but some other somewhat more sensitive groups, such as amphipods, isopods, and leeches, had appeared in low abundance. The recovery at this location was much advanced over that monitored directly across the river at Station 11. This difference illustrated the recovery power of the St. Lawrence River in the absence of the large continuous waste inputs found on the more developed Montreal shore.

At Station 13, biological conditions were improved over Stations 9 and 12. Sensitive taxa were collected in low abundance. Tolerant worms were not overly abundant, and many groups of facultative forms were noted. The fauna was more diverse than immediately upstream, but less abundant, indicating a lessening of deposited organic load. Recovery was definitely in progress, but far from complete. Water quality was more satisfactory here than across the river at Station 14. This illustrated the effects of the heavier wasteloads imposed on the north shore flow.

Station 25, across from Repentigny, was located on a sandy-clay erosional bottom, and the results were felt to indicate the limiting effects of this bottom type rather than pollutional sources. Nevertheless, the fauna collected was 99% oligochaetes, with only 3 other taxa. This may indicate that, just as at Station 24 across the river, recovery from Montreal area pollution was not complete.

Station 28, at Contrecoeur, revealed slightly better conditions than those recorded from Station 25. Total abundance was low, at 299.5/ft.$^2$, but diverse, with 13 taxa. Sensitive forms were present, but not abundant. Dominant forms were amphipods, but clams were also very abundant, and these two groups accounted for over 75% of the fauna. This fauna was of a generally lower sensitivity than that recorded from cleaner upstream areas, and some degree of impairment of water quality is evident. These results did reveal that water quality was apparently slightly better here than across the river at Station 26. The conditions at mid-stream Station 27 were slightly better than at either shore location.

The bottom fauna at Stations 30 and 33 was considered to be limited by substrate and current more than by water quality, as at Station 25 upstream. The sandy bottom was exposed to the erosional effects of waves and current.

Station 34 was located in Riviere Richelieu, just upstream of Sorel. The fauna sampled was very diverse, with 15 taxa, and was reasonably abundant ($937.0/ft.^2$). Over eleven percent of the collected organisms were considered sensitive. The dominant group was the Chironomidae, and the amphipods and oligochaetes were also abundant. This community revealed good water quality at this point, as determined by the benthic fauna.

Station 35, in Lake St. Peter at the mouth of the Yamaska River and Riviere St-Francois, revealed enriched conditions. Abundance of macroinvertebrates was high ($5694.1/ft.^2$) and the benthos was diverse (13 taxa). Sensitive forms were present. Tolerant forms comprised about one-quarter of the fauna. The clams were dominant, but caddisflies, chironomids, amphipods, isopods, and oligochaetes, were abundant. The Riviere St-Francois is known to be severely degraded at the sites of several upstream industries. Undoubtedly the enriching effects of these, and of municipal wastes, have contributed to the abundant fauna at this location.

Station 40, located at Port-St-Francois was just downstream of the mouth of the Riviere Nicolet, and for purposes of discussion has been considered as reflecting both the south shore flow, and the effects of the tributary. Benthic conditions were not as good as those defined across the river at Station 39. It is possible that the effects of the Riviere Nicolet and wastes from the Nicolet area serve to impair quality in this area.

## Water Chemistry

### (a) Riviere des Mille-Iles

Water chemistry data for this section may be found in Table 3a, Figure 3 (map summary) and Figures 4, 5, 6, 7, 8, and 9 (graphical).

The chemical characteristics of Riviere des Mille-Iles generally reflected the source of supply in the Ottawa River, and the effects of pollution as noted in the preceding discussion of benthic results. The interpretation of changes in water chemistry reinforced the biological evaluation.

Station 2 provided background data on Ottawa River water input. As discussed above, this water is considered to be eutrophic. Downstream in Riviere des Mille-Iles, changes in chemical water quality were noted which corresponded to changes in the benthic community. The pH was lower in the river than in Lac des Deux-Montagnes. Such a drop (from 7.2 at Station 2 to 6.9 at Station 15) may have indicated the effects of excess carbon dioxide liberated in decomposition and respiration of excess organic material. At Station 17, dissolved oxygen levels reached a low of 8.1 ppm (81% saturation) in surface waters. Biochemical oxygen demand ($BOD_5$) rose from 0.6 at Station 2, to 1.0 at Station 18. Conductivity rose steadily over the length of the river, from 75.7 µmho/cm at Station 2, to 110 µmho/cm at Station 18. This increase may have indicated inputs of wastewater or urban runoff. The solids analysis indicated that this change was associated with elevated volatile (organic) suspended solids.

Nutrient levels generally increased over the length of Riviere des Mille-Iles. Phosphate levels rose from $<0.05$ ppm at Station 2, to 0.25 ppm at Station 18. Nitrate levels rose rather less. These high nutrient levels may reflect municipal wastewater discharges, or runoff from agricultural areas.

Several trends noted above, especially pH and oxygen decreases were accentuated at Station 23 by mixing with the lower quality water of Riviere des Prairies.

(b) Riviere des Prairies

The data discussed below is presented in Table 3b and Figure 3(map summary) and Figures 4, 5, 6, 7, 8, and 9 (graphical).

Station 2 in Lac des Deux-Montagnes served as a control point for this river, which carries mainly water derived from the Ottawa River.

Changes of water chemistry characteristics similar to those noted in the Riviere des Mille-Iles were also noted here. These results supported the biological evaluation. The pH decreased more in the Riviere des Prairies than in Riviere des Mille-Iles, falling from 7.2 at Station 2, to 6.5 at Station 22, and 6.4 at Station 23, where the biological results indicated gross organic pollution. This trend indicated again that excess carbon dioxide was possibly being liberated from decomposition of excess organic material which was noted in benthic samples. Oxygen concentrations were lowest at Stations 22 and 23, at 8.8 and 8.9 ppm respectively, decreased from 9.7 ppm at Station 20, and 10.1 ppm at Station 2. $BOD_5$ values were elevated at Station 22 (1.6 ppm).

As in Riviere des Mille-Iles, conductivity rose over the length of Riviere des Prairies, from 75.7 µmho/cm at Station 2 to 102 µmho/cm at Station 22.

Total dissolved solids levels were high at Stations 19, 20, and 21, and volatile suspended solids were high at these stations too, indicating inputs of suspended organic material.

Phosphate levels rose sharply from <0.05 ppm at Station 21, to 0.25 ppm at Station 22. Station 22 has been noted to be the most degraded location on the two "back rivers" of Montreal. This is not unusual since a large collector sewer empties untreated domestic waste into Riviere des Prairies near Ile-de-la-Visitation, between Station 21 and Station 22.

(c) St. Lawrence River - North Shore

Water chemistry results discussed in this section are presented in Table 3c, Figure 3 (map summary) and Figures 4, 5, 6, 7, 8, and 9 (graphs).

The main inflow of water to this area is derived from the St. Lawrence River. However, there is a large, but apparently variable amount of Ottawa River water which enters at three places, Dorion, St-Anne-de-Bellevue, and Charlemagne (Repentigny). Thus, superimposed on any changes of water chemistry due to human activities, there are variations from the effects of mixing of the various water masses, which are basically dissimilar in chemical characteristics.

The upstream control for the St. Lawrence River was Station 1, just upstream of Lac St-Louis. Compared to the soft, neutral, brown-coloured Ottawa River flow, the St. Lawrence was slightly alkaline (pH = 8.3), more mineralized (total dissolved solids = 299 ppm, conductivity = 329 μmho/cm), and blue-green in colour.

As in the two "back rivers", pH values were observed to decline at locations where the biological results had indicated organic pollution. This was especially obvious at Station 3°, and Station 8. In the section of river downstream of the confluence of the Riviere des Prairies, pH values were naturally lower due to the less alkaline Ottawa River water, but a low value was noted at Station 26 (6.9). In conjunction with the possible excess of carbon dioxide which may accompany a pH decrease, was a lowering of dissolved oxygen concentrations. This effect was particularly noticeable at Stations 3°, 8, and 14. At Station 8, the oxygen drop was even more severe at the bottom than at the surface, illustrating the high oxygen demand of the organic deposits. Biological results indicated that this location was grossly impaired, and that Station 3° was also degraded. Elevated biochemical oxygen demand ($BOD_5$) was measured at Stations 3°, and 8 (again more so at the bottom), but also at Station 11, where benthic conditions were severely degraded as well.

Conductivity measurements reflected the different sources of water in different sections of the north shore flow. For instance, conductivity was especially low at Station 3°, taken near shore by the mouth of Ruisseau Bouchard in Lachine. Station 3, taken at mid-stream in the same area, was similar to the control station. Between Stations 14 and 24, conductivity decreased sharply (316 µmho/cm to 99.2 µmho/cm) with the inflow of Riviere des Prairies/Riviere des Mille-Iles water. From Station 24 downstream to Lake St. Peter conductivity increased steadily as the shore flow of predominantly Ottawa River water became mixed with more mineralized St. Lawrence River water. Dissolved solids levels showed similar fluctuations. Suspended solids levels were elevated at Station 8 in Montreal Harbour.

Phosphate levels were high at the control, Station 1. This may have been due to released phosphorus from decaying vegetation, or perhaps a carryover from Lac St-Francois, upstream. High phosphate levels downstream were noted at Stations

8, 14, and 39, with slightly lower levels at Stations 11, 24, 26, 29, and 31. The high levels at Station 39 probably reflected the results of decaying vegetation in Lake St. Peter. Elevated levels at upstream stations possibly indicated the effects of sewage discharges.

Nitrate levels were less variable, but were higher downstream from the Riviere des Prairies inflow. The highest concentrations of nitrate were monitored in, and downstream of, Lake St. Peter, and had possibly resulted from decaying organic material in the lake. Another source would be runoff from the agricultural areas flanking the river and lake.

(d) St. Lawrence River - Mid-Stream

Data discussed below is presented in Table 3d, Figure 3 (map summary) and Figures 4, 5, 6, 7, 8, and 9 (graphs).

Station 1 served as control for this water flow. Generally, chemical parameters showed less variation in this water mass than in the shore flows upstream of Lake St. Peter. Concentration of dissolved oxygen remained high, $BOD_5$ levels remained low, and conductivity was steady. Suspended solids ash levels were increased somewhat at Station 10, possibly from silt. Nutrient levels remained low, except for phosphate at Station 27. The location of this station, near rooted aquatic plants on islands in mid-stream, may explain this fact.

In Lake St. Peter, a definite deterioration of water quality was noticed. Transparency was reduced, as indicated by Secchi disc observations. $BOD_5$ at Station 36 was 5.2 ppm, the highest level measured during this study. Nitrate levels were also high here. In this delta region of Lake St. Peter, extensive beds of aquatic plants may contribute abundant amounts of decaying organic matter in late summer/early fall. This fact may account for the very high nitrate and phosphate levels detected at Station 40, downstream of Lake St. Peter. Suspended solids were also high at this location. There was a possibility of influence from the outflow of the Riviere Nicolet, but levels of nutrients were also high across the river at Station 39. Possibly these values are a further indication of eutrophication in Lake St. Peter.

(e) St. Lawrence River - South Shore and Tributaries

Data discussed below is presented in Table 3e and 3f and Figure 3 (map summary) and Figures 4, 5, 6, 7, 8, and 9 (graphs).

Station 1, upstream of Lac St-Louis served as control for this water mass. However, variations were noted from the several large tributaries which joined the south shore flow. These tributaries, the Riviere Chateauguay, Riviere Richelieu, River St-Francois, Yamaska River, and Riviere Nicolet, drain much of the Eastern Townships area south of the St. Lawrence River. This area contains denser populations, more industries, and more rich farmland than the previously considered north shore drainage.

Changes of water quality in the south shore flow could often be correlated to the observed biological conditions. Elevated $BOD_5$ levels (1.1 ppm) and high nutrient levels were observed at Station 9, which was characterized biologically as being grossly organically polluted. A reduced dissolved oxygen concentration (8.7 ppm) was detected at Station 13, where the benthic fauna had not yet recovered from severe upstream pollution. Nutrient levels were generally high in the south shore flow from Station 9, at Longueuil, downstream to Station 28, near Contrecoeur. These concentrations may reflect the continuing effects of the massive input of sewage at Longueuil from the south shore collector sewer, built in connection with the St. Lawrence Seaway. As noted above in Section (d), nutrient levels were high downstream of Lake St. Peter.

The three tributary streams investigated reflected some differences of water supply. For instance, the Riviere Richelieu, which derives much of its flow from Lake Champlain, was less alkaline, and less mineralized than the St. Lawrence River. The Riviere Chateauguay resembled the St. Lawrence, while the Riviere St-Francois was intermediate. Of these three rivers, the Riviere St-Francois was considered the most degraded because of high dissolved solids levels and elevated concentrations of nitrate and phosphates. Upstream, the Riviere St-Francois serves many large communities and industries, including several paper mills.

Sediment Analyses

The data supporting this discussion may be found in Table 4 and Figure 10.

Bottom sediment classification by analysis of core segments, produces an insight into the types of material deposited on the river bottom. From this, an understanding can be gained of the amount of decomposition and oxygen uptake.

Sediments of low carbon and nitrogen content are generally inorganic or stabilized organic deposits. High carbon sediments have a slow steady oxygen demand. Nitrogenous sediments would require further stabilization. Sediments with both high carbon and high nitrogen are actively decomposing and may have a high oxygen demand (Ballinger and McKee, 1971). Figure 10 illustrates the types of sediments in this study.

These characteristics may be used to calculate the Organic Sediment Index

(O.S.I.) which is the product of the % organic carbon and % organic nitrogen. High O.S.I. values ($\geq$ 1) indicate actively decomposing sludge and vegetation. Values above 5 may indicate fresh sewage.

In the present study, high O.S.I. values corresponded to areas defined, from the biological results, as organically polluted.

(a) Riviere des Mille-Iles

Most of the sediments sampled were classified as inorganic, or stabilized organic deposits. At Stations 15 and 16, there was a tendency to high nitrogen indicating that some stabilization was in progress.

(b) Riviere des Prairies

Sediments sampled were generally stabilized. Station 22 had an O.S.I. value of 1.35, and a high organic carbon of 7%. This sediment was classified as sewage sludge. The high carbon content indicated a slow oxygen demand. These data correlated with the degraded conditions noted in the biological results.

(c) St. Lawrence River - North Shore

High O.S.I. values were found at Stations 8 and 11, two of the most degraded locations according to benthic results. These sediments were high in both organic carbon and organic nitrogen, and could be classified as sewage sludge, or decaying organic material. At Station 31, a high O.S.I. and high percent organic nitrogen probably indicated decaying vegetation from nearby beds of rooted aquatic plants.

(d) St. Lawrence River - Mid-Stream

No high values were detected at mid-stream stations, and the sediments were generally inorganic in nature.

(e) St. Lawrence River - South Shore

The only high values from south shore stations came from Station 9, a severely degraded location. The sediment there was high in both carbon and nitrogen, and was classified as sewage sludge.

(f) Tributary Rivers

No unusually high values were obtained from analysis of core samples of sediments from tributaries to the south shore flow. Organic carbon was at slightly elevated concentrations in the Riviere Chateauguay and Riviere St-Francois, but these sediments were considered to be stabilized organic deposits.

Bacteriological Analysis

Data from these analyses is presented in Table 5.

Microbiological analysis of water presents a picture of a different type of pollution to that considered under the biological, water chemistry, and sediment analyses discussed above. Bacterial pollution can be more injurious to humans than other more observable types of pollution. Also bacterial pollution can be present in waters, which, from other indications, are not degraded. The hazard lies in the possible presence of pathogenic organisms, and their contamination of water supplies, or contact with people engaging in recreational activities. The present study considered the concentrations of fecal coliform and fecal streptococcus bacteria, both common in the intestines and feces of humans, and thus indicators of raw or inadequately treated sewage discharges. Potentially hazardous levels of fecal bacteria were found at some point in each of the five water bodies studies (Table 5).

(a) Riviere des Mille-Iles

Low concentrations, or absence of fecal bacteria, were found at control Station 2, and Station 15. However, higher levels were encountered at Station 16, and extremely high levels at Stations 17 and 18, and these carried over into the Riviere des Prairies at Station 23. The FC/FS (fecal coliform/fecal streptococcus ratio) generally indicated human rather than animal wastes as the source of this bacterial pollution (FC/FS values $\geq$ 4.0; Millipore, 1971).

(b) Riviere des Prairies

Concentrations of bacteria remained low downstream to Station 22, where they were extremely high. This condition continued downstream to Station 23. At Station 24, dilution by the St. Lawrence lowered these values. These high bacteria levels undoubtedly originated from raw sewage discharged into the river by the communities on the north side of Ile de Montreal, and the south side of Ile Jesus.

(c) St. Lawrence River - North Shore

Bacteria were scarcely detectable in the St. Lawrence River upstream of Montreal, and in Lac St-Louis at Pointe Claire. However, from Station 5 in LaPrairie Basin downstream to Station 24 at Repentigny, bacterial levels were apparently very high (unfortunately, some samples from this area may have been spoiled during shipping due to analysis later than 24 hours after collection). High concentrations were also measured downstream at Station 32, near Berthierville, however the FC/FS ratio in this section indicated the possibility of animal wastes as the origin of the bacterial pollution (FC/FS $\leq$ 0.7). Generally, the areas of bacterial contamination coincided with the areas outlined above as organically polluted from waste flows.

(d) St. Lawrence River - Mid-stream

High bacterial concentrations were measured at Station 10 and Station 36, in Lake St. Peter. The high levels at Station 10 were noteworthy since organic pollution common to the shoreline water masses at this area did not extend to mid-stream, but the bacterial pollution apparently did. The high levels at Station 36 may have resulted from sewage discharged in the Sorel and Berthier-ville area.

(e) St. Lawrence River - South Shore

As in the north shore flow, upstream concentrations were very low. Elevated concentration of fecal streptococcus were detected from Station 9 to Station 13. High concentrations were also noted at Stations 30 and 33. Although some samples were over 24 hours old, the results can be interpreted as reflecting inputs of raw sewage. Areas of bacterial contamination coincided with areas of organic pollution as outlined by other indices, above.

(f) Tributary Rivers

The Riviere St-Francois had high counts of fecal bacteria. The FC/FS ratio may not indicate the true source at this location, since the sampling point at the mouth of the river was possibly more than 24 hours flow downstream from the source of contamination, thus invalidating the FC/FS concept.

The Riviere Chateauguay, and Riviere Richelieu above Sorel, were not apparently contaminated at the time and place of sampling.

CONCLUSIONS

1. Evidence of eutrophication was detected at upstream control stations in both Lac des Deux-Montagnes and Lac St-Louis. These enriched conditions were apparently the result of upstream industrial and municipal discharges.

2. Riviere des Mille-Iles revealed signs of deteriorating water quality. Biological results indicated slightly reduced water quality downstream of Laval-Ouest, Ste-Rose, and Bois-des-Filion, while recovery was evident at Terrebonne. Elevated bacterial levels were monitored from Bois-des-Filion downstream to Terrebonne.

3. Riviere des Prairies maintained good quality water downstream past Ile Laval. At Chomedy (Cartierville Bridge) some degradation was apparent in the biological community. Near Montreal-Nord, gross organic pollution was detected. Bottom sediments were characterized as sewage sludge. Very little recovery had occurred before mixing in the St. Lawrence River. Bacteria levels were elevated from Montreal-Nord to Charlemagne.

4. The St. Lawrence River north shore revealed effects of urban drainage near shore in Lac St-Louis. In Montreal Harbour, the aquatic environment was severely degraded. The effects of this heavy pollution extended downstream past Pointe-aux-Trembles and recovery was not complete at Repentigny.

5. The mid-stream stations revealed generally good quality water flowing down the centre of the St. Lawrence River. Elevated bacteria levels from surface water samples were evident in the Montreal Harbour area.

6. The St. Lawrence River south shore water was biologically degraded from Longueuil downstream to Boucherville. Some recovery was in evidence by Varennes. The station at Longueuil was the most severely impaired, where raw sewage and gasification of bottom sediments (anaerobic decomposition) was observed.

7. The section of the St. Lawrence River from Repentigny to Sorel was apparently physically limiting to benthic invertebrates. Environmental conditions were not considered as good at the entrance to Lake St. Peter as they had been at the entrance to Lac St-Louis.

8. Lake St. Peter was enriched by the effects of upstream burdens, especially in the delta area. This lake is considered very eutrophic.

9. The tributary rivers revealed varying degrees of degradation. The Riviere St-Francois was enriched, and had the poorest water quality of the three tributaries studied.

10. At the outlet of Lake St. Peter the St. Lawrence River had not completely assimilated waste loadings discharged from the greater Montreal area and downstream communities.

11. Water chemistry data (excluding bacteria concentrations) throughout the study region revealed generally good water quality. At no point was D.O. found to be limiting nor $BOD_5$ levels found to be excessive. However, nutrient concentrations were an order of magnitude above clean water conditions.

# RECOMMENDATIONS

## Parameters of Importance

1. Nutrients (nitrogen and phosphorus) are of primary importance in the degradation of water quality in the Montreal area. These nutrients have given rise to excessive growths of aquatic plants, the decay of which places a burden on the assimilative capacity of the river. Nutrient additions are especially important to the water quality of Lac St-Louis, Lac des Deux-Montagnes, and Lake St. Peter, which act as traps for N and P deposition and produce abundant aquatic plant growths. The main source of N and P would appear to be domestic sewage.

2. Organic wastes (volatile suspended and volatile dissolved solids) have caused severe degradation of the aquatic ecosystem in local areas such as Montreal-Nord, Montreal Harbour, Montreal-Est, Pointe-aux-Trembles, Longueuil, and Boucherville. Heavy deposits of organic matter have limited the recovery powers of the river. A large portion of these organics probably originate from human sewage.

3. Possible toxic effects of industrial wastes were noted in the Montreal-Est area, and would bear further investigation.

4. Bacteria concentrations monitored in the waters surrounding Montreal are high and potentially hazardous. The results indicated that these bacteria were probably derived from human sewage.

## Future Action

1. The return of waters in and around the Island of Montreal to a level of quality compatible with present user requirements will necessitate a major effort to treat industrial and municipal wastes.

2. The data indicate that removal of suspended solids and limiting nutrients would be most beneficial to the system. Accordingly, the design of treatment systems should be programmed to reduce these contaminants first.

3. Studies should be performed to determine which nutrients are limiting in the St. Lawrence River system.

4. Further studies should evaluate the generally degraded areas identified in this report to quantify their areal extent. This should include more detailed evaluation of the following locations: Montreal-Nord, Montreal Harbour, and Montreal-Est.

5. Detailed environmental studies should be implemented following the installation and start-up of any major pollution abatement systems.

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# TABLES

PROJECT: A-1155

ENVIRONMENT CANADA
OTTAWA, ONTARIO

BEAK

# TABLE 1

## SAMPLING STATION LOCATIONS
## ST. LAWRENCE RIVER SYSTEM - SEPT.-OCT., 1972

| A1155 STATION | CENTREAU STATION | REGIE DES EAUX STATION | I.H.D. STATION | KORAB STATION | MISC. REF. | MAP | | LOCATION |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Hydro | Topo. | |
| 2 | - | - | Near QU 13-31 | - | BEAK T3187-88 Stn.L2M2 | 1540 | 31G/8E and 31H/5 | Lac des Deux-Montagnes, off Ile Cadieux. |
| 1 | 8 | Near 16 | QU 13-42 | 1410B1625 | - | 1410 | 31H/5 | St. Lawrence River above Lac St-Louis. |
| 3 | 7 | Between 19 & 20 | Between QU 13-2 and QU 13-32 | 1409B8165 1410B1002 | - | 1410 and/ or 1409 | 31H/5 | St. Lawrence River above Lachine Rapids. |
| 3° | 7 | Between 19 & 20 | Between QU 13-2 and QU 13-32 | 1409B8165 1410B1002 | - | 1410 and/ or 1409 | 31H/5 | Mouth of Ruisseau Bouchard - Dorval. |
| 3' | 7 | 19 | QU 13-3 | 1410B2025 | BEAK T3187-88 Stn.LL4 Magnin Stn. 9 | 1410 | 31H/5 | Lac St-Louis, off Pointe Claire |
| 4 | - | 18 | QU 13-46 | - | - | 1410 | 31H/5 | Riviere Chateauguay, at Chateauguay. |
| 5 | 6 | Near 24 | - | - | - | 1409 | 31H/5 | St. Lawrence River - Verdun transect, north shore. |

PROJECT: A-1155

ENVIRONMENT CANADA
OTTAWA, ONTARIO

BEAK

TABLE 1 (continued)

| A1155 STATION | CENTREAU STATION | REGIE DES EAUX STATION | I.H.D. STATION | KORAB STATION | MISC. REF. | MAP Hydro | MAP Topo. | LOCATION |
|---|---|---|---|---|---|---|---|---|
| 6 | 6 | - | - | - | - | 1409 | 31H/5 | Verdun transect, mid-river. |
| 7 | 6 | 22 | - | - | - | 1409 | 31H/5 | Verdun transect, south shore. |
| 8 | 5 | Near 27 | Near QU 13-33 | Sec. 1340E0005 | - | 1340 | 31H/12 | St.Lawrence River - Longueuil transect, north shore. |
| 9 | 5 | Near 27 | Near QU 13-34 | - | - | 1340 | 31H/12 | Longueuil transect, south shore. |
| 10 | - | 29 | QU 13-36 down-stream | 1340E2005 | - | 1340 | 31H/12 and 31H/11W | St. Lawrence River, off Ile de Boucherville, near island. |
| 11 | - | 30 | QU 13-36 upstream | 1339A1020 | - | 1352 | 31H/12 and 31H/11W | North channel, Ile de Boucherville, at Montreal Est |
| 12 | - | 31 | QU 13-36 upstream | 1339B7231 | - | 1352 | 31H/11W | South channel, Ile de Boucherville at Boucher-ville. |
| 13 | - | 33 | - | 1339A3065 | - | 1352 and 1339 | 31H/11W | South channel, Ile Ste-Therese at Varennes. |

TABLE 1 (continued)

| A1155 STATION | CENTREAU STATION | REGIE DES EAUX STATION | I.H.D. STATION | KORAB STATION | MISC. REF. | MAP | | LOCATION |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Hydro | Topo. | |
| 14 | - | 33 | - | 1339B6195 | - | 1352 and 1339 | 31H/11W | North channel, Ile Ste-Therese, near Bout-de-l'Isle. |
| 15 | 20 | - | QU 13-35 | - | - | 1540 | 31H/12 | R. des Mille-Iles at Laval Ouest. |
| 16 | - | - | - | - | - | - | 31H/12 | R. des Mille-Iles at Ste-Rose |
| 17 | - | - | QU 13-20 | - | - | - | 31H/12 | R. des Mille-Iles at Bois-des-Filion. |
| 18 | 4 | - | Near QU 13-43 | - | - | - | 31H/12 | R. des Mille-Iles, down-stream of Terrebonne. |
| 19 | 22 | - | - | - | - | 1540 | 31H/5 | R. des Prairies, Pierre-fonds. |
| 20 | - | - | QU 13-19 | - | - | 1540 | 31H/12 | R. des Prairies, at Ile Laval. |
| 21 | - | - | QU 13-18 | - | - | - | 31H/12 | R. des Prairies at Chomedy (Cartierville Bridge). |
| 22 | - | - | QU 13-44 | - | - | - | 31H/12 | R. des Prairies at Montreal-Nord. |

BEAK

TABLE 1 (continued)

| A1155 STATION | CENTREAU STATION | REGIE DES EAUX STATION | I.H.D. STATION | KORAB STATION | MISC. REF. | MAP | | LOCATION |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Hydro | Topo. | |
| 23 | 2 | - | QU 13-38 | - | - | 1339 | 31H/11W | R.des Prairies, at Charlemagne. |
| 24 | 1 | - | - | 1339B3100 | - | 1339 | 31H/11W | St. Lawrence River, at Repentigny, north shore. |
| 25 | 1 | - | - | - | - | 1339 | 31H/11W | Repentigny, south shore. |
| 26 | - | - | - | - | - | 1339 and 1338 | 31H/14 | St. Lawrence River, Lavaltrie-Contrecoeur transect, north shore. |
| 27 | - | - | - | - | - | 1339 and 1338 | 31H/14 | Lavaltrie-Contrecoeur, mid-channel. |
| 28 | - | - | - | - | - | 1339 and 1338 | 31H/14 | Lavaltrie - Contrecoeur, south shore. |
| 29 | - | - | QU 13-6 | 1338B6160 | - | 1338 | 31H/14 | St. Lawrence River - Lanoraie transect, north shore. |
| 30 | - | - | - | 1388A2065 | - | 1338 | 31H/14 | Lanoraie transect, south shore. |

TABLE 1 (continued)

| A1155 STATION | CENTREAU STATION | REGIE DES EAUX STATION | I.H.D. STATION | KORAB STATION | MISC. REF. | MAP | | LOCATION |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Hydro | Topo. | |
| 31 | - | - | - | - | - | 1338 | 31I/3 | St. Lawrence River - Sorel transect, north shore. |
| 32 | - | - | - | 1338B3035 | - | 1338 | 31I/3 | Berthierville, Sorel transect (Alencon). |
| 33 | - | - | - | 1338A4135 | - | 1338 | 31I/3 | Berthierville, Sorel transect, south shore. |
| 34 | - | - | - | - | - | 1338 | 31I/3 | R. Richelieu near mouth. |
| 35 | - | - | - | - | - | 1337 | 31H/2W | Baie St.-Francois. |
| 36 | - | - | - | 1338B0000 | - | 1337 | 31H/2W | Upstream end of Lake St. Peter. |
| 37 | - | - | - | - | - | 1337 | 31I/2W & 31I/2E | Lake St. Peter transect, south shore. |
| 38 | - | - | - | 1337A4155 | - | 1337 | 31I/2E | Lake St.Peter transect, north shore. |

BEAK

TABLE 1 (continued)

| A1155 STATION | CENTREAU STATION | REGIE DES EAUX STATION | I.H.D. STATION | KORAB STATION | MISC. REF. | MAP | | LOCATION |
|---|---|---|---|---|---|---|---|---|
| | | | | | | Hydro | Topo. | |
| 39 | - | - | - | - | - | 1336 | 31I/7 | Downstream of Lake St. Peter, near Pointe-du-lac. |
| 40 | - | - | - | - | - | 1337 and 1336 | 31I/7 | Downstream of Lake St. Peter, at Port-St-Francois. |

TABLE 2a

BIOLOGICAL RESULTS (AVG. NO. ORGANISMS/FT.$^2$)
RIVIERE DES MILLE-ILES - SEPT.-OCT., 1972

| STATIONS: | 2 | 15 | 16 | 17 | 18 | 23 | 24 |
|---|---|---|---|---|---|---|---|
| GROUP 3 ORGANISMS | | | | | | | |
| Ephemeroptera | 8.6 | 1.2 | - | - | 20.1 | - | 1.2 |
| Trichoptera | 2.8 | 1.9 | 0.3 | - | 0.9 | - | 11.7 |
| Plecoptera | - | - | - | - | 0.3 | - | - |
| Coleoptera | - | - | - | - | 2.8 | - | 7.7 |
| GROUP 2 ORGANISMS | | | | | | | |
| Hemiptera | - | - | - | - | 0.3 | - | - |
| Chironomidae | 17.9 | 4.6 | 0.3 | 0.3 | 23.5 | 0.3 | 261.1 |
| Other Diptera | 0.3 | 0.6 | - | - | - | - | 0.3 |
| Pelecypoda | 65.1 | 17.3 | 60.5 | 124.1 | 45.7 | 189.5 | 2795.7 |
| Gastropoda | 0.9 | 2.8 | 0.6 | 49.7 | 21.0 | 367.6 | 386.7 |
| Amphipoda | 1.2 | 0.6 | - | 0.3 | 115.7 | 86.4 | 122.2 |
| Isopoda | 12.3 | 1.9 | - | - | - | 14.8 | 24.7 |
| Turbellaria | 1.2 | 4.6 | 0.9 | 1.9 | 4.9 | 205.6 | 221.3 |
| Hirudinea | 4.6 | 0.3 | - | 0.3 | - | 7.7 | 44.1 |
| Nemata | 2.2 | 1.2 | 7.4 | 37.0 | 0.3 | - | 6.8 |
| Nemertea | - | 1.2 | 7.1 | 17.3 | 0.9 | - | 1.2 |
| Acari | - | - | - | - | 0.3 | - | - |
| Polychaeta | - | - | - | 0.9 | - | - | - |
| Bryozoa (Statoblast) | 0.6 | - | - | - | - | - | 1.2 |
| Pisces (Agnatha) | - | - | - | - | 0.3 | - | - |
| Indet. | 0.3 | - | - | 0.6 | - | - | - |
| GROUP 1 ORGANISMS | | | | | | | |
| Oligochaeta | 45.7 | 114.2 | 21.9 | 39.2 | 26.9 | 2791.4 | 4519.1 |
| TOTAL | 163.7 | 152.4 | 99.0 | 271.6 | 263.9 | 3663.3 | 8405.0 |
| NO. OF TAXA | 14 | 13 | 8 | 11 | 15 | 8 | 15 |

TABLE 2b

BIOLOGICAL RESULTS (AVG. NO. ORGANISMS/FT.$^2$)
RIVIERE DES PRAIRIES - SEPT.-OCT., 1972

| STATIONS: | 2 | 19 | 20 | 21 | 22 | 23 | 24 |
|---|---|---|---|---|---|---|---|
| GROUP 3 ORGANISMS | | | | | | | |
| Ephemeroptera | 8.6 | 0.6 | 3.1 | 1.9 | - | - | 1.2 |
| Trichoptera | 2.8 | 93.2 | 5.6 | 18.2 | - | - | 11.7 |
| Coleoptera | - | - | 4.3 | - | - | - | 7.7 |
| Odonata | - | - | 0.3 | - | - | - | - |
| GROUP 2 ORGANISMS | | | | | | | |
| Chironomidae | 17.9 | 196.3 | 344.1 | 94.8 | - | 0.3 | 261.1 |
| Other Diptera | 0.3 | - | - | 1.5 | - | - | 0.3 |
| Pelecypoda | 65.1 | 118.5 | 24.1 | 363.6 | 118.5 | 189.5 | 2795.7 |
| Gastropoda | 0.9 | 42.6 | 23.1 | 41.4 | 148.1 | 367.6 | 386.7 |
| Cladocera | - | 4.9 | - | - | - | - | - |
| Amphipoda | 1.2 | 124.1 | 178.1 | 0.3 | - | 86.4 | 122.2 |
| Isopoda | 12.3 | 32.1 | 27.8 | 4.3 | 19.8 | 14.8 | 24.7 |
| Turbellaria | 1.2 | 9.3 | 13.9 | 8.6 | - | 205.6 | 221.3 |
| Hirudinea | 4.6 | 7.4 | 0.6 | 3.7 | 158.0 | 7.7 | 44.1 |
| Nemata | 2.2 | - | 3.4 | 3.1 | - | - | 6.8 |
| Nemertea | - | - | 0.3 | 0.6 | - | - | 1.2 |
| Polychaeta | - | - | - | 0.3 | - | - | - |
| Bryozoa (Statoblast) | 0.6 | 4.9 | - | 0.3 | - | - | 1.2 |
| Indet. | 0.3 | - | - | - | - | - | - |
| GROUP 1 ORGANISMS | | | | | | | |
| Oligochaeta | 45.7 | 97.5 | 124.1 | 325.3 | 29858.0 | 2791.4 | 4519.1 |
| TOTAL | 163.7 | 731.4 | 752.8 | 867.9 | 30302.4 | 3663.3 | 8405.0 |
| NO. OF TAXA | 14 | 12 | 14 | 15 | 5 | 8 | 15 |

PROJECT: A-1155

ENVIRONMENT CANADA
OTTAWA, ONTARIO

TABLE 2c

BIOLOGICAL RESULTS (AVG. NO. ORGANISMS/FT.$^2$)
ST. LAWRENCE RIVER - NORTH SHORE
SEPT.-OCT., 1972

| STATIONS: | 1 | 3' | 3° | 5* | 8 | 11 | 14 |
|---|---|---|---|---|---|---|---|
| GROUP 3 ORGANISMS | | | | | | | |
| Ephemeroptera | 1.9 | 0.3 | - | - | - | - | - |
| Trichoptera | 9.0 | 2.5 | - | (5) | - | - | - |
| Coleoptera | - | - | - | - | - | - | - |
| Odonata | - | - | - | - | - | - | - |
| GROUP 2 ORGANISMS | | | | | | | |
| Lepidoptera | - | - | - | - | - | - | 0.3 |
| Chironomidae | 53.7 | 23.5 | 17.9 | - | - | - | 1.2 |
| Other Diptera | - | - | - | - | - | - | - |
| Insecta (Adult) | 0.3 | 0.3 | - | - | - | - | - |
| Pelecypoda | 16.0 | 671.6 | 50.9 | (8) | 123.5 | 260.5 | 5.6 |
| Gastropoda | 151.9 | 34.6 | 361.4 | (78) | 19.8 | 427.2 | 10.2 |
| Amphipoda | 84.3 | 1.9 | 139.2 | (7) | - | - | - |
| Isopoda | - | 21.3 | - | - | - | - | - |
| Turbellaria | 4.9 | 3.7 | 128.7 | - | 19.8 | 19.8 | - |
| Hirudinea | 0.3 | 13.3 | 0.3 | (1) | 2.5 | 69.1 | 1.9 |
| Nemata | 0.9 | 1.2 | - | - | - | - | 0.3 |
| Nemertea | 0.9 | - | - | - | - | - | - |
| Coelenterata | 0.9 | - | - | - | - | - | - |
| Acari | - | - | - | - | - | - | - |
| Polychaeta | - | - | - | - | - | - | - |
| Bryozoa (Statoblast) | 0.6 | - | - | - | 2.5 | - | 0.3 |
| Indet. | - | - | - | - | - | - | - |
| GROUP 1 ORGANISMS | | | | | | | |
| Oligochaeta | 54.0 | 79.0 | 1942.9 | (4) | 116014.8 | 32656.8 | 1492.3 |
| TOTAL | 379.6 | 853.2 | 2641.3 | (103) | 116182.9 | 33433.4 | 1512.1 |
| NO. OF TAXA | 14 | 12 | 7 | 6 | 6 | 5 | 8 |

* Qualitative Sample, composite of 4 core samples.

TABLE 2c (continued)

| STATIONS: | 24 | 26 | 29 | 31 | 32 | 38 | 39 |
|---|---|---|---|---|---|---|---|
| GROUP 3 ORGANISMS | | | | | | | |
| Ephemeroptera | 1.2 | - | - | - | - | - | 6.2 |
| Trichoptera | 11.7 | 6.2 | - | - | 0.3 | - | - |
| Coleoptera | 7.7 | - | - | - | - | - | 0.6 |
| Odonata | - | - | - | - | - | - | 1.9 |
| GROUP 2 ORGANISMS | | | | | | | |
| Lepidoptera | - | - | - | - | - | - | - |
| Chironomidae | 261.1 | 37.0 | 7.7 | - | 9.9 | 4.3 | 77.8 |
| Other Diptera | 0.3 | - | - | - | - | 0.3 | 3.1 |
| Insecta (Adult) | - | - | - | - | - | - | - |
| Pelecypoda | 2795.7 | 1224.7 | 9.0 | 2888.9 | 340.4 | 34.9 | 171.6 |
| Gastropoda | 386.7 | 22.2 | - | 895.1 | 47.5 | 1.5 | 0.6 |
| Amphipoda | 122.2 | 37.0 | 1.9 | 1155.6 | 66.4 | 2.8 | 17.9 |
| Isopoda | 24.7 | - | - | 19.8 | - | - | - |
| Turbellaria | 221.3 | 91.4 | 0.3 | 106.2 | 3.4 | 0.9 | 2.5 |
| Hirudinea | 44.1 | - | 0.3 | 55.6 | 0.9 | - | 1.2 |
| Nemata | 6.8 | 1.2 | - | 4.9 | 1.2 | 1.9 | 3.7 |
| Nemertea | 1.2 | - | - | - | 22.2 | - | 0.6 |
| Coelenterata | - | - | - | - | - | - | - |
| Acari | - | - | - | - | 0.3 | - | - |
| Polychaeta | - | - | 0.3 | 824.7 | 0.9 | - | - |
| Bryozoa (Statoblast) | 1.2 | - | - | - | - | - | 0.6 |
| Indet. | - | - | - | - | 0.3 | - | - |
| GROUP 1 ORGANISMS | | | | | | | |
| Oligochaeta | 4519.1 | 2865.4 | 66.7 | 2972.8 | 100.0 | 54.6 | 898.8 |
| TOTAL | 8405.0 | 4285.1 | 86.2 | 8923.6 | 593.7 | 101.2 | 1187.1 |
| NO. OF TAXA | 15 | 8 | 7 | 9 | 13 | 8 | 14 |

TABLE 2d

BIOLOGICAL RESULTS (AVG. NO. ORGANISMS/$FT.^2$)
ST. LAWRENCE RIVER - MID-STREAM
SEPT.-OCT., 1972

| STATIONS: | 1 | 10 | 27 | 36 | 40 |
|---|---|---|---|---|---|
| GROUP 3 ORGANISMS | | | | | |
| Ephemeroptera | 1.9 | - | - | - | - |
| Trichoptera | 9.0 | 1.9 | - | 5.2 | - |
| Coleoptera | - | - | 0.6 | - | 0.6 |
| Odonata | - | - | - | 0.6 | - |
| GROUP 2 ORGANISMS | | | | | |
| Chironomidae | 53.7 | 6.2 | 73.1 | 10.1 | 167.9 |
| Other Diptera | - | - | - | - | 0.3 |
| Insecta (Adult) | 0.3 | - | 0.3 | - | - |
| Pelecypoda | 16.0 | 304.0 | 181.2 | 2246.6 | 260.5 |
| Gastropoda | 151.9 | 23.5 | 83.0 | 20.7 | 14.2 |
| Amphipoda | 84.3 | 1.9 | 306.2 | 51.9 | 1.5 |
| Isopoda | - | - | 1.2 | 0.9 | - |
| Turbellaria | 4.9 | 0.9 | 4.6 | 6.2 | 11.1 |
| Hirudinea | 0.3 | 1.5 | 1.2 | 34.6 | 8.6 |
| Nemata | 0.9 | 2.5 | 6.5 | 18.8 | 3.4 |
| Nemertea | 0.9 | 1.2 | 2.2 | 2.8 | 8.3 |
| Coelenterata | 0.9 | - | - | - | - |
| Polychaeta | - | 7.4 | - | 16.0 | 3.1 |
| Bryozoa (Statoblast) | 0.6 | - | 1.2 | 5.6 | - |
| Porifera | - | - | - | - | 0.6 |
| GROUP 1 ORGANISMS | | | | | |
| Oligochaeta | 54.0 | 721.0 | 3.4 | 681.8 | 56.5 |
| TOTAL | 379.6 | 1072.0 | 664.7 | 3101.8 | 536.6 |
| NO. OF TAXA | 14 | 11 | 13 | 14 | 13 |

TABLE 2e

BIOLOGICAL RESULTS (AVG. NO. ORGANISMS/FT.$^2$)
ST. LAWRENCE RIVER - SOUTH SHORE
SEPT.-OCT., 1972

| STATIONS: | 1 | 7 | 9 | 12 | 13 | 25 |
|---|---|---|---|---|---|---|
| GROUP 3 ORGANISMS | | | | | | |
| Ephemeroptera | 1.9 | - | - | - | - | - |
| Trichoptera | 9.0 | 131.8 | - | - | 6.2 | - |
| Coleoptera | - | - | - | - | - | - |
| Odonata | - | - | - | - | - | - |
| GROUP 2 ORGANISMS | | | | | | |
| Lepidoptera | - | - | - | - | - | - |
| Chironomidae | 53.7 | 78.7 | 1.2 | - | 58.0 | 7.1 |
| Other Diptera | - | - | - | - | - | - |
| Insecta (Adult) | 0.3 | - | - | - | - | 0.3 |
| Pelecypoda | 16.0 | 30.6 | 1.2 | 1092.6 | 112.7 | 0.9 |
| Gastropoda | 151.9 | 260.2 | 2.5 | 1021.0 | 302.2 | 0.3 |
| Amphipoda | 84.3 | 16.0 | - | 53.1 | 29.0 | 4.9 |
| Isopoda | - | 24.4 | - | 80.2 | 1.5 | - |
| Decapoda | - | - | - | - | - | - |
| Turbellaria | 4.9 | 14.2 | - | 79.0 | 2.8 | - |
| Hirudinea | 0.3 | 1.9 | - | 29.6 | 4.6 | - |
| Nemata | 0.9 | 0.3 | - | 2.5 | 2.5 | 0.3 |
| Nemertea | 0.9 | 0.3 | - | - | 6.5 | - |
| Coelenterata | 0.9 | - | - | - | - | - |
| Polychaeta | - | - | - | - | - | - |
| Bryozoa (Statoblast) | 0.6 | 0.9 | - | - | - | 0.3 |
| Porifera | - | - | - | - | - | - |
| GROUP 1 ORGANISMS | | | | | | |
| Oligochaeta | 54.0 | 60.2 | 490.1 | 5750.6 | 111.4 | 7.1 |
| TOTAL | 379.6 | 619.5 | 495.0 | 8108.6 | 637.4 | 21.2 |
| NO. OF TAXA | 14 | 12 | 4 | 8 | 11 | 8 |

TABLE 2e (continued)

| STATIONS: | 28 | 30 | 33 | 36 | 40 |
|---|---|---|---|---|---|
| GROUP 3 ORGANISMS | | | | | |
| Ephemeroptera | 0.3 | - | 0.3 | - | - |
| Trichoptera | 2.2 | - | 0.3 | 5.2 | - |
| Coleoptera | - | - | - | - | 0.6 |
| Odonata | - | - | - | 0.6 | - |
| GROUP 2 ORGANISMS | | | | | |
| Lepidoptera | 0.3 | - | - | - | - |
| Chironomidae | 0.3 | 28.4 | 11.1 | 10.1 | 167.9 |
| Other Diptera | - | 12.7 | - | - | 0.3 |
| Insecta (Adult) | - | - | - | - | - |
| Pelecypoda | 104.9 | 78.1 | 171.0 | 2246.6 | 260.5 |
| Gastropoda | 1.5 | - | 5.9 | 20.7 | 14.2 |
| Amphipoda | 122.2 | 90.7 | 231.5 | 51.9 | 1.5 |
| Isopoda | 0.9 | - | - | 0.9 | - |
| Decapoda | 0.6 | - | - | - | - |
| Turbellaria | 4.3 | 0.9 | 1.5 | 6.2 | 11.1 |
| Hirudinea | - | - | 2.2 | 34.6 | 8.6 |
| Nemata | 0.6 | - | 0.3 | 18.8 | 3.4 |
| Nemertea | 3.4 | 0.6 | - | 2.8 | 8.3 |
| Coelenterata | - | - | - | - | - |
| Polychaeta | - | - | - | 16.0 | 3.1 |
| Bryozoa (Statoblast) | - | - | 0.3 | 5.6 | - |
| Porifera | - | - | - | - | 0.6 |
| GROUP 1 ORGANISMS | | | | | |
| Oligochaeta | 58.0 | 100.3 | 722.5 | 681.8 | 56.5 |
| TOTAL | 299.5 | 311.7 | 1146.9 | 3101.8 | 536.6 |
| NO. OF TAXA | 13 | 7 | 11 | 14 | 13 |

TABLE 2f

BIOLOGICAL RESULTS (AVG. NO. ORGANISMS/FT.$^2$)
TRIBUTARY RIVERS - SEPT.-OCT., 1972

| STATIONS: | 4 | 34 | 35 | 40 |
|---|---|---|---|---|
| GROUP 3 ORGANISMS | | | | |
| Ephemeroptera | 1.2 | 62.0 | 4.9 | - |
| Trichoptera | 33.0 | 24.1 | 273.8 | - |
| Coleoptera | 24.1 | 20.7 | - | 0.6 |
| Odonata | - | 0.3 | - | - |
| GROUP 2 ORGANISMS | | | | |
| Lepidoptera | 2.5 | - | - | - |
| Chironomidae | 156.8 | 271.0 | 319.4 | 167.9 |
| Other Diptera | 7.7 | 14.5 | 22.8 | 0.3 |
| Pelecypoda | 264.5 | 15.7 | 2906.5 | 260.5 |
| Gastropoda | 632.4 | 40.1 | 182.1 | 14.2 |
| Amphipoda | 226.5 | 259.9 | 235.2 | 1.5 |
| Isopoda | 117.6 | - | 102.2 | - |
| Turbellaria | 27.8 | 20.1 | 77.8 | 11.1 |
| Hirudinea | 20.7 | 4.6 | 64.5 | 8.6 |
| Nemata | 7.4 | 28.1 | 21.0 | 3.4 |
| Nemertea | - | 3.1 | - | 8.3 |
| Acari | 2.5 | 1.2 | - | - |
| Polychaeta | - | - | 1.2 | 3.1 |
| Bryozoa (Statoblast) | - | - | - | - |
| Porifera | - | - | - | 0.6 |
| GROUP 1 ORGANISMS | | | | |
| Oligochaeta | 132.1 | 171.6 | 1482.7 | 56.5 |
| TOTAL | 1656.8 | 937.0 | 5694.1 | 536.6 |
| NO. OF TAXA | 15 | 15 | 13 | 13 |

TABLE 3a

RESULTS OF PHYSICAL AND CHEMICAL ANALYSIS OF WATER
RIVIERE DES MILLE-ILES
SEPT.-OCT., 1972

| PARAMETER / STATION: | 2 | | 15 | | 16 | |
|---|---|---|---|---|---|---|
| DEPTH (ft.): | 1 | 12 | 1 | 12 | 1 | 15 |
| DATE (1972): | 12/10 | 12/10 | 29/9 | 29/9 | 29/9 | 29/9 |
| Secchi Disc Transparency (ft.) | 7.0 | - | 7.0 | - | 7.0 | - |
| Temperature ($^{o}$C) | 12.3 | 12.3 | 15.5 | 15.5 | 15.7 | 15.9 |
| pH | 7.2 | 7.0 | 6.9 | 7.1 | 7.0 | 7.0 |
| Dissolved Oxygen: % Saturation | 94.0 | 90.0 | 95.0 | 93.0 | 91.0 | 91.0 |
| ppm | 10.1 | 9.8 | 9.6 | 9.4 | 9.2 | 9.1 |
| $BOD_5$ | 0.6 | 0.5 | 0.6 | 0.8 | 0.6 | 0.4 |
| Conductivity (µmho/cm) | 75.7 | 75.7 | 79.0 | 79.0 | 87.1 | 86.4 |
| Dissolved Solids | 117 | 81 | 109 | 68 | 82 | 83 |
| Dissolved Solids Ash | 51 | 65 | 46 | 54 | 57 | 42 |
| Volatile Dissolved Solids | 66 | 16 | 63 | 14 | 25 | 41 |
| Suspended Solids | 19.2 | 1.6 | 1.2 | 11.2 | 7.6 | 2.4 |
| Suspended Solids Ash | 16.4 | <0.4 | <1 | 4.0 | <1 | <1 |
| Volatile Suspended Solids | 2.8 | 1.2 | 0.2 | 7.2 | 6.6 | 1.4 |
| Total Solids | 136 | 83 | 110 | 79 | 90 | 85 |
| Total Solids Ash | 67 | 65 | 83 | 58 | 57 | 42 |
| Volatile Total Solids | 69 | 18 | 27 | 21 | 33 | 43 |
| Nitrate | 0.21 | 0.30 | 0.23 | 0.17 | 0.18 | 0.15 |
| Phosphate (Ortho) | <0.05 | 0.09 | <0.05 | <0.05 | 0.14 | 0.09 |

All results expressed as ppm except pH, unless otherwise stated.

TABLE 3a (continued)

| PARAMETER / STATION: | 17 | 18 | 23 | 24 |
|---|---|---|---|---|
| DEPTH (ft.): | 1 | 1 | 1 | 1 |
| DATE (1972): | 29/9 | 1/10 | 1/10 | 5/10 |
| Secchi Disc Transparency (ft.) | 6.0 | 5.0 | 5.0 | 5.0 |
| Temperature (°C) | 16.0 | 14.5 | 15.5 | 15.0 |
| pH | 7.0 | 7.1 | 6.4 | 7.4 |
| Dissolved Oxygen: % Saturation | 81.0 | 94.0 | 89.0 | 85.0 |
| ppm | 8.1 | 9.6 | 8.9 | 8.7 |
| $BOD_5$ | 0.6 | 1.0 | 0.7 | 0.8 |
| Conductivity (μmho/cm) | 96.8 | 110 | 81.7 | 99.2 |
| Dissolved Solids | 54 | 92 | 123 | 99 |
| Dissolved Solids Ash | 6 | 68.7 | 62 | 19 |
| Volatile Dissolved Solids | 48 | 23.3 | 61 | 80 |
| Suspended Solids | 5.6 | 6.8 | 10.4 | 1.6 |
| Suspended Solids Ash | <1 | 2.4 | 6.0 | 0 |
| Volatile Suspended Solids | 4.6 | 4.4 | 4.4 | 1.6 |
| Total Solids | 118 | 99 | 133 | 101 |
| Total Solids Ash | 60 | 75 | 68 | 19 |
| Volatile Total Solids | 58 | 24 | 65 | 82 |
| Nitrate | 0.20 | 0.26 | 0.18 | 0.22 |
| Phosphate (Ortho) | 0.18 | 0.25 | 0.09 | 0.13 |

All results expressed as ppm except pH, unless otherwise stated.

TABLE 3b

RESULTS OF PHYSICAL AND CHEMICAL ANALYSIS OF WATER
RIVIERE DES PRAIRIES - SEPT.-OCT., 1972

| PARAMETER / STATION: | 2 | | 19 | 20 |
|---|---|---|---|---|
| DEPTH (ft.): | 1 | 12 | 1 | 1 |
| DATE (1972): | 12/10 | 12/10 | 28/9 | 28/9 |
| Secchi Disc Transparency (ft.) | 7.0 | - | >10.0 | 7.0 |
| Temperature (°C) | 12.3 | 12.3 | 15.5 | 16.5 |
| pH | 7.2 | 7.0 | 6.7 | 6.9 |
| Dissolved Oxygen: % Saturation | 94.0 | 90.0 | 93.0 | 99.0 |
| ppm | 10.1 | 9.8 | 9.4 | 9.7 |
| $BOD_5$ | 0.6 | 0.5 | 1.1 | 0.5 |
| Conductivity (μmho/cm) | 75.7 | 75.7 | 76.9 | 77.4 |
| Dissolved Solids | 117 | 81 | 269 | 268 |
| Dissolved Solids Ash | 51 | 65 | 126 | 129 |
| Volatile Dissolved Solids | 66 | 16 | 143 | 139 |
| Suspended Solids | 19.2 | 1.6 | 1.0 | 0.5 |
| Suspended Solids Ash | 16.4 | <0.4 | 0.0 | 0.0 |
| Volatile Suspended Solids | 2.8 | 1.2 | 1.0 | 0.5 |
| Total Solids | 136 | 83 | 270 | 269 |
| Total Solids Ash | 67 | 65 | 126 | 129 |
| Volatile Total Solids | 69 | 18 | 144 | 140 |
| Nitrate | 0.21 | 0.30 | 0.17 | 0.21 |
| Phosphate (Ortho) | <0.05 | 0.09 | <0.05 | <0.05 |

All results expressed as ppm except pH, unless otherwise stated.

TABLE 3b (continued)

| PARAMETER / STATION: | 21 | 22 | 23 | 24 |
|---|---|---|---|---|
| DEPTH (ft.): | 1 | 1 | 1 | 1 |
| DATE (1972): | 28/9 | 1/10 | 1/10 | 5/10 |
| Secchi Disc Transparency (ft.) | 7.0 | 3.0 | 5.0 | 5.0 |
| Temperature (°C) | 16.3 | 15.5 | 15.5 | 15.0 |
| pH | 6.8 | 6.5 | 6.4 | 7.4 |
| Dissolved Oxygen: % Saturation | 91.0 | 87.0 | 89.0 | 85.0 |
| ppm | 9.0 | 8.8 | 8.9 | 8.7 |
| $BOD_5$ | 0.3 | 1.6 | 0.7 | 0.8 |
| Conductivity (μmho/cm) | 80.0 | 102 | 81.7 | 99.2 |
| Dissolved Solids | 238 | 95 | 123 | 99 |
| Dissolved Solids Ash | 97 | 83 | 62 | 19 |
| Volatile Dissolved Solids | 141 | 12 | 61 | 80 |
| Suspended Solids | 0.5 | 5.2 | 10.4 | 1.6 |
| Suspended Solids Ash | 0.0 | <1 | 6.0 | 0.0 |
| Volatile Suspended Solids | 0.5 | 4.2 | 4.4 | 1.6 |
| Total Solids | 239 | 100 | 133 | 101 |
| Total Solids Ash | 97 | 83 | 68 | 19 |
| Volatile Total Solids | 142 | 17 | 65 | 82 |
| Nitrate | 0.17 | 0.23 | 0.18 | 0.22 |
| Phosphate (Ortho) | <0.05 | 0.25 | 0.09 | 0.13 |

All results expressed as ppm except pH, unless otherwise stated.

PROJECT: A-1155

ENVIRONMENT CANADA
OTTAWA, ONTARIO

TABLE 3c

RESULTS OF PHYSICAL AND CHEMICAL ANALYSIS OF WATER
ST. LAWRENCE RIVER - NORTH SHORE
SEPT.-OCT., 1972

| PARAMETER \ STATION: | 1 | 3' | | 3° | 3 | |
|---|---|---|---|---|---|---|
| DEPTH (ft.): | 1 | 1 | 22 | 1 | 1 | 18 |
| DATE (1972): | 27/9 | 27/9 | 27/9 | 26/9 | 26/9 | 26/9 |
| Secchi Disc Transparency (ft.) | >7.0 | 13.0 | - | >6.0 | 9.5 | - |
| Temperature (°C) | 18.1 | 18.0 | 18.0 | 17.9 | 18.3 | 18.3 |
| pH | 8.3 | 8.1 | 8.0 | 7.0 | 7.8 | 8.1 |
| Dissolved Oxygen: % Saturation | 112.0 | 100.0 | 94.0 | 87.0 | 95.5 | 94.5 |
| ppm | 10.7 | 9.6 | 9.0 | 8.4 | 9.1 | 9.0 |
| $BOD_5$ | 0.9 | 1.1 | 0.9 | 1.5 | 0.6 | 0.9 |
| Conductivity (µmho/cm) | 329 | 329 | 329 | 110 | 306 | 324 |
| Dissolved Solids | 299 | 364 | 371 | 231 | 308 | 339 |
| Dissolved Solids Ash | 254 | 213 | 246 | 181 | 234 | 263 |
| Volatile Dissolved Solids | 45 | 151 | 125 | 50 | 74 | 76 |
| Suspended Solids | 4.0 | 2.0 | 2.5 | 3.0 | 4.0 | 3.0 |
| Suspended Solids Ash | 1.5 | 1.5 | 1.0 | 2.0 | 2.0 | 2.0 |
| Volatile Suspended Solids | 2.5 | 0.5 | 1.5 | 1.0 | 2.0 | 1.0 |
| Total Solids | 303 | 366 | 374 | 234 | 312 | 342 |
| Total Solids Ash | 256 | 215 | 247 | 183 | 236 | 265 |
| Volatile Total Solids | 47 | 151 | 127 | 151 | 76 | 77 |
| Nitrate | 0.06 | 0.06 | 0.06 | 0.14 | 0.07 | 0.09 |
| Phosphate (Ortho) | 0.19 | <0.05 | <0.05 | 0.10 | 0.06 | 0.10 |

All results expressed as ppm except pH, unless otherwise stated.

TABLE 3c (continued)

| PARAMETER \ STATION: | 5 | 8 | | 11 | | 14 | 24 |
|---|---|---|---|---|---|---|---|
| DEPTH (ft.): | 1 | 1 | 40 | 1 | 30 | 1 | 1 |
| DATE (1972): | 2/10 | 3/10 | 3/10 | 3/10 | 3/10 | 4/10 | 5/10 |
| Secchi Disc Transparency (ft.) | >6.0 | 7.0 | - | 7.0 | - | 7.0 | 5.0 |
| Temperature ($^{o}C$) | 15.3 | 16.5 | 15.9 | 16.0 | 16.5 | 16.5 | 15.0 |
| pH | 7.7 | 7.6 | 7.6 | 7.9 | 7.7 | 7.8 | 7.4 |
| Dissolved Oxygen: | | | | | | | |
| % Saturation | 98.0 | 89.0 | 83.0 | 98.0 | 93.0 | 89.0 | 85.0 |
| ppm | 9.9 | 8.8 | 8.3 | 9.8 | 9.2 | 8.8 | 8.7 |
| $BOD_5$ | 1.1 | 1.6 | 1.9 | 1.3 | 1.2 | 1.1 | 0.8 |
| Conductivity (μmho/cm) | 262 | 300 | 305 | 305 | 300 | 316 | 99.2 |
| Dissolved Solids | 177 | 193 | 187 | 207 | 221 | 243 | 99 |
| Dissolved Solids Ash | 121.6 | 146.6 | 153.8 | 134.6 | 143.2 | 130.6 | 19 |
| Volatile Diss. Solids | 55.4 | 46.4 | 33.2 | 62.4 | 77.8 | 112.4 | 80 |
| Suspended Solids | 8.0 | 13.6 | 20.0 | 8.0 | 18.8 | 7.6 | 1.6 |
| Suspended Solids Ash | 4.4 | 8.4 | 13.2 | 4.4 | 14.8 | 2.4 | 0 |
| Volatile Susp. Solids | 3.6 | 5.2 | 6.8 | 3.6 | 4.0 | 5.2 | 1.6 |
| Total Solids | 185 | 207 | 207 | 215 | 240 | 251 | 101 |
| Total Solids Ash | 126 | 155 | 167 | 139 | 158 | 133 | 19 |
| Volatile Total Solids | 59 | 52 | 40 | 76 | 82 | 118 | 82 |
| Nitrate | <0.05 | 0.10 | 0.08 | 0.10 | 0.08 | 0.12 | 0.22 |
| Phosphate (Ortho) | <0.05 | 0.19 | 0.19 | 0.13 | 0.10 | 0.23 | 0.13 |

All results expressed as ppm except pH, unless otherwise stated.

TABLE 3c (continued)

| STATION: / PARAMETER | 26 | | 29 | 31 | | 32 | 38 | 39 |
|---|---|---|---|---|---|---|---|---|
| DEPTH (ft.): | 1 | 16 | 1 | 1 | 15 | 1 | 1 | 1 |
| DATE (1972): | 6/10 | 6/10 | 11/10 | 10/10 | 10/10 | 10/10 | 15/10 | 15/10 |
| Secchi Disc Transparency (ft.) | 5.0 | - | 4.0 | 3.5 | - | 4.0 | 5.0 | 2.0 |
| Temperature ($^{o}$C) | 15.5 | 15.2 | 10.5 | 11.0 | 11.5 | 11.5 | 10.0 | 7.0 |
| pH | 6.9 | 7.2 | 7.4 | 7.2 | 7.4 | 7.6 | 7.8 | 7.8 |
| Dissolved Oxygen: | | | | | | | | |
| % Saturation | 90.0 | 90.0 | 93.0 | 93.0 | 90.0 | 94.0 | 96.0 | 97.0 |
| ppm | 9.1 | 9.2 | 10.4 | 10.3 | 9.9 | 10.3 | 10.9 | 11.8 |
| $BOD_5$ | 0.9 | 1.0 | 0.8 | 0.3 | 0.4 | 0.2 | 0.5 | 0.5 |
| Conductivity (μmho/cm) | 87.5 | 95.0 | 110 | 109 | 117 | 128 | 154 | 115 |
| Dissolved Solids | 99 | 79 | 193 | 114 | 91 | 118 | 252 | 144 |
| Dissolved Solids Ash | 45.2 | 51 | 14 | 91 | 42 | 75 | 143 | 63 |
| Volatile Diss. Solids | 53.8 | 28 | 179 | 23 | 49 | 43 | 109 | 81 |
| Suspended Solids | 3.6 | 1.8 | 10.4 | 12.4 | 11.0 | 8.4 | 5.8 | 39.6 |
| Suspended Solids Ash | 0.8 | 0.0 | 8.8 | 9.6 | 10.6 | 7.0 | 5.2 | 36.8 |
| Volatile Susp. Solids | 2.8 | 1.8 | 1.6 | 2.8 | 0.4 | 1.4 | 0.6 | 2.8 |
| Total Solids | 103 | 81 | 203 | 126 | 102 | 126 | 258 | 184 |
| Total Solids Ash | 46 | 51 | 23 | 101 | 53 | 82 | 148 | 100 |
| Volatile Total Solids | 57 | 30 | 180 | 25 | 49 | 44 | 110 | 84 |
| Nitrate | 0.26 | 0.26 | 0.20 | 0.20 | 0.26 | 0.19 | 0.50 | 0.44 |
| Phosphate (Ortho) | 0.12 | 0.08 | 0.11 | 0.11 | 0.13 | <0.05 | 0.10 | 0.19 |

All results expressed as ppm except pH, unless otherwise stated.

TABLE 3d

RESULTS OF PHYSICAL AND CHEMICAL ANALYSIS OF WATER
ST. LAWRENCE RIVER - MID-STREAM
SEPT.-OCT., 1972

| PARAMETER / STATION: | 1 | 6 | 10 | | 27 | 36 | | 40 |
|---|---|---|---|---|---|---|---|---|
| DEPTH (ft.): | 1 | 1 | 1 | 12 | 1 | 1 | 13 | 1 |
| DATE (1972): | 27/9 | 2/10 | 3/10 | 3/10 | 6/10 | 11/10 | 11/10 | 15/10 |
| Secchi Disc Transparency (ft.) | >7.0 | 7.0 | 10.0 | - | 5.8 | 5.0 | - | 2.0 |
| Temperature ($^{o}$C) | 18.1 | 16.0 | 16.0 | 16.5 | 17.0 | 12.0 | 12.0 | 7.5 |
| pH | 8.3 | 7.8 | 8.0 | 7.9 | 8.1 | 7.8 | 7.2 | 7.9 |
| Dissolved Oxygen: % Saturation | 112.0 | 98.0 | 100.0 | 101.0 | 103.0 | 93.0 | 93.0 | 100.0 |
| Dissolved Oxygen: ppm | 10.7 | 9.8 | 10.0 | 10.0 | 10.0 | 10.2 | 10.1 | 12.1 |
| $BOD_5$ | 0.9 | 0.8 | 0.9 | 0.4 | 0.6 | 5.2 | 0.7 | 0.7 |
| Conductivity (μmho/cm) | 329 | 349 | 349 | 343 | 337 | 205 | 205 | 212 |
| Dissolved Solids | 299 | 207 | 241 | 237 | 217 | 174 | 149 | 199 |
| Dissolved Solids Ash | 254 | 119.2 | 167.2 | 174.8 | 124.6 | 101 | 112 | 74 |
| Volatile Diss. Solids | 45 | 87.8 | 73.8 | 62.2 | 92.4 | 73 | 37 | 125 |
| Suspended Solids | 4.0 | 11.2 | 15.2 | 20.8 | 3.4 | 15.6 | 2.4 | 29.4 |
| Suspended Solids Ash | 1.5 | 4.8 | 10.8 | 13.6 | 0.4 | 11.0 | 0.6 | 26.8 |
| Volatile Susp. Solids | 2.5 | 6.4 | 4.4 | 7.2 | 3.0 | 4.6 | 1.8 | 2.6 |
| Total Solids | 303 | 218 | 256 | 258 | 217 | 190 | 151 | 228 |
| Total Solids Ash | 256 | 124 | 178 | 188 | 125 | 112 | 113 | 101 |
| Volatile Total Solids | 47 | 94 | 78 | 70 | 92 | 78 | 38 | 127 |
| Nitrate | 0.06 | 0.07 | 0.04 | 0.06 | 0.07 | 0.16 | 0.15 | 0.35 |
| Phosphate (Ortho) | 0.19 | <0.05 | <0.05 | <0.05 | 0.11 | 0.09 | 0.10 | 0.29 |

All results expressed as ppm except pH, unless otherwise stated.

TABLE 3e

RESULTS OF PHYSICAL AND CHEMICAL ANALYSIS OF WATER
ST. LAWRENCE RIVER - SOUTH SHORE
SEPT.-OCT., 1972

| PARAMETER / STATION: | 1 | 7 | 9 | | 12 | 13 | 25 |
|---|---|---|---|---|---|---|---|
| DEPTH (ft.): | 1 | 1 | 1 | 6 | 1 | 1 | 1 |
| DATE (1972): | 27/9 | 2/10 | 5/10 | 5/10 | 5/10 | 4/10 | 5/10 |
| Secchi Disc Transparency (ft.) | >7.0 | >7.0 | 10.5 | - | 10.0 | 10.0 | 7.5 |
| Temperature (°C) | 18.1 | 15.3 | 17.0 | 16.5 | 16.5 | 17.0 | 17.0 |
| pH | 8.3 | 7.9 | 8.1 | 8.3 | 8.0 | 8.2 | 7.8 |
| Dissolved Oxygen: | | | | | | | |
| % Saturation | 112.0 | 98.0 | 101.0 | 102.0 | 88.0 | 99.0 | 101.0 |
| ppm | 10.7 | 9.9 | 9.9 | 10.1 | 8.7 | 9.6 | 9.9 |
| $BOD_5$ | 0.9 | 0.8 | 0.5 | 1.1 | 0.7 | 0.8 | 0.7 |
| Conductivity (µmho/cm) | 329 | 351 | 337 | 364 | 343 | 337 | 358 |
| Dissolved Solids | 299 | 214 | 243 | 243 | 225 | 190 | 216 |
| Dissolved Solids Ash | 254 | 163 | 148.6 | 162.2 | 157.4 | 42.2 | 149.6 |
| Volatile Diss. Solids | 45 | 51 | 94.4 | 80.8 | 67.6 | 147.8 | 66.4 |
| Suspended Solids | 4.0 | 16.4 | 3.4 | 3.8 | 7.2 | 2.8 | 5.8 |
| Suspended Solids Ash | 1.5 | 12.0 | 0.4 | 0.8 | 2.6 | 0.8 | 2.4 |
| Volatile Susp. Solids | 2.5 | 4.4 | 3.0 | 3.0 | 4.6 | 2.0 | 3.4 |
| Total Solids | 303 | 230 | 246 | 247 | 232 | 193 | 222 |
| Total Solids Ash | 256 | 175 | 149 | 163 | 160 | 43 | 152 |
| Volatile Total Solids | 47 | 55 | 97 | 84 | 72 | 150 | 70 |
| Nitrate | 0.06 | 0.09 | 0.08 | 0.11 | 0.06 | 0.13 | 0.14 |
| Phosphate (Ortho) | 0.19 | <0.05 | 0.04 | 0.12 | 0.15 | 0.14 | 0.12 |

All results expressed as ppm except pH, unless otherwise stated.

TABLE 3e (continued)

| PARAMETER / STATION: | 28 | | 30 | 33 | 36 | | 40 |
|---|---|---|---|---|---|---|---|
| DEPTH (ft.): | 1 | 18 | 1 | 1 | 1 | 13 | 1 |
| DATE (1972): | 6/10 | 6/10 | 11/10 | 10/10 | 11/10 | 11/10 | 15/10 |
| Secchi Disc Transparency (ft.) | 6.0 | - | 5.5 | 5.5 | 5.0 | - | 2.0 |
| Temperature ($^oC$) | 17.0 | 17.0 | 11.0 | 12.5 | 12.0 | 12.0 | 7.5 |
| pH | 7.9 | 7.8 | 7.8 | 7.9 | 7.8 | 7.2 | 7.9 |
| Dissolved Oxygen: | | | | | | | |
| % Saturation | 101.0 | 102.0 | 96.0 | 102.0 | 93.0 | 93.0 | 100.0 |
| ppm | 9.9 | 10.0 | 10.6 | 11.0 | 10.2 | 10.1 | 12.1 |
| $BOD_5$ | 0.7 | 0.8 | 0.7 | 0.2 | 5.2 | 0.7 | 0.7 |
| Conductivity (µmho/cm) | 358 | 347 | 389 | 347 | 205 | 205 | 212 |
| Dissolved Solids | 266 | 237 | 271 | 188 | 174 | 149 | 199 |
| Dissolved Solids Ash | 129.4 | 126 | 49 | 115 | 101 | 112 | 74 |
| Volatile Diss. Solids | 136.6 | 111 | 222 | 73 | 73 | 37 | 125 |
| Suspended Solids | 4.0 | 6.6 | 27.4 | 35.2 | 15.6 | 2.4 | 29.4 |
| Suspended Solids Ash | 0.6 | 3.0 | 24.6 | 32.4 | 11.0 | 0.6 | 26.8 |
| Volatile Susp. Solids | 3.4 | 3.6 | 2.8 | 2.8 | 4.6 | 1.8 | 2.6 |
| Total Solids | 270 | 244 | 298 | 223 | 190 | 151 | 228 |
| Total Solids Ash | 130 | 129 | 72 | 147 | 112 | 113 | 101 |
| Volatile Total Solids | 140 | 115 | 226 | 76 | 78 | 38 | 127 |
| Nitrate | 0.10 | 0.08 | 0.10 | 0.09 | 0.16 | 0.15 | 0.35 |
| Phosphate (Ortho) | 0.12 | 0.11 | 0.07 | <0.05 | 0.09 | 0.10 | 0.29 |

All results expressed as ppm except pH, unless otherwise stated.

TABLE 3f

RESULTS OF PHYSICAL AND CHEMICAL ANALYSIS OF WATER
TRIBUTARY RIVERS
SEPT.-OCT., 1972

| PARAMETER \ STATION: | 4 | 34 | 35 | 40 |
|---|---|---|---|---|
| DEPTH (ft.): | 1 | 1 | 1 | 1 |
| DATE (1972): | 26/9 | 10/10 | 11/10 | 15/10 |
| Secchi Disc Transparency (ft.) | >8.0 | 5.5 | 3.0 | 2.0 |
| Temperature ($^{o}$C) | 18.5 | 11.5 | 10.4 | 7.5 |
| pH | 8.2 | 7.2 | 8.0 | 7.9 |
| Dissolved Oxygen: % Saturation | 107.0 | 98.0 | 96.0 | 100.0 |
| ppm | 10.2 | 10.7 | 10.7 | 12.1 |
| $BOD_5$ | 0.6 | 0.9 | 0.8 | 0.7 |
| Conductivity (µmho/cm) | 324 | 179 | 212 | 212 |
| Dissolved Solids | 314 | 191 | 256 | 199 |
| Dissolved Solids Ash | 224 | 28 | 107 | 74 |
| Volatile Dissolved Solids | 90 | 163 | 149 | 125 |
| Suspended Solids | 2.0 | 16.0 | 10.4 | 29.4 |
| Suspended Solids Ash | 1.5 | 14.0 | 6.4 | 26.8 |
| Volatile Suspended Solids | 0.5 | 2.0 | 4.0 | 2.6 |
| Total Solids | 316 | 207 | 266 | 228 |
| Total Solids Ash | 226 | 42 | 113 | 101 |
| Volatile Total Solids | 90 | 165 | 153 | 127 |
| Nitrate | 0.09 | 0.20 | 0.24 | 0.35 |
| Phosphate (Ortho) | <0.05 | 0.47 | 0.75 | 0.29 |

All results expressed as ppm except pH, unless otherwise stated.

TABLE 4

RESULTS OF SEDIMENT ANALYSIS
ST. LAWRENCE RIVER SYSTEM
SEPT.-OCT., 1972

| STATION \ PARAMETER | % ORGANIC CARBON | % ORGANIC NITROGEN | O.S.I. (Organic Sediment Index) |
|---|---|---|---|
| a) R. des Mille-Iles | | | |
| 2 | 3.82 | 0.11 | 0.80 |
| 15 | 1.34 | 0.21 | 0.28 |
| 16 | 2.24 | 0.26 | 0.59 |
| 17 | 0.56 | 0.08 | 0.04 |
| 18 | 0.36 | 0.07 | 0.02 |
| 23-1 | 3.27 | 0.07 | 0.24 |
| *23-2 | 0.10 | 0.01 | 0.001 |
| 24 | 1.89 | 0.13 | 0.25 |
| b) R. des Prairies | | | |
| 2 | 3.82 | 0.21 | 0.80 |
| 19 | 2.19 | 0.15 | 0.33 |
| 20 | 0.75 | 0.01 | 0.01 |
| 21 | 1.65 | 0.13 | 0.22 |
| 22 | 7.00 | 0.19 | 1.35 |
| 23-1 | 3.27 | 0.07 | 0.24 |
| *23-2 | 0.10 | 0.01 | 0.001 |
| 24 | 1.89 | 0.13 | 0.25 |
| c) St. Lawrence R. North Shore | | | |
| 1 | 1.60 | 0.11 | 0.18 |
| 3' | 1.26 | 0.02 | 0.02 |
| 3° | 0.08 | 0.09 | 0.01 |
| 5 | 1.17 | 0.21 | 0.25 |
| 8 | 4.72 | 0.37 | 1.78 |
| 11 | 3.64 | 0.30 | 1.10 |
| 14 | 1.41 | 0.07 | 0.09 |
| 24 | 1.89 | 0.13 | 0.25 |
| 26 | 1.74 | 0.06 | 0.11 |
| 29 | 0.50 | 0.01 | 0.003 |
| 31 | 4.33 | 0.29 | 1.24 |
| 32 | 0.83 | 0.02 | 0.01 |
| 38 | 0.15 | 0.01 | 0.002 |
| 39-1 | 1.01 | 0.04 | 0.04 |
| *39-2 | 0.39 | 0.02 | 0.01 |

TABLE 4 (continued)

| STATION \ PARAMETER | % ORGANIC CARBON | % ORGANIC NITROGEN | O.S.I. (Organic Sediment Index) |
|---|---|---|---|
| d) St. Lawrence R. Mid-stream | | | |
| 1 | 1.60 | 0.11 | 0.18 |
| 10 | 0.46 | 0.08 | 0.03 |
| 27 | 0.75 | 0.03 | 0.03 |
| 36 | 1.18 | 0.06 | 0.08 |
| 40 | 0.82 | 0.04 | 0.04 |
| e) St. Lawrence R. South Shore | | | |
| 1 | 1.60 | 0.11 | 0.18 |
| 7 | 1.25 | 0.20 | 0.25 |
| 9 | 6.41 | 0.51 | 3.29 |
| 12 | 0.99 | 0.05 | 0.05 |
| *13-1 | 0.06 | 0.06 | 0.05 |
| 13-2 | 0.89 | 0.04 | 0.04 |
| 25 | 2.99 | 0.23 | 0.69 |
| 28 | 1.49 | 0.07 | 0.10 |
| 30 | 0.83 | 0.01 | 0.01 |
| 33 | 0.83 | 0.04 | 0.03 |
| 36 | 1.18 | 0.06 | 0.08 |
| 40 | 0.82 | 0.04 | 0.04 |
| f) Tributary Rivers | | | |
| 4 | 1.95 | 0.33 | 0.64 |
| 34 | 0.88 | 0.05 | 0.04 |
| 35 | 3.05 | 0.16 | 0.49 |
| 40 | 0.82 | 0.04 | 0.04 |

* Duplicate core taken in main current (erosional bottom).

TABLE 5

RESULTS OF BACTERIOLOGICAL ANALYSIS OF WATER
ST. LAWRENCE RIVER SYSTEM
SEPT.-OCT., 1972

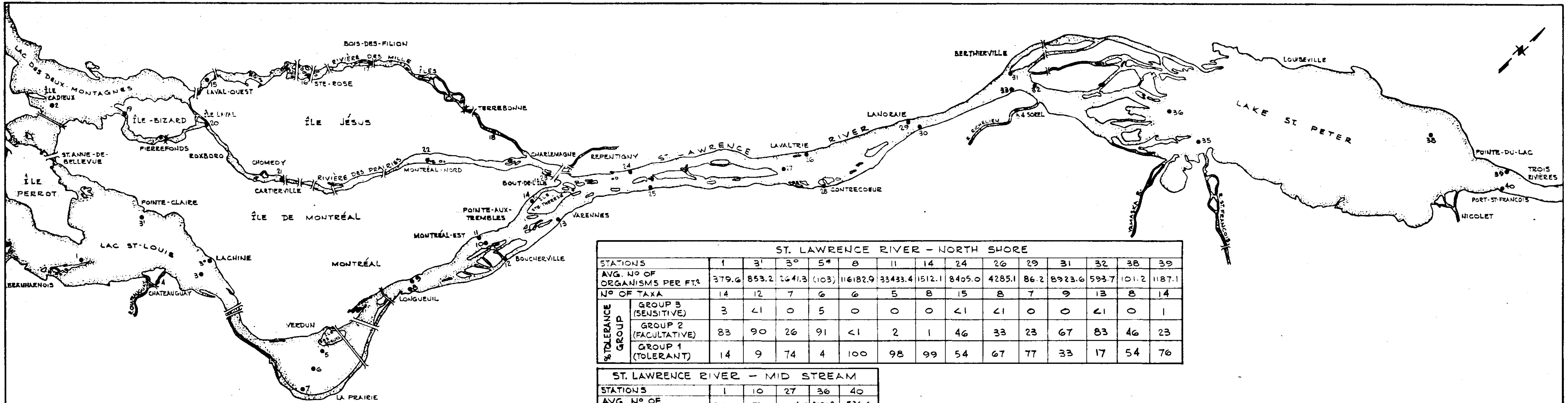
| STATION \ PARAMETER | FECAL COLIFORM (Colonies/100 ml.) | FECAL STREPTOCOCCUS (Colonies/100 ml.) | FC/FS RATIO |
|---|---|---|---|
| a) R. des Mille-Iles | | | |
| 2 | 14 | 2 | 7.0 |
| 15 | 0 | 3 | 0 |
| 16 | 175 | 30 | 5.8 |
| 17 | 1040 | 247 | 4.2 |
| 18 | TNTC | 373 | >1.0 |
| 23 | 325 | 340 | 0.96 |
| 24 | 6 | 300 | 0.02 |
| b) R. des Prairies | | | |
| 2 | 14 | 2 | 7.0 |
| 19 | 0 | 3 | 0 |
| 20 | 7 | 3 | 2.3 |
| 21 | 0 | 233 | 0 |
| 22 | 3900 | 4200 | 0.93 |
| 23 | 325 | 340 | 0.96 |
| 24 | 6 | 300 | 0.02 |
| c) St. Lawrence R. North Shore | | | |
| 1 | 0 | 0 | 0 |
| 3' | 0 | 0 | 0 |
| 3 | 0 | 3 | 0 |
| 5 | 1400 | 260 | 5.4 |
| 8** | 100 | 1500 | 0.06 |
| 11** | 4 | 0 | >4 |
| 14 | 500 | 5300 | 0.09 |
| 24 | 6 | 300 | 0.02 |
| 26 | * | * | * |
| 29 | 100 | 200 | 0.5 |
| 31 | 100 | 500 | 0.2 |
| 32 | 350 | 600 | 0.6 |
| 38 | * | * | * |
| 39 | * | * | * |

TABLE 5 (continued)

| STATION \ PARAMETER | FECAL COLIFORM (Colonies/100 ml.) | FECAL STREPTOCOCCUS (Colonies/100 ml.) | FC/FS RATIO |
|---|---|---|---|
| d) St. Lawrence R. Mid-stream | | | |
| 1 | 0 | 0 | 0 |
| 10** | TNTC | 900 | >1 |
| 27 | * | * | * |
| 36 | 700 | 100 | 7.0 |
| 40 | * | * | * |
| e) St. Lawrence R. South Shore | | | |
| 1 | 0 | 0 | 0 |
| 7 | 105 | 10 | 10.5 |
| 9** | 64 | 1800 | 0.04 |
| 12** | 2 | 500 | 0.004 |
| 13 | 2 | 3800 | 0.0005 |
| 25 | 330 | 40 | 8.3 |
| 28 | * | * | * |
| 30 | 200 | 34 | 5.9 |
| 33 | 164 | 100 | 1.64 |
| 36 | 700 | 100 | 7.0 |
| 40 | * | * | * |
| f) Tributary Rivers | | | |
| 4 | 67 | 23 | 2.9 |
| 34 | 0 | 6 | 0 |
| 35 | 170 | 300 | 0.57 |
| 40 | * | * | * |

* Sample spoiled in transit.
** Samples analyzed between 24 and 48 hours past collection.
TNTC Colonies too numerous to count.

# FIGURES




| RIVIÈRE DES MILLE ÎLES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| STATIONS | | 2 | 15 | 16 | 17 | 18 | 23 | 24 |
| AVG. Nº OF ORGANISMS PER FT.² | | 163.7 | 152.4 | 99.0 | 271.6 | 263.9 | 3663.3 | 8405.0 |
| Nº OF TAXA | | 14 | 13 | 8 | 11 | 15 | 8 | 15 |
| % TOLERANCE GROUP | GROUP 3 (SENSITIVE) | 7 | 2 | <1 | 0 | 9 | 0 | <1 |
| | GROUP 2 (FACULTATIVE) | 65 | 23 | 88 | 86 | 81 | 24 | 46 |
| | GROUP 1 (TOLERANT) | 28 | 75 | 22 | 14 | 10 | 76 | 54 |

| RIVIÈRE DES PRAIRIES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| STATIONS | | 2 | 19 | 20 | 21 | 22 | 23 | 24 |
| AVG. Nº OF ORGANISMS PER FT.² | | 163.7 | 731.4 | 752.8 | 867.9 | 30302.4 | 3663.3 | 8405.0 |
| Nº OF TAXA | | 14 | 12 | 14 | 15 | 5 | 8 | 15 |
| % TOLERANCE GROUP | GROUP 3 (SENSITIVE) | 7 | 13 | 2 | 2 | 0 | 0 | <1 |
| | GROUP 2 (FACULTATIVE) | 65 | 74 | 82 | 60 | 1 | 24 | 46 |
| | GROUP 1 (TOLERANT) | 28 | 13 | 16 | 37 | 99 | 76 | 54 |

| ST. LAWRENCE RIVER – NORTH SHORE | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STATIONS | | 1 | 3' | 3° | 5* | 8 | 11 | 14 | 24 | 26 | 29 | 31 | 32 | 38 | 39 |
| AVG. Nº OF ORGANISMS PER FT.² | | 379.6 | 853.2 | 2641.3 | (103) | 116182.9 | 33433.4 | 1512.1 | 8405.0 | 4285.1 | 86.2 | 8923.6 | 593.7 | 101.2 | 1187.1 |
| Nº OF TAXA | | 14 | 12 | 7 | 6 | 6 | 5 | 8 | 15 | 8 | 7 | 9 | 13 | 8 | 14 |
| % TOLERANCE GROUP | GROUP 3 (SENSITIVE) | 3 | <1 | 0 | 5 | 0 | 0 | 0 | <1 | <1 | 0 | 0 | <1 | 0 | 1 |
| | GROUP 2 (FACULTATIVE) | 83 | 90 | 26 | 91 | <1 | 2 | 1 | 46 | 33 | 23 | 67 | 83 | 46 | 23 |
| | GROUP 1 (TOLERANT) | 14 | 9 | 74 | 4 | 100 | 98 | 99 | 54 | 67 | 77 | 33 | 17 | 54 | 76 |

| ST. LAWRENCE RIVER – MID STREAM | | | | | | |
|---|---|---|---|---|---|---|
| STATIONS | | 1 | 10 | 27 | 36 | 40 |
| AVG. Nº OF ORGANISMS PER FT.² | | 379.6 | 1072.0 | 664.7 | 3101.8 | 536.6 |
| Nº OF TAXA | | 14 | 11 | 13 | 14 | 13 |
| % TOLERANCE GROUP | GROUP 3 (SENSITIVE) | 3 | <1 | <1 | <1 | <1 |
| | GROUP 2 (FACULTATIVE) | 83 | 33 | 99 | 78 | 89 |
| | GROUP 1 (TOLERANT) | 14 | 67 | 1 | 22 | 11 |

| ST. LAWRENCE RIVER – SOUTH SHORE | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STATIONS | | 1 | 4 | 7 | 9 | 12 | 13 | 25 | 28 | 30 | 33 | 34 | 35 | 36 | 39 |
| AVG. Nº OF ORGANISMS PER FT.² | | 3796 | 1656.8 | 619.5 | 495.0 | 8108.6 | 637.4 | 21.2 | 299.5 | 311.7 | 1146.9 | 937.0 | 5694.1 | 3101.8 | 1187.1 |
| Nº OF TAXA | | 14 | 15 | 12 | 4 | 8 | 11 | 8 | 13 | 7 | 11 | 15 | 13 | 14 | 14 |
| % TOLERANCE GROUP | GROUP 3 (SENSITIVE) | 3 | 4 | 21 | 0 | 0 | 1 | 0 | 1 | 0 | <1 | 11 | 5 | <1 | <1 |
| | GROUP 2 (FACULTATIVE) | 83 | 88 | 69 | 1 | 29 | 82 | 67 | 81 | 68 | 37 | 62 | 69 | 78 | 23 |
| | GROUP 1 (TOLERANT) | 14 | 8 | 10 | 99 | 71 | 17 | 33 | 19 | 32 | 63 | 18 | 26 | 22 | 76 |

## SUMMARY OF BIOLOGICAL RESULTS ST. LAWRENCE RIVER SEPT. & OCT. 1972

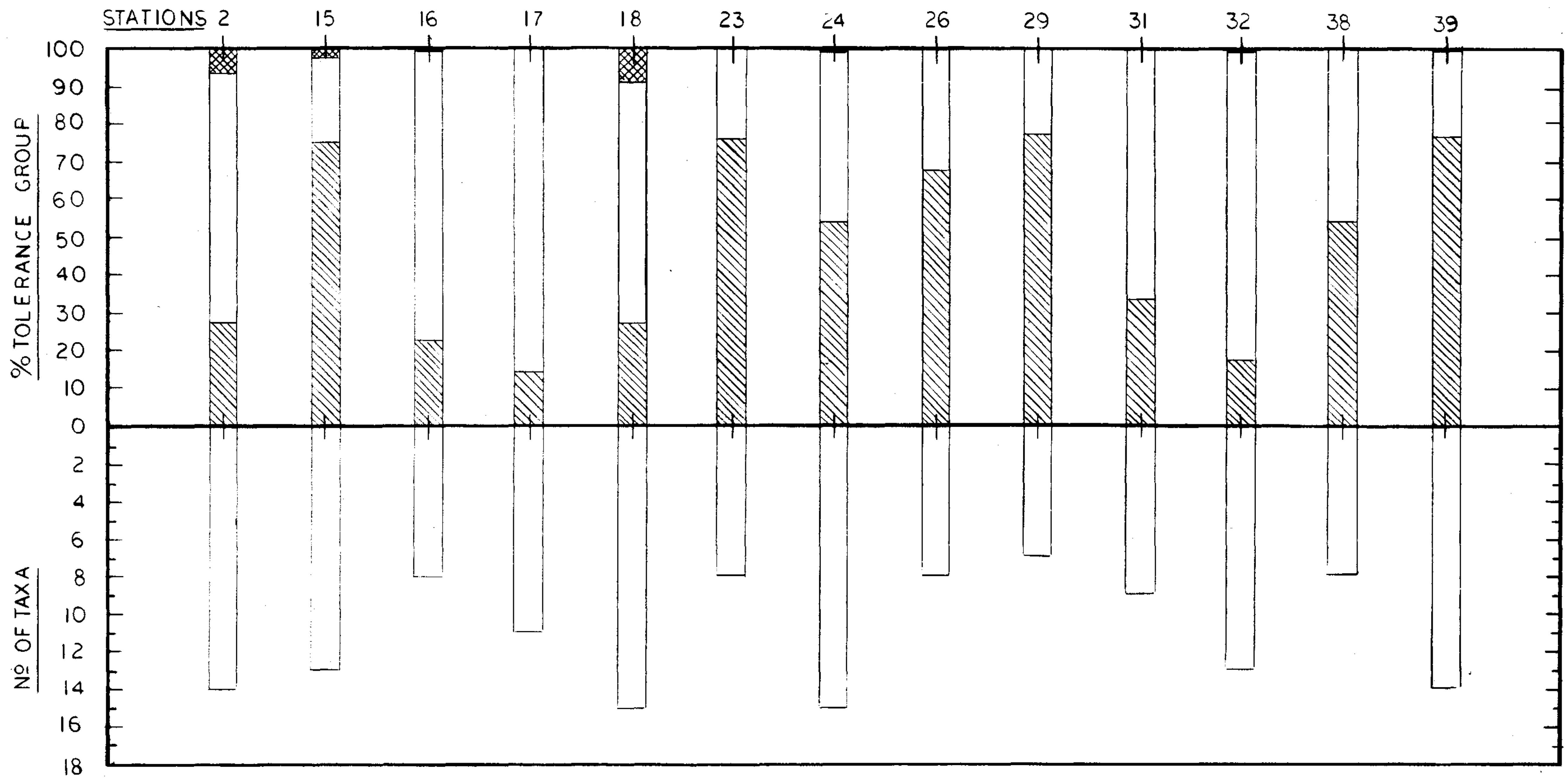
5 0 5 10 MILES
MAP SCALE

ENVIRONMENT CANADA
OTTAWA — ONTARIO

BEAK

| | |
|---|---|
| DATE | 29.5.1973 |
| PROJECT | A1155 |
| DWG. NO. | 51155-1 |

FIG. 1




TOLERANCE GROUPS

GROUP 3 (SENSITIVE) ORGANISMS

GROUP 2 (FACULTATIVE) ORGANISMS

GROUP 1 (TOLERANT) ORGANISMS

BIOLOGICAL TOLERANCE GROUPS
RIVIÈRE DES MILLE ILES &
ST. LAWRENCE RIVER-NORTH SHORE
SEPT. - OCT. 1972

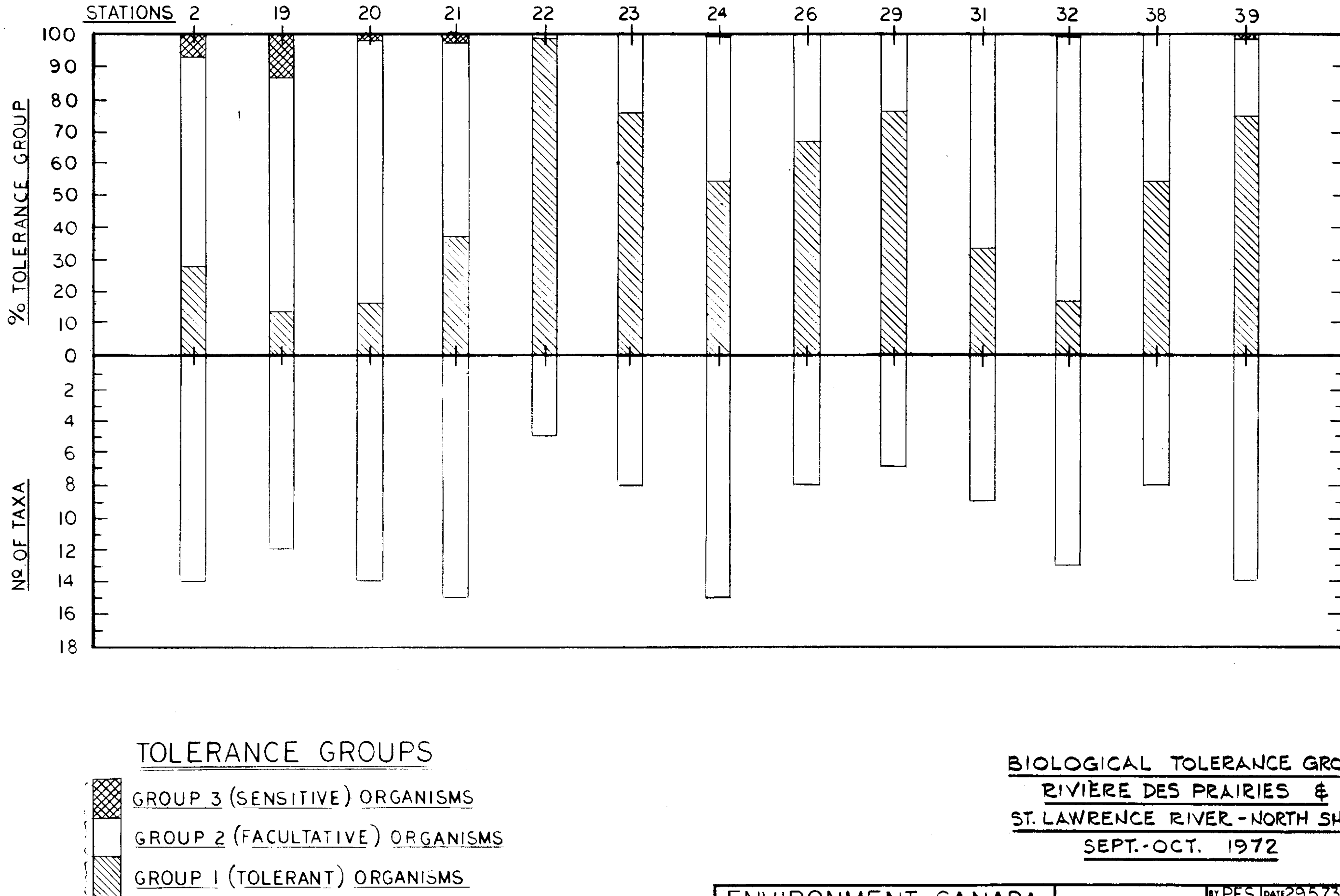
ENVIRONMENT CANADA
OTTAWA - ONTARIO

BEAK

BY P.E.S. DATE 29.5.73
DWG. NO. B1155-3

FIG. 2(A)

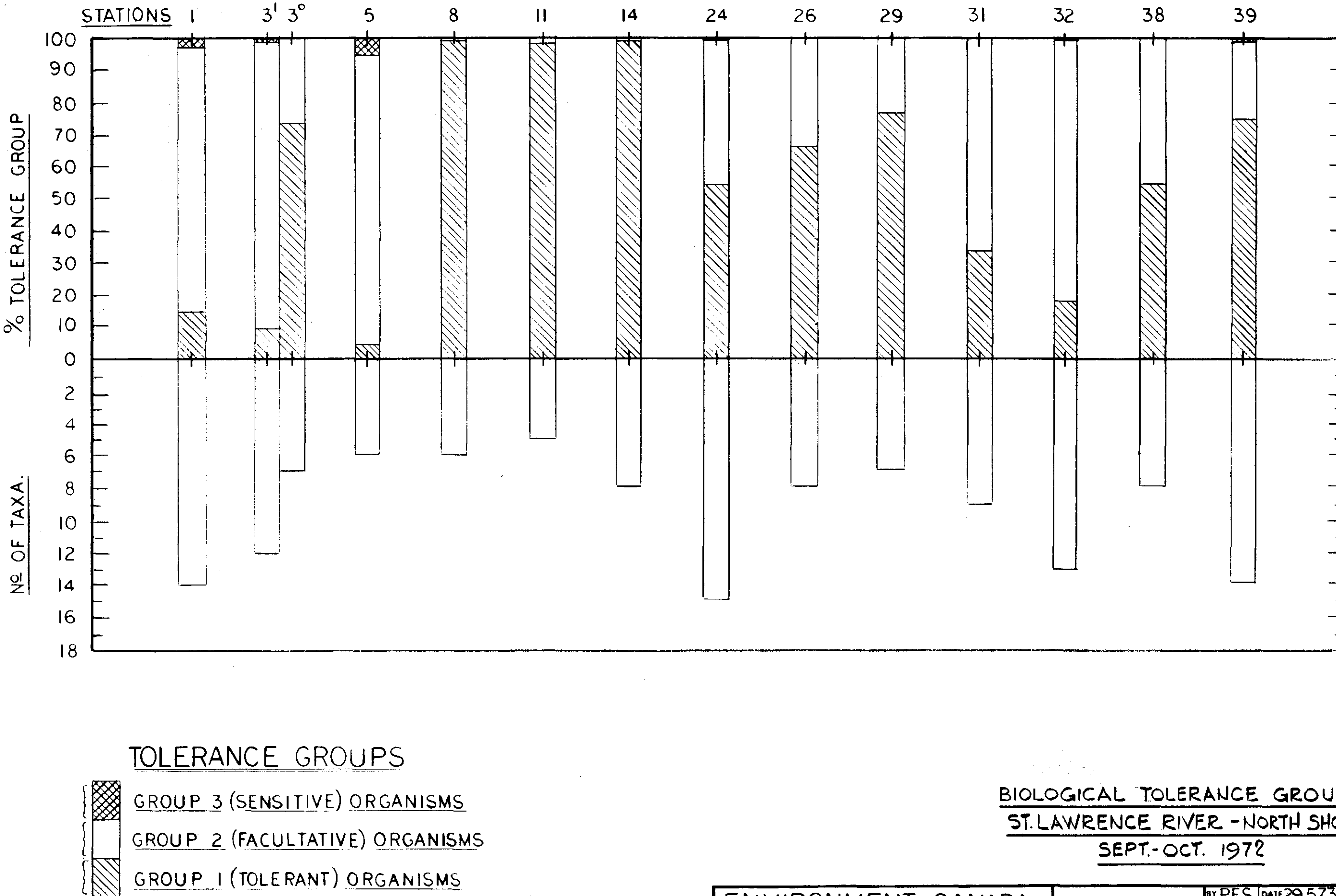
TRANSLAR 003




BIOLOGICAL TOLERANCE GROUPS
RIVIÈRE DES PRAIRIES &
ST. LAWRENCE RIVER - NORTH SHORE
SEPT.-OCT. 1972

| ENVIRONMENT CANADA OTTAWA — ONTARIO | BEAK | BY P.E.S. DATE 29.5.73 DWG NO B1155-4 | FIG. 2(B) |
| --- | --- | --- | --- |

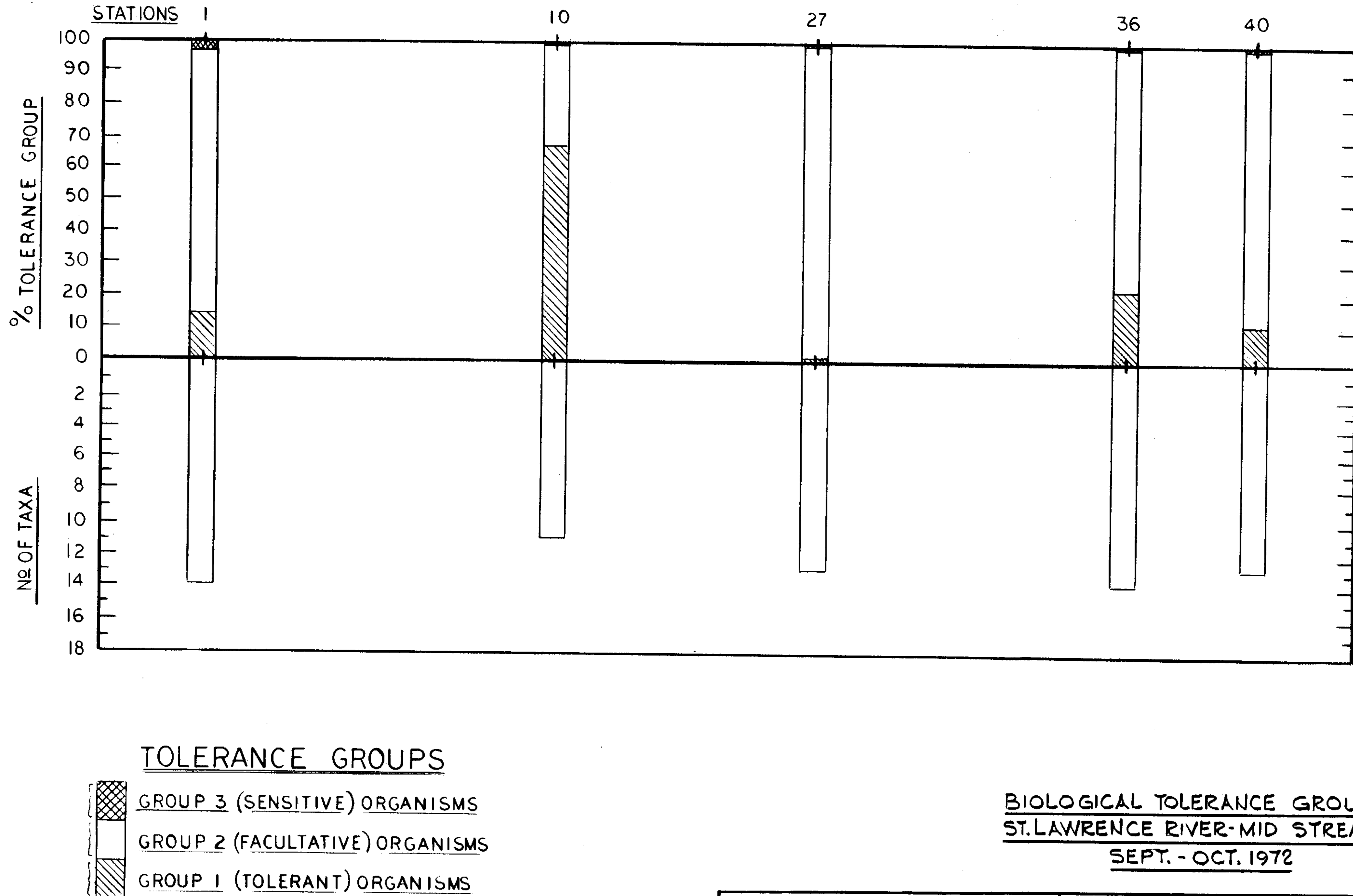
TRANSLAR 003




BIOLOGICAL TOLERANCE GROUPS
ST. LAWRENCE RIVER - NORTH SHORE
SEPT.-OCT. 1972

| ENVIRONMENT CANADA<br>OTTAWA — ONTARIO | BEAK | BY P.E.S. DATE 29.5.73<br>DWG. NO B1155-5 | FIG. 2(C) |
|---|---|---|---|

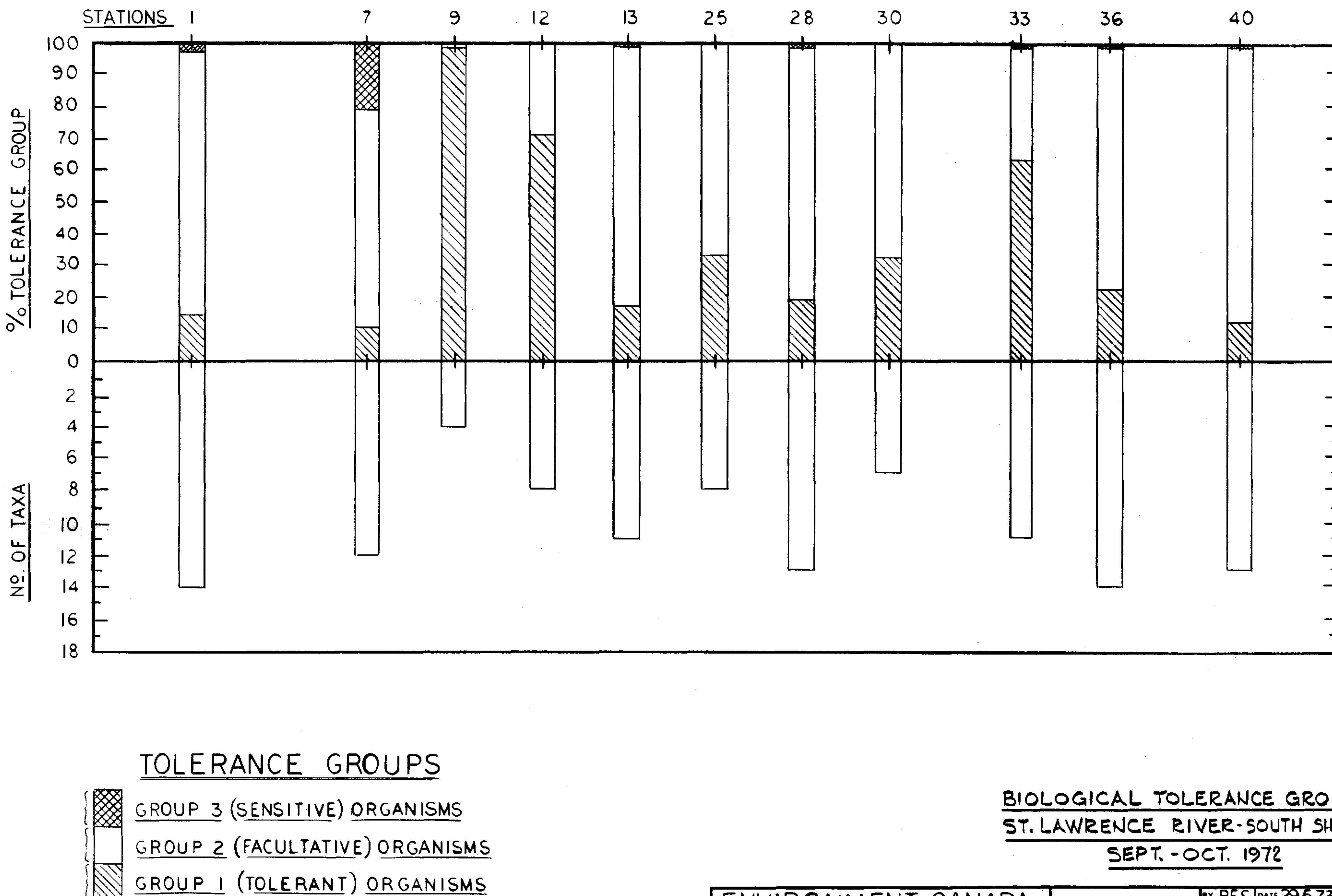
TRANSLAR 003




BIOLOGICAL TOLERANCE GROUPS
ST. LAWRENCE RIVER-MID STREAM
SEPT. - OCT. 1972

| ENVIRONMENT CANADA OTTAWA - ONTARIO | BEAK | BY P.E.S. DATE 29.5.73 DWG NO. B1155 - 6 | FIG. 2(D) |
|---|---|---|---|

TRANSLAR 003



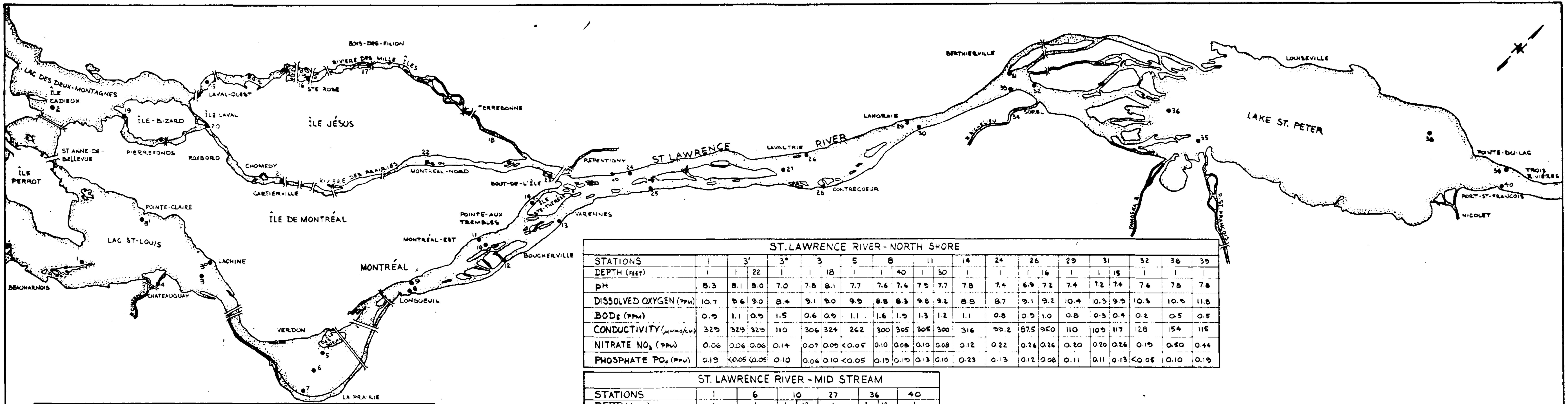

BIOLOGICAL TOLERANCE GROUPS
ST. LAWRENCE RIVER-SOUTH SHORE
SEPT. - OCT. 1972

ENVIRONMENT CANADA
OTTAWA — ONTARIO

BEAK

BY P.E.S. DATE 29.5.73
DWG. NO B1155-7

FIG. 2(E)




| ST. LAWRENCE RIVER - NORTH SHORE | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STATIONS | 1 | 3' | | 3° | 3 | | 5 | 8 | | 11 | | 14 | 24 | 26 | | 29 | 31 | | 32 | 38 | 39 |
| DEPTH (FEET) | 1 | 1 | 22 | 1 | 1 | 18 | 1 | 1 | 40 | 1 | 30 | 1 | 1 | 1 | 16 | 1 | 1 | 15 | 1 | 1 | 1 |
| pH | 8.3 | 8.1 | 8.0 | 7.0 | 7.8 | 8.1 | 7.7 | 7.6 | 7.6 | 7.9 | 7.7 | 7.8 | 7.4 | 6.9 | 7.2 | 7.4 | 7.2 | 7.4 | 7.6 | 7.8 | 7.8 |
| DISSOLVED OXYGEN (PPM) | 10.7 | 9.6 | 9.0 | 8.4 | 9.1 | 9.0 | 9.9 | 8.8 | 8.3 | 9.8 | 9.2 | 8.8 | 8.7 | 9.1 | 9.2 | 10.4 | 10.3 | 9.9 | 10.3 | 10.9 | 11.8 |
| $BOD_5$ (PPM) | 0.9 | 1.1 | 0.9 | 1.5 | 0.6 | 0.9 | 1.1 | 1.6 | 1.9 | 1.3 | 1.2 | 1.1 | 0.8 | 0.9 | 1.0 | 0.8 | 0.3 | 0.4 | 0.2 | 0.5 | 0.5 |
| CONDUCTIVITY (μMHO/CM) | 329 | 329 | 329 | 110 | 306 | 324 | 262 | 300 | 305 | 305 | 300 | 316 | 99.2 | 87.5 | 950 | 110 | 109 | 117 | 128 | 154 | 115 |
| NITRATE $NO_3$ (PPM) | 0.06 | 0.06 | 0.06 | 0.14 | 0.07 | 0.09 | <0.05 | 0.10 | 0.08 | 0.10 | 0.08 | 0.12 | 0.22 | 0.26 | 0.26 | 0.20 | 0.20 | 0.26 | 0.19 | 0.50 | 0.44 |
| PHOSPHATE $PO_4$ (PPM) | 0.19 | <0.05 | <0.05 | 0.10 | 0.06 | 0.10 | <0.05 | 0.19 | 0.19 | 0.13 | 0.10 | 0.23 | 0.13 | 0.12 | 0.08 | 0.11 | 0.11 | 0.13 | <0.05 | 0.10 | 0.19 |

| ST. LAWRENCE RIVER - MID STREAM | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| STATIONS | 1 | 6 | 10 | | 27 | 36 | | 40 |
| DEPTH (FEET) | 1 | 1 | 1 | 12 | 1 | 1 | 13 | 1 |
| pH | 8.3 | 7.8 | 8.0 | 7.9 | 8.1 | 7.8 | 7.2 | 7.9 |
| DISSOLVED OXYGEN (PPM) | 10.7 | 9.8 | 10.0 | 10.0 | 10.0 | 10.2 | 10.1 | 12.1 |
| $BOD_5$ (PPM) | 0.9 | 0.8 | 0.9 | 0.4 | 0.6 | 5.2 | 0.7 | 0.7 |
| CONDUCTIVITY (μMHO/CM) | 329 | 349 | 349 | 343 | 337 | 205 | 205 | 212 |
| NITRATE $NO_3$ (PPM) | 0.06 | 0.07 | 0.04 | 0.06 | 0.07 | 0.16 | 0.15 | 0.35 |
| PHOSPHATE $PO_4$ (PPM) | 0.19 | <0.05 | <0.05 | <0.05 | 0.11 | 0.09 | 0.10 | 0.29 |

| ST. LAWRENCE RIVER - SOUTH SHORE AND TRIBUTARIES | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STATIONS | 1 | 4 | 7 | 9 | | 12 | 13 | 25 | 28 | | 30 | 33 | 34 | 35 | 36 | | 40 |
| DEPTH (FEET) | 1 | 1 | 1 | 1 | 6 | 1 | 1 | 1 | 1 | 18 | 1 | 1 | 1 | 1 | 1 | 13 | 1 |
| pH | 8.3 | 8.2 | 7.9 | 8.1 | 8.3 | 8.0 | 8.2 | 7.8 | 7.9 | 7.8 | 7.8 | 7.9 | 7.2 | 8.0 | 7.8 | 7.2 | 7.9 |
| DISSOLVED OXYGEN (PPM) | 10.7 | 10.2 | 9.9 | 9.9 | 10.1 | 8.7 | 9.6 | 9.9 | 9.9 | 10.0 | 10.6 | 11.0 | 10.7 | 10.7 | 10.2 | 10.1 | 12.1 |
| $BOD_5$ (PPM) | 0.9 | 0.6 | 0.8 | 0.5 | 1.1 | 0.7 | 0.8 | 0.7 | 0.7 | 0.8 | 0.7 | 0.2 | 0.9 | 0.8 | 5.2 | 0.7 | 0.7 |
| CONDUCTIVITY (μMHO/CM) | 329 | 324 | 351 | 337 | 364 | 343 | 337 | 358 | 35[illegible] | 347 | 389 | 347 | 179 | 212 | 205 | 205 | 212 |
| NITRATE $NO_3$ (PPM) | 0.06 | 0.09 | 0.09 | 0.08 | 0.11 | 0.06 | 0.13 | 0.14 | 0.10 | 0.08 | 0.10 | 0.09 | 0.20 | 0.24 | 0.16 | 0.15 | 0.35 |
| PHOSPHATE $PO_4$ (PPM) | 0.19 | <0.05 | <0.05 | 0.04 | 0.12 | 0.15 | 0.14 | 0.12 | 0.12 | 0.11 | 0.07 | <0.05 | 0.47 | 0.75 | 0.09 | 0.10 | 0.29 |

| RIVIÉRE DES MILLE-ÎLES | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| STATIONS | 2 | | 15 | | 16 | | 17 | 18 | 23 | 24 |
| DEPTH (FEET) | 1 (T) | 12 (B) | 1 | 12 | 1 | 15 | 1 | 1 | 1 | 1 |
| pH | 7.2 | 7.0 | 6.9 | 7.1 | 7.0 | 7.0 | 7.0 | 7.1 | 6.4 | 7.4 |
| DISSOLVED OXYGEN (PPM) | 10.1 | 9.8 | 9.6 | 9.4 | 9.2 | 9.1 | 8.1 | 9.6 | 8.9 | 8.7 |
| $BOD_5$ (PPM) | 0.6 | 0.5 | 0.6 | 0.8 | 0.6 | 0.4 | 0.6 | 1.0 | 0.7 | 0.8 |
| CONDUCTIVITY (μMHO CM) | 75.7 | 75.7 | 79.0 | 79.0 | 87.1 | 86.4 | 96.8 | 110 | 81.7 | 99.2 |
| NITRATE $NO_3$ (PPM) | 0.21 | 0.30 | 0.23 | 0.17 | 0.18 | 0.15 | 0.20 | 0.26 | 0.18 | 0.22 |
| PHOSPHATE $PO_4$ (PPM) | <0.05 | 0.09 | <0.05 | <0.05 | 0.14 | 0.09 | 0.18 | 0.25 | 0.09 | 0.13 |

| RIVIÉRE DES PRAIRIES | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| STATIONS | 2 | | 19 | 20 | 21 | 22 | 23 | 24 |
| DEPTH (FEET) | 1 | 12 | 1 | 1 | 1 | 1 | 1 | 1 |
| pH | 7.2 | 7.0 | 6.7 | 6.9 | 6.8 | 6.5 | 6.4 | 7.4 |
| DISSOLVED OXYGEN (PPM) | 10.1 | 9.8 | 9.4 | 9.7 | 9.0 | 8.8 | 8.9 | 8.7 |
| $BOD_5$ (PPM) | 0.6 | 0.5 | 1.1 | 0.5 | 0.3 | 1.6 | 0.7 | 0.8 |
| CONDUCTIVITY (μMHO/CM) | 75.7 | 75.7 | 76.9 | 77.4 | 80.0 | 102 | 81.7 | 99.2 |
| NITRATE $NO_3$ (PPM) | 0.21 | 0.30 | 0.17 | 0.21 | 0.17 | 0.23 | 0.18 | 0.22 |
| PHOSPHATE $PO_4$ (PPM) | <0.05 | 0.09 | <0.05 | <0.05 | <0.05 | 0.25 | 0.09 | 0.13 |

SUMMARY OF CHEMICAL RESULTS ST. LAWRENCE RIVER SEPT. & OCT. 1972

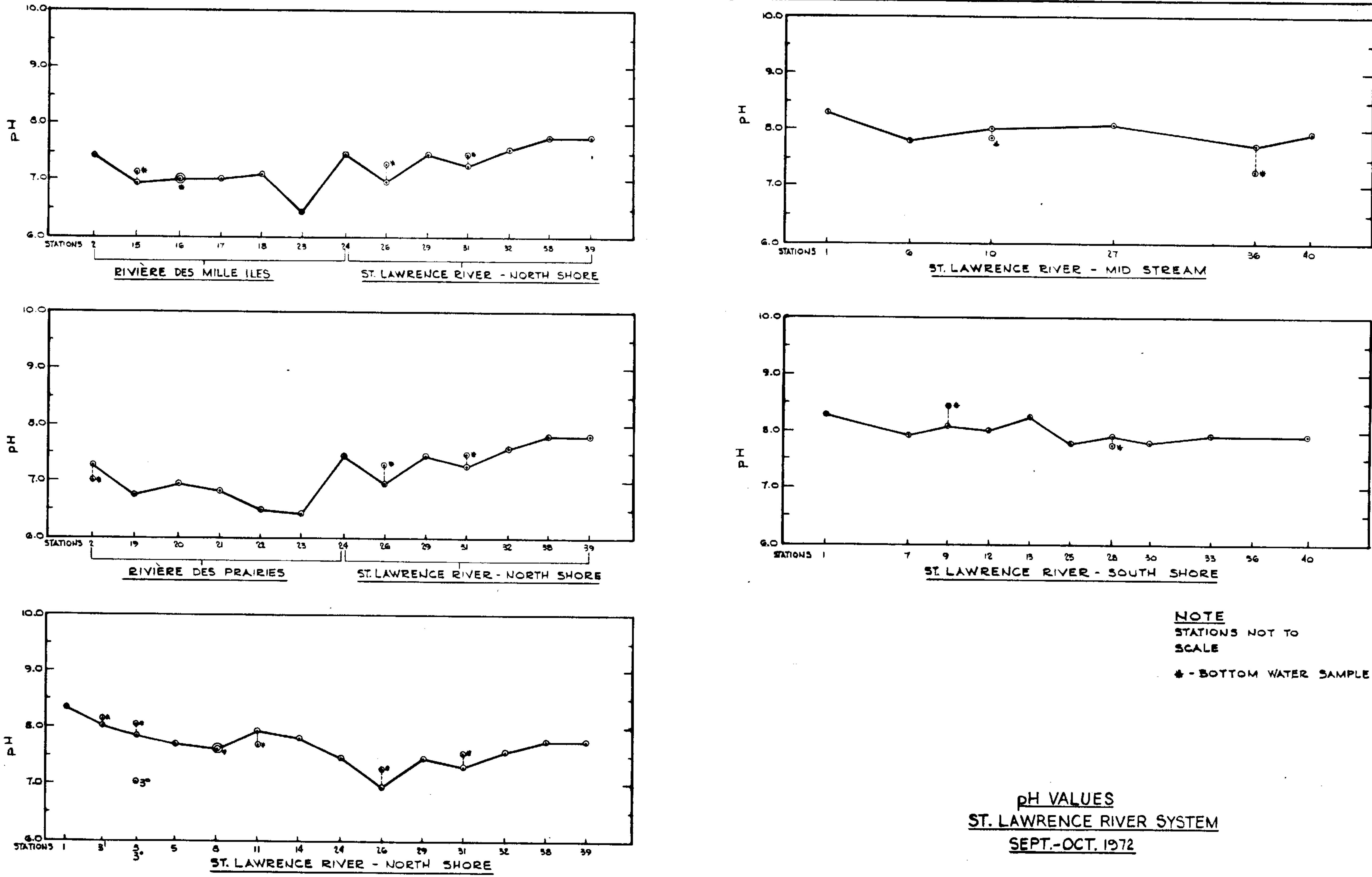
5 0 5 10 MILES
MAP SCALE

ENVIRONMENT CANADA
OTTAWA — ONTARIO

BEAK

DATE 29.5.1973
PROJECT A 1155
DWG. NO. S1155-2

FIG. 3

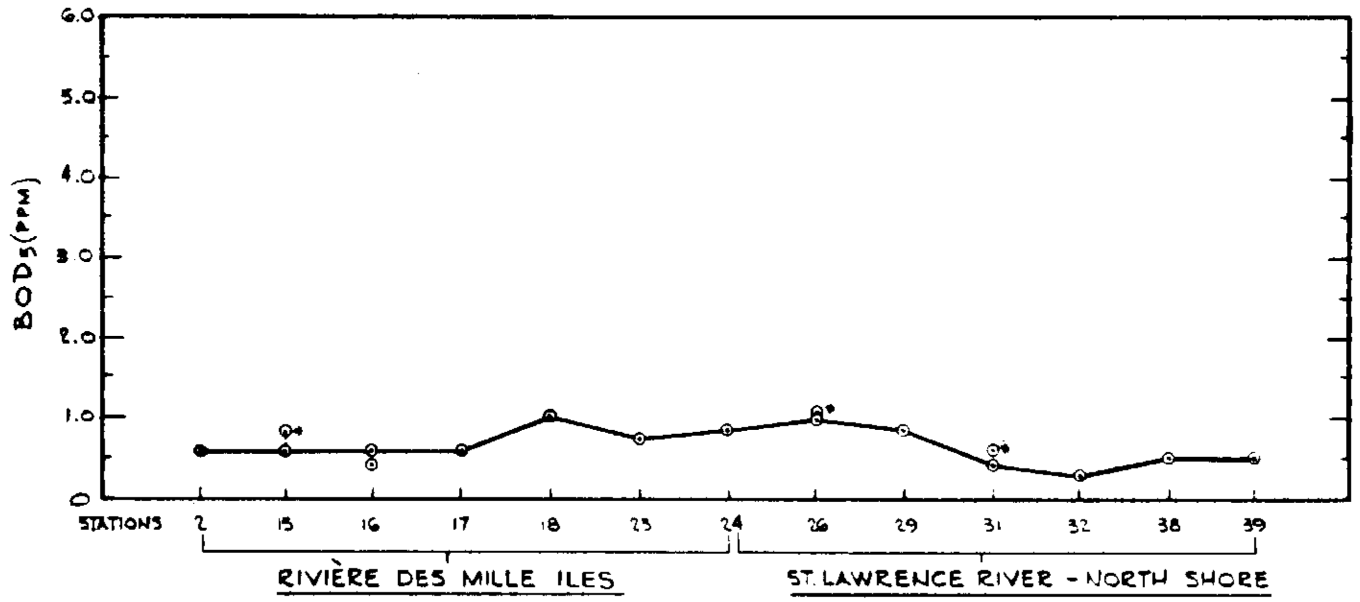


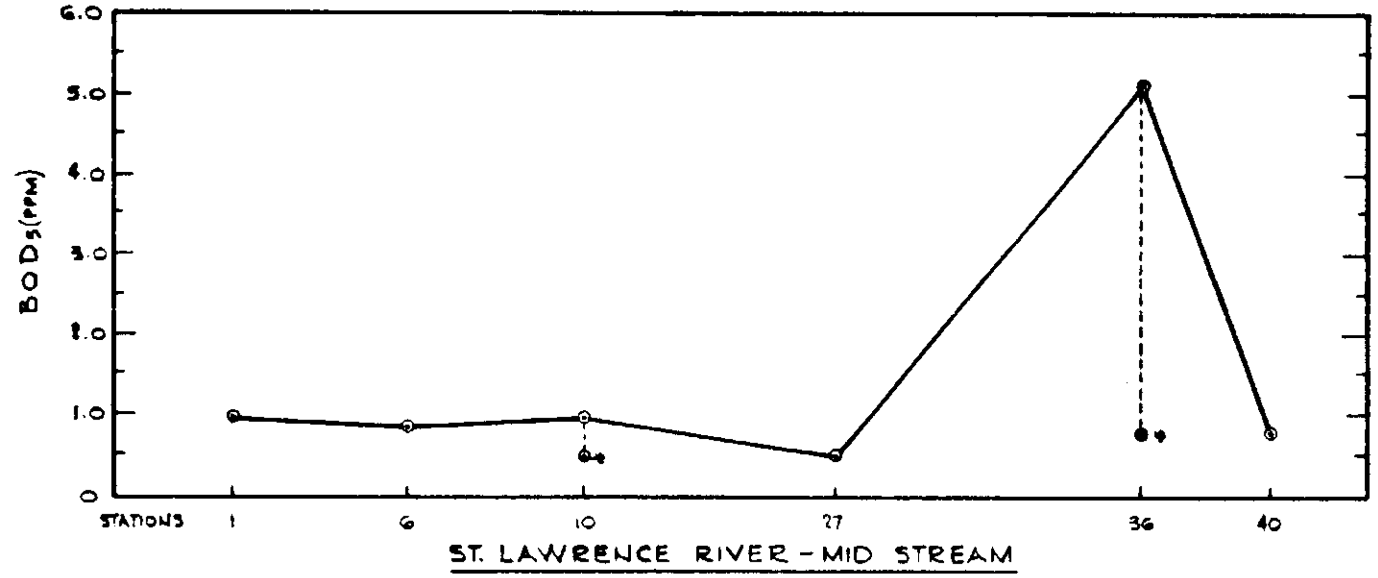

**NOTE**
STATIONS NOT TO SCALE

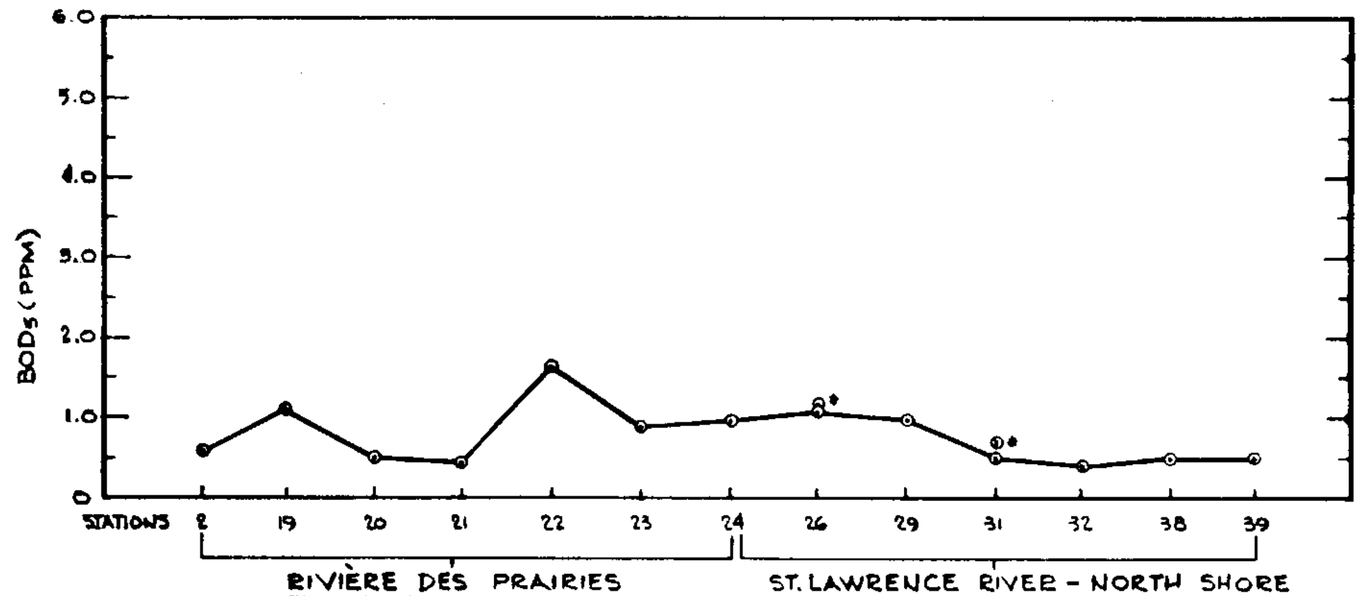
* - BOTTOM WATER SAMPLE

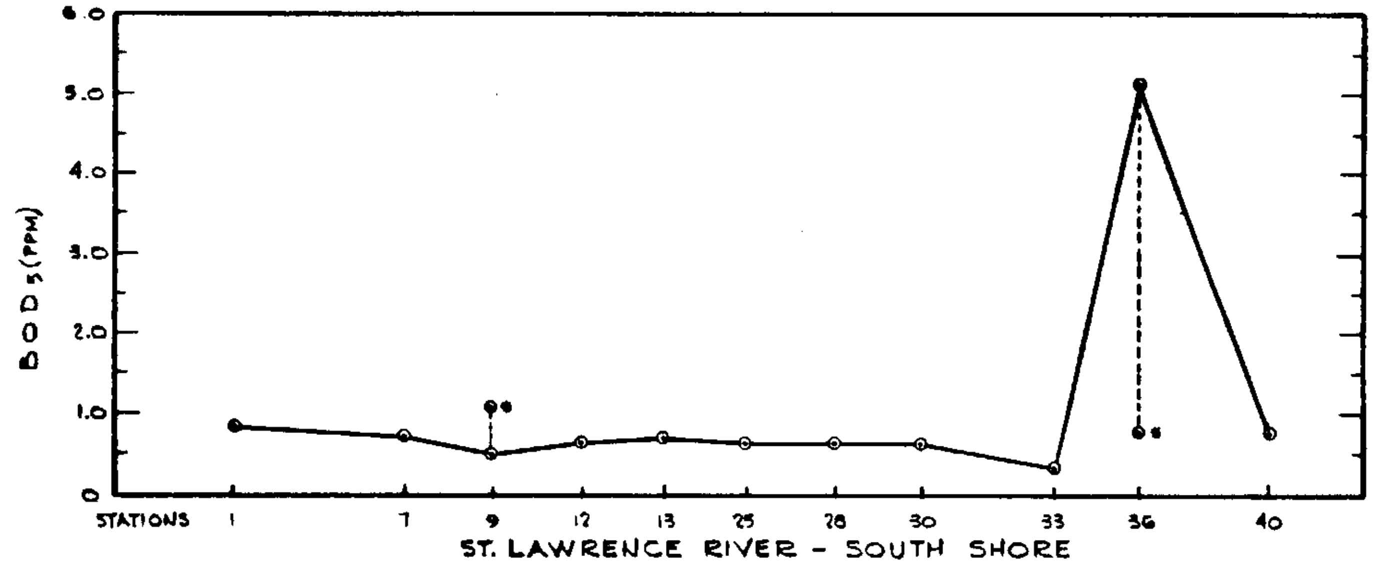
pH VALUES
ST. LAWRENCE RIVER SYSTEM
SEPT.-OCT. 1972

| ENVIRONMENT CANADA<br>OTTAWA — ONTARIO | BEAK | BY BG. DATE: 29.5.73<br>DWG. NO. B1155-8 | FIG. 4 |
|---|---|---|---|



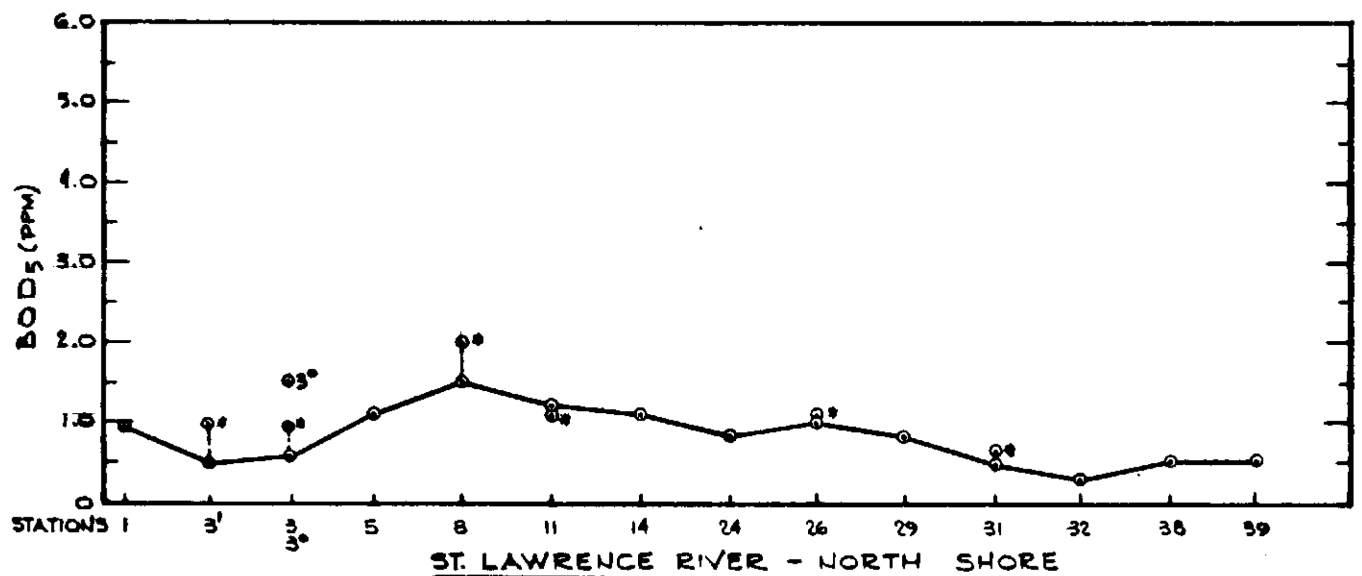



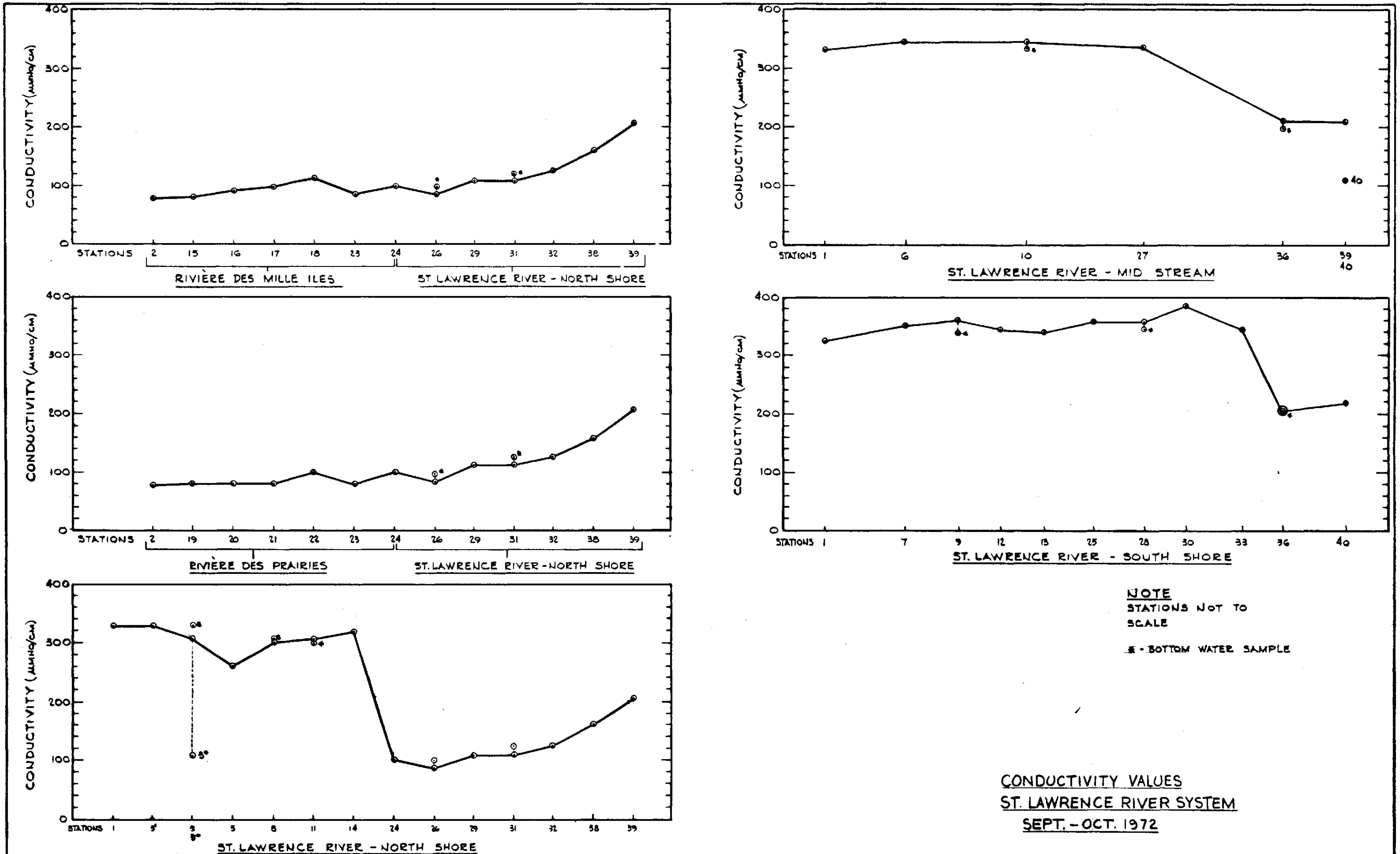

NOTE
STATIONS NOT TO SCALE

* BOTTOM WATER SAMPLE



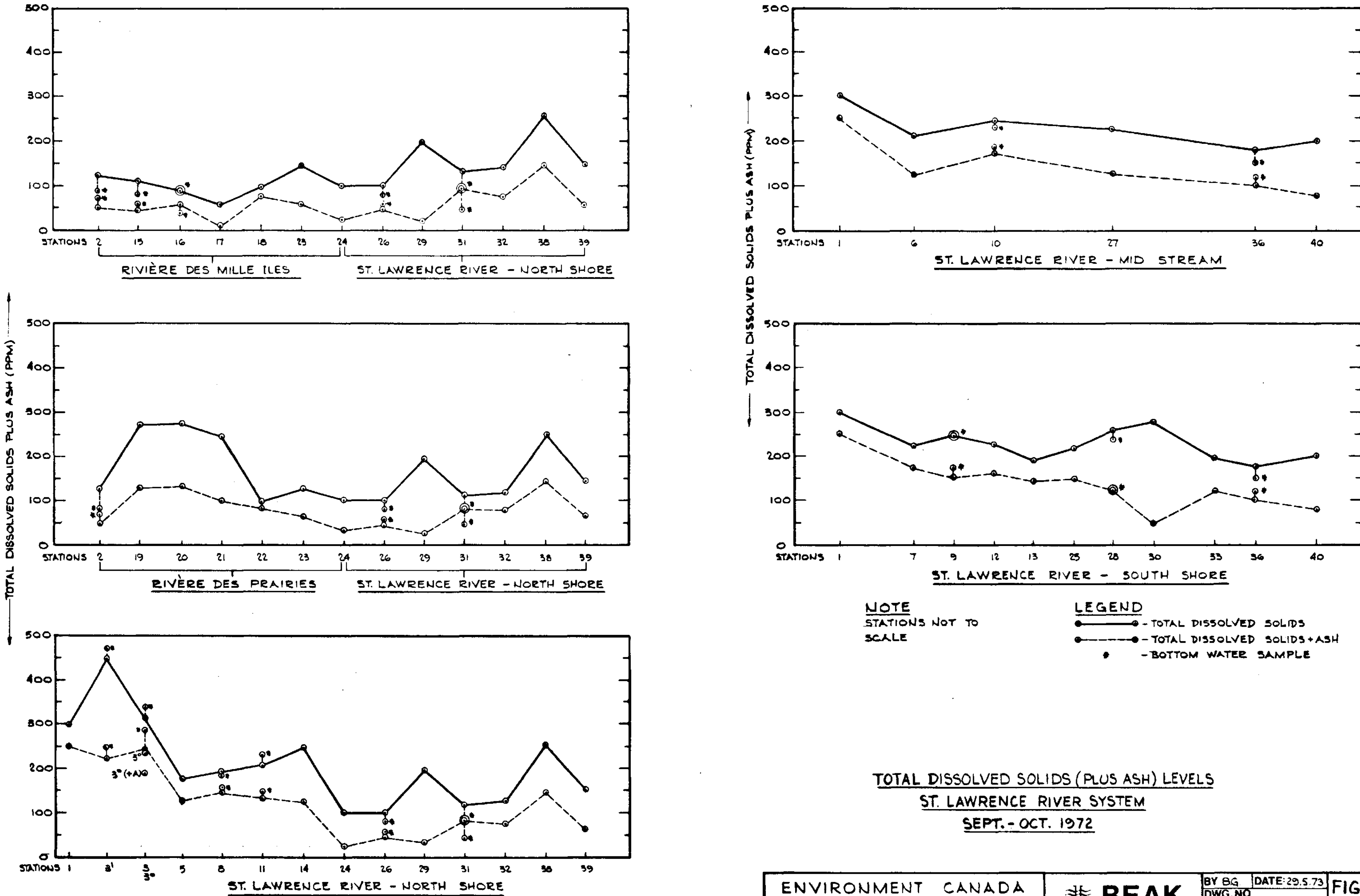

BIOCHEMICAL OXYGEN DEMAND ($BOD_5$ - PPM)
ST. LAWRENCE RIVER SYSTEM
SEPT.-OCT. 1972

| ENVIRONMENT CANADA<br>OTTAWA — ONTARIO | BEAK | BY B.G DATE: 29.5.73<br>DWG. NO. B1155-9 | FIG. 5 |
|---|---|---|---|



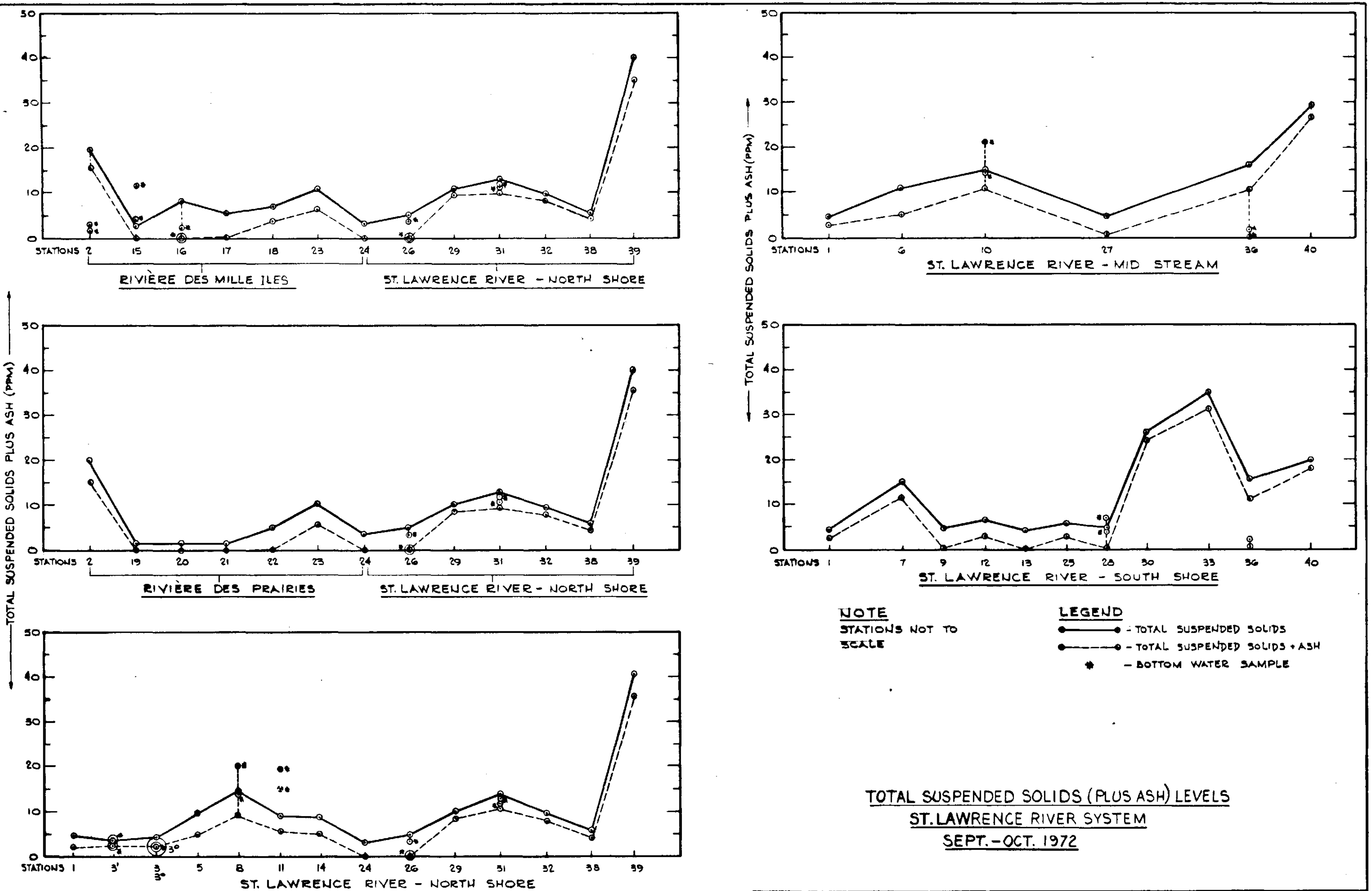

CONDUCTIVITY VALUES
ST. LAWRENCE RIVER SYSTEM
SEPT. - OCT. 1972

| ENVIRONMENT CANADA<br>OTTAWA — ONTARIO | BEAK | BY B.G DATE: 29.5.73<br>DWG. NO.<br>B1155-10 | FIG. 6 |
|---|---|---|---|



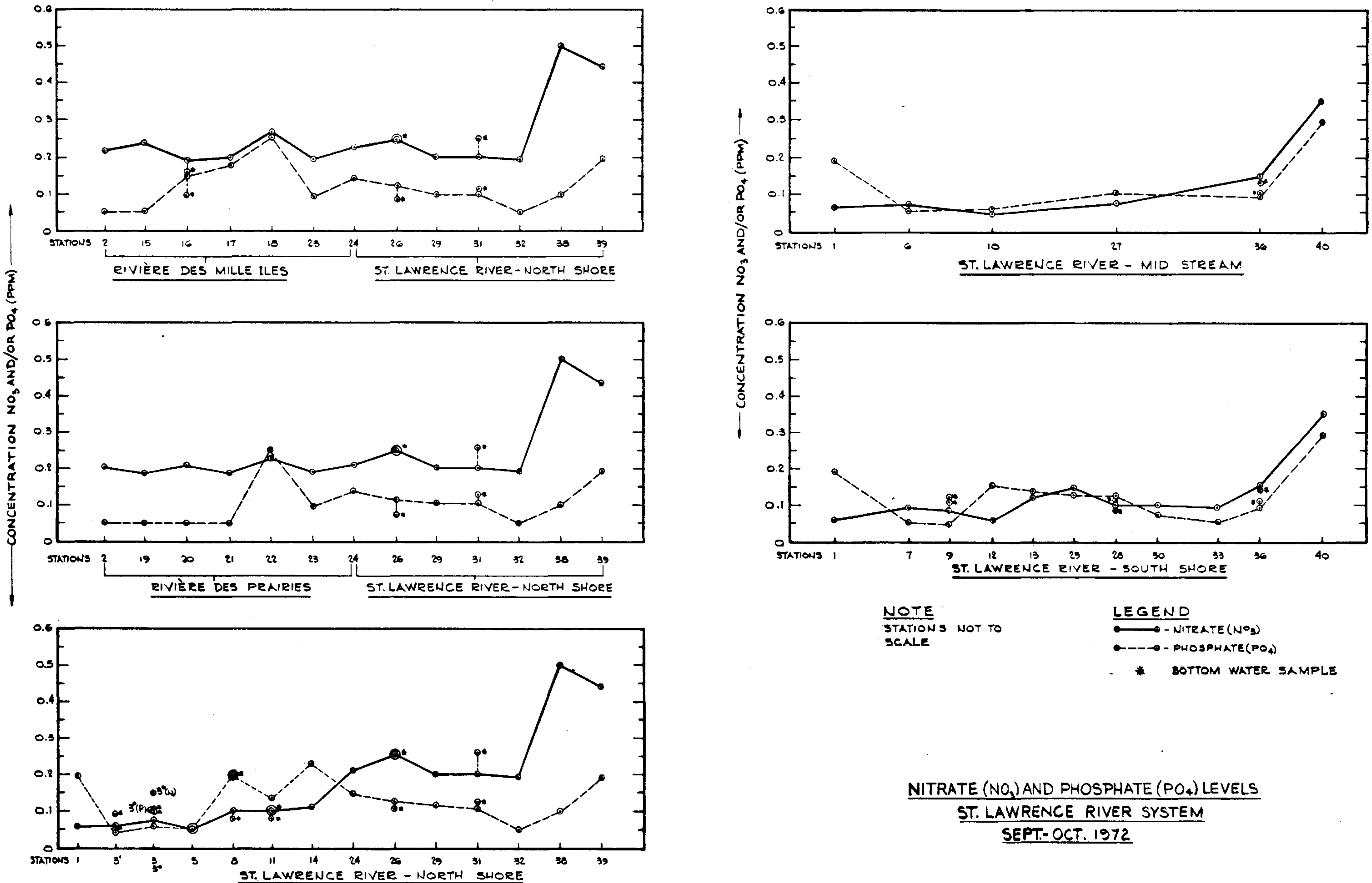

TOTAL DISSOLVED SOLIDS (PLUS ASH) LEVELS
ST. LAWRENCE RIVER SYSTEM
SEPT. - OCT. 1972

| ENVIRONMENT CANADA<br>OTTAWA — ONTARIO | BEAK | BY BG DATE: 29.5.73<br>DWG. NO. B1155-11 | FIG. 7 |
|---|---|---|---|



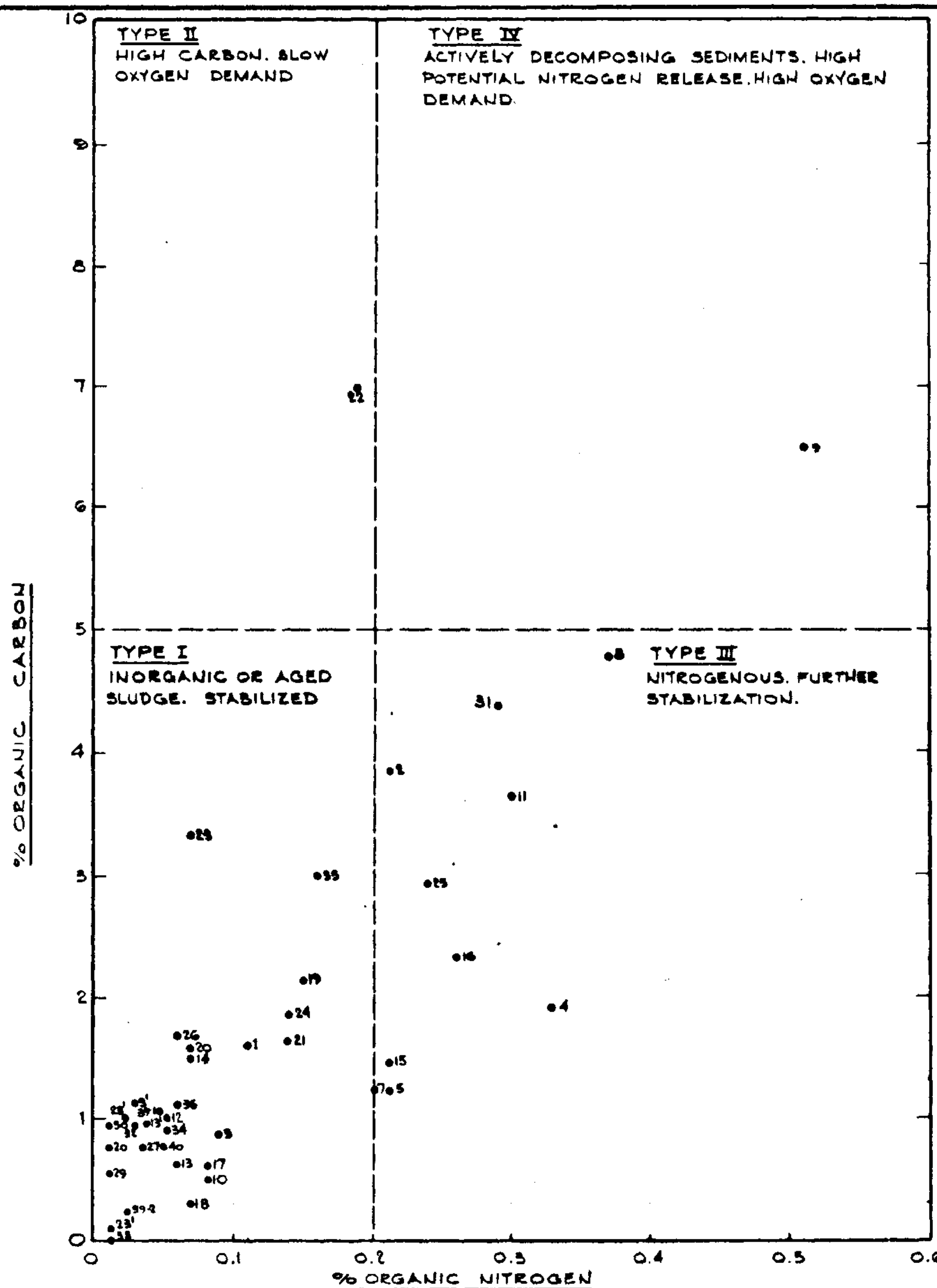

TOTAL SUSPENDED SOLIDS (PLUS ASH) LEVELS
ST. LAWRENCE RIVER SYSTEM
SEPT.-OCT. 1972

| ENVIRONMENT CANADA<br>OTTAWA — ONTARIO | BEAK | BY BG DATE: 29.5.73<br>DWG. NO. B1155-12 | FIG. 8 |
|---|---|---|---|




NITRATE ($NO_3$) AND PHOSPHATE ($PO_4$) LEVELS
ST. LAWRENCE RIVER SYSTEM
SEPT.-OCT. 1972

| ENVIRONMENT CANADA<br>OTTAWA — ONTARIO | BEAK | BY BG. DATE: 29.5.73<br>DWG. NO. B1155-13 | FIG. 9 |
|---|---|---|---|




BOTTOM SEDIMENT CHARACTERISTICS

| ENVIRONMENT CANADA<br>OTTAWA — ONTARIO | BEAK | BY B.G. DATE: 25.5.73<br>DWG. NO. A1155 - 14 | FIG. 10 |
|---|---|---|---|

# APPENDIX 1

# APPENDIX 1

## FIELD AND LABORATORY PROCEDURES

# FIELD AND LABORATORY PROCEDURES

## FIELD PROCEDURES

The present study of the St. Lawrence River drainage in the Montreal area was conducted from 25 September to 16 October, 1972. Field work was conducted by BEAK employees A. G. Appleby, Biologist, and C. Hade, Technologist. Water transportation was provided via the BEAK company boat, which was trailered and launched at convenient points in the waters surveyed. All field equipment was supplied by BEAK.

Sampling was conducted at 40 stations. The location of these stations and their correspondence to the stations used in other work being done on the river is presented in Table 1, and in Figure 1 on a map of the study area. The stations were chosen to give generally complete coverage of the Montreal urban area, and the St. Lawrence River both immediately upstream from Lac St-Louis and downstream from the outflow of Lake St. Peter. Sampling was also conducted in other areas of major interest: The Ottawa River (Lac des Deux-Montagnes); Riviere des Prairies; Riviere des Mille-Iles; Riviere Chateauguay; Riviere Richelieu, and Riviere St-Francois.

Samples were obtained of the following: benthos (bottom invertebrate animals); water; sediments; periphyton (attached algae); macrophytes (rooted aquatic plants). Collection methods are detailed in the following sections. Methods dealing with periphyton and macrophytes will be contained in Volume 2 of this report.

Benthos

Six samples of bottom material were obtained at each location by means of a Ponar grab. This clam-shell type sampling device procures a sample of 0.5 square foot of bottom material to a depth of penetration of 2 to 6 inches, depending on substrate type. Samples were placed in a sieve and screened through a No.30 mesh (0.5mm) wire cloth to remove silt and sand. The sample residue, consisting of animals and coarse debris retained by the sieve, was placed in a labelled carton and preserved in 5% buffered formalin solution for forwarding to the laboratory. Notes were made at each location of the bottom sediment type, the depth (checked by sounder or hand line), current and vegetation.

At several locations it was not possible to obtain grab samples of bottom material because of unsuitable substrate. At Station 5, a composite, qualitative sample was obtained by combining four core samples taken from between large rocks. At Station 6, no samples could be obtained by any means available. No samples were obtained at Station 37 because of three continuous days of rough weather.

Water

Water samples and associated physical/chemical measurements were taken at all sampling locations for surface waters. At stations where water depth exceeded 12 feet, bottom water samples were also obtained. Water samples were collected in a horizontal Van Dorn-style water sampler. Surface samples were taken from one foot under the surface, and bottom samples from approximately one foot over the bottom.

Secchi disc transparency was determined at each location using a 20 cm white disc. In situ measurements were made in the water sampler for: temperature; dissolved oxygen; pH; and conductivity. Temperature and dissolved oxygen were determined via an E.I.L. Model 15A Meter. The pH was determined with an E.I.L. Model 30C Meter equipped with a SCDN33C probe. Conductivity was determined using a portable conductivity meter developed by the Fisheries Research Board of Canada (Hoy, 1959), and a Y.S.I. 3400 cell.

Samples of water for laboratory analysis were placed in one-litre plastic bottles, iced in picnic coolers, and forwarded to the laboratory by Air Express or courier at the end of each day. Three litres were collected from each station and depth.

Surface samples were taken directly in 250 ml. glass bottles, cooled, and forwarded to the laboratory for coliform analysis.

Sediment

Samples of bottom material were obtained at each location using a Phleger-type core sampler. The cores were extruded and the top two inches placed in a plastic bag, labelled, and returned to the laboratory.

Other Samples

Samples were also obtained for periphyton and aquatic macrophytes. Collection methods will be detailed in Volume 2 of this report.

## LABORATORY PROCEDURES

### Benthos

All benthic macroinvertebrate animals were picked manually from the sieved sample residue, sorted into major taxonomic groups (biological classifications), and counted. The tabulated results of this analysis will be presented in Volume 2 of this report. In addition, the number of taxa (taxonomic groupings) and the density (per square foot) for each animal group was calculated and this data appears in Table 2.

Three samples from each of fifteen sampling stations were chosen for detailed biological analysis and identification to species. Results of this analysis will appear in Volume 2 .

### Water

Chilled water samples in one-litre plastic bottles were received in the laboratory within 24 hours of sampling. These samples were analyzed immediately for: $BOD_5$; total solids plus ash; suspended solids plus ash; ortho-phosphates; and nitrates. From the above analyses, levels of dissolved solids and dissolved solids ash, and volatile suspended, dissolved and total solids, were calculated. This data all appears in Table 3. All analyses were made according to "Standard Methods" of the American Public Health Association (A.P.H.A., 1971).

Surface samples in the sterilized bottles were analyzed for fecal coliform and fecal streptococcus bacteria. Analyses were made in accordance with Standard Methods (A.P.H.A.,1971, and Millipore Corp., 1972). Results of the bacteriological analyses plus the calculated fecal coliform: fecal streptococcus ratio are presented in Table 5.

Sediment

Core segments were homogenized and analyzed by standard methods for percent organic carbon and percent organic nitrogen. The organic sediment ratio (O.S.I.) was calculated as described in Ballinger and McKee, 1971. Tabulated results are presented in Table 4.

Other Samples

Methods of analysis used on other samples will be detailed in Volume 2.